SILVICULTURA

ANO VIII MAIO/JUNHO 1983 N.° 30

International Union of Forestry Research Organizations

IUFRO

SBS

SIMPÓSIO IUFRO EM MELHORAMENTO GENÉTICO E PRODUTIVIDADE DE ESPÉCIES FLORESTAIS DE RÁPIDO CRESCIMENTO

ANAIS

Para ser bom na cidade, bom no campo, bom em tudo, o melhor caminhão 6 toneladas só podia ter uma tecnologia: Volkswagen.

Os caminhões Volkswagen 6 toneladas incorporam as mais modernas técnicas de fabricação e os mais recentes desenvolvimentos tecnológicos desta década. Tudo neles foi projetado visando ao conforto, resistência, durabilidade e economia. Duas versões de motor, para atender à padronização de frotas. No modelo VW 6.80, motor Perkins 4.236 - Premium 4 cilindros, injeção direta, 85 cv (DIN) a 2.800 rpm, torque máximo de 25,6 m.kgf a 1.600 rpm, bomba injetora rotativa. Freios hidráulicos, auxiliados a vácuo, freio de estacionamento na transmissão. O modelo VW 6.90, equipado com o motor MWM D-229-4, 4 cilindros, injeção direta, 91 cv (DIN) a 3.000 rpm, torque máximo 26,5 m.kgf a 1.600 rpm, bomba injetora em linha.

Freios hidráulicos, auxiliados a ar comprimido, freios de estacionamento nas rodas traseiras, atuando através de molas acumuladoras (Spring Brake). Em ambos os modelos também o que há de mais avançado:

- Cabina basculante que reduz em 60% o tempo de manutenção e revisões periódicas.
- Conforto para o motorista, com banco de múltipla regulagem e apoio de cabeça.
- Painel de instrumentos moderno e eficiente que conjuga um tríplice sistema de alerta (sonoro, luzes de advertência e instrumentos de medição) para pressão do sistema de freio, temperatura da água e pressão do óleo do motor.
- Caixa de câmbio de 5 velocidades com engates sincronizados.
- Plataforma de carga de 4,45 m de comprimento.
- Distância entre eixos de 3.500 mm com raio de giro de 13,7 m.
- Capacidade de carga no eixo dianteiro de 2.400 kg e no traseiro de 4.420 kg.
- Peso bruto total de 6.300 kg.
- Capacidade de carga útil de 3.720 kg.
- Suspensão isenta de lubrificação apoiada em mancais flexíveis, amortecedores e barras estabilizadoras dianteira e traseira.
- Ajuste constante das sapatas de freio através de moderno sistema de microrregulagens automáticas.
- Tanque de combustível de 100 litros (opcional 150 litros).
- Filtro em banho de óleo com captador de ar acima do teto, equipado com separador de poeira e água (opcional).

CAMINHÕES

Procure o Concessionário Volkswagen Caminhões mais próximo. Aproveite as facilidades de financiamento, leasing ou consórcio.

Plante sua Árvore dentro da SBS.

Chegou o momento de juntar forças.

CAMPANHA DE AMPLIAÇÃO DO QUADRO SOCIAL

(pessoa física - pessoa jurídica)

Deixe-nos representar seus interesses e defender seus direitos.

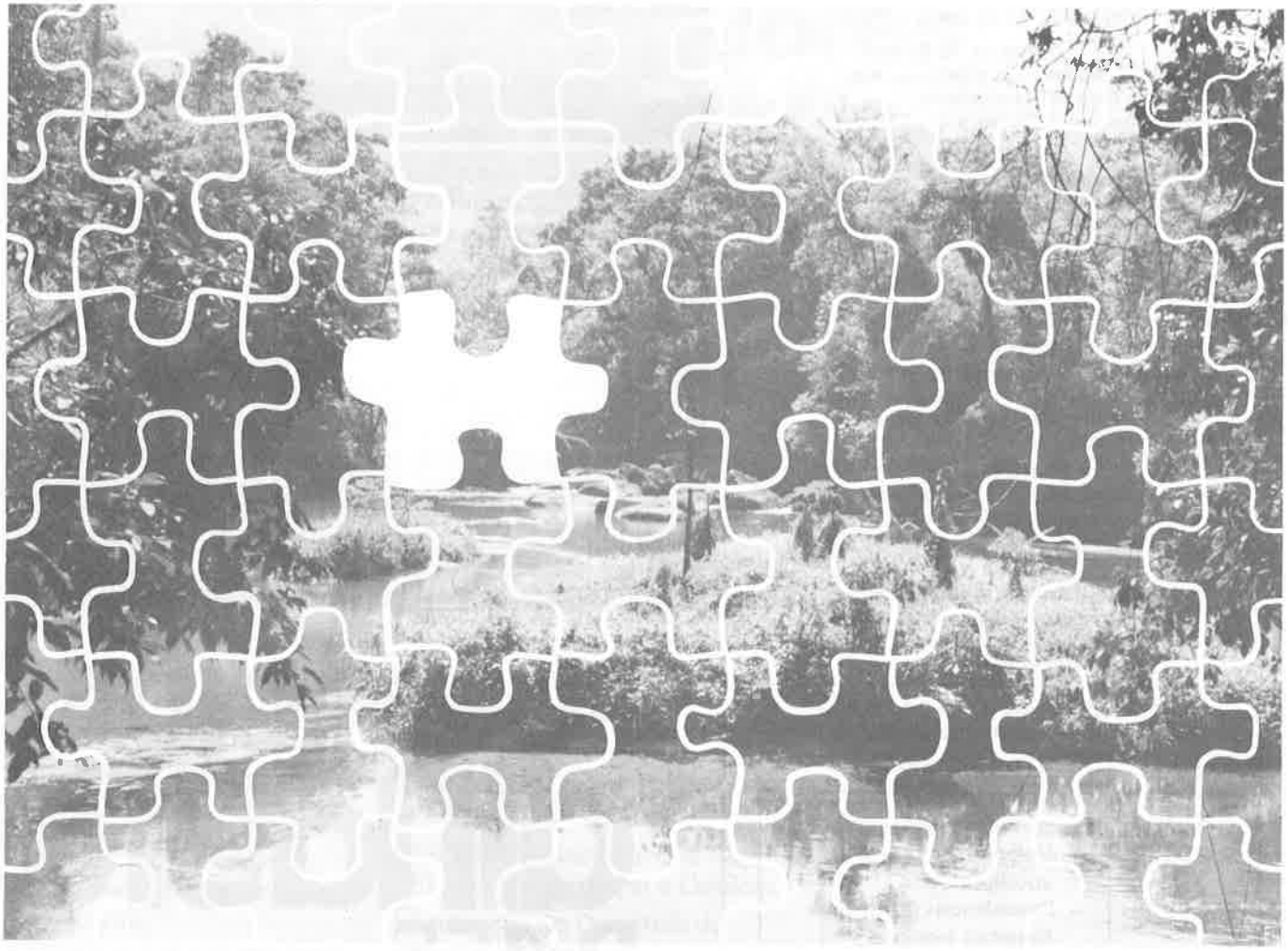
SBS

Sociedade Brasileira de Silvicultura

Av. Paulista, 2006 · 12º and. · conj. 1210/12 · Tels.: 289-2313 · 283-1850 · S. Paulo

FLORESTA

SOCIEDADE BRASILEIRA DE SILVICULTURA
BIBLIOTECA
Nº 01.11195
ex. 2



TEMOS A SOLUÇÃO

HÁ 14 ANOS CONTRIBUIMOS PARA O DESENVOLVIMENTO FLORESTAL DO PAÍS.

SUPRA DISTRIBUIDORA DE TITULOS E VALORES MOBILIÁRIOS LTDA.
CORRETORA DE CÂMBIO E VALORES MOBILIÁRIOS LTDA.

Rua da Consolação, 247 – 11º andar – São Paulo – SP – CEP 01301 – TELEX (011) 32106 – TEL. (011) 257-6744

SÃO PAULO – FORTALEZA – BELO HORIZONTE – RECIFE – NATAL

Organizers and Sponsors

Promoters:
SBS – SOCIEDADE BRASILEIRA DE SILVICULTURA (BRAZILIAN SILVICULTURE SOCIETY)
IUFRO – INTERNATIONAL UNION OF FORESTRY RESEARCH ORGANIZATIONS

Organization Committee:
Chairman:
Dr. Sérgio Carlos Lupattelli
Technical Director:
Dr. Mário Augusto Ferreira
Coordinator:
Dr. Mauro Antonio Moraes Victor

Australian Subcommittee:
Presidente:
R.N. Cromer
Members:
Alan Brown, Garth Nikles, Leon Pederick, Ken Eldridge e Hugh Waring.

SPONSHORSHIP

Ministério da Agricultura (Ministry of Agriculture)
Ministério da Indústria e Comércio – (Ministry of Industry and Trade)
Governo do Estado de São Paulo (São Paulo State Government)
IBDF – Instituto Brasileiro de Desenvolvimento Florestal – (Brazilian Institute for Forestry Development)
Embrapa – Empresa Brasileira de Pesquisas Agropecuárias – (Brazilian Agriculture and Livestock Research Company)
Finep – Financiadora de Estudos e Projetos – (Studies and Projects Finance Company)
CNPq – Conselho Nacional de Desenvolvimento Científico e Tecnológico – (National Council for Scientific and Technological Development)
Secretaria de Tecnologia Industrial – (Industrial Technology Secretariat)
Consider – Conselho Siderúrgico Nacional – (National Siderurgy (Metalworking) Council)
Fapesp – Fundação de Amparo à Pesquisa do Estado de São Paulo (São Paulo State Foundation for Support to Research)

CONTRIBUTIONS

Secretaria de Cultura do Estado de São Paulo – (São Paulo State Secretariat of Culture)
Secretaria da Agricultura do Estado de São Paulo – (São Paulo State Secretariat of Agriculture)
IPEF – Instituto de Pesquisas Florestais – (Institute for Forestry Research)
Instituto Florestal do Estado de São Paulo – (São Paulo State Forestry Institute)
Associação Nacional dos Fabricantes de Papel e Celulose (National Association of Paper and Cellulose Manufacturers)
Federação do Comércio do Estado de São Paulo – (São Paulo State Trade Federation)
FAO – Food and Agricultural Organization
Abecel – Associação Brasileira dos Exportadores de Celulose – (Brazilian Assocation of Cellulose Exporters)
Banco Itaú S.A.
Eucatex S.A. Indústria e Comércio
Olinkraft Celulose e Papel Ltda.
Klabin do Paraná
Agro-Florestal S.A.

PARTICIPATING ENTITIES INVOLVED

IPT – Instituto de Pesquisas Tecnológicas – (Technological Research Institute)
Assocaição Brasileira de Carvão Vegetal – (Brazilian Charcoal Association)
Associação Brasileira dos Reflorestadores – (Brazilian Association of Reforesters)
Associação Brasileira dos Produtores de Madeira – (Brazilian Association of Wood Producers)
Sindicato da Indústria de Serrarias, Carpintarias, Tanoarias, Madeiras Compensadas e Laminadas, Aglomerados e Chapas de Fibras de Madeira do Estado de São Paulo – (The Industrial Union Syndicate of Sawmills, Carpentry, Cooperage, Sheet-and Plywoods, Pulp and Plates of Wood Fibers of the State of São Paulo)
Associação Brasileira da Indústria de Compensados Especiais – (The Brazilian Association of the Industry of Special Plywoods)
Sociedade Brasileira de Agricultura – (The Nacional Agriculture Society) and
Abima – Associação Brasileira das Indústrias de Madeira Aglomerada – (Brazilian Particle Board Plywood Industrial Association)

índice contents

sessão II session II grupo A group A

—Exploração, conservação e melhoramento genético de *Gmelina* e *Tectona* — Estudo da situação atual do programa.
—Exploration, conservation and genetic improvement of *Gmelina* and *Tectona* — Study of the present situation of the program.
—Exploitation, conservation et amélioration génétique du *Gmelina* et *Tectona* — Etude de la situation actuelle du programme.
Chairman/Presidente — W. Barret
Rappourter/Relator — R.A. Woessner

sessão II session II grupo A' group A'

—Manejo e produtividade de florestas de pinheiros.
—Management and productivity of pine plantations.
—Conduite et productivité des forêts de pins.
Chairman/Presidente — S.A. Machado
Rappourter/Relator — F. Bertolani
Reviewer/Revisor — W.P. Lima

sessão III
session III
grupo A
group A

—Exploração, conservação e melhoramento genetético de *Araucaria* e *Agathis* — Estudo da situação presente do programa.
—Exploration, conservation and genetic improvement of *Araucaria* and *Agathis* — Study of the present situation of the program.
—Exploitation, conservation et amélioration génétique du *Araucaria* et *Agathis* — Etude de la situation actuelle du programme.

Chairman/Presidente — J.T.A. Gurgel
Rappourter/Relator — D.G. Nikles
Reviewer/Revisor — J.C. Delwaulle

sessão IV
session IV
grupo A
group A

—Progressos na seleção e melhoramento genético de outras espécies florestais tropicais.

—Progress in selection and genetic improvement of other tropical forest species.

—Progrès de la selection et l'amélioration génétique des autres espèces forestières tropicales.

Chairman/Presidente — B. Martin
Rapporter/Relator — P.J. Wood
Reviewer/Revisor — C.L.S. Pires

SBS

Sociedade Brasileira de Silvicultura

DIRETORIA

Presidente
Laerte Setubal Filho
Vice-Presidente
Sérgio Carlos Lupattelli
Secretário Geral
Roberto de Mello Alvarenga
Diretor Financeiro
Antônio Sebastião Rensi Coelho
Diretores
Nelson Luiz Ferreira Levy
Max Feffer
Pieter Willem Prange
Diretor Regional Norte
Israel H. Coslovsky
Diretor Regional Nordeste
José Maria Machado
Diretor Regional Centro
José Luiz Magalhaes Netto
Diretor Regional Sul
Athos de Santa Thereza Abilhoa
Diretores Setoriais
Leopoldo Garcia Brandão
Nelson Barboza Leite
Marco Aurélio A. Corrêa Machado
Amantino Ramos de Freitas
Luiz Ernesto George Barrichelo
Álvaro Fernando de Almeida
Evaristo Francisco de Moura Terezo
Isaias Vasconcelos de Andrade
Conselho Diretor
Antônio Paulo Mendes Galvão
Danilo Remor
Joésio Deoclésio Pierin Siqueira
Jorge Humberto Teixeira Boratto
José Carlos Carvalho
Luiz Gonzaga Murat Jr.
Manoel de Freitas
Mauricio Hasenclever Borges
Milton Wagner
Nodário R. Santos de Azevedo
Rubens Francisco Tocci
Walter Suiter Filho
Conselho Consultivo
Armando Martins Clemente
Clara Martins Pandolfo
H. Horácio Cherkassky
Jamil Nicolau Aun
José Benedicto Aranha
Maria Tereza Jorge Pádua
Moises Gonçalves Sabbá
Nelson Pizzani
Octávio Mello Alvarenga
Orlando Otto Kaesemodel
Roberto Maluf
Sérgio Roberto Vieira da Motta

Sede Central
Av.Paulista, 2006 – 12º.andar
cjs.1210/12
Fones: 283-1850 e 289-2313
CEP 01310 – São Paulo – SP

SILVICULTURA

Supervisão
Engº Florestal
Osvaldo Roberto Fernandes
Conselho Editorial
Laerte Setubal Filho
Sérgio Carlos Lupattelli
Roberto de Melo Alvarenga
Leopoldo Garcia Brandão
Nelson Barboza Leite
Marco Aurélio A.C.Machado
Amantino Ramos de Freitas
Luiz Ernesto G.Barrichelo
Álvaro Fernando de Almeida
Evaristo F. de Moura Terezo
Isaias Vasconcelos de Andrade
Clara Pandolfo
Pieter W. Prange
Osvaldo Roberto Fernandes

sessão II
session II
grupo A
group A

Gmelina arborea – OBSERVAÇÕES INICIAIS NOS TESTES DE PROCEDÊNCIA INTERNACIONAIS

L. C. Egenti
Forestry Research Institute of Nigeria, Ibadan
NIGERIA

Resumo

Observações iniciais nos testes de procedências internacionais da *Gmelina arborea* Roxb. na idade de 19 meses mostraram um crescimento vigoroso nos locais de bons "sites" florestais (Ikom) e "sites" de savanas (Mokwa). O melhor crescimento médio (10.22 m) e melhor circunferência média, ao D.A.P., (41.11 cm) foram registradas em Ikom para procedências 4035 (Costa do Marfim) e 4027 (India) respectivamente. As diferenças em vigor das procedências, dentro de locais, não foram significantes no nível de 5% mas as diferenças entre locais o foram ao nível de 1%.

A evidência das procedências foi geralmente boa em todos os locais.

Gmelina arborea – INITIAL OBSERVATIONS ON THE INTERNATIONAL PROVENANCE TRIAL

Summary

Initial observations on the Gmelina arborea Roxb. international provenance trial at the age of 19 months showed vigorous growth at the high forest site (Ikom) and guinea savanna site (Mokwa). The best mean height (10.22 m) and best mean girth (41.11 cm) were recorded at Ikom by provenances 4035 (Ivory Coast) and 4027 (India) respectively. Differences in vigour of provenances within sites were not significant at the 5% level, but differences between sites were significant at the 1% level. Survival of provenances was generally good in all the sites.

Introduction and background

Gmelina arborea Roxb. has been planted extensively in Nigeria and by 1962, commercial plantations existed. Nigerian plantations at Enugu have been providing mining timbers for the coal industry; and at Ilorin and Kaliba have also been supplying veneers for match splints and boxes.

Following the Federal Government plan to set up more paper mills in the country, numberous plantations of various sizes now exist to supply the needed pulp. All the seeds for the plantation establishment come from older plantations.

The opportunity to widen the genetic base of the Nigerian Gmelina arborea came in 1977 when Nigeria joined in the international provenance trials of the species. The aims and objectives of this trial have been very carefully set out in the Danish/FAO Forest Tree Seed centre Circular Letter No. 8 of 1977.

The present paper discusses the initial results of this trial in Nigeria.

Provenances represented

Provenances represented are shown in Table 1. They include those from different parts of India and Thailand; one from Malawi, one from Ivory Coast, and three from Nigeria.

Description of sites

Four sites were selected for this trial and these are Gambari, Ikom and Okwesan in the high forest area; and Mokwa in the savanna area. Table 2 shows the four sites including Latitude and Longitude, altitude, andual rainfall, soil type and forest type. Ikom has the highest rainfall while Mokwa has the lowest.

Table 1

Provenances represented

Provenances	Latitude Longitude	Altitude (m)	Annual rainfall (mm)	Type of Forest
4002 Muag Lek, Thailand	14°37' N 101° 07' E	250-300	1200	-
4003 Ngao, Thailand	18° 30' N 99° 45' E	310	1400	-
4004 Chinsapo, Malawi	14° 00' N 33° 43' E	1100	830	-
4005 Godamdabri - 3, W.B. India	26° 40' N 89° 20' E	50	4800	Moist deciduous
4007 Sitabai Valley Maharashtra, India	18° 22' N 73° 49' E	1000	750-1000	-
4008 Ghotil- 18 Maharashtra, India	17° 14' N 73° 57' E	900-1000	750-1000	Semi-moist deciduous
4009 Kudal Maharashtra, India	15° 54' N 73° 46' E	100	3000	Moist deciduous
4011 Bilaspur M.P. India	22° 23' N 82° E	-	1500	Semi-moist
4016 Kundrukutu Bihar, India	20° 30' N 85° 20' E	600	1400	Dry deciduous
4017 Nongpoh Meghalaya, India	25° 46' N 91° 46' E	525	2509	Moist deciduous
4020 South Dangs Gujarat, India	20° 44' N 73° 41' E	300-500	2000	-
4021 Dangs Unsp-1 Gujarat, India	20° 44' N 73° 41' E	300-500	2000	-

Table 1 contd.

Provenances	Latitude Longitude	Altitude (m)	Annual rainfall (mm)	Type of Forest
4023 Dima - 4 W.B. India	26° 45' N 89° 35' E	50	4800	-
4024 Thithimathi Karnataka, India	12° 42' N 76° 05' E	850	1375	Moist deciduous
4025 Herrur Karnataka, India	12° 27' N 75° 25' E	1000	1025	semi-moist deciduous
4027 Baramura-1965 Tripura, India	23° 46' N 91° 34' E	120	2200	Moist deciduous
4028 Shikaribari Tripura, India	24° 13' N 92° 07' E	100-200	2300	-
4030 Odah Assam, India	26° N 93° E	100	1824	Semi-evergreen
4032 Begur Range Kerala, India	11° 55' N 76° 05' E	700	4300	Moist-deciduous
4034 Longai R.F. Assam, India	24° N 92° 15' E	700	2500	Moist deciduous
4035 Ivory Coast	7° 48' N 5° 05' W	-	1673	Moist deciduous
N135 Nimbia, Kaduna State Nigeria	8° 30' E 9° 30' N	600	1750	Forest outlier in savanna
N136 Oniparaga, Ondo State Nigeria	6° 46' N	92	1524-2032	Moist semi-deciduous
N137 Kafanchan, Plateau State Nigeria	9° 36' N 8° 18' E	762	1651	Mixed Leguminous wooded savanna

Experimental design

Randomised complete block design was used at each location. There were 25 plants per plot at 3 m x 3 m with four replications per site.

Method of established

Seeds from the various provenances were sown in planting trays at the nursery in late 1977. Seedlings were later pricked into poly-pots and retained there until the 1978 planting season. The provenances were established in the field in May 1978.

Assessment and data collection

The provenances were assessed in December, 1979 at the age of 19 months. Data in respect of the height, girth and survival were collected.

Results

The ranking of provenances according to their performance at each location including percent survival (not ranked) is presented in Table 3. At Gambari site, provenances ranged in height from 3.06 m to 4.90 m and girth from 11.91 cm to 19.45cm with provenance 4016 having the best height and N137 the best girth. At Ikom, provenances ranged from 9.01 m to 10.22 m in height and from 24.88 cm to 41.11 cm in girth with provenance 4035 having the best height and provenance 4027 the best girth. Provenance 4008 had the best height and girth at Okwesan, and provenances ranged in height from 2.97 m to 5.67 m and in girth from 20.81 cm to 29.52 cm. At Mokwa provenances ranged in height from 4.69 m to 6.86 m and in girth from 16.11 cm to 26.35 cm with provenance 4003 having the best height and provenance 4016 the best girth.

Ikom site supports the best growth followed by Mokwa and Okwesan. India 4008 has not performed well in all the sites.

Ikom site has the best survival followed by Mokwa and Okwesan. Survival is generally good in all the sites.

Analyses of variance of these data collected showed that differences of provenances within sites were not significant at the 5% level. However, differences between sites were significant at the 1% level.

Table 2

Sites represented

Site	Latitude Longitude	Altitude (m)	Annual rainfall (mm)	Soil type	Forest type
Gambari	7° 12' N 3° 53' E	122	1260	Reddish loam to light clay	Moist semi-deciduous
Ikom	5° 59' N 8° 50' E	199	2540-3200	Red clay loam	Moist semi-deciduous
Mokwa	9° 18' N 5° 4' E	152	762-1066	Hydromorphic soils with organic matter	Mixed leguminous wooded savanna
Okwesan	6° 39' N 6° 23' E	167	1524-2032	Loose sandy sediments	Moist semi-deciduous

Table 3

Mean height, mean girth and percent survival at the age of 19 months of Gmelina arborea international provenance trial in Nigeria

GAMBARI SITE

Provenance	Mean height (m)	Survival (%) Prov.	Surv. %	Provenance	Mean girth (cm)
4016 India	4.90	4002	67	N137	19.45
N137 Nigeria	4.38	4016	74	4028	18.87
4028 India	4.26	4028	73	4035	18.63
N136 Nigeria	4.23	4017	82	4027	18.50
4030 India	4.21	4003	70	N136	18.50
4027 India	4.21	N137	74	4021	18.07
4035 Ivory Coast	4.18	4030	83	N135	17.17
4021 India	4.16	4007	84	4002	17.10
4002 Thailand	4.05	4021	87	4009	16.91
N135 Nigeria	4.05	4023	87	4017	16.81
4017 India	3.98	4008	70	4011	16.77
4007 India	3.90	4032	75	4007	16.75
4009 India	3.89	4035	73	4003	16.55
4025 India	3.85	4009	75	4025	16.55
4003 Thailand	3.83	4025	71	4030	16.16
4023 India	3.66	4027	86	4016	15.81
4011 India	3.57	4011	70	4023	15.10
4032 India	3.56	N135	83	4032	14.87
4008 India	3.06	N136	81	4008	11.91

IKOM SITE

Provenance	Mean height (m)	Survival Prov.	Surv. %	Provenance	Mean girth (cm)
4035 Ivory Coast	10.22	4035	90	4027	41.11
4016 India	10.11	4028	99	4035	35.07
N136 Nigeria	9.99	4002	99	4028	34.80
N137 Nigeria	9.92	4003	98	4002	33.83
4027 India	9.91	4021	100	4021	33.46
4009 India	9.91	4008	96	4023	33.17
4028 India	9.91	4016	92	4016	33.08
4030 India	9.88	4009	99	N137	32.92
4021 India	9.80	4027	94	N136	32.83
4007 India	9.78	4007	98	4030	32.50
4002 Thailand	9.65	4030	100	4007	32.15
4023 India	9.55	N136	89	N135	31.47
4008 India	9.48	4023	95	4008	31.12
N135 Nigeria	9.04	N135	97	4003	29.67
4003 Thailand	9.01	N137	97	4009	24.88

OKWESAN SITE

	Mean height (m)	Survival Prov.	Surv. %	Provenance	Mean girth (cm)
4009 India	5.67	4003	95	4009	29.52
4003 Thailand	5.66	4009	97	4007	28.70
4027 India	5.51	4007	96	4027	28.35
4035 Ivory Coast	5.50	N137	100	4035	27.82
4007 India	5.33	4002	85	4003	25.89
N137 Nigeria	5.13	4023	94	N136	25.25
4023 India	4.89	4008	77	N137	23.28
N135 Nigeria	4.60	4027	98	4023	22.25
N136 Nigeria	4.25	4035	97	N135	21.43
4008 India	3.31	N135	87	4008	21.15
4002 Thailand	2.97	N136	87	4002	20.81

MOKWA SITE

Provenance	Mean height (m)	Survival Prov.	Surv. %	Provenance	Mean girth (cm)
4003 Thailand	6.86	N135	91	4016	26.35
4028 India	6.77	4035	83	4002	25.56
W137 Nigeria	5.85	4021	97	4003	24.30
4035 Ivory Coast	5.70	4016	84	N137	23.27
4023 India	5.61	4009	79	4023	21.92
4007 India	5.56	4028	80	4035	21.64
4027 India	5.53	4027	94	4021	21.61
N136 Nigeria	5.49	4003	92	N136	21.25
4021 India	5.36	4007	89	4007	21.07
4032 India	5.19	N137	90	4030	20.42
4016 India	5.16	4023	90	4028	20.34
4030 India	5.15	4032	94.6	4032	19.90
4002 Thailand	5.11	N136	99	N135	19.31
N135 Nigeria	5.05	4002	96	4027	17.50
4008 India	4.72	4030	90	4008	16.62
4009 India	4.69	4008	96	4009	16.11

Tectona grandis — PROGRESSOS NA PRODUÇÃO DE SEMENTES MELHORADAS

L. C. Egenti
Forestry Research Institute of Nigeria, Ibadan
NIGERIA

Resumo

Em recentes anos, algumas tentativas tem sido feitas para expandir várias fontes de sementes melhoradas de Teca. Mais árvores plus são selecionadas de plantações antigas para produção de sementes e novas áreas de produção de sementes são estabelecidas. O número de pomares de produção de sementes está aumentando. Entretanto, mais esforços serão feitos para aumentar os suprimentos de sementes de fontes de sementes melhoradas. No momento, a quantidade é muito pequena enquanto a demanda dos serviços florestais do Estado estão aumentando a cada ano.

Tectona grandis — PROGRESS IN IMPROVED SEED PRODUCTION

Summary

Some attempts have been made in recent years to expand various sources of improved seeds for teak. More plus trees are selected from older plantations for seed supply and the new seed stands are established. The number of clonal seed orchards is increasing. However, more efforts will be made to further increase the sources of improved seed supply. At present, the quantity of improved seeds obtained is very little while demands from State forestry establishments are increasing every year.

Introduction

Large scale plantation establishment of Teak in Nigeria began in 1962. This upsurge in teak planting resulted in plans to supply improved seeds for plantation establishment. Older plantations were visited and plus trees (clonal stands) selected for immediate seed supply. Interest in the establishment of seed stands and clonal seed orchards began in the late sixties and is still continuing. The achievement so far made in improved seed supply is discussed in this paper.

Plus Trees (Clonal Stands), Multiplication Garden

Scouting for more plus trees is continuing while yearly collection of seeds from already selected plus trees is undertaken. The multiplication garden established about 10 years ago is now producing seeds. Records show that a total of 85 kg of dried cleaned seeds are collected annually from plus trees and the multiplication garden. In Table 1 is included the list of some plus trees, their ages and size of the area.

Seed Stands

At present, improved seeds are collected from the Gambari seed stand and the Olokemeji seed stand (see Table 1). Establishment of three other seed stands at Odoba in Benue State, Nimbia in Kaduna State, and Ikom in Cross River State is nearing completion. Annual seed yield of dried cleaned seeds from seed stands is 472 kg. This quantity will increase as soon as collection extends to the three new seed stands already mentioned.

Clonal Seed Orchards

The first clonal seed orchard was established in 1965 at Gambari near Ibadan. It has been the major source of improved seeds which are quickly distributed to the various State forestry establishments. Record of seed production from the orchard 3 hectares in size is as follows:-

1973	1043 kg.
1974	2590 kg.
1975	1705 kg.
1976	1145 kg.
1977	853 kg.
1978	1565 kg.
1979	1036 kg.

In 1976, a new 20 hectares clonal seed orchard was established at Umuahia, Imo State. It is hoped that when in full production, the orchard will increase the quantity of improved seeds. In addition, work is continuing at Okwesan clonal seed orchard (5ha.) in Bendel State; and at new Gambari clonal seed orchard (5 ha) in Oyo State.

International Provenance Trials

Great importance is attached to the current international provenance trials of teak in Nigeria as a source of improved seeds for the future. Variations already observed will aid in selecting plus trees for seed collection and for obtaining vegetative materials for grafting, and setting up clonal seed orchards.

Table 1.

List of seed Stands, clonal seed orchards and plus tree (clonal stands) as at March, 1980

Name	Size	Age
Gambari teak Stand compartment 12.	5.3 ha	65 years
Olokemoji seed stand	8.1 ha	70 "
Odoba seed stand	2.3 ha	21 "
Nimbia seed stand	4 ha	16 "
Ikom seed stand	3 ha	18 "
Gambari clonal seed orchard	3 ha	16 "
Umuahia clonal seed orchard	20 ha	4 "
Okwesan clonal seed orchard	5 ha	1 year
Gambari clonal seed orchard II	5 ha	1 "
Akilla Plus Trees (Clonal stands) Nos. 1, 2,3,4,5,6.	0.005 ha	40-43 years
Olokemeji Plus Trees (Clonal stands) Nos. 1,2,3,5,8,9,10, 11,12,13,14,15,16,17,18.	0.01 ha	40-43 "
Gambari Plus Trees (Clonal stands) Nos. 1,2,3,4,5,6,7, 8,9,10.	0.01 ha	46 years
Iva Valley, Enugu Plus Trees (Clonal stands) Nos. 1,2,3,4,5,6.	0.005 ha	35-40 "
Multiplication Garden of Teak Ibadan	0.01 ha	10 years.

FAST GROWING TREES

Gmelina arborea — PROGRESSOS NO MELHORAMENTO

L. C. Egenti — E.A. Oduwaiye
Forestry Research Institute of Nigeria, Ibadan
NIGERIA

Resumo

Este trabalho discute a situação atual do melhoramento de *Gmelina arborea* Roxb., que começou em 1957 na Nigéria e que cobriu a seleção de árvores superiores, propagação vegetativa, implantação de Áreas de Coleta de Sementes e Pomares de sementes, estudos do desenvolvimento das flores e dos frutos. Maior número de árvores plus foram selecionadas, 3 Áreas de Coleta de Sementes com áreas de 3 a 10 ha, e 3 pomares de sementes clonais com áreas de 1,2 a 5 ha foram implantados em várias localidades. Técnicas para enxertia de *Gmelina arborea* foram desenvolvidas e estudos do desenvolvimento de flores e frutos estão recebendo a devida atenção.

Gmelina arborea — PROGRESS IN BREEDING

Summary

The paper discusses the present status of tree improvement of Gmelina arborea Roxb., which began in 1957 in Nigeria and which covered plus tree selection, vegetative propagation, seed stands and seed orchard establishment, and flower and fruit development studies. More plus trees have been selected, three seed stands ranging from 3 to 10 ha, and three Clonal seed orchards ranging from 1.2 to 5 ha have been established at various locations. Techniques for scion grafting of Gmelina arborea have been developed and flower and fruit development studies are receiving attention.

Introduction

Gmelina arborea Roxb. was introduced to Enugu, Nigeria in 1924 from India (Streets, 1962). Since then various plantations have existed in many parts of Nigeria and more are being established every year.

The potentiality of Gmelina arborea as a fast growing plantation species for the lowland tropics has been discussed by various authors (Durant, 1964; Fox, 1967; Mensbruge, 1958; Lamb, 1968). In Nigeria, the first attempt at selecting superior phenotypes was made by Cooper in 1957 when 12 plus trees were selected in the Iva Valley Plantations at Enugu (Jones, pers. comm.). In the early sixties work was intensified

in the areas of vegetative propagation, seed orchard establishment and controlled pollination (Kei_ding, et al, 1964). These activities were carried out around Calabar, Enugu, Ukpom Bende and Ibadan all in Southern Nigeria. Omoyiola (1974) did some studies in variation in the early traits of Gmelina arborea Roxb. at the University of Aberdeen, under Prof. Matthews.

The works of these various research scientists no doubt have tremendous influence on the on - going research activities on the improvement of the species in Nigeria, and formed a good reference point. Plus tree selection, seed stands and seed orchard establishment, vegetative propagation, flower and fruit development studies, are still continuing. The present paper discusses the progress made in these areas.

References

(1) Durant, J.L. (1941) Gmelina arborea in Malaya. Mal. For. 10, (3) (89 - 92).

(2) Fox, J.E.D. (1967) The growth of Gmelina arborea Roxb. (Yemane) in Sierra Leone. Comm. For. Rev. 46 (2) : 138 - 144.

(3) Jones, N. (1980) Personal communication.

(4) Keiding, H., N. Jones and T. Webb (1964) A programme of tree breeding for Nigeria. Commonwealth Forestry Review 43 (4) 1964.

(5) Lamb, A.F.A. (1968) Fast growing timber trees of the Lowland Tropics. CFI Oxford.

(6) Langer, W., and K. Stern. (1955) Problems of experimental technique in the lay-out of clone orchards Z. Forestgenet. 4(3): 81-88.

(7) Mensbruge, G.de la (1958) Le Gmelina arborea introdent autour de Bouake - Proc. 2nd Inter. Afr. For. Conf. Pointe - Noire. Vol. II 460 - 463.

(8) Oduwaiye, E.A. (1977) Grafting of Gmelina arborea: Study on enviromental factors, scion sources and methods of grafting Nig. Jour. of Agric. Sci. In Press.

(9) Oduwaiye, E.A. (1978) Gmelina arborea: maximization of scion grafting. Proc. For. Assoc. of Nig. conference, Ilorin, Kwara State, Dec. 1978.

(10) Omoyiola, B.O. (1974). Variation in early traits and productivity of Gmelina arborea Roxb. under controlled environment. Ph.D. Thesis. Univ. of Aberdeen. (Unpublished.)

(11) Omoyiola, B.O. (1975) Gmelina tree Improvement project: Handing Over Note Unpubl.

(12) Okoro, O. O. (1976) Vegetative propagation of Gmelina arborea: Annual Report 1976/77 (FRIN).

(13) Streets, K (1962) Exotic Forest Trees in the British Commonwealth. Oxford University Press.

Tectona grandis — PROGRESSOS NOS TESTES DE PROCEDÊNCIA INTERNACIONAIS

L. C. Egenti
Forestry Research Institute of Nigeria, Ibadan
NIGERIA

Resumo

À idade de 6 anos e meio as variações entre procedências e entre locais, vigor e floração tornaram-se pronunciadas e a análise estatística mostrou-se significante ao nível de 1%. As procedências Asiáticas continuaram a desenvolvendo-se melhor que as da Nigéria e Ghana, indicando desta maneira a importância e utilidade deste teste para a Nigéria. O número de indivíduos em floração aumentou com a idade.

Tectona grandis — PROGRESS IN INTERNATIONAL PROVENANCE TRIALS

Summary

At the age of six and half the variations between provenances and between locations in vigour and flowering had become pronounced and analysis showed these variations to be significant at 1% level. The Asian provenances continued to perform better than the Nigerian and Ghana provenances used in the trial thus indicating the importance and usefulness of this trial to Nigeria. The number of flowering individuals increased with age.

Introduction

The first description of the trials established in Nigeria in 1973 and the results obtained at age three and half were presented at the Joint IUFRO Workshop, S2.02-08 and S2.03-01, Brisbane, Australia, in 1977 and they are now in the Proceedings of the Workshop (see "Progress And Problems of Genetic Improvement of Tropical Forest Trees," edited by D.G. Nikles, J. Burley and R.D. Barnes). For information on the background of trials, description of sites, experimental design and method of establishment see Nikles et al (1978).

Provenances Represented.

The provenances represented are presented in Table 1.

Maintenance of Trials and Assessment at Age Six and half

The trials established at Afaka and Nimbia (savanna sites), Bende, Gambari, Ikom, Ore and Sapoba (high forest sites) in 1973 were occasionally brushed and regularly protected from bush fires. Trials were assessed for the second time in December, 1979 at age six and half, and data in respect of height, girth, flowering characteristics of the various provenances were collected and analysed.

Results

Variations in height growth

The variations in height growth between provenances and between sites initially observed at age three and half, and reported at the 1977 Brisbane Workshop (Nikles et al, 1978) became more pronounced. Variations between provenances and between sites were found to be significant at 1% level including the Sapoba site where height was not significant at age three and half during the first assessment.

Variations in girth growth

Like the height, variations in girth between provenances and between sites were significant at 1% level.

Flowering behaviour and Survival of provenances

The flowering behaviour and survival of the various provenances at each location at age six and half are presented in Table 2. The flowering rates of between 0% to 24% were recorded for the Asian provenances while West African provenances (S119 and 3044) had between 20.5% to 37.1%. This shows that the number of flowering individuals in each provenance at every location is increasing with increase in age. Two factors appear to have influenced the flowering rates. The first is location (compare 3040 at Nimbia with 3040 at Afaka). The second is the seed source (compare Asian and West African provenances, and also note the variations between Asian provenances).

Analysis of survival figures showed that locations had insignificant effect. None of the provenances suffered death of individual trees during this period.

Performance of provenances at each location

Table 3 shows the ranking of provenances at each location in respect of height and girth. The performance of the Nigerian provenance, S119 in all the locations indicates the importance and usefulness of this trial in Nigeria.

References

Nikles, D. G., J. Burley and R.D. Barnes (1978). Progress And Problems of Genetic Improvement of Tropical Forest Trees. Dept. of For. C.F.I. Oxford.

Table 1

Provenances represented in the trials

Lot No.	Provenance	Latitude Longitude	Elevation (m)	Annual rainfall (mm)	Type of forest
3016	Mysore, Indian	11° 55' N 76° 0 E	823	1270	Semi-moist
3018	Mount stuart, India	10° 30 N 76° 47' E	640	2031	moist
3021	Nilambur, India	11° 21 N 76° 21 E	49	2565	very moist
3022	Bairluty, India	15° 51 N 78° 45 E	305	1016	dry
3026	Marripakala, India	17° 45 N 82° 15 E	407	1524	semi-moist
3033	Berbera, Mysore India	19° 52N 85 05 E	100	1200-1500	dry
3038	Ban Cham Pui Thailand	18° 29 N 99° 49 E	520	1000-2000	dry
3039	Ban Maekut Luang, Thailand	16° 49 N 98° 36 E	220	1644	dry
3040	Ban Pha Lai, Thailand	18° 13 N 99° 59 E	200	1100	dry
3042	Ban Huey Luang, Thailand	18° 14 N 97° 56 E	220	1282	dry
3043	Ban Doi Thon, Thailand	19° 03 N 99° 59 E	562	200	dry
3044	Jema, Ghana	7° 50 N 1° 50 W	267	-	dry
3047	Bangsri, Indonesia	6° 30 S 100 48 E	75-100	-	dry
3048	Nanas, Indonesia	6° 57 S 111° 30 E	250-280	1700	dry
3049	Ngliron, Indonesia	7° 12 S 111° 22 E	150	1200	"
3050	Temandsang, Indonesia	7° 12 S 111° 22 E	104	1200	"
3051	Beran, Indonesia	7° 35 S 112° 45 E	60	1830	"
3056	Savanna Khet II, Laos	16° 33 N 104° 45 E	100	-	"
S119	Gambari, Nigeria	7° 12 N 3° 53 E	122	1260	Moist semi deciduous

Table 2.

Flowering and Survival (in percentages) of all provenances at each location at Age Six and half years.

Afaka			Bende			Gambari			Nimbia			Ore			Sapoba		
Prov.	Surv. %	Flow. %	Prov.	Surv. %	Flow. %	Prov.	Surv. %	Flow. %	Prov.	Surv. %	Flow. %	Prov.	Surv. %	Flow. %	Prov.	Surv. %	Flow. %
3044	80	34.6	3033	64.7	2.4	3021	88.8	15.9	3022	100	0	3021	91.7	20	3049	84	15
3040	90	21.8	3049	85.2	5.6	3049	81.25	12	3039	89.5	8	3033	88.2	15	3021	88	5
3043	100	12				3016	75.5	10	3044	84.7	30						
						S119	86.78	28.4	3050	91.4	10	3049	95.8	15	3033	82	20
3039	97.23	8	3039	85.4	16.8	3048	73.13	8	3049	95	4	S119	91.7	35	S119	84	25.2
3022	100		S119	72.2	36.8				3042	91.7	6						
3050	91.68	24	3021	71.5	15.3	3039	80.5	17	3051	84.2							
S119	97.23	37.1				3018	85.4	21.2	3047	95	2						
3047	97.23	5				3033	95.3	20.8	3038	86.7	2						
3048	96.3	11				3026	84.7	22.1	3043	83.3	2						
3042		5				3043	74	15	S119	92	20.5						
						3047	80.45		3048	86	0						
						3042	93.5		3040	92	0						
									3056	59	0						

Table 3.

Ranking of all provenances according to their performances at each location

A F A K A

Provenance	Mean Height (m)	Provenance	Mean Girth (cm)
3042	5.70	3042	34.60
3050	4.95	3044	29.45
3043	4.83	3040	29.37
3040	4.55	3044	28.56
3048	4.42	3050	28.00
3044	4.21	3048	27.92
S.119	4.19	3039	26.17
3022	3.90	3047	24.57
3047	3.60	3022	23.56

B E N D E

3021	21.0	3033	51.23
S.119	20.44	3021	49.98
3033	20.20	S.119	47.77
3039	19.45	3033	46.31
3021	19.01	3039	46.09
3033	18.91	3049	46.06
3033	18.25	3021	44.21
3049	16.72	3033	40.72

G A M B A R I

3021	10.93	3047	59.00
3016	10.82	3049	58.91
3033	10.75	S.119	58.54
3042	10.70	3018	57.44
S.119	10.68	3039	55.48
3048	10.57	3048	55.25
3049	10.55	3043	55.01
3018	10.38	3026	53.69
3039	10.24	3021	52.92
3047	10.24	3016	52.86
3026	10.14	3042	51.76
3043	9.65	3033	50.47

Table 3. contd.

N I M B I A

Provenance	Mean Height (m)	Provenance	Mean Girth (cm)
3049	7.37	3049	39.40
3051	7.13	3042	35.96
3022	7.12	3039	34.87
3050	6.99	3043	34.76
3042	6.89	3038	34.60
3043	6.81	3056	34.59
3048	6.68	3044	34.44
3040	6.64	3051	34.30
3038	6.64	S.119	33.22
S.119	6.61	3050	33.10
3044	6.60	3022	32.25
3056	6.56	3040	31.80
3047	6.53	3048	31.37
3039	6.48	3047	30.34

O R E

3033	21.49	3033	60.09
3021	21.17	3049	59.95
3049	20.96	S.119	58.89
S.119	20.19	3021	57.91

S A P O B A

3033	17.64	3021	47.67
3049	16.58	3033	46.41
3021	16.32	3049	44.98
S.119	14.58	S.119	40.67

FAST GROWING TREES

Tectona grandis — DESENVOLVIMENTO DE RAÇAS NATIVAS E SUA ORIGEM NA NIGERIA

L. C. Egenti
Forestry Research Institute of Nigeria, Ibadan
NIGERIA

Resumo

As diferentes populações de teca na Nigéria são derivadas da introdução original feita em 1889. Como resultado das primeiras introduções em regiões de florestas tropicais e de savannas, duas importantes "raças locais" foram formadas, como demonstram o comportamento fenológico e os padrões gerais de crescimento das populações de teca nas duas regiões. Acrescente-se ainda "sub-raças" locais também formadas como resultado da distribuição de sementes e do programa anual de plantio do Estado. As sementes utilizadas normalmente são colhidas de plantações próximas. Portanto daí em diante variações fenológicas e no padrão do crescimento passaram a existir em populações de teca nas áreas das florestas tropicais e savanas.

Tectona grandis — DEVELOPMENT OF LAND RACES AND THEIR ORIGIN IN NIGERIA

Summary

The different teak populations in Nigeria came from the original introduction of 1889. As a result of early introductions to the high forest and savanna areas of the country, two major landraces have developed as exemplified by the phenological behaviour and general growth patterns of teak populations in both areas. In addition, sub-landraces have developed as a result of seed distribution and annual planting programme of various State forestry establishments. The seeds used usually come from near-by plantations. Hence variations in phenological response and growth patterns exist among teak populations in the high forest and in savanna areas.

INTRODUCTION

Teak was first introduced into Nigeria in 1889 (Unwin, 1920). There is no record of its origin. In 1902, some teak of India origin was planted in the Botanical Gardens at Olokemeji and Thompson (1910) reported these to be doing well. A two hectare plantation of teak from Burma and central India was established at Gambari near Ibadan in 1907, and the Burma teak showed better growth than that from India. Between 1910 and 1930, teak establishment had extended to Ikom in Cross River State; Idah, Ilorin in Kwara State; Zaria in Kaduna State; Akilla, Olokemeji in Ogun State; and Enugu in Anambra State. Extensive planting of teak particularly in southern Nigeria started from 1962.

DEVELOPMENT OF LAND RACES.

1. Teak Planting Programmes

There is no doubt that the various teak populations in Nigeria came from the original introduction. Table 1 shows teak planting programme of the various State Forestry Establishments in Nigeria as at November 1978 including the seed source for teak. Sources of seed are usually from near-by plantations whose seeds originally came from the early introductions. The question now is, have land races emerged in Nigeria since the original introduction.

2. Phenological Studies

Comparative phenological studies of teak in the high forest areas and in savanna were carried out in 1978 and in 1979 at Afaka, Lafiagi and Nimbia (savanna areas); Gambari, Bende, Ikom, Ore and Sapoba (high forest areas). Only summary of results is presented here.

(a) Leaf fall: In the high forest, initial leaf fall was observed in September and this continued into December; and from January to March which was the peak period. In the savanna, leaf fall which began in November was so severe in intensity from December, January to March that by April, all trees were leafless. The length of the leafless period was the major factor differentiating savanna areas from high forest areas in leaf fall periodicity.

(b) Leaf flushing: This occurred from January to March in the high forest, and from March to May in the savanna. In the high forest, leaf fall was followed immediately by leaf flushing with about four to seven days difference. The growth of leaves was faster and peak of flushing was in February. Complete leaf development occurred in April and May. In the savanna, leaf fall was followed by a long break of 30 to 45 days of leafless period before the commencement of leaf flushing. Leaf development following flushing was not as fast as in the high forest. Complete leaf development was in July and August.

(c) Flowering: Flowering started at the high forest sites in March and in wetter areas in February. At the savanna sites, flowering began in June. The period of flowering was usually longer at the high forest sites than at the savanna sites. In addition, the number of trees in profuse flowering was greater at the high forest sites than at the savanna sites. The peaks of flowering were in June and July at the high forest whereas at the savanna, it was August and September. Unlike the high forest, the cessation of flowering at the savanna was usually abrupt in October. In general, poor flowering occurred more in the savanna than in the high forest.

(d) Fruiting: Fruiting was also different in the two areas. At the savanna sites fruiting started in July and matured green fruits were observed in November of every year. Faster fruit development (less than five months duration) was recorded at the savanna sites. At the high forest sites, fruiting began in April and in wetter areas in late March, Green mature fruits were observed at the high forest sites in October.

Both sites had two peaks of fruiting: August and September at the savanna, and July and August at the high forest. The quantity of fruits per tree was higher at the high forest than at the savanna. In addition there were more individual trees with profuse fruiting at the high forest than at the savanna. In both sites dry fruits could be picked from December.

3. Procurement of Seeds

The various State forestry establishments obtain their seeds from near-by plantations (see Table 1) for their annual planting. Although improved seeds are distributed to the States, it is of recent and very meagre to meet large scale afforestation programmes.

4. Land races

The author is of the opinion that major landraces and sublandraces of teak have emerged in Nigeria over the years despite the fact that the original introduction was from one source.

The major landraces are teak populations growing in savanna areas and those growing in high forest areas. These landraces have adapted to the sites over the years.

The sub-landraces are those that have developed as a result of seed distribution and planting programmes. As already mentioned, most of the seeds used by the States for their planting programmes come from near-by plantations. The existence of sub-landraces is confirmed by the variations observed in phenological characters and growth patterns in various teak populations both in the savanna and in the high forest areas. It is also confirmed by the results obtained from local provenance trials where seed source was one of the factors influencing early growth patterns.

TABLE 1

TEAK PLANTING PROGRAMME OF THE VARIOUS STATE FORESTRY ESTABLISHMENTS AS AT NOVEMBER 1978

Names of States	Proposed Area to be planted	Location of Teak Area	Seed Source for Teak
Anambra	75 ha	Mamu River forest Reserve. Osumari forest Reserve. Achalla Forest Reserve	Enugu Teak Plantation
Bendel	950 ha	Ologbo For. Res. Owan For. Res. Uronigbe For. Res. Ohosu forest Res. Orle Forest Reserve South Ibie For. Res. Igarra Forest Res.	Older Plantations and Farms of Listed Reserves
Benue	120 ha	Acharane Forest Res. Okpobi Forest Res. Odoba Forest Reserve Kuramen Akanga Forest Reserve	Ihugh Forest Res. Shange - Tiv For. Reserve
Cross River	900 ha	Cross River North forest Reserve (Ikom). Agoi Forest Reserve (Obubra)	Ikom Plantations
Imo	80 ha	Ukpom Bende Forest Reserve	Older Plantations Ukpom Bende. Enugu Plantations
Kaduna	450 ha	Jema's Federation Local Authority. No. 9 Nimbia Forest Reserve	Nimbia Trinidad Teak plot at Nimbia. Idah No. 1 Town Teak plantation.
Kwara	200 ha	Olle Forest Res. Ajofu Forest Res. Ibaji-Ojoko For. Res. Alagbede For. Reserve.	Ida Town plantations. Olle For. Res. Plantations.

Table 1 contd.

Names of States	Proposed Area to be planted	Location of Teak Area	Seed Source for Teak
Lagos	12 ha	Ikorodu	Olokemeji forest Reserve
Ogun	1,000 ha	Akilla Forest Res. Omo Forest Reserve Olokemeji Forest Reserve	Ejigbo Plantations. Akilla plantations. Olokemeji Forest Reserve.
Ondo	80 ha	Idanre Forest Res. Owo Forest Res. Ifon Forest Reserve	Omo Forest Reserve
Oyo	750	Gambari Forest Reserve	Gambari plantations

References

Thompson, H.N. (1910). Annual report for the southern provenances of Nigeria, 1909.

Unwin, A. H. (1920). West African forests and Forestry, London.

PROGRESSOS NA PRODUÇÃO DE SEMENTE MELHORADA DE TECA NA ÍNDIA

I. F. S. Madan Gopal — P. G. Pattanath
Hyderabad
ÍNDIA

Resumo

Este trabalho discute as várias tentativas efetuadas, no passado, para a produção de semente melhorada de teca na Índia e dá detalhes da atual abordagem do problema. Enquanto que as tentativas passadas permaneceram ao nível de ítens da pesquisa de alguns aspectos do melhoramento, a presente abordagem tem sido dirigida ao desenvolvimento de um programa de produção de sementes melhoradas em escala massal. Nesta diretriz o Projeto Indo-Dinamarques está concentrando esforços para uniformizar os métodos a serem aplicados dentro do país pela: (1) Organização de grupos de trabalho para o melhoramento da espécie envolvendo membros do Departamento Florestal Estadual e do Projeto, (2) adoção de zoneamento para sementes, (3) desencadear a certificação de sementes e testes de procedências a nível nacional. Espera-se que esta abordagem promova um progresso crescente ano a ano e torne a produção de sementes melhoradas de teca, bem como de outras espécies, uma rotina na Silvicultura Indiana. São incluídas tabelas mostrando: (1) taxas de plantio, necessidades de sementes e posição do suprimento e da demanda de sementes de teca em diferentes estados da Índia, (2) progressos na seleção de árvores plus anteriores a 1977 e após. Progressos no estabelecimento de pomares de sementes de teca em diferentes estados, bem como as medidas intermediárias de conversão de Áreas de Coleta de Sementes em Áreas de Produção de Sementes também são discutidas.

PROGRESS OF IMPROVED SEED PRODUCTION OF TEAK IN INDIA

Summary

The paper discusses the various attempts made in the past for improved seed production of teak in India and gives details of the present approach to the problem. Whereas the past efforts remained at the level of items of research on some of the aspects of tree improvement, the present approach has been to develop a programme on improved seed production on a mass scale. In this connection the Indo-Danish Project is striving to bring about uniformity into methods being followed within the country by (1) organizing working group for improvement of species with members from State Forest Department and Project, (2) adoption of seed zonation, (3) launching of seed certification and a national level provenance trials. This approach is expected to bring about an increasing progress from year to year, and to make the production of improved seed of teak as well as other species a routine in Indian Forestry. Tables are included showing (1) plantation targets, seed requirements and demand-supply position of teak seeds in different states of India, (2) Progress of selection of plus trees prior to 1977 and after. Progress in the raising of seed orchards of teak in different states, as well as the interrim measure of conversion of seed stands into Seed Production areas have also been discussed.

INTRODUCTION

Teak has a wide but discontinuous distribution in India. In general it occurs predominantly and frequently in tropical moist deciduous and tropical dry deciduous forests. These two main types have been further divided into five sub-groups by Champion & Seth (1968). These sub-groups are (i) very moist, (ii) moist, (iii) slightly moist, (iv) dry and (v) very dry teak forests. This grouping is based on average annual rainfall, soil types, percentage of teak, associated species, type of under storey etc. In addition to these five types, teak has also been raised as plantations in tropical semi-ever green forests, tropical wet evergreen forests and sal forests. It is now being raised as plantations in seventeen states/union territories of India.

In each state a number of forest types occur, and both moist as well as dry type of teak forests may be found alongwith the other types, as in Gujarat, Madhya Pradesh, Bihar, Karnataka, Maharashtra etc. An interesting overlap of northern moist sal and southern dry teak (approaching moist teak) is met within north Raipur division of Madhya Pradesh especially in Gindola area. This discontinuity in the distribution of teak types has led to its tendency to break up into local forms which though not so different as to lend their recognition as of specific rank, are still distinguishable one from the other.

SOME RECORDED VARIATION OF TEAK IN INDIA

Variations have been recorded in the time of flowering and seed collection, number of fruits per unit weight, morphological variations of tree form, and texture of leaves, resistance to diseases, rate of growth, and timber quality.

Though March/April is the seed collection time in most places in India, there are some localities where seeds are collected in January/February eg. Mallatur range of Trichur division, and Begur range of Wynad division in Kerala. Fruit weight also exhibits considerable variations in different localities. In general, fruit weight in moister areas vary from

1100 to 2250 fruits/Kg., while ones from dry areas vary from 2000 to 3700 fruits per Kg.

Morphological variations in the form of a distinct variety known as Teli variety is found for example in Virnoli range in South Kanara division of Karnataka. Similarly in north Khandwa Forest division of Madhya Pradesh particularly in East Kalibhit range, Telia veriety of teak occurs over an area of about 65 sq. kms. There are also rich pockets of this variety in Damoh, Sagar, Durg and Bastar divisions.

In Seoni, Kanker and parts of Bastar in Madhya Pradesh, teak timber fetches a much higher price because of its golden yellow colour and blending of heartwood and sapwood. In the same state, in Khariar division adjacent to Raipur, teak timber is known to have good decorative grains. Teak wood of Godavari forest of Andhra Pradesh is also known to be figured and ornamental and priced for furniture and cabinet making.

In Western portion of Madhya Pradesh and particularly in Betul and parts of Hoshangabad, heartwood in teak is highly friable, and it is said to be difficult to obtain trees of good grain of sizes larger than 50 cm. in diameter.

Teak of Balugaon range of Puri division is noted for its fast growth and high germination percent.

IMPROVEMENT METHODS

In order to isolate inherent tendencies from those produced by environmental influences, progeny and provenance trials have to be carried out.

Provenance trials:

In India, provenance trials of teak have been attempted from very early times. But these attempts lacked continuity and coordination. In 1930 the Central Silviculturist at F.R.I. organized an All India Teak Seed Origin Co-operative experiment. A total of eleven seed origins were tried out at thirteen different sites. The experiment appears to have been planned in an elaborate manner as short term and long term experiments. The long term experiments laid out resulted in the formation of seven sets of sample plots viz. two in Tamilnadu, two in Uttar Pradesh, two in Madhya Pradesh and one in East Bengal, now Pakistan. (Mathauda 1951).

Progress of the trials is available in reports and literature for some of the sites such as Nilambur, South Coimbatore, Bilaspur, Haldwani and Gorakhpur. But there does not seem to be any coordination in the reporting of results from different sites. As a result comparison cannot be made for the performance of any given origin at different sites. However, as a number of seed origins are common at a number of sites, it is possible to conclude that (i) seed origins vary in their performance at different sites and (ii) some seed origins are more sensitive to provenance site interaction than others. For example in the results presented by Mathauda 1951 the performance of North Burma origin was very inferior at Nilambur and Bilaspur, but was quite good at Gorakhpur and Haldwani. On the other hand, Nilambur seed origin appeared to be uniformly good at Nilambur, Bilaspur, Gorakhpur and Haldwani.

The Teak study tour and symposium held in 1958 recommended that these indications from the All India Teak Seed Provenance Experiments should be kept in view when raising teak plantations outside its natural distribution.

In 1961 a National level tree improvement programme for India was put up by Prof. Matheus which included the improvement of teak as well as other species. The Forest Geneticist at F.R.I. was given the responsibility of implementing the programme. He concentrated mostly on development of technique for selection of plus trees and seed production areas, vegetative propagation and controlled pollination. The main ommission during that period was the failure of the Geneticist to organize provenance trials of teak to determine the best sources of seed available in India and to introduce a seed certification scheme for the country. This resulted in the fact, that in spite of a national tree improvement programme, the forest departments and plantation corporations were still using seeds from unregistered sources.

In 1972 the Danish/FAO Tree Seed Centre initiated an international provenance trials of teak. In this trial, India was a participant with the Silviculture Branch of the F.R.I. as the Coordinating Centre for 4 sites distributed in different states of India. Andhra Pradesh in India also participated independently as the coordinating Centre for four sites in Andhra Pradesh. F.R.I. received seeds from 31 provenances and Andhra Pradesh from 34 provenances. In the trials to be coordinated by F.R.I., data are being collected by some of the sites independently but a consolidated report of the upto date position of the 4 sites are not available at the F.R.I. Similarly no consolidated report about the sites under Andhra Pradesh is available in literature. As such information from these trials have not yet yielded results ready to be used in practice.

In 1977 the Indo-Danish Project on Seed Procurement and Tree Improvement started functioning and was responsible for the coordination of tree improvement actigities throughout the country. One of the first steps taken by the project to hasten the progress of tree improvement within the country was to prepare seed zone maps of individual states within the country, and to gather and document information on species distribution within each seed zone.

Country's forests have been tentatively divided into 137 seed zones as per following criteria:

(i) Except for hilly areas each seed zone has more or less same forest type.

(ii) Extent of a seed zone is limited to an administrative circle or a part thereof - this makes it somewhat compact.

(iii) It was ensured that bounderies of each seed zone were easily identifiable on the ground even it it entailed some compromise on criteria 1 & 2 and

(iv) In case of hilly zones, each zone is to be divided into sub-zone on the basis of 600 m. altitudinal intervals.

Information about occurrance of various tree species in individual zones is being compiled. We intend to use these seed zones as a basis for seed certification and also to plan our provenance trials. Out of the 137 seed zones teak occurs in about 50.

Based on information gathered from the States on plantation targets and seed requirements, a list of species priority was drawn up. As teak ranked high on this list, the Project initiated provenance trials to study all available variations in the entire distribution range of teak in India.

Seventeen States were ready to participate in the trials. The Project therefore prepared guidelines for seed collection and circulated it to the participants to ensure uniformity of methods of collection, and maintenance of records. 30 samples of seed were collected for national level trials from 28 seed zones of 8 States in 1979. The seeds were then distributed by the Project to 41 sites of seventeen states for the first stage of the trials in 1980 alongwith guidelines.

Provenance trials were planned so as to dovetail two phases of the trial (viz. elimination phase and testing phase) to run simultaneously. Thus national level trials to be coordinated by the Project was meant to understand the types of variation

Table-1

DETAILS OF DEMAND & SUPPLY POSITION OF TEAK SEED IN DIFFERENT STATES IN INDIA

S.No.	State	Plantation target in hectares	Seed requirement in Kg.	Sowing density in practice Kg/ha.	Quantity that can be collected locally in Kg.	Quantity required from outside source in Kg.	Preference of source
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	Andamans	200	2500	12.5	300	2200	Kerala and Assam
2.	Andhra Pradesh	4000	120000	30	120000	Nil	Not applicable
3.	Arunachal Pradesh	1000	20000	20	NIL	20000	Kerala
4.	Assam	1090	8720	7	-	-	-
5.	Bihar	2000	40000	-	As required	Nil	Not applicable
6.	Gujarat	8000	345000	43	200000	145000	Maharashtra & M.P.
7.	Karnataka	4000	400000	-	300000	Nil	Not applicable
8.	Kerala	2000	20000	-	100000	Nil	Not applicable
9.	Madhya Pradesh	20000	800000	10	-	-	-
10.	Maharashtra	18000	606000	65	300000	306000	Kerala & M.P.
11.	Meghalaya	1000	10000	3	1500	8500	Nilambur, Bori
12.	Nagaland	1500	7500	5	Nil	7500	-
13.	Orissa	5000	75000	15	-	-	-
14.	Tamilnadu	1030	2600	2	20000	Nil	Not applicable
15.	Tripura	3500	35000	10	-	-	-
16.	Uttar Pradesh	2000	28219	14	8219	20000	Kerala, Karnataka and Tamilnadu
17.	West Bengal	1600	15000	19	10000	5000	Kerala.
		75,920	25,35,539		10,60,019	5,13,200	

TABLE 2 PROGRESS IN SELECTION OF PLUS TREES OF TEAK

S.No.	Name of state	No.of Plus trees of Teak prior to 1977	No.of Plus trees of Teak in 1977 and after
1.	Madhya Pradesh	36	277
2.	Maharashtra	19	183
3.	Andhra Pradesh	33	63
4.	Kerala	11	43
5.	Gujerat	15	36
6.	Orissa	16	34
7.	Karnataka	0	33
8.	Arunachal Pradesh	0	27 candidate trees
9.	Tamilnadu	16	21
10.	Uttar Pradesh	16	16
11.	West Bengal	4	10
12.	Bihar	42	No information
13.	Assam	7	No information

present within species over its entire distribution range in the country and may be classed under elimination phase. The state level trials to be coordinated by individual states was meant for selection and dilination of potential seed collection areas and may be classed under testing phase. 30 samples included in 1980 trials however do not represent adequately all the teak bearing areas. It is therefore planned to have fresh collections in 1980-'81 for repeat trials and also for the state level trials. Strategy and programme for these trials will be decided in working group meeting contemplated to be arranged sometime this year.

The interest aroused on provenance trials by the Project has also resulted in a number of isolated attempts to analyse the existing sample plots established during the All India seed origin trials of 1930. An example of such a study is that reported by Suri 1980. He carried out observations from a sample plot laid out in 1931 at Kothari RF block of Sonkhan range of North Raipur division with six seed origins viz. Nilambur, Betul, Tenduchua, Kankankoti, Kanara and Burma origin. In order to quantify the qualitative growth, the author classified stems in each sample plot into five categories viz. (A) Sound healthy and straight, (B) Sound and healthy but forked, (C) Malformed ie. branchy and knotty, (D) Unhealthy (dead, diseased and dying), and (E) Other Prominent defects such as water blisters etc. After classifying stems in categories, the percentage of stems in each category was computed, and plantations ranked in accordance with the percentages in the category. Observations recorded by him indicate that Nilambur origin is superior even to the local origins. This accounts for the great demand for Nilambur seeds in deficit states.

SEED PRODUCTION AREAS, PLUS TREES AND SEED ORCHARDS

In 1978 the Project organized a working group for the improvement of teak, with members from State Forest Departments, the Project, F.R.I. and Universities. This was done to ensure greater success, a uniform pace throughout the country and to curb all wastage of resources by drawing up modalities for collective action.

Comprehensive background information on teak was prepared by the Project and circulated to members of the working group to aid them in chalking out a programme on a realistic basis to meet the immediate requirement of seeds on the one hand and species improvement on the other.

At the working group meeting, tentative targets were laid down for (i) the selection of seed stands and their conversion into the seed production areas to make them self sufficient in seed supply for the interim period and (ii) for selection of plus trees and creation of clonal orchards for the production of improved seed.

From the information gathered from the States on plantation targets and seed requirements it was seen that teak is being raised as plantations by seventeen states, and the total annual plantation target is about 76,000 hectares. The total seed requirement is 25,000 tons of seeds annually. State wise details of plantation targets, seed requirement, sowing density, quantity that can be collected locally, quantity required from outside sources and preference of source of each state is presented in Table-1. A perusal of this statement indicates wide variation in seed requirement/per hectare which in turn may be partly due to variation in germination percent and spacing in plantation, but major factor appears to be diverse nursery techniques. It is strongly felt that this needs to be set right.

Though seed collection and certification Units as suggested by the Indo-Danish Project have not yet been incorporated into the infrastrucutre of the State Forest Departments, the States have been made conscious of the importance of having registered seed sources to meet their seed requirements. The working group meeting on teak held in Nagpur in 1978 has played a constructive role in activating state forest departments in this direction. Accordingly some states have gone ahead with the selection of seed sources.

Seed Production Areas:

The participants of the 1978 working group meeting from the folbwing states agreed to have targets for seed production areas of teak as mentioned against them:

Bengal 500 ha. of which 36 ha. have already been selected Madhya Pradesh 10000 ha. of which 1100 ha. have been selected, Tamilnadu 50 ha. of which 15 ha. have been selected, Bihar 400 ha. But there is no information from Bihar as to how many ha. have already been selected.

In Maharashtra the potential teak forests of West Chanda, Allapalli, Nanded, Sawantwadi, east and west Nasik forest divisions have been screened and suitable seed plots (1127 ha.) identified at the end of 1979 (Anon 1980).

Karnataka aims to set apart 325 ha. of superior teak plantations covering all the climatic variations within the teak zone for constituting seed production stands. Out of this, 200 ha. have already been identified. In this area intensive thinning, cultural operations, manuring and introducing cover crops are in different stages of implementation. The balance 125 ha. is under identification (Shyamsunder 1980).

In Kerala a total of 271 ha. of seed stands have been converted into seed production areas at Nilambur, Sungam, Wynad, Konni and Ariencavu. These stands get fertilizer (factomphos to induce flowering and fruiting) at the rate of 1 Kg. per tree, just at the close of monsoons. (Anantha Subramanian 1980).

In Andhra Pradesh efforts were being made since the last few years to develop a number of seed stands both in natural forests and in plantations. So far 400 ha. of seed production areas in 64 plots have been developed. About 2500 mother trees with good form and well developed crowns have been retained in the stands exclusively for seed collection purposes. As seed produced in these seed production areas, is not yet adequate, about 6000 ha. of seed collection areas have also been identified (Rao 1980)

On the whole, however, much remains to be done as may be judged from the plantation targets and seed requirements tabulated in Table-1. In most of the States seed collection is still being done indiscriminately with the help of illiterate labourers from wherever trees seed profusely or by sweeping up forest floor. To overcome this problem, the Indo-Danish Project is attempting to get the State Forest Departments to have a wing for seed collection and tree improvement incorporated within their infrastructure.

Plus trees and Clonal orchards:

From the time Mathews introduced the national tree improvement programme in 1961, the emphasis has been on the selection of plus trees. Guidelines for selection of plus trees was prepared by the F.R.I. and later modified by the Project. But both are based on tree form and growth rate. The number of plus trees of teak in different states of India before the Project came into existence and after are tabulated in Table-2. A number of clonal orchards have been raised from these plus trees.

A few seed orchards were introduced from 1966 (ie. one in Orissa and one in Gujerat). A small seed orchard for demonstration purpose was started by the Geneticist at F.R.I., Dehra Dun with 20 clones in 1969.

On a commercial scale seed orchards of teak was first started by the Maharashtra forest department at Lohara and Mohagata in 1974. In Lohara 21 grafts flowered out of 198 in the fifth year. At Mohagata 202 grafts of 31 clones out of 1496 grafts of 45 clones flowered in the fifth year. Amount of fruits produced at Mohagata weighed about 2 Kg. None of these orchards are however producing enough seeds for commercial purposes.

At present ten out of the seventeen states raising teak plantations have established seed orchards. These states are - Maharashtra (nine in number) and a total area of 64 ha., Madhya Pradesh (twelve) total 34.5 ha., Tamilnadu (three) total 17 ha., Andhra Pradesh (three) total 20 ha., Gujerat (two) total 20 ha., Uttar Pradesh including F.R.I. (three) total 4 ha., Assam two (details not available), Arunachal Pradesh one of 8.0 ha., Karnataka one of 6 ha., Kerala one of 2 ha.

Progeny testing:

Regarding progeny trials there has been only a few desultory attempts in the past. As for example in Orissa, seeds were collected from twelve plus trees and sent to F.R.I. Observations taken by the F.R.I. on this trial include height measurements, number of internodes and leaf characters.

A small plantation was also raised in Dhaltangarh from seeds of plus trees. Details of experimental design and observations made etc. are not available.

Recently however there have been some serious attempts. In Maharashtra half sib progeny testing of teak plus trees were conducted, and 684 plants were raised from seeds collected from 16 clones and planted at Lohara and Mohagata (Anon 1979).

Further, in Maharashtra 59 teak plants raised from elite trees by tissue culture by the National Chemical Laboratory Pune, were planted at Panchgaon Parwati (49 plants) and at Research Garden Pune (10 plants) and these are under observation (Anon 1979).

A progeny trial of teak has also been taken up at Top Slip by Tamilnadu Forest Department in 1975, and at Maredumilli by Andhra Pradesh Forest Department in 1977.

REFERENCES

1. Ananthasubramanian, A.S. 1980: Present Status of Tree Improvement and Seed Requirement in Kerala. Submitted for Forestry Conference, F.R.I., Dehra Dun.
2. Anon 1978: Recommendations of the Joint working group meeting on teak, Semul and Gmelina.
3. Anon 1978: Technical News Bulletin of Genetics Section Maharashtra Vana Samshodhan Samsthan, Chandrapur, Maharashtra.
4. Anon 1978: Tree Improvement work in M.P. on Teak, Semul and Gmelina. Report read at the Jt. Working Group meeting on teak, semul and Gmelina, Nagpur.
5. Anon 1979: Extracts from Minutes of the meeting of the Research Committee of the Forest Department of Maharashtra state held on 12th February, 1979.
6. Anon 1980: Annual Report on Silvicultural Research for Maharashtra State for 1978-'79.
7. Beniwal, B.S. 1980: Present status of Tree Improvement and Seed requirement in Arunachal Pradesh. Submitted for Forestry conference, F.R.I., Dehra Dun.
8. Burley, J. 1974: Report to the Govt. of India on Tree Improvement and Introduction with particular reference to Tropical Pines.
9. Champion, H.C. & Seth, S.K. 1968: Forest Types of India, Govt. of India Publication, New Delhi.
10. Keiding, H. 1977: Five year Progress Report on international provenance trials in Teak (Tectona grandis L) Danish FAO/ Tree Seed Centre, Humlebaek.
11. Mathauda,G.S. 1951: All India Teak Seed Origin Sample plots. Proceedings of 8th Silvicultural conference, Dehra Dun.
12. Rao, A.L. 1980: Present Status of tree Improvement and seed requirement in Andhra Pradesh. Submitted for Forestry conference, F.R.I., Dehra Dun.
13. Rath, T. 1980: Present status of Tree Improvement and Seed Production in Orissa. Submitted for Forestry conference, F.R.I., Dehra Dun.
14. Sham Suner, S. 1980: Present Status of Tree Improvement and Seed Requirement in Karnataka. Submitted for Forestry conference, F.R.I., Dehra Dun.
15. Suri, S.K. 1980: Analytical study of teak provenance tests in North Raipur Division of Madhya Pradesh. Submitted for Forestry conference, F.R.I., Dehra Dun.
16. Venkatraman, K.G. 1978: Manual of instruction for the formation and maintenance of seed production areas in Teak. Madhya Pradesh State Forest Development corporation, Bhopal.

FAST GROWING TREES

TECA (*Tectona grandis* LINN. F.) DISTRIBUIÇÃO NATURAL E FATORES RELACIONADOS

Apichart Kaosa-ard
Teak Seed Centre, Ngao, Lampang
THAILAND

Resumo

A teca (*Tectona grandis* Linn. f.) ocorre naturalmente somente na Índia, Burma, Tailândia e Laos. A espécie na Indonésia foi introduzida da Índia a cerca de 400 - 600 anos. Há um número de fatores limitantes na distribuição e crescimento da teca, por exemplo: quantidade de chuvas/umidade do solo, temperatura, luz, formação geológica e condições do solo. As respostas da teca a estes fatores individuais são abordadas neste trabalho.

TEAK (*Tectona grandis* LINN. F.) NATURAL DISTRIBUITION AND RELATED FACTORS

Summary

Teak (Tectona grandis Linn.f.) occurs naturally only in India, Burma, Thailand and Laos. The species in Indonesia was introduced from India about 400 - 600 years ago. There are a number of factors limiting the distribution and growth of teak, viz. amount of rainfall/soil moisture, temperature, light, geological formation and soil conditions. The responses of teak to these individual factors are revealed in this paper.

1. INTRODUCTION

Teak is one of the most valuable timber of the tropics. It is extensively used for ship building, furnitures, carving and numerous other purposes. The properties of teak which make it so valuable are lightness with stronght, stability, durability, ease of working without cracking and splitting, resistance to termites, resistance to fungi, resistance to weather and non-corrosive properties. The physical and mechanical properties of the teak timber are also similar to or even superior to other well-known timbers from European and American countries. The comparison of physical and mechanical properties of the teak timber and some timbers from the temperate region are shown in Table 1 (page 2).

Owing to its timber qualities, teak has been planted outside its natural range since the 14th - 16th century (Altona, 1922a). Large scale planting programmes of this species have also been set up in several countries both within and outside teak natural range. Such programmes, however, require a great deal of informations dealing with natural distribution and factors controlling the distribution and growth of the species. In this paper, attempt is made to clarify factors involving natural distribution and growth of teak.

Table 1 Comparative strength of teak and some European and American species

English Name.	Botanical Name	Weight.	Strength as a beam.	Stiffness as a beam	Suitability as a post.	Shock Resisting ability.	Shear.	Hardness.	Shrinkage.
Teak	Tectona grandis.	100	100	100	100	100	100	100	100
Ash	Fraxinus excelsior.	90	70	85	70	175	120	85	245
Beech	Fagus sylvatica.	95	65	85	65	110	130	90	-
Douglas Fir.	Pseudotsuga taxifolia.	80	70	100	80	75	85	55	190
Elm	Ulmus campestris.	75	45	45	40	65	115	70	-
Hickoly	Carcya ovata.	105	90	-	85	-	120	-	225
Larch, European	Larix europea.	80	55	70	65	125	85	50	175
Oak	Quercus pedunculata.	95	65	80	75	95	110	95	-
Pine, Scots	Pinus sylvestris.	50	55	80	60	80	70	40	170
Spruce, Sitka	Picea rubra.	65	50	80	60	75	70	35	180
Walnut	Juglans nigra.	85	80	-	80	-	110	75	175

Source : Anon. 1956a "Country Report on Teak" p.11

2. NATURAL DISTRIBUTION OF TEAK

Teak is a tropical deciduous forest tree species. The species is a member of the family "Verbenaceae" order "Laminales" (Troup, 1921) and has a set of chromosome number of 2n = 36 (Hedegart and Eigaard, 1965).

The natural distribution of teak is limited to the Southeast Asian region. The species occurs naturally only in the Indian Peninsular, Burma, Northern Thailand and Northwestern Laos (along the northern Thai border) (Troup, 1921; Mahaphol, 1954, Anon, 1956; Kermode, 1957; KoKoGyi, 1972; Kaosa-ard, 1977). It has a distribution range from the longitude of 73°E in India (Troup, 1921) to 104° 30' in Thailand (Mahaphol, 1954). The northern boundary limit of teak is about 25° 30' N lat. in the Kachin state of Burma (Kermode, 1957); and its southern boundary limit lies from 9°N lat. in India (Troup, 1921) through 15°-16°N lat. in Burma (Kermode, 1957) to 16°30' lat. in Thailand (Mahaphol, 1954). Cambodia and the greater part of Laos were formally believed to be another natural sources of teak (Banijbhatana, 1957; Haig, Hubermann and AungDin, 1958). According to KoKoGyi (1972), this part of the Southeast Asian region appears to be outside of the teak range. There is some doubt whether teak in Java and in the small islands of the Indonesian Archipelago, such as Moena and Boetueng, is an indigenous or introduced species. According to Altona (1922a, 1922b), the species in these areas was said to be introduced from India by the Hindus sometime between the 14th and 16th century. The natural distribution of teak is illustrated in Figure 1.

3. FACTORS CONTROLLING DISTRIBUTION AND GROWTH OF TEAK

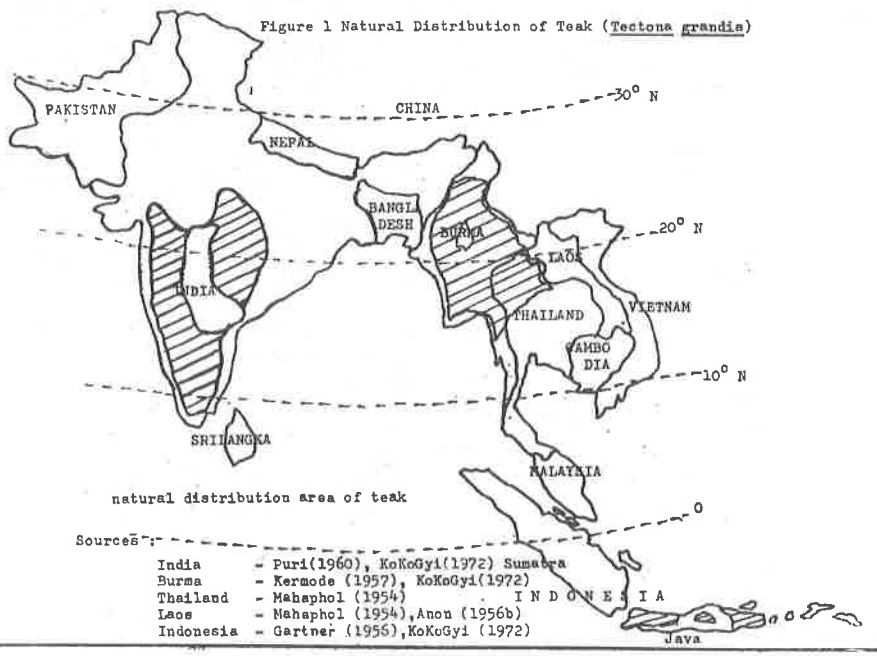
As mentioned earlier, teak is native to the Southeast Asian region and it occurs naturally only in India, Burma, Thailand and Laos. The distribution pattern of this species within these countries is also discontinuous. Since Troup (1921) published his famous text entiltled "Silviculture of Indian Trees", there have been a number of studies on ecology and silvicolture of teak attempting to explain the distribution phenomenon of this species. These studies showed that there were many factors controlling the distribution and growth of teak viz. rainfall/soil moisture, temperature, light, geological formation and soil conditions. The responses of teak to these individual factors are the subject of this section.

3.1 Rainfall/Soil Moisture

Teak occurs naturally over a wide range of climatic conditions, from very dry localities with annual rainfall as low as 500 mm (e.g. in Khandesh, Nimar and West Kurnool in India) to very moist localities with annual rainfall as high as 5,000 mm (e.g. on the west coast of India) (Seth and Khan, 1958). Actually, it grows best and reaches large dimensions in a warm-moist tropical climate with rainfall ranging from 1,270-3,800 mm per annum (Kaosa-ard, 1977). However, for the production of good timber qualities the species requires a periodic marked dry period of 3 - 5 months.

Teak appears to avoid both very dry and very moist sites. On dry sites where severe drought stress occurs in the hot-dry season, teak is found to be stunted and shrubby probably due to reduced growth and early loss of apical control. On very moist sites, on the other hand, the tree is usually large and fluted and tends to be replaced by a variety of evergreen forest species.

Figure 1 Natural Distribution of Teak (Tectona grandis)



Sources :-

India - Puri(1960), KoKoGyi(1972) Sumatra
Burma - Kermode (1957), KoKoGyi(1972)
Thailand - Mahaphol (1954)
Laos - Mahaphol (1954), Anon (1956b)
Indonesia - Gartner (1955), KoKoGyi (1972)

A study under controlled environmental conditions, Kaosa-ard (1977) reported that teak required a relatively high soil moisture conditions for its growth and development. The seedlings of this species when grown under the high constant soil moisture (near the saturating point) for eight weeks were about five times greater, in term of dry matter production, than those grown under the severe soil moisture stress (near the wilting point). Studies on ecology of the teak forests in India, Seth and Khan (1958), and Champion and Seth (1968) classified the teak forests in India by correlating the amount of annual rainfall, stand composition and the qualities of teak into five types. The characteristics of these five forest types are as follows :

1. Very moist teak forest :	rainfall over 2,500 mm/annum; deep alluvial or sedimentary loams often clay soils; low (< 10) percentage of teak; very dense evergreen undergrowth; little natural regeneration; no fires.
2. Moist teak forest :	rainfall 1,600-2,500 mm/annum; deep loamy soils; fair to medium (10-25) percentage of teak; dense undergrowth; fair but patchy natural regeneration; no fires.
3. Semi-moist teak forest :	rainfall 1,300-1,600 mm/annum; moderately deep and loamy soils; medium to high (20-60) percentage of teak; moderate undergrowth; fairly adequate natural regeneration; occational fires.
4. Dry teak forest :	rainfall 900-1,300 mm/annum; shallow or sandy or stiff clayey top-soil soils; high (50) percentage to almost pure stand of teak; light and patchy undergrowth; group or patchy natural regeneration; frequent fires.
5. Very dry teak forest :	rainfall less than 900 mm/annum; poor shallow and rapid run-off or drainage soils; medium percentage of teak; scanty ground cover; practically absent natural regeneration; annual fires.

Similarly, Kaosa-ard (1979) delineated the teak zones in Thailand for the purpose of seed collection and seed utilization by using the P : T ratio moisture index method (P = annual rainfall in mm, T = annual mean temperature in °C). Kaosa-ard (1979) divided the teak area in Thailand into four different zones as follows :-

Zone 1 : dry-humid zone with the P/T ratio smaller than 40
Zone 2 : medium-humid zone with the P/T ratio of 40-50
Zone 3 : moist-humid zone with the P/T ratio of 50-60
Zone 4 : wet zone with the P/T ratio of greater than 60

The teak seed zones of Thailand as delineated by Kaosa-ard (1979) are illustrated in Figure 2. (page 8).

3.2 Temperature :

Temperature is one of the most important factors controlling distribution, growth and development of teak. Naturally, teak occurs over a wide range of climatic conditions, varying from one locality where the maximum temperature may be as high as 48°C for the hottest month to a locality where the minimum temperature may be as low as 2°C for the coldest month (Seth and Khan, 1958; Haig et al, 1958; Champion and Seth, 1968). It appears that teak grows best in the localities with the mean monthly maximum temperature of about 40°C and mean monthly minmum temperature of about 13°C (Haig et al, 1958). Studies on growth and development of teak seedlings under controlled temperatures made by KoKoGyi (1972), Kanchanaburangura (1976) and Kaosa-ard (1977) showed that teak seedlings grew best under day/night temperature ranging from 27/22° to 36/31°C with the most suitable temperature of 30/25°C. The critical maximum and minimum day/night temperature for growth and development of teak seedlings were about 36/31° and 21/16°C, respectively (KoKoGyi, 1972; Kanchanaburangura, 1976; Kaosa-ard, 1977). KoKoGyi (1972) and Kanchanaburangura (1976) also reported that given favourable day temperature, night temperature seemed to play an important role in influencing growth and development of the seedlings of this species. The optimum night temperature for teak seedling growth was between 25° and 28°C (Kanchanaburangura, 1976).

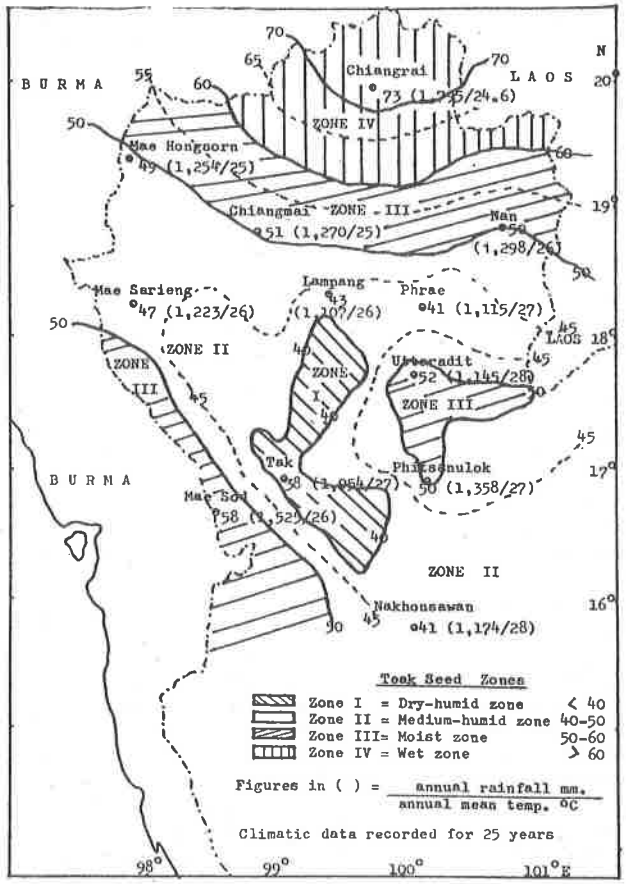


Figure 2 Thailand teak seed zones

Prepared by Kaosa-ard (1979)

Frost appears to be one of the most important factors limiting the distribution of teak. Under frost conditions, seedlings, saplings and even the pole-size trees of this species are severly damaged, especially at the succulent parts such as terminal buds and shoots, young leaves and bark cambium, leading to die-back (Haig et al, 1958; Kotwal, 1958; Kermode, 1964; Kadambi, 1972).

3.3 Light :

Several studies indicated that teak is a light demanding tree species; in other word this species is intolerant of shade (Troup, 1921; Kermode, 1957; Qureshi. 1964; Bhatnager, 1966; Kadambi, 1972; Nwoboshi, 1972). Studies on natural regeneration of teak, Troup (1921) Kermode (1957) and Kittinanda (1969) reported similar result that one of the major causes of the failure in natural regeneration (i.e. seed germination and seedling establishment) of this species especially in the moist teak forests was inadequate light at the ground level of the forests. Kermode (1957) observed that germination of teak seed in nurseries under natural forest canopies was less than 10 %, whereas that in the open nurseries was between 40-50 %. Kermode (1957) also noted that most of seedlings grown under the forest canopies eventually died by the end of the rainy season. Studies on growth and development of teak seedlings under shade of different light intensities, Bhatanagar (1966) and Nwoboshi (1972) found that the optimum light intensities, as determined by percentage of the full day-light, for the best growth and development of teak seedlings was between 75 and 94 %. Nwoboshi (1972) for example, reported that under the light intensities of 100, 75, 53 and 25 %, (a) the total dry matter production of the teak seedlings grown for eight months were 5.2, 14.6, 11.0, and 0.6 gm, respectively and (b) the total dry matter production of plants grown by planting of seedling-stumps for eight months were 47.7, 78.2, 64.5 and 21.5 gm, respectively.

Daylenght or photoperiod seems to have minor effects on growth and development of teak at least at the seedling stage (KoKoGyi, 1972; Kanchanaburangura, 1976). KoKoGyi (1972) conducted an experiment under controlled environment and found that both relative growth rate and net assimilation rate of teak seedlings grown under the photoperiod of 8, 12, and 16 hours were not significantly different. Similarly, Kanchanaburangura (1197) found that there were no differences in all growth parameter measured among seedlings of teak grown under the photoperiod of 9.5, 11 and 14 hours.

3.4 Geology

Among environmental factors, geology seems to be one of the most important factors controlling the distribution of teak. It is well-known that soils which are derived from different geological formation are normally different in both physical and chemical qualities. Under adverse climatic conditions, soils which are not suitable for growth conditions are likely to inhibit the distribution of the species. Although teak can grow on soils derived from a variety of geological formations such as trap, basalt (dark volcanic rock), gniess, schist, shale, limestone, granite, sanstones etc., it occurs predominenely and grows best only on soil derived from rocks of volcanic origin, e.g. igneous rocks (trap, basalt etc.), metamorphic rocks (gneiss, schist etc.) and sedimentary rocks (shale, silt-stones etc.), even when the soils where it grows are shallow. In areas where sandstones, conglomerates and laterite are present, the species appears to be stunted in growth with poor forms and qualities and may be absent (Kulkarni, 1951; Puri, 1951, 1960; Bhatia, 1954; Bloch, 1958; Seth and Yadav, 1959; Samapuddhi, 1963; Komkris et al, 1969). A quantitative study on relationship between geological formation and natural occurence of teak on the northern slope of Satpuras in India made by Kulkarni (1951) showed that teak is definitely associated with rocks of volcanic origin and it grows better on basic than acidic rocks. Kulkarni (1951) explained that the volcanic rocks usually contained relatively high proportion of some chemical ingradients such as Ca, K, Mg etc. which are required by teak. This explanation was later supported by Puri (1951, 1960), Bhatia (1954) and Seth and Yadav (1959). Figures presented in the Table 3 show the percentage of stocking of teak and non-teak in relation to the geological formation as observed by Kulkarni (1951).

Table 3 Relationship between geological formation pH of soils and distribution of teak

Geological Formation	Average pH value of the resultant soils	Composition of Species	
		Teak %	Non-teak %
Deccan trap (volcanic rock)	7.0	80	20
Alluviam	7.0	80	20
Granitic gneisses	7.5	75	25
Calcareous crystalline rock	7.7	60	40
Phyllites and schists	7.2	50	50
Bagra conglomerate	6.8	45	55
Jabalpur conglomerate and hoematite	6.5	15	85
Talchirs and Barakare conglomerate		8	92
Bijoris sandstone	6.0	3	97
Pachmarhi sandstone	5.6	0	100
Denwa sandstone	5.5	0	100
Jabalpur sanstone	6.0	0	100

Source : Kulkarni (1951)

3.5 Soil pH

Since teak has been known to grow best on soil derived from rocks of volcanic origin such as trap basalt and granitic-gneisses, several attempts have been made in systematic studies of soils and geoligical formations in relation to teak distribution. For example, Kulkarni (1951) found that there were relationships among geological formations, pH value of soil and the percentage stocking of teak in natural forests. This author reported that teak occured predominantly on soils with pH values ranging from 6.5-7.5. The species was totally absent from natural forests where soils were more acidic than 6.0 pH. On the other hand, an alkaline soils with pH values ranging from 7.5-8.5, teak deteriorates in qualities, and above a pH level of 8.5 the presence of excess alkalies in soils seemed to be definitely toxic toward teak growth. This author also found that soils derived from volcanic rocks such as trap and river alluvia formed from these rocks, to which the best teak stands in the region were confined, were either nearly neutral or slightly alkaline. Kulkarni's assumption was supported by the work of Puri (1951) and Bhatia (1954). The relationships among geological formations, soil pH and the percentage of stocking of teak in natural forests as observed by Kulkarni (1951) are shown in Table 3.

In contrast to the observation made by Kulkarni (1951), several studies conducted in Thailand showed that the soil which is suitable for teak is generally acidic. The pH values of the top-soils (at the A-horizon) throughout the natural teak forests in Thailand are ranging between 6.2 to 7.0, with an average value of about 6.5 (Bloch, 1958; Samapuddhi, 1963; Komkris et al, 1969; Kemnark et al, 1972; Buranakanond, 1974). However, this average pH value is still in the range of teak soil pH requirement as proposed by Kulkarni (1951).

3.6 Calcium and other mineral elements in soil

Apart from soil pH, a number of mineral elements content in soil such as Ca, P, K, Mg, N etc. have been found to play an important role in controlling distribution and growth of teak. Several studies showed that teak is a "calciolus" tree species. It requires a relatively large amount of calcium for its growth and development (Puri and Gupta, 1950; Bhatia, 1954; Puri, 1960; Kaul, Sharma and Tandon, 1979). Puri and Gupta (1950), for example, compared the amount of calcium content in the leaves of teak and sal (Shorea robusta) grown under the same site conditions. These authors reported that the amount of calcium content in the teak leaves (2.9 % o.d.w.) was almost double that in the sal leaves (1.5 % o.d.w.). Puri (1960) disintegrated the ash of teak wood and reported that calcium (CaO), phosphorus (P_2O_5) and silica (SiO_2) were the major constituent of the teak wood ash; i.e. 31.3 % for CaO, 29.7 % for P_2O_5 and 25.0 % for SiO_2. Similarly, Kaul, Sharma and Tandon (1979) extracted Ca, Mg, P, K and N from various parts of teak trees grown in the 38-year-old plantation in India and found that Ca was the major mineral content in all parts (i.e. leaves, twigs, live-branches, dead-branches, stem bole and bark) of the studied trees. The amounts of Ca, Mg, P, K and N content in the teak trees as reported by Kaul et al (1979) are shown in Table 4.

Table 4 Mineral content in sample teak trees grown in the 35-year-old plantation in India

Samples from tree parts	mineral content (% o.d.w)				
	Ca	Mg	P	K	N
Leaves	2.47	0.31	0.18	0.75	1.84
Twigs	1.67	0.15	0.07	0.75	0.42
Live-branches	0.76	0.12	0.04	0.38	0.25
Dead-branches	1.35	0.07	0.02	0.30	0.27
Stem-bole	0.25	0.06	0.08	0.16	0.17
Bark	3.78	0.22	0.08	0.60	0.48

Source : Kaul, Sharma and Tandon and Srivastava (1979)

Several attempts have been made to estimate the calcium requirement of teak especially in the plantation. For example, a study conducted at the CTFT (Centre Technique Forestrier Tropical) in Ivory Coast, West Africa showed that the five-year-old teak plantation in Togo required about 108 kg/ha of calcium for its growth and development (Anon, memeo, undated). In this report, the teak trees from the five-year-old plantations were harvested and extracted for the amount of CaO content in leaves, bark, branches and wood parts. The consumption of calcium of the teak plantation was estimated and reported as follows :

leaves	71.0	kg of CaO/ha of plantation
bark	23.6	"
branches	9.0	"
wood	4.2	"
Total	107.8	"

Based on this estimation, the CTFT also proposed the model for estimation the teak site quality by using the relationships among the timber production of the plantation, soil depth and the amount of exchangeable bases (especially calcium). That model is as follow :

$$H = \frac{1}{3} P.S$$

where H = yield of plantation in m^3/ha; P = depth of soil in decimeter (dm) and S = total exchangeable bases (especially calcium) in milliequivalents.

In relation to geological formation, it has been mentioned ealier that teak thrives on soil derived from rocks of volcanic origin. Kulkarni (1951) and Puri (1951) gave similar explanation that the volcanic rocks usually consist of a number of minerals such as felspar, hornblende, magnetite etc. These minerals especially hornblende would release a relatively large amount of calcium, phosphorus and some other mineral nutrients, which are required for growth and development of teak during the processes of decomposition and/or soil formation. The decomposition of felspar also resulted in clayey soils which have a relatively high water-holding capacity. Consequently, soils derived from the rocks of volcanic origin were favourable for teak growth and development. This explanation was later supported by the work of Bhatia (1954) who analysed soils of different geological formations for amount of exchangeable calcium and magnesium. Relationships between geological formation, soil pH, amount of exchangeable calcium and magnesium and percentage stocking of teak are shown in the following table.

Table 5 Relationships between geological formations, soil pH, exchangeable calcium and magnesium and teak distribution.

Geological formation	soil pH	exchangeable CaO	exchangeable $Mg_2P_2O_7$	percentage stocking of teak
Igneous rocks				*
Deccan trap	7.1	0.73	0.32	80
Dykes and sills	6.3	0.50	0.38	-
Granitic gneisses	6.2	0.41	0.28	75
Calcareous crystalline	7.6	0.76	0.54	60
Vindhyan sanstones, shale and conglomerate	6.0	0.37	0.25	-
Quartzites	6.0	0.26	0.25	-
Gondwana sandstones				
Begra conglomerate	6.6	0.37	0.33	45
Jabalpur sandstone	6.0	0.23	0.20	0
Pachmarhi sandstone	5.6	0.24	0.13	0
Alluvium soils				
Calcareous	8.3	2.48	0.33	-
Non-calcareous	8.3	0.56	0.46	-

Sources : Bhatia (1954) cited by Puri (1960)

* Kulkarni (1951)

Apart from calcium and other inorganic mineral elements, organic matter and nitrogen content in soil also play an important part in ecological distribution of teak. A number of studies conducted in Thailand showed that both organic matter and nitrogen content in soils from the teak forests were comparatively higher than those in soils from the nearby dry dipterocarp forests (Bloch, 1958; Samapuddhi, 1963; Kemnark et al, 1972). Samapuddhi (1963), for example, reported that the amounts of organic matter content in the top soils from the Mixed Deciduous with Teak, Mixed Deciduous without Teak and Dry Dipterocarp forests in northern Thailand were 5.2 - 6.1, 2.1 - 2.9 and 0.2 - 4.0 %, respectively. In a study on the estimation of site quality of the teak forest by using the amount of organic matter and nitrogen content in soil as the index, Sahunalu (1970) found that there was a strong positive relationship between yield of the forest (as determined in term of dry matter production per unit area) and both the amount of organic matter and nitrogen content in soils. That is, the higher content of either organic matter or nitrogen in the soils the greater amount of dry matter production per unit area of the forest.

4. SUMMARY AND CONCLUSION

Teak occurs naturally only in India, Burma, Thailand and Laos. The distribution of this species within these countries is discontinuous. Teak in Indonesia was said to be introduced about 400 - 600 years ago. There are many factors controlling the distribution and growth of teak. The important factors are rainfall/soil moisture, temperature, light, geological formation or soil parent material and soil conditions. The responses of teak to these individual factors can be summarised as follows :

1. Teak grows much faster under moist than under dry planting conditions. For the production of a good quanlity of teak, the moist localities with an average annual rainfall ranging from 1,250 to 2,500 mm, associated with a marked dry period of 3 - 5 months are the most suitable for plantation establishment of this species.

2. Based on studies under controlled environment, the optimum temperatures for better growth and development of teak are between 27° and 36°C during the day time and between 20° and 30° C during the night time. Under natural conditions, this species grows best in localities which have seasonal fluctuation in temperatures between 13° C (in the coldest month) and 40° C (in the hottest month).

3. Teak is a "light demanding" forest tree species. The range of light intensity of 75 - 95 percent of the full day-light appears to be most favourable for growth and development of the species. Photoperiod or day-lenght, especially within the tropical region, was found to have minor effects on growth and development of teak.

4. Geological formation seems to play an important role in controlling the distribution of teak. The most suitable soils ar usually derived from rocks of volcanic origin such as trap, basalt, granitic-gneisses. Soils derived from sanstones and quartzites appear to be unsuitable for growth and development of teak.

5. Soil pH is one of the most important factors limiting the distribution of teak. Teak thrives on soils which are neutral or slightly alkaline. The most favourable soils for growth and distribution of teak are usually having pH between 6.5 and 7.5 .

6. Teak is a "calciolus" tree species. It requires a relatively large amount of calcium in soil for its growth and development. Soil organic matter and soil nitrogen are also important for teak. It was found that the dry matter production of the teak forest is positively correated with the amount of both organic matter and nitrogen content in soils. Phosphorus and silica are also reported to be contained in a relatively large amount in the teak wood. However, the responses of teak to these two mineral elements are not well doeumented.

REFERENCES

Altona, T. 1922a Teak and Hindoos. Tectona 15 : 457-506

_____ 1922b The teak forest (Tectona grandis L.f.) in the Bismark Archipelago. Tectona 15 : 862 - 868

Anon. 1956a Country report on teak forestry (Burma). In "Country Reports on Teak" F.A.O. Rome page 11

_____ 1956b Teak in Laos. In "Country Reports on Teak" F.A.O. Rome page 112

Banijbhatana, D. 1957 Teak forest of Thailand. In "Tropical Silviculture" Vol 2 F.A.O Rome

Bhatnagar, H.P. 1966 Effect of light intensity on growth and uptake of nutrients in some forest tree species. Indian For. 92 : 79-84

Bhatia, K.K. 1954 "Factors in the Distribution of Teak (Tectona grandis L.) and A Study of Teak Forests of Madhya Pradesh. Ph.D. Thesis Sauger University, India

Blooh, P. 1958 Thailand forest soils. Nat. His. Bull. Siam Soc. vol 19 : 45-56

Buranakanond, U. 1974 Relation between chemical and physical properties of soil to the growth of teak. Jour. Nat. Res. Coun. of Thailand vol 6 : 59-82

Champion, H.G. and S.K. Seth 1968 "A Revised Survey of the Forest Types of India". Manager of Publications, Delhi, 113 - 117 pp. and 181 - 184 pp.

Gartner, I. 1956 Teak in Indonesia. In "Country Reports on Teak" F.A.O. Rome 49-105 pp.

Haig, I.T., M.A. Hubermann and U Aung Din 1958 "Tropical Silviculture" Vol 1 F.A.O. Rome, 190 p.

Kadambi, K. 1972 "Silviculture and Management of Teak" Bull. No. 24 School of Forestry, Stephen F. Austin State University, Texas 137 p.

Kanohanaburangura, C. 1976 "Teak (Tectona grandis L.) Seedlings and Provenance Variation". M.So. Thesis, A.N.U. Department of Forestry, Canberra, Australia

Kaosa-ard, A. 1977 "Physiological Studies of Sprouting of Teak (Tectona grandis Linn.f.) Planting Stumps" Ph.D. Thesis Department of Forestry, A.N.U. Canberra, Australia

_____ 1979 "Teak Seed Centre" Annual Report No. 1" Teak Seed Centre, Ngao, Lampang, Thailand 35 p.

Kaul, O.N., D.C. Sharma, V.N. Tandon and P.B.L. Srivastava 1979 Organic matter and plant nutrient in a teak (Tectona grandis) plantation. Ind. For. Vol 105 : 573-582

Kemnark, C., S. Wacharakiti; S. Aksornkoae; and T. Kaewla-aird 1972 Forest product and soil fertility at Nikom Doi Chiengdao Chiengmai Province. For. Res. Bull. No. 22, Faculty Forestry, Kasetsart University, Bangkok, Thailand

Kermode, C.W.D. 1957 Teak In "Tropical Silviculture" Vol 2 F.A.O. Rome 168 - 192 pp,

_____ 1964. "Some Aspects of Silviculture in Burma" For. Dept. Burma Central Press Rangoon, 162pp.

Kittinanda, S.P. 1963. Natural regeneration of teak in Lampang. Vanasarn, 21:261-268.

KoKoGyi. 1972. "An Investigation of Factors Relevant to Development of Teak Plantations in South East Asia with Particular Reference to Burma". M.Sc. Thesis, A.N.U., Canberra.

Komkris, T., V. Naraballobh, K. Chunkao, C Ngampongsai and N. Tangtham 1969. Effect of fire on soil and water losses at Mae Huad forest, Amphur Ngao, Lampang provinve. For. Res. Bull. No. 6 Faculty of Forestry, Kasetsart University, Bangkok, Thailand

Kotwal, E.K. 1958. Teak in Bombay - Some Preblems. In All India Teak Study Tour 1957-1958, Forest Research Institute, Dohra Dun India 157-158 p.

Kulkarni, D.H. 1951. Distribution of teak (Tectona grandis) on the northern slopes of the Satpuras, with special relation to geology. In India. Proc. Eight Silvic. Conf. Dehra Dun. pp.254-263.

Manapol, S. 1954. "Teak in Thailand", Royal For. Dept,, Thailand, Paper No. R. 16, 31pp.

Nwoboshb, L. 1972. Responses of teak (Tectona grandis L.f.), idigbo (Terminalia ivorensis A.chev) and opepe (Nauclea diderrichii Merrill) seedlings to various light intensities. The Nigerian J. For. 2 (2) : 48-53

Puri, G. S. 1951. Advances in the ecology of teak (Tectona grandis Linn. f.). In India. Proc. Eight Silvic. Conf. Dehra Dun. 242-249.

_____ 1960. "Indian Forest Ecology" Vol. 2. Oxford Book Stationery Co. India. 710pp.

_____ , and Goupta, A.C. 1950. The calcium content of the foliage of sal and its common associates in the Dun valley. Jour. Ind. Bot. Soc., 29:139-144

Qureshi, I.M. 1964 The concept of tolerance in forest crops. In Silver Jubilee Souvenir 1938-1963. Indian Forest College, Dehra Dun pp 90-100

Sahunalu, P. 1970 The estimation of site quality of mixed deciduous forest with teak at Mae Huad, Lampang as determined by organic matter and nitrogen content of soils. For. Res. Bull No. 11 Faculty of Forestry, Kasetsart University, Bangkok, Thailand

Samapuddhi, K. 1963 A study of forest soils of Thailand. No. R. 62, Royal Forest Department, Bangkok, Thailand

Seth, S.K. and M.A.W. Khan 1958 Regeneration of teak forests. In All India Teak Study Tour 1957-1958, F.R.I. Dehra Dun 107 - 120 pp

Seth, S.K., and Yadav, J.S.P. 1959. Teak soils. Indian For., 85; 2-14.

Troup, R.S. 1921. "The Silviculture of Indian Trees", Oxford Press, 1184pp.

FAST GROWING TREES

PROPAGAÇÃO VEGETATIVA DE *Tectona grandis* L. E *Pinus merkusii* JUNG ET DE VRIES USANDO TÉCNICAS DE CULTURA DE TECIDO

E. Noerhadi
Institut Teknologi Bandug, Bandung
Hartono Wirjodarmodjo
Perum Perhutani, Jakarta
INDONESIA

Resumo

Um projeto de pequisa financiado pelo Perum Perhutani (Forest State Corporation) é descrito. Um dos objetivos deste projeto é desenvolver um método de propagação vegetativa para duas espécies arbóreas, *Tectona grandis* L. e *Pinus merkusii* Jungh e De Vries, que tornará possível propagar árvores de elite de Teca e de Pinus para serem utilizadas em plantações clonais em escala comercial. A cultura esterelizada de tecidos é o método selecionado para este objetivo .

Calos foram produzidos utilizando várias partes das árvores de teca, e de raízes e segmentos de hipocótilo de mudinhas de Pinus.

Brotações podem também ser produzidas através de segmentos de mudinhas de teca.

VEGETATIVE PROPAGATION OF *Tectona grandis* L. AND *Pinus merkusii* JUNG ET DE VRIES USING TISSUE CULTURE TECHNIQUE

Summary

A research project financed by Perum Perhutani (Forest State Corporation) is described. One of the objectives of this project is to develop a method of vegetative propagation of two tree species, Tectona grandis L. and Pinus Merkusii Jungh et De Vries, which will enable genetically elite teak plants and Pinus to be bulked up for planting on a commercial scale. Sterile tissue culture is the method of choise for such a purpose.

Callus has been produced from several parts of the teak plant, and from root and hypocotyl segments of the Pinus seedling.

Shoot can also be produced from hypocotyl segments of teak seedling.

INTRODUCTION

The technique of tissue culture have been used for many years in the propagation of certain plants. One of the earliest successes was with ornamentals, and successes with othe commercial plants soon followed. MURASHIGE (1974) makes the point that successful regeneration by means of tissue culture "has thus far been confined to those plants whose cuttings can be rooted without difficulty".

His review is almost entirely concerned with herbaceous plants and he feels that the information in his review is not applicable to the propagation of woody perennial. ABBOTT (1977) reports major break throughs in investigations with the woody genera and shows almost forty woody species from which active tissue cultures have been obtained and which show a potential for in vitro propagation.

For many years, teak and Pinus breeders in Indonesia have been working to improve varieties by mass selection techniques (HARTONO et al., 1978). In order to multiply elite teak and Pinus and the progeny from the later genera tions of breeding programmes, a method of vegetative propagation is essential (NOERHADI, 1979).

THE PROJECT

The project is financed by Perum Perhutani (Forest State Corporation) in Jakarta and the research activity is located in the Laboratory of Plant physiology at Institut Teknologi Bandung in Bandung, Indonesia. Every month, several parts of the local teak variety is collected near Purwakarta (West Java) or in Cepu (Central Java).
The day after arrival in Bandung, all the plant parts such as leaf, leaf stalk, inflorescence stalk and stem segments are used as explants.
Almost at the same time, segments of Pinus seedling such as suspensor, root and hypocotyl are used as explants.

This paper will report the following headings :
1. culture of organ tissues,
2. subculture of proliferating tissues,
3. culture of hypocotyl tissues.

CULTURE OF ORGAN TISSUES

Any part of the parent plant can be used as source material for the production of callus, an unorganised mass of cells produced rather similar to wound tissue. Under appropriate conditions callus cells can first be induced on the original tissue, then detached and multiplied.
By changing the culture conditions it is often possible to stimulate differen tiation resulting in production of plantlets.

1.1. Tectona grandis L.

A variety of sources of teak plants have been used for the production of callus. Stem tissue from just below the main growing area, leaf stalk and young leaf tissue of a one year old seedling, and the same source of tissues plus inflorescence stalk of trees up to 15 year old have been used. All these tissues readily yield callus on the surface when cultured on either special developed JL medium or on a modified Murashige and Skoog mineral formulation supplemented with suitable organic factors.

Callus growth on stem segments and leaf stalk form the predominant type of response. In combination with Benzylamino Purine (BAP) and within three weeks after planting those explants, 2,4-Dichloropehoxyacetic acid (2,4-D) up to 3,5 ppm produces much better and larger callus than Naphthalene Acetic Acid (NAA) up to 10 ppm. All those callus show a nodular type of growth. Therefore, those tissues have been the most useful since it seems to be a fairly uniform tissue which can be cut up and replicated through a large numbers of treatments.

Portions of young leaf and inflorescence stalk will also produce callus but at a very slow rate and more irregular than the tissues of stem segments and leaf stalk.

Root formation is also observed within two months after planting the explants on the same synthetic medium with NAA 3.5 ppm and BAP as much as 0.25 ppm.

1.2. Pinus Merkusii Jungh et De Vries.

Suspensor, root tissue and hypocotyl segments of a two weeks old seedling have been used. All these tissues readily yield callus on the surface when cultured on the same medium as is used for teak tissues with NAA 0.25-0.65 ppm and BAP 1.0-2.0 ppm.

SUBCULTURE OF PROLIFERATING TISSUES

It has been possible to subculture callus fragments on a callusinducing medium. The best response is obtained on medium with a NAA-high sugar concentration.

CULTURE OF HYPOCOTYL TISSUES

Portions of hypocotyl of a month old teak seedling will produce plant lets directly on medium with a very small amount of auxin and cytokinin. This result opens a particular aspect that it may be possible to produce plants directly from plantlets.

CONCLUSIONS

Steady progress towards the aim of vegetative propagation of teak has been made. Since callus has been formed, a further possibility has arisen to yield isolated naked protoplasts. This opens up an alternative route for vegetative propagation (COCKING, 1972) and also the possibility for somatic hybridisation (GAMBORG, 1977).

LITERATURE CITED

1. Abbott, A.J. (1977) : Propagating temperate woody species in tissue culture. Scientific Horticulture No. 28 pp 155 - 162.
2. Cocking, E.C. (1972) : Plant cell protoplasts - isolation and development. Ann. Rev. Plant Physiol No. 23 pp 29 - 50.
3. Gamborg, O.L. (1977) : Somatic cell hybridization by protoplast fusion and morphogenesis. IN : Plant tissue culture and its bio-technological application. Springer-Verlag, Berlin, New York.
4. Hartono W, R. Harahap, Suhendi and H.Alrasjid (1977): Tree breeding in Indonesia. Proceeding of The Third World Consultation on Forest Tree Breeding, 1977.
5. Murashige, T. (1974) : Plant propagation through tissue culture. Ann. Rev. Plant Physiol No. 25 pp 135 - 166.
6. Noerhadi, E. (1979) : Pemuliaan pohon di Indonesia. Duta Rimba No. 30/V/1979, Perum Perhutani (With English translation).

FAST GROWING TREES

ESTUDO COMPARATIVO DA PROCEDÊNCIA DA TECA NA ÁFRICA OCIDENTAL

O. Souvannavong
Centre Technique Forestier Tropical
COSTA DO MARFIM

Resumo

O C.T.F.T. tem implantado testes de procedência de Teca em vários países da África Ocidental, envolvendo procedências da Ásia, África Oriental e Ocidental.

O estudo dos testes não mostra nenhuma diferença importante em vigor entre as procedências locais e as outras, mas demonstra a pior qualidade dos troncos nas procedências da África Ocidental.

ETUDE COMPARATIF DE PROVENANCES DE TECK EN AFRIQUE DE L'OUEST

Resume

Le C.T.F.T. a mis en place dans différents pays de l'Afrique de l'Ouest des essais comparatifs de provenances de Teck, incluant des origines d'Asie, d'Afrique de l'Est et d'Afrique de l'Ouest. Les observations faites sur ces dispositifs n'ont pas dégagé d'importantes différences en vigueur entre les provenances locales et les autres, elles ont par contre démontré la supériorité sur le plan qualitatif des provenances d'Afrique de l'Est et d'Asie sur les provenances d'Afrique de l'Ouest.

INTRODUCTION.

Le Centre Technique Forestier Tropical a établi plusieurs essais comparatifs de Provenances de Teck dans différents pays d'Afrique de l'Ouest. Une première campagne de mise en place a eu lieu en 1970 intéressant le Cameroun, la Côte d'Ivoire, la Haute Volta et le Sénégal. En 1974 a été mis en place en Côte d'Ivoire un dispositif entrant dans le cadre des Essais internationaux de Provenances de Teck.

Les résultats des premières observations effectuées sur les essais mis en place en 1970 permettent de comparer la réussite et la vigueur de différentes provenances dans les sites d'essai en Afrique de l'Ouest. Les arbres ayant atteint un développement suffisant, une étude des caractères qualitatifs a été effectuée récemment sur les essais mis en place en Côte d'Ivoire. Les premiers résultats intéressants qui commencent à se dégager sont également présentés dans cette note.

Essais Comparatifs de Provenances mis en place en 1970.

Le Centre Technique Forestier Tropical a réalisé en 1969 une campagne de récolte de graines de Teck en Asie (Inde, Thailande, Indonésie), en Afrique de l'Est (Tanzanie) et de l'Ouest (Bénin, Cameroun, Côte d'Ivoire, Sénégal). Cette campagne a permis la mise en place d'essais comparatifs de Provenances au Cameroun, en Côte d'Ivoire, en Haute Volta et au Sénégal. Les dispositifs seront brièvement décrits et les résultats obtenus seront exposés ci-dessous.

1. - Cameroun.

L'essai a été mis en place à Bambuko (4°15 N, 9°15 E) sur bon sol à substrat volcanique. La pluviométrie annuelle y est de 1.780 mm.

11 Provenances sont concernées :

TJEPU	d'INDONESIE
NELLICUTHA	d'INDE
NILAMBUR	"
VERMOLI RANGE	"
DJIGBE	du BENIN
TOFFO	"
BAMBUKO	du CAMEROUN
DJIBELOR	du SENEGAL
KALOUNAYES	"
BAMORO A/29	de COTE D'IVOIRE
BAMORO A/20	"

Le dispositif comporte 4 blocs complets formés de placeaux de 13 x 13 plants à espacement de 2,5 x 2,5 m.

Seules des observations de vigueur ont été effectuées les premières années. Elles mettent en évidence une supériorité initiale des provenances d'Afrique de l'Ouest qui s'estompe par la suite.

2. - Haute Volta.

Le site est la forêt de DINDERESSO, dans la région de BOBO-DIOULASSO, sur bon sol alluvionnaire. La pluviométrie annuelle est de 1.180 mm, répartie sur 6 1/2 mois.

10 Provenances sont concernées :

NILAMBUR	d'INDE
VERMOLI RANGE	"
NELLICUTHA	"
DJIBELOR	du SENEGAL
KALONNAYES	"
DJIGBE	du BENIN
TOFFO	"
BAMORO A/29	de COTE D'IVOIRE
BAMORO A/20	"
LA TECKE	"

- Dispositif monoarbre à 50 répétions et 5 blocs.
- Espacement entre les plants : 2,5 x 2,5 m.

Les observations de vigueur montrent une meilleure croissance des provenances de l'Afrique de l'Ouest les premières années. Une première cotation qualitative à été faite à l'âge de 5 ans. Les provenances KALOUNAYES, DJIGBE, LA TECKE ont été jugées les meilleures et les provenances DJIBELOR et BAMORO les moins bonnes.

3. - SENEGAL.

Site : LES BAYOTTES (CASAMAMCE)

Pluviométrie annuelle : 1.640 mm.

5 Provenances : DJIGBE du BENIN
TOFFO "
NILAMBUR d'INDE
VIRMOLI RANGE d'INDE
BAMORO de COTE D'IVOIRE.

La croissance initiale observée est moins bonne pour les provenance du Bénin que pour les autres.

4. - COTE D'IVOIRE.

Site : LA SEGUIE (6° 15 N, 4°25 O) en Forêt dense humide semi-décidue, sur sol ferralitique moyennement de saturé à roche-mère granitique.

La pluviométrie annuelle est de 1.500 mm répartie en deux saisons des pluies.

L'essai concerne 15 provenances. Outre 10 Provenances déjà rencontrées (celles du Cameroun moins TJEPU) sont représentées :

- 3 Provenances de THAILAND MAE HUAT
  PONG SALEE
  HUOI NAM OON
- 2 Provenances de TANZANIE MJIBWA
  KIHUHWI.

Le dispositif est un lattice carré équilibré. Les placeaux sont formés de 13 x 8 plants à l'espacement de 2,1 x 2,7 m.

Les observations de la vigueur et de la floraison ont été faites régulièrement depuis la mise en place, ainsi que la fourchaison. A six ans les différences n'étaient pas significatives quant à la vigueur, mais étaient déjà hautement significatives quant à la floraison, la fourchaison et la longueur de fût libre de fourche. Les provenances d'Afrique de l'Ouest fleurissent et fourchent plus tôt que les provenances d'Asie et d'Afrique de l'Est.

En début 1980 a été effectuée une étude de différents caractères qualitatifs en plus de l'observation des caractères déjà cités. Les caractères qualitatifs ont été appréciés pour un arbre sur deux dans chaque placeau en attribuant une note fictive, de 1 à 4, par caractère. Les principaux résultats sont donnés ci-dessous :

* - Les différences de vigueur (circonférence et hauteur totale) soht devenues significatives, les provenances de l'Afrique de l'Ouest étant parmi les moins bien classées (C = 55-57 cm, H_t = 17-18 m). Les provenances d'Inde et de Tanzanie ont une circonférence moyenne de 58 à 60 cm. La provenance KIHUHWI de Tanzanie est nettement supérieure aux autres en hauteur totale avec 19 m.
* - Une partition nette apparaît aussi de l'étude de la fourchaiso et de la hauteur de fût libre de fourche, les provenances d'Afrique de l'Ouest ont de 95 à 98 % d'arbres fourchus avec une hauteur moyenne libre de fourche de 9 à 11 m. Les provenances d'Asie et de Tanzanie ont de 75 à 90 % d'arbres fourchus et un hauteur moyenne libre de fourche comprise entre 12 et 13 m.
* - La hauteur de la première grosse branche vivante, rendant compte de l'aptitude à l'élagage naturel, permet de faire la même partition que la fourchaison. Cette hauteur est comprise entre 6 et 7,5 m pour les provenance d'Afrique de l'Ouest et entre 8 m et 9 m pour les autres.
* - La différence entre provenances est aussi significative quant à l'importance des bosselures. Trois groupes peuvent être en gros distingués :
  - Les provenances les plus bosselées sont celles d'Afrique de l'Ouest et de Thailande.
  - La provenance MTIBWA de Tanzanie est nettement moins bosselée que les autres.
  - Le reste des provenances forme le groupe intermédiaire.

* - Les cannelures et la cylindricité du fût dégagent aussi des différences significatives. Les provenances de l'Inde étant les meilleures.

3 - Les essais internationaux de provenances en Côte d'Ivoire.

Le dispositif a été mis en place en 1974 à la TENE en Forêt dense semi-décidue sur sol ferralitique moyennement désaturé à roche-mère granitique. La pluviométrie moyenne annuelle est de 1.300 mm, répartie en deux saisons.

10 Provenances sont concernées :

n° 3016	MASALE VALLEY	d'INDE
n° 3034	PURUNAKOTE	"
n° 3038	BAN CHAM	de THAILAND
n° 3040	BAN PHA LAI	"
n° 3054	PAKSE	du LAOS
n° 3061	PAKLAY	"
n° 3037	BAMORO	de COTE D'IVOIRE
n° 3063	TOVE	du TOGO
n° 3065	BIGWA	de TANZANIE
n° 3067	BAMBUKO	du CAMEROUN.

Le dispositif est en blocs incomplets équilibrés :

. Nombre de blocs = nombre de provenances = 11 (la provenance BAMORO a été doublée).

. Nombre de répétitions = nombre de provenances par bloc = 5.

. Placeaux de 16 x 5 pieds à espacement de 3 x 3 cm.

Les premières observations ont mis en évidence des différences dans la précocité de la floraison, les provenances de l'Afrique de l'Ouest et de PAKSE (LAOS) étant très précoces. Les différence en hauteur totale n'étaient pas significatives à deux ans.

En début 1980 ont été faites les mêmes observations que sur ces essais de la SEGUIE. Les principaux résultats sont les suivants.

* - La vigueur de la provenance PAKSE est nettement inférieure à celle des autres qui forment un groupe homogène
  - C = 45 cm et H_t = 13-7 m pour PAKSE
  - C = 49 à 53 cm et H_t = 14-5 à 15-5 m pour les autres.

* - Les caractères de floraison et de fourchaison confirment le classement de la SEGUIE. Il est remarquable que la provenance BIGWA de TANZANIE se détache nettement des autres pour ces caractères.

* - L'importance des bosses met en évidence aussi la meilleure qualité de la provenance BIGWA.

* - Les provenances d'Asie sont les moins cannelées, les provenances d'Afrique de l'Ouest étant les plus cannelées.

* - La rectitude du fût permet de distinguer deux groupes, les provenances de THAILANDE, du LAOS et de BIGWA ayant les fût les plus droits.

CONCLUSION.

Les résultats obtenus dans les différents essais qui ont été passés en revue ici ont permis d'apprécier la variabilité intraspécifique des caractères de vigueur et plus récemment des caractères de qualité.

Du point de vue pratique ils démontrent le grand intérêt qu'il y aurait, en Afrique de l'Ouest, dans un premier temps, à renouveler le matériel génétique utilisé en plantation. Il est en effet remarquable que toutes les provenances de l'Afrique de l'Ouest aient le même comportement du point de vue tant qualitatif que quantitatif ; elles ont sans doute la même origine primitive. Le observations ont montré que bien qu'ayant parfois un développement initial supérieur elles n'ont pas à la longue une croissance supérieure aux autres provenances. Du point de vue qualitatif par contre leur médiocrité par rapport aux autres provenances est démontrée. Les provenances de TANZANIE sont à tous points de vue très intéressantes.

REFERENCES

- Akunti, J. C. 1970. Tectona grandis provenance trial at Bambuko. Situation at 31/12/1970 - CTFT - Cameroun

- Birot, Y et A. Villeneuve 1970. Note sur la mise en place des essais comparatifs de provenances de Teck de la Séguié. Annexes - Fiches de récolte - CTFT - Côte d'Ivoire.

- Bonnet - Masimbert, M. 1971 - Rapport sur l'inventaire de reprise et de croissance en hauteur de l'essai provenances Teck. CTFT - Côte d'Ivoire.

- Bonnet - Masimbert, M. 1971 - Résultats d'une année d'observations sur la floraison, la ramification du Teck. CTFT - Côte d'Ivoire.

- Clément, J. 1970 - Note sur les premiers résultats en pépinière de provenances de Teck à la Séguié. CTFT - Côte d'Ivoire.

- C T F T - Cameroun - Rapports annuels 1969-70, 1971-72, 1973-74

- C T F T - Haute-Volta - Rapport annuel 1978

- C T F T - Sénégal - Rapports annuels 1971 et 1972.

- Delauney, J ; Diabaté, K. 1974 - Rapport sur la mise en place des essais internationaux de provenances de Teck à la Téné. CTFT - Côte d'Ivoire

- Delauney, J. 1976 - Les essais de provenances de Teck six ans après leur mise en place à la Séguié. CTFT - Côte d'Ivoire

- Delauney J. 1977 - Premiers résultats des essais internationaux de provenances de Teck, Tectona grandis, deux ans après leur mise en place en Côte d'Ivoire - CTFT - Côte d'Ivoire.

- Delauney J. 1979 - L'amélioration génétique du Teck. Travaux réalisés. Perspectives. CTFT - Côte d'Ivoire.

FAST GROWING TREES

Tectona grandis — TESTE DE PROCEDÊNCIA NA JARI: UMA AVALIAÇÃO DE 5 ANOS

R. A. Woessner — V. A. S. Tiburcio
Jari Florestal, Belém , PA.
BRASIL

Resumo

Nenhuma procedência sobressaiu-se até a idade estudada. As procedências que foram as mais altas e as mais baixas aos 21 meses ainda mantêm a menor classificação. Entretanto, a diferença de percentagem entre elas tem caído de 130% para 60% aos 5 anos. Infelizmente, as melhores procedências de crescimento não são as mais livres de defeitos, levando a crer que a teca não produz madeira de alta qualidade em rolos argilosos bem apropriados para *Gmelina arborea* nesta parte da região amazônica.

Tectona grandis (DAN/FAO) PROVENANCE TRIAL AT JARI — AN ASSESSMENT AT 5 YEARS

Summary

No outstanding provenance can be recognized at this age. The provenances that were tallest and shortest at 21 months still have the same rank. However, the percentage difference

between them has dropped from 130 percent to 60 percent by age five. Unfortunately, the best growing provenances are not the most defect free. It appears that teak will not produce high quality crop trees on medium-to-good clay soils well suited to Gmelina arborea in this part of the Amazon basin.

INTRODUCTION

The world wide acceptance of teak (Tectona grandis) as a superior veneer and solid wood species encouraged Jari to participate in the (DAN/FAO) Provenance Trial program. The Jari Amazonian lands contain some clay Alfisol soils of very high natural fertility which generally occur on steep slopes. Such soils, if cleared of native forest, could be planted to a long rotation, high value crop like teak. The clay Ultisol soils, although lower in natural fertility, were also considered as having a potential for teak. Another member of the family Verbenaceae, Gmelina arborea, is extremely productive on the Alfisols and produces good pulpwood yield on six year rotations on Ultisols. On the better sites, dominant height would be 22 to 24 m at 6 years.

This provenance trial was established in the field in January of 1975 using seedlings raised from seed supplied by the Danish/FAO Forest Tree Seed Center (Keiding 1976). The trial was assessed for survival and height at 11 and 21 months after field planting (Woessner 1977). At these ages, provenance 3042 from Thailand and 3074 from Burma were the tallest while provenance 3073 from Burma was the shortest. The percentage difference between the two tallest and the shortest provenance was 130 percent, but these differences were not statistically significant at the .05 probability level, due to the extreme amount of plot-to-plot variability within provenances. This led to a very high coefficient of variation for height--49 percent. The plot-to-plot variability can be attributed in a large part to a lack of uniformity in seedling size both within and among plots of a given provenance. This, in turn, was caused by the unevenness in speed and percentage of germination. Keiding (1977) mentions that numerous trials were plagued with this problem.

MATERIAL and METHODS

The provenance trial was planted in January of 1975 at a 3.5 x 3.5 m spacing on a clay Ultisol soil which had been cleared of Amazonian tropical rainforest in September of 1974 and burned in October of the same year. The trial was cleaned by hand several times a year for the first three years and once a year thereafter. The trees were pruned up to a height of 1 m in September of 1976 and 1.5 m in July of 1977.

Average annual rainfall is about 2200 mm with 85 percent of the rain falling January through August. The months of September through December average 68 mm per month. The driest month is October and it receives 45 mm of rain. Average daily temperatures range from a high of 34°C to a low of 24°. There is little yearly variation in temperature as the planting site lies less than one minute south of the equator. The longitude is 52 degrees west and the altitude approximately 100 m.

The experiment was planted in a randomized-complete-block design of four replications with 16-tree square plots representing a provenance. Provenance data is given in Table 1. The growth in replication four is quite erratic so the data for this replication was not used. Provenance 3068 was also dropped because it occurs in only one of the first three replications.

An assessment of height, diameter at 1.4 m, survival, incidence of flowering and fruiting, incidence of basal and bole sprouts, incidence of leader die-back, and incidence of trunk lesions was made in January of 1980. The percentage of defect free trees was derived by considering only those individuals as defect free which had a live leader, no sprouts, and no trunk lesions.

Table 1. Provenances Represented in the Jari Trial

Number	Source: Country	Source: Name	Altitude of Origin (m)	Rainfall at Origin (mm)
3042	Thailand	Ban Huey Luang	220	1282
3074	Burma	Virnoli	488	2082
3071	Burma	Mt. Stuart	640	2032
3016	India	Masale Valley	823	1270
3058	Laos	Chumpi	75	1925
3034	Laos	Purunakote	133	1350
3073	Burma	Nilambur	49	2565

The plot means or percentage values were calculated and submitted to an analysis of variance with 2 degrees of freedom for replications and 6 for provenances.

At first trunk lesions were thought to be a canker disease. Later, more complete observations made by the company pest control specialist found only termite damage in the bark but not extending into the wood. At present, the true nature of the problem remains obscure but further observations are under way.

RESULTS

The provenance plot means for height, diameter, percent survival, percentage of trees without fruit or flowers, and percentage of defect free trees are given at the top of Table 2. At the bottom of Table 2 are given the provenance mean percentage values for basal sprouts, bole sprouts, the sum of basal sprouting and bole sprouting, live leaders, and trunk lesions.

The experimental mean height at 5 years is 5.8 m and mean diameter is 7.9 cm. The tallest source is 3042 (7.2 m) and the shortest is 3073 (4.5 m). Source 3073 also has the smallest diameter (6.6 cm). Source 3016 ranks fifth in height but first in diameter, 9.5 cm. The experimental mean survival is 78 percent. The source with the best survival (88 percent) is also the source with the largest diameter (3016). Source 3073 has the worst survival (59 percent) as well as the smallest values for height and diameter.

Eighty-eight percent of the trees are without flowers or fruit. Source 3071 had no flowers or fruit. Source 3058 has 56 percent of the trees with flowers or fruit.

The experimental mean value for defect-free trees is 10 percent. Defect-free trees are those having a live leader, no sprouting, and no trunk lesions. The fecund source (3058) has the highest percentage of defect-free trees (25 percent).

The percentage of basal sprouting was 24 percent lower than the percentage of bole sprouting. Seventy-four percent of the trees have sprouts. All sources have more than 59 percent of the trees with this defect.

A large proportion of the trees have dead leaders (55 percent). Sources 3016 (20 percent) and 3071 (24 percent) have relatively low numbers of live leaders.

Twenty-two percent of the trees have trunk lesions. The worst source for this characteristic is also the tallest, 3042.

Of the 10 variables analyzed, only two were statistically significant at the .05 probability level. These were percentage of trees without flowers or fruit and percentage of trees with a live leader. The Tukey test (.05 level) was used to determine which provenance means were significantly different. None of the provenance means was found to be significantly better in terms of live leaders. Source 3058 was found to have a signicantly higher flowering level than sources 3074, 3034, 3071, and 3073.

The coefficients of variation are quite high, ranging from 17 to 108 percent.

Table 2. Variables assessed at age 5 in the Jari teak trial.

Source	Height (m)	Diameter (cm)(1.4m)	Survival Percent	Percentage of trees without fruit or flowers	Percentage of trees defect free
3042	7.2	8.5	86	91	8
3074	6.3	8.4	75	97	17
3034	6.2	7.2	71	95	15
3058	5.9	7.6	83	44/a	25
3016	5.7	9.5	88	92	2
3071	5.1	7.3	81	100	0
3073	4.5	6.6	59	95	3
$\bar{X}$	5.8	7.9	78	88	10
'F' test	NS	NS	NS	.025	NS
CV	19	22	17	19	108

Source	Percentage of Trees with basal sprouts	bole sprouts	basal + bole	a live leader/b	trunk lesions
3042	43	60	81	58	36
3074	30	60	73	46	23
3034	37	55	73	63	10
3058	39	49	65	60	11
3016	49	81	88	20	33
3071	37	64	78	24	23
3073	17	51	59	47	20
$\bar{X}$	36	60	74	45	22
'F' test	NS	NS	NS	05	NS
CV	44	27	19	35	49

NS Not statistically significant at the .05 probability level.
.05 Statistically significant at the .05 probability level.
.025 Statistically significant at the .025 probability level.

a Significantly higher in flowering by the Tukey test (.05) than 3074, 3034, 3071, 3073

b No significant differences among sources by the Tukey test (.05).

DISCUSSION

Because of the low level of precision in this trial, there is little that can be said with certainty at this age in terms of defining an outstanding provenance. Generally speaking, all sources have a disappointingly high number of defects of some type. The excess seedlings used to establish this trial were planted at two other sites. Both of these other sites have a somewhat higher Gmelina site index than the provenance trial. An intensive survey of defects was done at all three sites by the company pest control forester. 2/ The trees on the better site index locations are essentially no more defect free than the provenance trial. It appears at this point in time, that teak will not produce a high quality crop tree on medium-to-good quality Gmelina sites. A small additional teak trial is planned for one of the best Alfisol Terra Roxa soils.

2/ The authors wish to acknowledge the assistance of G.T. Ribeiro in carrying out these surveys.

REFERENCES

Keiding, H. (1976) Progress in international provenance trials of teak. Circular letter No. 7: Danish/FAO Forest Tree Seed Centre.

Keiding, H. (1977) Five-year progress report on international provenance trials of teak, Tectona grandis L.F. In "Progress and Problems of Genetic Improvement of Tropical Forest Trees." (Nikles et al. eds.) CFI, Oxford, 761-778.

Woessner, Ronald A. (1977) Tectona grandis L.F. (DAN/FAO) provenance trial at Jari, Para, Brazil. In "Progress and Problems of Genetic Improvement of Tropical Forest Trees." (Nikles et al. eds.) CFI, Oxford, 794-796.

FAST GROWING TREES

Gmelina arborea ROXB. – VARIAÇÃO DA DENSIDADE, ALTURA E DIÂMETRO DA MADEIRA EM TESTES DE PROCEDÊNCIA INTERNACIONAL NA JARI

R. A. Woessner
Jari Florestal, Belém, PA.
BRASIL

Resumo

A densidade da madeira entre procedências de *Gmelina Arborea* Roxb. aos 17 meses variou de .29 a .38 g/cc. O diâmetro variou de 2.4 a 3.3 cm e a altura de 3.6 a 5.4 m. Estas diferenças entre procedências foram estatisticamente significantes, e das três características avaliadas neste trabalho, a densidade da madeira, nesta idade, parece ser a mais adequada para uma significante contribuição na melhoria genética das futuras produções nas plantações da Jari. As procedências com a mais alta densidade da madeira poderiam ser usadas num programa de cruzamento inter-procedências com os clones dos pomares de sementes locais a fim de aumentar a densidade do material.

Gmelina arborea ROXB – VARIATION IN WOOD DENSITY, HEIGHT AND DIAMETER OF THE INTERNATIONAL PROVENANCE TRIAL AT JARI

Summary

Wood density among provenances of Gmelina arborea Roxb. at 17 months ranged from .29 to .38 g/cc. Diameter ranged from 2.4 to 3.3 cm and height from 3.6 to 5.4 m. These among-provenance differences were statistically significant. Of the three characteristics evaluated in this paper, wood density appears at this age to be the one most likely to make a significant contribution to improving future yields from Jari plantations. The provenances with the highest wood density could be used in an inter-provenance crossing program with the local seed orchard selections in order to increase wood density of the local material.

INTRODUCTION

The first Melina plantations on the Jari Amazonian holdings in the Brazilian state of Para were established in 1968. The seed for these plantations came from naturalized stands growing in western and southern Africa and Belize in Central America. The original seed sources of this material are not documented. Seed orchards composed of outstanding trees selected from these company plantations are already established. Additional genetic improvement is possible by taking advantage of the genetic variation among provenances. A comprehensive series of provenance trials were initiated through the Indian Forest Research Institute and the Danish/FAO Forest Tree Seed Center 2/.

At the Jari location, definitive evaluations of these provenance trials will be possible about four years after outplanting or at two-thirds of rotation age. The juvenile results presented here based on 14-and 17-month data are tentative.

2/ Lauridsen, E.B. (1977). Gmelina arborea - International provenance Trials Study Tour and Seed Collection in India 1976. Forest Occasional Paper 1977/1, FAO: 24-37.

MATERIALS and METHODS

The provenances used are shown in Table 1 along with the country of origin and the altitude and rainfall for the collection location. Eight of the provenances are native to India. There are 3 naturalized provenances, 2 from Africa and 1 from Jari.

Table 1. List of Provenances

Code	Name	Country	Altitude(m)	Rainfall mm/yr
4008	Ghotil-18	India	1000	1000
4038	Lambasingi	India	1500	1500
4027	Baramura	India	120	2200
4042	Thithimathi	India	850	1375
4037	Maredumilli	India	500	1500
4040	São Miguel	Brazil	66	2476
4028	Shikaribari	India	200	2300
4035	Bamoro	Ivory Coast	300	1200
4017	Nongpoh	India	525	2509
4045	Sankos-1	India	50	4800
4004	Chinsapo	Malawi	1100	830

The seeds were planted in November of 1977 at the Jari company nursery in blocks arranged in a completely random design composed of 5 replications. The soil is an Oxisol derived from Tertiary sediments. The surface layer of sandy loam grades into sandy clay at about 30 cm.

Trees not needed for outplanting the provenance trials were left to grow in the nursery beds. Samples for wood density were taken at age 14 months in January of 1979. Average height of the trees was about 2 m. Wood samples were taken from the trunk beginning at a height of 5 cm above the ground line. A 7 cm long segment was cut from each stem. Diameter of the samples measured outside bark averaged about 3 cm. At the age of 17 months, the remaining trees were sufficiently tall to allow 7 cm samples to be taken at a height of 1.4 m above ground line.

At 14 months of age, all provenances had sufficient dominant trees to allow harvest of eight trees in each of the five replications. At 17 months, source 4008 and 4045 had eight samples taken from only three replications while source 4004 and 4017 had eight samples taken from only four replications. The remaining seven provenances were represented by eight samples from all five replications.

Immediately after collection, the wood samples were placed in water for 24 hours and then the bark was removed. Volume was determined by displacement. The samples were dried at 104°C in a laboratory oven for 24 hours or until constant weight was reached. The samples were then weighed in air to the nearest 0.1g after cooling in a dessicator for 30 minutes. Wood density was calculated as oven-dry weight divided by green volume.

Height at 17 months was measured to the nearest 0.1 m while diameter was measured to the nearest 0.1 cm.

A plot mean value was obtained for each provenance by averaging the eight samples of each replication. These means were analyzed as a standard, completely randomized design. The Dunnett procedure was used to see which provenances were significantly better or poorer than the local Jari source.

Simple linear correlations were run between wood density, height, diameter, rainfall, altitude, longitude, and latitude of the eight provenances native to India.

RESULTS

The experimental provenance mean values of the four characteristics are given in Table 2. At 14 months of age, the wood density between provenances ranges from .43 to .56 while at 17 months, the range is from .29 to .38 g/cc. The much greater density of the near ground samples is normal for this species, but this value gives an overestimate of average tree wood density. The samples taken at the different heights give essentially the same relative results, as the Ghotil-18 provenance is the most dense and the Chinsapo the least dense in both cases.

The 'F' test of the analysis of variance indicates significant differences among provenances at the .01 level of significance. Using Dunnett's procedure for identifying those provenances that are different from the local São Miguel source, we find the Chinsapo provenance to be significantly less dense at 14 months while the Ghotil-18 provenance is significantly heavier. At 17 months of age, none of the provenances is lighter than the São Miguel source while three are significantly heavier, Ghotil-18, Thithimathi and Lambasingi.

At 17 months of age, the diameter among provenances ranges from 2.4 to 3.3 cm. The provenance of least diameter is Sankos-1 while the largest is Nongpoh. None of the provenances is significantly of greater or lesser diameter than the local São Miguel source by the Dunnett test.

Table 2. Wood density, diameter and height for the provenances

Provenance	Wood density g/cc		Diameter (cm)	Height (m)
	14 months	17 months	17 months	17 months
Ghotil-18	.56+	.38+	2.8	4.5
Lambasingi	.51	.35+	2.5	3.6-
Thithimathi	.50	.36+	3.1	4.5
Maredumilli	.50	.34	3.2	4.5
Baramura	.50	.33	3.2	5.2
Shikaribari	.49	.32	3.1	5.2
São Miguel	.49	.31	3.0	5.3
Bamoro	.49	.31	2.8	5.1
Nongpoh	.48	.31	3.3	5.4
Sankos-1	.45	.30	2.4	3.6-
Chinsapo	.43-	.29	3.2	4.8
mean	.49	.33	3.0	4.7
Provenance 'F' value	11.1**	19.0**	3.3**	7.1**
Coefficient of variation %	4.6	4.2	10.9	10.6
Dunnett,.01 value	.05	.03	.7	1.1
Dunnett,.05 value	.04	.03	.6	.9

** Statistically significant at the .01 level.
\+ Significantly of greater wood density than São Miguel
\- Significantly of lesser wood density or shorter than São Miguel

At 17 months, the height among provenances ranges from 3.6 to 5.4 m. The Sankos-1 and Lambasingi sources are the shortest, while the Nongpoh source is the tallest. By the Dunnett test, there are no sources significantly taller than the local São Miguel source, but the Sankos-1 and Lambasingi sources are significantly shorter.

The simple linear correlations among the experimental variables and the seed source variables of only the eight provenances native to India are given in Table 3. At 14 months, the only significant 'r' values are those between wood density and rainfall and wood density and longitude. At 17 months, wood density is significantly correlated with all four of the seed source variables. At both ages, the tendency is for wood density to be greater with less rainfall, a higher altitude, a more southern latitude and a less eastern longitude. Height and diameter are not significantly correlated with any of the seed source variables. All 'r' values were .41 or less.

Table 3. Simple linear correlation for wood density with altitude, rainfall, latitude, and longitude

	Altitude	Rainfall	Latitude	Longitude
wood density 14 months	+.61	-.84**	-.58	-.71*
" " 17 months	+.71*	-.95**	-.85**	-.91**

* Statistically significant at the .05 level.
** Statistically significant at the .01 level.

DISCUSSION

This juvenile assessment indicates there is a sizeable amount of variation among these provenances. The percentage difference among provenances is 30 percent for wood density, 38 percent for diameter, and 50 percent for total height. These results are based on a small sample of the provenances that were collected. Larger differences will presumably be found when range-wide comparisons can be made.

For Jari, it appears from these juvenile results that genetic gains will be in wood density rather than growth. The approach would be to use plus trees from Jari and the most dense provenances, Ghotil-18, Thithimathi, and Lambasingi as parents in an inter-provenance hybridization program.

Gmelina arborea ROXB – PROGRAMA DE MELHORAMENTO GENÉTICO NA JARI

R. A. Woessner
Jari Florestal, Belém, PA.
BRASIL

Resumo

Melina tem características muito desejáveis que a faz apropriada para a produção de polpa, madeira para serraria ou laminados. Entretanto, mesmo em espalamentos apropriados para a produção de celulose, ela não é uma árvore de frente reto. A seleção de fenótipos de boa qualidade foi iniciada no Jari em 1973. 56 árvores "Plus" foram localizadas e usadas para estabelecer 70 ha de pomar de sementes. A produção de sementes no pomar mais antigo variou de 0.8 kg na idade de 1 ano para 87 kg na idade de 4 anos. Estão sendo feitos testes de progenes e assim os piores clones poderão ser removidos.

Um programa de cruzamento controlado entre os clones selecionados foi planejado a fim de possibilitar uma segunda geração de seleções. Um grande número de procedências de melina necessitam ser testadas para ampliar a base genética.

Gmelina arborea ROXB– GENETIC IMPROVEMENT PROGRAM AT JARI

Summary

Melina has very desirable wood characteristics which make it suitable for production of pulp, sawnwood, or veneer. However, even at spacings suitable for pulpwood production it is not a very straight tree. Selection of outstanding phenotypes was initiated at Jari in 1973. The goal was to select healthy straight trees of above average growth with well formed crowns. Fifty-six "Plus" trees were located and used to establish 70 ha of seed orchard. Seed production in the oldest orchard ranged from 0.8 kg at age one to 87 kg at age four. The orchards are being progeny tested so that the worst clones can be removed.

A controlled crossing program among the local selected clones is planned in order to provide second generation selections. A wider range of melina provenances needs to be tested to broaden the genetic base.

INTRODUCTION

Melina (Gmelina arborea Roxb.) is a native of southeast Asia that has been planted as an exotic in such places as Africa, Belize, Costa Rica and at Jari in the Brazilian Amazon. The planting program on the Jari lands in the state of Para, Brazil, began in 1968, and about 65,000 hectares had been planted at the close of the 1980 planting season. Most seed for the early planting program was collected from plantations in Africa. After 1975 Jari plantings were established with seed collected in our own plantations.

Melina is a desirable exotic plantation species not only because of its rapid early growth on clay soils and its ease of establishment, but also because of its suitability for a wide range of wood products; i. e., pulp, sawnwood, and veneer. From a genetic improvement viewpoint, the most serious problem is stem straightness. A reasonable spacing for pulpwood production is 3 m X 3 m. Even at this spacing, the majority of the stems have some degree of either sweep, crook, lean or forks. A fairly straight melina is an exception.

TREE IMPROVEMENT PROGRAM

Background

Tree improvement efforts were started at Jari in 1970 with the establishment of a 60-family replicated test using seed collected from individual trees in Belize. Measurements made after the trees were nine years old indicated that the best family was 62 percent (4.7 m) taller and 64 percent (7.5 cm) larger in diameter than the poorest. A test of eight naturalized African seed sources was also established in 1970. A 9-year growth evaluation indicated differences among the eight origins were smaller than differences between the individual families. However, the best seed origin was three percent taller and 19 percent larger in diameter than the poorest. The results from these two studies certainly indicated some degree of heritable variability.

A search of the literature cited in Forestry Abstracts revealed little information relative to genetic variation among melina families or provenances. Also, nothing was found on the biology of flowering or fruiting or the breeding system of melina. Lamb (1968) did state that no provenance trials existed and that little had been done to improve the properties and yield of melina. He further stated that the plants could be budded, but that no work had been done on the floral biology, and that melina may be self-pollinated.

A preliminary study on flower and fruit development led Okoro (1978) to conclude that the mode of pollination was not clear. An informal study done at Jari in 1976 indicated that the following orders of insects visited melina flowers: Hymenoptera, Diptera, Coleoptera, and Hemiptera.

Another trial at Jari revealed that flowers that were protected with pollination bags did not develop fruit. Bagged flowers that were cross-or self-pollinated developed fruit; unfortunately, the fruit aborted before full development. The suspected cause of the fruit loss was high temperatures inside the pollination bags.

Selection of "Plus" Trees

Selection of outstanding phenotypes was initiated in Jari stands in 1973. In total, some 15,000 hectares were searched, and 250 trees were selected for grading. Of these 250, only 56 were used in the seed orchard program, about one per 330,000 planted. The goal of the improvement program was to select healthy straight trees of above average growth with well formed crowns. The program was implemented in five stages:

a. The best stands were located by questioning field management personnel. Stands ranged in age from three to seven years.
b. A trained crew of five men and a tree improvement technician searched the selected stands and marked promising trees with flagging tape.
c. The tree improvement forester inspected the marked trees; some were graded and others were rejected after no or partial grading.
d. Final scores were calculated for each graded tree in the office.
e. Final acceptance of the "Plus" trees was determined after all graded trees were re-inspected by the tree improvement forester and the geneticist.

The grading sheet filled in by the tree improvement forester evaluates the following characteristics.

a. total height, apical height and height to live crown
b. diameter at 1.4 m and at 5 meters
c. bark thickness
d. stem straightness, pruning and roundness
e. branch angle and size
f. crown form and crown radius
g. site characteristics
h. tree age

When evaluating pruning ability, the candidate tree was compared to the eight nearest crop trees in order to assign points. For straightness, roundness, branch angle and size, and crown form, the candidate tree was rated against an established scale.

Superiority for diameter and height was based on a positive deviation from a linear regression equation. This was necessary because the tree age ranged from three to seven years. Tree diameters were adjusted for age, crown radius, and crown length (R^2= .66). The tree heights were adjusted only for age (r^2= .57).

The 250 graded trees were ranked by growth and form characteristics using the previously assigned scores. The top 100 of the 250 were selected for a re-examination in the field. A final selection of 56 "Plus" trees was made after this re-examination. The values for height, diameter and form characteristics of these 56 "Plus" trees are shown in Table 1 by age class.

Table 1. Values for 56 Jari melina "Plus" trees

Age yrs	Total height (m)	Diameter (cm)	Form 2/ factor	Branch Size 3/	Branch Angle 4/	Crown radius (m)	Apical 5/ height (m)	Number of trees
7	25.8	28.8	.79	1/8	2.0	3.3	20	13
6	22.8	27.3	.76	1/8	2.2	2.9	18	11
5	19.8	25.6	.75	2/8	2.5	2.8	13	2
4	19.2	25.2	.82	2/8	1.9	3.0	15	16
3	14.0	16.9	.71	3/8	2.0	2.3	11	4

2/ Form factor= diameter outside bark at 5 m/diameter outside bark at 1.5 m

3/ A branch size score of 1/8 means that the branches in the middle of the crown were 1/8 bole size at the point of branch attachment to the bole.

4/ The branch angle scores indicate that the average angle from the vertical in the middle of the crown was between 61 and 75°.

5/ Apical height is the central stem length up to a fork or where a definite central stem is no longer apparent.

No data have been collected on Jari stand averages for the various characteristics included in the grading system. However, the superiority of the 56 "Plus" trees over the 194 trees that were not accepted is shown in Table 2.

These values range from a high of 36 percent for stem straightness to 0 percent for angle, pruning, and roundness. The values in this table would indicate that there was a reasonably high phenotypic gain for height, diameter, stem straightness, and crown form and a low phenotypic gain for crown radius, form factor, and branch size. There was no gain in the case of branch angle, pruning, and stem roundness.

Table 2. Percentage superiority of the 56 "Plus" trees over 194 rejected candidate trees.

Height	Diameter	Straight stem	Crown Form	Crown Radius	Form factor	Branch Size	Branch Angle	Stem Pruning	Stem Roundness
16	21	36	25	7	3	1	0	0	0

Orchard establishment

Seed orchards were established at four different locations at Jari. Seventy hectares of orchard have been established to date. The preferred method for orchard establishment is to patch graft buds from the ortet onto seedlings planted in pots. The resulting grafts are well-formed, and they are easily transported to the field for transplanting where mortality and die-back are minimal. Using this method, seven thousand plantable grafts were produced and used to establish 61 hectares of orchard in one year. The average grafting success was 82 percent. Variation in survival among ortets ranged from 68 to 96 percent. Orchards have been established at spacings of 6 x 6, 7 x 7, and 10 x 10 m. The 10 x 10 m spacing is probably the best for most sites.

Orchard development

The growth, survival, and percentage of grafts with flowers or fruits is shown in Table 3 for the Caracurú and Pilão seed orchards. At 53 months the Caracurú orchard had the same crown width but was 10 percent shorter than the Pilão orchard at 26 months. These growth differences are due to soil type. The Caracurú orchard is on a sandy loam soil, whereas the Pilão orchard is on a clay soil.

The crown width data indicate the potential spacings that should be used. Any spacing not greater than 7 x 7 m would be too close after four years at Caracurú or two years at Pilão.

Survival at both orchard sites is excellent, an average for both sites of 97 percent. Little, if any, of the three percent mortality can be attributed to graft incompatibility as occurs in pine. If it occurs, there are no obvious symptoms.

At the Caracurú orchard, 94 percent of the grafts had either flowers or fruit by age 32 months; at Pilão only 5 percent of the grafts had flowers or fruit at 26 months. Melina appears to flower more heavily when planted slightly off-site.

Table 3. Tree development in the two oldest Jari melina seed orchards.

Age months	Diameter (cm)	Height (m)	Crown Width (m)	Percent Survival	Percent Fl/Fr 6/
			Caracurú		
32	10.6	-	-	99	94
43	16.6	7.6	6.3	99	97
53	16.7	7.7	6.4	99	98
			Pilão		
6	-	1.6	-	98	-
15	8.5	4.8	5.2	97	-
26	15.5	8.5	6.4	95	5

6/ Percentage of grafts with flowers or fruit.

Seed Production

The productivity of the Caracurú seed orchard over a four year period is shown in Table 4. Production in kilos of dried seed per ha was 0.8 at age one and rose to 95.7 at age three. The lower production of 87.2 kilos per ha in year four was due solely to low production during the normally peak month of

December since in both years three and four, essentially the same amount of seed was collected at the beginning and end of the collection season.

Weekly from November through March green or yellow fruit is collected from the ground. The methods for depulping the fruit, cleaning, and then storing the seed are described by Woessner and McNabb (1979).

The data from Table 4 can be used to estimate that about 145,000 seeds will be produced per hectare of orchard at age four. The germination of orchard seed was higher than woods run seed based on the seed collected at age two in this orchard. One hundred and forty seedling germinated for every 100 seeds planted. This is not unusual for melina since a seed can have up to five viable embryos. Seventy-four percent of the seeds should have no more than two embryos (Woessner and McNabb, 1979).

Table 4. Seed produced in the Caracurû Seed Orchard.

Years after establishment	Production Fruit Kilos/ha	Production Seed Kilos/ha	Seeds produced per ha of orchard 7/
1	13	0.8	1,280
2	922	57.6	92,160
3	1531	95.7	153,120
4	1395	87.2	139,520

7/ Assumes 1600 seeds per kg. Spacing is 7 x 7 m.

Testing of the Orchard

The superiority of the selected clones in the orchard is being evaluated in three ways. First, seed is collected from ramets of each individual cone and used to test each clone against all others and a nursery-run lot. Second, bulked lots of seed collected in the orchard are compared to a nursery-run lot. These tests are planted in two different years at three to four different locations. The normal pulpwood rotation for melina is six years, so a definitive evaluation for growth and form can be made four years after the establishment of the progeny test. The third evaluation is done on the grafts in the orchard. This is mainly on branching characteristics since even casual observations reveal some rather striking differences among clones in branch size and angle.

Areas in Need of Further Research

Future gains can be made by breeding the local selections and by obtaining new genetic material from other sources. A controlled crossing program needs to be initiated with the clones that have been selected so far. However, the techniques for controlled pollination must be worked out before this can be started. Also, the question of whether melina is mainly self-or cross-pollinated needs to be resolved.

Jari is currently testing various provenances of melina supplied by the DAN/FAO forest tree seed center. Height measurements made at 18 months after field planting indicated that none of the provenances had grown any taller than the Jari nursery run, but some had denser wood. The majority of these provenances are from India; possibly sources from Burma or Thailand would be faster growing. Jari looks forward to putting more provenances under test.

REFERENCES

Lamb, A.F.A. 1968 Fast-growing timber trees of the lowland tropics NO 1, Gmelina arborea. Oxford: Commonwealth Forestry Institute, University of Oxford, 31 pp.

Okoro, O.O. 1978 Preliminary studies on flower and fruit development in Gmelina arborea Roxb. Proceedings: A symposium on Flowering and Seed Development in Trees. Mississippi State University U.S.A. pp. 83-95.

Woessner, R.A. and McNabb, K.L. 1979 Large Scale Production of Gmelina arborea Roxb. Seed--A Case Study. Commonw. For. Rev. 58,2 (1979). pp. 117-121.

sessão 11 session 11 grupo group A'

FAST GROWING TREES

COMPORTAMENTO DE ESPÉCIES E VARIEDADES DE *Pinus* EM JABOTICABAL, SP — RESULTADOS AOS 5 ANOS

I. B. Aguiar — S. V. Valeri — M. Soma
F. C. A. V. / UNESP — Jaboticabal
BRASIL

Resumo

O presente experimento teve a finalidade de estudar o comportamento de 6 espécies e variedades de *Pinus* em Jaboticabal, SP. Os resultados obtidos aos 5 anos mostraram que (a) *P. caribaea* var. *bahamensis* e *P. caribaea* var. *caribaea* apresentaram ótimo crescimento e boa uniformidade; (b) *P. oocarpa* e *P. caribaea* var. *hondurensis* apresentaram ótimo crescimento e pouca uniformidade em DAP nas duas espécies e em altura no *P. caribaea* var. *hondurensis*; (c) *P. patula* apresentou crescimento razoável e pouca uniformidade em DAP e (d) *P. elliottii* var. *densa* mostrou-se imprópria para a região em estudo.

BEHAVIOUR OF *Pinus spp* IN JABOTICABAL, SP (BRAZIL): FIVE YEARS GROWTH

Summary

The behaviour of 6 pine species and varieties was studied in Brazil, 48° 19' west Greenwich long. and 21° 16' south lat., 575 m. The results obtained to 5 years showed that (a) the best growth was obtained by *P. caribaea* var. *bahamensis*, *P. caribaea* var. *caribaea*, *P. caribaea* var. *hondurensis* and *P. oocarpa*, but only *P. caribaea* var. *bahamensis* and *P. caribaea* var. *caribaea* presented a good uniformity in diameter and height; (b) *P. oocarpa* presented a good uniformity only in diameter; (c) *P. patula* presented a reasonable growth, but little uniformity in diameter; (d) *P. elliottii* var. *densa* was considered non adaptable.

Introdução

Informações locais sobre a adaptação de espécies de *Pinus* são de real importância na eleição da espécie a ser utilizada na implantação de reflorestamentos. Assim, o presente trabalho tem o objetivo de avaliar o comportamento de algumas espécies e variedades de *Pinus* no Município de Jaboticabal - SP.

Trabalhos de pesquisa desenvolvidos no Estado de São Paulo fornecem

informações sobre o comportamento de espécies de *Pinus* em outras regiões, como os trabalhos de VEIGA (1963), GOLFARI (1967), GURGEL FILHO (1970), KRONKA et alii (1976), GARRIDO & NEGREIROS (1976), BERTOLANI & NICOLIELO (1977) e BALLONI et alii (1978).

Material e Métodos

O experimento foi instalado em área pertencente à Faculdade de Ciências Agrárias e Veterinárias - UNESP "Campus" de Jaboticabal, localizada a 48º 19' de longitude oeste de Greenwich e 21º 16' de latitude sul, a uma altitude de 575 metros. O clima e o solo da área são classificados por ALOISI & DEMATTÊ (1974) como Cwa com base no sistema de Köppen e latossol vermelho escuro fase arenosa, série Santa Tereza, respectivamente.

As seguintes espécies e variedades de *Pinus* foram testadas, com os respectivos países de origem das sementes: *P. caribaea* Mor. var. *caribaea* (Cuba), *P. caribaea* Mor. var. *hondurensis* Barr. & Golf. (Guatemala), *P. caribaea* Mor. var. *bahamensis* Barr. & Golf. (Bahamas), *P. elliottii* Eng. var. *densa* Litt. & Dorm. (EUA, Flórida), *P. oocarpa* Sch. (Honduras) e *P. patula* Schl. & Cham. (Brasil , Cia. Melhoramentos de São Paulo).

O plantio foi efetuado em 25 de março de 1975 sob o espaçamento de 3 x 2 m, seguindo um delineamento de blocos casualizados com 6 tratamentos e 4 repetições, sendo cada parcela constituída de 25 plantas úteis mais bordadura simples.

Os resultados foram avaliados aos 5 anos de idade, quando foram levantados dados de diâmetro a altura do peito (DAP), altura total, volume cilíndrico e porcentagem de sobrevivência.

Resultados

Verifica-se pelos dados do quadro 1, que das espécies testadas, *P. oocarpa* e as 3 variedades de *P. caribaea* apresentaram excelente índice de crescimento e resultados bastante semelhantes. Maior uniformidade foi apresentada pelo *P. caribaea* var. *bahamensis* e *P. caribaea* var. *caribaea*, como se constata pelos valores de coeficiente de variação. *P. caribaea* var. *hondurensis* apresentou pouca uniformidade tanto em diâmetro como em altura, enquanto que *P. oocarpa* mostrou uma boa uniformidade apenas em altura.

Estes resultados vem confirmar as afirmações de GOLFARI (1967) que considerou aptas para a região onde se localiza o Município de Jaboticabal, entre outras espécies, *P. caribaea* var. *caribaea*, *P. caribaea* var. *hondurensis* e *P. oocarpa*. Vem também confirmar a espectativa de GOLFARI (1967) e GURGEL FILHO (1970), que consideraram o *P. caribaea* var. *bahamensis* uma espécie promissora para a região em estudo.

Embora os valores de altura alcançados pelo *P. patula* tenham sido inferiores apenas aos do *P. oocarpa*, o seu crescimento pode ser considerado inferior, levando-se em conta os valores de DAP e volume cilíndrico. *P. elliottii* var. *densa* foi a espécie que apresentou menor índice de crescimento e embora GOLFARI (1967) a tivesse considerado promissora, o seu incremento médio anual em altura foi inferior a 1 m o que, de acordo com o próprio autor, torna esta espécie imprópria para a região em estudo.

Referências Bibliográficas

ALOISI, R.R. & DEMATTÊ, J.L.I. - Levantamento de solos da Faculdade de Medicina Veterinária e Agronomia de Jaboticabal. *Científica*, Jaboticabal 2(2): 123-136, 1974.

BALLONI, E.A.; KAGEYAMA, P.Y.; NICOLIELO, N.; JACOB, W.S. Resultados parciais dos testes de procedências dos *Pinus* tropicais e potencial de produção de sementes no Estado de São Paulo. *IPEF, Boletim Informativo*, Piracicaba, 6(19): 63-81, 1978.

BERTOLANI, F. & NICOLIELO, N. *Comportamento e programa de melhoramento genético de pinus tropicais na região de Agudos - SP., Brasil.* PRODEPEF, Brasília, 1977, 18 p. (Comunicação Técnica, 18).

GARRIDO, M.A.O. & NEGREIROS, O.C. *Competição entre diferentes espécies do gênero Pinus em Assis e Teodoro Sampaio.* Instituto Florestal, São Paulo, 1976, p. 1-15. (Boletim Técnico, 22).

GOLFARI, L. Coníferas aptas para repoblaciones forestales en el Estado de São Paulo. *Silvicultura em São Paulo*, São Paulo, 6: 7-62, 1967.

GURGEL FILHO, O.A. Pesquisa e experimentação com *Pinus* sp. no Estado de São Paulo. *Silvicultura em São Paulo*, São Paulo, 7: 127-146, 1970.

KRONKA, F.J.N.; EMMERICH, W; KRONKA, S.N. Ensaio de competição de espécies de *Pinus* em duas regiões do Vale do Paraíba. *Silvicultura em São Paulo*, São Paulo, 10: 37-43, 1976.

VEIGA, A.A. Competição entre espécies de *Pinus*. *Revista de Agricultura*, Piracicaba, 38(2): 63-66, 1963.

QUADRO 1 - Valores médios de diâmetro (DAP), altura (H), volume cilíndrico (V) e porcentagem de sobrevivência (S) obtidos aos 5 anos para *Pinus* spp. plantados em Jaboticabal em março de 1975.

	Diâmetro			Altura			Volume cilíndrico		S
	DAP(cm)	CV(%)	IMA	H (m)	CV(%)	IMA	V(m^3/ha)	IMA	(%)
P. oocarpa	13,09 a	24,66	2,62	9,95 a	18,01	1,99	224,48 a	44,90	94
P. caribaea var. *bahamensis*	13,50 a	19,81	2,70	9,52 ab	15,64	1,90	232,78 a	46,56	99
P. caribaea var. *caribaea*	12,89 a	15,46	2,58	9,24 ab	19,20	1,85	191,84 a	38,37	94
P. caribaea var. *hondurensis*	13,42 a	36,13	2,68	8,92 ab	27,92	1,78	222,42 a	44,48	93
P. patula	10,78 b	31,74	2,16	8,42 b	20,23	1,68	119,12 b	23,82	86
P. elliottii var. *densa*	7,15 c	23,30	1,43	4,07 c	24,58	0,81	27,23 c	5,45	95
Valores de F	39,60**			57,17**					2,38
D.m.s. (Tukey a 5%)	1,82			1,31					-
Coeficiente de Variação (%)	6,71			6,85					8,79

Médias seguidas da mesma letra não diferem entre si, ao nível de 5% de probabilidade.

CV = Coeficiente de variação; IMA = Incremento médio anual.

PRODUÇÃO DE MADEIRA SECA DE *Pinus elliottii*

M.A. Mourão Brasil — R.A.A.Veiga
Faculdade de Ciências Agronômicas — Botucatu
L. C. Costa Coelho
Instituto Florestal — São Paulo
BRASIL

Resumo

Neste trabalho os autores apresentam um modelo estatístico para determinar o peso seco sem casca, do fuste de árvores de *Pinus elliottii* var *elliottii*. Os dados utilizados foram obtidos através do abate de 101 árvores (10 a 20 anos de idade) em diferentes regiões do Estado de São Paulo — Itapeva, Itapetininga e Mogi Guaçu.

Diferentes modelos foram testados através do método dos quadrados mínimos. O melhor modelo obtido foi o seguinte:

$$\log_e P = -5,44686333 + 1,71136277 \log_e D + 1,776049 \log_e H$$

onde P representa o peso seco do fuste sem casca, expresso em kilogramas, D o diâmetro a altura do peito em centímetros e H a altura total do fuste (até 4 cm com casca) em metros.

STEM DRY WEIGHT YIELD IN SLASH PINE *(Pinus elliottii* ENGELM. VAR. *elliottii)* TREES

Summary

In order to determine the stem dry weight without bark up to 0,04 m top diameter with bark, one hundred one Slash Pine trees, 10 to 20 years old, were cut off at Itapeva, Itapetininga and Mogi Guaçu, different sites of São Paulo State, Brazil.

Different regression models were tested by the least squares regression method.

The equation

$$\log_e P = -5,44686333 + 1,71136277 \log_e D + 1,776049 \log_e H ,$$

express the stem dry weight without bark (P), in kilograms, as a function of dbh without bark (D) and total height (H) expressed respectively in centimeters and meters.

Introdução

Em trabalhos com *Eucalyptus propinqua, E. saligna* e *E. urophylla*, VEIGA & BRASIL (1980) e VEIGA, BRASIL & FERREIRA (1980) desenvolveram equações para estimativa do peso de matéria seca em função do DAP e da altura total da árvore.

No presente estudo procura-se dar continuidade aos referidos trabalhos testando modelos de regressão para selecionar equação de peso para *Pinus elliottii* Engelm. var. *elliottii*.

Material e Métodos

A espécie estudada foi *Pinus elliottii* Engelm. var. *elliottii*, de plantações localizadas em Hortos Florestais pertencentes ao Instituto Florestal, no Estado de São Paulo.

Foram amostradas 101 árvores, sendo 41 de Itapeva, 38 de Itapetininga e 22 de Mogi Guaçu. Os solos dos locais de amostragem são: latosol vermelho amarelo orto, em Itapeva; podzólico vermelho amarelo variação Laras, em Itapetininga; e latosol vermelho amarelo fase arenosa, em Mogi Guaçu. Os climas dessas localidades são classificados segundo o sistema de Köppen como Cfa em Itapeva e Itapetininga, e Cwa em Mogi Guaçu.

As árvores utilizadas tinham DAP com casca variando de 12,2 a 27,3 cm e alturas totais desde 12,4 a 21,6 m. As idades variaram de 10 a 13 anos em Itapeva, de 13 a 20 anos em Itapetininga, e as árvores de Mogi Guaçu tinham de 18 a 19 anos de idade.

De cada árvore amostrada foram extraídos discos de 2 em 2 m (e à altura do DAP) cujas densidades foram determinadas através do método da balança hidrostática. Foram realizadas medições de diâmetro em cada secção, para estimativas de volume pela fórmula generalizada de Smalian. Calculou-se para cada árvore o volume comercial sem casca até o diâmetro de desponta de 4 cm, e a densidade básica média e o peso correspondentes.

Foram testados os modelos de regressão seguintes:

$$P = b_o + b_1 V$$

$$P = b_o + b_1 D^2 H$$

$$P = b_o + b_1 D^2 + b_2 H + b_1 D^2 H$$

$$P = b_o + b_1 D^2 H + b_2 d_D$$

$$\log_e P = b_o + b_1 \log_e (D^2 H)$$

$$\log_e P = b_o + b_1 \log_e D + b_2 \log_e H$$

onde P exprime o peso em kg de matéria seca da parte comercial do fuste, excluida a casca. V representa o volume comercial sem casca, em dm^3; d_D a densidade ao nível do DAP; e D e H exprimem o DAP com casca e a altura total da árvore, respectivamente em cm e m.

Resultados e Discussão

Os valores obtidos testando as 5 equações em estudo constam nas tabelas 1 e 2.

Cotejando-se os resultados inseridos nas tabelas 1 e 2, destaca-se a elevada precisão com que o peso de matéria seca pode ser estimado em função do volume comercial sem casca (equações 1, 7, 13 e 19). Tais equações deverão ser de utilidade às estimativas de peso para a espécie em estudo.

Do ponto de vista prático, cabe ressaltar a viabilidade de estimar-se o peso em função do DAP com casca e da altura total da árvore. Os resultados obtidos mostram que boa precisão pode ser atingida pelo uso do modelo

$$P = b_o + b_1 D^2 + b_2 H + b_3 D^2 H$$

para os dados de Itapetininga e Mogi Guaçu (equações 9 e 15) e

$$\log_e P = b_o + b_1 \log_e D + b_2 \log_e H$$

para Itapeva e para o conjunto de locais (equações 6 e 24). A precisão dessas equações é pouco inferior à do modelo

$$P = b_o + b_1 D^2 H + b_2 d_D$$

(equações 4, 10, 16 e 22), que incorre na desvantagem de incluir mais uma variável, a densidade básica ao nível do DAP, cuja determinação envolve atividades de laboratórios.

Desse modo, pode-se indicar para Itapeva, Itapetininga e Mogi Guaçu, respectivamente as equações 6, 9 e 15, para a estimativa do peso de matéria seca da parte comercial do fuste de árvores da espécie em estudo em condições de idade similares às do presente trabalho.

Considerando-se os resultados de maneira global, pode-se recomendar para o conjunto de locais a equação 24, para maciços com características semelhantes aos utilizados neste estudo. Com base na referida equação foram calculados valores de P em função de D e H, os quais encontram-se inseridos na tabela 3, estando delimitada entre linhas cheias a distribuição original dos dados utilizados.

Os autores tem intenção em dar continuidade ao presente trabalho, com ampliação na amostra e extensão a outras espécies.

Tabela 1. Resultados obtidos para as equações testadas. Valores de P expressos em kg, de V em dm^3, de H em m e de D em cm.

	Equação obtida
Itapeva	
1	$P = -4,55638636 + 0,40555671\ V$
2	$P = -0,80951035 + 0,01236372\ D^2\ H$
3	$P = 28,18937292 - 0,14213790\ D^2 - 1,42872989\ H + 0,02023720\ D^2\ H$
4	$P = -77,52955502 + 0,01217077\ D^2\ H + 187,140176\ d_D$
5	$\log_e P = -4,34124433 + 0,99218410\ \log_e D^2\ H$
6	$\log_e P = -4,89001818 + 1,84776826\ \log_e D + 1,33972559\ \log_e H$
Itapetininga	
7	$P = 2,474919 + 0,41891637\ V$
8	$P = -14,39226068 + 0,01672559\ D^2\ H$
9	$P = 125,01724395 - 0,41699234\ D^2 - 7,43192982\ H + 0,03892089\ D^2\ H$
10	$P = -96,86307487 + 0,01753153\ D^2H + 156,042327\ d_D$
11	$\log_e P = -4,60306904 + 1,04005039\ \log_e D^2\ H$
12	$\log_2 P = -4,93024533 + 1,95735739\ \log_e D + 1,28485585\ \log_e H$
Mogi Guaçu	
13	$P = -9,25221647 + 0,56258198\ V$
14	$P = 1,31678379 + 0,01544119\ D^2\ H$
15	$P = -111,16752544 + 0,15178810\ D^2 + 7,36439908\ H + 0,00480451\ D^2\ H$
16	$P = -99,57715282 + 0,01493275\ D^2H + 185,253985\ d_D$
17	$\log_e P = -4,40442873 + 1,02694263\ \log_e D^2\ H$
18	$\log_e P = -5,72384175 + 1,67390591\ \log_e D + 1,89115188\ \log_e H$
Conjunto de locais	
19	$P = 0,49173832 + 0,42686498\ V$
20	$P = -4,69049335 + 0,01452236\ D^2\ H$
21	$P = 55,58968858 - 0,31766897\ D^2 - 2,65871105\ H + 0,03105793\ D^2\ H$
22	$P = -82,03122446 + 0,01479452\ D^2\ H + 157,969432\ d_D$
23	$\log_e P = -4,37073674 + 1,00824843\ \log_e D^2\ H$
24	$\log_e P = -5,44686333 + 1,71136277\ \log_e D + 1,776049\ \log_e H$

Tabela 2. Parâmetros estatísticos correspondentes às equações relacionadas na tabela 1 (R^2 = coeficiente de determinação; CV = coeficiente de variação; s = desvio padrão residual; F = valor do teste F da regressão).

Equação	R^2	CV(%)	s	F
Itapeva				
1	0,9539	9,42	7,9861	806,73
2	0,8914	14,46	12,2584	319,96
3	0,8972	14,44	12,2417	107,64
4	0,9284	11,88	10,0748	246,71
5	0,9221	2,99	0,1301	461,83
6	0,9244	2,98	0,1298	232,33
Itapetininga				
7	0,9660	9,74	9,3833	1021,55
8	0,8778	18,45	17,7765	258,60
9	0,9058	16,67	16,0633	108,93
10	0,9063	16,38	15,7806	169,41
11	0,8699	3,66	0,1635	240,69
12	0,8743	3,65	0,1630	121,76
Mogi Guaçu				
13	0,9614	8,61	9,0399	498,74
14	0,9040	13,59	14,2632	188,38
15	0,9194	13,12	13,7699	68,52
16	0,9219	12,58	13,2019	112,11
17	0,8838	3,55	0,1621	152,06
18	0,9134	3,15	0,1436	100,14
Conjunto de locais				
19	0,8942	15,46	14,4619	836,91
20	0,8288	19,67	18,3980	479,28
21	0,8649	17,56	16,4267	313,70
22	0,8947	15,51	14,5025	416,34
23	0,8526	3,99	0,1772	572,89
24	0,8772	3,66	0,1626	350,18

TABELA 3. Estimativa do peso de uma árvore em função do DAP e da altura total. Valores expressos em kg de matéria seca, estimados para o fuste sem casca de *Pinus elliottii* var. *elliottii* até o limite de desponta de 0,04 m, calculados para árvores de 3 locais, com idades de 10 a 20 anos.

DAP	ALTURA TOTAL (m)															
(cm)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
9	11,0	13,0	15,2	17,6	20,0	22,7	25,4	28,3								
10	13,2	15,6	18,3	21,0	24,0	27,2	30,5	33,9								
11	15,5	18,4	21,5	24,8	28,3	32,0	35,9	39,9								
12	18,0	21,4	25,0	28,8	32,8	37,1	41,6	46,4	51,3	56,5	61,9	67,5	73,3	79,4		
13	20,7	24,5	28,6	33,0	37,7	42,6	47,7	53,2	58,9	64,8	71,0	77,4	84,1	91,0		
14	23,5	27,8	32,5	37,5	42,8	48,3	54,2	60,4	66,8	73,6	80,6	87,9	95,5	103,3		
15	26,4	31,3	36,6	42,2	48,1	54,4	61,0	68,0	75,2	82,8	90,7	98,9	107,4	116,3		
16	29,5	35,0	40,9	47,1	53,7	60,8	68,1	75,9	84,0	92,5	101,3	110,5	120,0	129,9		
17	32,8	38,8	45,3	52,3	59,6	67,4	75,6	84,2	93,2	102,6	112,4	122,6	133,1	144,1		
18	36,2	42,8	50,0	57,6	65,8	74,3	83,4	92,9	102,8	113,1	123,9	135,2	146,8	158,9		
19		47,0	54,8	63,2	72,1	81,5	91,5	101,9	112,7	124,1	136,0	148,3	161,0	174,3		
20		51,3	59,9	69,0	78,8	89,0	99,9	111,2	123,1	135,5	148,4	161,9	175,8	190,3		
21		55,8	65,1	75,1	85,6	96,8	108,6	120,9	133,8	147,3	161,4	176,0	191,1	206,8		
22		60,4	70,5	81,3	92,7	104,8	117,5	130,9	144,9	159,5	174,7	190,6	207,0	224,0		
23		65,2	76,1	87,7	100,1	113,1	126,8	141,3	156,4	172,1	188,6	205,6	223,3	241,7		
24		70,1	81,8	94,3	107,6	121,7	136,4	151,9	168,2	185,1	202,8	221,2	240,2	260,0	280,4	301,5
25		75,2	87,8	101,2	115,4	130,5	146,3	162,9	180,4	198,5	217,5	237,2	257,6	278,8	300,7	323,3
26				108,2	123,4	139,5	156,5	174,3	192,9	212,3	232,6	253,6	275,5	298,1	321,5	345,7
27				115,4	131,7	148,8	166,9	185,9	205,8	226,5	248,1	270,6	293,9	318,0	343,0	368,8
28				122,8	140,1	158,4	177,6	197,8	219,0	241,1	264,0	288,0	312,8	338,5	365,0	392,5
29				130,4	148,8	168,2	188,6	210,1	232,5	256,0	280,4	305,8	332,1	359,4	387,6	416,8
30				138,2	157,7	178,2	199,9	222,6	246,4	271,3	297,1	324,0	352,0	380,9	410,8	441,7

Conclusões

Com base nos resultados pode-se indicar as seguintes equações para a estimativa do peso de matéria seca (P) da parte comercial sem casca do fuste de árvores de *Pinus elliottii* Engelm. var. *elliottii*.

a. Para populações com 10 a 13 anos, da região de Itapeva, S.P.:
$\log_e P = -4,89001818 + 1,84776826 \log_e D + 1,33972559 \log_e H$

b. Para povoamentos com 13 a 20 anos, da região de Itapetininga, S.P.:
$P = 125,01724395 - 0,41699234 D^2 - 7,43192982 H + 0,03892089 D^2H$

c. Para maciços com 18 a 19 anos, da região de Mogi Guaçu, S.P.:
$P = -111,16752544 + 0,15178810 D^2 + 7,36439908 H + 0,00480451D^2H$

d. Para o conjunto de locais, com idades de 10 a 20 anos:
$\log_e P = -5,44686333 + 1,71136277 \log_e D + 1,776049 \log_e H$

sendo os valores do DAP (D) expressos em cm, os da altura total (H) em m, e do peso de matéria seca em kg.

Referências

VEIGA, R.A.A.; BRASIL, M.A.M. Equações para estimativas de peso de matéria seca e de volume para *Eucalyptus propinqua* Deane ex Maiden. *Simpósio IUFRO em melhoramento genético e produtividade de espécies florestais de rápido crescimento*, Águas de São Pedro, 1980.

VEIGA, R.A.A.; BRASIL, M.A.M.; FERREIRA, M. Estimativa do peso da parte comercial do fuste de *Eucalyptus saligna* e *E. urophylla* em ocasião de primeiro corte. *Simpósio IUFRO em melhoramento genético e produtividade de espécies florestais de rápido crescimento*, Águas de São Pedro, 1980.

FAST GROWING TREES

DADOS PRELIMINARES SOBRE A POTENCIALIDADE DE RESINAGEM NA REGIÃO DE SACRAMENTO (MG)EM QUATRO ESPÉCIES DE PINUS TROPICAIS

L.R. Capitani — G. E. Speltz
Reflorestadora Sacramento Resa Ltda
J. O. Brito
ESALQ — USP
BRASIL

Resumo

1. A espécie *Pinus caribaea* var. *bahamensis* com 77 meses de idade demonstrou maior produção de resina com variação menor de coeficiente em relação ao *Pinus elliottii* var. *deusa*, *Pinus caribaea* var. *hondurensis* e *Pinus oocarpa*, este com 91 meses de idade, com um diâmetro mínimo de 16 centímetros, na região de Sacramento — MG.

2. As maiores produções das espécies estudadas foram nos meses de Setembro/Outubro e Março/Abril, mostrando alguma correlação com as condições climáticas (temperatura média e precipitação pluviométrica).

3. Esta análise química mostra que o *Pinus caribaea* var. *hondurensis* apresentou bom rendimento em resina, e o *Pinus elliottii* var. *densa* em turpentina e α e β pipeno, não havendo diferença entre as quatro espécies em relação a qualidade da resina, excepto para o *Pinus oocarpa*.

TROPICAL PINES POTENTIAL FOR RESIN PRODUCTIONS IN SACRAMENTO (MG) BRAZIL

Summary

1. With relation of resin production the species Pinus caribaea var. bahamensis with 77 (seventy seven) months of age is demonstrated to producer bigger of resin with variation of coefficient less by relation of Pinus elliottii var. densa, Pinus caribaea var. hondurensis and Pinus oocarpa, this with 91 (ninety one) months of age, for one minimun diameter of 16 (sixteen) centimeters, in Region of Sacramento - Minas Gerais.

2. This larger produtions of resin given for studies species in months of September/October and March/April, there's slowing some correlation with the climate conditions (mean temperature and precipitation pluviometric).

3. This chemistry analusis slowing that Pinus caribaea var. hondurensis introduced the preferable revenue by pitch and this Pinus elliottii var. densa by turpentine and puport by α and β pipeno, don't having difference between this four species with relation of pitch quality, except to the Pinus oocarpa.

1. INTRODUÇÃO

A área reflorestada incentivada com o gênero Pinus, originais de zonas tropicais da América Central, vem aumentando consideravelmente em zonas de cerrado no Brasil Central, e a diversificação do uso de sua madeira vêm assumindo grande importância no cenário madeireiro nacional.

As espécies P. caribaea Morelet e P. oocarpa Shiede vem mostrando um grande potencial em função dos altos incrementos volumétricos até então alcançados.

Sendo assim e tendo as empresas Reflorestadoras que arcar com um alto custo de manutenção à partir do 5º ano da floresta, no que se refere principalmente à proteção, urge que estas busquem fontes alternativas, visando uma integração florestal, procurando antecipar com estas o retorno mais rápido da remuneração do capital.

Uma destas alternativas é a resinagem; e, tendo em vista os poucos trabalhos existentes sobre esta prática, principalmente nos Pinus tropicais plantados em zonas de cerrado e acentuado deficit hídrico levaram à condução deste ensaio, visando também objetivar a indispensável orientação técnica e econômica sobre esta operação.

2. REVISÃO BIBLIOGRÁFICA

BARRICHELLO & BRITO (1.978) estudando as condições climáticas sobre produção de resina em pinheiros tropicais de 10 anos de idade, na localidade de Piracicaba - SP, concluíram que o P. caribaea v. bahamensis produziu maior quantidade de resina em relação ao P. oocarpa e P. kesiya, sendo que a medida de produção quinzenal da variedade bahamensis for superior estatisticamente ao nível de 1% de probabilidade e que entre as outras duas espécies não houve diferença significativa. Concluiram ainda não haver correlação entre a produção de resina das espécies e a temperatura e precipitação pluviométrica. Afirmam ainda que a resinagem em Pinheiros tropicais pode ser feita durante o ano todo sobre temperaturas médias quinzenais situadas entre 16° e 25° C.

Segundo BERZAGHI (1.972), a resinagem deve ser interrompida quando a temperatura média diária for inferior à 16° C. O Pinus elliottii var. elliottii produz menor quantidade de resina da estação primavera para o inverno. A diferença entre as estações foi de 23% e este decréscimo foi correlacionado com a diminuição da temperatura e precipitação (GURGEL - 1.972).

GURGEL et allii (1.978), relatam não haver diferença significativa entre as médias de altura das árvores, incrementos periódicos e diâmetros, nas árvores de P. elliottii v. elliottii, resinadas durante dois anos em 1 e 2 faces e a testemunha, em um povoamento estagnado e o outro não. Em outro experimento os mesmos autores concluiram que as árvores da face de resinagem voltadas ao norte, dão maior produtividade no 1º ano de exploração, já no 2º ano, não houve diferença estatística entre as faces voltadas ao norte e leste.

A fertilidade do solo e o espaçamento influenciam diretamente o crescimento da copa, diâmetro e altura das árvores e estas com a produção de resina (KAGEYAMA & FONSECA - 1.978).

Com relação à um programa de melhoramento estes autores relatam que ganhos expressivos na produção de resina são fáceis de serem conseguidos se fosse aliada à tecnologia de resinagem, um material genético superior selecionado para alta produção. SQUILLACE & DORMAN (1.961) citado por KAGEYAMA & FONSECA (1.978), mostraram em vários trabalhos que o P. elliottii v. elliottii possui forte controle genético para a característica "produção de resina".

Com relação ao mercado, dados da HARIMA DO PARANÁ IND. QUÍMICA LTDA, mostram que o Brasil possui todos os requisitos essenciais para competir pela quantidade e qualidade de resina no mercado mundial. Segundo os autores, se forem aproveitados somente 50% dos Pinus plantados no Brasil, em 1.986 o Brasil poderá abastecer todo o mercado interno, restando cerca de 140 mil tons. de breu para exportar. Em 1.978 previram que o Brasil tinha a capacidade de produzir 7,5% do total de colofonia produzida no mundo e 7,3% do breu de TALL-OIL. Já em 1.986 poderá ser alcançada 70% da produção mundial de 1.978 de colofonia e o 2º lugar na escala mundial de produção de breu de TALL-OIL.

Segundo a CIA. AGRO FLORESTAL MONTE ALEGRE (1.978), para o mercado daquele ano e pelo preço de venda da goma resina somente era viável produzi-lá, pelo método normal de resinagem, para a

espécie P. elliottii v. elliottii com idade de 16 anos e 500 arv/ha, que alcançava em média 165 gr/arv/coleta.

Para as demais espécies de Pinus tropicais o custo total de produção comercial não compensava a operação.

3. MATERIAL E MÉTODOS

3.1. Material

Neste ensaio foram escolhidos quatro talhões de Pinus, assim distribuídos:

Espécie	Data Plantio	Espaçamento	Idade
a. Pinus elliottii v. densa	02/71	3,0 X 2,5 m	91 m
b. Pinus caribaea v. hondurensis	02/71	3,0 X 2,5 m	91 m
c. Pinus caribaea v. bahamensis	04/72	3,0 X 2,0 m	77 m
d. Pinus oocarpa	02/71	3,0 X 2,5 m	91 m

Estes plantios foram efetuados sem nenhuma correção de solo, bem como adubação, em solos do Horto Florestal Chapadão do Bugre, município de Sacramento, MG, Segundo GOLFARI et allii (1.978), em Zoneamento Ecológico Esquemático para Reflorestamento no Brasil, esta Região foi classificada bioclimaticamente como de nº 11, e possui as seguintes características:

. Altitude - 900 - 1.250 m
. Vegetação - Cerrado e campo sub-montanos
. Clima - Sub tropical moderado úmido
. Temperatura média anual - 18 - 21° C
. Precipitação média anual - 1.400 - 1.800 mm
. Deficiência Hídrica - De pequena a moderada (no inverno)
. Unidade de solos dominantes - Litossolos, cambissolos e regossolos (SOIL MAP OF THE WORLD - VOL IV - FAO - UNESCO)

Segundo Golfari (1.975), no Chapadão do Bugre predominam os arenossolos ferralicos profundos de baixa fertilidade (areias Quartzosas Distróficas).

3.2. Métodos

— Em cada talhão foram escolhidos 35 árvores, com diâmetro mínimo de 16 cm com casca, boa forma e copa, e bom aspecto fitossamitário.

As árvores escolhidas foram devidamente identificadas no campo e anotadas em ficha individual, o diâmetro e altura de cada indivíduo, bem como os demais dados de produção por época de resinagem.

Abaixo demonstramos os valores encontrados para os parâmetros altura e diâmetro (DAP) médio por espécie das árvores resinadas, com o respectivo Coeficiente de Variação.

Quadro 1

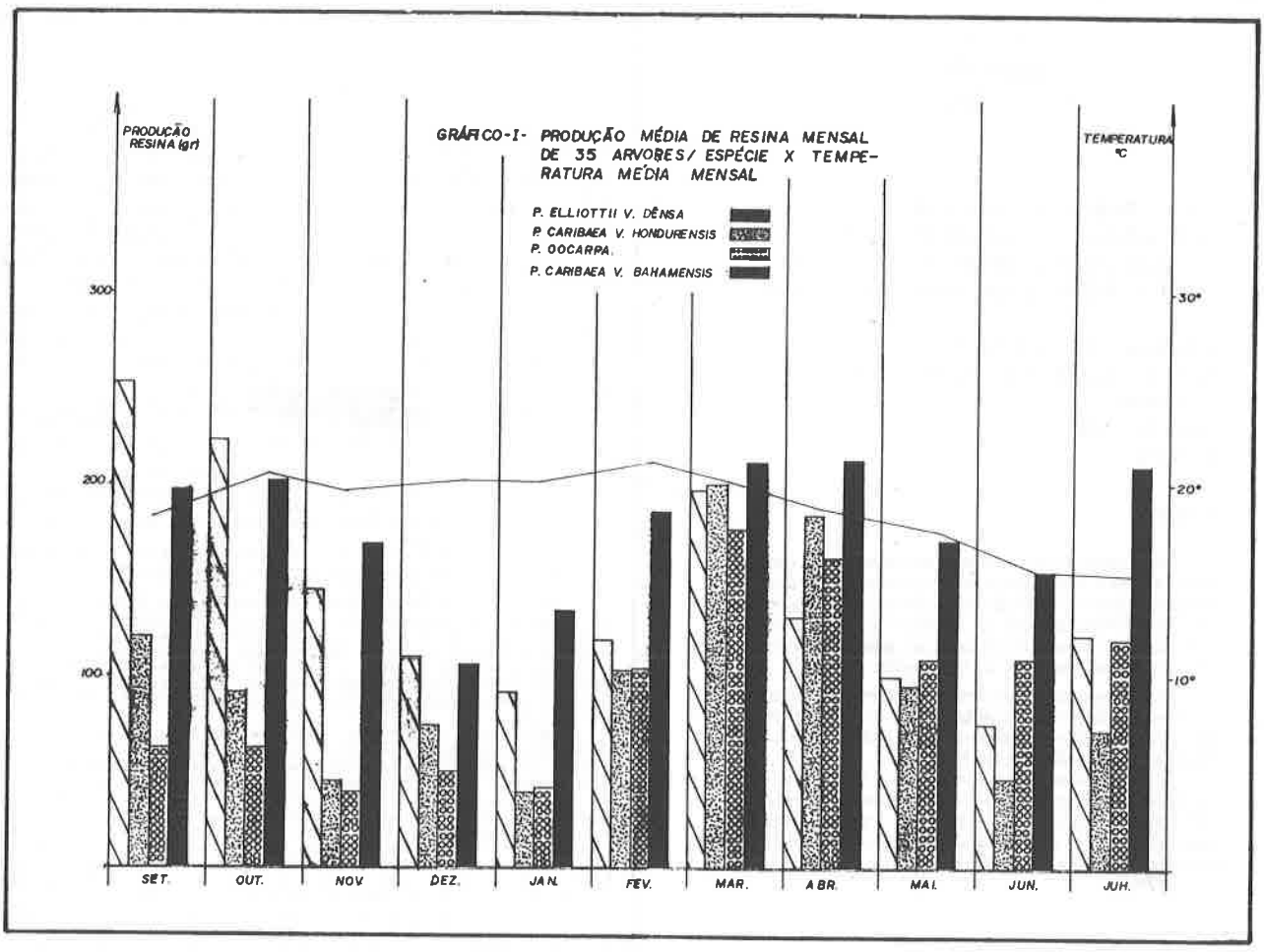
Espécie	DAP (cm)	CV (%)	H (M)	CV (%)
P. elliottii v. densa	17,6	6,91	9,24	10,18
P. caribaea v. hondurensis	18,9	10,54	11,73	12,39
P. caribaea v. bahamensis	17,2	6,43	10,65	8,97
P. oocarpa	17,8	8,70	11,16	9,12

Utilizou-se para a resinagem os seguintes materiais:

a. Recipiente de coleta
b. Calha horizontal
c. Calha espiral
d. Pregos de cabeça dupla
e. Pregos de 120 mm
f. Descascador
g. Estriador
h. Aplicador e pasta ácida Harima
i. Balança portátil de precisão 0,1 gr.

Para o presente ensaio os cortes (estria) foram feitos a cada 15 dias (CLEMENTS - 1.960) e a pesagem de resina coletada mensalmente. Todas as estrias foram feitas com a face voltada para o norte. Portanto durante o período em que foi conduzido este experimento (12/09/78 a 07/08/79) foram feitas 11 coletas e 22 cortes no painel de exploração da árvore, permanecendo as calhas e recipiente no local instalado originalmente, ou seja não foi deslocada para pontos mais próximos à estria. Os dados meteorológicos coletados para a análise no presente ensaio foram originários de uma estação localizada na sede do Horto Florestal Bugre a uma distância média de 4,8 km dos talhões escolhidos para resinagem. Para que fossem feitas análises física e química das resinas mensalmente, foram coletadas amostras de + 200 gr. do total coletado para cada espécie, e imediatamente eram armazenadas em geladeira. A cada 3 meses estas amostras foram enviadas à laboratório para análise.

A resina bruta sofreu purificação através de um aquecimento à 40° C e após foi filtrada e passada em peneira de 15 mech de aço inox a fim de se retirar impurezas mais grosseiras. Após a filtragem as resinas das diversas coletas foram misturadas em um só lote para análise. Para obtenção do breu e terebentina a resina sofreu uma destilação a vácuo, à cerca de 10 mm hg, através



de um condensador de vidro. O aquecimento indireto em banho de areia atingiu cerca de 180° C a 200° C.

Terminada a destilação a água e terebentina foram separadas na forma de uma camada inferior, e os volumes de ambas medidas. Esta medição juntamente com as densidades possibilitaram a obtenção de suas porcentagens em peso de resina. O breu resultante, T como parte residual na destilação foi pesado para cálculo de seu porcentual na resina.

O breu foi analisado quanto à:

a. Número de acidez
b. Número de saponificação
c. Teor de materiais insaponificaveis
d. Cor

A terebentina foi analizada por cromatografia de fase gasosa para determinação da sua composição.

4. RESULTADOS

Abaixo são mostrados nos quadros II, III, IV, V e VI e gráficos I e II o comportamento da produção de resina por espécie, T os dados climáticos registrados durante o período da resinagem e os rendimentos e análises do breu e terebentina.

Quadro II - Produção média de resina por espécie e por coleta mensal de 35 árvores.

PRODUÇÃO DE RESINA (GR)

Espécie / Meses	P.elliottii v. densa	P. caribaea v. hondurensis	P. caribaea v. bahamensis	P. oocarpa	Total	Média
Setembro	253	120	197	062	632	158,0
Outubro	223	091	202	062	578	144,5
Novembro	145	046	169	039	399	99,7
Dezembro	109	074	106	050	339	84,7
Janeiro	091	039	134	041	305	76,2
Fevereiro	119	103	186	104	512	128,0
Março	197	200	212	177	786	196,5
Abril	131	184	213	162	690	172,5
Maio	100	095	171	109	475	118,7
Junho	075	047	155	109	386	96,5
Julho	121	071	209	119	520	130,0
Total	1.564,0	1.070,0	1.954,0	1.034,0	5.622,0	1.405,3
Média/mensal	142,0	97,0	178,0	94,0	-	127,7
CV (%)	40,4	55,0	19,6	50,5	-	25,6
Erro padrão da média	142,0 ± 17,3	97,0 ± 16,1	178,0 ± 10,5	94,0 ± 14,3	-	127,7 ± 11,4

F= 7,28 **

Teste de Tukey - Diferença significativa - 5% - 55,99
1% - 69,42

Quadro III - Temperatura média e Precipitação mensal registrada durante o periodo de resinagem.

Meses	Temperatura Média (°C)	Precipitação Mensal (mm)
Setembro	18,38	49,10
Outubro	20,60	190,00
Novembro	19,78	428,00
Dezembro	20,24	400,00
Janeiro	20,23	319,00
Fevereiro	21,23	243,00
Março	20,08	171,00
Abril	18,87	166,00
Maio	17,56	103,00
Junho	15,23	0,00
Julho	15,37	37,00
Total	207,57	2.106,10
Média	18,87	191,50

Quadro IV - Rendimentos em breu e terebentina das destilações das resinas.

Espécie	Teor (%) Breu	Terebentina	Água
P. oocarpa	82,6	11,0	2,0
P. caribaea v. hondurensis	90,9	5,7	1,5
P. caribaea v. bahamensis	81,1	12,4	2,4
P. elliottii v. densa	81,7	13,6	1,9

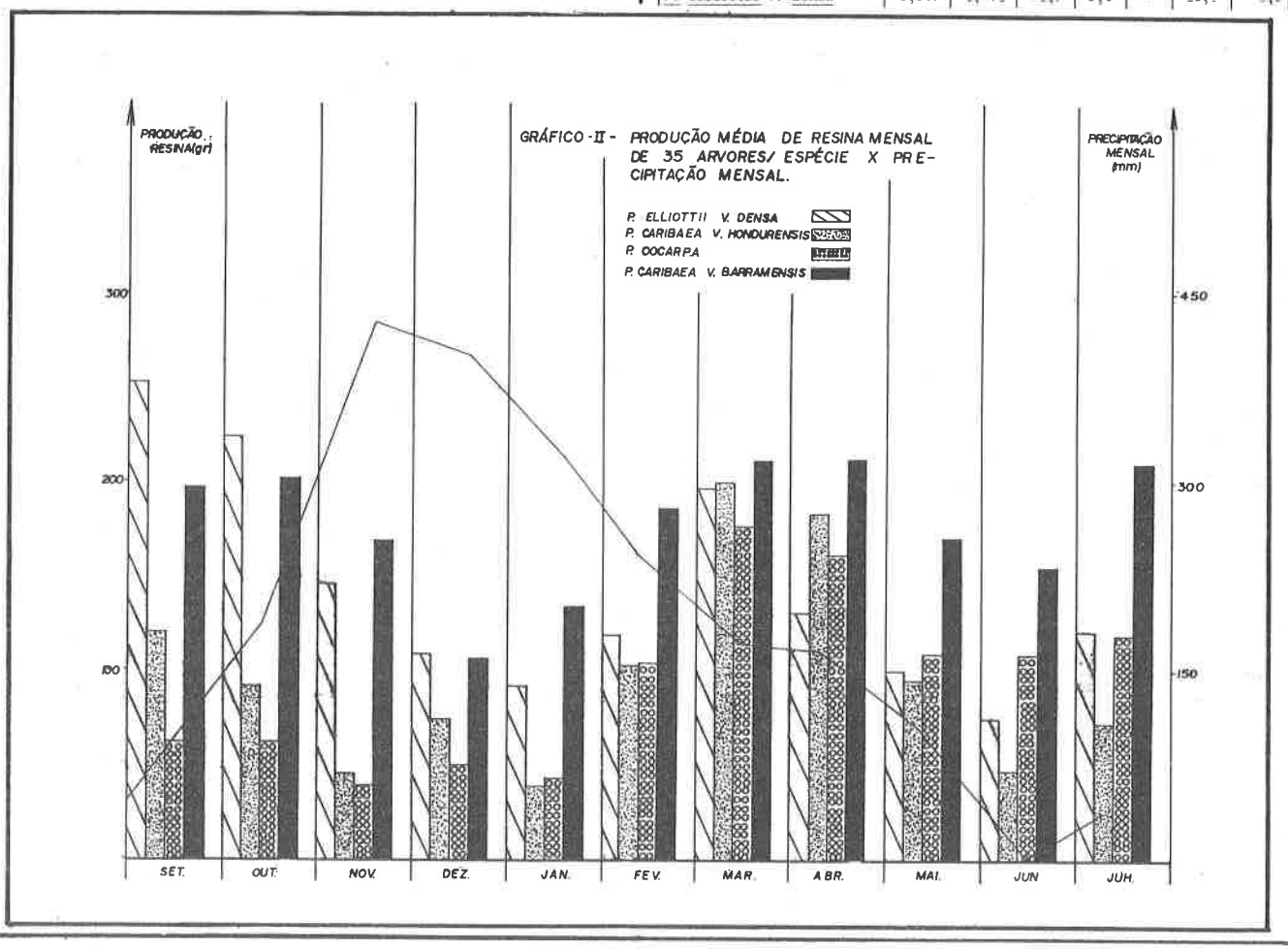
Quadro V - Análises no breu.

Espécie	Análise A	B	C	D	E
P. oocarpa	K	158	185	5,4	0,15
P. caribaea v. hondurensis	WG	162	194	6,4	0,42
P. caribaea v. bahamensis	X	158	187	4,4	0,04
P. elliottii v. densa	WG	162	190	6,7	0,11

A = Cor
B = Número de acidez
C = Número de saponificação
D = Teor de materiais insaponificáveis (%)
E = Teor de cinzas (%)

Quadro VI - Análises na terebentina.

Espécie	Análise A	E	C	D	E	F	G
P. oocarpa	5,146	1,476	55,2	5,4	-	14,2	11,1
P. caribaea v. hondurensis	5,619	1,479	84,8	-	1,7	7,1	6,4
P. caribaea v. bahamensis	4,98	1,477	82,4	-	5,9	23,6	4,2
P. elliottii v. densa	6,80	1,48	74,4	5,6	-	19,5	3,4



5. DISCUSSÃO DOS RESULTADOS

Pode-se notar através do quadro II, que com relação à produção média mensal de resina coletada, um predomínio do P. caribaea v. bahamensis (88,8 gr/arv/coleta), durante 8 meses sendo que em termos de média mensal foi a espécie que apresentou melhor produção. Seguem em ordem decrescente as espécies P. elliottii v. densa (71,1 gr/arv/coleta), P. caribaea v. hondurensis (48,6 gr/arv/coleta) e P. oocarpa (47,0 gr/arv/coleta). Segundo dados experimentais da Cia Agro Florestal Monte Alegre de Agudos - SP, os valores encontrados para as espécies acima foram respectivamente 106 gr/arv/coleta, 104 gr/arv/coleta, 100 gr/arv/coleta e 64 gr/arv/coleta, ou seja a ordem decrescente de produção/espécie foi a mesma, havendo uma diferença à maior para a Região de Agudos do P. caribaea v. bahamensis de 19,4%.

Nota-se que não foi levada em conta para esta diferença a idade do povoamento e o nº de arv/ha, pois não foram citadas estas informações neste trabalho.

Já BRITO et allii (1.978) conseguiram para a variedade bahamensis com 10 anos de idade no município de Piracicaba - SP, o valor de 128 gr/arv/coleta, situando-se em uma posição de 44,1 % à maior do valor encontrado para esta mesma espécie com 6,4 anos em Sacramento - MG,

Com relação às variações existentes entre coletas, nota-se que a espécie P. caribaea v. bahamensis foi à que apresentou o menor Coeficiente de Variação seguindo o P. elliottii v. densa, P. oocarpa, P. caribaea v. hondurensis. BRITO et allii (1.978), verificaram que a variedade bahamensis foi também a que apresentou o menor Coeficiente de Variação (26%).

Observa-se também que a média de produção mensal no período do P. caribaea v. bahamensis demonstrou ser estatisticamente superior ao nível de 1% de probabilidade em relação ao P. caribaea v. hondurensis e P. oocarpa, sendo que não apresentou diferença significativa com relação ao P. elliottii v. densa.

5.1. Produção X Condições climáticas

Pode-se verificar através do quadro III e gráficos I e II que as produções de resina para as quatro espécies foram menores no período de novembro a fevereiro, coincidindo com a época das águas, sendo que neste espaço de tempo choveu 54,46% do total.

As maiores produções para as quatro espécies pesquisadas deram-se nos meses de setembro, outubro e março, abril, períodos em que choveu 27,35% do total.

Já com relação à temperatura média nota-se que a produção de resina aumenta a partir do momento em que a temperatura média permanece na faixa de 18° C à 20° C, coincidindo com os períodos de setembro, outubro e março, abril, diminuindo quando as temperaturas médias se posicionam abaixo ou acima destes limites.

5.2. Análise Breu e Terebentina X Produção

O P. caribaea v. hondurensis foi o que apresentou maior rendimento em breu e consequentemente o menor rendimento em terebentina. Tal resultado foi sensivelmente diferente das resinas das demais espécies que apresentaram rendimentos superiores em terebentina, indo ao encontro com outros trabalhos de pesquisa que mostram também o destaque desta espécie em termos de rendimento em breu se comparado com as outras espécies estudadas neste trabalho.

Com relação à qualidade do breu, os resultados mostram que as espécies tiveram praticamente o mesmo comportamento químico.

Exceção feita ao P. oocarpa, as demais espécies apresentaram bastante claras com índices iguais ou superiores a X.

Na análise da terebentina a observação maior deve ser feita no que diz respeito ao teor de alfa e beta-pipeno, que possuem maior interesse comercial. Frente ao citado, pode-se dizer que os melhores comportamentos foram mostrados pela terebentina do P. caribaea v. hondurensis e P. elliottii v. densa.

6. CONCLUSÕES

1. Com relação à produção de resina a espécie P. caribaea v. bahamensis com 77 meses de idade demonstrou ser a maior produtora de resina com o menor Coeficiente de Variação em relação ao P. elliottii v. densa, P. caribaea v. hondurensis e P. oocarpa, estes com 91 meses, para um diâmetro mínimo de 16 cm, na Região de Sacramento - MG.

2. As maiores produções de resina para as espécies estudadas deram-se nos meses de setembro/outubro e março/abril, mostrando haver alguma correlação com as condições climáticas (temperatura média e precipitação pluviométrica).

3. As análises químicas mostraram que o P. caribaea v. hondurensis apresentou o melhor rendimento em breu e o P. elliottii v. densa em terebentina e teor de alfa e beta-pipeno, não havendo diferença entre as quatro espécies com relação à qualidade do breu, exceção ao P. oocarpa.

7. REFERÊNCIAS BIBLIOGRÁFICAS

1. BERZAGHI, C - Pinus spp e resinagem. São Paulo, Instituto Florestal, 1.972 - 39 p.

2. BRITO, J.O., BARRICHELLO, L.E.G. & TREVISAN, J.F. - Condições climáticas e suas influências sobre a produção de resina de Pinheiros tropicais - IPEF - Piracicaba. (16) 37:45 Junho 78.

3. Cia Agro Florestal Monte Alegre - Eq. Técnica - Resinagem em escala comercial - Circular Técnica - IPEF - Piracicaba (34) - 1:13 - Maio 78.

4. FONSECA SM & KAGEYAMA P.Y. - Melhoramento genético face à produção de resina - Circular Técnica - IPEF - Piracicaba (36) 1:10 - Maio 78.

5. GALFARI, L. - Zoneamento Ecológico do Estado de Minas Gerais para Reflorestamento - Série Técnica - PRODEPEF - Belo Horizonte (3) - 1.975.

6. GALFARI, L., CASER, L.R. & MOURA, VPG - Zoneamento Ecológico Esquemático para Reflorestamento no Brasil - Série Técnica - PRODEPEF - Brasília (11) - 1.978.

7. GOMES, F.P. - Curso de Estatística Experimental - ESALQ-USP - Piracicaba - 1.973.

8. GURGEL FILHO, O do A - Contribuição à resinagem - São Paulo - Instituto Florestal - 1.972 - 39 p.

9. GURGEL FILHO, O do A et allii - Fatores que influem na resinagem de Pinus - Circular Técnica - IPEF - Piracicaba (37) - 1:20 - Maio 78.

10. Harima do Paraná Ind. Química Ltda - Eq. Técnica - Potencialidade e prespectivas do mercado de resina de Pinus - Circular Técnica - IPEF - Piracicaba (41) - 1:8 - Maio 78.

FAST GROWING TREES

DISTRIBUIÇÃO DE BIOMASSA E NUTRIENTES EM TALHÕES DE *Pinus oocarpa* COM DIFERENTES IDADES

C. F. de A. Castro — F. Poggiani
ESALQ — USP
N. Nicolielo
CAFMA
BRASIL

Resumo

Quinze árvores de talhões com 8-14e 18 anos pertencentes a plantações de Pinus oocarpa (Agudos, Estado de São Paulo) foram cortadas e seus componentes: folhas, galhos, lenho do tronco e casca, pesados. Amostras dos componentes foram secas em estufas para determinar o teor de umidade e estabelecer as relações entre a fitomassa das folhas, galhos, lenho e casca. Também os macro e micro-elementos de cada componente foram analisados para avaliar o conteúdo de nutrientes removidos do "site" pela exploração do tronco ou da árvore inteira. A biomassa se distribui no estande nas seguintes proporções: 14% na copa, 13% na casca e 73% no lenho do fuste. Todavia a distribuição dos nutrientes na biomassa corresponde a 37% na copa, 15% na casca e 48% no lenho do fuste. Isto sugere que a utilização da árvore inteira não seria conveniente, principalmente, em rotações curtas, visto que a exploração da copa implica numa considerável remoção de nutrientes.

BIOMASS AND NUTRIENTS DISTRIBUTION IN *Pinus oocarpa* STANDS AT DIFFERENT AGES

Summary

Fifteen trees of 8-14 and 18 years old stands of Pinus oocarpa planted in São Paulo state (Brazil) were weighted by component parts (leaves, limbs, bolewood and bark). Samples were oven-dried to determine moisture content and to establish bark,wood, limbs and leaves relationships. Also macro and microelements of each component of the trees were analysed to estimate the nutrient contents removed by conventional bolewood harvest and by complete tree utilization. Biomass distribution among the components of the stand is about 14% in the crown, 13% in the bark and 73% in the bolewood. However nutrient content in the stand biomass is about 37% in the crown, 15% in the bark and 48% in the bolewood. It seems to be not convenient to exploit the crown mainly for short rotation, because the increase yield is accompanied by a strong increase in nutrients removal.

1. Introdução

O rápido crescimento que as árvores do gênero Eucalyptus e Pinus apresentam no Brasil, permite que seus ciclos de corte sejam extremamente curtos. Contudo não foi ainda avaliado o impacto que estas rotações curtas causam no ecossistema.

Apesar disso, já há uma tendência para uma utilização mais completa dos componentes da árvore e para a adoção de rotações ainda mais curtas, a fim de preencher a demanda de energia e fibras. Com isto, os solos florestais poderão sofrer uma drástica redução na sua capacidade de repor os nutrientes removidos pelas exploração da biomassa arbórea. Pesquisas realizadas com pinheiros do sul dos E.U.A. (Pritchett, 1979), revelam que a exploração da fitomassa total acima do solo remove cerca de duas vezes a quantidade de nutrientes que são retirados em uma exploração convencional (madeira e casca do fuste comercial).

Entretanto, a depleção ou não dos nutrientes do solo, devido à remoção da fitomassa vai depender das reservas do solo, da sua capacidade de recuperação e da entrada natural ou artificial de nutrientes.

Foi objetivo desta pesquisa obter informações quanto à distribuição de fitomassa e nutrientes em talhões de Pinus oocarpa Schiede, com diferentes idades.

2. Material e Métodos

Descrição da Área Experimental.

O estudo foi conduzido em tres talhões de Pinus oocarpa Schiede, localizados na Companhia Agro-Florestal Monte Alegre, no Município de Agudos, Estado de São Paulo (22°25' Sul, 48° 50'Oeste), numa altitude aproximada de 600 metros. O clima é do tipo Cwa, segundo Koeppen, com temperatura média anual de 21,1°C. A temperatura média de inverno gira ao redor de 18,6°C, e a do verão, de 23,3°C. No mes mais frio, a temperatura média varia de 16 a 18°C.

A precipitação média anual é de 1 300mm, sendo que cerca de 1 000mm deste total caem durante a estação chuvosa; que vai de outubro a março. O solo predominante na região é o Latossolo Vermelho Amarelo fase arenosa e era anteriormente coberto por vegetação de cerrado.

Os pinheiros foram plantados com espaçamento de 2 x 2 metros e sofreram desrama artificial até 2 metros de altura aos 6 anos de idade. Tres desbastes foram feitos no talhão de 14 anos e 4 no de 18 anos. A tabela 1 apresenta os dados dendrométricos das plantações estudadas.

Métodos

Amostragem

- Em cada talhão, 3 parcelas circulares de 500 m^2 foram locadas e medidas quanto à altura e ao diâmetro (DAP) de todas as árvores.

TABELA 1. Dados dendrométricos dos estandes.
TABLE 1. Growth data of the stands.

Talhão plantado Planted stand (years)	1971	1965	1961
árvores/ha trees/ha	2313	720	533
média D.H.P. (cm) mean D.B.H.	13,81	21,36	26,10
média em altura (m) mean height	12,10	18,84	22,29
Área basal m^2/ha Basal area	34,67	25,65	28,53

As árvores foram classificadas em 5 classes de diâmetro, conforme mostra a Tabela 2. Foram amostradas 3 árvores dentro de cada classe, totalizando 15 árvores para cada idade. As 45 árvores foram derrubadas no mês de julho de 1979.

TABELA 2. Classes de diâmetro das árvores amostradas (cm).
TABLE 2. D.B.H. Classes (cm).

D.A.P. D.B.H.	8 anos years	14 anos years	18 anos years
A	4 - 7,9	12 - 15,9	15,1 - 19
B	8 - 11,9	16 - 19,9	19,1 - 23
C	12 - 15,9	20 - 23,9	23,1 - 27
D	16 - 19,9	24 - 27,9	27,1 - 31
E	20 - 23,9	28 - 31,9	31,1 - 35

- Após a derrubada, foram medidos o diâmetro em vários pontos da árvore, a altura comercial e total e a largura e altura da copa. Os componentes acículas, ramos, casca do tronco e madeira do tronco foram separados e seus pesos frescos determinados no campo com precisão de 0,5 kg. Foram retiradas amostras dos componentes para determinação de peso seco e conteúdo químico. As acículas foram amostradas de modo que incluissem todas as classes de idade e partes da copa. As amostras dos ramos procuraram abranger todas as variações de diâmetro e partes da copa. Para a análise química, foram coletados 3 discos da parte média de 3 ramos localizados no meio da copa. Cinco discos equidistantes (base, 1/4, 1/2 e 3/4 da altura e topo) foram retirados para determinação do peso seco da madeira e casca do tronco. Para a análise dos nutrientes, foi utilizado o disco do tronco coletado na metade da altura de cada árvore (YONNG, 1976). As amostras foram pesadas, sendo os discos separados em madeira e casca. Foram secas em estufa a 80 C até atingir peso constante, determinando-se, após, os seus teores de umidade. As amostras para análise química foram moídas em moinho tipo Willey com malha de 20 mesh e o material resultante levado para análise.

Análise Química.

O N foi analizado em Auto-analisador, conforme o método descrito por JORGENSEN (1977). O P foi analisado por fotocolorimetria e os demais nutrientes foram determinados em espectrofotometro de absorção atômica. Todas as amostras foram analisadas em duplicata. As sequencias operacionais foram conforme SARRUGE e HAAG (1974).

Estimativa do Produto em Pé.

O peso seco de cada componente foi correlacionado com diversos parâmetros da árvore sob vários modelos. A correlação mais útil foi na forma $\ln Y = A + B \ln X$; onde A e B são constantes, Y é o peso seco do componente e X é o diâmetro à altura do peito nas equações para acículas e ramos. Para os componentes casca e madeira do tronco a varável independente é altura X (diâmetro)^2. A densidade do talhão não teve efeito significante nestas relações e uma única expressão foi desenvolvida para cada componente, sem considerar a idade do plantio. Os coeficientes de correlação para os componentes individuais variaram de 0,96 a 0,99. As equações são altamente siginificativas, $P < 0,0001$.

Utilizando-se dessas regressões, estimou-se o peso de todas as árvores contidas nas parcelas de amostragem de 0,5 ha. A soma das estimativas obtidas foi então multiplicada por 20 para se ter o peso do componente por hectare.

A quantidade de nutriente por hectare foi obtido multiplicando-se o peso seco do componente por hectare pelo seu teor de nutriente.

3. Resultados e Discussão

Fitomassa acima do solo

Os dados estimados da Fitomassa acima do solo são mostrados na tabela 3. Verifica-se que há um aumento na proporção de madeira do tronco à medida que a plantação amadurece. Aos 8 anos este componente representa 69,2% da biomassa acima do solo, sendo 76% aos 18 anos. Nos demais componentes observa-se um decréscimo relativo, principalmente das acículas. A proporção de acículas é similar aos observador em pinheiros do sul dos Estados Unidos (JORGENSEN et alli,1975; CLARK e TARAS, 1976 e 1977), mas difere grandemente do observado por EGUNJOBI e BADA (1979) em Pinus caribaea de 10 anos, de idade na Nigeria.

Os dados deste autor, quando comparados com os dados de biomassa das nossas observações aos 8 anos, evedienciam que embora a matéria seca da madeira seja somente ligeiramente superior (76,5 ton. e 70,5 toneladas, respectivamente), o peso seco das acículas de P.caribaea plantado na Nigeria é 3,5 vezes maior que o do P.oocarpa de Agudos.

Nas tres idades, a fitomassa apresentou a seguinte ordem de distribuição: Madeira Casca Ramos Acícula.

TABELA 3. Distribuição da biomassa em P.oocarpa nas diferentes idades (kg/ha e percentagem).
TABLE 3. Biomass distribution in P.oocarpa at different ages (kg/ha).

	8 anos years	14 anos years	18 anos years
ACICULAS Needles	5833 5,7%	5304 4,2%	6619 3,8%
RAMOS Limbs	10089 9,9%	11089 8,9%	15382 9,0%
COPA Crown	15922 15,6%	16393 13,1%	22001 12,8%
CASCA Stem bark	15485 15,2%	15595 12,5%	19244 11,2%
MADEIRA Stem wood	70552 69,2%	92888 74,4%	130712 76,0%
FOSTE Stem	86037 84,4%	108483 86,9%	149956 87,2%
ÁRVORE TOTAL Total tree	101959 100,0%	124876 100,0%	171957 100,0%

TABELA 4. Concentração dos macro e micronutrientes nos componentes das árvores de P.oocarpa (PPM) (média - desvio padrão da média).

TABLE 4. Macro and micro-nutrients concentrations in the tree components of P.oocarpa (PPM) (mean-standard error).

TREES Componente	IDADES age	N	P	K	Ca	Mg	Fe	Mn	Zn
ACICULAS									
Needles	8	15910 ± 400	860 ± 20	5400 ± 380	1830 ± 100	880 ± 40	232,1 ± 15,1	217,8 ± 6,9	15,8 ± 0,5
	14	15270 ± 300	790 ± 20	4970 ± 260	2070 ± 140	680 ± 40	294,8 ± 12,0	220,5 ± 9,6	16,4 ± 2,4
	18	15070 ± 270	770 ± 10	4320 ± 160	1980 ± 120	730 ± 50	187,3 ± 9,8	225,2 ± 8,6	19,1 ± 3,4
RAMOS									
Limbs	8	3700 ± 360	250 ± 20	2050 ± 170	1160 ± 100	450 ± 60	63,7 ± 8,4	104,3 ± 9,4	13,8 ± 0,9
	14	3430 ± 160	180 ± 10	1610 ± 80	1160 ± 80	330 ± 10	54,6 ± 4,1	111,7 ± 8,6	25,3 ± 4,6
	18	3070 ± 130	150 ± 10	1070 ± 60	870 ± 70	280 ± 10	63,0 ± 5,1	95,7 ± 5,0	8,7 ± 0,3
CASCA									
Bark	8	3010 ± 330	160 ± 20	1170 ± 180	1820 ± 130	310 ± 50	68,5 ± 3,7	32,4 ± 6,1	6,7 ± 0,8
	14	2270 ± 130	140 ± 10	1240 ± 110	860 ± 60	210 ± 30	77,1 ± 4,2	28,9 ± 2,7	83,3 ± 2,1
	18	2610 ± 170	170 ± 10	1360 ± 120	680 ± 50	300 ± 30	68,2 ± 8,7	43,8 ± 4,0	22,7 ± 3,1
MADEIRA									
Wood	8	1330 ± 90	120 ± 3	900 ± 40	530 ± 20	170 ± 4	23,3 ± 2,3	56,3 ± 3,4	7,1 ± 0,6
	14	1040 ± 110	90 ± 1	730 ± 20	710 ± 20	170 ± 10	14,1 ± 0,7	65,4 ± 2,6	5,4 ± 0,3
	18	1140 ± 140	70 ± 1	620 ± 20	640 ± 10	170 ± 10	12,1 ± 0,9	65,9 ± 2,8	6,0 ± 0,1

Composição Química dos Componentes da Planta.

A Tabela 4 apresenta as concentrações de nutrientes nos componentes de P.oocarpa de 3 diferentes idades. As acículas contém a maior concentração de todos os nutrientes. A madeira do tronco apresenta as menores concentrações. A concentração de N, P e K tendem a decrescer com a idade nos componentes acículas, ramos e madeira do tronco.

Observa-se, quanto a ordem relativa dos teores de nutrientes a sequencia: N> K> Ca> P≳Mg> Fe≳ Mn> Zn no componente acícula. A casca apresenta a seguinte ordem: N> K≳Ca> Mg≳ P> Fe> Mn> Zn. Para ramos e madeira do tronco a sequência é N> K≳Ca> Mg> P> Mn> Fe> Zn.

Comparado ao Pinus caribaea de 10 anos de idade da Nigéria (EGUNJOBI e BADA, 1979), que apresentou concentração de 0,87% de N, 0,03% de P, 0,75% de K, 0,35% de Ca e 0,18% de Mg; o P.oocarpa por nos estudado mostra uma concentração de N e P distintamente superior, porém com concentrações de K, Ca e Mg inferiores. Para os demais componentes, os teores dos nutrientes diferem muito pouco entre as duas espécies.

Distribuição dos nùtrientes na Fitomassa acima do solo.

O conteúdo dos nutrientes distribuídos nos diferentes componentes acima do solo em 3 idades de P.oocarpa apresentadas nas tabela 5.

TABELA 5. Distribuição de nutrientes nos componentes das árvores de P.oocarpa em diferentes idades (kg/ha).

TABLE 5. Nutrients distribution in the components of P.oocarpa at different ages (kg/ha)

COMPONENTE Componente	IDADE age	N	P	K	Ca	Mg	Fe	Mn	Zn
ACICULAS									
Needles	8	42,8	4,0	31,5	10,7	5,1	1,4	1,3	0,1
	14	81,0	4,2	26,4	11,0	3,6	1,6	1,2	0,1
	18	99,7	5,1	28,6	13,1	4,8	1,2	1,5	0,1
RAMOS									
Limbs	8	37,3	2,5	20,7	11,7	4,5	0,7	1,0	0,1
	14	26,9	2,0	17,9	12,9	3,7	0,6	1,2	0,3
	18	31,8	2,3	16,5	13,4	4,3	1,0	1,5	0,1
COPA									
Crown	8	130,1	7,5	52,2	22,4	9,6	2,1	2,3	0,2
	14	107,9	6,2	44,3	23,9	6,3	1,8	3,6	0,4
	18	131,5	7,4	45,1	26,5	9,1	2,2	3,0	0,2
CASCA									
Stem bark	8	46,6	2,5	18,1	18,9	3,3	1,1	0,5	0,1
	14	35,4	2,2	19,3	13,4	3,3	1,8	0,5	0,4
	18	50,2	3,3	26,8	13,1	5,8	1,3	0,9	0,4
MADEIRA									
Stem wood	8	93,9	8,5	63,5	36,0	12,0	1,7	3,9	0,5
	14	96,6	8,3	67,8	66,0	15,8	1,3	6,0	0,5
	18	149,0	9,1	80,3	83,6	22,3	1,6	8,6	0,8
FUSTE									
Stem	8	140,5	11,0	81,6	51,9	15,3	2,8	4,4	0,6
	14	132,0	10,5	87,1	79,4	19,1	3,5	6,5	0,9
	18	199,2	12,4	106,5	96,7	28,1	2,9	9,5	1,2
ARVORE TOTAL Complete Tree	8	270,6	18,5	133,8	77,3	24,9	4,9	6,7	0,8
	14	239,9	16,7	131,4	109,3	26,4	4,7	8,9	1,3
	18	330,7	19,8	151,6	123,2	37,2	3,1	12,5	1,4

A figura 1 mostra a distribuição relativa da fitomassa e dos nove nutrientes.

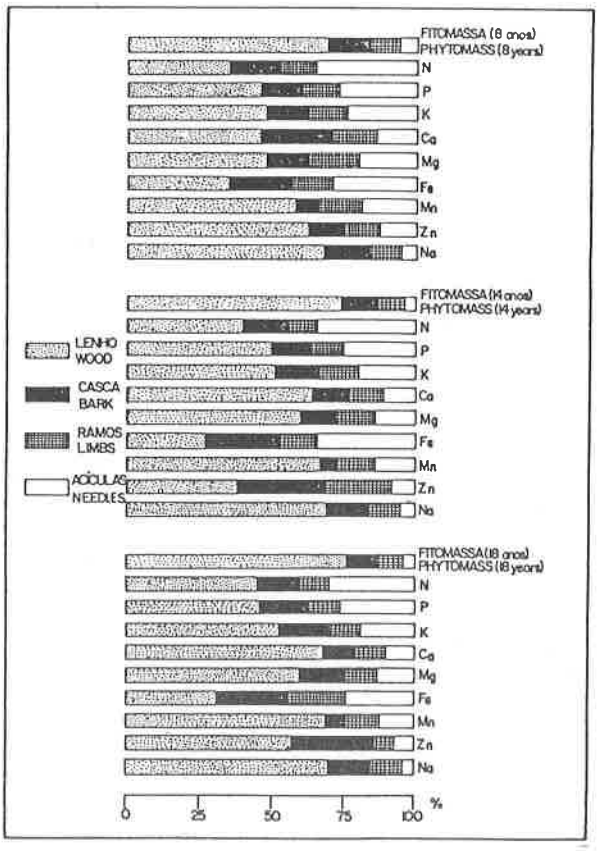


Figura - 1.

DISTRIBUIÇÃO RELATIVA DOS DIVERSOS COMPONENTES EM RELAÇÃO AO PESO SECO TOTAL.

Relative distribution of the different componets as a percentage of total Dry Weight.

TABELA 6. Acumulação de nutrientes na fitomassa acima do solo de vários ecossistemas florestais.

TABLE 6. Nutrient accumulation in the above-ground Phytomass of several forest ecosystems.

ESPÉCIE Species	IDADE Ages	N	P	K	Ca	Mg	FONTE Source
		Kg/ha					
P.oocarpa	8	271	19	134	77	25	Presente estudo (this study)
P.caribaea	10	374	18	258	187	74	Egunjobi e Bada, 1979
P.elliottii	15	345	24	137	226	53	Pritchett e Smith, 1974
P.taeda	16	257	31	165	187	46	Wells e Jorgensen, 1975
P.oocarpa	18	331	20	152	123	37	Presente estudo (this study)
P.taeda	25	190	20	115	100	32	Switzer et al., 1968
P.radiata	26	224	28	224	129	-	Orman e Will, 1960

Os seguintes aspectos se evidenciam: a) os nutrientes contidos nos talhões aumentam juntamente com o incremento do biomassa arbórea; b) o aumento da quantidade de nutrientes não é diretamente proporcional ao aumento da fitomassa, pois a relação nutriente/fitomassa diminui com o envelhecimento da plantação. Aos 8 anos, por exemplo, para cada Kg de matéria seca temos 5,8 gramas dos nove nutrientes analisados. Esta relação cai para 4,4 g/kg nas árvores de 18 anos de idade. c) esta diminuição da relação nutriente/fitomassa pode ser explicada pela decréscimo da concentração da maioria dos nutrientes a medida que a plantação amadurece. Por exemplo, os componentes da copa apresentam quantidade de nutrientes muito similar aos 8 e 18 anos, embora a fitomassa da copa do talhão mais velho seja 38% superior à copa das árvores de 8 anos. Um outro aspecto importante é o fato de haver menor proporção dos componentes de maiores teores de nutrientes (copa e casca) nas plantações mais antigas. Aos 8 anos, a copa representa 15,6% da matéria seca do talhão e contém 48% do N, 41% do P e 39% do K acumulado na fitomassa acima do solo. Aos 18 anos, ela representa 12,8% da fitomassa e contém 40% do N, 37% do P e 30% do K. A distribuição relativa da casca também diminui, passando de 15,2% para 11,2% aos 18 anos. Porisso, embora o talhão de 18 anos apresenta uma fitomassa 69% maior que o de 8 anos, o peso total por hectare dos nove nutrientes analisados é somente 28% superior ao do plantio mais novo.

Na tabela 6 as estimativas dos macronutrientes acumulados na fitomassa de P.oocarpa do presente estudo são comparadas com outra espécies do gênero Pinus.

Exportação de Fitomassa e Nutrientes sob diferentes intensidades de exploração florestal.

A Tabela 7 mostra a quantidade de matéria seca e nutrientes que seriam removidos devido a diferentes intensidades de utilização da árvores. A exploração apenas do fuste comercial resultaria em um decréscimo de 16% na produção de fitomassa total do talhão de 8 anos de idade, mas iria reduzir a exportação de N em 48%, P em 40%, K em 38%, Ca em 29% e Mg em 39%. A utilização somente da madeira do fuste iria reduzir em 31% o rendimento em matéria seca, porém diminuiria mais substancialmente a remoção de nutrientes do ecossistema florestal. A exportação do nitrogênio seria reduzido em 65 por cento, fósforo em 54 por cento, cálcio em 53 por cento e potássio e magnésio em 52 por cento. A remoção de micronutrientes do sitio seria reduzida de 31 a 65%. Nas plantações mais antigas, em comparação com a de 8anos, a exploração da madeira comercial resultaria em uma menor redução do produto de matéria seca acompanhado por um menor de créscimo das perdas de nutrientes do sítio, principalmente o cálcio.

Tal fato ocorre devido a maior proporção de fitomassa e nutrientes acumulados na madeira do fuste à medida que as árvores envelhecem.

Conclusões:

Pode-se concluir destes dados que:

1) quanto maior for a idade do talhão, maior será o conteúdo de nutrientes na biomassa.

2) Os talhões mais jovens apresentam de maneira geral maior proporção de nutrientes em relação à matéria seca devido ao maior teor de nutrientes nos tecidos e devido também à maior proporção de copa em relação à árvore total.

3) A utilização integral da árvore não é conveniente principalmente em regimes de rotações curtas, visto que a exploração da copa representa apenas um pequeno acréscimo em biomassa (14%) enquanto que ocorre uma forte exportação de nutrientes do "site" (cerca de 37%).

4. Referências bibliográficas

CLARK III, A. & TARAS, M.A. - Aboveground biomass of longleaf pine in a natural sawtimber stand in southern Alabama. USDA. Forest Service. SE research paper, Asheville (162) : 1 - 32, 1977.

CLARK III, A. & TARAS, M.A. - Biomass of shortleaf pine in a natural sawtimber stand in northern Mississipi. USDA. Forest Service. SE research paper, Asheville (146):1-32, 1976.

EGUNJOBI, J.K. & BADA, S.O. - Biomass and nutrient distribution in stands of Pinus caribaea L. in the dry forest zone of Nigeria. Biotropica, Fairfax, 11(2):130-5, 1979.

JORGENSEN, J.R.; WELLS, C.G. & METZ, L.S. - The nutrient cycle: key to continuous forest production. Journal of forestry, Washington, (7):400-3, jul. 1975.

JORGENSEN, S.S. - Metodologia utilizada para análises químicas de rotina. Piracicaba, CENA, 1977. 22p.

ORMAN, H.R. & WILL, G.M. - The nutrient content of Pinus radiata trees. New zealand journal of science, Rotorua, 3:510-22, 1960.

TABELA 7. Fitomassa e nutrientes removidos pela exploração convencional do fuste e pela utilização da árvore inteira.

TABLE 7. Phytomass and nutrients removed by conventional bolewood harvest and by complete tree utilization.

1) Árvore inteira - Whole tree
2) Fuste comercial - Stem wood with bark
3) Fuste sem casca - Debarked stem.

		FITOMASSA Phytomass t/ha %	N	P	K	Ca	Mg	Fe	Mn	Zn
						kg/ha & (%)				
	1	102,0(100)	270,5(100)	18,5(100)	139,0(100)	77,0(100)	25,5(100)	0,91(100)	0,71(100)	0,81(100)
8 anos	2	86,0 (84)	139,5 (52)	11,0 (60)	84,5 (62)	55,0 (71)	15,3 (61)	2,8 (57)	0,4 (56)	0,6 (74)
	3	70,5 (69)	95,0 (35)	8,3 (45)	61,5 (44)	36,0 (47)	12,0 (47)	1,7 (35)	0,3 (42)	0,5(62,5)
	1	125,0(100)	260,0(100)	16,7(100)	131,5(100)	101,0(100)	26,5(100)	0,2(100)	0,9(100)	1,3(100)
15 anos	2	108,5 (87)	134,0 (51)	10,1 (61)	87,0 (66)	72,5 (72)	10,1 (38)	2,5 (53)	0,4 (44)	0,9 (69)
	3	91,0 (73)	96,5 (37)	8,3 (50)	68,0 (52)	46,0 (46)	11,8 (44)	1,3 (28)	0,2 (22)	0,5 (38)
	1	172,0(100)	330,5(100)	14,8(100)	151,5(100)	133,0(100)	32,5(100)	5,1(100)	12,5(100)	1,5(100)
18 anos	2	150,0 (87)	179,0 (54)	12,5 (83)	104,5 (70)	96,5 (72)	18,1 (55)	3,7 (73)	7,5 (76)	1,2 (84)
	3	130,5 (76)	159,0 (45)	9,1 (56)	80,5 (53)	83,5 (63)	12,1 (38)	1,4 (27)	4,6 (46)	0,8 (52)

PRITCHETT, W.L. - Properties and management of forest soils. New York, John Wiley, 1979. 500p.

PRITCHETT, W.L. & SMITH, W.H. - Management of wet savanna soils for pine production. Florida Agricultural Experiment station technical bulletin (762):1-22, 1974.

SARRUGE, J.R. & HAAG, H.P. - Análises químicas em plantas. Piracicaba, ESALQ/DQ, 1974. 56p.

SWITZER, G.L.; NELSON, L.E. & SMITH, W. H. - The mineral cycle in forest stands. In: FOREST FERTILIZATION: theory and practice. Knoxville, Tennessee Valley Authority, 1968. p. 1-9.

WELLS, C.G. & JORGENSEN, J.R. - Nutrient cycling in loblolly pine plantations. In: BERNIER, B. & WINGET, C.H., ed. - Forest soils and forest land management. Quebec, Laval University Press, 1975. p.137-58.

YOUNG, H.E. & CARPENTER, P.N. - Sampling variation of nutrient element content within and between trees of the same especies. In: OSLO BIOMASS STUDIES. Orono, University of Maine, 1976. p.75-99.

FAST GROWING TREES

INTRODUÇÕES DE *Pinus* E *Eucaliptus* NA FERROVIA PAULISTA S/A — FEPASA

G. R. A. Cavalcanti
Ferrovia Paulista S/A
BRASIL

Resumo

Relatório do número de diferentes espécies de Eucalyptus introduzidos entre 1952 e 1978 e Pinus de 1953 a 1970, no Departamento Florestal de Ferrovia Paulista — FEPASA.

Até agora os Eucalyptus perfazem 99 espécies, trazidos de 4 países e os Pinus, 46 espécies de 17 países.

INTRODUCTIONS OF PINES AND EUCALYPTUS IN FERROVIA PAULISTA S/A — FEPASA

Summary

I related here the number of different species of Eucalyptus introduced between 1952 and 1978 and pinus between 1953 and 1970;in the Department Florestal Of paulista Railway S/A-FEPASA.
Eucalyptus 99 species and pinus 46; until now.
The pinus came from 17 countries and Eucalyptus from 4.

MATERIAL E MÉTODOS

O número de espécies de eucaliptos diferentes introduzidos no Departamento Florestal da Ferrovia Paulista S/A-FEPASA,atingiu 244 e atualmente existem 78 entre espécies variedades e híbridos.

Do gênero pinus recebemos 44 espécies diferentes incluindo híbridos,de 23 países.

Ao Eng Agr Rubens F Guimarães devemos principalmente as introduções de pinus.

Alem dos dados das regiões de origens, foram verificados os pesos das sementes e o número de sementes por introdução,em croquis foram colocados dados de espaçamento, semeação e plantio bem como o número das introduções.

Cuidados contra insetos e pássaros foram tomados no viveiro.

Reclassificações foram necessárias.

As sementes do Brasil vieram em ordem decrescente de quantidade das seguintes lugares: Hortos Florestais da FEPASA e Hortos do Instituto Florestal de São Paulo, Industrias Klabin do Paraná e do Instituto do pinho, e Cia Melhoramentos de São Paulo.

CODIGO PARA OS PAISES

Ale-Alemanha	Hai-Haití
Arg-Argentina	Hon-Honduras
Aus-Austrália	Ind-India
Bra-Brasil	INd-Indonésia
Cub-Cuba	Jap-Japão
Fil-Filipinas	Méx-México
Fra-França	Por-Portugal
Gua-Guatemala	Usa-Estados Unidos
	Vie-Viet Nan

ANO DA INTRODUÇÃO-ESPÉCIE-NUMERO DA INTRODUÇÃO-LUGAR DE ONDE VIERAM AS SEMENTES

1953-P Elliottii, Engelm-C 11-C 36- C 37- Aus
P halepensis, Mill- C 3-Bra
P kesiya, Royle ex Gordon-C 10-Aus
P patula, Schle S Cham- C 1- Méx-C 41-Aus
P pinaster, Aiton- C 12-Bra
P occidentalis, Swa-C 44-Bra
P oocarpa, Schied-C 15-C 43-Aus-C 45-Hon
P radiata, D Don-C 8-Bra-C 40-Aus
P rigida, Mill-C 2-Bra
P taeda,L-C 9-C 39-Aus

1954-P Elliottii,Engel-C 21-Bra
P montezumae,Lamb-C 20-Méx
P palustris, Mill-C 24-Bra
P pinaster, Aiton-C 13-Bra
P patula, Schle S Cham-C 19-Méx
P radiata,C 18-Bra
P rigida,Mill-C 2-Bra
P sylvestris, L-C 7-Bra
P taeda,L-C 22-Bra

1955-P halepensis,Mill-C 23-por
P longifolia, Roxb-C 25-Arg

1956-P caribea,Morelet-C 17-321-Cub
P contorta,Dougl-332-Usa
P Coulteri, D Don- 328-Usa
P Elliottii,Engel-42-Bra
P echinata, Mill-331-Usa
P herrerai,Mart-381-Méx
P kesiya,Royle ex Gordon-323-Vie
P occidentalis, Swa-C 46-Bra
P pinea,L-327-por
P pinaster,Aiton-324-Fra
P patula, Schle S Cham-330-Usa-326-Fra
P rigida,Mill-334-Usa
P sylvestris,L-334-Fra
P taeda,L-329-325-Usa

1957-P ayacahuite,Ehrenb- 379-Méx
P ayacahuite Ehrenb var Braxhyptera,Shaw-374-Méx
P caribaea, Morel var hondurensis, Barr S Golf-347-Usa-348-Hon 349-Cub
P canariensis,C Smith-421-Usa
P cembroides,Zucc-419-Usa
P cembroides,Zucc var edulis ,Voss-C 35-420-Usa
P durangensis,Martinez-378-Méx
P echinata,Mill-C 32-Bra- 344- Usa
P Elliottii, Engel- C 30-C 33-Bra-C 36-Aus- 345-Usa
P herrerai,Mart-381-Méx
P kesiya, Royle ex Gordon-431-Ind
P Laricio,Poir-429-Por- 430-Bra
P lutea, Blanco-377-Méx P lutea var ornelazi Mart-376-Br
P montezumae,Lamb-380-Méx
P macrophylla,Lindl-375-Méx
P palustris, Mill-340-Bra- 346-Usa
P radiata, D Don-341-Bra
P taeda, L-342-Bra-343-Usa- 427-Usa-C 31-Bra
P teocote, Schl S Cham-373-Méx

1958
P ayacahuita, Ehrenb-444-Méx
P Banksiana, Lamb-482-Fra
P canariensis, C Smith-Arg
P Elliottii, Engel-469-467-466-461-458-457-455-456-454-452-451-Bra- 448-Usa
P halepensis, Mill-422-Arg
P merkusii,Jungh de Vrie- 492-INd
P nigra, Ait-483-Arg

P occidentalis, Swartz-493-Hai-460-Bra
P patula, Schle S Cham-446-Méx-480-Afr
P ponderosa, Dougl-445-Méx
P sylvestris, Linn-481-Arg
P tropicalis, Morelet-435-Cub
P taeda, L-475-Usa

1959-P caribaea, Morelet-C 519-Cub
P canariensis, C Smith-C 516-Arg
P densiflora, Sieb & Zucc
P Elliottii, Engel- 503-504-515-C 517-Bra
P kesiya, Royle ex Gordon-505-507-513-
P patula, Schlecham-C 501-Bra
P thunbergii,Parlatori-494-Jap
P taeda, L- 509-514-518-Bra

1960-P ayacahuite, Ehrenb-C 521-Méx
P caribaea, Morelet
P caribaea, Morelet, var hondurensis, Barr S Golf-525-Gua
P kesiya, Royle ex Gordon-524-Fil
P montezumae,Lamb-522-Méx
P pseudostrobus, Lindl-520-Méx

1961-P Elliottii, Engel-584-Usa
P echinata, Mill-583-594-Usa
P oocarpa, Schiede, 587-Bra-596-Méx
P patula, Schl S Cham- 598-Méx
P palustris,Mill-C 585-Usa
P pseudostrobus, Lindl-C 597-Méx
P taeda, L- C 586-Usa

1962-P caribaea, Morelet var hondurensis, Barr S Golf-C 601-Bra
P caribaea, Morelet
P kesiya, Royle ex Gordon

1965-P caribaea, Morelet var bahamensis, Barr S Golf-599-Bra
P kesiya, Royle ex Gordon-611-Bra

1967-P Elliotti, Engel-C 613-Bra

1970-P Koraiensis, Sieb S Zucc-Coroa-616

INTRODUÇÕES DE EUCALYPTUS A PARTIR DO ANO 1952

ANOS DAS INTRODUÇÕES	NÚMEROS DAS INTRODUÇÕES
1952	450 a 700
1964	701 a 704
1965	705 a 740
1966	741 a 757
1967	758 a 767
1968	768 a 771
1969	772 a 773
1970	774 a 775
1971	776 a 779
1972	780 a 782
1974	783 -
1975	784 a 786
1976	787 a 830
1979	831

ORIGEM DAS INTRODUÇÕES

Austrália-450 a 452--550--562--673--682--683--701--759-a 767--770-771-778-779-78-782-785 a 818--820-
Africa -780--783--786--819--830--
Argentina-772--773-774-776--
Brasil -768--769--775--777--821 a 829

Obs: As introduções: 787 a 818 foram conseguidas pelo prof Gurgel-Convênio Hôrto-Faculdade- Horto Florestal da Ferrovia Paulista S/A e Instituto de Biociências -Universidade Estadual Paulista "Julio de Mesquita Filho"- Campus de Rio Claro.

FAST GROWING TREES

PRODUTIVIDADE E QUALIDADE DA MADEIRA DE *Pinus elliottii* ENGEL. VAR. *Elliottii* EM FUNÇÃO DO ATRASO NOS DESBASTES

M. de A. Fagundes — W. J. M. de Souza
Instituto Florestal
BRASIL

Resumo

Este trabalho (Nota Prévia) busca detectar os efeitos causados nos incrementos volumétricos e nas qualidades da madeira, devido à ocorrência de atrasos nos desbastes (1 a 4 anos), durante o período de rotação, em plantações de Pinus elliottii Engel. var. elliottii. São apresentados os dados obtidos em um período de 7 anos.

PRODUCTIVITY AND WOOD QUALITY OF *Pinus elliottii* ENGEL. VAR. *Elliottii* AS A FUNCTION OF A DELAY IN THE THINNING

Summary

This paper (previous notice) deals with the effects caused on the volume increment and on the wood qualities produced under the effect of delay in thinnings, and that variation goes 1 to 4 years, during the rotation period, in Pinus elliottii Engel. var. elliottii plantation.

Are presented the data got untill now, in a period of 7 years.

I n t r o d u ç ã o

O objetivo desta pesquisa, em andamento, é procurar determinar os efeitos de diversos graus de atraso de desbastes em plantações de Pinus elliottii Engel. var. elliottii, na produção quantitativa e qualitativa da madeira.

Neste trabalho são divulgados os resultados obtidos até a presente data, devendo a experimentação se prolongar até o final da rotação.

M a t e r i a l e M é t o d o

O projeto foi implantado na Floresta de Avaré, São Paulo, em 1972, em plantio de 1967. O espaçamento inicial era de 2,00 x 2,50 m (5m²/planta). Cada parcela tem 200 m², com um número teórico inicial de 40 plantas. Deixou-se o equivalente a 2 linhas de plantas como bordadura entre as parcelas. O experimento se compõe de 5 tratamentos (A, B, C, D e E) com 4 repetições, em blocos ao acaso.

O tratamento A é sempre desbastado na época tecnicamente indicada, não devendo portanto sofrer durante todo o período de rotação, de estagnação por competição. Representa, portanto, a testemunha do experimento. Os demais tratamentos (B, C, D e E) sofrerão, respectivamente, 1, 2, 3 e 4 anos de atraso em seus desbastes, atrasos esses não em seqüência. Quando cada um desses tratamentos sofrer todos os atrasos a que estão sujeitos, a nova área basal/ha será o indicador das épocas dos novos desbastes. Assim, por exemplo, o tratamento B que deverá sofrer somente um ano de atraso, terá, evidentemente, seu 1º desbaste feito um ano após o 1º desbaste do tratamentoA, e a área basal que apresentar na ocasião será o indicador para os desbastes seguintes. Os tratamentos C, D e E sofrerão o 1º desbaste juntamente com o tratamento B, ficando todos, portanto, com 1 ano de atraso. Quando o tratamento B atingir novamente a sua área basal de condução, sofrerá o 2º desbaste, porém, os tratamentos C, D e E serão atrasados de mais um ano. E assim sucessivamente.

Considera-se a área basal contatada após o pultimo atraso programado como "área basal de condução". Toda vez que essa área basal é alcançada, faz-se o desbaste.

R e s u l t a d o s

Quando da implantação do experimento, a plantação estava

com 5 anos de idade. Medições anuais indicaram a necessidade de desbaste em agosto de 1974, ocasião em que se fez o primeiro desbaste no tratamento A.

A área basal média do tratamento A era então de 22,03 m^2. Essa área basal será o indicador do momento dos novos desbastes, tão logo seja alcançada, representando sua área basal de condução.

As operações já realizadas são encontradas na FIGURA 1.

Época mês/ano	Tratamento/nº Desbaste	Tratamento/nº Atraso	Área Basal de Condução m^2/ha
08/1974	A/1	B-C-D-E/1	A = 22,03
08/1975	B-C-D-E/1	-	B = 27,47
03/1976	A/2	-	-
03/1977	B/2	C-D-E/2	-
09/1977	A/3	-	-
03/1978	C-D-E/2	-	C = 29,14

FIGURA 1 - Operações realizadas.

A madeira produzida nos diversos tratamentos, até a medição realizada em fevereiro de 1980, consta da Tabela 1 e é representada pelas médias das parcelas de cada tratamento, extrapolados para m^3/cc/ha.

TRATAMENTO	VOLUME RETIRADO (m^3)			ESTOQUE ATUAL (m^3)	TOTAL PRODUZIDO (m^3)
	1º DESB.	2º DES.	3º DESB.		
A	19,758	27,520	35,765	123,865	206,908
B	26,397	40,199	-	158,412	225,008
C	20,186	45,696	-	154,520	220,402
D	21,871	52,805	-	152,350	227,026
E	22,318	40,507	-	156,583	219,408

TABELA 1 - Madeira produzida m^3/cc/ha.

Os diâmetros (DAP) e as alturas obtidas na medição realizada em fevereiro/80, constam da TABELA 2 e representam as médias das parcelas de cada tratamento.

TRATAMENTOS	A	B	C	D	E
DAP	23,66	20,81	20,65	20,29	20,55
H	13,67	13,36	13,23	13,27	13,33

TABELA 2 - Diâmetros (cm) - alturas (m).

Os estudos de regressão entre os dados obtidos indicam as tendências de crescimento nos tratamentos A, B e C, que já atingiram as suas áreas basais de condução. Os tratamentos D e E encontram-se na mesma situação do tratamento C, com variações bem pequenas, sendo portanto representados por esse tratamento.

A Figura 2 apresenta as diversas equações usadas para a confeção de Figura 3, bem como os seus coeficientes de determinação.

TRATAMENTO	DIÂMETROS	ALTURAS
A	$y = -0,81 + 1,99x$ $r^2 = 1,00$	$y = -14,61 + 11,18lnx$ $r^2 = 1\ 1,00$
B	$y = 1,20 + 1,62x$ $r^2 = 0,98$	$y = -15,15 + 11,31lnx$ $r^2 = 0,99$
C	$y = 1,32 + 1,57x$ $r^2 = 1,00$	$y = -14,96 + 11,20lnx$ $r^2 = 0,99$

FIGURA 2 - Equações estudadas.

A proximidade dos valores das equações logarítmicas das alturas permitem a adoção do Tratamento C como representativo da tendência do crescimento das alturas de todo o experimento, na atual fase.

A diferença existente na madeira produzida entre os diversos tratamentos não é significativa.

A mesma análise feita para as alturas indica o mesmo resultado.

Pretende-se, tão logo se observe diferenças estatísticas nos tratamentos, iniciar os estudos sobre os comportamentos físico e mecânico das madeiras produzidas.

Referências Bibliográficas

HILEY, W.E. 1959. Conifers; South African methods of cultivation. London, Faber and Faber. 123p.

SMITH, J.H.G. 1958. Better yields through wider spacing. Journal of Forestry. 56: 492-97.

SCHÖNAU, A.P.G. 1975. Effect of site quality and initial stocking density on average diameter in Black Wattle plantation in Kenya. Forest Science. 21: 2-9.

VEIGA, A.A. 1976. Curso de atualização florestal. 3ª ed. Publ. I.F., São Paulo, 8:1 - 68-72 e 79-91, jul. (V-1).

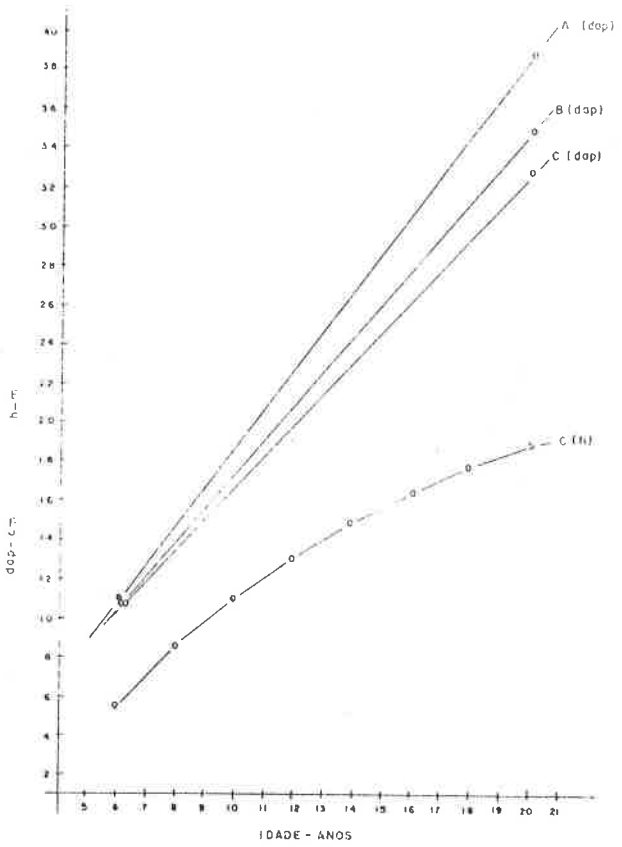


FIGURA 3 - TENDÊNCIA DOS CRESCIMENTOS DIÂMETRO - ALTURA

FAST GROWING TREES

TRANSPIRAÇÃO E BIOMASSA DE *P. caribaea* VAR. *hondurensis* EM PIRACICABA

E. S. B. Ferraz
ESALQ – USP
C. A. Sansigolo
Eng. Agr. MS
BRASIL

Resumo

A água tritiada é usada como marcador radioativo para medições diretas de transpiração e biomassa em uma população de 5 anos de idade de *Pinus caribaea* var. *hondurensis* na região de Piracicaba, Estado de São Paulo, Brasil. O método é baseado na teoria da dinâmica do marcador para sistemas em equilíbrio dinâmico.

Os experimentos foram conduzidos em duas estações do ano - verão e inverno - isto é, sob condições climáticas muito diferentes. O fluxo de transpiração foi calculado, bem como a biomassa e o período médio de permanência da água na árvore.

Os parâmetros climatológicos foram anotados durante o experimento e foram comparados com os resultados do fluxo de transpiração diário, mostrando ser, em média, 3 vezes maior no verão do que no inverno.

TRANSPIRATION AND BIOMASS OF *Pinus caribaea* VAR. *hondurensis* IN PIRACICABA

Summary

Tritiated water as radioactive tracer is used for direct measurements of transpiration and biomass in a population of 5-year old *Pinus caribaea* var. Hondurensis in the region of Piracicaba, State of São Paulo, Brasil. The method is based on the theory of tracer dynamics for systems in dynamic equilibrium.

Experiments were carried out in two seasons of the year - summer and winter - i.e., under quite different climatic conditions. The transpiration flow was calculated, as well as biomass and mean residence time of the water in the tree.

Climatological parameters collected during the experiment have been compared with the results of daily transpiration flows, showing to be, as an average, 3 times greater in summer than in winter.

Introduction

The measurement of transpiration rate of plants and particularly of forests has always been the concern of researchers, because it is the link between soil and atmosphere in the hydrological cycle. Most of the methods in use are theoretical-empirical estimates which take into account some of the soil or atmosphere parameters. Tree transpiration is then estimated indirectly, either by following the variation in soil moisture content or through calculations with atmospheric parameters such as solar radiation, relative humidity, wind speed, air temperature, etc.

KLINE et al. (1970, 1972) proposed a method for direct measurement of tree transpiration, based on the theory of tracer dynamics. The non-destructive measurement of transpiration rate uses tritiated water as tracer. Tritiated water is added to the natural flow by injecting it into the tree trunk at ground level, and it is then distributed through all the parts of the tree. From time to time leaves are collected from several points in the tree, and the radioactivity in the samples is measured. Tree transpiration is proportional to the are of the curve made for the specific activity as a function of time (SANSIGOLO, 1980).

The objective of this work was to demonstrate that the tritium method can and should be used for determination of transpiration rate in fast-growing forests, with greater advantages over the conventional methods of estimation.

Experimental Part

An area reforested with 5-year old *Pinus caribaea* trees, var. Hondurensis, spacing 2 x 3 m, was used. It was located in the area belonging to the Department of Forestry, Escola Superior de Agricultura "Luiz de Queiroz", University of São Paulo, in Piracicaba, State of São Paulo, Brasil (latitude 22°43'S, longitude 47°38'W, altitude 580 m).

Injections of tritiated water (HTO) were made into five trees representative of the population, on two different occasions. In the summer period, which is also the rainy season, 3 trees were used and in the winter, which coincides with the beginning of the dry season, other two trees were used. The objective was the obtention of data under two climatic conditions. Table I shows the trees' characteristics, amounts of HTO used and date of application.

Tritiated water of known specific activity was injected into the tree trunk at 30 cm above ground level. After the injection, leaf samples were successively collected until the radioactivity level of the samples was equal to the background's. The sampling was made by collecting 60 to 80 leaves representative of the whole canopy, i.e., young and old leaves, from the upper and lower parts, on the north, south, east and west sides. On the first day of the experiment, six samples were collected from each tree, one hour and a half approximately between one collecting and the next. On the subsequent days the number of daily samples progressively decreased until only one sample a day was collected.

Immediately after collecting the samples were placed in a refrigerator and taken to the laboratory. The water of the leaf tissues was extracted by pressing and purified by centrifugation. Radioactive counts were made by liquid scintillation through the conventional methods for tritium determination, routine corrections being made for quenching and background.

Methodology

a) the mean transpiration flows ($\overline{F}$) of the 5 trees were computed through curves of specific activity as a function of time (SANSIGOLO,1980) using the equation:

$$M = \overline{F} \int_0^{\infty} f'(t)dt \approx \overline{F} \sum_{i=1}^{n} \overline{f'(t)}\,\Delta t \qquad (1)$$

where M is the total tracer injected into the tree, $\overline{f'(t)}$ is the mean specific activity in the Δt interval and n is the number of intervals.

For obtention of the daily means (F_i) of the transpiration flow from the mean transpiration during the experimental period ($\overline{F}$), the solution utilized was that proposed by MONTEITH (1975) which, taking into account meteorological parameters observed in the period, makes a weighted distribution:

$$T_i = \frac{SRn + \rho c\,(e_s - e)/r_a}{\lambda S + \lambda\gamma(r_a - r_s)/r_a} \qquad (2)$$

where T_i is the daily mean transpiration ($cm.s^{-1}$), S is the rate of variation of daily mean value of saturating vapor pressure with temperature ($mb.^{\circ}C^{-1}$), Rn is the net solar radiation ($cal.cm^{-2}s^{-1}$), ρ is the air density ($1.29 \times 10^{-3} g.cm^{-3}$), c is the specific air heat ($0.24\ cal.g^{-1}.^{\circ}C^{-1}$) e_s is the saturation vapor pressure, daily mean (mb), e is the actual vapor pressure, daily mean (mb), r_a forest external resistance ($S.cm^{-1}$), λ water vaporization latent heat ($590\ cal.cm^{-3}$), γ psychrometric constant, r_s stomatal resistance, daily mean ($S.cm^{-1}$).

The mean flow for an experimental period ($\overline{T}$) was also obtained by solving MONTEITH's equation, using the mean values of the variables:

$$\overline{T} = \frac{\overline{S}\,\overline{Rn} + \rho c\,(\overline{e_s} - \overline{e})/r_a}{\lambda S + \lambda\gamma(r_a - r_s)/r_a} \qquad (3)$$

Assuming the actual transpiration to be proportional to the rate computed by Monteith's equation, equations (2) and (3) were used for the relative calculations:

$$F_i = \overline{F}\left[\frac{SRn + \rho c(e_s - e)/r_a}{SRn + \rho c(e_s - e)/r_a}\right]\left[\frac{\overline{S} + \lambda/r_a(r_a + \overline{r_s})}{S + \lambda/r_a(r_a + r_s)}\right] \qquad (4)$$

Supposing there was no significant variation in soil moisture content during the period (which was checked through soil sample analysis), one can say that:

$$r_s / \overline{r_s} = 1$$

i.e., the term involving the stomatal resistance would become equal to the unit, since $\overline{S}$ and S do not have significant influence on the F_i final value.

b) the mean residence times of water in the trees were calculated through the slope of the descending branches of the curves of activity vs time. This method is valid in cases where the system is homogeneously labeled by the tracer. The rate of decrease of the activity in the system (tree) is proportional to the total amount of tracer present and is described by an equation of the type:

$$A = A_o.e^{-\lambda t} \qquad (5)$$

where A_o and A are, respectively, the initial and present activities in the time t, and λ is the rate of decrease of this activity. The term λ is the slope when the function is plotted on mono-log paper. The mean residence time (T) is then easily calculated, being the reciprocal of λ:

$$T = \frac{1}{\lambda} \qquad (6)$$

c) the estimate of biomass was made indirectly, after the values of transpiration flow and residence time were known. With these values, the residence water in the tree was calculated:

$$D_e = \frac{1-U}{U}.\overline{F}.T \qquad (7)$$

Using samples taken from the tree trunk with a pressler auger, the mean moisture content of the wood (U) was calculated. The moisture content and residence water being known, the tree dry weight (D_e) was estimated.

The actual dry weight (D) of the trees, i.e., the biomass, was obtained by cutting the trees, weighing the fresh material and correcting for dry weight through the determined wood moisture content.

Results

Figs. 1 and 2 show the curves of variation in the specific activity as a function of time, obtained from the analysis of the samples collected. Fig. 1 refers to 3 trees used in the summer period and Fig. 2 to 2 trees used in the winter.

Table II shows the results obtained by using the methodology just described, which are the integrals of the curves in Figs. 1 and 2 ($DPM.h.ml^{-1}$), the mean transpiration flow in the period ($\overline{F}$ in liters of water per day) and the mean residence time of water in the tree (T, in hours).

Tables III and IV present the values of daily mean transpiration (F_i) computed from the mean transpiration flows ($\overline{F}$) for the 5 trees and from climatic parameters, using Monteith's formula (equation 4). The values of daily mean transpiration (F_i) for trees 1, 2 and 3 in the period between 23 and 27 Jan. 1979 (summer) can be found in Table III. Table IV shows the values for trees 4 and 5 during the period between 16 and 30 July 1979 (winter). In the first cases (summer) the mean soil moisture content in the period was $0.324\ cm^3.cm^{-3}$, which corresponds to approximately 0.5 atmospheres of soil water tension. In the second case (winter) the moisture content was $0.309\ cm^3.cm^{-3}$ and the soil water tension around 1.5 atmospheres.

The biomass values obtained through tritium methodology as compared with those calculated directly after cutting and weighing of trees 1, 2 and 3 are shown in Table V.

Table I. Characteristics of trees, total amount of HTO injected and date of beginning of experiment.

TREE	HEIGHT (m)	DAP (m)	TOTAL HTO INJECT. (DPM)	DATE OF INJECTION
1	6.40	0.103	2.026 exp 9	23 Jan 79
2	6.70	0.127	2.026 exp 9	23 Jan 79
3	6.90	0.143	2.026 exp 9	23 Jan 79
4	6.90	0.118	1.969 exp 9	16 Jul 79
5	7.80	0.143	1.969 exp 9	16 Jul 79

Table II. Daily mean transpiration and mean residence time of water for the 5 trees studied, under two distinct climatic conditions.

TREE	PERIOD OF YEAR	INTEGRAL OF CURVE $f'(t)$ vs t (DPM.h.mℓ$^{-1}$)	MEAN TRANSPIR. $\bar{F}$ (liters.day^{-1})	MEAN RESIDENCE TIME $\bar{T}$ (hours)
1	Summer	10.410 exp 5	46.7	21.1
2	Summer	6.567 exp 5	74.0	18.1
3	Summer	6.944 exp 5	70.0	24.4
4	Winter	19.730 exp 5	24.0	55.6
5	Winter	15.220 exp 5	31.1	63.7

Table III. Daily mean transpiration (F_i, ℓ/day) computed from the mean flows and climatic variables for the 3 trees injected with tritiated water in summer period.

DATE	NET RADIATION Daily Mean ($\underline{Rn}$, cal.cm^2.day)	TEMPERATURE Daily Mean (°C)	SATURATION DEF. Daily Mean (mb)	TRANSPIRATION Daily Mean (F_i, ℓ/day)
23/01/79	305	20.9	100	1. 48.7 2. 77.2 3. 74.0
23/01/79[a]	313	22.3	72	1. 49.9 2. 79.2 3. 74.9
25/01/79	223	21.3	44	1. 35.6 2. 56.4 3. 53.4
26/01/79	351	22.3	66	1. 56.0 2. 88.7 3. 83.9
27/01/79	271	23.0	64	1. 43.3 2. 68.7 3. 64.9

[a] θ = 0.324 cm^3/cm^3 e ξ = 0.5 atm

Table IV. Daily mean transpiration (F_i, ℓ/day) computed from the mean flows and climatic variables for the 2 trees injected with tritiated water in winter period.

DATE	NET RADIATION Daily Mean ($\underline{Rn}$, cal.cm^2.day)	TEMPERATURE Daily Mean (°C)	SATURATION DEF. Daily Mean (mb)	TRANSPIRATION Daily Mean (F_i, ℓ/day)
16/07/79	100	14.5	42	4. 27.0 5. 35.1
17/07/79	94	14.8	52	4. 25.4 5. 33.0
18/07/79[a]	85	10.4	45	4. 23.0 5. 29.9
19/07/79	1	11.0	16	4. 0.2 5. 0.2
20/07/79	98	8.6	40	4. 26.3 5. 34.2
21/07/79	112	9.8	39	4. 30.3 5. 39.4
22/07/79	94	13.1	48	4. 25.3 5. 32.9
23/07/79	41	13.6	49	4. 11.0 5. 14.3
24/07/79	55	16.9	44	4. 14.8 5. 19.2
25/07/79	94	19.2	57	4. 25.4 5. 33.0
26/07/79	118	17.0	39	4. 31.7 5. 41.2
27/07/79	98	15.5	52	4. 26.4 5. 34.3
28/07/79	114	14.8	47	4. 30.7 5. 39.9
29/07/79	114	16.3	61	4. 30.7 5. 39.9
30/07/79	114	17.1	67	4. 30.8 5. 40.1

[a] θ = 0.309 cm^3/cm^3 e ξ = 1.5 atm

Table V. Biomass calculated by the HTO method and by the process of weighings.

TREE no.	$\bar{F}$ (liters.hour^{-1})	$\bar{T}$ (hours)	BIOMASS / TREE HTO (kg)	BIOMASS / TREE Weight (kg)
1	1.95	21.1	25.2	18.5
2	3.09	18.1	34.3	23.3
3	2.92	24.4	43.7	29.5
4	1.00	55.6	34.1	-
5	1.29	63.7	50.4	-

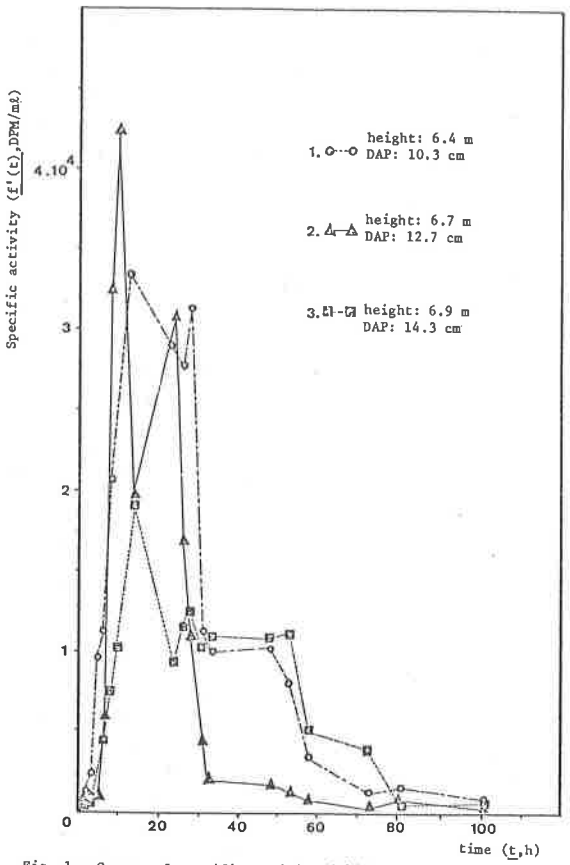


Fig. 1 - Curves of specific activity ($f'(t)$, DPM/mℓ) as a function of time (t, h) for the 3 trees which received injections of tritiated water in the summer period.

Discussion

The results indicate that the transpiration activity in summer was around three times that in winter (means of 63.6 and 27.5 liters/day). Consequently, the residence time of water in the tree was three times shorter in summer (means of 21.2 and 59.7 hours). This was expected, considering that the net solar radiation during summertime was also ca. 3 times greater than that in winter (means of 293 and 89 cal/cm^2.day) and the availability of water in the soil was not significantly different for the two seasons. In winter, although there were days with low mean temperature and a few days with temperatures below zero, the daily mean net radiation was high for the season, thus justifying the mean transpiration rate, which was 27.5 liters/day/tree.

The biomass values estimated from equation (7) showed to be somewhat consistent with the tree dimensions (Table I), but after cutting of trees 1, 2 and 3, weighing of green mass and determination of moisture content by sampling, it was found that the weights of dry matter of these trees were lower than those calculated by the tritium method. This can be explained as the biomass estimates are subject to all sources of errors inherent to transpiration measurements, in addition to those due to determination of moisture content and mean residence time of the water in the trees.

The percentage of moisture content refers to the moisture content weighted mean obtained from a limited number of samples. In practice, it is not difficult to obtain this datum, but the weighting factors for the leaves, twigs and stem are not well known and certainly will differ regarding species, age, environmental conditions, etc. In the present case, the moisture content of the stem at 1.5 m above the ground has been taken as being equal to the moisture content for the entire tree.

However, the greatest source of uncertainty lies in the calculation of mean residence time. The shorter the residence time, as in tropical climate during summer, the greater the uncertainty.

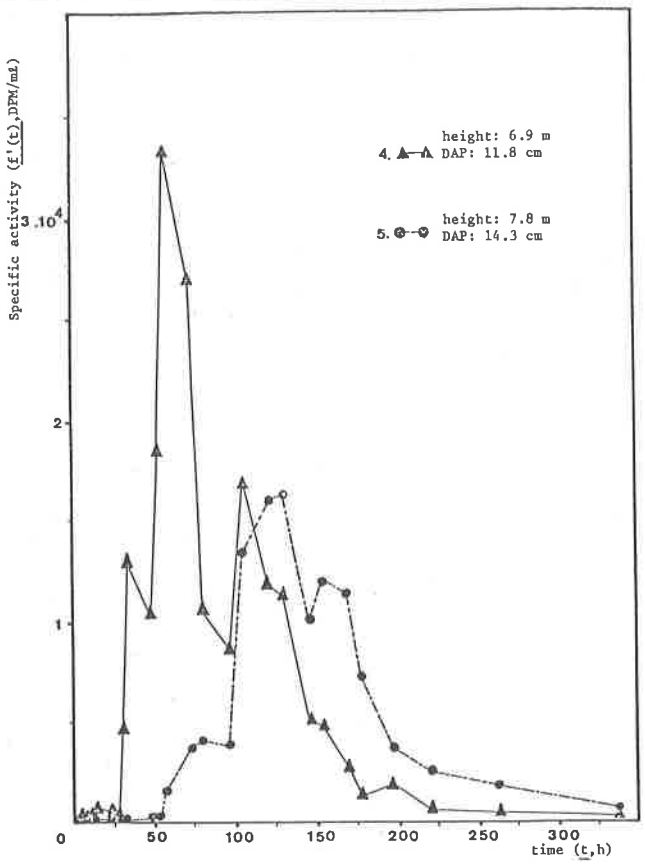


Fig. 2 - Curves of specific activity (f'(t), DPM/mℓ) as a functiom of time (t,h) for the 2 trees which received injections of tritiated water in the winter period.

It can be concluded, therefore, that the methodology using tritiated water as tracer is a real and practical tool for measuring tree transpiration under field conditions. The method makes possible the obtention of new experimental details on forest hydrology, which so far has not been possible by conventional methods of estimation.

References

KLINE, J.R. et al. 1970. Measurement of transpiration in tropical trees with tritiated water. Ecology 51: 1068-1073.

KLINE, J.R. et al. 1972. Use of tritiated water for determination of plant transpiration and biomass under field conditions. In: Isotopes and Radiation in Soil-Plant Research Including Forestry. Vienna. Anais IAEA: 419-437.

MONTEITH, J.L. 1975. Vegetation and the Atmosphere. New York, Academic Press, V.1, 278 p.

SANSIGOLO, C.A. 1979. Medida de Transpiração e Biomassa de Coniferas com Água Tritiada. Piracicaba, ESALQ/USP, 53 p. (MS thesis, in Portuguese)

FAST GROWING TREES

ÁREAS PRODUTORAS DE SEMENTES SOB DISTINTOS ESPAÇAMENTOS

M.A.de O. Garrido – J.L.Assini – C. Ribas
Instituto Florestal – São Paulo
BRASIL

Resumo

Instalou-se simultaneamente na Floresta de Manduri e na Estação Experimental de Assis, pertencentes ao Instituto Florestal de São Paulo, um projeto para se estudar o desenvolvimento e a produção de sementes de árvores de Pinus elliottii, em Áreas Produtoras de Sementes, quando submetidas a diferentes densidades de plantio.

Os valores de DAP, altura total e largura de copa anotados, foram semelhantes nos diferentes tratamentos.

A produção de sementes por árvore, foi maior nos espaçamentos mais amplos.

Summary

A research project was simultaneously installed at the Manduri State Forest and at the Experimental Station of Assis, in order to study the development and the seed production of Pinus elliottii trees, pertaining to Seed Production Areas, when submited to differents planting densities.

There was no difference in the DBH, crown width and total height values. The higher seed productions per tree were related to the lower densities treatments.

Introdução

A produção de sementes florestais sofre a influência de diversos fatores que afetam não só a quantidade como também a qualidade das sementes. Para se atingir um bom florescimento e uma boa frutificação é indispensável que alguns desses fatores tais como a densidade, tratos culturais, doenças, pragas e fertilidade do solo sejam controlados através de um manejo adequado para o povoamento em questão.

Florence e McWilliam (1955) afirmam que para se obter uma máxima produção de sementes por área, o espaçamento deve ser em torno de 36 m² por planta e acima de 81 m² para se obter uma máxima produção por árvore.

Segundo Giertych (1975) o espaçamento inicial para pomares de sementes em quase todos os países do mundo, está em torno de 6 x 6 m, porque permite uma mecanização de tratos culturais e colheita de sementes.

Citando trabalhos de diversos pesquisadores, Baena (1977) afirma que há uma grande variação de espaçamentos os quais podem ser desde 5 x 5 m até 10 x 10 m.

De acordo com Nikles (1970), a progressiva pressão sócio-econômica para a produção de sementes genotipicamente melhores, confere à presente pesquisa as características de imprescindibilidade e de oportunidade.

Material e Métodos

Este experimento foi instalado concomitantemente na Floresta de Manduri e na Estação Experimental de Assis, pertencentes ao Instituto Florestal, a partir de povoamentos puros, coetaneos de Pinus elliottii Eng. var. elliottii, plantados em 1964, sob o espaçamento de 1,50 x 1,50 m. Nos dois locais o experimento foi iniciado em 1971, configurando-se os tratamentos pelas diferentes densidades.

O delineamento adotado foi o de blocos ao acaso, com 7 tratamentos e 4 repetições, possuindo cada parcela 1440 m², conforme o Quadro 1.

Quadro 1 - Tratamentos observados e respectivas densidades de plantas.

Tratamentos	m²/planta	Nº plantas por parcela	Nº planta por ha
A	20	72	500
B	30	48	333
C	40	36	250
D	60	24	167
E	80	18	125
F	100	14	100
G	120	12	83

A metodologia desenvolvida na pesquisa foi uniforme nas duas dependências, destacando-se as dendrometrias anuais em altura total, DAP e largura de copa, bem como a coleta anual de todos os frutos e subseqüente pesagem dos cones e das sementes.

A primeira dendrometria foi realizada em 1971 e a primeira coleta de cones e sementes em 1974.

Resultados

Nesta oportunidade são apresentados apenas os dados dendrométricos da última mensuração realizada em 1979, que estão no Quadro 2.

Quadro 2 - Valores de DAP, altura total e largura de copa, na E.E. de Assis e na Floresta de Manduri em 1979.

Tratamentos m²/planta	DAP (cm)		Altura (m)		Largura da copa (m)	
	Assis	Manduri	Assis	Manduri	Assis	Manduri
20	20	21	13	14	5	5
30	21	22	13	14	5	5
40	21	23	12	14	5	6
60	21	25	12	14	5	6
80	21	25	12	14	5	6
100	21	24	12	13	5	6
120	22	27	11	14	5	6

A visualização do Quadro 2 mostra que não houveram diferenças marcantes entre os tratamentos no que se refere às mensurações de DAP, altura total e largura de copa. De uma maneira geral, o desenvolvimento das árvores da Floresta de Manduri foi ligeiramente superior ao das árvores da E.E. de Assis.

O Quadro 3 apresenta as produções de sementes obtidas em cada espaçamento. Devido as diferenças anuais de produção, observadas entre 1977 e 1980, trabalhou-se com a produção acumuladora de cada tratamento, de acordo com Garrido (1977).

Quadro 3 - Produção anual média de sementes por árvore e por hectare, nos diferentes tratamentos, de 1977 a 1980.

Tratamentos plantas / ha	Produção/árvore (g)		Produção/ha (Kg)	
	Assis	Manduri	Assis	Manduri
500	72	62	36	31
333	103	133	34	45
250	114	185	29	46
167	167	363	29	61
125	163	335	20	42
100	154	332	15	32
83	210	525	17	44

Foi observado pelo Teste F que houve diferença entre os tratamentos. O Teste de Tukey indicou para Manduri, que as melhores produções de sementes por árvore, acorreram nos espaçamentos mais amplos ou sejam 83, 167, 125 e 100 plantas por hectare. Em Assis, a análise da variância calculada, não acusou diferença significativa.

Conclusões

Conforme evidenciam os resultados obtidos nesses 9 anos de pesquisa e experimentação, pode-se concluir que:

1) A produção de sementes por árvore, foi maior nos espaçamentos mais abertos, em ambos os locais do presente experimento.

2) Houve uma maior produção de sementes em Manduri.

Literatura Citada

Baena, E.S. 1977. Áreas e pomares de sementes: implantação e manejo de pomares de sementes por clones e por mudas - E.S.A.L.Q. Piracicaba. (não publicado) 30p.

Garrido, M.A.O. 1977. Produção de sementes florestais: tratos culturais, fertilização, calagem e irrigação. Publicação IF. nº 15. p. 1-18.

Giertych, M. 1975. Seed orchards designs. In: Seed Orchards. Ed. Roy Faulkner - Forestry Commission. Bulletin nº 54. 149p.

Nikles, D.G. 1970. Mejora genetica para aumentar el crecimiento Unasylva. vol. 24. nº 97-98. p. 9-22.

FAST GROWING TREES

REGIME DA UMIDADE DO SOLO NAS PLANTAÇÕES DE PINHEIRO TROPICAL E VEGETAÇÃO DO CERRADO NO ESTADO DE SÃO PAULO

W. de P. Lima
ESALQ – USP
BRASIL

Resumo

A umidade do solo foi medida gravimetricamente durante um período de 24 meses em plantações de *Pinus caribaea* Mor. var. *hondurensis* e *Pinus oocarpa* Shiede, com 12 anos de idade, assim como numa reserva natural de cerrado no estado de São Paulo, para comparar o regime de água no solo nestas diferentes vegetações. As medidas foram feitas mensalmente nas profundidades de 0, 50, 100, 150 e 200 centímetros, com três repetições em cada parcela.
Os canteiros de *P. hondurensis* e de cerrado eram vizinhos, tanto quanto *P. oocarpa* distarte apenas 800 metros. O solo na área era típico do cerrado, sendo arenoso, muito profundo e bem drenado. Os resultados em geral não mostraram nenhum efeito adverso ao regime de água no solo, o qual poderia ser indicado ao reflorestamento dos solos de cerrado com espécies de pinheiros tropicais. O solo sob a vegetação do cerrado era geralmente mais úmido do que o solo das plantações de pinheiros durante o período de estudos.
Entre as espécies de pinheiros, a plantação de *P. oocarpa* causou uma perda menor da água do solo, apresentando um regime de água bastante similar aos do solo de cerrado.

SOIL MOISTURE REGIME IN TROPICAL PINE PLANTATIONS AND IN "CERRADO" VEGETATION IN THE STATE OF S.PAULO - BRAZIL

Summary

Soil moisture was measured gravimetricaly during a 24-month period in 12-year old plantations of Pinus caribaea Mor. var. hondurensis and Pinus oocarpa Schiede, as well as in an adjacent natural reserve of "cerrado" vegetation, in the state of São Paulo, and the data were used to compare the soil water regime in these different vegetations. Measurements were made monthly at the depths of 0, 50, 100, 150 and 200 centimeters, with three replications in each plot. The P.hondurensis and the "cerrado" plots were adjacent, whereas the P.oocarpa plot was about 800 meters apart. Soil in the area was typical of cerrado soils, being sandy, very deep, and well drained. The results in general did not show any adverse effect to the soil water regime which could be ascribed to the reforestation of "cerrado" soils with tropical pine species. The soil under cerrado vegetation was in general more umid.than the soil under the pine plantations throughout the study period.Between the pine species, the P.oocarpa plantation caused a smaller depletion of the soil water, presenting an overall soil water regime which was very similar to the one observed in the "cerrado".

Introduction

The study of soil water regime in forest plantations can be viewed in two important aspects: first, soil moisture is one of the most important environmental factor affecting site productivity (McCLURKIN, 1958), (ZAHNER, 1968), (ZIMMERMAN et al, 1972), (MADER, 1978), (FRALISH et al, 1978); secondly, it provides a means of evaluating some environmental effects of these plantations, particularly those related to any adverse effect caused to the soil water (REYNOLDS and WOOD, 1977).

This second aspect should be scrutinized in any large scale reforestation program. As PEREIRA (1973) puts it: "...it is clear that forests should neither be felled nor plantdd on a large scale without a study of the potential hydrological changes which may be expected... There is good sense, both pratically and scientifically, in early initiation of pilot schemes to provide measurements. The reduction in guesswork can save very large sums of money."

In some parts of the country, several reforestation programs have been using various pine species for the formation of fast-growing pine forests. In the region where the present study was conducted, extensive areas of "cerrado" vegetation have been replaced by tropical pine forests. In view of the need for information regarding soil moisture management in these new forests (STONE, 1978), and also considering the relevance of scientifically assessing any possible adverse hydrologic effect of such vegetation replacements, the present study was aimed at acquiring the following information:

a) the annual range of soil water under plantations of tropical pine species in comparison with that observed under "cerrado" vegetation:

b) the patterns of soil water depletion in tropical pine forests and in "cerrado";

c) the total amount of water stored in the soil profile in different periods of the year in these different vegetational covers;

d) comparison of soil water utilization pattern and the growth rate of the pine species studied.

Similar studies have been conducted in various countries in the world: (COHEN et al, 1966), (KITCHING, 1967), (SHACHORI et al, 1967), (ORR, 1968), (REPNEVSKAJA, 1969), (HERRING, 1970), (LAMBERT et al, 1971), (BUBLINEC, 1972), (BREWER & LINHARTZ, 1978). In Brazil, very few such studies have been carried out : (FERRI, 1961), (CERVELLINI et al, 1972), (LIMA & REICHARDT, 1977).

Material and Methods

The Study Area

The experiment was carried out on lands owned by the Companhia Agro-Florestal Monte Alegre (CAFMA), which is located in the county of Agudos, in the State of São Paulo, Brazil (Figure 1). Total area of the Company is about 12 000 ha, almost all reforested with conifers, chiefly tropical pine species.

The plots were located in two tropical pine stands: a 28,7 ha stand of Pinus caribaea Morelet var. hondurensis and a 53,0 ha stand of Pinus oocarpa, Schiede. Both were planted in 1966, on a 2,5 m x 2,0 m spacing. A third plot was also installed in a reserve of "cerrado", which represents the original vegetation cover in the area. The location of the study stands and of the "cerrado" reserve can be seen in the inset in Figure 1, which is a part of a map of the area of CAFMA. The "cerrado" vegetation is surrounded by the stand of P.caribaea, whereas the stand of P.oocarpa is located about 800m apart. Growth characteristics and results of thinnings already performed in the study stands are given on Table 1.

Climatic characteristics of the study area can be observed in the climatic diagram in Figure 2.

The topography is,in general, gently sloping, but the experimental plots were located in level ground.

Soil is typical of "cerrado", being sandy, very deep, well drained, acid, and of low fertility. Table 2 shows some profile characteristics of the soil in the study area.

Table 2: Soil horizons, depth, mechanical analysis and bulk density of the study area.

Horiz.	Depth (cm)	Mechanical analysis sand (%)	silt (%)	clay (%)	Bulk density (g/cm^3)
A_p	0-15	87,1	2,4	10,5	1,44
A_3	15-43	86,4	2,7	10,9	1,52
B_1	43-73	83,8	3,3	12,9	1,52
$B_{2.1}$	73-120	80,1	5,8	14,1	1,55
$B_{2.2}$	120-165	81,5	3,2	15,3	1,54
B_3	165-205	80,5	3,8	15,7	1,53
C	205-300	80,7	2,9	16,4	—

Table 1 : Average d.b.h., height, and dendrometric data of three thinnings performed in the study stands, (data from the file of CAFMA).

Species	date	ave. dbh (cm)	ave. heigth (m)	N°of trees after each thinning	Basal Area (m^2/ha) Before	After	Thinning production (m^3/ha of debarked wood)
P.caribaea var. hondurensis	1974 (1st thinning)	15,7	14,2	-	38,3	28,5	45,9
	1976 (2nd thinning)	19,4	18,1	993	35,2	31,2	16,0
	1978 (3rd thinning)	27,0	20,1	700	38,4	28,6	56,6
P.oocarpa	1974 (1st thinning)	14,8	13,7	-	33,4	27,2	26,2
	1976 (2nd thinning)	18,2	16,7	1040	34,5	28,3	18,5
	1978 (3rd thinning)	20,1	19,9	700	32,9	24,9	40,2

Part of a map of CAFMA (Scale 1 : 40 000)

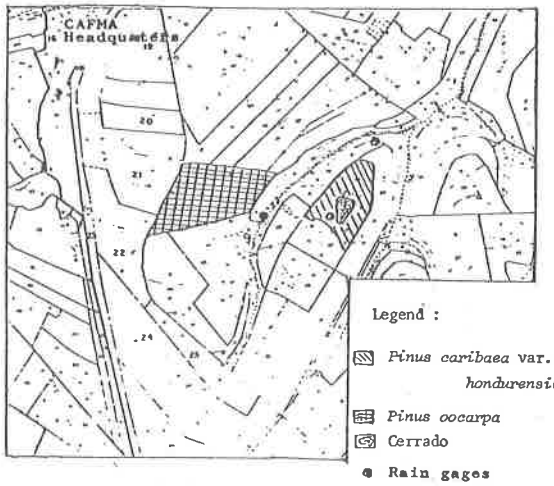


Figure 1 : Location of Agudos in the State of São Paulo and inset of part of a map of the area of CAFMA, showing the location of the experimental stands.

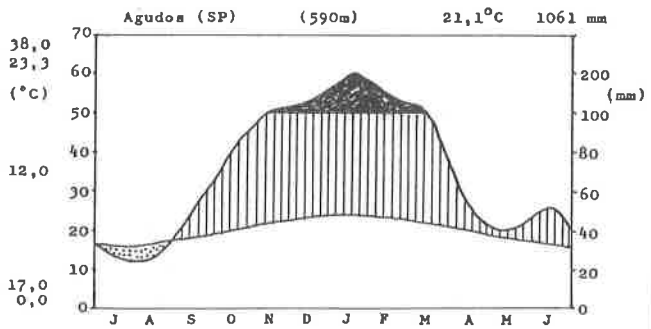


Figure 2: Climatic diagram of the study area.

Methods

Precipitation was measured weekly in nearby open areas with three, non-recording, rain gages.

Soil moisture was monitored monthly by the gravimetic method. In each stand, samples were taken in three different points, at the depths of 0, 50, 100, 150 and 200 centimeters, using a core-type soil auger.

Data collection prolonged from june 1977 through may 1979.

Soil pits were excavated in each plot for the purpose of collecting appropriate samples in each depth for the laboratory determination of soil bulk density, and soil water retention at the -1/3 and -15 atm pressure.

Results and Discussion

Figure 3 shows the monthly means of volumetric soil moisture in cm^3/cm^3 for the total two meters of soil profile, and the monthly rainfall data in milimeters, for the entire measurement period, for the three vegetation covers. The average values of moisture retention at -1/3 atm and -15 atm of pressure for the profile are also depicted in this figure.

Figure 3 is a representation of the soil water regime, i.e., the fluctuations in soil moisture in each cover condition along the period of study, in response to the precipitation input. For the two-meter profile, it shows large variations in total soil water along the months. Apparently, soil water content falls below the 15-atm tension only in two occasions during the year, that is, in august-september, and in march-april.

In Figure 4, on the other hand, it can be seen the way these fluctuations in soil moisture occurred in each depth of the soil. Much of the total monthly variation in soil water content shown in Figure 3 occurred only at the surface (0 cm depth) and down in the 50-cm depth. Below the depth of 100 cm, Figure 4 shows that the water content in the soil was more uniform throughout the period of study in the three different vegetations. It can also be seen in Figure 4 that the differences in soil water content among the species studied are greatest in the surface layer of the soil.

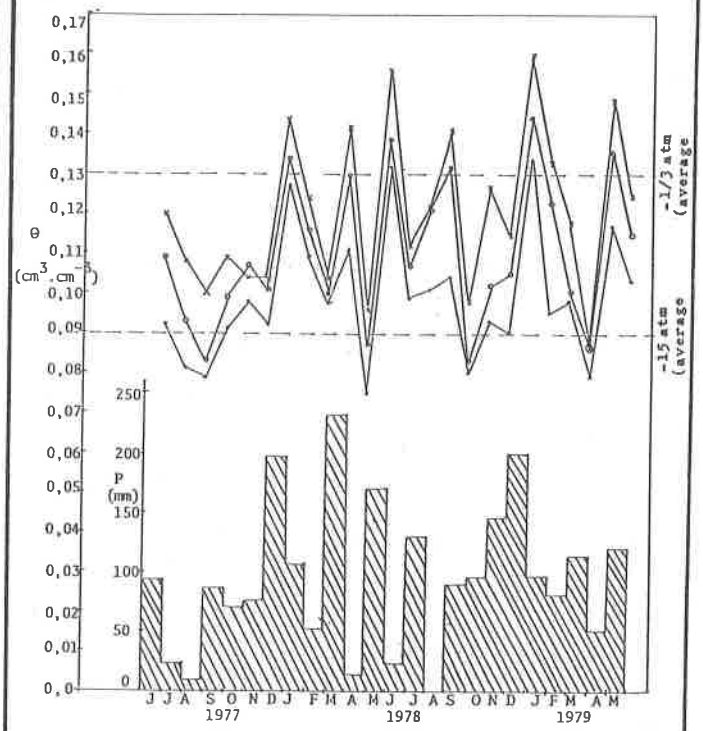


Figure 3 : Monthly variation of average volumetric soil water content (θ) for the 200 cm soil profile, and monthly precipitation during the experimental period.

x—x "cerrado" o—o P.oocarpa •—• P.caribaea var. hondurensis

Considering the 24 months of the study period, and taking the average monthly values of soil moisture content for the total profile, and rainfall data, these average values were used to construct Figure 5, which shows the mean annual fluctuation of total soil water, in mm, for the tropical pine forests in comparison with that of the "cerrado" vegetation, together with the mean monthly precipitation, and with the average values of moisture retention in the soil at 1/3- and 15 atm of negative pressure. As can be seen in Figure 5, the mean curves smoothed down most of the monthly variations which appear in Figures 3 and 4, as well as decreased the influences on soil water of abnormal monthly precipitation measured during the study period.

These figures show that the soil under "cerrado" vegetation was, in general, always more umid than the soils under the tropical pine forests. Between the pine species, the soil was always more umid under the Pinus oocarpa forest. The Pinus caribaea var. hondurensis forest, therefore, was responsible for the highest depletion of soil water throughout the study period. The differences in soil water utilization

among the covers tended to be higher during the dry months of the year. As shown in the average pattern of soil moisture - utilization of figure 5, only in the case of P.caribaea plot - did the soil water content fall below the 15 atm tension during the driest period of the year (august-september).

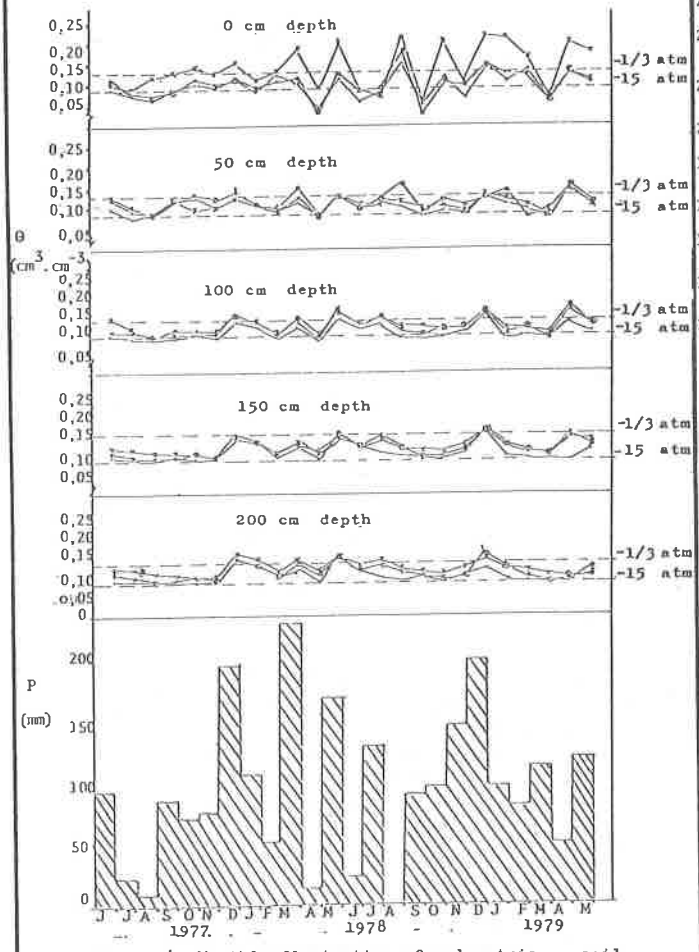


Figure 4: Monthly fluctuation of volumetric soil moisture content in each study soil depth, and monthly precipitation during the experimental period.

x—x "cerrado" o—o P.oocarpa •—• P.caribaea

The differences in soil water regime thus discussed are, therefore, in terms of monthly values of soil moisture, species studied, and different depths of the soil profile. To test the significance and the extent of these differences, the data was submitted to analysis of variance. Table 3 summarizes the - results of the separate analyses:

Table 3 : Analysis of variance for the monthly values of soil moisture contents in the three different study vegetation.

Source	d.f.	S.S.	M.S.	F
Species (S)	2	301,46	150,73	6,37 *
Depths (D)	4	37,80	8,20	0,35 n.s.
Interaction (SxD)	8	189,16	23,65	2,15 *
Error	276	1013,71	11,02	

* significant at the 5% level
n.s. non significant

Table 3 shows that the difference in monthly soil water content among the covers during the study period was significant at the 5% level. Results of the Tukey's test showed, however , that the difference was significant only between Pinus caribaea and "cerrado". In another words, there was no difference, from the statistical viewpoint, between the tropical pine species, or between the Pinus oocarpa forest and the "cerrado" - vegetation, in regards to soil moisture utilization.

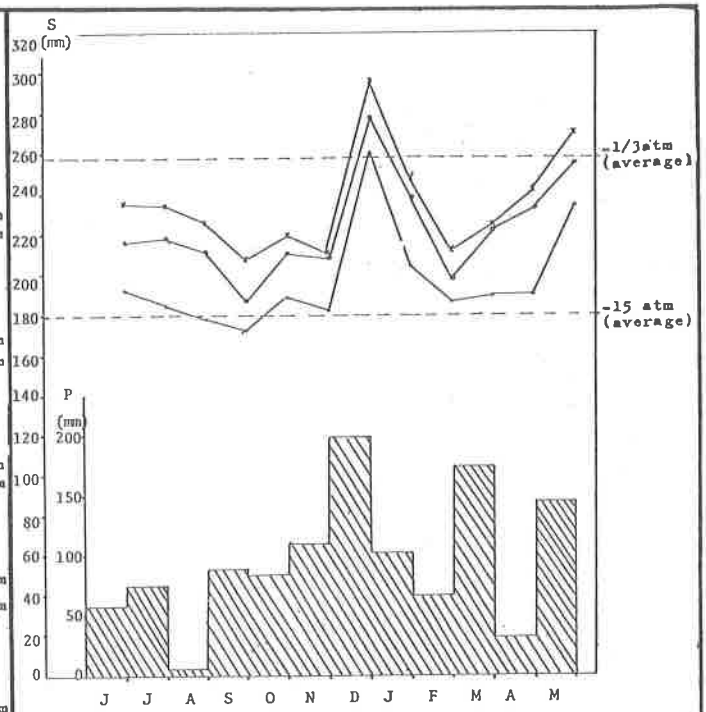


Figure 5 : Average monthly fluctuation of total soil water in the 200 cm soil profile (S) in milimeters and average monthly - precipitation for the study period - (average of two-year measurements).

Legend: x—x Cerrado
o—o *Pinus oocarpa*
•—• *Pinus caribaea var. hondurensis*

Table 3 also shows that the species studied act differently in the different depths of the soil, as can be inferred from the significance, at the 5% level, of the interaction (S x D) . This inference was checked by the partitioning of the degrees of freedom of the interaction and by further comparison through Tukey's test. Results showed that the difference between - P.caribaea and "cerrado" was significant only at the surface layer of the soil. In another words, only the surface layer of the soil (0 cm depth) of the "cerrado" vegetation was - significantly more umid than the corresponding layers in the pine forests. In all other studied depths, monthly soil water contents were not significantly different among the covers, as well as there were no diferences between the pine species in any individual soil depth.

Another may of viewing the differences in the pattern of soil moisture utilization by the study vegetation during the experimental period is through the curves of Figures 6 and 7 .

Figure 6 shows the distribution of soil water in the entire profile in two occasions: part A of the figure depicts the - lowest reading of soil moisture contents, which were determined in august 31st, 1977; part B shows the highest values - determined in january 2nd, 1979. The values of the 1/3- and 15 atm tension are averages for individual determinations in each depth in the three plots. In Figure 7, part A is the mean - moisture content in the soil for the dry season (april- - september), and part B is the mean moisture content for the rainy season (october-march). Again the values of 1/3- and 15 atm tension are averages for each depth. The differences in the pattern of soil moisture utilization by the three covers along the 200 cm of soil profile are again shown in these figures , noticing the glaring tendency of the soil under Pinus caribaea var. hondurensis forest of being always drier in comparison with the other pine forest and with the "cerrado" vegetation.

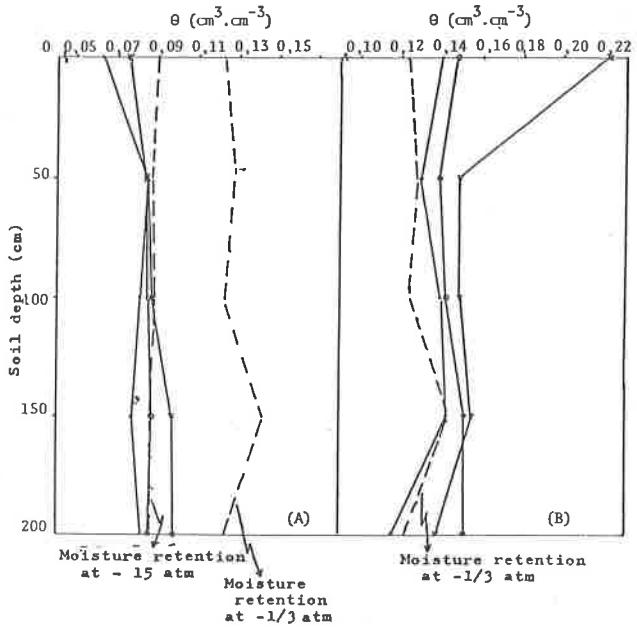


Figure 6 : Volumetric moisture profile in the 200 cm depth of soil : (A) smallest values of moisture content observed during the study period, as determined in august 31, 1977; (B) highest reading observed in January 02, 1979.

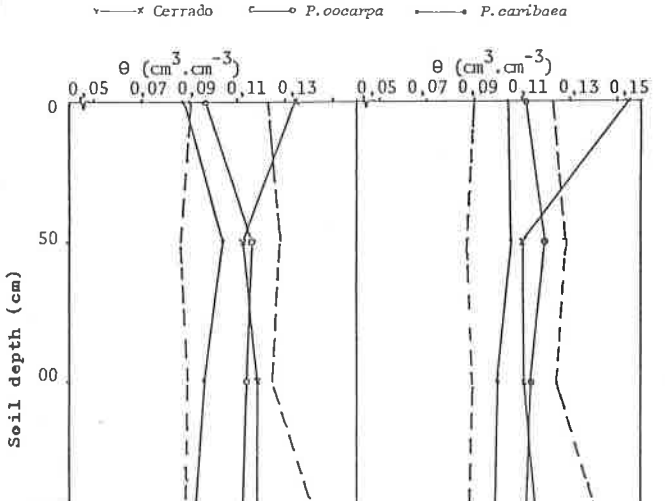


Figure 7 : Average volumetric moisture content in the 200 cm soil profile. (A) dry period (april-september) average; (B) rainy season (october-march) average: 1977 through 1979.

It is interesting to make additional comments on the difference in soil water utilization between the two tropical pine species. Although the quantitative differences in soil water depletion between them were not statistically significant, they can however, be compared with differences in silvicultural characteristics of each species, as already given in Table 1 . On the other hand, BERTOLANI & NICOLIELO (1977) state that Pinus caribaea var. hondurensis forests in Agudos are presenting excellent volumetric growth, with mean annual increment around 28 m^3/ha/year of debarked wood at the age of 15 years. For this species, however, the authors cite that the percentage of defective trees is high. As for the Pinus oocarpa forests, mean annual increment in Agudos is around 20 to 25 m^3/ha/year, at the same age, but presenting less defective trees. In terms of wood specific gravity for populations of the two pine species in Agudos, Table 4 is according to data given in FERREIRA et al (1978), and shows the following values of specific gravity according to the age of the plantations:

Table 4 : Wood specific gravity of population in g/cm^3 (after FERREIRA et al, 1978).

Species	Age (years)	Specific gravity (g/cm^3)
Pinus caribaea var. hondurensis	6	0,351
	12	0,408
	14	0,417
Pinus oocarpa	6	0,390
	12	0,413
	13	0,443

It can thus be seen that the P.oocarpa species presents a smaller rate of development in comparison with P.caribaea var. hondurensis in the study area. This difference should, however, be viewed in terms of the better form of the trees in the case of P.oocarpa, of the higher value of the wood specific gravity, as well as from the hydrological standpoint, according to the results of the soil water regime obtained in the presenty study, i.e., of the tendency of the P.oocarpa forest to use less water in comparison with P.caribaea var. hondurensis.

Preliminary, unpublished data of rainfall interception which is being measured in the study plots can also be used to give additional explanation of the differences in soil water utilization patterns. Average values of rainfall interception are as follows: "cerrado", 28%; P.oocarpa, 13,4%; P.caribaea var. hondurensis, 11,9%. RUTTER (1968), SINGH & SZEICZ (1979) , and BORMAN & LIKENS (1979) contain results and discussion important about the implication of the interception results in this aspect. SINGH & SZEICZ (1979), for instance, determined that the evaporation of intercepted water occurs at a rate 2 to 3 times greater than the transpiration that would have occurred if it had not rained, and that about 1/3 to 1/20 of the intercepted water corresponds to the economy of soil water use as a consequence of the reduction in transpiration.

Conclusions

From the viewpoint of soil water utilization, the results of the present study did not show any adverse effect which could be ascribed to the replacement of "cerrado" vegetation by fast-growing forests of tropical pine species. The soil under "cerrado" vegetation was always more umid than the soil under pine, throughout the study period, but the difference was statistically significant only in relation to the surface layer of soil, and only in relation to one of the pine species studied. Comparing Pinus oocarpa with Pinus caribaea var. hondurensis, the first species would be recommended for reforestation in areas of "cerrado" similar to the study area. Besides presenting a relatively good development, this species presented an overall soil water utilization pattern which was very similar to that observed under the original "cerrado" vegetation.

Literature Cited

BERTOLANI, F. & NICOLIELO, N.- Performance and tree improvement programme of tropical pines in the region of Agudos, São Paulo, Brazil. In : Workshop on Progress and Problems of Genetic Improvement of Tropical Forest Trees. Oxford, Commonwealth Forestry Institute. p. 808-818, 1977.

BORMAN, F.H. & LIKENS, G.E. - Patterns and process in a forested ecosystem. New York, Springer-Verlag; 253 p, 1979.

BREWER, C.W. & LINHARTZ, N.E. - Soil moisture utilization by mature loblolly pine stands in the Coastal Plain of southeastern Louisiana. In : Soil moisture-site productivity symposium. Myrtle Beach, S.C., Nov. 1977. USDA Forest Service, p.296-306, 1978.

BUBLINEC, E. - Influence of pine monocultures on momentary soil moisture. Acta Inst. Forestalis Zvolen., 3:125-160,1972. Apred : Forestry abstracts. Oxford, 35(7):3470, 1974.

CERVELLINI, A.; REICHARDT, K.; SALATI, E.; ZUR, B. - Preliminary studies on the water economy in "cerrados". Piracicaba, CENA, Boletim Científico BC-008,18p., 1972.

COHEN, O.P.; KAPLAN, J; SHARABANI, N. - Water balance under pine plantations and natural herbaceous vegetation in the Judean Foothills. In : 6th World Forestry Congress Madrid . p.3811-3814, 1966.

FERREIRA, M.; AMARAL, A.C.; BERTOLANI, F.; NICOLIELO, N. - Rendimento em peso seco de madeira de plantações de pinheiros. IPEF, Piracicaba (17):78-89, 1978.

FERRI, M.G. - Aspects of the soil-water-plant relationships in connexion with some Brazilian types of vegetation. In : Tropical soil and vegetation proc., Abidjan symposium, Unesco, p.103-109, 1961.

FRALISH, J.S.; JONES, S.M.; O'DELL, R.K.; CHAMBERS, J.L. - The effect of soil moisture on site productivity and forest composition in the Shawnee Hills of southern Illinois. In : Proc. soil moisture-site productivity symposium. Myrtle Beach, SC, USDA Forest Service, 1978.

HERRING, H.G. - Soil moisture trends under three different cover conditions. U.S. Forest Service Research Note PNW 114, 1970.

KITCHING, R. - Water use by tree plantation. Journal of hydrology, Amsterdam, 5:206-213, 1967.

LAMBERT, J.L.; GARDNER, W.R.; BOYLE, J.R. - Hydrologic response of a young pine plantation to weed removal. Water resources research, Washington, 7(4):1013-1019, 1971.

LIMA, W.P. & REICHARDT, K. - Regime da água do solo sob sob florestas homogêneas de eucalipto e de pinheiros. CENA, Boletim Científico BC-043, Piracicaba, 31 p, 1977.

MADER, D.L. - The role of soil moisture in forest site productivity in Massachussets. In : Symp. on soil moisture-site productivity. Myrtle Beach, SC, USDA Forest Service, 1978.

McCLURKIN, D.C. - Soil moisture content and shortleaf pine radial growth in north Mississipi - Forest Science, Washington, 4(3):232-238, 1958.

ORR, H.K. - Soil moisture trends after thinning and clearcutting in a second-growth ponderosa pine stand in the Black Hills. U.S. Forest Service Research Note RM-99, 8 p , 1968.

PEREIRA, H.C. - Land use and water resources in temperate and tropical climates. London, Cambridge University Press, 246p. 1973.

REPNEVSKAJA, M.A. - Soil moisture regime in the scots pine forests of the Kola Peninsula. Lesove., Moskva, 3:78-82, 1969. Apud: Forestry abstracts, Oxford, 31(2):2143, 1970.

REYNOLDS, E.R.C. & WOOD, P.J. - Natural versus man-made forests as buffers against environmental deterioration. Forest ecology and management, (1):83-96, 1977.

RUTTER, A.J. - Water consumption by forests. In : Kozlowski , T.T. (Ed.) Water deficits and plant growth, New York, Academic Press, p. 23-84, 1968.

SHACHORI, A; ROSENZWEIG, D.; POLJAKOFF-MAYBER, A. - Effect of mediterranean vegetation on the moisture regime. In : Sopper, W.E. & Lull, H.W. (Ed), International Symposium on Forest Hydrology, New York, Pergamon Press, p. 291-311, 1967.

SINGH, B. & SZEICZ, G. - The effect of intercepted rainfall on the water balance of a hardwood forest. Water resources research, Washington, 15(1):131-138, 1979.

STONE, E.L. - A critique of soil moisture site productivity relationships. In : Soil moisture-site productivity symposium. Myrtle Beach, SC, USDA Forest Service, p. 377-387 1978.

ZAHNER, R. - Water deficits and growth of trees. In :Kozlowski, T.T. (Ed.) Water deficits and Plant Growth, New York, Academic Press, p.191-254, 1968.

ZIMMERMAN, R.W.; ROLFE, G.L.; ARNOLD, L.E. - Soil moisture and radial tree growth on a southern Illinois oak-hickory watershed. University of Illinois Forestry Research Repert nº 77, 2p. 1977.

Acknowledgements: The study area is located on lands owned by Cia. Agro-Florestal Monte Alegre. Financial support was provided by the BNDE (Banco Nacional de Desenvolvimento Econômico), through the Project FUNTEC Nº 305/76. Research grant was provided by the CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico), Project Nº 1111.0135/78.

FAST GROWING TREES

PRIMEIROS RESULTADOS DOS TESTES DE FERTILIZAÇÃO EM PLANTAÇÕES DE *Pinus* EM MADAGASCAR

C. Malvos
CENRADERU
FRANCE

Resumo

Há mais de 10 anos que a experimentação com relação e fertilização de pinus tropicais vem sendo executada em Madagascar (especialmente *Pinus caribaea* e *Pinus kesiya*). Todos estes testes vêm mostrando bons resultados no uso da fertilização fosfato-potássica (aplicada na cova). Esta técnica está sendo aplicada em larga escala nas plantações industriais de High Mangoro (6 000 ha por ano).

PREMIERS RESULTATS DES ESSAIS SUR LA FERTILIZATION DE DEPART DES PLANTATIONS DE PINS A MADAGASCAR

I N T R O D U C T I O N

Les premières introductions de résineux exotiques à Madagascar remontent à 1914, mais c'est à partir de 1953 que l'effort de reboisement en pins s'est considérablement accru. Dès 1963, le Centre Technique Forestier Tropical s'est préoccupé des problèmes de fertilisation à la plantation (fertilisation de départ) et le travail expérimental s'est poursuivi par le Département des Recherches Forestières et Piscicoles du Centre National de Recherches Appliquées au Développement Rural.

L E S F A C T E U R S D U M I L I E U

Les expérimentations ont été réalisées dans les stations ci-dessous :

Manankazo

18°18' LS - 47°13' lE - Climat tropical semi-humide d'altitude - Pluviométrie moyenne annuelle 1 828 mm - 5 mois secs (< 50 mm) - Température moyenne 17° (minima 12°, maxima 22°) - Altitude 1 850 m - Sols ferrallitiques carencés.

Vakinankaratra

19°27' LS - 47°45' lE - Climat tropical semi-humide du type soudano-guinéen (Aubréville) - Pluviométrie annuelle 1 655 mm - Température moyenne 15° (minima 10°, maxima 19°) - Altitude 1 650 m - Sols ferrallitiques lessivés et carencés.

Mangoro

18°38' LS - 48°14' lE - Climat tropical semi-humide type soudano-guinéen (Aubréville) - Pluviométrie moyenne annuelle 1 610 mm - 4 mois secs (< 50 mm) - Température moyenne 19° (minima 12°, maxima 25°) - Sols ferrallitiques typiques très désaturés sur migmatiques schisteuses - Altitude 920 m

D'une façon générale ces sols très pauvres présentent une carence très grave en phosphore, grave à moyenne en potasse et plus ou moins prononcée en calcium, magnesium et soufre.

E F F E T D E S E L E M E N T S P R I N C I P A U X

Sur Pinus patula :

Un essai factoriel NPK a été mis en place en 1966 sur la station de Manankazo, avec parcelle unitaire de 50 x 50 m, selon un dispositif en blocs incomplets. L'apport d'engrais a été

fait au trou de plantation pour P et K (52 g de P205 et 24 g de K20) et en épandage superficiel après plantation pour l'azote (9 g de N).

Les résultats sont les suivants en m :

Traitements	N	NK	O	K	P	NP	PK	NPK
Hauteur 1968 (1 an ½)	0,26	0,35	0,56	0,65	0,95	0,98	1,06	1,21
Hauteur 1973 (6 ans ½)	2,47	3,77	3,57	4,51	4,83	4,74	6,03	6,21

Nota : Moyennes soulignées = différences non significatives au seuil 5 %

On constate, à l'analyse, que l'effet K lent à s'établir devient important dès la 4ème année. Par ailleurs on constate un effet remarquable d'homogénéisation (CV 1973 des parcelles sans P, 31 %, avec P, 17 %).

Au Vakinankaratra (essai 1 et 7), un essai du même type mis en place en 1972 a donné les résultats ci-dessous :

Traitements	N	P	K	NPK	NP	NK	PK	O
Hauteur (m) (2 ans)	0,34	0,83	0,42	0,96	0,89	0,33	0,81	0,36
Hauteur (m) (6 ans)	2,48	3,45	3,77	4,79	3,60	3,41	4,79	2,58

On constate là aussi un effet P important les premières années puis ensuite un effet K. L'ensemble P + K permet un gain de 85 % en hauteur.

Sur Pinus kesiya :

Un essai a été mis en place au Mangoro (essai 1) en 1968. C'est un essai en blocs complets à 10 traitements intéressant l'apport d'engrais : phosphates, potasse, dolomie et chaux. Là aussi l'effet principal des phosphates apparait dès le début mais par la suite l'effet K devient très important. Les résultats sont donnés dans le tableau ci-dessous :

Traitements	O	Dol	K	K Ch	K Dol	Ph	Ph Dol	Ph K	Ph K Ch	Ph K Dol
Hauteur (m) 1969 (6 mois)	0,19	0,17	0,19	0,17	0,20	0,26	0,25	0,28	0,26	0,27

Traitements	O	Dol	Ph	Ph Dol	K Ch	K Dol	K	Ph K	Ph K Ch	Ph K Dol
Hauteur (m) 1978 (9 ans 1/2)	7,64	8,68	9,06	9,11	11,47	11,46	11,53	11,85	11,92	12,00

Toujours sur Pinus kesiya, un essai factoriel NPK (50 g de P205 - 24 g de K20 - 8 g de N) mis en place au Mangoro en 1973 donne les résultats ci-dessous à 4 ans ½ (h en m) :

	N	P	K	NPK	NP	NK	PK	O
h. 4 ans ½	3,94	4,25	4,78	5,21	4,26	4,81	5,28	3,44

Sur Pinus elliottii, au Mangoro, un essai factoriel PK aux mêmes doses d'apport avec en comparaison un traitement NPK donne à 5 ans ½ les résultats ci-dessous :

	O	P	K	PK	NPK
h 78 (m) 5 ans ½	5,15	4,89	5,64	5,69	5,69

Enfin un essai factoriel NPK aux mêmes doses a été mis en place au Mangoro sur Pinus oocarpa, Pinus kesiya, Pinus caribaea var hondurensis et Pinus elliottii qui a donné les résultats ci-dessous (hauteur en m) :

	N	P	K	NPK	NP	NK	PK	O
P. oocarpa	3,66	4,18	6,14	6,78	4,14	6,33	6,63	3,58
P. kesiya	4,18	4,15	5,33	5,76	4,18	5,20	5,80	3,60
P. caribaea	3,36	4,01	5,67	5,48	3,45	5,56	5,60	3,01
P. elliottii	2,43	2,42	3,00	2,99	2,18	2,86	3,08	2,26

En conclusion, on peut voir que sur les Hauts Plateaux et avec Pinus patula (Manankazo et Vakinankaratra) la réponse au phosphore est la plus importante pendant les premières années, puis ensuite l'effet potasse se fait sentir. Les meilleurs résultats sont obtenus avec une fertilisation phosphopotassique qui permet d'obtenir un gain sur les hauteurs, vers 5 ans, de l'ordre de 80 %.

Dans la zone du Mangoro, surtout avec Pinus kesiya, si au départ il y a un effet phosphate net, l'effet potasse devient très important à partir de la 4ème année. Les meilleurs résultats sont obtenus avec une fertilisation phosphopotassique. Selon les espèces, on peut remarquer également une réponse très nette avec Pinus oocarpa, kesiya, patula et caribaea et moins nette avec Pinus elliottii.

FORMES ET DOSES D'APPORT

Concernant le phosphore :

Un essai sur Pinus patula a été mis en place à Manankazo. On a comparé 3 doses (30, 60, 90 g de P205) sous 2 formes (Hyperphosphates et scories). Après 4 ans et demi un très léger effet dose apparait ainsi qu'un léger avantage de l'hyperphosphate.

Sur Pinus kesiya, un essai aux mêmes doses a été réalisé au Mangoro ainsi qu'un essai de doses (12,5 - 25 - 50 - 100 - 200 g d'hyperphosphate) de phosphore. Les résultats ont montré que le phosphate agissait à partir de 25 g et qu'il y avait peu de différence entre les doses de 50 à 200 g à 4 ans ½ :

	0	12,5g Hyper	25g Hyper	50g Hyper	100g Hyper	200g Hyper
Hauteur à 4 ans ½	4,47	4,55	4,97	4,94	5,00	4,96

Concernant la potasse :

Les essais ont porté surtout sur la comparaison des formes d'apports, sulfate et chlorure en présence de phosphore dont l'importance est grande au plan économique. Ces essais ont été réalisés sur Pinus kesiya et Pinus patula au Mangoro et à Manankazo. (h en m)

	0	50 g Sulfate	100 g Sulfate	40 g Chlorure	80 g Chlorure
Pinus patula Hauteur à 4 ans ½	3,29	3,99	4,15	3,82	3,74
Pinus kesiya Hauteur à 4 ans ½	4,57	4,99	5,03	5,03	5,17

Aucune différence n'a été constatée dans ces 2 espèces entre sulfate et chlorure sur la croissance et la mortalité, ni d'effet dose.

Concernant l'azote :

Les essais ont porté sur les formes (Urée - Ammonitrate), les doses et les modalités (apport épandage ou au trou). Les résultats sur Pinus kesiya et patula sont les suivants : (h en m)

	PK + 0	PK + 20g Perlurée Trou	PK + 40g Ammonit. Trou	PK + 20g Perlurée Superf.	PK + 40g Ammonit. Superf.	150 g 11.22.16 Trou
P. patula Manankazo h. 4 ans ½	4,24	4,06	4,08	4,24	3,87	4,08
P. kesiya Mangoro h. 5 ans ½	6,83	7,10	6,72	7,05	6,83	6,52

En conclusion, on peut remarquer que pour le phosphore on n'a pas constaté de différence entre les formes d'apport et à partir de 30 g de P205 par plant on n'a pas vu apparaitre d'effet dose à ce jour. Pour la potasse, les essais ont montré qu'il n'y avait aucun inconvénient à utiliser l'apport sous forme de chlorure. Quant à l'azote, il semble bien, compte tenu des conditions de démarrage de la végétation, qu'il soit possible d'envisager l'apport au potet avec les autres éléments et que la forme d'apport ait peu d'influence.

LOCALISATION DE L'APPORT

Des essais ont été mis en place sur Pinus patula et Pinus kesiya qui comparaient l'apport localisé au potet, l'apport diffus dans la raie de sous-solage et la combinaison des deux. Les résultats ont montré que la localisation au potet permettait une réaction plus rapide du jeune plant, cette différence s'estompe au bout de quelques années et seul demeure l'effet fertilisation.

ESSAIS OLIGOELEMENTS

Par suite de l'apparition de phénomènes de déssèchement sur Pinus kesiya au Mangoro en 1975 deux essais ont été mis en place. Le premier visait à voir l'effet de l'apport de la nutramine sur les fumures, P, K, PK, NPK, vis-à-vis de l'apparition du déssèchement et la croissance ; le second visait à connaitre l'effet de Bo, Cu, Zn, Mo. Les résultats ont montré que l'apport de Zn était nécessaire à un bon équilibre physiologique de Pinus kesiya.

INTERACTION FERTILISATION / TREVAIL DU SOL / MODE D'ELEVAGE DES PLANTS / DATE DE PLANTATION

Un essai, mis en place sur P. patula à Manankazo, comparant divers travail du sol avec ou sans engrais, donne, à 8 ans ½, les résultats suivants :

	Trouaison	Sous-solage	Billonnage	Sous-solage billonnage
Sans engrais	5,38 m	6,24 m	7,16 m	6,66 m
Moyenne	6,38 m			
Avec engrais	7,26 m	8,06 m	8,48 m	8,53 m
Moyenne	8,08 m			

Ces résultats sont confirmés par un autre essai associant deux autres types de travail du sol (labour en bande et sous-solage sarclé).

Les résultats sont identiques pour P. kesiya.

Des essais visant à connaitre l'interaction fertilisation avec les autres paramètres intervenant lors de la création du peuplement (mode d'élevage des plants, date de plantation) ont été également réalisés sur P. patula et P. kesiya. On peut dégager les quelques observations générales suivantes :

Si le travail du sol semble devoir jouer un rôle plus net en l'absence de fertilisation (ce qui n'est pas pour surprendre), c'est avec la combinaison bonne préparation et apport de fertilisants que l'on a le meilleur gain de croissance. En présence de sols carencés c'est la fertilisation qui joue le rôle principal, notamment en ce qui concerne l'homogénéité du peuplement.

Vis à vis des modes d'élevage du plant en pépinière, il n'y a pas de différence visible quelques années après la plantation. Le seul paramètre à prendre en compte semble bien être celui de la bonne conformation de l'enracinement qui dépend du mode d'élevage en pépinière.

Enfin l'apport d'une fertilisation au potet doit être envisagé avec prudence si l'on se trouve en présence de périodes de pluviométrie déficitaire. On constate (sans doute dû à la toxicité des solutions) un accroissement de la mortalité des plants fertilisés, lorsque la plantation est effectuée en période déficitaire.

CONCLUSION

Les diverses expérimentations sur la fertilisation de départ des Pins tropicaux mises en place à Madagascar ont surtout intéressé P. patula et P. kesiya. Elles ont mis en évidence la réponse rapide au phosphore les premières années et une réponse plus lente à la potasse qui peut devenir prédominante dans certaines situations. Une fertilisation phosphopotassique au potet de plantation comprenant 52 g de P205 et 24 g de K20 permet d'obtenir, dès l'âge de 5 ans, un gain sur les hauteurs de 80 %. Le programme de plantation industrielle du Mangoro de 7 000 ha par an est réalisé avec apport de fertilisation de départ de PK 24.12. La réponse des autres pins semble voisine pour P. oocarpa et caribaea mais moins nette pour P. elliottii.

Aucune différence n'a été observée concernant les formes d'apport du phosphore et de la potasse qui peut être apporté sous forme de chlorure. Pour l'azote il semble qu'il soit possible de l'apporter, sous diverses formes, au potet avec les autres éléments.

Un apport de zinc est nécessaire pour P. kesiya au Mangoro à l'équilibre physiologique. Enfin si les interactions fertilisation/travail du sol sont intéressantes, il faut noter que sur ces sols très carencés c'est l'apport de fertilisants qui joue le rôle principal, notamment pour homogénéiser le peuplement.

BIBLIOGRAPHIE

Bailly, C., Ramanantsoavina, G., Benoit de Coignac, G., Rakotomanampison, A., Malvos, C., 1974 : Fertilisation des plantations de Pins à Madagascar. Bois et Forêts des Tropiques, Nov.-Déc. 1974

FAST GROWING TREES

ENSAIO DE COMPETIÇÃO ENTRE 20 PROCEDÊNCIAS DE *Pinus taeda*

R. F. R. Monteiro — R. M. Speltz — J. A. Cordeiro
Klabin do Paraná : Agro-Florestal S/A
BRASIL

Resumo

Os autores, apoiados nos dados dos levantamentos dendrométricos - anuais de um ensaio de 20 procedências de Pinus taeda, instalado em 1.968 na Fazenda Monte Alegre, após a interpretação estatística, concluem que a procedência que mais se destacou, tendo em vista a maior produção volumétrica, foi a de Jackson, Florida, com um incremento médio anual de 49, 69 st/ha, seguida da de Georgetown, South Carolina e Central Mississipe, respectivamente com os incrementos médios anuais de 47,10 e 46,84 st/ha. Na primeira parte do trabalho, referem a distribuição geográfica desta espécie, os nomes vulgares e o hábito e ecologia. Na segunda parte, além do ' objetivo do estudo, descrevem a ecologia do local onde foi instalado o ensaio, o preparo do solo realizado, a procedência das sementes, o ensaio e o seu delineamento.

Summary

The authors, based in a colletion of annuals dendrometric facts of 20 Pinus taeda origin, settled in 1.968 in Fazenda Monte Alegre, - after a statistic interpretation, they concluds that the better proceding, seeing the great volume production of wood, were fron Jackson, Florida, with a annual increment the volume of 49,69 st/ha after that come Georgetown Country, South Carolina and Central Mississipi, with an annual increment the volume of 47,10 and 46,84 st/ha respectively. In part one of the study, they refers to the geografic distribution of this variety, the common names and ecological habits. In part two, beside the finnality of the study, they describe the local ecology - where was done the test, where the soil preparation was realized,the origin of the seed, the test and their results.

Introdução

Reveste-se de grande importância a seleção das procedências que se afigurem mais adequadas para a região a reflorestar, quando se pretende promover a introdução de espécies exóticas.

É perfeitamente sabido que plantas da mesma espécie, mas de procedências diferentes, nomeadamente de latitudes diferentes, se podem comportar num mesmo local de forma tão distinta umas das outras ' como se na realidade se tratasse de outras espécies.

Naturalmente que ao se pretender ensaiar várias procedências de uma mesma espécie há que selecionar as que se nos apresentam com maior probabilidade de êxito de bom desenvolvimento nas condições mesológicas da região onde as mesmas serão introduzidas, não devendo contudo ser esquecido o objetivo de utilização da madeira produzida.

As Indústrias Klabin do Paraná de Celulose S/A. preocupadas em produzir matéria prima lenhosa de rápido crescimento e cientes da viabilidade silvícola da introdução do Pinus taeda na região, selecionaram 19 procedências dos Estados Unidos de América do Norte, de zonas

que lhes pareceram mais adequadas para a Fazenda Monte Alegre.

Baseados nos principios atrás sumariamente referidos foi instalado, em abril de 1.968, um ensaio de procedências de Pinus taeda no talhão - 121 A, da Guarda Florestal Trinita, na Fazenda Monte Alegre, propriedade das Indústrias Klabin do Paraná de Celulose S/A., com o código PC -006 B, com o objetivo de selecionar as procedências que melhor se adaptem e que simultâneamente produzam maiores rendimentos volumétricos.

Após 10 anos de registros de dados, obtidos através de levantamentos dendrométricos anuais, não foi dificil atingir o desiderato pretendido a quando da instalação do experimento. Contudo, com alguma surpresa, a procedência utilizada como testemunha, proveniente de um dos nossos talhões de plantio comercial, da Guarda Florestal Mandaçaia, ocupou uma posição - bem destacada, quando comparada com as 19 introduzidas.

1 - Distribuição Geográfica

De acôrdo com Gurgel Filho (1.965/66), o gênero Pinus ocorre naturalmente desde 2º 06' de latitude Sul, na parte central de Sumatra, até 69º 45' de latitude Norte, na Finlândia, Sibéria e Mongólia. Verifica-se pois, que este gênero tem o seu habitat no hemisfério norte, com o Pinus sylvestris L. no seu limite extremo norte, ocorrendo na Europa, Ásia, - América do Norte, América Central e Malesia. Só se dá conta de uma pequena penetração no hemisfério Sul através do Pinus merkusii De Vries.

O Pinus taeda é uma espécie nativa da Coastal Plain e Piedmont - (Wahlenberg, 1.965), mas encontrando-se dispersa desde o nivel do mar ' até, ocasionalmente, a 4.500 metros de altitude, com grande variação de solos, nos Estados de Nova Jersey, Delaware, Caroline do Norte, Florida, Oeste e Leste do Texas, Arkansas, Oklahoma, Vale do Mississipe, e Tennessee (Sussuma, 1.977; Wahlenberg, 1.965; Gurgel Filho, 1.965/66; Critchfield, 1.966; Mirov, s/data). Ainda nos Estados Unidos de América, fora ' da sua área natural, tem sido plantada na zona Sul dos Appalachian, Kentucky, Indiana, Illinois e Missouri (Wahlenberg, 1.965).

Wenger e Harlow & Harrar (Gurgel Filho, 1.965/66) dizem encontrar-se dispersa desde a Carolina do Norte à latitude de 40º Norte, ao Sul do Tennessee, a 35º de latitude Norte, à parte central da Florida e a Oeste e Este do Texas, à latitude de 30º Norte.

2 - Nomes Vulgares

Esta espécie tem as seguintes designações:

Loblolly pine - ingleses e americanos;

Pino de incienso - argentinos

Weihnachte kiefer - alemães.

3 - Hábito e Ecologia

Árvore que pode atingir 30 metros de altura, de fuste cônico, de maior volume de copa do que o Pinus elliottii, de ramos espalmados, acículas persistentes, agrupadas em fascículos de 3, ocasionalmente de 2.

Segundo Wahlenberg (1.965) a distribuição do Pinus taeda é muito mais condicionada pela temperatura e umidade do que pela textura e estrutura do solo. Parece preferir um clima úmido, com verão quente e longo e inverno - não muito rigoroso(Gurgel Filho, 1.965/66). Nas latitudes e altitudes maiores tona-se problemática a sobrevivência da espécie, em consequência das - mais severas e menores temperaturas, fato que limita a absorção da umidade dos solos frios (secura fisiológica).

No seu habitat natural, a precipitação média anual oscila de 1.016 a 1.524 mm e a temperatura de 24º C a 2º C, com extremos ocasionais de 38º C e - 13º C (Gurgel Filho, 1.965/66) e, no planalto do Brasil, até mesmo -17º C (Golfari, Unasylva, nº 68), assemelhando-se à Araucaria angustifolia na necessidade em frio.

Zobel (1.972) refere que o P.taeda proveniente de Virginia é muito - mais resistênte às condições frias do que o P.taeda de Florida e que o das regiões centrais do Texas é muito mais resistente a condições de ambiente - sêco do que do Sul da Georgia. Este mesmo autor diz que "as gerações provenientes de árvores das costas mais úmidas crescem mais rapidamente do que ' as gerações provenientes das regiões onde os solos são mais argilosos e o - ambiente é mais rigoroso, como nas proximidades de Piedmont. As gerações o riundas de Piedmont produzem conas mais cedo e em muito maior quantidade do que os das regiões costeiras".

Pela bibliografia consultada sabe-se que é possivel obter mais rápido crescimento transportando procedências do Sul para o Norte e que, pelo contrário, uma mudança para o Sul causa atrazo no crescimento.

Golfari(Unasylva, nº 68) admite que o frio invernal deve ser uma condição indispensável para o seu normal desenvolvimento e considera significativo o fato de que a espécie se tenha estabelecido com êxito no Brasil sòmente nas regiões onde ocorrem geadas, o mesmo sucedendo na Argentina e no Uruguai. Também se tem notado no Sul do Brasil que esta espécie necessita de - uma umidade constante no solo ao longo de todo o ano.

II PARTE

ENSAIO DE PROCEDÊNCIAS DE PINUS TAEDA L.

1 - Objetivo

Trata-se de um ensaio de competição entre procedências de Pinus taeda com o bjetivo fundamental de determinar qual ou quais as procedências que - melhor se adaptem às nossas condições ecológicas e que permita obter povoamentos de boa produtividade lenhosa.

2 - Material

2.1 - Localização

O presente experimento, identificado como Projeto PC - 006 B, foi instalado em 29.04.68, no talhão 121 A, da Guarda Florestal Trinita, na Fazenda Monte Alegre, propriedade da Klabin do Paraná Agro-Florestal S/A., situada no segundo planalto Paranaense, entre os paralelos 24º 02' 02" e 24º 27' 48" Sul e entre os meridianos 50º 17' e 50º 55' Oeste de Greenwich. Contudo, o talhão em causa tem as seguintes coordenação geográfica: latitude de 24º 15' Sul longitude de 50º 25' Oeste.

2.2 - Perfil Geológico e Solo

A Fazenda Monte Alegre está dentro do Segundo Planalto Paranaense e é praticamente toda ocupada pela Série Tubarão.

O solo onde foi instalado o presente ensaio é do tipo arenito argiloso, vermelho, de campo. A côr vermelha ou mesmo amarela é provocada pelo enriquecimento em óxido e hidroxidos de ferro, sob a ação continua e prolongada dos agentes climáticos.

2.3 - Clima

De acordo com a classificação de KOEPPEN, o clima da Fazenda Monte - Alegre é do tipo Cfb, significando:

C - clima temperado úmido, porque a temperatura média do mês mais frio é inferior a 18º C e a precipitação anual é superior a 1.000 mm.

f - clima sem estiagem porque a queda pluviométrica do mês mais sêco - é superior a 30 mm.

b - clima temperado brando porque a temperatura média do mês mais quente não ultrapassa os 22º C.

A temperatura mínima registrada foi de -4º C.

2.4 - Preparo do Solo

O solo sofreu o preparo normalmente realizado antes de qualquer plantio, ou seja de 2 passagens de grade após o desmatamento e a limpeza do terreno.

2.5 - Procedência das Sementes

As sementes utilizadas neste ensaio tiveram as seguintes procedências:

A - Sulesta, Virginia
B - Bastrop, Texas
C - Berkeley, South Carolina
D - Jakson, Florida
E - Nordeste da Georgia
F - Mississipe
G - Virginia (área costeira)
H - Mandaçaia, talhão 072 - Telêmaco Borba, PR.
I - South Carolina Forest Service
J - Georgetown Country, South Carolina
L - Central Lousiana
M - South Arkansas
N - Central Alabama
O - Central Mississipe
P - South Mississipe

Q - Central Georgia
R - Eastern North Carolina
S - Piedmont North Carolina
T - South Coastal Plains of North Carolina
U - South Coastal Loblolly of North Carolina

As sementes das procedências de A a G foram recebidas através da Escola Nacional de Florestas - Curitiba, PR., a H dos nossos plantios em Mandaçaia e as restantes adquiridas através da Firma M.M. Soares, de Nova York, U.S.A..

3 - Métodos

3.1 - Descrição do Ensaio e seu delineamento

O ensaio foi instalado obdecendo ao delineamento de blocos casualizados, com as seguintes características:

espaçamento	2,00 X 2,00 m.
Número de parcelas	80
Área total	42.542,0 m2
Área da parcela	400,0 m2
Número de repetições	4
Número de tratamentos	20 (procedências)
Número de plantas/parcela ..	11 X 11 plantas

Este ensaio teve como principal objetivo determinar o comportamento das diversas procedências de Pinus taeda anteriormente referidas, para, posteriormente, se selecionarem as que melhor se adaptem às nossas condições ecológicas, tendo em vista a maior produção volumétrica conjugada aos melhores fenotipos.

Para cada parcela foi implantada uma bordadura de duas linhas, ficando por tanto cada quadro sómente com 9 x 9 plantas.

4 - Conclusões

Com base nos dados obtidos fizeram-se as análises estatísticas em que nos apoiamos para tirar as conclusões que se seguem:

a) - a procedência que mais se destacou, tendo em vista a maior produção volumétrica, foi a D - Jakcson, Florida, com um incremento médio anual de 49,69 st/ha;

b) - as procedências que imediatamente se seguiram tomando também em conta a produção lenhosa, foram a J - Georgetown Country, South Carolina e a O - Central Mississipe, respectivamente com os incrementos médios anuais de 47,10 e 46,84 st/ha;

c) - a procedência local, que serviu de testemunha, a H - Mandaçaia, Telêmaco Borba, PR. (KPAF), ocupou a oitava posição, por ordem decrescente, com o incremento médio anual de 41,73 st/ha;

d) - deve-se chamar a atenção para o fato de que, embora a procedência O - Central Mississipe tenha apresentado a maior área basal, não foi a que apresentou maior volume, devido certamente à menor sobrevivência e também à menor altura;

e) - a procedência H - Mandaçaia, Telêmaco Borba, PR. (KPAF), é 16% inferior em incremento médio anual à que ocupou a primeira posição - (D - Jackson, Florida);

f) - a procedência que originou maior volume no primeiro desbaste foi - também a D - Jackson, Florida, com o valor de 172,82 st/ha;

g) - a procedência local, de Mandaçaia, produziu 141,03 st/ha nesse mesmo desbaste, o que corresponde a 18,39% menos de que a D - Jackson, Florida;

h) - comparando a procedência D - Jackson, Florida com a H - Mandaçaia, Telêmaco Borba, PR.(KPAF), respectivamente a que mais se destacou - em produção volumétrica e a que serviu de testamunha, verifica-se, que:

D - H = 498,59 st/ha - 416,16 st/ha = 82,43 st/ha

considerando que o preço da madeira em pé na floresta é de Cr$ 55,00 a Cr$ 68,00 por estere e tomando um valor médio de Cr$ 61,50/st teremos 82,43 st/ha X Cr$ 61,50 = Cr$ 5.069,45/ha.

A procedência D - Jackson, Florida,originou uma melhoria de rendimento da ordem de Cr$ 5.069,45/ha, valor que multiplicado pelos - 24.229,9 ha que tinhamos de plantio de Pinus taeda no final de 1.977 dará:

24.229,9 ha X Cr$ 5.069,45/ha = Cr$ 122.832.266,60;

i) - em face das conclusões anteriores somos de opinião de que valeria a pena procurar obter semente da procedência D - Jackson, Florida, para futuros plantios comerciais, tendo em conta os benefícios que - daí poderiam advir.

Bibliografia

CRITCHFIELD, Willian B. e LITTLE JR, Elbert L. - Geographic Distribution of the Pines of the World - Miscellaneous Publication - 991, Forest Service, U.S. Department of Agricultura, Washington, D.C. 1.966.

GOLFARI,L. - Exigências Climáticas de las Coníferas Tropicales y Sub-Tropicales - Unasylva (FAO), vol. 17 (1), nº 68.

GURGEL FILHO, O.A. e SERVIÇO FLORESTAL DE SÃO PAULO - Silvicultura e Economia no Estado de São Paulo - Silvicultura em São Paulo, Revista Técnica do Serviço Florestal do Estado de São Paulo, Ano 4/5, nº 4, 1.965/66.

MIROV, N.T. - The Genus Pinus - The Ronaldo Press Company, New York.

SUASSUNA, J.-A Cultura do Pinus - Uma Perspectivas uma Preocupação - Revista Brasil Florestal, nº 29, Jan-Mar. 1.977.

WAHLENBERG, W.G. - A Guide to Loblolly and Slash Pine Plantation - Management in Southeastern USA - Georgia Forest Research Council, Report nº 14, Macon, Géorgia, 1.965.

ZOBEL, B.J. - Melhoramento Genético dos Pinus do Sul dos E.U.A.-Brasil Florestal, nº 12, Ano 3, out.- dez. 1.972.

FAST GROWING TREES

ESTUDO DE ADAPTAÇÃO DE ESPÉCIES TROPICAIS ALIENÍGENAS DE RÁPIDO CRESCIMENTO NA REGIÃO DO TRÓPICO ÚMIDO BRASILEIRO

L. M. Pedroso — C. A. C. Lopes
SUDAM
BRASIL

NATURAL REGENERATION STUDY OF PAST GROWTH TROPICAL ESPECIES IN THE BRAZIL TROPIC HUMID REGION

Summary

Silvicultural technics used in the Curuá-Una Experimental Station (CTM/SUDAM), to create optimae conditions for the artificial regeneration of the exotics species of fast growing introduced in the region of the Middle and low Amazon. Behaviour of the followings species: Pinus caribaea var. hondurensis, Pinus oocarpa, Fragrea fragans, Gmelina arborea, Aucumea klainiana, and Eucalyptus.

INTRODUÇÃO:

A política florestal de um país ou de uma região, como no caso da Amazônia, deve ter seus alicerces em bases técnicas,tendo como essêncial a existência e a manutenção de um patrimonio florestal permanente que para se perpetuar, deve ser assistido por um corpo técnico capaz de dar à mesma uma orientação constante, segura e efetiva.

A criação de um patrimônio florestal permanente é de primeira importância. Esse patrimônio poderá ser estabelecido a base de florestas naturais existentes ou através do estabelecimento de florestas artificiais. Os fatores primordiais que devem ser levados em consideração para a criação de patrimonio florestal, deve ser, principalmente, a prioridade absoluta às essências já reconhecida nos mercados mundial e local e de um modo menos acentuado àquelas que poderão tornar-se de valor comercial.

Nos programas de produção (adaptação), a regra da escolha das essências de base deve ser respeitada rigorosamente, mesmo que ainda não estabelecidas no mercado, mas que tem mostrado qualidades indiscutíveis através de testes tecnológicos e análises econômicas. O estudo de adaptação das espécies de base devem ser essencialmente baseado em ensaios de natureza puramente silvicultural - exigências ecológicas, características de crescimento, ausência de pragas e doenças, exigências pedológicas, etc.

Nos trópicos as plantações de florestas, de crescimento rápido, de um modo geral dão resultados excelentes, acontecendo o mesmo com a regeneração natural. Para determinado número de técnicos florestais as plantações artificiais são consideradas dispendiosas no início e podem envolver riscos de fracasso originários de causas emprevistas que incluem existência de pragas, ataque de insetos, etc, mas que, como já citamos, procurando ser observado as condições silviculturais adequadas, podem reduzir a um mínimo todos os riscos. Outra consideração que deve ser levada em conta, que poderá causar fracasso em plantações nos trópicos de floresta artificial, principalmente, é a falta de planejamento adequado para aquelas atividades.

CONSIDERAÇÕES GERAIS:

A pesquisa na Amazônia teve sua origem em 1957, com a criação do atual Centro de Tecnologia Madeireira (CTM), Unidade descentralizada do Departamento de Recursos Naturais (DRN) da Superintendência do Desenvolvimento da Amazônia (SUDAM), cujas finalidades básicas e específicas é a Pesquisa Florestal e o Treinamento de Mão-de-Obra operária à Industria Madeireira.

A pesquisa florestal do CTM está voltada especificamente para as atividades na própria floresta, objetivando o melhor conhecimento de sua composição, através de inventários, desenvolvendo métodos apropriados de corte e arraste e transporte de toras, por meio mecanizado, em substituição a primitivos processos manuais usados nessas operações, estudando técnicas de manejo que permitam a recomposição da mata nas áreas exploradas, enriquecendo-as com espécies de maior valor comercial, através de tratos silviculturais, adequados, estudo de comportamento de espécies nativas e exóticas plantadas em "Pleno Aberto" de modo a amenizar o problema da heterogeneidade da floresta tropical e Úmida da Amazônia.

Com esses objetivos é que justificou a criação da Estação Experimental de Curuá-Una com as seguintes atribuições:

- Promover o treinamento de Mão-de-Obra especializada em atividade de exploração florestal.
- Promover a experimentação de silvicultura tropical através de plantios de espécies nativas e aclimatação de espécies exóticas de valor comercial.
- Desenvolver trabalhos de condução e manejo florestal.

Estação Experimental de Curuá-Una:

1. Área e Localização:

Fica situada a margem direita do rio Curuá-Una, afluente do rio Amazônas, entre os rios Tapajós e Xingú, a 50 km de sua desembocadura, sua posição geográfica é equatorial, com 2º23' latitude sul e 54º24' longitude Oeste.

A atual área de domínio da Estação Experimental é de 1.800 ha, passando brevemente a ser ampliada para 100.000 ha aproximadamente.

2. Infraestrutura:

O acesso para a reserva ocorre atualmente somente por via fluvial.

Existe na base um acampamento com residências para técnicos e trabalhadores, garagem e oficina para manutenção de equipamentos e veículos, um Viveiro Florestal, energia elétrica e água encanada.

Para atender a execução dos trabalhos que vem sendo desenvolvidos na Estação Experimental, temos hoje, aproximadamente 40 km de estradas florestais transitável. (vide Fig. nº1).

3. Aspectos e Condições Climáticas:

Na Estação Experimental assim como em toda a Amazônia a característica geral do clima é quente e Úmido. Entretanto especificamente as condições macro-climáticas de Curuá-Una apresenta:

- Temperatura do ar - apresenta uma média anual de 26ºC, oscilando entre 25,4º a 27ºC.
- A temperatura máxima alcança extremos elevados variando de 30,0ºC, nos meses mais chuvosos e 33,1ºC nos meses mais secos. A média está em torno de 31,2ºC.
- A temperatura mínima oscila em torno de 21,9ºC.a 23,ºC, apresentando uma média anual de 22,6ºC. (vide Fig. nº 2).
- Umidade relativa do ar - A umidade relativa na Região é de um modo geral elevada uniformemente durante todos os meses do ano. Na Estação Experimental de Curuá-Una há uma variação anual de 78% a 89%, com a média de 84%, anual.
- Pluviosidade - A incidência de chuvas é relativamente elevada durante o ano inteiro, entretanto apresentando um nítido período de estiagem de 3 a 4 meses. Os indices pluviométricos mensais variam de 39mm nos meses de setembro a 358mm, nos meses de março, atingindo um total anual de 2095mm. (vide Fig.nº 2 e nº 3).

4. Descrição dos Solos:

As áreas de plantio da Estação Experimental de Curuá-Una se dividem em dois (2) grupos: solos arenosos do Flanco e solos argilosos do Planalto, onde a maior parte das espécies tropicais de valor comercial ocorrem.

As características desses solos são as seguintes:

PLANALTO: Latosolo amarelo, limo argiloso, de camada profunda, com textura pesada, fortemente ácido (PH 4,5- 5,0) muito lixiviado, com poucos remanescentes no perfil além da sílica, óxido hidratado de ferro e alumina e argila caolinítica. Apresenta uma fertilidade natural baixa, problema de fixação de fosfato. Uma camada de folhas semi-decompostas cobrem o piso florestal.

FLANCO: Os solos de Flanco estão subdivididos em:

Flanco baixo: Os solos desta área são profundos, bem drenados possuindo textura muito leve, fortemente ácido (PH 4,5-5,0), com uma fácil penetração das raízes e de água. Devido sua textura leve, além da reduzida fertilidade natural, reduz também a capacidade de reter a água, tornando-se desse modo suscetíveis à seca.

FOTO Nº1

Plantio de Pinus caribaea var.hondurensis, ano de 1961, em solo argiloso de Planalto.

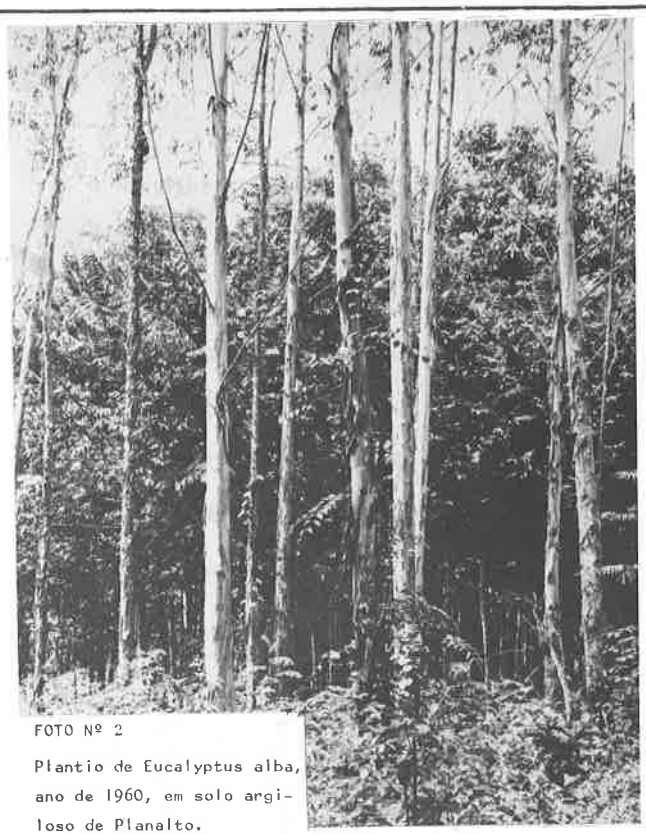


FOTO Nº 2

Plantio de Eucalyptus alba, ano de 1960, em solo argiloso de Planalto.

FOTO Nº 3

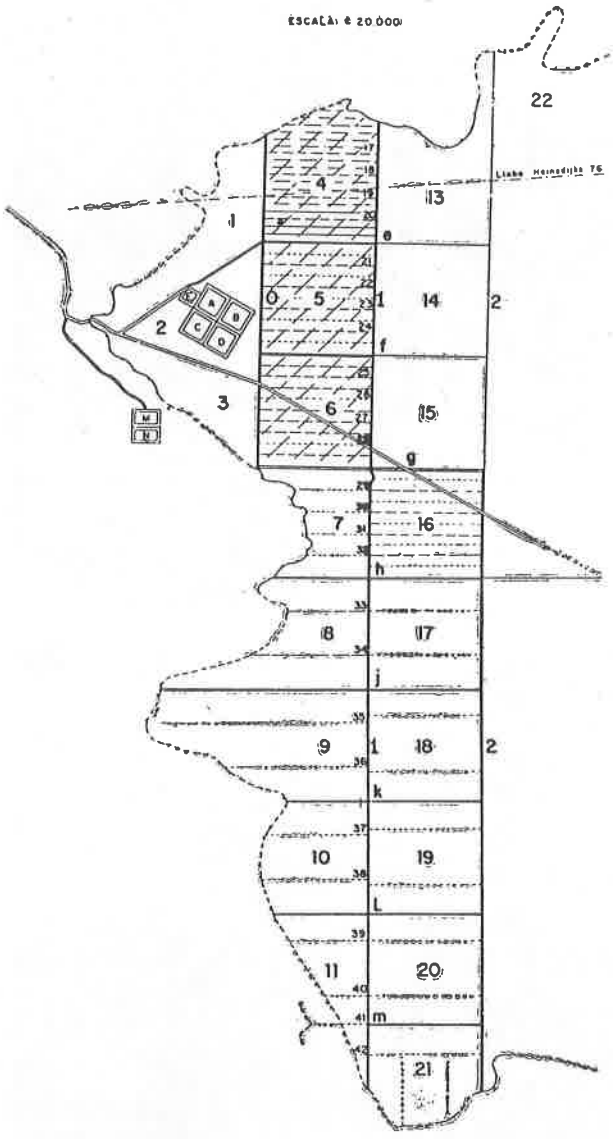
Plantio de Pinus caribaea var. hondurensis, ano de 1960, em solo arenoso de Flanco.

FOTO Nº 4

Plantio de Pinus oocarpa, ano de 1968, em solo arenoso de Flanco.

FIG.Nº 1

FLORESTA DE CURUÁ-UNA



TALHÃO	ÁREA	TALHÃO	ÁREA
1	80	11	64
2	44	13	104
3	56	14	100
4	115	15	100
5	100	16	98
6	97	17	100
7	64	18	100
8	96	19	100
9	152	20	100
10	90	21	85

LEGENDA

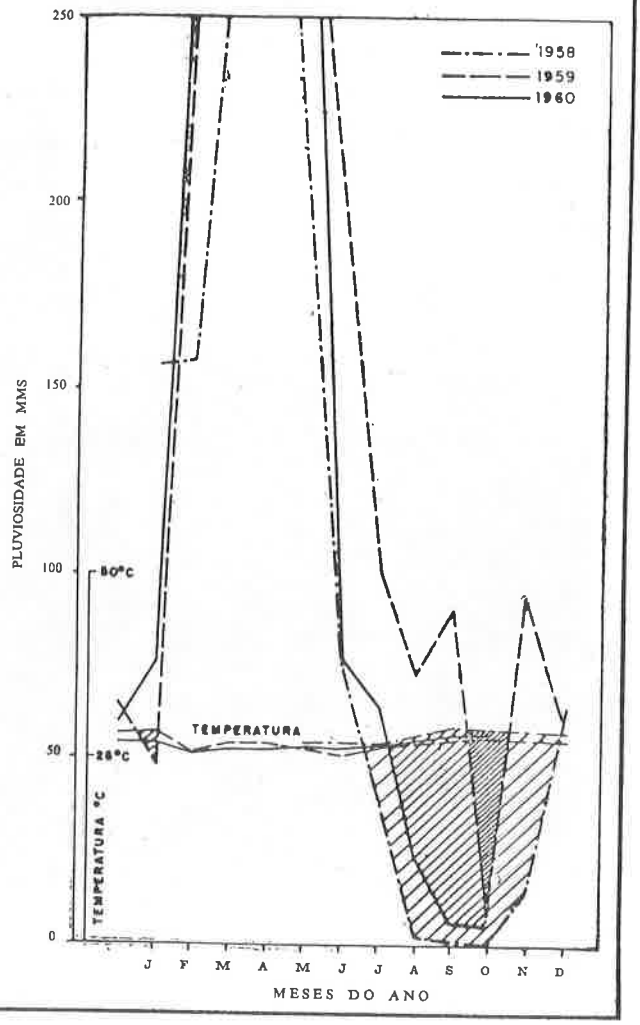
- Caminhos e estradas demarcadas
- Caminhos e estradas desmatadas
- Estrada principal
- Linhas de levantamento da regeneração e inventário - Propostas ou cortadas
- 9 Número do talhão
- Linhas de levantamento da regeneração e inventário - Enumeradas
- A, D Canteiros de pesquisas
- Borda do planalto fixada
- Borda do planalto suposta
- Corte de cipós
- Linhas de enriquecimento

FIG. Nº 2

MESES	TEMPERATURA C			INSOLAÇÃO	U.R.	P P mm
	Média	Máxima	Mínima	Horas e Decimos	%	
J	25,8	30,8	22,7	142,1	85	179
F	25,8	30,8	22,5	105,9	87	275
M	25,8	30,8	22,6	107,6	88	358
A	25,6	30,0	22,8	117,9	88	262
M	25,6	30,3	22,7	146,7	89	293
J	25,4	30,4	22,3	177,5	88	174
J	25,4	31,0	21,9	213,7	86	112
A	26,2	32,0	22,2	243,6	83	50
S	26,7	32,7	22,8	222,9	80	39
O	27,0	33,1	23,0	230,1	78	46
N	26,9	32,6	23,1	149,9	79	85
D	26,5	31,9	22,9	188,6	80	123
ANO	26,0	31,2	22,6	2.091, 5	84	2.096

DADOS CLIMÁTICOS DA ESTAÇÃO DE SANTARÉM VÁLIDOS PARA A ÁREA.

FIG.Nº 3 TEMPERATURA E PLUVIOSIDADE EM CURUÁ, ANOS DE 1958, 1959 E 1960. MÉDIA DA TEMPERATURA MENSAL: 1 Cm, 5º C. A ESTAÇÃO SÊCA É REPRESENTADA PELA PARTE ONDE A CURVA DA PLUVIOSIDADE CAI ABAIXO DA MÉDIA DA TEMPERATURA MENSAL.



T A B E L A - I

NOME VULGAR DA ESPÉCIE	NOME CIENTÍFICO	LOCAL DO PLANTIO	ANO DO PLANTIO	ÁREA DA PARCELA (ha)	ESPAÇAMENTO INICIAL (m)	ORIGEM DAS SEMENTES	Nº ATUAL DE ÁRVORES
PINHO	Pinus caribaea	PL	1959	0,131	2,5x2,5	H.Britanica	48
EUCALIPTO	E.citriodora	PL	1959	0,039	2,5x2,5	São Paulo	30
PINHO	P.caribaea V.Hon	FL	1959	0,131	2,5x2,5	H.Britanica	68
EUCALIPTO	E.citriodora	FL	1959	0,27	2,5x2,5	São Paulo	98
PINHO	P.caribaea V.Hon	PL	1960	0,120	2,5x2,5	H.Britanica	71
EUCALIPTO	E. grandis	PL	1960	0,032	2,5x2,5	Australia	11
EUCALIPTO	E.alba	PL	1960	0,063	2,5x2,5	São Paulo	33
EUCALIPTO	E.camaldulensis	PL	1960	0,063	2,5x2,5	São Paulo	30
EUCALIPTO	E.tereticornis	PL	1960	0,065	2,5x2,5	São Paulo	9
PINHO	P.caribaea V.Hon	FL	1960	0,25	2,5x2,5	H.Britanica	145
PINHO	P.caribaea V.Hon	PL	1961	0,1352	2,5x2,5	H.Britanica	95
EUCALIPTO	E.maculata	PL	1961	0,053	2,5x2,5	Australia	11
EUCALIPTO	E.robusta	PL	1961	0,015	2,5x2,5	Australia	5
GMELINA	Gmelina arborea	PL	1961	0,070	2,5x2,5	Ghana	66
AUCUMEA	Aucumea klainiana	PL	1961	0,1352	2,5x2,5	Africa	55
PINHO	P.caribaea V.Hon	FL	1961	0,161	2,5x2,5	H.Britanica	52
FRAGREA	Fragrea fragans	PL	1963	0,0162	1,40x0,7	Asia	7
PINHO	Pinusoocarpa	FL	1968	0,18	2,0x2,0	Dist.Belize	141
GMELINA	Gmelina arborea	PL	1970	0,18	2,0x2,0	Curuá-Una	326

T A B E L A - II

DADOS COMPLEMENTARES DA TABELA I

E S P É C I E	DIÂMETRO (CM)			ALTURA (M)			ABT	ABM	VT	V/Ha	I/Ha/ANO	ASPECTO ATUAL
	MAX.	MED.	MIN.	MAX.	MED.	MIN.	(m2)	(m2)	(m3)	(m3)	(m3)	DO PLANTIO
PINHO	49,0	30,2	19,0	22,6	18,5	10,7	3,4287	0,0714	38,059	290,523	13,834	Bom
EUCALIPTO	37,7	25,6	6,5	33,5	21,4	12,0	1,5426	0,0514	23,108	592,517	28,215	Bom
PINHO	44,5	30,6	17,0	35,0	23,7	17,1	4,9939	0,0734	71,013	542,086	25,814	Muito bom
EUCALIPTO	51,8	23,8	9,5	36,5	24,1	11,7	4,3679	0,0446	73,687	272,913	12,996	Bom
PINHO	43,0	27,0	17,5	27,0	20,4	13,5	4,0707	0,0573	49,825	415,211	20,761	Muito bom
EUCALIPTO	49,6	34,3	14,5	31,7	19,2	10,5	1,0160	0,0923	13,655	426,720	21,336	Muito bom
EUCALIPTO	53,0	27,9	10,3	30,0	21,0	10,0	2,0171	0,0611	29,651	470,657	23,533	Regular
EUCALIPTO	51,0	31,1	10,0	29,2	20,4	8,0	2,2837	0,0761	32,611	517,639	25,882	Regular
EUCALIPTO	47,5	31,0	21,0	21,5	18,9	16,5	0,6779	0,0753	8,969	137,979	6,899	Result.não satisf.
PINHO	40,8	28,3	18,2	30,5	22,6	14,0	9,0959	0,0627	123,340	493,362	24,668	Muito bom
PINHO	39,3	25,9	17,0	26,0	21,0	16,7	5,0344	0,0529	63,433	469,182	24,694	Muito bom
EUCALIPTO	49,0	24,5	12,6	26,8	22,6	9,0	0,5203	0,0473	8,231	155,305	8,174	Result.não satisf.
EUCALIPTO	61,0	35,5	19,0	31,5	18,6	12,0	0,4938	0,0987	6,429	428,618	22,559	Regular
GMELINA	30,1	18,7	5,6	13,5	9,1	4,5	1,8201	0,0275	11,594	165,629	8,717	Result,não satisf.
AUCUMEA	45,8	29,3	17,7	25,0	15,8	8,0	3,7055	0,0673	40,983	303,127	15,954	Regular
PINHO	41,3	26,0	17,5	26,0	20,1	12,0	2,7647	0,0531	33,34	207,095	10,90	Muito bom
FRAGREA	33,0	24,2	13,5	12,5	10,4	9,0	0,3238	0,0462	2,357	145,510	8,559	Result.não satisf.
PINHO	38,0	25,1	11,0	27,6	21,2	11,6	2,3221	0,0494	29,537	164,095	13,675	Muito bom
GMELINA	27,0	13,3	5,0	16,0	9,9	2,5	4,5771	0,0140	31,719	176,218	17,622	Regular

Flanco baixo de transição: Neste caso os solos desta área são semelhantes aos descritos acima, apresentando uma textura mais pesada (franco arenoso sobre franco argila-arenoso), por esta razão tendentes a serem menos secos. Devido a mudança da textura, já são áreas de solos considerados bem próximo dos solos do Flanco alto, que possuem uma textura mais pesada podendo ser considerados solos originalmente para os estudos de Silvicultura.

Flanco alto: Os solos desta área possuem muitas características semelhantes aos do Flanco baixo. São solos fortemente ácidos, bem drenados e facilmente penetrados por raízes e umidade. Possuem uma textura ligeiramente mais pesada (franco arenoso transmudando-se em argila no sub-solo mais baixo) e são fortemente concrecionários numa profundidade de 100 a 150cm. Apresentam baixa fertilidade de fixação de fosfato.

OBJETIVO:

Na programação sobre os estudos de silvicultura que foram estabelecidos na Estação Experimental de Curuá-Una, os objetivos pretendidos com os ensaios das espécies florestais foram:

a) Quais as espécies mais promissoras e

b) Melhores técnicas para estabelece-las.

Os estudos que ora realizamos visa averiguar o comportamento de espécies florestais alienígenas, de crescimento rápido, mais apropriadas para plantios homogeneos nos solos de Planalto e Flanco em condições de abertura total da mata original.

Desta maneira, o presente trabalho apresenta um resumo

sobre espécies que estão sendo testadas, com informações sobre alturas, diâmetro médio e outros dados que fundamentalmente poderão predizer e avaliar o indice de adaptabilidade que alcançaram na área que estão sendo experimentadas.

MATERIAL E MÉTODO EMPREGADO:

Os ensaios silviculturais delineados nesta experiência foram exclusivamente voltados para a verificação do comportamento de algumas essências florestais exóticas de crescimento rápido, procurando observar as que melhor se adaptaram climáticas e edafológicamente na Região.

O método com plantios artificiais pode ser levado a efeito de diversas formas, dependendo de fatores que facilitem a sua adaptação tais como: exigência das espécies quanto ao crescimento, fatores econômicos, etc.

O método usado neste experimento foi o de plantio uniforme em condições de abertura total, de espécies de crescimento rápido em solo argiloso e arenoso do planalto e do flanco, respectivamente. Os plantios foram estabelecidos após a exploração, destruição completa e queima na mata residual. As espécies estudadas foram plantadas nas mesmas épocas e sob as mesmas condições tanto no flanco como no planalto.

Vale salientar também, que as espécies experimentadas, na sua maioria, com excessão dos Eucalyptos, foram originadas de Regiões tropicais (Ásia, África e A.Central), com semelhantes condições ecológica às da Região do Médio Amazonas. Estes experimentos foram conduzidos recebendo tôda a atenção quanto a sua manutenção e tratos silviculturais comuns, sendo; limpeza de capina, raleamento, poda, desbaste, etc.

Para se ter uma análise do comportamento dessas espécies além do caráter qualitativo, levamos em considerações principalmente dados dendronmétricos, tais como DAP, altura, conformação da copa, qualidade do fuste e o estado de sanidade.

RESULTADOS: Vide tabelas I e II

CONCLUSÕES E COMENTÁRIOS

Os estudos em plantios artificiais de espécies alienígenas de crescimento rápido, neste caso, usando o método de plantios uniformes em "Pleno Aberto", na Região do Trópico Úmido Brasileiro, começa a despontar, podendo mesmo considerar que esta é uma experimentação pioneira na Região.

Os resultados apresentados estão limitados à avaliação do desempenho médio das espécies. Os mesmos não devem ser considerados como definitivos, quer para as essências que tiveram um desempenho bom ou não, visto que alguns fatores de ordem técnica não foram levados em consideração, como por exemplo: Não foram feitas replicações em número suficiente, assim como o tamanho reduzido que apresentam as parcelas de experimento.

Conclui-se portanto, com os dados obtidos, quais as espécies que apresentaram mais sensibilidade de adaptação dentro das condições e ambiente em que foram testadas.

ILUSTRAÇÃO FOTOGRÁFICA - Vide Anexos I, II e III.

FONTES CONSULTADAS:

- PEDROSO, L.M. E PEREIRA, A.P - Informações preliminares sobre a adaptação de Pinus caribaea var. hondurensis Mor. no Baixo Amazonas. Belém, SUDAM/Divisão de Documentação, 1971.
- PITT JOHN - "Relatório ao Governo Brasileiro sobre a aplicação de métodos silviculturais a algumas florestas da Amazônia. Belém, SUDAM/Divisão de Documentação, 1969.
- SUDAM DOCUMENTA. V.5- Out.1973/Set.1974 - PEDROSO, L.M. - "Informações sobre o atual comportamento de espécies exóticas na Região do Médio Amazonas.".
- JANKAUSKIS, J. - "Relatório Característico de Espécies Nativas e exóticas dos plantios da Estação Experimental de Curuá-Una, CTM/SUDAM-Convênio SUDAM/FCAP, 1978.

FAST GROWING TREES

SELEÇÃO INDIVIDUAL DE FENOTIPOS VISANDO ALTA PRODUÇÃO DE RESINA EM *Pinus elliottii* ENG.

C. Ribas — M.A. de O. Garrido — J. L. Assini e N. Haga
Instituto Florestal — São Paulo
BRASIL

Resumo

Durante o biênio 78/79, na Floresta de Manduri pertencente ao Instituto Florestal de São Paulo, estudou-se 50.990 árvores numa área de 100 ha. A seleção baseou-se na produção de resina e na forma do tronco, tendo sido selecionadas 51 árvores.

A porcentagem de seleção foi de 0,1% ou 1:1000. A propagação das sementes das árvores selecionadas dará origem a uma população cuja produção de resina será 70% superior à produção média da população estudada que foi de 2795 g.

A propagação por enxertia acarretará, nas mesmas condições a um ganho genético de 140%. As árvores obtidas por qualquer um destes métodos darão origem a populações nas quais o valor da resina produzida será superior ao valor da madeira, considerando os preços mínimos atuais dados pelo Instituto Florestal de São Paulo a esses produtos.

INDIVIDUAL TREE SELECTION OF *Pinus elliottii* PHENOTYPIC FOR HIGH RESIN PRODUCTION

Summary

During the years 1978 and 1979, at the Manduri Forest Station - Instituto Florestal, we studied 50.990 trees in a 100 ha area. The trees were selected for high resin yield and straight stem form. A total of 51 trees were selected with a percentage of selection of 0,1 %. Propagating the seeds colected from these trees we will have a population with a resin yield 70% higher than the mean of the original trees that was of 2 795 g. Propagation by grafting will result in a genetic gain of 140 %. The resin yielded by these trees will be more valuable than the wood, according to the minimum prices stablished by the Instituto Florestal, São Paulo.

I n t r o d u ç ã o

A extração de resina de Pinus elliottii para a obtenção de terebentina breu e outros produtos, tem sido economicamente importante em vários países há décadas. No Brasil, nesses últimos anos, tem ocorrido um aumento acentuado na demanda desses pro-

dutos e, como consequência das dificuldades relacionadas às importações, a procura dessa materia primano mercado interno, tem aumentado sobremaneira.

A realização de um estudo visando a seleção genêtica e propagação de indivíduos com a característica de alta produção de resina associada a outros fatores desejaveis é no momento, altamente necessário.

Material e Métodos

Instalou-se esse trabalho no biênio 78/79, em conjunto com uma exploração comercial de resina, na Floresta de Manduri, pertencente ao Instituto Florestal de São Paulo. Estudou-se 50.990 árvores com 19 anos de idade, com DAP acima de 19 cm, plantadas sob espaçamento inicial de 1,50 x 1,50 m. Essas árvores pertencem a 6 talhões contíguos cuja área total é de 100 ha aproximadamente, os quais já haviam sofrido 3 desbastes de 40 % cada um.

A seleção iniciou-se com a observação da quantidade de resina presente nos recipientes, antes da realização da primeira coleta.

As árvores cujos recipientes coletores de resina se apresentavam relativamente mais cheios eram marcadas, numeradas e passaram a ter sua produção controlada. Da mesma maneira, procedeu-se com as árvores que apresentavam as menores produções, para ser avaliada a variabilidade genética da característica.

Como as árvores situadas nas bordaduras dos talhões são favorecidas no tocante à competição por luz, água e nutrientes, e como esses fatores influenciam a produção de resina, foi usado um critério de seleção mais rigoroso para essas árvores.

Após a 4ª coleta da resina contida nos recipientes, realizada quando as árvores já haviam passado pelo período de máxima produção da safra, foram eliminadas dentre as árvores marcadas, aquelas que menos produziram.

A terceira seleção somente foi realizada após o término do período de resinagem daquela safra. Essa seleção foi bastante severa pois já se dispunha da quantidade total de resina produzida pelos indivíduos em estudo. Foi considerado nessa seleção, além da produção de resina e a localização da árvore no talhão, também a produção média do talhão.

A quarta e última seleção foi realizada para se encontrar os indivíduos que, além de boa produção de resina, apresentassem também uma boa forma de tronco.

Resultados

Os resultados obtidos estão dispostos nos quadros a seguir.

QUADRO 1: Valores referentes à área, número total de árvores existentes, número de árvores resinadas, produção total de resina, rendimento médio por árvores e número de árvores selecionadas em cada talhão.

Nº do talhão	área ha	Nº de árvores do talhão	Nº de árvores resinadas	Rendimento médio por árvores g	Nº de árvores selecionadas
1	5,1	4.915	3.286	2.863	1
2	21,9	20.976	13.513	2.628	11
3	25,0	17.125	11.501	2.771	8
4	13,9	9.535	7.350	2.739	10
6	31,3	21.441	12.094	2.861	8
8	4,3	3.400	3.246	3.372	13
TOTAL	101,5	77.392	50.990	2.795	51

QUADRO 2: Número de árvores selecionadas em função de cada característica considerada e respectivas produções médias.

característica	número de árvores	produção média g
Nº inicial de Indivíduos	50.990	2.795
Produção de resina	338	7.946
Forma do tronco e Produção de Resina	51	7.517

A maior quantidade de resina extraída de uma única árvore não pertencente à bordadura foi de 9.260 g e, a menor produção constatada foi de 1.240 g. A partir desses valores, de acordo com PIRES (1979), o desvio padrão observado foi de 2.095 g e o coeficiente de variação de 75%.

Considerando-se que a intensidade de seleção (i) foi igual a 3,40, o coeficiente de variação de 75% e considerando uma herdabilidade da característica de 55%, (FRANKLIN, 1970) poderemos segundo FONSECA e KAGEYAMA (1978), chegar a diferentes ganhos genêticos, dependendo do método de seleção que for adotado:

a) Através da coleta de sementes das árvores selecionadas (propagação por sementes), poder-se-á conseguir um ganho genético de 70%.

g = - 0,70 ou 70%

Considerando a produção média da população original de 2.795 g., a produção média dos indivíduos obtidos com aplicação desse método de seleção seria de 4.751 g.

b) Em pomares de sementes clonais de 1ª geração (propagação por enxertia), poder-se-á conseguir um ganho genético de 70%.

Considerando a produção média da população original de 2.795 g., a produção média dos indivíduos obtidos com a aplicação desse método de seleção será de 6.708 g.

Conclusões

1. A propagação a partir de sementes ou por enxertia dos indivíduos selecionados e a posterior implantação de povoamentos com esse material proporcionará umgrande avanço, no tocante ao rendimento, na extração comercial de resina (70 e 140% respectivamente), sem que haja prejuízo na característica referente à forma do tronco.

2. Devido ao aumento na produção de resina a ser obtido com a multiplicação do material selecionado, mesmo considerando os prejuízos acarretados pela prática da resinagem ao desenvolvimento das árvores e à qualidade da madeira, existem vantagens em se resinar. Fazendo-se uma projeção dos preços atuais, o valor obtido com a venda da resina extraída será maior do que o valor que se obteria com a venda da madeira das árvores resinadas.

3. A instalação de testes de Progênie com o material selecionado e posterior eliminação dos genótipos inferiores permitirá a aplicação de métodos seletivos mais aprofundados que possibilitariam a obtenção de ganhos genéticos ainda maiores no que se refere a produção de resina.

Literatura citada

DORMAN, K.W. 1976. The genetics and breeding of southern pines. Agriculture handbook nº 471, U S D A. 407 p.

FONSECA, S.M. e KAGEYAMA, P.Y. 1978. Melhoramento genético face a produção de resina. Circular Técnica nº 36, IPEF-ESALQ-16p.

FRANKLIN, E.C., TARAS, M.A. e VOLKMAN, D.A. 1970. Genetic gains in yelds of oleoresin wood extractives an tall oil. Tappi vol. 55, nº 12 pp.2302 - 2304.

GURGEL FILHO, O.A. 1972. Contribuição a resinagem. Instituto Florestal - São Paulo 39 p.

GURGEL FILHO, O.A. e GARRIDO, M.A.O. 1977. Influência do diâmetro e da copa na produção de resina. Brasil Florestal, vol. VIII, nº 32 pp.27 - 32.

PASZTOR, Y.P.C. 1963. Seleção de fenotipos. Silvicultura em São Paulo, vol 1, nº 2 pp 265-274.

PIRES, C.L. da Silva, 1979. Seleção de árvores superiores. Publicações I.F., São Paulo nº 20 12 p.

FAST GROWING TREES

ÁGUA TRITIADA PARA MEDIÇÃO DE CAMPO DA TRANSPIRAÇÃO

C. A. Sansigolo
Eng. Agr. MS student
E. S. B. Ferraz
ESALQ – USP
BRASIL

Resumo

Usando água tritiada como marcador, é possível determinar diretamente a transpiração das árvores. Este trabalho mostra como isto foi feito em coníferas de 6 anos, vegetando em Piracicaba, S.P. A parte teórica do método está discutida e a parte experimental está detalhada desde a coleta e preparação de amostras, contagem de radioatividade até a análise dos dados para obtenção do tempo de fixação de água na árvore, fluxo de transpiração e cálculo de biomassa. Os resultados permitem concluir que o método é praticável, com boa indicação, e que pode ser aplicado com sucesso nos cálculos florestais de transpiração.

TRITIATED WATER FOR FIELD MEASUREMENT OF TRANSPIRATION

Summary

Using tritiated water as tracer it is possible to directly determine transpiration of trees. This paper shows how this was done in 6-year old conifers grown in Piracicaba, SP. The theoretical part of the method is discussed and the experimental part is detailed from collecting and preparation of samples, radioactivity counts, to data analysis for obtention of residente time of the water in the tree, transpiration flow and biomass calculation. The results lead to the conclusion that the method is feasible, with good indication that it can be successfully applied in forest transpiration calculations.

Introduction

Plant transpiration is the most important characteristic of ecosystems, but very difficult to measure directly. The methods for determination of movement of water in trees, including use of radioisotopes and heat pulses, were reviewed by SLATYER (1967) and SLAVIK (1974).

KLINE et al. (1970) proposed a method for measurement of transpiration, based on the theoretical analysis of tracer dynamics, developed by BERGNER (1961, 64), ZIERLER (1964), LJUNGGREN (1967) and ORR & GILLESPIE (1968): the non-destructive measurement of transpiration rates using tritiated water (HTO) as a tracer. The HTO is added to the flow by injecting it into the trunk at ground level, and its pathway is followed by tritium monitoring as a function of time in the foliage. Tree transpiration is proportional to the area under the curve of specific activity as a function of time.

KLINE et al. (1976) described a method for estimating transpiration of a Douglas-fir forest using the tritium method. Through the linear relation between tree transpiration and sapwood area, it was possible to extend the measured HTO values to the whole forest by sampling of sapwood of different size classes.

JORDAN and KLINE (1977) used the method of Kline et al. (1976) in a tropical forest in the Amazon Basin and concluded that the sapwood area has a high correlation with transpiration when there is a high and continuous supply of water, regardless of species.

KLINE et al. (1972) applied the theory of tracer dynamics for non-destructive measurements of biomass of some conifers and concluded that the tritium method can generally be used for these determinations.

The main objective of this paper was to develop a precise and feasible methodology for measuring transpiration, mean residence time and biomass in conifers.

Theory

For measurements of flow and of volumes of biological systems in dynamic equilibrium, ORR and GILLESPIE (1968) proposed the occupancy principle. This principle deals with the relationship among three parameters: occupancy (θ), capacity (c) and flow (F).

In a given time after injecting the tracer, a definite part of the system contains a fraction of the tracer f(t). Occupancy is defined by:

$$\theta = \int_0^\infty f(t)dt \qquad (1)$$

The capacity (c) of any portion of the system is the quantity of the material being studied (not the tracer) which exists in this portion, regardless of time. The occupancy principle states that the ratio occupancy/capacity is the same for all parts of the system and equal to the reciprocal of the incoming flow:

$$c = F.\theta \qquad (2)$$

In principle, by equation (2) it should be possible to determine flow F by labeling the incoming flow with a radioisotope and determining the resultant of the activity vs time curve somewhere in the system. The experimental difficulty in repeated measurements of fraction of the original activity f(t) and of capacity c make the use of this equation impracticable. It is more convenient to use the specific activity, which is related to the fractional activity, as shown in equation (3):

$$f(t) = c/M\ f'(t) \qquad (3)$$

where f'(t) is the specific activity, M is the total tracer injected during the experiment, and the remaining parameters are those previously define.

Substituting the results of (3) in (1), a new expression is obtained, which after being substituted in (4) and rearranged becomes:

$$M = F \int_0^\infty f'(t)dt \qquad (4)$$

Equation (4) simply suggests that, for a system in dynamic equilibrium the product of the flow by the total integral of the curve of specific activity vs time is equal to the total amount of tracer originally injected.

Since both the total activity and the curve of specific activity vs time can be obtained independently, this equation can be resolved in flow, which in plants is equivalent to transpiration.

The theory of tracer dynamics permits also the calculation of total content of material of a system through which there is a flow. The derivation of the expression which makes possible the calculation of volume of the system is given by ZIERLER (1964):

$$c = F.T_m \qquad (5)$$

where c is the volume of the system, F the flow through the compartment and T_m the mean residence time of the fluid in the system.

The most difficult parameter to measure in equation (5) is the mean residence time. Three different criteria to obtain this parameter are cited in literature:

1) Through the slope of the activity vs time curve, T_s, valid when the system is homogeneously labeled by the tracer. Such a system is described by an equation of the form $A = A_o e^{-\lambda t}$, where A_o = initial activity, A = activity over time, t, and λ rate of decrease in activity. The mean residence time is simply the reciprocal of $\lambda (T_s = 1/\lambda)$.

2) By computing the first moment of the activity vs time curve, T_m^*, described by LJUNGGREN (1976). The first moment is the centroidal axis of the activity vs time distribution, i.e., the vertical axis which divides the distribution into two equal areas:

$$T_m^* = \frac{\int_0^\infty t.f(t).dt}{\int_0^\infty f(t).dt} \qquad (6)$$

3) By measuring the transit time between the injection point and the point of exit of the tracer in the system, T_p. If T_1 is the time of passage of tracer through point 1 and T_2 the time of passage of tracer through point 2 downstream in the flow, then $T_p = T_2 - T_1$, where T_p is the mean residence time between the two points of subsampling. Since the tracer is subject to a peak deformation, T_1 and T_2 are taken as the time when the distribution peak passes through the sampling points.

Experimental Procedure

The injections of tritiated water were made into three trees of *Pinus caribaea*, var. Hondurensis, the characteristics of which are shown in Table I, together with the amounts of HTO used.

Table I. Description of trees, and amounts of HTO used in the experiments with transpiration and biomass

TREE	HEIGHT (cm)	DAP (cm)	TOTAL HTO INJECTED	DATE OF INJEC.
1	6.4	10.3	2.026 exp 9	23/Jan/79
2	6.7	12.7	2.026 exp 9	23/Jan/79
3	6.9	14.3	2.026 exp 9	23/Jan/79

Tritiated water of known specific acitivy was introduced in the tree stem, at 30 cm above ground level. The injection was made pipetting 1 ml of tritium solution into each of three holes which were drilled immediately prior and sealed immediately after injection.

After the injection, leaf samples were being picked from the trees until the HTO pulse had completely passed through the tree canopy. The sampling was made by collecting 60 to 80 leaves, representative of the whole canopies, 1 to 6 times a day, with higher frequency in the beginning of the experiment.

Immediately after being collected, the samples were placed in plastic bags and stored in order to avoid loss of tritium by evaporation.

The water of leaf tissues was extracted from the samples by pressing on a system shown in Fig. 1. The extract is centrifuged and from this solution 1 ml is taken for counting.

The scintillating solution used for countings of tritium in aqueous solutions was that of PATTERSON and GREENE (1967). The standardization of samples was made by the method of external source. Corrections for quenching and background were made for all samples and the data were expressed in DPM/ml (desintegrations per minute per mililiter).

Results and Discussion

The values of specific activity as a function of time obtained and subsequently utilized for calculation of the area under the response curve are shown in Fig. 2.

The mean transpiration flows ($\bar{F}$) computed as shown in (4) are presented in Table II.

Table II. Mean transpiration of *Pinus caribaea* for the 3 trees that were injected with tritium under summer conditions.

TREE	HEIGHT (m)	DAP (cm)	TOTAL HTO INJECTED (DPM)	INTEGRAL OF CURVE f'(t) vs t (DPM.h/ml)	MEAN TRANSPIRATION ($\bar{F}$,l/day)
1	6.4	10.3	2.026 exp 9	1.041 exp 6	46.7
2	6.7	12.7	2.026 exp 9	6.567 exp 5	74.0
3	6.9	14.3	2.026 exp 9	6.944 exp 5	70.0

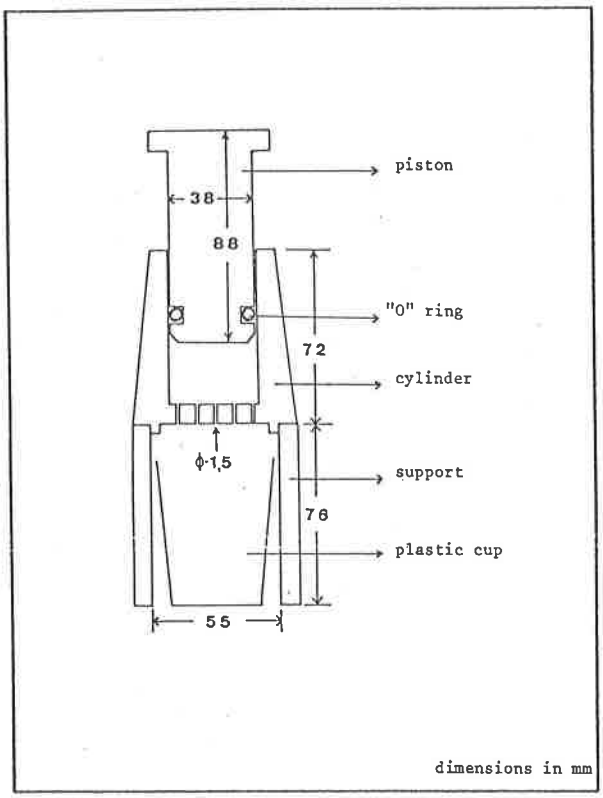


Fig. 1 - Sketch of extractor of water from leaf tissues.

Equation (4) is derived on the assumption that the flow is measured at a constant rate during the experiment. This is the so called stationarity principle (ZIERLER, 1964). As stated by ORR and GILLESPIE (1968), the equation is not extremely sensitive to deviations from the assumed constant flow and can even be used in systems where this assumption is not strictly true. The result obtained by applying this equation is the estimate of a flow over rainy and sunny periods, daytime and nighttime, and over other variations that are likely to occur during the experiment.

Since the equation on which the method is based is strictly derived, the best method for corroborating the experiment is through examination of the experimental deviations and of the necessary conditions for derivation. Specifically, equation (4) depends on the tracer being homogeneously mixed. The tree is seen as a leaf compartment served by an incoming flow, water, moving through the wood parts. Therefore, the model does not require the tracer to be mixed through the entire tree. If a uniform mixing is obtained before the incoming flow reaches the leaf compartment, the model requirements are met.

Another assumption concerning the use of equation (4) is that the total tritium pulse is removed via the transpiration flow and that no other significant pathway exists.

a) The tritium can be either exchanged with the hydrogen of organic molecules or incorporated within them and removed from the flow.

b) Part of the tritiated water solution can move downward from the injection point and be lost on its way the soil.

c) The tritiated water can be trapped as free water in more or less isolated elements and become inadequate for transpiration.

KLINE et al. (1970) concluded, from their tritium experiments, that pathways (a) and (b) are negligible, because soil samples from the base of the trees contained no tritium in the soil water and wood samples taken at the conclusion of the experiment contained no tritium in their combustible produtcts.

For pathway (c) a correction can be made for transpiration by estimating the total tritium in the tree and using the value thus obtained to correct the M value in equation (4)

$$M' = M - R$$

where M is the amount of tritium originally injected and R is the amount of residual tritium at the conclusion of the experiment. Thus, equation (4) is resolved for M'. As a rule, the sampling period must be extended until R becomes negligible.

SLATYER (1967) described the effects of damage in the tree xylems, including drainage of vessels and incorporation of air within them at the point where damage occurred. This author states that there are many alternative pathways for water around the damaged point and that air incorporation does not take place throughout the stem, but only near the affected area. Total transpiration is little affected by small cuts in the xylem.

RANEY and VAADIA (1965) demonstrated that plants transpiring tritiated water have a lower HTO concentration in their leaves than in their water source. These authors attributed this to the exchange between the water molecules in the leaves and in the atmosphere. For this dynamic exchange, water molecules keep continuously leaving the foliar surface and returning to it. Like the other water molecules, the tritiated water irreversibly leaves the leaf, and the return flow of molecules from the atmosphere to the leaf is composed of a population whose identity is different from that which left. It is this return flow of water molecules that dilutes the remaining HTO. The rate of isotope exchange can be measured in the HTO-labeled trees by using the ratio specific activity in the leaves over that in the twigs of samples collected at the same time. This can be made because twigs are isolated from vapor atmosphere exchange (RANEY & VAADIA, 1965). KLINE et al. (1976) observed, during an experimental period, that ca. 30% of the water in the foliage was of atmospheric origin.

If the leaf data are used to build the curve of specific activity as a function of time, the flow computed includes the transpiration flow and the isotopic exchange.

An important assumption to every experiment with tracers is that its behavior is identical to that of the substance being labeled. Tritiated water has a significant mass difference in relation to simple common water, therefore a tritium enrichment may occur in the leaves due to differential

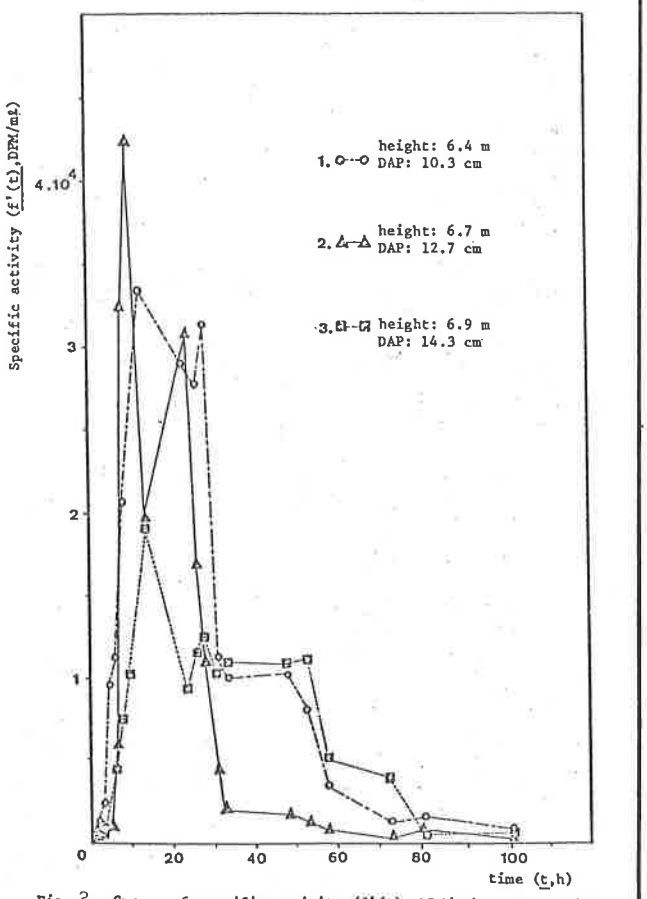


Fig. 2 - Curves of specific activity (f'(t), DPM/ml) as a function of time (t, h) for the 3 trees which received injections of tritiated water in the summer period.

evaporation and to different coefficients of molecular diffusion of HTO and H_2O in the walls of the mesophylls and intercell spaces.

However, none of these factors is strong enough to influence the results so as to cause any damage. For the sake of greater rigor, some corrections can be made, if thought necessary.

The mean residence time (T_m) was the most difficult parameter to obtain mainly because the most adequate criteria for calculation were not known "a priori".

Table III shows the T_m values calculated through the three previously discussed criteria.

Table III. Values of mean residence time of water in the trees (T_m, h), obtained through T_s, T_m* and T_p.

TREE	T_s (h)	T_m* (h)	T_p (h)
1	21.1 (r = 0.96***)	23.3	13.3
2	18.1 (r = 0.91***)	19.6	9.5
3	24.4 (r = 0.89***)	34.2	13.2
$\bar{M}$	21.2 ± 1.8	25.7 ± 4.4	12.0 ± 2.7

After analysing the results, the only values of mean residence time (T_m) considered were those calculated through the slopes of the descending branches of the curves of specific activity as a function of time (T_s). This is possible by well adjusting the experimental data to the regression curves, by the method of the minimum squares, which implies the occurrence of a homogeneous mixing of the tracer, and this is the basic condition for the use of this criterion.

References

BERGNER, E.E. Tracer Dynamics: I A Tentative Approach and Definition of Fundamental Concepts. J.Theor. Biol.,2: 120-140, 1961.

BERGNER, E.E. Tracer Dynamics and the Determination of Pool-Sizes and Turnover Factor in Metabolic Systems. J. Theor. Biol.,6: 137-58, 1964.

JORDAN, C.F. & KLINE, J.R. Transpiration of Trees in a Tropical Rain Forest. J. Appl. Ecol.,14: 853-60, 1977.

KLINE, J.R. et alii. Measurement of transpiration in Tropical Trees with Tritiated Water. Ecology,51: 1068-73, 1970.

KLINE, J.R. et alii. Use of Tritiated Water for Determination of Plant Transpiration and Biomass under Field Conditions. In: Isotopes and Radiation in Soil-Plant Research Including Forestry, Vienna, 1972. Anais, IAEA, 1972. p.419-37.

KLINE, J.R. et alii. Field Measurement of Transpiration in Douglas-Fir. J. Appl. Ecol. , 13:272-83, 1976.

LJUNGGREN, K. A REview of the Use of RAdioisotope Tracers for Evaluating Parameters Pertaining to the Flow of Material in Plant and Natural Systems. Isotop. Radiat. Technol., 5: 3-24, 1967.

ORR, J.S. & GILLESPIE, F.C. Occupancy Principle for Radioactive Tracers in Steady-State Biological Systems. Science, 162: 138-9, 1968.

SLAVIK, B. Liquid Water Movement in Plants. In: JACOBS, J. et alii, eds. Methods for Studying Plant Water Relations. Berlin, Springer-Verlag, 1974. p. 219-35.

ZIERLER, K.L. Basic Aspects of Kinetic Theory as Applied to Tracer Distribution Studies. In: KNISELEY, R.M. & TAUXE, W.N., eds. Dynamic Clinical Studies with Radioisotopes . Germantown, U.S. Atomic Energy Comission, 1964. p.55-79.

FAST GROWING TREES

QUEIMA CONTROLADA EM PLANTAÇÕES DE *Pinus spp* NA REGIÃO DE SACRAMENTO, MG

R. V. Soares
Universidade Federal do Paraná
BRASIL

Resumo

O principal objetivo deste trabalho foi testar a viabilidade do uso de fogo controlado na redução do material combustível acumulado sob plantios de *Pinus caribaea* var.*hondurensis* e *Pinus oocarpa* na região de Sacramento, MG.

De acordo com a prescrição, as condições ideais para a queima seriam: temperatura máxima de 18°C, velocidade mínima do vento 1,05 m/s e umidade relativa mínima do ar 60%. Apesar das condições do dia previsto para a queima não estarem de acordo com a prescrição (às 9 horas da manhã a temperatura era 20°C, velocidade do vento zero e umidade relativa do ar 42%), por razões administrativas a queima teve que ser realizada assim mesmo.

Devido às condições adversas do dia, a intensidade do fogo e a altura de crestamento foram maiores que o esperado,variando respectivamente de 121,0 kcal/m-s e 7,8 m em *Pinus caribaea hondurensis* a 128,5 kcal/m-s e 8,0 m em *P.oocarpa*.

Apesar da relativamente alta intensidade, os danos aparentes ao povoamento foram mínimos e o fogo esteve sob controle durante toda a operação. A redução de material combustível no piso da floresta foi de aproximadamente 90% em *Pinus oocarpa* e 91% em *Pinus caribaea hondurensis*. Observou-se , após o fogo, uma queda excessiva de acículas, motivada pela intensidade do fogo. Entretanto, devido a uma maior compactação e muito menor peso por área, as acículas se constituem num tipo de combustível bem menos perigoso que o existente antes do fogo.

CONTROLLED BURNING IN *Pinus spp* PLANTATIONS IN SACRAMENTO, BRAZIL

Summary

The main objective of this research was to test the efficiency of a prescribed burning in the reduction of fuel accumulations under *Pinus oocarpa* and *Pinus caribaea* var. *hondurensis* plantations in the southwest of Minas Gerais State, Brazil.

According to the prescriptions, the optimum conditions for the burning were: maximum air temperature 18°C, minimum windspeed 1,05 m/s and minimum relative humidity 60%. The burning was scheduled for June 9th, 1979 and due to administrative problems it was carried out on that day, although the weather conditions were not according to the prescription : at 9:00 AM air temperature was 20°C, windspeed zero and relative humidity 42%.

Due to the adverse weather conditions, fire intensity and scorch height were higher than expectation. Fire intensity

and scorch height ranged, respectively from 121.0 kcal/m-s and 7.8 m in *Pinus caribaea hondurensis* to 128.5 kcal/m-s and 8.0 m in *Pinus oocarpa*.

Regardeless of the fact that intensity was higher than it should be, apparent damage to the trees was minimum. The fire was under control during the entire operation. Reduction of the fuel bed was approximately 90% in *Pinus oocarpa* and 91% in *Pinus caribaea hondurensis*. Due to the fire intensity, there was an excessive needle fall after the fire, even though needle accumulation was much less and not as dangerous as the fuel bed existing before the fire.

1. INTRODUÇÃO

O acúmulo de material combustível sob plantações de *Pinus* spp aumenta sensivelmente o risco de danos caso ocorra um incêndio florestal na área. O material combustível entretanto é parte inerente da floresta. Acículas caídas, gramíneas, material residual, arbustos e mesmo as árvores podem representar, dependendo do estado em que se encontram, concentrações de combustível consideradas perigosas caso ocorra uma ignição na área.

Considerando que o material combustível é um dos componentes do "triângulo do fogo" e, principalmente, que é o único desses componentes que pode ser alterado pelo homem, não resta dúvida que o manejo do material combustível merece uma atenção especial por parte dos técnicos florestais.

Controlando-se a quantidade de material combustível em uma floresta, o risco de danos pelo fogo será sensivelmente menor. A remoção completa do material combustível no entanto não é possível nem desejável. A remoção parcial, porém, pode ser feita com segurança através de vários métodos, alguns deles entretanto economicamente inviáveis.

Queima controlada parece ser, no momento, uma das melhores soluções para o problema de acúmulo de material combustível em florestas de *Pinus* spp, que são espécies resistentes a fogo de baixa intensidade. Por ser uma técnica relativamente barata, sua aplicação poderia representar grande economia nos custos de proteção contra incêndios florestais.

O objetivo principal deste trabalho foi realizar uma queima controlada para reduzir a quantidade de material combustível existente sob plantios de *Pinus* spp, eliminando ou diminuindo, por conseguinte, o risco potencial de destruição das plantações por eventuais incêndios florestais.

2. REVISÃO DA LITERATURA

De acordo com Cooper (2) o fogo controlado, aplicado de maneira científica, tem demonstrado ser até agora o melhor dos métodos conhecidos para manter o material combustível de uma floresta em níveis toleráveis. Mobley et al (8) afirmam que o fogo controlado é a mais prática ferramenta disponível, em manejo florestal, para controlar perigosas concentrações de material combustível que se acumulam sob plantações equianas.

Onde existe a possibilidade de destruição de plantios pelo fogo, a queima controlada para redução do risco é geralmente o melhor seguro (11). Eliminação de altas acumulações de combustível através de fogo controlado, sob condições adequadas, mantem o plantio temporariamente à prova de fogo (11), pois mesmo que ocorra uma ignição, não haverá material combustível para queimar.

Um importante fator para o sucesso de uma queima controlada é evitar o crestamento das acículas, ou pelo menos mantê-lo abaixo de 30 a 40% do total da superfície da copa (9). A altura de crestamento é proporcional à intensidade do fogo e também depende da temperatura e velocidade do vento (12). A intensidade do fogo pode ser calculada após as estimativas da quantidade de material combustível e da velocidade de propagação(1). Conhecida a intensidade potencial é possível estabelecer as condições de temperatura e velocidade do vento que permitam manter a altura de crestamento abaixo do limite desejado, que depende da altura média das árvores (9).

Uma das limitações do uso de fogo controlado é o temor de danos ao ambiente, especialmente ao solo. O fogo porém é um elemento natural, que sempre foi parte integrante de diversos ecossistemas terrestres. Quando bem prescrito e manejado, o fogo pode proporcionar mais benefícios do que danos (9). Segundo Lotti, Klawitter e LeGrande (6), as diversas análises de solo - matéria orgânica, físicas e químicas - não indicaram nenhuma evidência de danos aos solos em povoamentos de *Pinus taeda* no Sudeste dos Estados Unidos, após dez anos de tratamento com fogo controlado. King et al (5) evidenciam que a perda de minerais em um programa de queima controlada devidamente elaborado é muito menor do que no caso de um incêndio florestal. Além disto, o fogo controlado poderá ser um agente reciclador dos nutrientes incorporados à matéria orgânica, melhorando a qualidade dos solos onde a decomposição natural é muito lenta.

3. MATERIAL E MÉTODOS

3.1. Características do local.

A pesquisa foi desenvolvida na fazenda "Chapadão do Bugre", de propriedade da Reflorestadora Sacramento - RESA Ltda, situada no município de Sacramento, Minas Gerais. A altitude média do local está em torno de 1.200 m s.n.m. De acordo com os dados meteorológicos (Quadro 1) a região apresenta um clima tipo "Cwa" segundo a classificação de Koppen (3) e tipo "Floresta úmida sub-tropical montano-baixo" segundo a classificação de Holdridge (4).

Quadro 1. Dados meteorológicos da fazenda "Chapadão do Bugre", Sacramento, MG.

Mês	Média Mensal	
	Temperatura (°C)	Precipitação (mm)
Janeiro	21,50	304,9
Fevereiro	21,96	189,3
Março	20,93	204,6
Abril	18,60	122,2
Maio	17,20	69,2
Junho	15,20	25,4
Julho	16,40	39,4
Agosto	16,80	2,0
Setembro	18,40	34,6
Outubro	20,60	182,8
Novembro	22,05	341,9
Dezembro	20,71	300,1
Média anual	19,20	1.811,4

3.2. Prescrição da queima

Para se prescrever as condições ideais sob as quais a queima seria realizada, foi necessário estimar a quantidade de material combustível fixar a intensidade máxima de fogo desejada e calcular a velocidade máxima de propagação do fogo permitida.

A quantidade de material combustível existente no piso das florestas foi estimada através das equações (10):

$$P_t = -11{,}523623 + 0{,}225737\ I^2 + 58{,}81606\ /\ I$$

sendo

P_t = peso seco total em ton/ha, para *Pinus caribaea* var. *hondurensis*

I = idade do povoamento em anos

e

$$P_t = -21{,}007840 + 0{,}334142\ I^2 + 92{,}134990\ /\ I$$

sendo

P_t = peso seco total em ton/ha, para *Pinus oocarpa*

I = idade do povoamento em anos.

A intensidade máxima de fogo desejada foi fixada em 80 kcal/m-s (7) e a velocidade máxima de propagação foi calculada com base na seguinte equação (1):

$$I = H.w.r$$

sendo

I = intensidade do fogo em kcal/m-s

H = capacidade calorífica do combustível (4.000 kcal/kg)

w = peso do material combustível disponível em kg/m^2

Tomando por base a intensidade máxima permitida foram determinadas as condições ideais de temperatura do ar e velocidade do vento no dia da queima para evitar danos às copas através do crestamento das acículas. Considerando-se a altura média das árvores, foi fixada uma altura máxima de crestamento de 5m. As condições de vento e temperatura foram determinadas através da equação (2):

$$h_\delta = \frac{3{,}94\ I^{\frac{7}{6}}}{(0{,}107\ I + U^3)^{\frac{1}{2}}\ (60-T)}$$

sendo

h_δ = altura de crestamento em m.

I = intensidade do fogo em kcal/m-s

U = velocidade do vento em m/s

T = temperatura do ar em °C.

3.3. Preparo da área

Foram escolhidos dois talhões, um de *Pinus oocarpa* e outro de *Pinus caribaea* var. *hondurensis*, ambos com 7 anos de idade, para se queimar. A área a ser queimada, dentro de cada talhão, media 150 m de comprimento por 125 m de largura. Essas áreas foram devidamente isoladas do resto dos talhões por aceiros de aproximadamente 2,50 m de largura. Não houve nenhum preparo interno das áreas.

3.4. Técnica utilizada e precauções tomadas na queima

Como se tratava da primeira queima, a técnica a ser utilizada obrigatoriamente devia ser "queima contra o vento" (9). Essa técnica consiste em colocar uma linha de fogo ao longo de uma barreira natural ou artificial (aceiro), e deixar o fogo se propagar contra o vento ou montanha abaixo, em terrenos inclinados. O comprimento da faixa a ser queimada varia de acordo com as condições locais. No presente caso, o comprimento foi de 150 m.

Devido a falta de experiência com esse tipo de trabalho na região, foram tomadas todas as precauções no sentido de evitar que o fogo escapasse ao controle. Foram usados os equipamentos de combate contra fogo disponíveis, tais como 1 caminhão tanque, bombas costais, ferramentas manuais e operários suficientes para manter uma vigilância efetiva nos aceiros.

3.5. Avaliação da queima

A avaliação da queima foi feita em duas etapas. Na primeira, realizada 1 mês após a queima, foi feito um inventário do material combustível remanescente, a fim de se estimar a quantidade consumida pelo fogo. Para esse inventário foram aleatorizadas 25 parcelas de amostragem de 1 x 1 m em cada uma das áreas queimadas. Dessas parcelas foi retirado todo o material combustível, classificado por tamanho, e pesado. De cada classe de tamanho foi retirada uma amostra, pesada, e levada ao laboratório para a determinação do peso seco, após secagem em estufa a 75°C por aproximadamente 24 horas. Com base na amostragem, foi determinado o peso seco do material remanescente por hectare, para ser comparado com a quantidade total existente antes da queima.

A segunda etapa, realizada quatro meses após a queima, constou de uma verificação da área para se ter uma idéia dos eventuais danos causados pelo fogo e do tipo de vegetação que estava regenerando no sub-bosque.

4. RESULTADOS

4.1. Prescrição da queima

A estimativa da quantidade de material combustível existente nas áreas preparadas para a queima controlada indicou os seguintes valores:

i) Em *Pinus oocarpa* - 8,5 ton/ha

ii) Em *Pinus caribaea* var. *hondurensis* - 7,9 ton/ha

Considerando-se que cerca de 85% desse material poderia ser considerado como disponível e fixando-se a intensidade máxima em 80 kcal/m-s, a velocidade de propagação do fogo deveria ser, no máximo:

i) Em *Pinus oocarpa* - 0,028 m/s ou 1,68 m/min.

ii) Em *Pinus caribaea* var. *hondurensis* - 0,029 m/s ou 1,78 m/min.

Fixando-se a altura máxima de crestamento em 5,0 m, as condições climáticas ideais para a realização da queima seriam:

i) Temperatura máxima do ar - 18°C

ii) Velocidade mínima do vento - 1,05 m/s ou 3,78 km/h

iii) Umidade relativa do ar mínima - 60%

4.2. Comportamento do fogo

Devido a problemas administrativos e de disponibilidade de tempo, a queima foi programada para o dia 09 de junho de 1979. As condições climáticas nesse dia, entretanto, não estavam de acordo com a prescrição. Às 9:00 horas a temperatura do ar era de 20°C, a velocidade do vento zero e a umidade relativa do ar 42%. A temperatura máxima do dia foi 22°C e a umidade relativa 42%, ambos às 13:00 horas. Como toda a infra-estrutura para a queima estava preparada e devido a falta de datas disponíveis no futuro, decidiu-se realizar a queima mesmo em condições adversas e observar o comportamento do fogo nessas condições.

O fogo foi iniciado às 10:00 horas e a primeira área queimada foi a de *Pinus caribaea* var. *hondurensis*, que não havia sofrido derrama artificial e apresentava ramificação muito baixa. Como não havia vento, foi usada a declividade do terreno como elemento moderador do fogo. Assim, o fogo foi colocado na parte mais alta para se propagar em direção ao declive.

No início, o fogo começou a se propagar a uma velocidade de 0,5 m/min., ou seja, menos do que a velocidade máxima desejada. À medida que a temperatura ambiente aumentou, o fogo se tornou mais intenso e a propagação chegou a 2 m/min., acima portanto do limite máximo ideal. Apesar da intensidade, o fogo não chegou a fugir do controle. Entretanto, um contra-fogo não programado, colocado precipitadamente na extremidade da área aumentou exacessivamente a intensidade, chegando mesmo a queimar algumas copas e aumentando por conseguinte a intensidade de danos.

Além da ramificação baixa nas árvores dessa parcela, a grande quantidade de acículas secas existentes ao longo do tronco das árvores favoreceu a tendência do fogo subir às copas, o que não pode ser evitado em algumas árvores.

Na parcela de *Pinus oocarpa*, o fogo se comportou mais ou menos da mesma forma que no *Pinus caribaea* var. *hondurensis*. O fogo foi iniciado às 16:00 horas e terminou uma hora depois, propagando-se a uma velocidade média de 2,5 m/min., acima portanto do máximo recomendável. Como a parcela havia sido derramada artificialmente, havia mais dificuldade do fogo subir até a copa. Mesmo assim, em árvores com excesso de acículas presas ao tronco, havia a tendência do fogo subir, necessitando controle com auxílio das bombas costais.

Apesar da intensidade do fogo ter excedido, em ambas as parcelas, o limite máximo desejado, não houve problema quanto ao confinamento do fogo na área queimada. O fogo foi mantido sob controle durante toda a queima.

4.3. Avaliação da queima

4.3.1. Redução do material combustível

Para estimar com maior precisão a quantidade de material combustível consumido pelo fogo foi feito um inventário um mês após a queima. Os resultados do inventário são apresentados no Quadro 2.

Quadro 2. Peso seco do material combustível residual, por classes de diâmetro, em *Pinus oocarpa* e *Pinus caribaea* var. *hondurensis*.

Classes de diâmetro	*Pinus oocarpa*		*Pinus caribaea hondurensis*	
	g/m²	ton/ha	g/m²	ton/ha
0,7	14,68	0,147	8,60	0,086
0,7 - 2,5	49,75	0,498	62,10	0,621
2,5 - 7,6	15,23	0,152	-	-
7,6	3,53	0,035	-	-
Total	83,19	0,832	70,70	0,707

Considerando-se a quantidade de material combustível existente antes do fogo, a redução foi de aproximadamente 90 % no plantio de *Pinus oocarpa* e cerca de 91% no *Pinus caribaea hondurensis*.

O inventário acusou por outro lado uma quantidade relativamente grande de acículas crestadas no solo, caídas em consequência do fogo. O peso seco das acículas era aproximadamente 4,0 e 5,0 ton/ha em *Pinus oocarpa* e *Pinus caribaea hondurensis* respectivamente.

4.3.2 Efeitos da queima

Baseando-se nos dados do inventário, que permitem estimar a quantidade de combustível consumida pelo fogo e na velocidade média de propagação do fogo, a intensidade média do fogo foi de cerca de 128.5 kcal/m-s em *Pinus oocarpa* e de 121,0 kcal/m-s em *Pinus caribaea hondurensis*. Considerando-se essas intensidades e as condições climáticas durante a queima, a altura de crestamento letal das copas foi de aproximadamente 7,8 e 8,0 m em *Pinus caribaea* e *P. oocarpa*, respectivamente.

A intensidade do fogo, em ambos os plantios, superou o máximo desejado. Portanto era de se esperar que alguns danos fossem causados às árvores. A vistoria realizada 4 meses após a queima mostrou entretanto que os danos, pelo menos visualmente, foram mínimos. A mortalidade foi praticamente nula. Apenas algumas árvores suprimidas, de diâmetro inferior a 5cm, foram mortas pelo fogo. Mesmo na parte do plantio de *Pinus caribaea hondurensis* afetada pelo contra-fogo, onde a intensidade foi muito maior e impossível de se estimar, não houve mortalidade entre as árvores, embora os danos à copa possam resultar em atraso de crescimento.

A regeneração do sub-bosque foi principalmente composta de ervas e arbustos do cerrado. A regeneração foi mais intensa sob o *Pinus oocarpa*, onde existe mais luminosidade.

O principal objetivo da queima, redução do material combustível, foi atingido. É flagrante a diferença entre a parte queimada e a não queimada. O tipo de material combustível considerado perigoso, principalmente gramíneas secas e material fino, foi totalmente eliminado.

5. DISCUSSÃO E CONCLUSÕES

A principal preocupação ao se planejar uma queima controlada é manter a intensidade do fogo dentro de limites que alcancem os objetivos desejados sem causar danos as árvores. Enquanto McArthur (7) estabelece em aproximadamente 82 kcal/m-s o limite máximo de intensidade do fogo em povoamentos comerciais, Brow e Davis (1) dizem que certas espécies podem suportar intensidades de até cerca de 120 kcal/m-s.

Embora a prescrição para a presente queima tenha fixado o limite máximo em 80 kcal/m-s, a intensidade média chegou a 121,0 e 128,5 kcal/m.s em *Pinus caribaea hondurensis* e *Pinus oocarpa* respectivamente. Estes números, apesar de considerados altos para as condições, principalmente de idade, dos povoamentos, estão ainda muito aquém dos limites de intensidade alcançados por incêndios florestais, que normalmente superam 400 kcal/m-s (9).

Apesar da relativamente alta intensidade do fogo, os danos aparentes às árvores não foram significativos, com excessão da área onde foi colocado o contra-fogo. Neste local, a intensidade, apesar de não poder ser estimada, seguramente foi superior a 130 kcal/m-s, provocando danos às copas das árvores sem entretanto causar mortalidade.

Muito embora não tenha havido mortalidade entre as árvores, com excessão de algumas suprimidas, não se pode ainda avaliar os efeitos indiretos do fogo sobre o povoamento. Haverá redução do crescimento das árvores? Os nutrientes liberados (mineralizados) pelo fogo terão efeito sobre o crescimento, compensando o crestamento letal da parte da copa em algumas árvores? Perguntas como estas somente poderão ser respondidas a médio prazo, através de pesquisas complementares na área do ensaio.

O objetivo principal da queima, que era a redução do material combustível foi plenamente alcançado. Devido a alta intensidade do fogo, a redução foi maior que o esperado. A previsão era de uma redução em torno de 80% e na realidade ela chegou a casa dos 90%.

Um efeito indesejável, que ocorreu em função da alta intensidade do fogo e da elevada altura letal de crestamento, foi a excessiva queda de acículas após o fogo, chegando a 4 ton/ha em *Pinus oocarpa* e 5,0 ton/ha em *Pinus caribaea hondurensis*. Apesar da intensidade do fogo e altura de crestamento terem sido maiores em *Pinus oocarpa* a queda de acículas foi menor porque o talhão havia sido derramado artificialmente. As acículas entretanto, devido a uma maior compactação, representam um tipo de combustível bem menos perigoso que o existente antes do fogo. Um melhor controle da intensidade do fogo certamente evitaria ou minimizaria esse problema.

Comparando-se visualmente as áreas queimadas e não queimadas nota-se uma nítida diferença na vegetação do sub-bosque. Enquanto nas áreas não queimadas predominam as gramíneas, nas áreas queimadas se observa a regeneração de ervas e arbustos típicos do cerrado. A regeneração dessas espécies é mais intensa em *Pinus oocarpa*, onde a luminosidade do sub-bosque é maior. A brotação nova e suculenta de ervas e arbustos da região apre

senta aspectos positivos tanto na melhoria do habitat para a vida silvestre, aumentando a disponibilidade de alimentação para a fauna herbívora, como na preservação do ecossistema local.

Um dos aspectos importantes a considerar na implantação de um programa de queima controlada é o custo da operação. Nesse trabalho não houve a preocupação de se analisar os custos, por três motivos principais. Em primeiro lugar, como se tratava de um trabalho pioneiro e de certo risco, foram mobilizados todos os recursos disponíveis para se evitar danos no caso do fogo escapar ao controle. Em segundo lugar, como não havia pessoal com experiência suficiente, procurou-se compensar a qualidade com quantidade de mão de obra. Finalmente, a operação de queima controlada foi aproveitada como treinamento para o pessoal na área de controle de incêndios florestais.

As conclusões mais importantes do presente trabalho, em síntese, seriam as seguintes:

a) A queima controlada para a redução de material de combustível em plantações de *Pinus oocarpa* e *Pinus caribaea hondurensis* a partir de sete anos de idade é viável e exequível.

b) Obedecendo-se as condições estabelecidas pela prescrição pode-se atingir os objetivos da queima sem causar danos significativos às árvores.

c) Intensidade de fogo e alturas de crestamento acima dos níveis máximos desejados promovem excessiva queda de acículas, contribuindo para um indesejável aumento da quantidade de material combustível no piso da floresta, embora em níveis bem menores e menos perigosos que os anteriores à queima.

d) A queima controlada altera drasticamente a vegetação do sub-bosque, favorecendo a regeneração de ervas e arbustos, em detrimento das gramíneas.

e) Efeitos indiretos da queima, tais como alterações nas quantidades totais e disponíveis de nutrientes, influência no crescimento das árvores e alterações no ecossistema somente poderão ser avaliados mediante programas de pesquisas complementares.

7. LITERATURA CITADA

1. BROWN, A.A. e DAVIS, K.P. Forest fire: control and use. New York, McGraw - Hill, 2nd ed., 1973. 686p.
2. COOPER, R.W. Prescribed burning : why it is a vital forest management tool. Forest Farmer 31 (7) : 18-19. 1972.
3. HAURWITZ, B. e AUSTIN, J.M. Climatology. New York, McGraw - Hill, 1944. 410 p.
4. HOLDRIDGE, L.R. Ecologia basada en zonas de vida. San José, IICA, 1978. 216 p.
5. KING, N.K. et al. Studies on bushfire smoke. In Fire in the Environment Symposium Proceedings, Denver, U.S. Forest Service, 1971. 251 p.
6. LOTTI, T., KLAWITTER, R.A. e LEGRANDE, W.P. Prescribed burning for understory control in loblolly pine stands of the coastal plain. U.S. Forest Service, Southeastern Forest Experiment Station Paper nº 116, 1960. 19 p.
7. McARTHUR, A.G. Fire behaviour in eucalypt forests. Camberra, Dept. of National Development, Forestry and Timber Bureau, Leaflet nº 107, 1967. 36 p.
8. MOBLEY, H.E. et al A Guide for prescribed fire in South eastern Area State and Private Forestry, 1973. 40 p.
9. SOARES, R.V. The use of prescribed fire in forest management in the State of Parana, Brazil. Seattle, University of Washington, Ph.D. Dissertation, 1977. 203p.
10. SOARES, R.V. Determinação da quantidade de material combustível acumulada em plantios de *Pinus* spp na região de Sacramento, MG. Curitiba, Revista Floresta 10(1): 48-62.
11. TURNER JR., J.C. Techniques and tools of fire protection. Forest Farmer 30 (7) : 76-76. 1971.
12. VAN WAGNER, C.E. Height of crown scorch in forest fires. Canadian Journal of Forest Research 3 : 373 - 378. 1973.

FAST GROWING TREES

AVALIAÇÃO TÉCNICA E ECONÔMICA DE DOIS MÉTODOS DE EXTRAÇÃO EM PRIMEIRO DESBASTE DE *Pinus taeda* L. COM TRATORES AGRÍCOLAS

G. W. D. Stohr
Universidade Federal do Paraná
A. J. Baggio
Unidade Regional de Pesquisa Florestal Centro Sul
BRASIL

Resumo

O trabalho objetiva analisar o desempenho e os custos na operação de arraste principal, de dois tratores agrícolas de 61 HP, equipados respectivamente com barra de tração com correntes e com pinça hidráulica e lâmina dianteira.

A pesquisa foi instalada em uma plantação de Pinus taeda com 9 anos de idade, submetida a 1º desbaste, de forma sistemática e seletiva.

O trator com barra apresentou um volume médio por ciclo de 0,8 m^3 de madeira e, em uma distância média de 200 m, o rendimento de 6,85 m^3/h, a um custo de Cr$ 60,80/m^3. O trator com pinça, sob condições iguais de arraste, porém com um volume médio por ciclo de 0,5 m^3 de madeira, alcançou um rendimento de 5,39 m^3/h a um custo de Cr$ 82,10 m^3.

Para as condições testadas, recomenda-se a utilização do equipamento barra de tração com correntes, quando houver disponbilidade de mão de obra, pois este arrasta maior volume de madeira a um custo mais baixo.

Introdução

O grande volume de madeira oriundo das florestas implantadas e a pequena capacidade de mão de obra, aliada à estrutura de custos existentes no sul do país, são grandes desafios que não podem ser enfrentados sem um grau mínimo de mecanização.

Entre as atividades parciais mais onerosas que ocorrem num desbaste, estão o descascamento e o arraste principal com 23 a 44% e 20 a 33%, respectivamente, dos custos por metro cúbico, posto no caminhão (BAGGIO & STOHR, 1978). A racionalização dessas operações é portanto prioritária na redução dos custos da exploração florestal.

Inúmeros trabalhos de pesquisa têm demonstrado as vantagens na utilização de tratores agrícolas para o arraste principal de madeira oriundas de florestas jovens. Em um estudo comparativo entre um trator agrícola com pinça hidráulica em um "Skidder", MACKINTOSH (1975), concluiu que o primeiro é mais econômico no arraste de árvores com um volume de até 0,1 m^3.

Por outro lado, CARLESTAL & FOGEBY (1977), em um estudo de trabalho em 1º desbaste de Picea abies, usando trator agrícola com carreta para 5 toneladas e guincho com alcance de até 30 m, concluiram que o método era mais econômico que tratores florestais projetados para aquela finalidade.

Em outro estudo, comparando um trator agrícola e um cavalo, na operação de arraste principal de Pinus sylvestris, SCHAAFSMA (1977), constatou que a produtividade da máquina foi maior. Seus custos foram mais elevados, até a distância de 70 m, porém a partir dessa distância, passaram a ser menor.

Tendo em vista que, no Brasil, atualmente, a extração de fustes de desbastes de povoamentos de Pinus spp., em locais planos até ondulados, vem sendo feita principalmente por tratores agrícolas com barra de arraste ou pinça hidráulica traseira, objetiva-se através deste trabalho, analisar os rendimentos, custos e a conveniência destes sistemas de arraste mecanizado.

Material e Métodos

Descrição do local

A pesquisa foi desenvolvida na Fazenda Monte Alegre, de propriedade das Indústrias Klabin do Paraná*. A localização geográfica é de 24°22'30" latitude sul e 50°37'30" longitude oeste. A topografia é levemente ondulada e o solo argiloso (Figura 1).

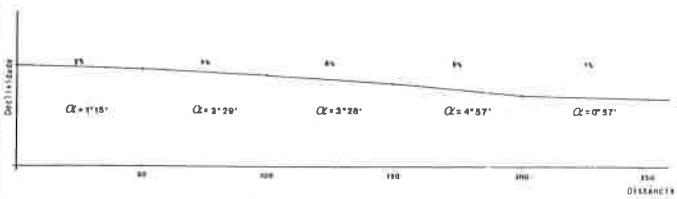


FIGURA 1 - DECLIVIDADE DO TERRENO NO SENTIDO DOS RAMAIS
(Inclination of the terrain in direction of hauling strips)

O povoamento tinha um espaçamento inicial de 2 x 2 m e foi desbastado, aos 9 anos de idade, sob a forma sistemática a cada 6ª linha e seletivo, tipo baixo, entre os ramais. Na intervenção foram retiradas 45,7% das árvores e 37,3%, da área basal, produzindo um volume de 108,0 m^3/ha.

Descrição dos meios de produção

Os tratores estudados foram do tipo "Massey Ferguson MF-265" de 61 HP. Um deles estava equipado com uma pinça hidráulica, com capacidade de levante para até 1,5 t e de tração até 3,0 t, e ainda uma lâmina dianteira de acionamento hidráulico. A outra máquina estava equipada com uma barra, montada no sistema hidráulico convencional e apresentando numerosas fendas onde são presas as correntes que seguram as toras e fustes.

O arraste com o conjunto trator/pinça requereu apenas o tratorista, enquanto que o trator com barra, além deste, exigiu dois operários para a formação e engate das cargas, em tempo integral e dois operários em tempo parcial para o desengate. Esses últimos, fizeram parte também da equipe de traçamento dos fustes na estrada. O esquema da sequência de trabalho está ilustrado na Figura 2.

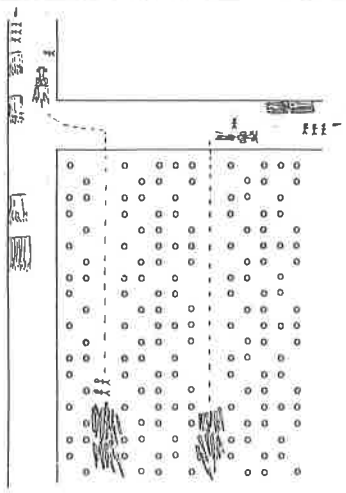


FIGURA 2 - ESQUEMA DA SEQÜÊNCIA DE TRABALHO
(Scheme of operation sequences)

Coleta de dados, processamento e análise estatística

Previamente foi feito um inventário do local da pesquisa, marcadas as distâncias, cubadas e numeradas as árvores abatidas. A equipe de coleta foi composta por um cronometrista, que também anotava as distâncias, e dois ajudantes que anotavam o número das toras ou fustes, previamente cubados na floresta.

Para a medição das atividades parciais, usou-se o método de cronometragem de multimomento com intervalo de 25/100 minutos. Paralelamente, procedeu-se também a cronometragem pelo método de tempo contínuo, para a medição dos ciclos, pois facilita-se a descoberta de erros e evita-se a perda de toda uma série de ciclos, caso aconteça um erro na cronometragem de um só ciclo (STOHR, 1974).

Usaram-se cronometros "HANHART" com divisão em centiminutos. A unidade de observação foi o ciclo, formado pelas atividades efetivas de carregamento, viagem com carga, descarga e viagem de retorno e, pelas atividades gerais de preparo, manutenção, descanso, perturbações técnicas e outros.

Cada ciclo foi considerado como uma unidade de uma amostra, podendo portanto ser analisado sem reserva pelos métodos estatístico-matemáticos correspondentes (TIMINGER, 1971).

Foram cronometrados 43 ciclos para o trator com barra e 54 ciclos para o trator de pinças, totalizando cerca de 1500 dados amostrados que foram processados em um computador tipo HP9830-A. Ciclos que apresentaram erros de cronometragem superiores a 5% foram eliminados das análises posteriores.

A análise estatística baseou-se nas análises de correlação e regressão. Devido à falta de informações prévias sobre as funções de regressão que melhor explicaria a variação da variável dependente, foram testadas as seguintes: a) Linear: $Y=b_o \pm b_i x_i$; b) $\ln y=b_o \pm b_i \ln x_i$. Para essas duas funções, foram testadas todas as combinações de variáveis independentes, de explicação lógica.

Resultados

Rendimentos

Na Tabela 1 encontram-se os rendimentos líquidos (só atividades efetivas) e brutos (incluídas as atividades gerais, porém excluídas as paradas

maiores) dos tratores com barra e com pinça hidráulica baseados numa regressão linear na qual participaram como variáveis independentes a distância de arraste e o volume por carga.

TABELA 1 - Quadro comparativo do tempo de trabalho e rendimento para determinadas distâncias de arraste e volumes de cargas.
(Comparison of working time and yield for differents distances and volumes)

Tipo de Trator	Distância média de arraste m	Volume médio unitário¹ m³	Volume médio da carga m³	Atividades efetivas: Tempo trab. min/m³	Atividades efetivas: Rendimento m³/h	Acrescimo devid. atividades gerais min/m³	Total atividades²/: Temp. trab. min/m³	Total atividades²/: Rendimento m³/h
C/barra e correntes	-	-	0,3	-	-	-	-	-
	100	0,05	0,5	6,10	9,84	1,32	7,42	8,09
		0,10	0,8	4,15	14,46	0,90	5,05	11,88
		0,20	1,3	-	-	-	-	-
	-	-	0,3	-	-	-	-	-
	200	0,05	0,5	9,15	6,56	1,99	11,14	5,39
		0,13	0,8	7,20	8,33	1,56	8,76	6,85
		0,20	1,3	3,96	15,15	0,86	4,82	12,45
	-	-	0,3	-	-	-	-	-
	300	0,05	0,5	12,20	4,92	2,65	14,85	4,04
		0,10	0,8	10,24	5,86	2,22	12,46	4,83
		0,20	1,3	7,00	8,57	1,52	8,52	7,04
C/pinça hidráulica	50	0,05	0,3	7,30	8,22	1,52	9,22	6,51
		0,10	0,5	3,97	15,11	1,04	5,01	11,98
		0,20	0,8	-	-	-	-	-
	-	-	1,3	-	-	-	-	-
	100	0,05	0,3	8,52	6,73	2,35	11,27	5,32
		0,10	0,5	5,59	10,73	1,47	7,06	8,50
		0,20	0,8	-	-	-	-	-
	-	-	1,3	-	-	-	-	-
	200	0,05	0,3	12,15	4,94	3,20	15,35	3,91
		0,10	0,5	8,82	6,80	2,32	11,14	5,39
		0,20	0,8	3,83	15,67	1,01	4,84	12,40
	-	-	1,3	-	-	-	-	-
	300	0,05	0,3	15,38	3,90	4,04	19,42	3,09
		0,10	0,5	12,05	4,98	3,17	15,22	3,94
		0,20	0,8	7,66	8,50	1,86	8,52	6,73
	-	-	1,3	-	-	-	-	-

1/ Nas atividades gerais estão incluídas: perturbação técnica (que não aconteceu), manutenção, abastecimento e consertos menores, deslocamento do trator até o local de trabalho e volta à sede.
2/ Tempo de trabalho/m³ e rendimento correspondente a hora de uso ou atividade de máquina, estão portanto excluídos os tempos de parada devido a horas perdidas, consertos e esperas por deficiências no planificação, chuvas e outros motivos.

Esses resultados demonstraram que, para igual distância e igual volume da carga, o trator com pinça consegue rendimentos maiores. Esta aparente superioridade deve-se principalmente ao menor tempo de carregamento e à ausência da atividade de descarregamento, feito em movimento apenas com a abertura da pinça. No entanto, os volumes médios arrastados pelos tratores, foi na realidade, diferente (trator com barra: 0,8 m^3/viagem; trator com pinça: 0,5 m^3/viagem).

O motivo desta diferença, se deve à reduzida capacidade de carga da pinça e aos comprimentos, relativamente pequenos, das toras e fustes.

Assim, o trator com pinça apresentou nos testes, rendimentos inferiores ao trator com barra. Numa distância média de arraste de 200 m e um volume unitário de 0,10 m^3 o trator com pinça atingiu 5,39 m^3/h e o trator com barra 6,85 m^3/h. Pode-se constatar também que o rendimento de ambos os tratores poderá ser incrementado sensivelmente ao aumentar o volume unitário das toras ou fustes. Isto pode-se atingir num mesmo povoamento através do aumento do comprimento das toras, ou seja evitando o traçamento de fustes antes do arraste mecanizado. Desta forma, aumentar-se-ía o volume unitário que é um dos fatores de maior influência na produtividade técnica, tanto da mão de obra como das máquinas.

Custos

Para se determinar os custos de produção foram calculados os custos por hora de uso (hu) dos tratores e de seus acessórios, como também da mão de obra que participa de cada método de arraste. Os cálculos foram baseados no esquema modificado da FAO/ECE/KWF (STOHR, 1977). Os custos totais*, incluindo um acréscimo devido aos custos administrativos e pessoal de supervisão chegam a Cr$ 416,52/hu para o trator com barra e Cr$ 442,50/hu para o trator com pinça. A pequena diferença de 6,2% deve-se ao fato de que os custos dos ajudantes (2 em tempo integral e 2 em tempo parcial), no caso do trator com barra, quase compensam o custo horário do conjunto pinça e lâmina. Os custos de arraste, variaram para cargas de 0,5 m^3, desde Cr$ 52,00, para distâncias de arraste de 100m, até aproximadamente Cr$ 103,00 a 112,00 para distâncias de arraste de 300 m. Considerando uma distância média de arraste de 200 m e um volume unitário de 0,10 m^3, o método de arraste pelo trator com barra (0,8 m^3/carga) custa Cr$ 60,80/m^3 e com o trator de pinça (0,5 m^3/carga) o custo chega a Cr$ 82,10/m^3, ou seja 35% mais caro (Figura 3).

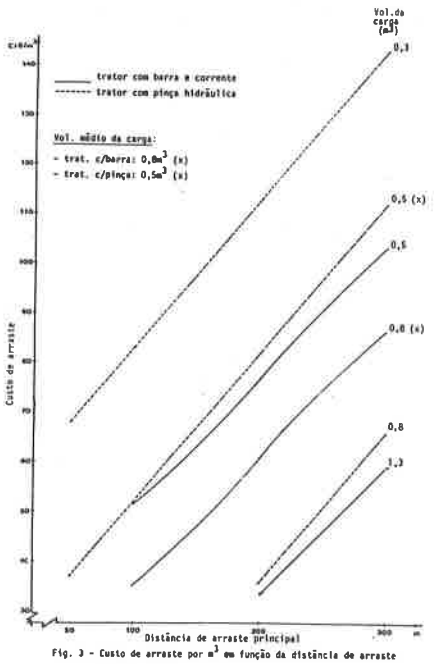


Fig. 3 - Custo de arraste por m^3 em função da distância de arraste e o volume da carga
(Skidding cost as a function of distance and volume)

Avaliação técnica

Analisando devidamente o volume das cargas arrastadas pode-se observar que os dois tratores não aproveitaram bem suas capacidades de carga. Tendo em consideração a capacidade de abertura da pinça (0,40 m^2) e evitando cargas inferiores a 0,5 m^3, poder-se-á atingir facilmente 0,7 m^3/carga, como média, aumentando sensivelmente o rendimento e reduzindo os custos de arraste em 24%. Embora a situação no trator com barra não seja tão acentuada no sentido da carga mínima (0,256 m^3), a amplitude é excessivamente grande (carga máxima 2,230 m^3). Isto demonstra que a capacidade não foi bem aproveitada podendo ser aumentada a carga média, sob condições similares, até 1,3 m^3, o que vem a corresponder a aproximadamente 50% da capacidade de arraste máximo. Assim, o custo de arraste poderá, segundo um modelo de simulação, ser reduzido em 27%.

Ao analisar as atividades gerais (deslocamento, preparo, perturbação técnica, descanso, manutenção e abastecimento) e as paradas (esperas, chuvas, horas perdidas, consertos), constatou-se que as atividades gerais diárias e semanais são idênticas, com os tratores, requerendo ambos, aproximadamente, 1h/dia. Porém, os tempos de parada das máquinas diferem drasticamente, sendo que as horas perdidas (espera por consertos e outros) e as paradas por consertos do trator de pinças superam em 51% o tempo requerido para tais fins, pelo trator com barra.

* Os cálculos de custos têm por base o mês de março de 1980 - US$ = Cr$ 48,00.

Considerando todas as paradas computadas durante um semestre, restaram para o trator com barra, 1700 hu/a de tempo de trabalho (atividades efetivas e atividades gerais), ou seja 5,66 hu/dia, e para o trator com pinça 1400 hu/a, ou seja 4,66 hu/dia. Portanto, a produção anual estimada é, sob as condições estudadas, de aproximadamente 11.500 m^3/ano para o trator com barra e 7.500 m^3/ano para o trator com pinça.

Conclusões

Menores tempos de trabalho por ciclo foram obtidos pelo trator com pinça, porém, o trator com barra arrastou em média 65% mais volume por ciclo, ocasionando rendimento médio superior. Os custos/hora trabalhada da máquina e pessoal foram 6,2% mais baixos para o trator com barra e os custos/m^3 arrastado, aproximadamente 26% mais baixos, para o mesmo equipamento.

O melhor aproveitamento na capacidade de carga poderá reduzir os custos em cerca de 27% para o trator com barra e 24% no trator com pinça.

Com base nos resultados obtidos no presente trabalho, recomenda-se a utilização de tratores agrícolas equipados com barra e correntes, para esse tipo de arraste, quando houver disponibilidade de mão de obra, pois o custo é compensador e a produtividade anual 35% superior.

Literatura Citada

BAGGIO, A.J. & STOHR, G.W.D., 1978: Resultados preliminares de um levantamento dos sistemas de exploração usados em florestas implantadas de coníferas no sul do Brasil. FLORESTA, vol. 2, nº 9, pp. 76-96.

CARLESTAL, B.; FOGEBY, J., 1977: Jordbruks traktor med linkran igallring. Ekonomi Forsningsstiftelsen Skogsarbetar, nº 3, 4 pp.

MACKINTOSH, J., 1975: Looking for profit in production thinning. Forest Industries Review, vol. 6, nº 12, pp. 25-26.

SCHAAFSMA. A.H., 1977: The use of the HSM winch in thinnings. Nederlands Bosbow Tijddschrift, vol. 49, nº 3, pp. 138-143.

STOHR, G.W.D., 1974: Untersuchungen über die Eignung mobiler kurzstrecken seilkrane bei Durchforstungen am Steilhang. Diss. Universität München, R.F.A., 232 pp.

STOHR, G.W.D., 1977: Cálculo de custos de máquinas florestais. FLORESTA, vol. 8, nº 2, pp. 23-30.

TIMINGER, V., 1971: Arbeitsuntersuchungen bei der Seilbringung in Nadelholzhieben oberbayerischer Gebirgsförstamter. Diss. Universität Munchen, R.F.A. 156 pp.

FAST GROWING TREES

COMPORTAMENTO DO *Pinus caribaea* VAR. *hondurensis* BARR. ET GOLF. AOS 16 ANOS EM DIFERENTES ESPAÇAMENTOS SEM DESBASTES

D.V. Toledo Filho – C.L. da S. Pires
Instituto Florestal
BRASIL

Resumo

Foi instalado um ensaio com Pinus caribaea var. hondurensis Bar. et Golf. em diversos espaçamentos retangulares na região de Moji-Mirim - SP. Após 16 anos de observações sem ter sofrido desbaste, é mostrada a influência do espaçamento no desenvolvimento da altura, DAP, área basal e sobrevivência.

Summary

It was carried out a research on Pinus caribaea var. hondurensis Bar. et Golf. under several spacings in Moji-Mirim, São Paulo State, Brasil. After 16 years in the unmanaged stand it is showed the influence of the spacing on the development of heigh DBH, basal area and survival.

I n t r o d u ç ã o

Dependendo de vários fatores, tais como, a espécie, a finalidade da madeira, o valor comercial do primeiro desbaste, a mecanização e exploração, é adotado o compasso inicial de um povoamento florestal.

Sabe-se atualmente, baseado em inúmeras pesquisas, que o melhor espaçamento para os reflorestamentos do Brasil, é aquele que varia de 4 a 6 m2/planta.

Após a implantação de um povoamento florestal, ele irá se desenvolver até explorar completamente os fatores limitantes, tais como água, luz e nutrientes daquele local. Nesta fase as taxas anuais de acréscimos tornam-Se muito baixas, quando então é recomendado ao talhão, um corte raso ou um tratamento de desbaste.

Em trabalho sobre manejo do Pinus caribaea var. hondurensis, FERNANDES (1967) apresenta dados de um desbaste realizado na Estação Experimental de Tupi - SP.

VEIGA, (1972), chama de "site index". a área basal que um povoamento atinge em dadas condições, havendo um "site" fixo para cada espécie vegetal em determinadas condições edafo-climáticas. Segundo o autor, o "site" não varia com o espaçamento, mas somente com a idade, entrando o povoamento em estagnação, em idades diferentes conforme o espaçamento adotado, mas sempre com uma mesma área basal, se o "site" for o mesmo.

O objetivo deste trabalho é mostrar as diferenças ocasionadas pela influência do espaçamento no desenvolvimento da espécie em estudo, mesmo depois de ter passado da época ideal de corte ou do primeiro desbaste.

M a t e r i a l e M é t o d o s

A espécie estudada foi o Pinus caribaea var. hondurensis Bar. et Golf. As mudas foram preparadas em torrão paulista, levadas para o campo com uma altura média de 20cm, em dezembro de 1963.

No local do estudo, havia primitivamente uma vegetação de cerrado, apresentando a seguinte localização e condições de clima e solo, segundo VEIGA (1975), apresentados na TABELA 1.

TABELA 1 - Dados de localização, clima e solo e local.

Local	Lat. S	Long. W	Alt. m	Precip. mm	Temp. média 9C	Clima	Solo	Def. Hidr. mm.
Moji-Mirim	22926'	46957'	631	1.355	20,3	Cwa	LVa	19

O delineamento estatístico foi o de blocos ao acaso, com 8 tratamentos e 5 repetições, utilizando parcelas de tamanho fixo de 17m x 17m, seguindo o seguinte esquema, conforme TABELA 2.

TABELA 2 - Relação dos tratamentos com a área individual por plantas.

Tratamento	Espaçamento	Área individual
1	1,0 x 2,0m	2,0 m^2
2	1,0 x 2,5m	2,5 m^2
3	1,0 x 3,0m	3,0 m^2
4	1,5 x 2,0m	3,0 m^2
5	2,0 x 2,0m	4,0 m^2
6	1,5 x 3,0m	4,5 m^2
7	2,0 x 2,5m	5,0 m^2
8	2,0 x 3,0m	6,0 m^2

Os dados de altura foram coletados através do relascópio das 20 plantas centrais da parcela e os de DAP com a suta sobre as mesmas plantas.

A área basal foi calculada a partir daquelas 20 plantas, depois de calculadas as respectivas áreas basais individuais, achada a área basal da parcela e depois extrapolada para a área de 1 ha.

Resultados e Discussão

Os valores médios obtidos aos 16 anos dos parâmetros analisados, são mostrados na TABELA 3.

TABELA 3 - Dados de altura, DAP, Área basal e Sobrevivência.

Espaçamento	Altura m	DAP cm	Área basal m^2/ha	Sobrevivência
1,0 x 2,0	18,90	15,72	72,30	75,0%
1,0 x 2,5	20,80	16,38	76,16	88,0%
1,0 x 3,0	20,68	16,90	64,42	81,0%
1,5 x 2,0	20,32	17,32	73,94	89,0%
2,0 x 2,0	21,42	19,22	70,10	92,0%
1,5 x 3,0	20,92	19,52	63,20	90,0%
2,0 x 2,5	21,94	20,08	59,50	90,0%
2,0 x 3,0	22,46	21,14	55,18	91,0%

Em virtude da ocorrência de certa porcentagem de mortalidade o espaçamento atual não correspondente ao inicial, devendo haver certa correção.

Houve variação altamente significativa entre os tratamentos para o DAP, altura e área basal, até o momento.

Os seguintes tratamentos se diferenciam pelo Teste de Tukey a nível de 5%.

DAP: 1, 2, 3, 4 ≠ 6, 7, 8
1, 2, 3 ≠ 5
5

Área basal: 1, 2, 4, 5 ≠ 8
2 ≠ 7

Altura: 1 ≠ 5, 7, 8

Houve influência dos tratamentos de sobrevivência, evidenciando que quanto mais exíguo o espaçamento, maior a porcentagem de falhas, depois que o talhão atingiu o ponto de estagnação.

Considerando os dados médios dos parâmetros analisados, constatou-se que todos os espaçamentos estão estagnados há muitos anos, não havendo mais aumento da sua área basal. O lento aumento do diâmetro, é conseguido em virtude do número de pinheiros que vão morrendo.

Conclusões

Houve influência dos diferentes espaçamentos no desenvolvimento do DAP, da altura e da área basal, até o momento.

A sobrevivência também foi influenciada pelos tratamentos demonstrando que quanto mais exíguo o espaçamento, maior o número de falhas, depois que o talhão atingiu o ponto de estagnação.

Constatou-se que todos os tratamentos estão estagnados há muitos anos, havendo uma tendência, a longo prazo, dos espaçamentos mais abertos, diminuiram a diferença dos espaçamentos mais apertados.

Literatura citada

FERNANDES, P.S. 1967. Manejo do Pinus caribaea var. hondurensis. Silvicultura em São Paulo, 6:203-208.

VEIGA, A.A. 1975. Balanços hídricos das dependências da Divisão de Florestas e Estações Experimentais. São Paulo - Instituto Florestal. Apostila 31p.

VEIGA, A.A. 1976. Curso de Atualização Florestal. Vol. 1, 3a. Ed. Public. 8 - I.F. São Paulo.

FAST GROWING TREES

FATOR DE EMPILHAMENTO – IMPLICAÇÕES TÉCNICAS NA MEDIÇÃO DA MADEIRA EMPILHADA

M.C. Torquato
Cia. Agrícola e Florestal Santa Bárbara
BRASIL

Resumo

O presente trabalho demonstra um erro comum em inventário florestal relacionado com a unidade estere na medição de volume de madeira.

O estere é definido como sendo a quantidade de madeira que pode ser empilhada ordenadamente dentro do espaço de um metro cúbico.

Todavia, a razão entre o volume de madeira empilhada e o volume sólido de tal madeira, chamada Fator de Empilhamento, é função das dimensões das toras e também da maneira pela qual elas foram empilhadas.

Na avaliação do comportamento de diferentes espécies, "sites", ou manejo, a utilização do estere como unidade de volume de madeira pode conduzir a conclusões errôneas.

Summary

This study demonstrates a commonly commited mistake in forestry handling, when one states the volume of wood in steres.

The stere is defined as the quantity of wood that can be orderly stacked within an space delimitated by one cubic meter.

However, the ratio of the volume of the stacked wood and the solid volume of such wood, called Stacking Factor, is the function of the dimensions of the logs and the form of stacking them.

In the evaluation of the differente species, sites or handling, the utilization of the stere as a volume unit can lead to wron conclusions.

1 - INTRODUÇÃO

A unidade de medir volume de uso obrigatório no Brasil, é o metro cúbico (símbolo: m^3). O metro cúbico é a unidade de volume correspondente a um cubo, cuja aresta tem o comprimento de um metro.

Entretanto, quando o material existente em um cubo de um metro de aresta é heterogêneo, por exemplo, toras de madeira empilhadas, o metro cúbico compreende o volume de material sólido (madeira) e os vazios existentes entre as toras. Neste caso a unidade de volume é representada pelo metro cúbico estere (símbolo:st).

O estere é definido como a quantidade de madeira que se pode ordenar em um espaço delimitado por um metro cúbico. Entretanto, na realidade dependendo da utilização e do meio de transporte, as árvores são desdobradas em toras maiores ou menores que um metro, e o estere toma diferentes formas; e a arrumação das pilhas sofre influência do método de empilhamento. Estes dois fatores, ou sejam, o comprimento das toras e a arrumação destas toras na pilha afetam a quantidade de material sólido existente por unidade de volume empilhado.

Neste trabalho pretende-se informar a ordem de grandeza das relações existentes entre o volume de madeira desdobrada em toras de diversos tamanhos e empilhadas, e o volume sólido desta madeira, demonstrando um erro comumente cometido em manejo florestal, quando expressa-se o volume de madeira em esteres.

2 - MATERIAL E MÉTODOS

A relação entre o volume de madeira desdobrada em toras e empilhada e o volume sólido desta madeira, é denominada de fator de empilhamento (símbolo: Fe).

$$Fe = \frac{\text{Volume de Madeira Empilhada - st}}{\text{Volume sólido de Madeira - } m^3}$$

O fator de empilhamento é, portanto, a quantidade de esteres que um metro cúbico de madeira pode produzir, enquanto a sua recíproca ou 1/Fe, é a expressão da percentagem de material sólido que um estere de madeira contém.

Para determinar quantos esteres um metro cúbico de madeira produz, em função do comprimento das toras, foram cubados rigorosamente as árvores de 24 parcelas demarcadas em plantações de Eucalyptus spp, variando de 05 a 07 anos de idade. A cubagem rigorosa foi feita segundo o método de Smaliam, medindo-se a circunferência de metro em metro. As árvores foram desdobradas em toras de 1,30 m, 1,80 m e 2,20 m, e empilhadas. O empilhamento foi feito manualmente, procurando-se arrumar as pilhas o melhor possível.

Em seguida, procurou-se observar a variação que ocorre no volume de madeira empilhada em cima de caminhões, quando o carregamento é feito mecanicamente.

Para isto foram separados, aleatoriamente, oito caminhões que vinham com madeira desdobrada em toras de 2,20 m, de uma plantação de Eucalyptus grandis de 05 anos de idade, para o depósito de secagem, e oito caminhões que transportavam esta madeira do depósito de secagem para o forno de carvão. Portanto, nos primeiros oito caminhões, a madeira foi empilhada mecanicamente uma vez, e nos outros oito caminhões, a madeira foi empilhada mecanicamente duas vezes.

O volume empilhado de cada caminhão foi medido e em seguida as toras foram cubadas rigorosamente.

3 - RESULTADOS E DISCUSSÃO

A quantidade de esteres que um metro cúbico de madeira pode produzir, ou seja, o fator de empilhamento, é função do comprimento das toras desta madeira (quadro nº 1).

Apesar de ter sido considerado somente três comprimentos diferentes, observou-se que quanto menor o comprimento das toras, menor é o fator de empilhamento. Obviamente, este fato é valido para o intervalo de 1,30 a 2,20 metros de comprimento.

O fator de empilhamento foi calculado pela média dos dados observados para cada comprimento de tora estudado.

COMPRIMENTO DAS TORAS (m)	FATOR DE EMPILHAMENTO (MÉDIA)	ERRO PADRÃO	ERRO PADRÃO%	LIM.CONF. 95% PROB.		DESVIO PADRÃO	COEF. DE VARIAÇÃO %
				SUPERIOR	INFERIOR		
1,30	1,43	0,04	6,40	1,52	1,34	0,11	7,65
1,80	1,54	0,03	4,22	1,61	1,47	0,08	5,04
2,20	1,64	0,03	4,57	1,71	1,57	0,09	5,46

Entretanto, constatou-se uma grande variação dos dados em torno da média. Este fato demonstra que o fator de empilhamento é influenciado por outras variáveis, como por exemplo, a habilidade do trabalhador em empilhar a madeira.

O fator de empilhamento é, também, influenciado pelo método de empilhamento, sendo maior quando a madeira é empilhada mecanicamente (quadro nº 2).

O fato mais interessante observado, foi que quando uma pilha de madeira empilhada mecanicamente, é reempilhada mecanicamente, o fator de empilhamento aumenta (quadro nº 3). E neste caso a variação dos dados em torno da média é maior.

METODO DE EMPILHAMENTO	COMPRIMENTO DAS TORAS	FATOR DE EMPILHAMENTO (MÉDIA)	ERRO PADRÃO	ERRO PADRÃO %	UNID.CONF. 95%PROB.		DESVIO PADRÃO	COEF.DE VARIAÇÃO %
					SUPERIOR	INFERIOR		
EMPILHAMENTO MANUAL	2,20	1,64	0,03	4,57	1,71	1,57	0,11	7,65
EMPILHAMENTO MECÂNICO	2,20	1,77	0,04	4,80	1,86	1,68	0,10	5,74
REEMPILHAMENTO MECÂNICO	2,20	1,88	0,05	6,76	2,00	1,76	0,15	8,08

4 - CONCLUSÕES

O fator de empilhamentc e o fator de cubicação variam com o comprimento das toras que compõem a pilha de madeira e com o método de empilhamento.

QUADRO Nº 1: DADOS OBTIDOS PARA DETERMINAÇÃO DO FATOR DE EMPILHAMENTO, PARA TORAS DE DIVERSOS COMPRIMENTOS, EMPILHADAS MANUALMENTE.

COMPRIMENTO DAS TORAS	PARCELA Nº	Nº DE ÁRVORES CUBADAS	DIÂMETRO MÉDIO cm	ALTURA MÉDIA (COMERCIAL) m	VOLUME SÓLIDO m^3	VOLUME EMPILHADO st	FATOR DE EMPILHAMENTO	FATOR DE CUBICAÇÃO
1,30 m	1	69	11,7	13,4	6,598	10,30	1,56	0,64
	2	93	10,9	11,7	6,083	9,67	1,59	0,63
	3	87	10,6	12,9	6,345	8,35	1,32	0,76
	4	75	11,6	12,1	6,112	8,37	1,37	0,73
	5	69	10,2	12,5	4,740	6,52	1,38	0,72
	6	75	12,7	14,9	8,202	10,93	1,33	0,75
	7	49	13,1	12,5	6,097	8,26	1,35	0,74
	8	74	10,3	10,3	5,083	7,67	1,51	0,66
	MÉDIA	74	11,4	12,5	6,157	8,76	1,43	0,70
1,80 m	1	48	12,7	17,1	5,334	8,55	1,60	0,62
	2	75	11,6	12,5	5,690	8,89	1,56	0,64
	3	70	10,5	11,7	5,508	7,75	1,41	0,71
	4	87	10,2	11,9	6,301	9,42	1,50	0,67
	5	77	10,9	13,2	6,683	9,80	1,47	0,68
	6	75	10,9	10,7	6,132	10,04	1,64	0,61
	7	72	11,0	12,2	5,548	8,94	1,61	0,62
	8	68	12,4	14,2	7,695	11,90	1,55	0,65
	MÉDIA	72	11,3	12,9	6,111	9,41	1,54	0,65
2,20 m	1	44	10,4	10,5	2,319	4,20	1,81	0,55
	2	38	11,9	10,2	2,379	4,00	1,68	0,60
	3	38	10,6	8,6	2,232	3,50	1,57	0,64
	4	37	12,3	12,7	3,305	5,00	1,51	0,66
	5	47	11,1	11,3	3,314	5,30	1,60	0,63
	6	33	11,6	9,7	2,201	3,60	1,64	0,61
	7	41	10,8	10,0	2,367	4,00	1,69	0,59
	8	35	13,0	11,6	3,036	5,00	1,65	0,61
	MÉDIA	39	11,5	10,6	2,644	4,33	1,64	0,61

QUADRO Nº 2: DADOS OBTIDOS PARA DETERMINAÇÃO DO FATOR DE EMPILHAMENTO PARA TORAS DE 2,20 m DE COMPRIMENTO, EMPILHADAS MECANICAMENTE.

CAMINHÕES	Nº DE TORAS	DIÂMETRO MÉDIO DAS TORAS cm	VOLUME EMPILHADO EM CIMA DO CAMINHÃO - st	VOLUME SÓLIDO m^3	FATOR DE EMPILHAMENTO	FATOR DE CUBICAÇÃO
1	553	11,8	18,63	11,521	1,62	0,62
2	628	11,0	21,06	12,261	1,72	0,58
3	640	11,2	21,96	13,116	1,67	0,60
4	632	11,0	23,44	13,056	1,80	0,56
5	586	11,1	22,49	12.228	1,84	0,54
6	444	11,6	20,31	10,459	1,94	0,52
7	513	11,9	21,59	11,856	1,82	0,55
8	549	11,7	22,39	12,446	1,80	0,56
MÉDIA	568	11,4	21,48	12,118	1,77	0,56

QUADRO Nº 3: DADOS OBTIDOS PARA DETERMINAÇÃO DO FATOR DE EMPILHAMENTO, PARA TORAS DE 2,20 m DE COMPRIMENTO, REEMPILHADAS MECANICAMENTE

CAMINHÕES	Nº DE TORAS	DIÂMETRO MÉDIO DAS TORAS cm	VOLUME EMPILHADO EM CIMA DO CAMINHÃO - st	VOLUME SÓLIDO m^3	FATOR DE EMPILHAMENTO	FATOR DE CUBICAÇÃO
1	348	11,8	14,83	8,160	1,82	0,55
2	394	11,0	17,31	8,221	2,11	0,47
3	517	9,4	14,06	7,421	1,90	0,53
4	452	10,5	13,24	7,782	1,70	0,59
5	379	11,6	13,69	7,640	1,79	0,56
6	438	10,7	13,56	7,772	1,74	0,57
7	595	9,0	15,41	8,074	1,91	0,52
8	564	9,2	15,31	7,328	2,09	0,48
MÉDIA	460	10,4	14,68	7,800	1,88	0,53

Quanto menor o comprimento das toras, menor é o fator de empilhamento e maior é o fator de cubicação. Este fato é válido para toras com comprimento entre 2,20 e 1,30 m.

A madeira empilhada manualmente, tem menor fator de empilhamento e maior fator de cubicação do que a madeira empilhada mecanicamente.

O fator de empilhamento aumenta e o fator de cubicação diminui quando se faz o reempilhamento mecânico de uma pilha de madeira.

Nas 40 pilhas estudadas, verificou-se que um estere de madeira pode conter entre 48% e 76% de material sólido. Portanto, as informações de produção volumétrica de uma floresta ou mesmo de uma área experimental, devem ser apresentadas, fundamentalmente, em metros cúbicos sólidos.

É lógico que é necessário conhecer o espaço que a madeira de uma floresta comercial, ou de uma área experimental ocupará, quando desdobrada e empilhada, para dimensionamento das áreas de estocagem, de transporte e da própria indústria. Entretanto, a utilização do volume de madeira em esteres para analisar os resultados obtidos, e compará-los entre diferentes espécies, locais ou tratamentos, é imprecisa e acarreta erros grosseiros, levando o manejador florestal a tomar decisões indevidas.

5 - REFERÊNCIAS BIBIOGRÁFICAS

1.- HEINS DIJK, DAMMIS et alii - PLANTAÇÕES DE EUCALIPTOS NO BRASIL - Boletim nº 10, Ministério da Agricultura, Departamento de Recursos Naturais Renováveis, 20-22, 1965.

2 - TORQUATO, MARCIO CAMPOS - DETERMINAÇÃO DO FATOR DE EMPILHAMENTO - Belo Horizonte, 1-5, 1977.

FAST GROWING TREES

EFEITOS DE ALGUNS DEFENSIVOS NO DESENVOLVIMENTO DE MUDAS DE *Pinus elliottii* ENGELM. VAR. *elliottii* E *Pinus caribaea* MORELET VAR. *hondurensis* BARRET E GOLFARI

N. K. S. Yokomizo — E.S.F. Mucci
Instituto Florestal
BRASIL

Resumo

Os efeitos da aplicação de benomyl, aldrin e orizalina sobre o crescimento de mudas de Pinus caribaea Morelet var. hondurensis Barret e Golfari e P. elliottii Engelm var. elliottii foram avaliados através da determinação, em centímetros, da altura das plantas e do desenvolvimento das raízes, após 130 dias de plantio.

Observou-se o efeito tóxico de orizalina a dosagem de 0,23 g/m^2, em mudas de ambas as espécies, e de benomyl, na dosagem de 5 g/m^2, em P. elliottii.

Summary

The effects of benomyl, aldrin and orizalyn on Pinus elliottii Engelm var. elliottii and Pinus caribaea Morelet var. hondurensis Barret e Golfari were evaluated measuring the total height and the lenght of roots of seedlings 130 days old.

It was noticed the toxicant effects of orizalyn at 0,23 g/m^2 rate in seedlings of both species and benomyl at 5 g/m^2 rate in Pinus elliottii.

I n t r o d u ç ã o

O emprêgo de defensivos na produção de mudas vem adquirindo um caráter obrigatório quando se deseja uma produção em larga escala, de mudas em perfeitas condições fitossanitárias para uma boa performance em campo.

No entanto, a toxicidade dos defensivos não se limita unicamente ao agente causal da moléstia, da praga, etc. Ela se estende a outros organismos, causando desequilíbrio no ecossistema, cujas consequências podem ser danosas à finalidade da cultura da qual se deseja produção.

ROWAN (1978), constatou a toxicidade do herbicida trifluralina em mudas de P. taeda inibindo o crescimento da raiz.

ILOBA (1977) determinou a sensibilidade "in vitro" dos fungos micorrízicos Amanita citrina, Tricholoma pessundatum e T. saponaceum na presença de trifluralina a 10 ppm. O autor questiona a utilização de herbicidas em viveiros, pois considera que a maioria deles desorganiza a atividade da rizosphera e sua população microbiana, entre eles, os fungos micorrízicos.

BAKSHI & DOBRIYAL (1970) observaram que mudas de Pinus patula, quando tratados com fungicidas para combate aos fungos do "damping-off", apresentava um retardamento do desenvolvimento micorrízico em relação àquelas não tratadas. As micorrizas eventualmente ocorriam quando as raízes penetravam zonas não atingidas pelos fungicidas, ou quando a toxicidade se perdia com o decorrer do tempo.

Tendo em vista tais aspectos, programou-se um ensaio para avaliação do efeito de benomyl, aldrin e orizalina em mudas de Pinus elliottii var. elliottii e Pinus caribaea var. hondurensis. Nesta etapa, estão sendo apresentados resultados relativos ao desenvolvimento das mudas; posteriormente serão avaliados os efeitos sobre a associação micorrízica.

M a t e r i a l e M é t o d o

O ensaio foi realizado em canteiros com mudas de Pinus elliottii Engelm var. elliottii e Pinus caribaea Morelet var. hondurensis Barret e Golfari, acondicionadas individualmente em sacos plásticos, utilizando-se os defensivos (a) benomyl 1(butilcarbamoil)2, benzimidazol metilcarbamato na dosagem de 5 g/m^2 ; (b) aldrin 1,2,4,4,10,10-hexacloro-1,4,4a,5,8,8a-hexahidro-1,4,endo-exo 3,8,-dimetanonaftaleno na dosagem de 0,24 g/m^2 e (c) orizalina 3,5-dinitro-N^4,N^4-dipropisulfanilamida na dosagem de 0,23 g/m^2.

Benomyl e aldrin foram aplicados quinzenalmente durante o período do experimento e orizalina, apenas durante a semeadura.

O delineamento estatístico foi de blocos casualmente distribuídos com quatro repetições, sendo os tratamentos assim constituídos:

- Pinus elliottii + benomyl
- Pinus elliottii + aldrin
- Pinus elliottii + orizalina
- Pinus caribaea var. caribaea + benomyl
- Pinus caribaea var. caribaea + aldrin
- Pinus caribaea var. caribaea + orizalina
- Pinus elliottii
- Pinus caribaea var. caribaea

A avaliação foi realizada 130 dias após a semeadura, tomando-se como parâmetro o comprimento linear, em centímetros, de toda a muda da raiz e da copa.

R e s u l t a d o s

Os resultados obtidos constam no QUADRO 1.

QUADRO 1 - Média* de crescimento de Pinus elliottii Engelm var. elliottii e Pinus caribaea Morelet var. hondurensis Barret e Golfari após 130 dias de desenvolvimento em presença de benomyl, aldrin e orizalina.

Tratamentos	comp. raiz (cm)	altura copa (cm)	altura total (cm)
P.elliottii + benomyl	18,169 bc	9,501 abc	27,670 bc
P.elliottii + aldrin	16,480 bc	9,664 ab	26,144 bc
P.elliottii + orizalina	5,553 d	7,308 c	12,861 e
P.caribaea var. hondurensis + benomyl	23,084 ab	10,891 a	33,975 ab
P.caribaea var. hondurensis + aldrin	25,823 a	10,861 a	36,684 a
P.caribaea var. hondurensis + orizalina	11,494 cd	8,684 bc	20,178 ce
P.elliottii	15,997 bc	9,659 ab	25,656 bc
P.caribaea var. hondurensis	26,436 a	10,548 ab	36,984 a
	CV = 17,518%	CV= 9,036%	CV= 12,950%

* Médias seguidas pela mesma letra não diferem entre si (Tukey 5%)

Existe efeito de orizalina no desenvolvimento radicular e da copa de ambas as espécies de Pinus.

No desenvolvimento da copa P. elliottii mostrou sensibilidade a orizalina e benomyl.

D i s c u s s ã o

Os resultados obtidos confirmam a existência de efeitos de defensivos no desenvolvimento de mudas. Orizalina apresentou efeito tóxico, notadamente no desenvolvimento radicular das mudas, que em muitos exemplares nem chegava a se formar, de maneira similar àquela encontrada por ROWAN (1978) em Pinus taeda na presença de trifluralina.

Quanto ao desenvolvimento da copa, houve diferença na sensibilidade entre as espécies de Pinus testadas. Pinus caribaea var. hondurensis mostrou maior tolerância que P. elliottii tanto para orizalina, como para benomyl nas dosagens testadas.

Quanto a presença de micorrizas, esta estava diretamente relacionada com a quantidade de raízes, não sendo observada quando em presença de orizalina, ficando confirmada assim a hipótese de ILOBA (1977) no que concerne à utilização de herbicidas em viveiros. Neste aspecto ecológico, é possível que os defensivos tenham atuação sobre determinados grupos de microorganismos, onde seria interessante avaliar a susceptibilidade dos fungos micorrízicos , pois conforme MIKOLA (1973), eles são importantes para o desenvolvimento das mudas.

C o n c l u s ã o

Comprovou-se que durante a fase de viveiro, existem efeitos de orizalina e benomyl no desenvolvimento de Pinus elliottii var. elliottii e de orizalina em P. caribaea var. hondurensis.

Esta diferença interespecífica pode existir para outros compostos químicos utilizados como defensivos, indicando a necessidade de mais pesquisas neste sentido.

L i t e r a t u r a C i t a d a

BAKSHI, B.K. & DOBRIYAL, N.D. 1970. Effect of fungicides to control damping-off on development of mycorrhiza. Indian Forester 96 (9): 701-703.

ILOBA, C. 1977. The effect of trifluralin on the formation of ectotrophic mycorrhizae in some pine species. I. Toxicity to mycorrhiza forming fungi. Eur. J. For. Path., 7: 47-51.

MIKOLA, P. 1973. Application of mycorrhizal symbiosis in forestry practice. In: MARKS, G.C. Ectomycorrhizae; their ecology and physiology. Academic Press 444p. cap 10, 383-406.

ROWAN, S.J. 1978. Treflan injury of loblolly pine seedlings. Tree Planters' Notes, USA, 29(3): 25-26.

sessão III
session III
grupo A
group A

O COMPORTAMENTO E POTENCIAL DE ARAUCARIA E *Agathis* NA MALASIA PENINSULAR

Johari bin Baharudin
Forest Research Institute, Kepong, Selangor
MALAYSIA

Resumo

Uma avaliação preliminar dos resultados de algumas parcelas de espécies de *Araucaria* e *Agathis* implantadas na Malasia Peninsular, mostraram que seu crescimento varia com o clima e condições de sítio. O melhor crescimento para as espécies de *Araucaria* foi encontrado nas parcelas implantadas nas maiores altitudes. *Araucaria cunninghamii* saiu-se melhor em sítios que são mais secos. Todavia, secas severas causariam alta mortalidade durante a fase de implantação. Nas fases iniciais *A. cunninghamii* apresenta um comportamento levemente superior em crescimento em altura, mas a *Araucaria hunsteinii* parece ser mais saudável. O crescimento posterior das duas espécies parece ser igualmente bom. *Agathis borneensis* demonstrou ter um crescimento mais lento que as duas Araucarias em todos os estágios de desenvolvimento. *A. cunninghamii* também demonstrou ser mais suscetível ao ataque de cupins do que a *A. hunsteinii* e *A. borneensis*. O ataque foi primário e ocorreu em todas as fases do desenvolvimento.

Em geral as duas espécies de Araucarias, e em particular a *A. hunsteinii*, mostraram ser altamente promissoras para plantações na Malasia Peninsular. Todavia o suprimento de sementes permanece, no momento, como o maior problema para qualquer programa de reflorestamento em larga escala.

THE PERFORMANCE AND POTENTIAL OF ARAUCARIA AND *Agathis* IN PENINSULAR MALAYSIA

Summary

A preliminary assessment of the results os fome plots os Araucaria and Agathis species established in Peninsular Malaysia showed that their growth varies with the climate and conditions of the site. The best growth for both Araucaria spp was recorded in plots established ar higher elevarions. Araucaria cunninghamii fared better in sites that are drier and a dry spell. However, severe drought could cause hihg mortalities during the establisment phase. In the A. cunninghamii showed a slightly better performance in height growth but Araucaria hunsteinii seemed to be healthier. Later growth of both species appeared to be equalyy good. Agathis borneensis was found to be a slower grower than either of the Araucaria spp at all stages of development. A. cunninghamii was also found to be more susceptible to termite attack than A. hunsteinii and A.borneensis That attack was primary and accured at all phases of development.

In general both Araucaria spp particularly A. hunsteinii, showed outstandinf promise as possible plantation species in Peninsular Malaysia. However, seed supply remains the major problem for any large scale refforestation programme ar the moment.

INTRODUCTION

Araucaria species, particularly A. bidwilli Hooker, A. cunninghamii Ait and A. excelsa Brown have been grown as ornamentals at hill stations in the peninsula since the early 1920's but the Forestry Department only started planting some of the species in the early 1950's. However, due to poor viability and high cost of seeds, plantings have been very limited. Of the two Agathis species indigenous to the peninsula only A. borneensis Warburg is of commercial importance. Until its recent discovery in the coastal part of Trengganu (Kochummen, 1980), it was believed that the species only occurred in the highlands, at elevations exceeding 250m a.s.l. Several attempts have been made to plant the species but mainly due to the difficulty of procuring viable seeds or wildings, plantings have also been very limited.

This report gives a preliminary assessment of the performance of the three species based on information of certain plots established in the country (Fig. I).

PERFORMANCE

Germination

The germination percentage of all three species has always been poor and inconsistent. Previous tests showed that the viability of A. hunsteinii was slightly better. As a satisfactory method of storing the seeds has not been developed, all the seeds were sown soon after collection or arrival.

Early Growth

Araucaria species have a slower initial growth rates than Pinus spp grown in this country (Fielding, 1972). However later growth is just as fast, if not faster than, pines. Generally A. cunninghamii performed slightly better than A. hunsteinii. The rate of growth was lowest at Kemasul while those at Bahau were comparable to the plots at Tapah Hills. Poorly-drained soils adversely affected growth. 26-month old seedlings of A. hunsteinii at Bahau appeared unhealthy and there was a general yellowing of the foliage. The plot was also associated with a higher incidence of termites. Severe drought could cause a high mortality rate. In a plot at Mata Air more than 50% of the seedlings died as a result of a prolonged drought which occured soon after planting. In terms of height growth, survival and general state of health, the plots at Tapah Hills were definitely the best (Table 1).

No data on the growth of A. borneensis are available but a single 7-year old tree at the Institute recorded a height of 10.8m and a diameter of 10.5 cm.

Later Growth

No volume table had been formulated for either of the species of Araucaria in this country and hence the volume of the various plots could not be compared. However, by plotting the productivity index, obtained from the product of the predominant height (PDH) and the square of the mean diameter, against age, Anon (1975) was able to obtain a measure of the growth index of the plot. Using this method the various plots were compared and it was found that the young plots at Tapah Hills were performing better than those in New Guinea.

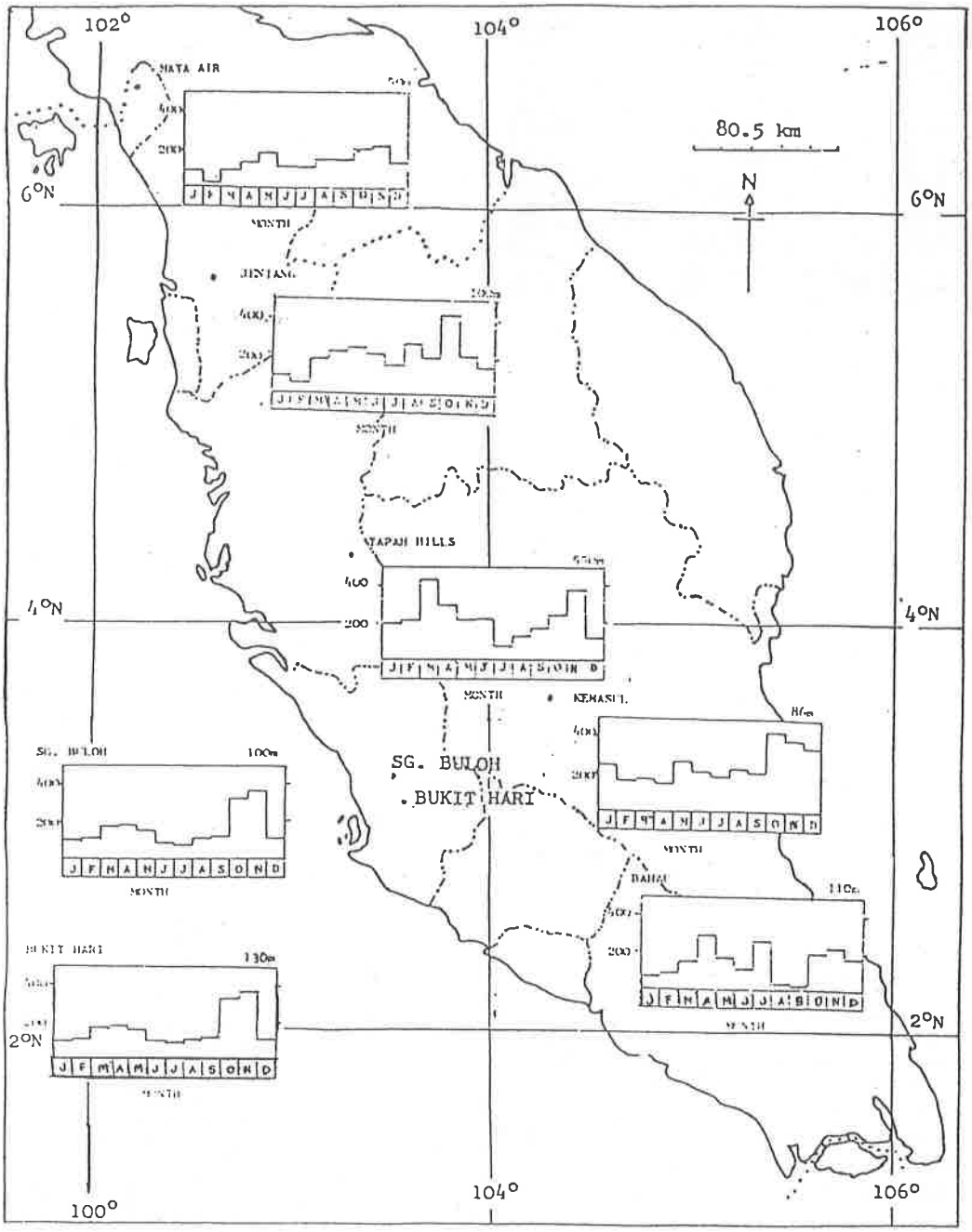
For the plots that were more than 10 years old, in terms of PDH, the best growth was recorded at Tapah Hills, followed by those at Mata Air, Bukit Hari, Sg. Buloh and Jeniang (Fig.2). The oldest plot of A. cunninghamii at the Institute had a PDH of 25.2m at age 23 while that of A. hunsteinii at Bukit Hari recorded a PDH of 33.8m at 21 years of age.

In terms of basal area increment the growth of the plots is as shown in Table 2. For A. hunsteinii the greatest m.a.i. occured in the plots at Tapah Hills, followed by those at Bukit Hari Sg. Buloh and Jeniang. For A. cunninghamii the plots at Tapah Hills again gave the best m.a.i. and this is followed by those at Mata Air and Sg. Buloh.

Good growth was recorded in plots established at higher elevations as manifested by the consistently high m.a.i. for both height and basal area in the plots at Tapah Hills. The soils at Tapah Hills and Bukit Hari were both derived from granite and have quite similar chemical & physical properties. In fact the Bt. Temiang soils type at Tapah Hills is characterised by its shallowness and frequent outcropping of the parent rocks. The slightly cooler climate and freely draining soils could be responsible for this difference.

Among the lowland plots good growth was recorded in the plots that were established in the better soils. The soil at Bukit Hari is of the Rengam type and derived from granite. The soil is deep, free-draining and with a sandy loam texture. Shallow soils, such as those at Kemasul, and poorly drained soils, such as those of the Lunas type at Bahau, advervely affected

Fig. 1 Map of Peninsular Malaysia showing the locations of the Araucaria spp plots considered in the Report



the growth of Araucaria species. The plot at Mata Air registered the best growth for A. cunninghamii. This has been pointed out to be due to the slightly drier climate of the area (Anon, 1975) and also the presence of a dry spell.

In the later period of development, A. hunsteinii performed as well as A. cunninghamii of similar age and in similar site. In general A. hunsteinii was better and healtheir-looking and appeared more robust than A. cunninghamii. Part of the reason was that A. cunninghamii was more prone to termite attack but the main reason has been attributed to the place of origin of the species.

In terms of height and diameter growth, A. borneensis is a much slower grower than the Araucarias.

Termite attack

The main cause of mortality in Araucaria & Agathis plots in this country is undoubtedly due to the attack of termites, particularly that of Coptotermes curvignathus which attack living trees. The root system are first attacked and then the termites chew their way up the trunk of the tree. Occasionally a gallery of mudwork is seen around the tree but the best way to detect an infected tree is by the general yellowing of thelcaves and drooping of the terminal shoots of branches.

Termite attack is primary and healthy and vigorous trees and seedlings of all ages could be attacked. 20-month old seedlings of A. cunninghamii had been attacked in the plots at Bahau (Chew, 1975) while the same was true with older plots, such as those at the Institute, some of which were more than 20 years old. Mortality could be total as were the cases of two plots of A. cunninghamii and A. hunsteinii at Bahau, Kedah and another plot of A. cunninghamii at Tapah Hills (Tho, 1974).

A. cunninghamii is more susceptible to termite attack as was clearly indicated in a 6-year old stand of mixed planting of A. cunninghamii and A. hunsteinii at Tapah Hills. While termite attack had done much damage to many A. cunninghamii trees, A. hunsteinii trees seemed comparatively free from the attack.

The use of agrocide, a gamma BHC compound, was not effective as was demonstrated at Bahau (Tho, 1974). However, the application of 1/2 oz. of Heptachlor in the planting hole at the time of planting was effective in preventing termite attack for the first six years.

Termite infestations were generally very localised and treatment could be applied around attacked trees and in their immediate vicinity. Control is achieved by the application of 1 pint per tree of Dieldrin 15 or Aldrex 2 at a dilution of 2 oz. in 5 gallons of water (Chew, 1975). The termite galleries around the trunk are scraped-off from the bark of the tree and the trunk is sprayed. The ground in the vicinity of two feet radius is drenched with the solution. All the immediate surrounding trees are similarly treated.

Phenology and Reproduction

Matured female cones have been observed on 14-year old trees of A. hunsteinii in a plot at Tapah Hills but the resulting seeds that were collected from the ground were all empty. In another 16-year old plot of the same species at Bukit Hari, empty seeds were found scattered all over the forest floor. So far no male strobili have been observed in the lowland plots. In the highlands A. cunninghamii were capable of producing viable seeds (Mitchell, 1962). Some wildings have also been observed under two trees of A.cunninghamii of an unknown age near the Forest Department Quarters at Tanah Rata, Cameron Highlands (1,448m asl). However, a few seeds obtained from Maxwell Hill (1,037m asl) of A.cunninghamii were tested at the Institute recently but all were found to be empty.

The species coppice better than most other conifers andA. hunsteinii could easily be propagated by top cutting of juvenile plants. However, it has been reported that it is impossible to develop a leader from branch cuttings of hoop pine (Lahiri, 1947). Preliminary tests carried out at the Institute's nursery showed that roots from top cuttings started to appear two months after planting them in a sand medium without the aid of any hormones.

No viable seeds have been collected from planted trees of A. borneensis male strobili have been found on the forest floor of a 22-year old A. borneensis stand at Bukit Hari but no female cones were observed.

Utilisation

No data on the wood properties of Araucaria species grown in this country

Table 1. The early growth of Araucaria as indicated by height (100 tallest trees per ha)

Species	Location	Age Year/month	Height (m)	M.A.I (m)
A. hunsteinii	Kemasul	6/0	4.3	0.7
	Bahau	8/8	13.1	1.5
	Tapah Hills	8/8	16.8	1.9
A. cunninghamii	Kemasul	6/0	4.6	0.8
	Bahau	8/8	12.8	1.5
	Tapah Hills	8/8	17.7	1.8

FIG. 2 THE GROWTH OF SOME ARAUCARIA SPP IN PENINSULAR MALAYSIA.

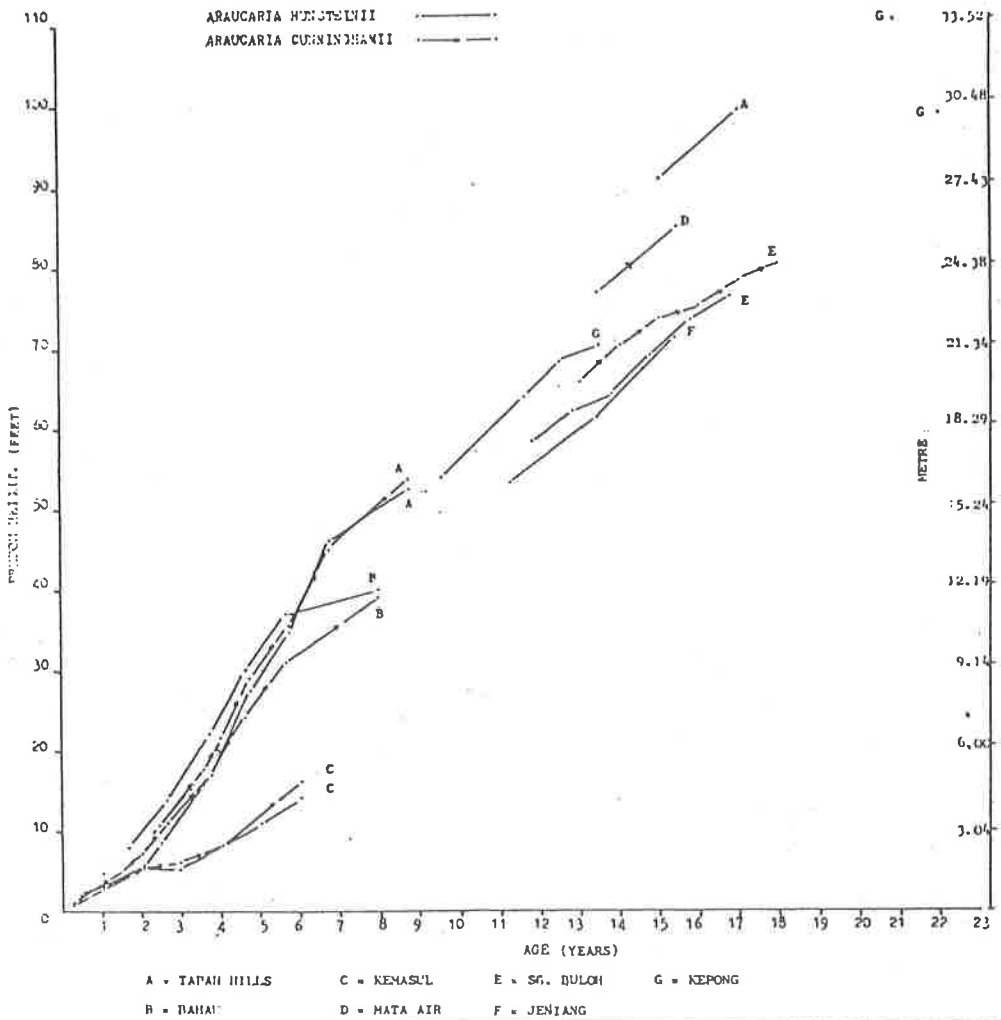


Table 2. Growth data of Araucaria and Agathis species from sample plots. Figures per ha for all stems of 7.6 cm diameter and over

Species	Location	Age (Year/month)	Dominant Height (m)	No. of stems	Total B.A (m^2)	mean diameter (cm)	MAI (m^2)
A. hunsteinii	Bahau	5/8	11.0	877	10.27	12.2	
	Bt.Hari	13/7	19.8	667	22.64	20.8	
	Tapah Hills	8/8	16.8	865	26.63	19.8	
	Jeniang	13/5	18.6	716	18.87	18.3	1.41
	Sg. Buloh	13/10	22.9	469	15.20	20.3	
A. cunninghamii	Mata Air	13/5	23.5	914	31.25	20.8	2.33
	Bahau	5/8	11.6	519	5.02	11.1	
	Tapah Hills	8/8	16.3	741	26.75	21.4	
	Sg. Buloh	13/1	20.0	815	17.70		
A. borneensis	Bt. Hari	21/8	21.6	395	30.03	21.6	1.36
	Bt. Hari	16/11	14.4	273	24.87	21.4	1.46

are available. In other areas the wood of both species have been found to be fine and uniformly textured and of medium density, hardness and strength. It is easy to cut, nail, dress, polish, season and glue. It is ocourless and tasteless and dries without any discloration. However, it is soft and marks easily, is susceptible to termite attack and blue stain and may contain compression wood (Ntima, 1968).

The quantity of Araucaria stand present in this country is too little to warrant any exploitation and its use has been very limited to indoor panelling. In other areas it is used principally in the manufactura of sawnwood, veneer, plywood and for pulp and paper (Ntima, 1968). Recent tests by local match factory showed that it is also suitable for making match boxes as well as match splints and the splints produced were comparable in quality to those of imported poplar.

In this country the timber of A. borneensis is chiefly used for indoor-panelling and cabinet work but the timber is available only in very limited quantities. Unlike other conifer-growing countries of South East Asia, the resin has never developed into an industry.

CONCLUSION

The performance of the plots of Araucaria spp. in this country, particularly A. hunsteinii, showed outstanding promise and could be successfully grown on fertile sites. Seed supply is a major problem but if adequate planting material could be assured then its potential as a plantation species is better than pines for the following reasons:-

(a) The form of Araucaria spp. is excellent and far superior to that of pines,
(b) Araucaria spp and A. borneensis can act as a source of high grade multipurpose raw material suitable for timber, veneer and pulp,
(c) although pines grow faster in the initial stages, Araucaria spp. fare better in the latter stages. However, A. borneensis is a slow grower,
(d) Araucaria spp. is easily vegetatively propagated by top cuttings and mass scale production of planting materials through vegetative propagation is a possibility and
(e) termite attack can be effectively controlled by the application of granular heptachlor at time of planting at least in the first six years for the Araucaria spp

LITERATURE CITED

on, 1975 - Feasibility study on the planting of Araucaria species in Peninsular Malaysia. FRI Report (Cyclo.)

Chew, T.K., 1975 - Preliminary notes on the performance of experimental plantations in Bahau F.R. Malay. Forester 38: 140-148.

Fielding, J.M., 1972 - Establishment of an experimental plantation and trial plantations and investigations of growth rates, fertilising and wood characteristics in West Malaysia. UNDP/FAO working Paper 22.

Kochummen, K.M., 1980 - The occurence of Agathis borneensis Warburg (Damar minyak) in heath forest in Peninsular Malaysia. Malay. Forester 43: 119-123.

Lahiri, K.L., 1947 - A note on Araucaria cunninghamii, Ait (Hoop pine). Indian Forester 73: 211-215.

Mitchell, B.A., 1962 - The place of exotics in Malayan Forestry. Malay. Forester 26: 224-236.

Ntima, O.O., 1968 - Fast growing timber trees of the lowland tropics. The Araucarias. CFI, Oxford.

Tho, Y.P., 1974 - The termite problem in Plantation forestry in Peninsular Malaysia. Proc. 5th Malaysian Forestry Conference.

PROPORÇÃO DO SEXO EM PINHEIRO BRASILEIRO, *Araucaria angustifolia* (BERL.) O.KTZE.

G. Bandel
ESALQ – USP
J.T.A. Gurgel
Instituto de Biociências
BRASIL

Resumo

A *Araucaria angustifolia* é uma espécie dióica, isto é, tem as flores masculinas e femininas em árvores separadas. Neste trabalho são relatados os resultados oriundos de um levantamento de proporção do sexo em áreas típicas da distribuição natural do pinheiro brasileiro, e também de dois povoamentos artificiais. Realizou-se também um estudo citológico para se tentar observar os possíveis cromossomos sexuais, e um estudo da madeira de árvores dos dois sexos para se estudar variações na sua densidade básica.

O estabelecimento da distinção morfológica, afora os órgãos florais, entre árvores masculinas e femininas de pinheiro brasileiro é inviável. Nos levantamentos realizados, para se determinar o sexo dos indivíduos, sempre se observaram os órgãos florais com o auxílio de um binóculo.

Nos levantamentos efetuados determonou-se o sexo de 1887 árvores de povoamentos naturais e de 239 árvores de povoamentos artificiais. A média geral de plantas masculinas e femininas foi de 52,4% e 47,6% respectivamente, tanto em povoamentos artificiais, como nos naturais. Os testes estatísticos efetuados indicaram que a proporção de 50% de indivíduos masculinos: 50% de indivíduos femininos, não é válida para a *Araucaria angustifolia* em toda a área fitogeográfica estudada pela amostragem executada. O teste de heterogeneidade realizado, entre todas as regiões estudadas, foi não significativo, o que significa que a proporção de 52,4% de árvores masculinas, para 47,6% de árvores femininas é estatisticamente válida para todas as regiões do Brasil estudadas.

O estudo citológico do pinheiro brasileiro não possibilitou a observação de um possível cromossomo sexual, que seria responsável pelo mecanismo determinante do sexo. Dos 2n=26 cromossomos da *Araucaria angustifolia*, 22 são metacêntricos, 2 são submetacêntricos e 2 são acrocêntricos.

O estudo de 36 árvores de ambos os sexos de pinheiro brasileiro indicou que não existem diferenças relacionadas com a densidade básica da madeira, quando são comparadas amostras dos dois sexos.

Summary

Araucaria angustifolia, the Paraná pine, is a dioecious South-American species. In the present paper are given the results of a survey done in the sexual proportion of plants in not disturbed areas of the natural distribution of the species and as well as in two artificial plantations. So, the research covers the States of Minas Gerais, São Paulo, Paraná and Rio Grande do Sul.

Initially several hypothesis based on phenotypic characters of male and female plants were tested, but none did work. So, the only feasible way was to look for the floral structure and determine male and female plant. This was done in the forest with the acid of a binocular, and 1887 trees were studied in natural forests and 239 trees in artificial plantations. The proportion found of male and female plants was 52.4% : 47.6% in both types of plant stands. The comparison between the observed frequency of the sexes with the expected frequency of 50% = 50% was done by x^2 test and found not significant at 0,5 level of probability; so in this species the determination of sexes may not be a simple one based on simple chromosome difference, but on a more complex schemes. The x^2 heterogeneity test among all regions studied was not significant, what means that the proportion of sexes previously quoted is the same for all studied regions in the south Brazil.

The research on chromosome morphology did not reveal any difference between plants of both sexes and also no detectable sexual chromosome was found. *Araucaria angustifolia* has a diploid number of 26 chromosomes, from those 22 are metacentric, 2 are submetacentric and 2 acrocentric.

Another research done on specific gravity of the wood in both sexes did not reveal any detectable difference.

INTRODUÇÃO

O pinheiro brasileiro é uma espécie dióica, isto é, ocorrem árvores masculinas e femininas. Nas árvores masculinas formam-se os amentilhos que produzem o polem, e nas femininas originam-se os cones, conhecidos como estróbilos ou pinhas, que produzem as sementes ou pinhões.

A determinação do sexo do pinheiro brasileiro é feita exclusivamente pela visualização dos órgãos florais. Não existem outras características morfológicas fenotípicas que possam diferenciar os indivíduos masculinos e femininos.

Pouco se conhece a respeito da proporção do sexo desta importante conífera brasileira, não se encontrando na literatura dados sobre a proporção de plantas masculinas e femininas, e mais ainda sobre o mecanismo da dioicia. Procedeu se a um levantamento da frequência de plantas masculina e feminina em áreas típicas da distribuição geográfica da *Araucaria augustifolia*.

Os levantamentos foram feitos em matas nunca desbastadas, nos Estados do Paraná, Santa Catarina e Rio Grande do Sul, nas zonas de ocorrência natural do Pinheiro brasileiro. As reservas naturais dos Estados de São Paulo, Minas Gerais e Espírito Santo estão quase que completamente extintas, não possibilitando mais oportunidade para um levantamento razoavelmente bom.

É facil de se explicar esta exigência de serem virgens os pinherais onde forem feitos os levantamentos, pois os locais onde já houve derrubadas de árvores não são mais representativos, pois houve perturbação nas condições naturais. As matas onde foram efetuados os levantamentos constituiam-se exclusivamente de árvores adultas. –

Efetuou-se ainda a contagem de árvores masculinas e femininas de duas plantações de pinheiro brasileiro, em dois Hortos Florestais do Estado de São Paulo, para fins de verificação da proporção dos sexos.

Estudou-se também a citologia da *Araucaria angustifolia* para se verificar a possível existência de um cromossomo sexual ou de possíveis estruturas cromossômicas para distinguir os sexos. A variação da densidade básica da madeira dos dois sexos de pinheiros brasileiro, também é discutida no presente trabalho.

Material e Métodos

A contagem de árvores masculinas e femininas de pinheiro brasileiro é bastante trabalhosa, pois os amentilhos masculinos e os estróbilos femininos situam-se em galhos localizados muitas vezes em alturas superiores à 30 metros do solo. O uso de binóculos é indispensável para se visualizar os órgãos florais da araucaria e determinar o sexo das árvores. A *Araucaria angustifolia* não apresenta dimorfismo sexual, isto é, não se distinguem as árvores dos dois sexos morfologicamente.

As árvores de pinheiro brasileiro começam a frutificar a partir dos 15 - 20 anos de idade, quando a altura das mesmas atinge 10 - 15 metros de altura. O período entre a polinização e a frutificação (produção de pinhões) é de 2 anos e 8 meses, segundo KOSCINSKI (1934), SHYMOYA (1962) e BANDEL (1966).

Nos levantamentos realizados nos pinhais do sul do Brasil, alguns métodos que tentam diferenciar morfologicamente as árvores dos dois sexos da *Araucaria angustifolia*, foram apresentados por técnicos e agrônomos, mas nenhum deles mostrou- se correto.

Num povoamento natural de pinheiro brasileiro, quando um observador tenta identificar do solo a presença de órgãos florais nas copas das árvores, ele encontra inúmeras dificuldades para a distinção dos sexos. As copas dos pinheiros de uma mata fechada adulta são todas em forma de candelabro, com a parte terminal dos galhos situados numa linha horizontal; a disposição dos galhos e ramos é para cima, formando uma massa compacta, o que dificulta a observação das pinhas e dos amentilhos, devido ao seu tamanho, forma e côr. A altura das copas das árvores é bem elevada, atingindo muitas vezes 40 metros; mesmo utilizando-se os binóculos, a tarefa de se visualizar os órgãos florais foi trabalhosa, porque a luminosidade e claridade nem sempre foram ideais.

Em povoamentos nos quais a densidade de árvores é inferior à 100 unidades por hectare, pode-se adotar o critério de classificar a árvore como feminina ou masculina - na impossibilidade de se visualizar os órgãos florais na própria árvore com auxílio de binóculos - quando se encontram em abundância, ao redor do tronco e embaixo da árvore, sementes ou restos de órgãos florais.

Nos levantamentos efetuados sempre se contou com o auxílio de 2 a 3 trabalhadores que procediam a abertura de picadas e auxiliavam na observação e marcação das árvores.

Com os dados obtidos nesses levantamentos foram feitos os testes estatísticos de qui-quadrado e de heterogeneidade, para comprovar-se a relação teórica de 50% de árvores do sexo masculino: 50 de árvores do sexo feminino, teoricamente esperada, e para se verificar se as amostras estudadas são estatisticamente homogeneas ou se elas divergem entre si.

Para o estudo citológico dos cromossomos de pinheiro brasileiro utilizou-se como material sementes originários de Campos de Jordão, SP. Os pinhões postos a germinar em placas de Petri, emitiram raizes que atingiram aproximadamente 1 cm de comprimento depois de uma semana. Depois desse período, estas placas de Petri foram colocadas em geladeira com temperatura de 4ºC, aí permaneceram durante 15 dias. Em seguida foram preparadas lâminas pelo método do esmagamento, utilizando-se como corante a orceina propiônica à 1% e a reação de Feulgen. O pré-tratamento das raizes de pinheiro brasileiro à 4ºC por 15 dias permitiu o perfeito reconhecimento dos 2n = 26 cromossomos. Os cromossomos mostraram-se bem espalhados na placa metafásica das células e os centrômeros estavam bem visíveis.

As lâminas preparadas com pontas de raizes de araucária não submetidas à pré-tratamentos apresentam cromossomos finos e enrolados, onde é impossível a sua identificação individual. O tratamento à 4ºC encurta e engrossa os cromossomos, de modo que é possível identificá-los e contá-los. O pré-tratamento com colchicina, paradiclorometabenzeno e hidroquinoleina das raizes de pinheiro não surtiram efeito, no sentido de individualizar os cromossomos.

As lâminas de pontas de raízes de *Araucaria angustifolia* foram preparadas seguindo-se as técnicas usuais do método do esmagamento (BANDEL, 1971). As fotografias das metáfases foram tiradas num fotomicroscópio Zeiss. As contagens e medições dos cromossomos para o estudo do complemento cromossômico da araucária foram realizadas em várias raizes, pertencentes provavelmente a sementes dos dois sexos; convém lembrar que não se distinguem os pinhões do sexo masculino e as do sexo feminino.

Para o estudo da madeira de árvores dos dois sexos de pinheiro brasileiro foram obtidas amostras de povoamentos naturais de Clevelândia, Paraná. Utilizaram-se amostras de 18 árvores de cada sexo, retiradas por meio de sondas de Pressler (com 5 mm de diâmetro) ao nível de 1,30m acima do solo, e conservadas em câmaras frigoríficas. A técnica da determinação da densidade básica da madeira é descrita por BANZATTO et al ii. (1971).

Resultados e discussão

Nos levantamentos efetuados foi determindo o sexo de 1.887 árvores de povoamentos naturais, e de 239 árvores de povoamentos artificiais (Tabela 1). Tanto em povoamentos artificiais, como nos naturais, a média geral das plantas masculinas e femininas foi de 52,4% e 47,6+, respectivamente (Tabela 2).

O teste de qui-quadrado, para os valores do sexo masculino e feminino, feito na base da relação teórica de 50%:50%, indicou que o valor do qui-quadrado achado é significativo ao nível de 5% de probabilidade. Portanto a proporção de sexo de 1:1 não é valida, pela amostragem executada para a *Araucaria angustifolia*, para toda a área fitogeográfica estudada.

O excesso de plantas masculinas sobre femininas encontrado, sugeriu que fosse pesquisado-se nas diversas regiões distintas havia variação ao acaso, dentro e entre as mesmas regiões de São Paulo, Paraná, Santa Catarina e Rio Grande do Sul, e dentro e entre as sub-regiões de cada estado.

As comparações realizadas pelo teste de heterogeneidade mostraram que sempre houve homogeneidade dentro das regiões estudadas, exceto no estado do Paraná; o mesmo teste de heterogeneidade mostrou uma não-significância quando se compararam as médias de proporções do sexo masculino e feminino entre e dentro das sub-regiões estudadas.

O teste de heterogeneidade mostrou também que, entre todas as regiões estudadas, houve uma não significância, o que significa que a proporção encontrada de 52,4% de machos, para 47,6% de fêmeas é válida para toda a região fitogeográfica estudade. (Tabela 3).

O estudo citológico do pinheiro brasileiro mostrou que o número de comossomos da espécie e de 2n = 26 (BANDEL, 1970). Determinou-se o comprimento relativo e a relação de bralos dos cromossomos, em microfotografias ampliadas (Tabela 4).

A *Auracaria angustifolia* tem 11 cromossomos metacêntricos, 1 submetacêntrico e 1 acrocêntrico. Não foram observados prováveis cromossomos sexuais, ou alguma estrutura cromossômica que pudesse servir para a distinção das plantas dos dois sexos. Desta forma, não foi possível se descobrir a possível causa do mecanismo da determinação do sexo, o que aliás também ainda não foi descoberto em outras ginospermas dióicas. Também ainda não foi descoberto nenhum método para a distinção de sementes e mudas dos dois sexos. Mesmo a distinção das árvores adultas dos dois sexos, somente é possível pela observação dos seus órgãos florais.

O estudo da madeira de pinheiro brasileiro mostrou que, tanto as árvores do sexo masculino como do sexo feminino, se comportam identicamente quanto à variação da densidade básica da madeira (BANZATTO et alii, 1971), tomada da medula em direção à casca. Esta variação segue em ambos os sexos um efeito linear crescente da medula para a casca. As 36 árvores estudadas apresentaram uma alta variabilidade individual tanto para indivíduos do sexo masculino como para o sexo feminino, o que permite concluir que existem ótimas possibilidades para um programa de melhoramento visando a seleção de matrizes no povoamento estudado, de Clevelândia, Paraná.

Tabela 1 – Número de árvores masculinas e femininas de pinheiro brasileiro em povoamentos naturais e artificiais.

		ÁRVORES mascul.	ÁRVORES feminin.	TOTAL
POVOAMENTOS ARTIFICIAIS				
SÃO PAULO –	São Paulo – Horto Florestal Cantareira	70	66	136
	Capão Bonito – Horto Getúlio Vargas	55	48	103
TOTAL		125	114	239
POVOAMENTOS NATURAIS				
PARANÁ –	São João do Triunfo			
	Áreas 1 a 4 – Fiat Lux	255	215	470
	Guarapuava – Faz.Reserva	32	16	48
	Monte Alegre – Klabin	23	18	41
	Ponta Grossa – Vila Velha	39	27	66
	Clevelandia			
	Ginásio Agrícola	122	115	237
	Fazenda das Tunas	53	48	101
	Pato Branco – Faz.Chicketa	19	15	34
	Santa Isabel – Reserva Nat.	41	36	77
SANTA CATARINA –	Lages			
	Áreas 1 a 3 – Olinkraff	162	144	306
	Chapecó – Fazenda Cella	63	69	132
	Faxinal do Irani			
	Fazenda Zanell	52	52	104
	São Joaquim – Faz. Martins	33	51	84
RIO GRANDE DO SUL –	Cambará			
	Áreas 1 e 2 – Celulose Camb.	95	92	187
TOTAL		989	898	1887

Tabela 2 - Porcentagem de árvores do sexo masculino e feminino de pinheiro brasileiro no sul do Brasil.

Proporção do sexo em povoamentos artificiais

machos	125	proporção: machos	52,4%
fêmeas	114	fêmeas	47,6%
Total	239		

Proporção do sexo em povoamentos naturais

machos	989	proporção: machos	52,4%
fêmeas	898	fêmeas	47,6%
total	1887		

Comparação entre a proporção do sexo em povoamentos naturais da Paraná, Santa Catarina e Rio Grande do Sul.

PARANÃ

machos	584	proporção: machos	54,4%
fêmeas	490	fêmeas	45,6%
Total	1074		

SANTA CATARINA

machos	310	proporção: machos	49,5%
fêmeas	316	fêmeas	50,5%
Total	626		

RIO GRANDE DO SUL

machos	95	proporção: machos	50,8%
fêmeas	92	fêmeas	49,2%
Total	187		

Tabela 3 - Resultados dos testes de qui-quadrado e de heterogeneidade, relativos à proporção do sexo em araucária.

São Paulo	qui-quadrado	heterogeneidade
POVOAMENTOS ARTIFICIAIS		
HC	0,118 (1)	
HGV	0,476 (1)	
Total	0,506 (1)	0,088 (1)
POVOAMENTOS NATURAIS		
Paraná		
SJT-1	0,012 (1)	
SJT-2	4.000 (1)	
SJT-3	0,791 (1)	
SJT-4	1,710 (1)	
Sub-total	3.404	3,109
Guar.	0,248 (1)	
M.A.	0,207 (1)	
P.G.	2.181 (1)	
Clevel.-1	0,610 (1)	
Clevel.-2	5,333 (1)*	
Sub-total	0,426 (1)	0,029 (1)
P.B.	0,470 (1)	
S.I.	0,325 (1)	
Total	8,227 (1)*	4,522 (5)
Santa Catarina		
Lages-1	2,195 (1)	
Lages-2	0,103 (1)	
Lages-3	0,028 (1)	
Sub-total	1,059 (1)	1,267 (2)
Chapecó	0,273 (1)	
F.I.	0,000 (1)	
S.J.	3,057 (1)	
Total	0,058 (1)	5,131 (3)
Rio Grande do Sul		
Cambará-1	0,472 (1)	
Cambará-1	0,030 (1)	
Total	0,048 (1)	0,454 (1)
TOTAL GERAL	4,894 (1)*	3,945 (3)

Tabela 4 - Comprimento relativo e relação de braços dos cromossomos da *Araucaria angustifolia*.

Números dos cromossomos	Comprimento relativo	Relação de braços	Designação dos cromossomos
1	9,4	1,4	metacêntrico
2	9,3	1,1	metacêntrico
3	8,9	1,0	metacêntrico
4	8,6	1,1	metacêntrico
5	8,6	1,1	metacêntrico
6	8,6	1,1	metacêntrico
7	8,4	1,0	metacêntrico
8	7,4	1,6	metacêntrico
9	6,8	1,3	metacêntrico
10	6,7	2,5	sub-metacêntrico
11	6,1	1,1	metacêntrico
12	5,8	3,5	acrocêntrico
13	5,5	1,2	metacêntrico

BIBLIOGRAFIA

BANDEL, G., 1966, O Pinheiro Brasileiro, *Araucaria angustifolia* (Bert.) O.Ktze. Piracicaba, São Paulo. Edição do Autor, 68p.

BANDEL, G., e J.T.A.GURGEL, 1967, Proporção do sexo em pinheiro brasileiro, *Araucaria angustifolia* (Bert.) O. Ktze., Revista Silvicultura em São Paulo 6:209 - 219, São Paulo

BANDEL, G., 1970, Os cromossomos da *Araucaria angustifolia* (Bert.) O. Ktze. e da *A. araucana* (Molina) Koch. O Solo LXII (2): 69 - 72, Piracicaba, São Paulo.

BANDEL, G., 1971, A técnica de esmagamento para estudo de cromossomos em plantas. O Solo LXIII (2): 35 - 39. Piracicaba, São Paulo.

BANZATTO, A.C., M. FERREIRA e G. BANDEL, 1969, Variação da densidade básica da madeira da *Araucaria angustifolia* (Bert.) O. Ktze. O Solo LXI (2) - 43 - 46, Piracicaba, São Paulo

GURGEL, J.T.A. e O.A. GURGEL FILHO, 1965, Evidências de raças geográficas no pinheiro brasileiro, *Araucaria angustifolia* (Bert.) O. Ktze. Ciência e Cultura 17 (1): 33 - 39. São Paulo.

HERTEL, R.J.G., 1966, Estudos sobre a *Araucaria angustifolia*. Bol. Inst. Hist. Nat. 4 : 24 p. Curitiba, Paraná.

KOSCINSKI, M., 1934, O pinheiro brasileiro na silvicultura paulista. Publicação da Diretoria de Publicidade Agrícola, da Secretaria da Agricultura, 56p., São Paulo.

MATTOS, JOÃO R., 1972. O Pinheiro Brasileiro, 620 pp. Gremio Politécnico - Edição do autor. São Paulo, Brasil.

SHYMOIA, C., 1962, Contribuição ao estudo do ciclo biológico da *Araucaria angustifolia* (Bert.) O. Ktze. Experientiae 2(2): 519 - 540, Viçosa, Minas Gerais.

FAST GROWING TREES

Agathis, POSSÍVEIS CAMINHOS PARA FUTURA PESQUISA

M.R. Bowen — T. C. Whitmore
Commonwealth Forestry Institute — Oxford University
ENGLAND

Resumo

Propostas p/pesquisa futura no gênero *Agathis* são delineados, com objetivo de popularizar esta espécie, a qual produz madeira de excelente qualidade.

Agathis, POSSIBLE LINES FOR FURTHER RESEARCH

Summary

Proposals for future research on the genus Agathis are outlined, with the aim of increasing the popularity of these fine timber trees as plantation species.

INTRODUCTION

Over the past few years increasing attention has been paid to the potential of all Agathis species, the Kauri pines, as plantation trees (Sudarmo, 1956; Team Reboisasi, 1971; Whitmore, 1977; Bowen and Whitmore, in press (a) and (b)). In the 1950s and 1960s the basis of extensive plantations were established in Australia, but planting stopped after a severe defoliation by a coccid. In Java successful plantations have been developed since the 1940s. Elsewhere throughout its range numerous trial plots have been established to give indications of plantation potential.

FUTURE RESEARCH

Seed storage

The scale of plantations has often been severely restricted by difficulties in both obtaining seed and then storing it for any length of time after collection. And international seed exchanges have met with limited success with a high proportion of the seed dying in transport. We see the overcoming of these difficulties as key areas for future research. Small scale, carefully controlled experiments are needed to examine the effects of drying rate on seed viability, and the degree of desiccation that the seed can withstand. These experiments should be designed to give both short and long term information, with sub-samples of seed sown at the time of collection and drying, after short storage intervals of around six months, and after longer term storage of, say, three years. Previous experience (Queensland State F.S.; R.D. Smith, pers.comm. has strongly indicated that low temperatures (+3 °C to -10 °C) are necessary for maintaining seed viability, as is storage in airtight containers. But these results have often been confounded by a lack of knowledge of seed viability immediately after collection and prior to transport. More carefully documented experiments are also required on the best ways of transporting seeds from the collection/drying areas to the point of sowing/storage. Present indications are that transport in a tightly packed, well insulated container give the best results, possibly by restricting the quantity of oxygen available and minimising the thermal shocks experienced in aircraft holds and staging areas. Again, available data are of limited value as the original germination percentages were rarely known. These problems must be overcome before the full potential of the genus can be realised on an international scale.

Seed stands

The female cone shatters on the tree releasing the seed at maturity. Thus seed has to be collected by picking the cones as they approach maturity, a difficult task as the cones are borne on the outermost branches of large trees which often grow in accessible forests. The establishment of small seed stands or grafted orchards should therefore be a priority to ensure adequate, easily accessible seed supplies, even though they may take up to twenty years to become productive.

Silviculture

Agathis species differ markedly from each other in their growth rate and the tolerance of bright open conditions by seedling trees. At one extreme are species which can only be established under shade and grow slowly, at the other a few provenances can be planted in the open and grow fast. Leucaena leucocephala has proved successful as a nurse (Team Reboisasi, 1971; S.C. Halos pers. comm.). Further work could profitably be undertaken in glasshouses and the forest to analyse shade requirements in order to develop silvicultural prescriptions. Most species and provenances occur in climates with virtually no dry season but a few grow naturally in seasonally very dry places and these might have potential for growing in seasonal climates or the harsh sites commonly available for plantation forestry. Species and provenances differ in their ability to self-prune and propensity for the bole to branch. Spiral grain is a problem in some cases.

Once problems of obtaining planting stock have been overcome there is scope for developing Agathis with desirable characteristics for any particular situation.

Seedlings and young trees are known to suffer from grass competition, perhaps through allelopathic effects. Inadequate weeding frequently checks early growth.

Insect pests

In areas of the South Pacific seed crops are often considerably reduced by the seed-eating larva of the moth Agathiphaga spp. (see Bowen and Whitmore, in press (a)) and in Papua New Guinea there is evidence that the larvae of two other moths attack female cones (H. Roberts, pers. comm.), as further collections are made in other areas more insect pests are likely to be found and the establishment of seed orchards could further increase the problem. Work on the control of these pests will eventually be needed. Insect damage to timber appears to be minimal but plantations will need continuous monitoring.

Vegetative propagation

Preliminary experiments carried out in Edinburgh (Leakey and Longman, 1978) indicate that cuttings from seedlings of most Agathis species root easily and grow strongly. However, there are indications that growth tends to be plagiotropic. Besides circumventing the need for scarce seed, clonal forestry offers additional advantages over seedlings and has been demonstrated very successfully for a number of species in the tropics e.g. Triplochiton scleroxylon, Eucalyptus deglupta and Eucalyptus hybrids. Further work within the tropics would give information on the feasibility of scaling up the early work on Agathis and a chance to examine the problems of plagiotropism in more detail.

REFERENCES

Bowen, M.R. and Whitmore, T.C. (in press a). A second look at Agathis. C.F.I. Occasional Paper 13.

Bowen, M.R. and Whitmore, T.C. (in press b). Agathis, a genus of fast growing rain forest conifers. Commonw. For. Rev.

Leakey, R.R.B. and Longman, K.A. 1978. First Annual Report of the Ministry of Overseas Development Research Scheme R3454. Institute of Terrestrial Ecology, Edinburgh.

Sudarmo, M.K. 1956. Tabel-tegakan sementara dari Agathis loranthifolia Salisb. (=Agathis alba). Peng. Penj. Hut. Indon. 52 and 53.

Team Reboisasi, 1971. Pedoman tanaman damar (Agathis loranthifolia Salisb.) Direktorat Reboisasi dan Rehabilitasi.

Whitmore, T.C. 1977. A first look at Agathis. C.F.I. Trop. For. Pap. 11.

FAST GROWING TREES

A CONÍFERA TROPICAL *Agathis* COMO POTENCIAL PARA PLANTAÇÕES

M. R. Bowen — T. C. Whitmore
Commonwealth Forestry Institute
Oxford University
ENGLAND

Resumo

Agathis, os pinheiros Kauri, são coníferas de crescimento moderadamente rápido, encontradas principalmente no Sudeste do Pacífico e no Leste tropical. Elas foram extensivamente exploradas em função da sua madeira valiosa e são também fonte de resina Manila. Sua taxonomia, distribuição exploração e conservação, juntamente com os problemas de armazenagem das sementes são discutidos sumariamente.

THE TROPICAL CONIFER *Agathis* AS A POTENTIAL PLANTATION TREE

Summary

Agathis, the Kauri Pines, are moderately fast growing conifers found mainly in the south-west Pacific and tropical Far East. They have been felled extensively for their valuable timber and are also the source of Manila Copal. Their taxonomy, distribution, exploitation and conservation, together with problems of seed storage are discussed briefly.

INTRODUCTION

Agathis and *Araucaria* together form the family Araucariaceae, they differ technically in that in *Agathis* the ovuliferous scale is not attached to the cone scale. The genus *Agathis*, irrespective of species, is most widely known in world markets by its Maori name, Kauri or Kauri Pine. Throughout their range *Agathis* have a high reputation as timber species and are much sought after for their lustrous, finely grained, pale, uniform timber which is easy to work. The genus has the additional advantage of being self-pruning and the timber is therefore largely knot free. The resin obtained from the cut bark of some species is commercially important and enters world trade as Manila Copal.

This proven popularity, together with the diversity inherent to a whole genus of wide ecological amplitude, successful cultivation in some areas, and the typically tall, narrow, monopodial crown and the long fibres of a conifer, make *Agathis* potentially a most important plantation tree. In this paper we discuss briefly aspects of taxonomy, distribution, exploitation and seed storage, and indicate where appropriate, when fuller information is available.

TAXONOMY

The overall taxonomy of the whole genus has recently been revised by Whitmore (1980), taking into account local revisions by de Laubenfels (1972) and Hyland (1978). Emphasising the importance of the taxonomically useful variation in the male cone Whitmore chose to combine certain taxa of the Melanesian islands and Malesia, recognising worldwide a total of 13 species of which two have a second subspecies: a considerably more conservative view than some previous authors, (Warburg 1900, Meijer Drees, 1940 de Laubenfels 1978).

It is this more restricted view of Whitmore that we have chosen to follow.

Australia has three, and New Caledonia five, sympatric species. The remaining species are allopatric except for a few montane populations of central Malesian *A. dammara* which lie within the western range of *A. borneensis*. One of these is distinctive as *A. dammara* ssp. *flavescens* (Ridley) Whitmore. It was formerly a full species.

Using microsporophyll characters Whitmore (1980) divided the taxa into two groupings and three, separate, individually distinctive species. The smaller group includes *A. microstachya* (Australia) and *A. labillardieri* (West New Guinea and Sepik basin); while the larger group is of eight species, *A. australis* (New Zealand), *A. corbassonii*, *A. lanceolata* and *A. montana* (New Caledonia), *A. macrophylla* (Melanesian islands and including *A. obtusa* and *A. vitiensis*), *A. atropurpurea* (Australia), *A. dammara* (mainly central Malesia) and *A. borneensis* (West Malesia). Both of the last two species have long synonomies. The three individually distinct species are *A. moorei* and *A. ovata* (New Caledonia) and *A. robusta* of Australia with its new subspecies *nesophila* of Eastern New Guinea and New Britain.

Neither ecotypic variation nor variation in habit is closely related to taxonomy. And variation in the morphology of leafy twigs and reproductive parts is less than the variation in ecology and tree form. Therefore the formal taxonomy cannot fully reflect field variations even though the latter are economically important (see Whitmore, 1976).

DISTRIBUTION

Agathis occurs from northernmost Philippines to north New Zealand (18°N to 38°S) and Sumatra to Fiji (96° to 180°E). With two exceptions, *A. robusta* (S. Queensland) and *A. australis* (New Zealand), the species are confined to the tropics. Within the tropics *Agathis* shows considerable ecological amplitude. Most are restricted to evergreen rain forest (perhumid climate) but some occur in areas with a marked dry season of one to several months duration (semi-evergreen rain forests). Altitudinal range is from sea-level to approximately 2500 m, where it occurs in upper montane rain forest. Soil and rock types are also diverse and *Agathis* can be found growing on podsolized sands, limestone, ultabasics, igneous and sedimentary rocks, where it may be the only top of the canopy species, or in scattered groves, or as individual trees. All these ecotypes can be found in Borneo.

EXPLOITATION

For many years, and wherever it is found, *Agathis* has been sought for its valuable timber, Coupled with the premium price it fetches in world markets (up to twice that of Far Eastern light tropical hardwoods) this has lead to a heavy and sustained exploitation of natural stands. For example, in New Zealand only *c.a.* 7000 ha of virgin forest containing *Agathis* remain, reduced from over one million hectares in 150 years. A similar picture emerges in the Far East. In Borneo extensive stands in south Kalimantan were heavily logged in the 25 years from 1940, yielding 100-400m^3 of timber per hectare, and smaller stands on the island are still being exploited.

In Peninsular Malaysia declining export figures suggest that most accessible stands have now been exhausted. Similarly in Queensland, New Caledonia, Santa Cruz and New Hebrides the main stands have been seriously depleted and felling has almost ceased.

Considerable reserves of *Agathis* remain only in inaccessible areas e.g. the Sepik region of Papua New Guinea, or where legislation prevents felling for timber, e.g. Irian Jaya and the Philippines, where the tree is conserved for its other economic product, resin.

This resin is a translucent or clear white exudate of the living inner bark which hardens slowly on exposure to air. It used to be an important constituent of varnishes and linoleum, and today still finds a steady market in specialised varnishes, colour printing, etc., although production is greatly reduced from pre-1940 figures.

CULTIVATION

Most, but not all, *Agathis* timber and Manila Copal has been harvested from forest trees. Throughout the natural range and in countries with a similar climate in Africa and South America there has been, and still is, a considerable interest in establishing plantations. This has led to the planting of a considerable number of trial plots (Whitmore, 1977) and recently to the attempt to establish an international provenance trial (Bowen and Whitmore, in press). However the scope of these trials has been severely limited by the difficulty in obtaining adequate seed supplies and by the poor storage characteristics of *Agathis* seed.

Enrichment planting has been practised in Peninsular Malaysia (Ismail, 1966) and is still in progress in Brunei and the Solomon Islands where it is planned to restock areas of 6000 and 1500 ha respectively.

Larger plantations have been established in Java and Queensland for timber, and in Irian Jaya for resin, and on a smaller scale in New Zealand for timber and conservation. In the Philippines there is considerable enthusiasm for the tree and a start has been made on establishing plantations, particularly on Samar where early growth appears to be excellent.

In southern Queensland approximately 750 ha of A. robusta had been planted by 1959 when a massive defoliation by Coniferococcus agathidis caused a considerable decrease in growth and many deaths. At this point Agathis was abandoned in favour of Araucaria cunninghammi, Hoop Pine, even though Agathis was producing 24$m^{-3}h^{-1}$ of marketable timber at age 22, a considerably greater volume of high grade knot free timber than Hoop on a similar site.

Most of the data on Agathis timber yield comes from the more extensive Javanese plantations of some 8500 ha. Trials were conducted throughout Java in the 1930s using seed of A. dammara from the Moluccas. These showed that for good growth a continuously wet climate, or nearly so, was required. Newer timber plantations are concentrated in central Java where some 3500 ha have been established since 1950 and are now being felled and replanted in rotation. Seedlings are established under taungya, with food crops being grown for two years. Leucaena leucocephala is also included in the rotation to give the early shade that seedlings of A. dammara require. It also checks weed growth, prevents erosion and improves soil fertility (Team Reboisasi, 1971). Similarly L. leucocephala has been shown in the Philippines to act as an excellent nurse crop and it seems likely that a similar mixed crop could be used with considerable benefits wherever Agathis is planted.

Whitmore (1977) has summarised the yields of Javan plantations using figures from a number of previous authors, principally Sudarmo(1956a,b). At thirty years age, the recommended pulpwood rotation, total volume including thinnings is estimated at 702-961m^3ha^{-1}. A fifty year rotation is recommended for veneer and the total yield is then predicted at 1099-1411m^3ha^{-1}.

The exploitation of tropical forests for timber has overshadowed their importance as producers of minor forest products, including Manila Copal, but with the increasing cost of oil-based synthetics these potentially renewable resources may again become important. Thus, despite the fact that Agathis has not always been a success in the past, the experience with some plantations and in enrichment planting and trial plots confirms that there is an assured place for the genus in world forestry as a moderately fast growing tree, producing valuable timber and resin. The careful selection of species and provenance, together with improved silvicultural techniques, should go a long way to overcoming the early slow growth of seedlings. Currently A. macrophylla from the Santa Cruz islands and the southern New Hebrides, and A. robusta from Queensland are showing excellent promise.

CONSERVATION

The conservation of Agathis is inextricably linked to the wider problems of the preservation of tropical forests as a whole. In many places the rain forest is fast disappearing and the land being converted to agriculture.

And this is certainly true in the Far Eastern and Pacific areas in which Agathis occurs (Lanly and Clement, 1979). Where selected felling takes place it is often, but not always, the practise to restrict the size of tree that may be taken. For example, in Peninsular Malaya at Gading some stands of Agathis have been left for seed, and at Semangko trees under 0.43m diameter were retained. Similar provision is made in Indonesia and Brunei. In Australia and New Zealand felling has virtually ceased. In the Philippines Agathis is completely and effectively protected as a source of resin, although in some areas the structure of the surrounding forest is badly damaged by felling of other species. In other areas considerable stands remain untouched, for example, in Abra province, northern Luzon, a concession of 196,000 ha is estimated to contain 1.3 x 10^6m^3 of Agathis, and on enumeration an area of 1000 ha was found to contain 13000 trees over 0.6m dbh.

In the longer term the only effective conservation measures are going to be by the complete protection of the habit, i.e. in situ conservation by the preservation of the ecosystem in carefully selected Reserves. Evidence on the ecological status of Agathis in these forests is incomplete and mostly based on isolated observations. However, the generalisation which emerges is that Agathis stands comprising trees of all sizes, i.e. those which are apparently self perpetuating, are restricted to 'poor' sites thoroughout Malesia, and only on the south western Pacific islands do they grow on normal zonal soils. How the isolated trees and small groups of Agathis on zonal soils in Malesian rain forests perpetuate themselves remains uncertain (Whitmore and Page, 1980).

In a few cases the ex situ establishment of conservation stands can help, particularly if there seems little chance of protecting valuable seed stands, or these stands are in remote and inacessible areas where it is expensive to collect seed e.g. New Hebrides and Santat Cruz. It is possible that in Agathis the allopatric, but taxonomically close, species may be interfertile, and the establishment of juxtaposed taxa will open the door to tree breeding. Ex situ stands for seed collection outside the normal range of the species may also allow the protection against the ravages of the larva of the moth Agathiphaga, which is a serious pest in the Pacific area.

SEED COLLECTION AND STORAGE

It is probably true to say that problems of seed collection and storage are one, if not the main, reason why reafforestation with Agathis has not taken place on a much wider scale. The comparatively small, winged seeds are difficult to collect because the cones shatter when ripe, and on forest trees are borne in quantity only on the smaller peripheral branches of large, old trees with spreading crowns. Large quantities are therefore only available when such trees are felled during the very limited period as the cones approach maturity. However, once small plantations have been established cones with fertile seed are present on comparatively small trees from age 20 years onwards. These are easily harvestered for a more extensive second rotation. In Australia and New Caledonia scions from adult trees have been successfully grafted onto seedling rootstocks, and the small trees (3-4m, 12 years) in New Caledonia are now beginning to fruit.

If mature cones are collected there is, unfortunately, no guarantee of a subsequent crop of quality seed. A considerable number of the seeds may be empty, e.g. in 1979 on Aneityun island in the New Hebrides 95 per cent of the 110-180 seeds per cone were sterile, and in Java the average number of fertile seeds per cone is reported to range from five to 70. Also a range of insect pests attack the developing seed. Most noticeable of these is the larva of the moth Agathiphaga spp., in the south-west

Pacific region. In Fiji levels are normally less than 5 per cent, but occasionally 20-30-(70) per cent are destroyed, and in New Caledonia the pest has only recently been reported (Bowen and Whitmore, in press). In Australia, where the original description of Agathiphaga queenslandensis was made (Dumbleton, 1952), the attack levels are also low. However, in the Solomon Islands and New Hebrides, two potentially important seed sources, 70-(95) per cent of seeds are destroyed.

Agathiphaga has not yet been found in Papua New Guinea but two other species of moth have been raised by H. Roberts from caterpillars destroying seed in cones of A. robusta ssp. nesophila and A. labillardierii. The scale of damage has not yet been quantified but may be large, as in some instances damage occurs at a very early stage in female cone development.

It appears likely that if Agathis seed collections become more detailed and widespread further cone and scale insects will be discovered throughout the range. Insect attacks may be easier to control in small seed stands or seed orchards or by the ex situ conservation of Agathis species grown outside the natural range of its pest.

Difficulty has always been experienced with seed storage and in most cases viability drops quickly to a low percentage in only a few weeks. Where large plantations have been established they have almost invariably been raised from freshly collected seed which has been germinated as soon as the drying cones have been split open in the sun. These seeds contain c. 65 per cent moisture at cone opening and do not fall below 20 per cent through natural drying.

Part of the problem in collecting seeds for longer term storage arises from the difficulty of ensuring that all cones (and hence seeds) are fully mature at the time of harvest. If seeds are even slightly immature they lose viability quickly and ripens frequently varies considerably between neighbouring trees and often within a single crown. Considerable uncertainty also exists over the best method of transporting seed from freshly opened cones over long distances for either final storage or immediate planting. Incorrect CO_2/O_2 balance, overheating, and chilling in airliner cargo holds have been suggested as causing premature seed death. At the present time transport in a densely packed, well-insulated container seems to offer the best chance of success. Despite the difficulties some successes in storage have been reported. Between 1958 and 1962 Queensland State Forest Service stored air dried seeds (12-15 per cent moisture content) of A. robusta (possibly in fact A. microstachya or A. atropurpurea) at -15°F in airtight containers with no loss of the initial viability of 64 per cent. In non-airtight containers viability fell to 17.5 per cent, while at room temperature all seeds died. These results are in broad agreement with those of R. D. Smith at the Royal Botanic Gardens, Kew, who has found that seeds of A. australis, A. macrophylla (Solomon Islands provenance) and A. robusta behave in an 'orthodox' manner when dried to between 16 and 6 per cent moisture content, i.e. reducing the moisture content of the seed or reducing the storage temperature, increases longevity.

Further, detailed work is clearly required before a wholly satisfactory solution to the storage problem can be found but not until it is solved will it be possible to organise large scale trials and inter-country exchanges with any degree of confidence.

ACKNOWLEDGEMENTS

The research on which this paper is based was financed by the British Overseas Development Administration (Scheme R2881). The generous co-operation of Forest Departments, timber companies and foresters throughout the range where Agathis grow and elsewhere is most gratefully acknowledged.

LITERATURE CITED

Bowen, M.R. and Whitmore, T.C., in press: A second look at Agathis. C.F.I. Occasional Paper.

de Laubenfels, D.J., 1972: Coniferae. Flore de la Nouvelle Caledonie.

de Laubenfels, D.J., 1979: The Moluccan dammars (Agathis, Araucariaceae) Blumea 24, 499-504.

Dumbleton, L.J., 1952: A new genus of seed-infesting Micropterygid moths. Pacific Sci. 6, 17-29.

Hyland, B.P.M., 1978: A revision of the genus Agathis (Araucariaceae) in Australia. Brunonia 1, 103-115.

Lanly, J.P. and Clement, J., 1979: Present and future forest and plantation areas in the tropics. FAO, Rome.

Meijer Drees, E., 1940: The genus Agathis in Malaysia. Bull. Jard. Bot. Buitenz. Ser. 3, 16, 455-74.

Sudarmo, M.K., 1956a: Tabel-tegakan sementara dari Agathis lorathifolia Salisb. (=Agathis alba). Peng. Penj. Hut. Indon. 52.

Sudarmo, M.K., 1956b: Tabel-volume untuk Agathis loranthifolia (=A. alba). Peng. Penj. Hut. Indon. 53.

Team Reboisasi, 1971: Pedoman tanaman damar (Agathus loranthifolia Salisb.) Diektorat Reboisasc dan Rehabilitasi.

Warburg, D., 1900: Coniderae. Araucariinae. Monsunia 1, 182-6.

Whitmore, T.C., 1976: Natural variation and its taxonomic treatment within tropical tree species as seen in the Far East. In Burley, J. and Styles B. T. eds. Tropical trees: variation, breeding and conservation. London and New York.

Whitmore, T.C., 1977: A first look at Agathis. C.F.I. Trop. For. Pap. 11.

Whitmore, T.C., 1980: A monograph of Agathis. Plant Syt, and Evol. (in press)

Whitmore, T.C. and Page, C.N. 1980: Evolutionary implications of the distributions and ecology of the tropical conifer Agathis. New Phytol 84, 407-416.

O PINHEIRO KAURI — UM LUGAR NA SILVICULTURA SUL AFRICANA?

B. Bredenkamp
Natal Forestry Research Centre, Pietermaritzburg
REPUBLIC OF SOUTH AFRICA

Resumo

O crescimento de duas procedências de *Agathis robusta* e uma mistura de *A. microsthachya* e *A. atropurpurea*, nas condições ecológicas da Zululândia, e comparado com *P. elliottii*. Equações de regressão para volume e estimativas de espessura da casca e conicidade do caule são apresentadas.

KAURI PINE – A PLACE IN SOUTH AFRICA FORESTRY?

Summary

The growth of two provenances of Agathis robusta and a mixture of A. microstachya and A. atropurpurea under Zululand conditions are compared with that of Pinus elliottii. Volume regression equations and estimates of bark thickness and stem taper are supplied.

INTRODUCTION

Most timber growers have seen the magnificent Kauri Pines grown in many of our parks and botanical gardens. These specimens are members of the genus Agathis and their most noteworthy feature are the massive, columnar trunks. However, virtually no use of the genus has been made for commercial afforestation in South Africa. Even ornamental plantings are scarce in comparison with Araucaria which is botanically it's closest relative.

Kauri Pines are tall, evergreen and natives of New Zealand, Australia, New Caledonia, Fiji, Philippine Islands and the Malay Peninsula (Dallimore and Jackson,1966). Apart from the considerable geographic range, the Kauri Pines have a wide ecological amplitude from evergreen rain forest to climates with a marked dry season. Altitudinal variation ranges from sea level to 2000 m (Whitmore, 1977).

Although Dallimore and Jackson (ibid) list 21 species of Agathis the taxonomy "is in a state of considerable confusion" (Whitmore, ibid) and it appears as if provenances have been elevated to species status. Whitmore (ibid) has recognized 13 species.

Three sample plots of Agathis are in existence in Southern Zululand. The oldest, A. robusta, was discovered by research staff at Port Durnford when the trees were already 30 years old. The origin of the seed and sylvicultural history have been lost but accurate records have been maintained for the last 27 years. The other two plots were established in an arboretum at KwaMbonambi (28° 40' S, 32° 10' E) and detailed records are available. Both seedlots were received from the Queensland Forest Service, Brisbane. These were imported as A. palmerstonii in 1936 and A. microstachya in 1940. An adjacent arboretum plot was established with Pinus elliottii, the major conifer used in Zululand, and valid (albeit not statistical) comparisons between the growth rates can be made. No comparison with the older Agathis plot is possible, but data are presented to complete the picture in respect of the genus' potential.

A recent revision of Agathis in Australia (Hyland, 1978) has shown A. palmerstonii to be the Northern Queensland provenance of A. robusta. Although reproductive material was not available, a recent inspection of the local stands by forest botanist R.J. Poynton (pers. comm.) has shown the A. microstachya plot to be a mixture of A. microstachya and A. atropurpurea and the A. robusta plot represents the Southern Queensland provenance of the species. To summarize, this article deals with the two major provenances of A. robusta and a mixture of A. microstachya / A. atropurpurea. The provenances of A. robusta will be referred to as N.Q. A. robusta and S.Q. A. robusta. The mixture is denoted in the tables as A. micro/atro.

METHOD

The plots were established in the open with nursery raised plants at an espacement of 2.74 x 2.74 m. The trees were subsequently pruned to 7 m height in three lifts. Measurement was at irregular intervals on an individual tree basis. Thinnings were carried out at the discretion of various research officers. The diameter and height growth are shown together with the applicable thinning regimes in Figures 1a – d.

At each thinning operation a sample of the culled trees were measured as sample trees. Earlier data were collected by dividing the entire bole into 3 m lengths and determining the over-and under bark midpoint diameters of each section. In these cases the last sections were of irregular length. Later data were collected by Hohenadl's method whereby the bole (to 75mm o.b. diameter) was divided into 10 sections of equal length. The under-bark volumes of each section were in both cases determined by Huber's method. As the two methods of sample tree data collection were incompatible, all earlier data were brought into line with more recent work by graphically determining the length of the bole to an o.b. diameter of 75 mm and then re-calculating the u.b. volume of the last section.

Volume regression equations per species were fitted according to the model:

$$\log_{10} V = b_0 + b_1 \log_{10} D.b.h. + b_2 \log_{10} Ht$$

where V = underbark volume to 75 mm diameter (m^3),
D.b.h. = overbark diameter at 1,30 m height (cm),
Ht = Total tree height to apical tip (m).

Objections have been raised about this type of model (Cao, Burkhart and Max, 1980) but it is the standard model used by the Directorate of Forestry and the results can thus be easily incorporated into existing data processing systems. The data base is also too small for more sophisticated modelling and areas currently planted with Agathis are so small as to be of no consequence.

The range of tree sizes measured as sample trees are shown in Figure 2.

Figure 1a : N. Queensland Agathis robusta

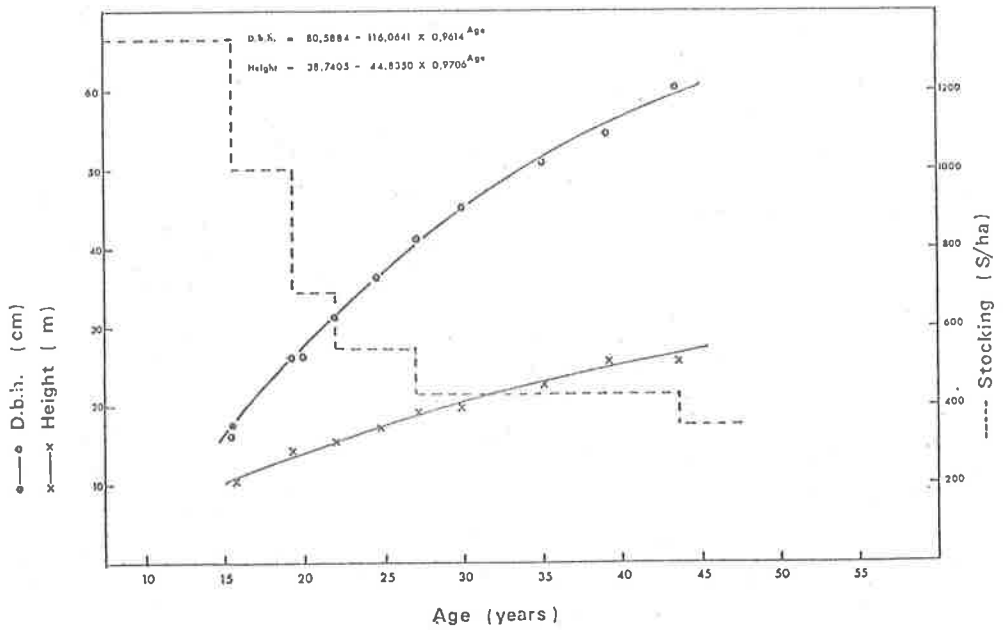


Figure 1b : Agathis microstachya / A. atropurpurea mixture

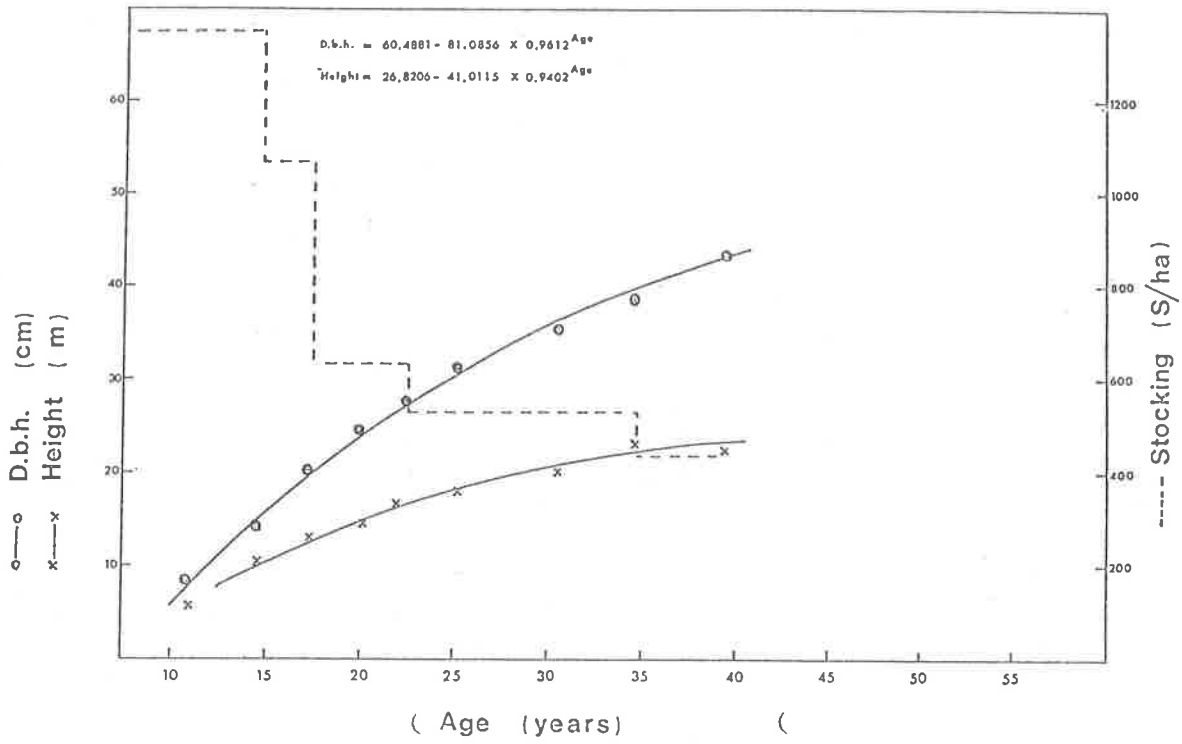


Figure 1c : S. Queensland Agathis robusta

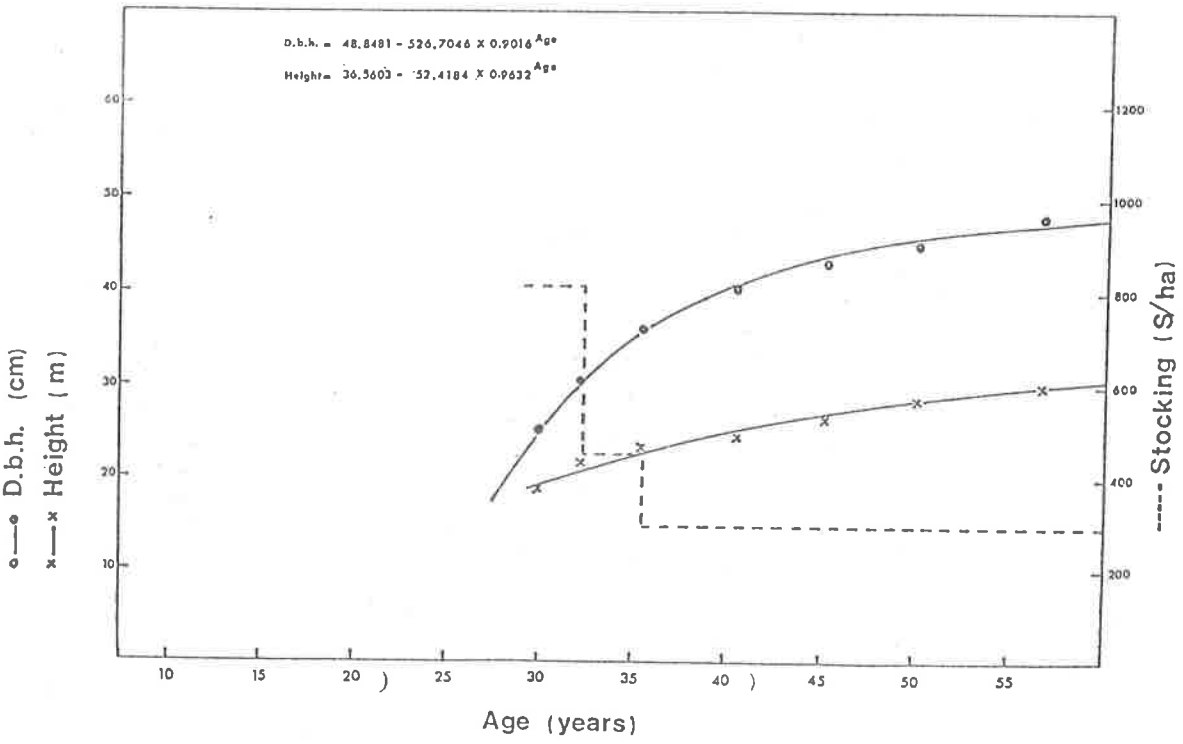


Figure 1d : Pinus elliottii

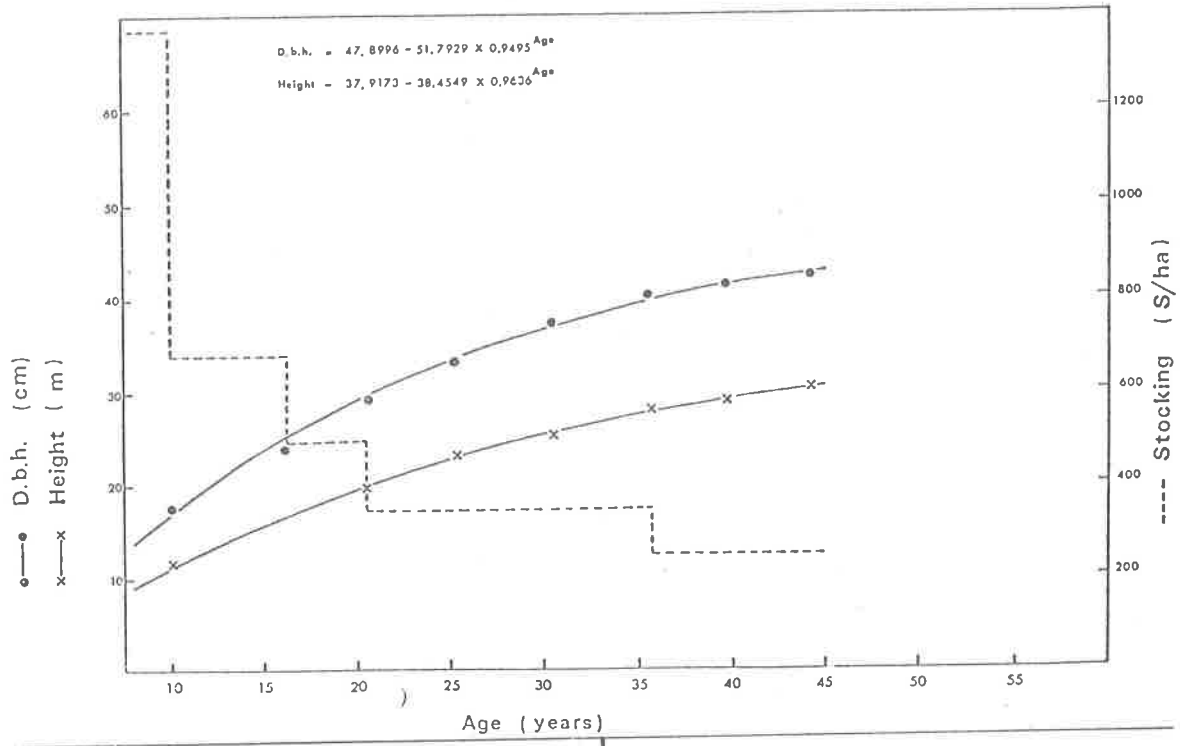


Figure 2

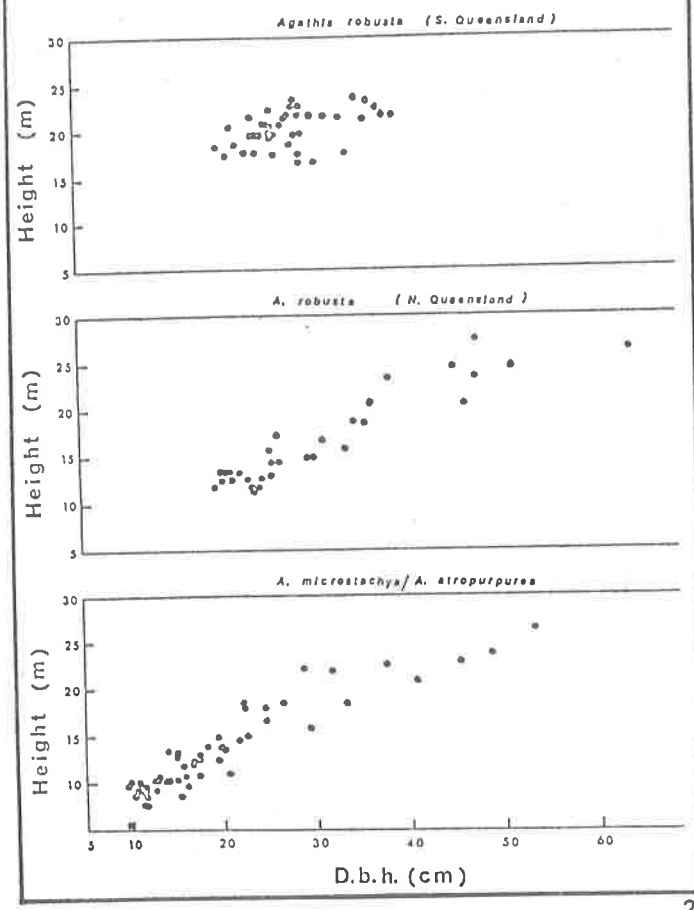
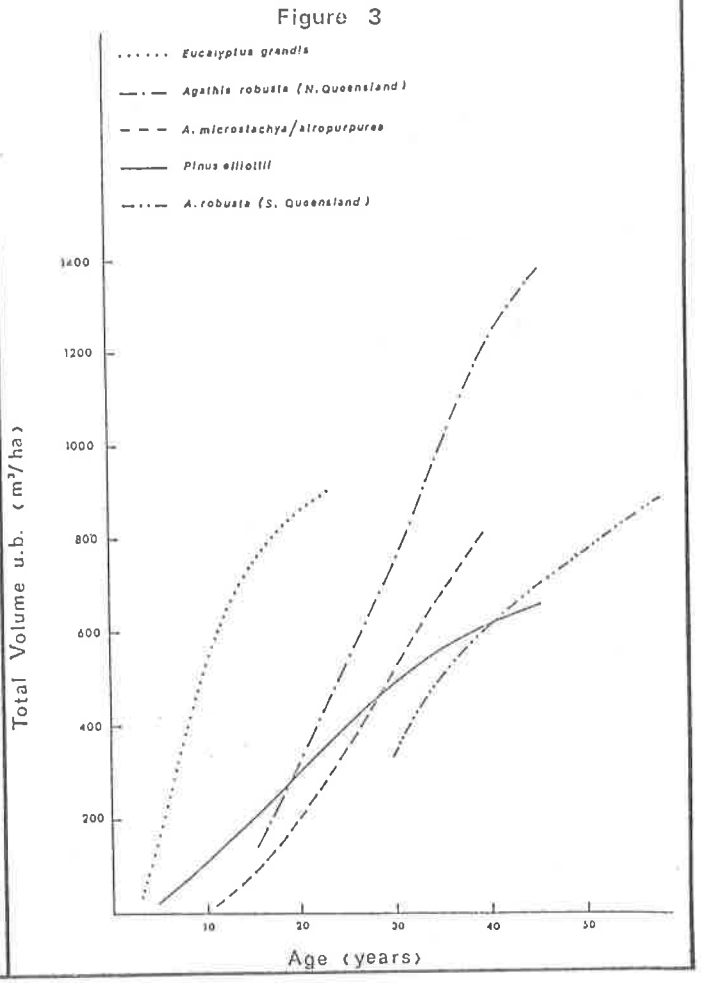


Figure 3



The use of 75 mm diameter as the cut off point in respect of tree height is purely arbitrary but the underbark volume to that point is of more use than that to the apical tip. The height at which this diameter occurs was further investigated by regression analysis.

As both o.b. and u.b. midpoint diameters were recorded for sample tree measurements bark thickness could be investigated. Bark thickness was defined as (β o.b. - β u.b.) /2 and the influence of tree size and position on the bole was analyzed with the use of regression techniques.

One of the most striking features of Agathis trees is the apparent lack of taper resulting in columnar boles. As the diameter growth is particularly good without any corresponding increase in height, the taper must be more pronounced than expected. The taper was investigated for a basal log of 6 m length and a second log 3 m in length. Overbark diameters at 6 m and 9 m were determined graphically. By means of subtraction and then division by log length taper was determined in units of mm/m.

RESULTS

Fitting of the sample tree data to the volume model yielded the regression coefficients presented in Table 1.

It would be most convenient to have only one volume equation for the varieties of Agathis planted in South Africa. The hypothesis that there is no difference between the volume equations was tested with an analysis of covariance shown in Table 2. The differences are highly significant ($p = 0,01$) and the individual equations were used for subsequent analysis.

Prediction of the height where the diameter o.b. is 75 mm was attempted by means of multivariate regression analysis. Of the variables tested only top height was significant without any polinomial of a higher order than the linear term. The homogeneity of the regression coefficients was tested with an analysis of covariance and the differences were found to be highly significant ($p = 0.01$). The regression equations are presented in Table 3.

Table 1 Regression coefficients for volume model

Variety	b_0	b_1	b_2	r
N.Q. A.robusta	-4,2679	1,6712	1,2184	0,995
S.Q. A.robusta	-4,0762	2,1300	0,5652	0,968
A.micro/atro.	-4,8212	2,3252	0,8638	0,996
P. elliottii	-4,6370	1,9306	1,1567	-

Table 2 Analysis of covariance : volume regression equations

Source	SSD	df	ms	F
Deviations from common regression	0,334			
Between regression coefficients	0,079	2	0,040	18,35**
Error	0,255	118	0,002	

Table 3 Equations for prediction of height where diameter (o.b.) is 75 mm as a function of top height.

Type	n	Equation	r
N.Q. A.robusta	25	Ht_{75} = -2,5266 + 0,9779 Ht	0,981
S.Q. A.robusta	40	Ht_{75} = 1,6464 + 0,7939 Ht	0,827
A.micro/atro	43	Ht_{75} = -5,6850 + 1,0832 Ht	0,953

Prediction of bark thickness in a multivariant analysis showed both diameter (o.b.) and the height above ground at which that diameter was measured to be significant. An analysis of covariance showed highly significant differences between varieties. The prediction equations are thus distinct and of the form:

$$B.T. = b_0 + b_1 D + b_2 Ht$$

where B.T. = bark thickness (mm)
D = diameter (o.b.) where B.T. determined (cm)
Ht = height where B.T. determined (m)

The regression coefficients, means and standard deviations are presented in Table 4.

Prediction of stem taper for a butt log 6 m in length by means of d.b.h. and height could not be achieved with sufficient accuracy. Prediction of taper in a second log 3 m in length was not feasible. Mean taper with the relevant standard deviations is presented in Table 5.

COMPARISON WITH MAJOR COMMERCIAL SPECIES

The Zululand forestry area is planted almost exclusively with either P. elliottii or Eucalyptus grandis. Any conclusion as to the viability of Agathis as a commercial timber species must be based on a comparison with these species.

Volume estimates were made with the previously mentioned model using the coefficients supplied in Table 1. The coefficients for P. elliottii are from the standard regression equation in use by the Directorate of Forestry. Total volume was calculated as the standing volume in m^3/ha at time of each measurement plus the cumulative volume removed in thinnings. The results are presented in Figure 3.

Comparisons between N.Q. A. robusta, the A. microstachya / A. atropurpurea mixture and P. elliottii are considered valid as the arboretum plots are in close proximity. The data on S.Q. A. robusta was gathered on a different site and is negatively biased as no record of volumes removed in early thinnings are available. The E. grandis volume production represents the growth from the treatment which has performed the best in a replicated spacing experiment situated a few kilometres from the Agathis plantings. This is probably far superior to that achieved in normal practice. The P. elliottii volumes are biased very slightly upwards in that the volume equation is based on volume (u.b.) to the tip whereas the Agathis is to a 75 mm diameter cut off point.

It is apparent that volume production of Agathis starts more slowly in comparison with the major commercial species and the development of the mean annual increment with time is shown in Figure 4. Comparative figures are presented in Table 6.

CONCLUSIONS

1. D.b.h. and height growth of open planted Agathis is slower than that of P. elliottii during an initial period of 19 to 29 years.
2. Mean annual increment of Agathis in Zululand is still on the increase after 40 years whereas that of P. elliottii on an adjacent plot culminated at 30 years age.
3. In comparison to P. elliottii, N.Q. A. robusta and a mixture of A. microstachya and A. atropurpurea have produced respectively 96,6 and 32,7 % more underbark volume per unit area after 40 years.
4. A common volume regression equation for the species investigated is not feasible.
5. The length of the bole to an overbark diameter of 75 mm can be accurately predicted if tree height is known.
6. Agathis bark is thin and rarely exceeds 12 mm in thickness. Bark thickness is correlated with both diameter and height above ground.
7. Stem taper of Agathis could not be predicted with accuracy. It exceeds the figure normally used for softwood sawlogs.

Table 4 Parameters of bark thickness data

Variety	Regression coefficients b_0	b_1	b_2	n	mean	s.d.
N.Q. A.robusta	2,1977	0,2423	0,0553	104	7,30	2,63
S.Q. A.robusta	0,4327	0,2692	0,1688	266	7,33	2,97
A.micro/atro	3,2534	0,1927	-0,0779	126	5,246	1,662

Table 5 Mean taper of butt and second logs

Variety	Butt log (0-6 m)		Second log (6-9 m)	
	Mean (mm/m)	S.D.	Mean (mm/m)	S.D.
N.Q. A.robusta	18,03	3,82	17,47	2,57
S.Q. A.robusta	11,37	2,58	9,65	2,94
A.micro/atro.	14,96	3,04	13,60	4,48

DISCUSSION

The normal rotation for coniferous sawlog production in State Forests in South Africa is 35 years. Over an equivalent period Agathis has the potential to produce considerably more timber. Initial growth rates are slow in comparison to the species currently in use but open planting is possibly the cause. The project leader for Agathis at the Commonwealth Forest Institute, M.R. Bowen (pers. comm.) has recommended the use of Leucaena as a nurse crop to provide shade for the first five years. More recent plantings in Zululand have incorporated interplanting with pines without any markedly beneficial effect. Inter - planting does not provide shade for several years.

At this stage very little is known about the sylvicultural requirements of Agathis under local conditions. Seedlings are produced in profusion when seed beds are prepared under mature stands and these can be transferred to a nursery without difficulty. Seed collection must be accurately timed as the cones disintegrate upon ripening. Seed is highly perishable. Propagation from cuttings is possible and the stumps left by thinning in research plots have coppiced readily.

Although the stands described in this article were pruned, Agathis is an efficient self pruner and live pruning will probably prove to be unnecessary. There are indications that pockets of decay may form at self-pruning wounds. Very early live pruning in recent plantings had the result that the crowns flopped over although the trees subsequently recovered.

It appears as if Agathis is quite happy at stocking levels much higher than those at which pines are normally grown in South Africa. Recent thinnings were not aimed at sylvicultural benefit to the stand but rather as a source of timber for testing purposes.

Unfortunately the results of these timber tests are not yet available. Timber from natural forests is eminently suitable for general joinery. The exceptionally good diameter growth and late culmination of mean annual increment make Agathis very promising for the production of peeler logs for veneer.

It is recommended that further research into Agathis as a commercial timber species under South African conditions be undertaken. Provenance testing of the species already tried in Zululand and at least a preliminary screening of the 10 species not yet introduced are imperative. Establishment research into the use of nurse crops such as Leucaena or Albizia with available plants should proceed forthwith.

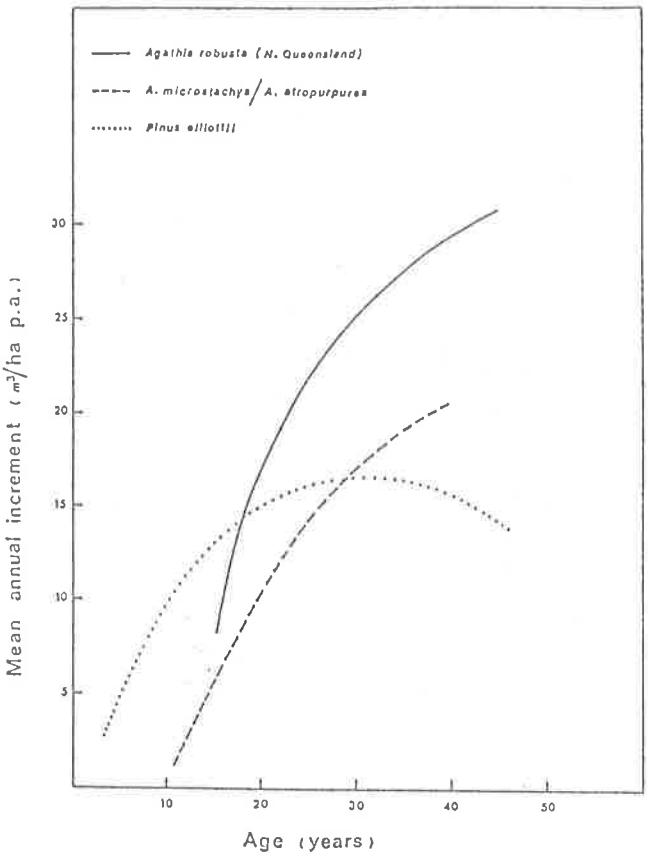
ACKNOWLEDGEMENTS

The assistance of Tony Buckingham, Larry Bentley and Ray Pillay with the collection of data and preparation of diagrams is gratefully acknowledged.

Table 6 Volume production of Agathis expressed as a percentage of P. elliottii production on the same site

Age	A.microstachya/atropurpurea	N.Q. A.robusta
15	42,9	61,2
20	66,2	114,2
25	86,8	132,4
30	102,4	150,0
35	117,5	171,9
40	132,7	196,6

Figure 4



REFERENCES

1. Cao, Q.V., H.E. Burkhart and T.A. Max, 1980. Evaluation of two methods for cubic-volume prediction of loblolly pine to any merchantable limit. Forest Sci., Vol. 26, No. 1, 1980: pp 71 - 80.

2. Dallimore, W. and A.B. Jackson 1966. A Handbook of Coniferae and Ginkgoaceae, Fourth Edition, Edward Arnold (Publishers) Ltd., London, 1966: 729 pp.

3. Hyland, B.P.M. 1978. A revision of the Genus Agathis (Araucariaceae) in Australia. Brunonia, Vol. 1, No. 1. February, 1978: pp 103 - 115.

4. Whitmore, T.C. 1977. A first look at Agathis. Tropical Forestry Papers, No. 11. Unit of Tropical Silviculture, Commonwealth Forestry Institute, Univ. of Oxford, 1977: 54 pp.

CULTURA DE HOOP PINE (*Araucaria cunninghamii* AITON EX D.DON.) IN VITRO

G. E. Burrows
Departmente of Botany —
University of Queensland
AUSTRALIA

Resumo

Tecidos juvenis e adultos de Hoop pine (*Araucaria cunninghamii* Aiton ex D. Don) foram induzidos para formação de brotações. Segmentos do hipocôtilo, quando em cultura em um meio contendo 10 µM BA, formaram gemas adventícias. Segmentos de caule de mudas com 2 anos de idade, e segmentos de brotações das cepas de árvores com 18 anos, desenvolveram brotações ortotrópicas de gemas axilares adventícias. Esta resposta foi obtida em um meio de cultura com deficiências de hormônios, mas é mais intensificada através de baixos níveis de BA (0,01 - 0,10 µM). O enraizamento das brotações produzidas ainda não foi testado.

IN VITRO CULTURE OF HOOP PINE (*Araucaria cunninghamii* AITON EX D.DON)

Summary

Juvenile and mature tissues of hoop pine (*Araucaria cunninghamii* Aiton ex D. Don) were induced to form shoots. Hypocotyl segments, when cultured on a defined medium containing 10 µM BA, formed adventitious buds. Stem segments from 2 year old seedlings and coppice segments from 18 year old trees developed orthotropic shoots from concealed axillary bud traces. This response was achieved on a medium lacking plant hormones, but is enhanced by low levels of BA (0.01 - 0.10 µM). Rooting of shoots produced has not been attempted.

INTRODUCTION

Traditional techniques of vegetative propagation possess limitations to their usefulness, especially in the field of forest tree breeding. In *Araucaria cunninghamii* the specialized physiological characteristics of the bud system further restrict the usefulness of these techniques. It is, therefore, desirable that tissue and organ culture techniques be developed which provide alternate means for propagating selected genotypes.

In the last decade many reports have appeared concerning the use of tissue culture techniques in the propagation of gymnosperms (Pierik, 1979). However, in most reports the material cultured has been of embryonic or young seedling origin. A greater gain by tissue culture techniques will lie in the production of new plants from mature trees of superior genotype.

This report deals with progress further to the initial work of Haines and de Fossard (1977) on the culture of concealed axillary bud traces, taken from the orthotropic stem. Also reported are initial investigations into the culture of embryos, and hypocotyl and cotyledon explants.

MATERIAL and METHODS

Juvenile Tissue

The experimental material comprised hypocotyl and cotyledon explants from 7 day old seedlings raised in a glasshouse and embryos from mature seed.

Hypocotyl explants (8 - 10 mm length) were cultured vertically with their morphologically basal end in the media, while cotyledon explants (8 - 12 mm length) were cultured with their abaxial surface on the media. The established seedlings were cut at the soil surface level, sterilized in 0.5% available Cl NaOCl for 15 minutes, rinsed three times in sterile water, then dissected aseptically.

Recently a disinfestation regime for obtaining aseptic seedlings *in vitro* has been established. Seed is soaked for 2 hours, cracked open, the embryo and endosperm removed and placed in sterile petri dishes to imbibe sterile water at 27°C for 24 hours. The embryo and endosperm is then surface sterilized in 0.5% available Cl NaOCl for 3 - 4 minutes, washed 3 times in sterile water, after which the embryo is excised from the endosperm.

Mature Tissue

The experimental material comprised various types of explants from 2 and 6 year old seedlings and coppice from 18 year old trees decapitated at ground level.

Disinfestation of stem material consisted of washing 50 mm lengths, cut from the upper part of the orthotropic mainstem, in running tap water for 15 minutes. These pieces were then immersed for 5 minutes in 70% ethanol, then for 15 minutes in 5.0% available Cl NaOCl, followed by 3 rinses in sterile water. During dissection dead needle tips and necrotic stem lesions were excised to reduce contamination by saprophytic fungi . With these measures contamination was less than 25%, even for field grown material.

Typically, explants cut from the 50 mm lengths were 4 - 6 mm long, containing 2 to 5 leaf axils, and were cultured vertically with their morphologically basal end embedded in the medium.

In the basal portion of 6 year old seedlings, after peeling off dead bark to expose a sterile surface, 10 x 15 x 4 mm slices of tissue were excised. The excised tissue extended inward from the exposed surface to include a sliver of secondary xylem.

Media

Media concentrations used correspond to those of Haines and de Fossard (1977), except the medium (M) level of mineral nutrients which was replaced by half strength Murashige and Skoog (1962) (MS) inorganic salts, supplied in powder form by Flow Laboratories. This basal medium (BM) without plant hormones was variously supplemented with benzyladenine (BA) and naphthalene acetic acid (NAA) at the concentrations 0 to 50 µM and 0 to 1 µM, respectively.

A medium consisting of half strength MS, 2% sucrose and 0.7% agar was used in raising aseptic seedlings from embryos.

10 ml of nutrient agar medium was dispensed into 80 x 25 mm polycarbonate tubes with screw caps, and autoclaved at 121°C for 15 minutes at 103 kPa. Cultures were maintained under low level fluorescent lighting at 23 ± 1°C with a 16 hour photoperiod. Experiments were assessed after 5 to 6 weeks.

RESULTS

Juvenile Tissue

On BM supplemented with BA (2, 10, 50 µM), in the presence or absence of NAA (0.1 µM), excised hypcotyls of hoop pine seedlings produced adventitious buds within 4 to 5 weeks. BA at 10 µM, with or without NAA, gave best bud development. Under the same conditions cotyledon explants gave no response. The organogenetic response of the hypocotyl tissue is analogous to that of other gymnosperm species similarly cultured.

To investigate the response of even younger material in culture and to develop a source of known sterile seedlings aseptic embryo culture was commenced. To date progress has been limited to the development of a disinfestation regime which gives sterile, easily excised embryos.

Mature Tissue

On BM the response of stem explants from 2 year old

seedlings to 5 concentrations (0, 0.01, 0.1, 1.0, 10 µM) of BA and 3 concentrations (0, 0.1, 1.0 µM) of NAA, in all combinations, was assessed.

Table 1. Shoot growth from cultured stem segments: average length (mm) of longest shoot after 38 days

NAA (µM)	BA (µM)				
	0.00	0.01	0.10	1.00	10.00
0.00	3.8	5.9	4.9	1.9	0.0
0.10	3.9	5.4	3.6	1.9	0.0
1.00	3.8	3.3	3.4	1.4	0.0

All treatments supported development of shoots from the concealed bud traces, except those incorporating 10 µM BA which resulted in unorganized swelling of the explants. 1.0 µM BA resulted in misshapen shoots of limited growth. The remaining BA levels supported normal shoots, the relatively low levels of 0.01 - 0.10 µM promoted best growth. In combination with BA, NAA had no promotive effect in the growth of shoots. No adventitious bud formation was induced at any BA concentration.

Stem segments, excised from coppice of 18 year old trees, when cultured on BM also exhibited development of shoots from bud traces. The coppice material used gave a very variable response in culture, indicating more research is necessary on this mature aged material.

Shoots which developed from the concealed bud traces were excised and placed on BM, as were the original explants. From the original explants 2 - 4 vigorous shoots then developed from the bud traces of leaves which remained from the base of the excised shoot. The excised shoots, once decapitated, could form 1 or 2 buds, but these buds did not elongate. Hormonal control of these processes may be effective.

Slices of tissue excised from the base of 6 year old seedlings were placed on BM. This type of explant was able to form a shoot provided that a bud trace was included in the tissue. This source of buds has not, to the author's knowledge, been exploited previously. This technique could replace the need to decapitate or girdle trees to obtain coppice.

D I S C U S S I O N

Although the above results do not represent, to this stage, a great advance on the work of Haines and de Fossard (1977), they do show the establishment of a workable system of proliferation, and that orthotropic shoots can be formed in vitro from trees old enough to be judged as superior genotypes.

The system of proliferation which appears most suitable for hoop pine bears comparison with systems used in the propagation of other mature gymnosperms, as shown in Table 2.

Table 2. Response of mature gymnosperm tissue in vitro

Author	Species	Ortet age (yrs)	Explant	Organogentic response
----	*Pinus radiata*	8	needle sections	callus → adventitious buds
Coleman & Thorpe (1977)	*Thuja plicata*	4-10	lateral shoot tip	adventitious buds
Boulay & Franclet (1977)	*Pseudotsuga menziesii*	15	decapitated buds	axillary buds
Mehra-Paltra et al. (1978)	*Pinus taeda*	5	needle fascicle	adventitious buds, shoot development
Von Arnold & Eriksson (1979)	*Picea abies*	5-50	vegetative buds	adventitious buds
Wochok & Abo El-Nil (1977)	*Pseudotsuga mensiesii*	53	shoot tip	adventitious and axillary buds

Development of adventitious buds has been the most commonly reported response, an observation shared by Jansson and Bornman (1980). In hoop pine shoot formation and proliferation has been achieved by means of concealed axillary bud traces. A similar procedure has proven successful in the propagation of some angiosperm tree species eg. *Populus* spp. (Christie, 1978), *Eucalyptus* spp. (Hartney and Barker, 1980), *Malus domestica* (Lane, 1978). Proliferation rates for hoop pine are unlikely to equal those of angiospermous species because growth rates are slower and strong control over potential bud sites is evident, even with decapitation and cytokinin stimulation.

A factor to be considered in proliferation by either axillary or adventitious buds is stem habit. In hoop pine, which has a strongly determined bud system, culture of the mainstem bud traces has resulted in the formation of orthotropic shoots. While it is very probable that any adventitious shoots produced in vitro would also be orthotropic in nature, this has not yet been proven. Information gained from adventitious shoots borne on juvenile material will be important in this regard.

Consideration should also be given to the physiological age of tissues cultured. Coppice from low on the mainstem is in a physiologically juvenile condition, thus shoots from this coppice should display juvenile characteristics such as high growth rates and rootability. This is not certain for adventitious buds borne on a mature tree's current season's growth.

Shoot production has been achieved from tissues ranging in age from those of embryonic origin to those from trees of an age where selection of superior genotypes is possible. Problems in relation to proliferation rates, shoot elongation and rooting remain.

A C K N O W L E D G E M E N T S

This research is being supported by the Rural Credits Development Fund and the Reserve Bank of Australia. Queensland Department of Forestry is assisting.

L I T E R A T U R E C I T E D

- - - - -, 1979. Vegetative propagation by tissue culture. Report N.Z. For. Res. Inst. 1979. 29-30.

Arnold, S. von & Eriksson, T. 1979. Induction of adventitious buds on buds of Norway spruce (*Picea abies*) grown in vitro Physiol. Plant 45: 29-34.

Boulay, M. & Franclet, A. 1977. Recherches sur la propagation vegetative du Douglas: *Pseudotsuga menziesii* (Mirb) Franco. C.R. Acad. Sc. Paris: Ser. D 284: 1405-1407.

Christie, C.B., 1978. Rapid propagation of aspens and silver poplars using tissue culture techniques. Proc. Inter. Pl. Prop. Soc. 28: 255-260.

Coleman, W.K. & Thorpe, T.A. 1977. In vitro culture of Western Redcedar (*Thuja plicata* Donn). I. Plantlet formation. Bot. Gaz. 138: 298-304.

Haines, R. J. & de Fossard, R. A. 1977. Propagation of Hoop Pine (*Araucaria cunninghamii* Ait.) by organ culture. Acta Hort. 78: 297-302.

Hartney, V.J. & Barker, P.K. 1980. The vegetative propagation of eucalypts by tissue culture. Paper for Symposium & Workshop IUFRO Brazil, August, 1980.

Jansson, E. & Bornman, C.H. 1980. In vitro phyllomorphic regeneration of shoot buds and shoots in *Picea abies*. Physiol. Plant. 49: 105-111.

Lane, W.D. 1978. Regeneration of apple plants from shoot meristem-tips. Pl. Sci. Letts. 13: 281-285.

Mehra-Palta, A., Smeltzer, R.H. & Mott, R.L. 1978. Hormonal control of induced organogenesis. Tappi 61: 37-40.

Murashige, T. & Skoog, F. 1962. A revised medium for rapid growth and bioassays with tobacco tissue cultures. Physiol. Plant. 15: 473-497.

Pierik, R.L.M. 1979. In Vitro Culture of Higher Plants. Bibliography. R.L.M. Pierik, Wageningen.

Wochok, Z.S. & Abo El-Nil, M. 1977. Conifer tissue culture. Proc. Inter. Pl. Prop. Soc. 27: 131-136.

FAST GROWING TREES

ANÁLISE DA DISTRIBUIÇÃO, VARIAÇÃO E UTILIZAÇÃO DE RECURSOS GENÉTICOS DA *Araucaria araucana* (MOL.) KOCH NO CHILE

R. Delmastro – C. Donoso
Faculty of Forestry Engineering –
Universidad Austral
CHILE

Resumo

No Chile existem por volta de 140.000 hectares de *Araucária araucana* (MOL.) Koch e estima-se que 85.000 hectares de terra (em 6 parques nacionais) incluem este tipo de floresta. A quantia exata de floresta de Araucária é desconhecida, porque uma grande exploração foi feita nas regiões mais acessíveis antes dos parques serem estabelecidos.

A espécie foi declarada "monumento natural" em 1976, entretanto hoje está sob estudos, a viabilidade de exploração em algumas áreas.

Foi sugerido que existem 2, talvez 3 diferentes classes ecológicas de *Araucária araucana,* baseadas em diferenças climáticas, características de solo e substrato onde as espécies ocorrem, assim como nas diferenças de comportamento e ciclos de desenvolvimento das florestas de Araucária.

Um estudo nas classes ecológicas está em andamento ao presente momento, o qual também preservará alguns recursos genéticos florestais da espécie. Algumas considerações na viabilidade das sementes de Araucária são também discutidas.

REVIEW OF DISTRIBUTION, VARIATION AND UTILIZATION OF GENE RESOURCES OF *Araucaria araucana* (MOL.) KOCH IN CHILE

Summary

In Chile there are around 140.000 hectares of Araucaria araucana (Mol.) Koch and it is estimated that some 85.000 hectares of land, in six national parks, includes this type of forest (after Oltremari, 1979). The exact amount of Araucaria forest conserved is unknown, because heavy exploitation was common in the more accessible regions before some parks were established.

The species was declared "natural monument" in 1976, however today it is under study the feasibility of exploitation in some areas.

It is suggested that two, perhaps three, different ecological races of Araucaria araucana exists, based on different climate, substrata and soil characteristics where the species occurs, as well as on different behavior of copice and development cycles of the Araucaria forests.

A study on ecological races is under way at present time, which also will preserve some of the forest genetic resource of the species. Some considerations on viability of Araucaria seeds are also discussed.

1.- Introduction

Araucaria araucana (Mol.) Koch, is one of the native tree species growing in Chile which has the highest value due to the quality of its timber, used widely in mining, construction, furniture industry, and because the form of the trees makes many places attractive for recreation.

In 1974, the FAO Panel of Experts on Forest Gene Resources, published a list of forest species which should have priority in a worldwide action to preserve the main species under threat of extinction or those which have been seriously diminished in their original distribution (FAO, 1974).

Later, in 1976, another paper updated the information, concerning the current status of this species in Chile, in relation with its gene resources situation (Veblen and Delmastro, 1976).

The purpose of this report, is to add some new information about this subject, since legislation concerning the species has changed and, in the meantime, additional studies have been developened.

2.- Natural Distribution

Araucaria araucana grows in two areas in Chile and Argentina (Fig. 1). 1. Two relatively small populations are found in the massive Nahuelbuta Cordillera of the coastal mountains. The northernmost one grows from 37°40' to 37°50' S and from 1000 to 1400 meters above sea level on both, western and eastern slopes of the mountains (Montaldo, 1974), covering a few thousands of hectares. The other population is a small patch of aproximately 1000 ha at 600 meters altitude found at 38°40' S. (Montaldo, 1974). 2. The mass of the Araucaria forest is located in the Andes Mountains in both, the Chilean and the Argentinean slopes. The northern limit of the species lies at 37°27' S near the Laja lake in Chile (Yudelevich et al., 1965), whereas the southernmost extension is recorded in Argentina at 40°20' S (Tortorelli, 1942). The southern limit in the Chilean side is at 39°48' S near Carirriñe (Montaldo, 1974). In the Andes Araucaria grows between 900 and 1700 m above sea level (Montaldo, 1974). According to Schmitthusen (1960) and Quintanilla (1974) it grows in 1700 to 2000 m in its northern regions and only 1500 meters in its southern habitat.

3.- Environment

Climate

According to Fuenzalida (1965) the general climates where Araucaria grows, following Koeppen classification, are Cfsbi or warm-temperate climate with less than 4 dry months; EFH or ice climate due to altitude, and BSK or cold steppe climate. The first has a strong mediterranean influence and is the prevalent climate of the Nahuelbuta Araucaria forests and of the low and mid altitude forests of the western side of the Andes Araucaria forests. The EFK climate is the one of the highest altitudes where scarce trees grow near the timberline. The BSK climate belongs to the east side of the Andes, which identifies the location of Araucaria forests in Argentina.

Detailed description of precipitation and temperature over the range of the species can be found in Fuenzalida (1950, Almeyda and Saez (1958), Martínez (1965), Montaldo (1974), Quintanilla (1974), Burschel et al. (1976) and Peralta (1980).

Differences in general climate suggest the probability of finding 3 different populations, or ecological races, in Araucaria araucana: One in Nahuelbuta, which is a very isolated population, another on the wet west side of the Andes, and the last one in the drier areas of Argentina and some Chilean valleys on the east side of the mountains.

Substrata and soils

The Araucaria forest of Nahuelbuta grow over granitic rocks from the Precambrian and the Paleozoic. They are described by Ferriere (1963), cited by Montaldo (1974),

The Araucaria forest soils on the Andes are developed over metamorphic and igneous rocks in some places, and mainly over volcanic rocks of the Quaternary (andesitic-basaltic rocks). However, most of these substrata are covered by layers of volcanic ash and pumicilit and other coarse volcanic materials. The effect of glaciation is also evident on the bottom of the Andean valleys in this area, which are covered by alluvial deposits of volcanic materials (Peralta, 1980). A description of these soils is found in Tortorelli (1956), Montaldo (1974) and Peralta (1975 and 1980).

Again, the substrata and soil characteristics also suggest the possibility of differentiation of Araucaria forests at least in two different population - one from the Nahuelbuta mountains, and the other from the Andes.

Biota

A vegetational transect undertaken by one of the authors in Nahuelbuta, shows that up to 1300 m Araucaria is associated with Nothofagus dombeyi, N. obliqua, small trees of N. antarctica and Drimys winteri. It is unusual to find Nothofagus alpina in these forests. N. obliqua and especially N. antarctica are more abundant in or near frost pockets. Above 1300 m and up to 1400 m N. dombeyi is the principal and larger tree besides Araucaria. Above 1400 m N. pumilio appears and becomes more abundant than N. dombeyi with increasing altitude. The understory of Araucaria forests is relatively dense in Nahuelbuta, with Drimys winteri var andina and Chusquea culeou representing 50% or more of the vegetation cover. Other common shrubs are Gaultheria sp, Azara lanceolata, Desfontainea spinosa, Berberis darwini, Pernettya sp., Escallonia sp., Berberis buxifolia, Ribes sp., Pseudopanax laetevirens, Maytenus magellanica, Lomatia ferruginea, Myrceugenia shrysocarpa, Myochilos oblonga, etc. In open areas it is common to find Embothrium coccineum, Lomatia hirsuta and Ovidia pillopillo.

Araucaria seems to be severely attaked by Micronegeria fagi in the Nahuelbuta forests. This is probably due to the common occurrence of N. obliqua in the area.

Associated trees and understory vegetation in the Andes have been described by Montaldo (1974), Landrum and Nimlos (1975) and Gajardo (1980).

According to Peredo et al.(1979), there are many fungi and insects reported on Araucaria. Nevertheless, besides Micronegeria fagi, the only other species that are known to cause damage to Araucaria are Ulelia chilensis, a fungus that destroy seeds (Oehrens, 1963; cited by Peredo et al., 1979), and Calicopsis brevipes, a fungus that attack leaves and bark of the young branches (Butin, 1970, cited by Peredo et al., 1979).

There are some differences in species composition between the forest of Nahuelbuta and the Andes, particularly in understory vegetation. For example, the shrubs Azara lanceolata and Pseudopanax laetevirens and some herbs are common in the Nahuelbuta forests, but do not appear in the Andes.

The reverse occurs with Berberis pearcei, Chiliotrichium rosmarinifolium, Maytenus disticha, etc., and some herbaceous plants like Valeriana lapathifolia. This suggests again the occurrence of some differentiation in two Araucaria populations. The differentiation may be enhanced if it is true that there is a strong tendency of the trees of Nahuelbuta to regenerate vegetatively from the stumps (Schilling and Donoso, 1976). One of the authors has seen only one Araucaria regenerating vegetatively in the Andes Mountains, in Conguillío.

The structure of the forest has been studied in the Andes by Schmidt (1977) and Puente (1980), and the dynamics by Schmidt (1977). According to them most of the forests are unevenly aged, and Araucaria represents 65 to 70% of the number of trees per hectare and 80 to 90% of the basal area in forests in which N. pumilio and/or N. dombeyi are codominant trees. The uneven age composition of the forest is represented by a mosaic of patches of different ages; these patches are interpreted as three or four different phases in a cyclic vegetational change, through which Araucaria is able to autogenically replace itself in all pure or mixed Araucaria stands.

However the conclusion of a work performed by Veblen during 1979 (unpublished data) in Conguillío (Andes mountains) and Nahuelbuta, are at variance with the cyclical development proposed by Schmidt. Veblen shows catastrophically controlled regeneration in the massively disturbed stands in the Andes and gap-phase regeneration in mature stands.

It is probable that the Nahuelbuta Araucaria forests are less influenced by massive disturbance than those of the Andes mountains. This fact may be another point that permits so suggest a differentiated population of Araucaria in Nahuelbuta.

4.- Utilization and Conservation

In its natural area, A. araucana has a very slow growth rate, being one of the long-lived conifers in the world, together with Fitzroya cupressoides, Sequoia sempervirens and others. It is common to find trees over 600 years old in natural forests, and trees over 1000 years old (Tortorelli, 1942 in Montaldo 1974) have been reported.

The height growth of A. araucana growing in natural conditions, is between 5 to 12 centimeters per year, and its diameter growth not more than 2.5 milimeters per year. The total volume per hectare in a natural stand frecuently reaches over 2000 cubic meters, with average yields over 1000 c.m./ha (Nielsen, 1963; Montaldo, 1974; Puente, 1980).

Forests of this species have a high value for turism, since young and adult trees have a unique shape and because the regions where it grows are extremely attractive, especially in the Andes mountains. Besides this, A. araucana together with Fitzroya cupressoides, are by far the two most valuable tree species growing in Chile and for this reason have been seriously threatened through intensive exploitation during the present century.

Forest genetic conservation is a matter of concern of most foresters, because history has demonstrated in many instances that commercially important species have eventually disappeared or seriously diminished in their natural distribution, and are no more available today for their utilization. Although A. araucana is not an extreme case, its potential and distribution have been decreased considerably in some regions in Chile.

"In situ" Conservation.

In Chile there are 6.5 millions of hectares in 52 National Parks and around 7.7 millions hectares in Forest Reserves. It is estimated that 30% of the national territory is owned by the state through different forms of properties. However, the actual trend is to decrease national ownership, but at he same time to rationalize and improve the type and quality of the land under state control (CONAF, 1980).

The A. araucana is naturally preserved in six national parks as shown in the Figure 1. As can be seen on the map, the northernmost portion of Araucaria in natural distribution is outside of any park and therefore lacks any protection.

The total area of this species in Chile is around 150.000 hectares (Yudelevich et al., 1967) and there are some 85.000 hectares of national parks which includes this type of forest (after Oltremari, 1979).

The exact amount of forest of the species conserved today in parks is unknown. Before parks were established, heavy exploitation of the species with varying intensity and frequency was common (SAG, 1970) hence only in rare cases it is possible today to find untouched stands.

In some places where the species occurs its natural regeneration is difficult, because its seeds are eaten by native parrots and it is commercialized as food by the people. In general, portions of the gene pool of A. araucana are definitely lost, especially in the coastal population of Nahuelbuta, and also in the more accessible regions of the Andes mountains.

The current status of A. araucana is quite different as it was reported before by Veblen and Delmastro (1976), because in that year the species was declared a "national monument", which prohibits exploitation and commercialization of its timber. However, at the present time this legislation is under study and probably exploitation will be allowed in the near future; harvesting will be permited under a strict control, in such a way that adequate regeneration must be ensured (Donoso et al., 1980).

The future of the conservation of A. araucana in natural conditions, is still uncertain due to the pending legislation, and because every day there is more pressure on this type of forest for turism and recreational activities (Veblen and Delmastro, 1976).

"Ex-situ" Conservation

Some preliminary work is under way regarding "ex-situ" conservation of this species in Chile. In 1978, a small collection of seeds from the Andes mountains population was sowed, althought its exact origin is not clear.

The purpose of this study is to compare, under the same environmental conditions, different seed lots of the species. In 1979 two new seed lots were included, one from the Andes and one seed lot from the coastal region. The probability of the existence of different ecological races was discussed in previous paragraphs.

These experimental plantings, besides providing some ideas about race differences of the species, will also be a way of conservation of the genetic potential of A. araucana for future utilization.

Because of the difficulty to obtain seeds of this species, and due to the rapid decrease of germination after collection, which has been described in the literature, the seed lots obtained so far have been sowed as soon as possible after seed collection, and this practice will be continued in the future, until the experimental plantations are established.

It is assumed that there will be not much difference in size between seed lots due to sowing on different years, since the growth rate of this species is extremely slow and probably initial differences will be unimportant in long terms. If the seed lots are not collected at once, seeds must be sown in different years as they became available.

Rapid decrease of the viability of A. araucana's seeds under storage has been reported by many authors and most agree, that after four months of storage germination decrease below 10 percent (in Montaldo, 1974). However, our experience indicates that after seven months of storage in a refrigerator in one case, and five months in another case, over 70% of the seeds germinated normally. In both instances, seeds were stratified during 5 or 6 weeks in humid sand under refrigeration. The seed of A. araucana must be classified in the group of short lived seeds, together with other species of the genus reported by Wang (1975). These and other results indicate that much more studies should be conducted on this subject, to ensure future "ex-situ" conservation programs of A. araucana .

A. araucana has been widely planted throughout the world as an ornamental tree, and even though the exact provenance of those trees is unknown, somehow this contributes to preserve some of its genetic potential (Veblen and Delmastro, 1976).

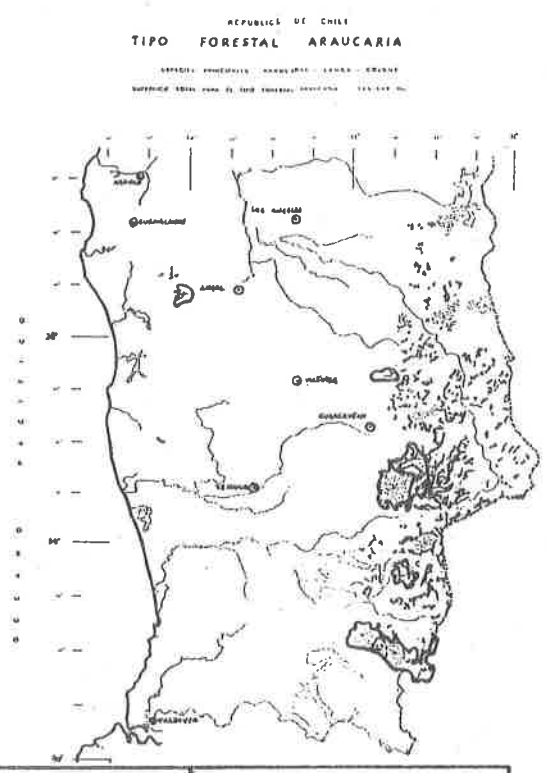


FIG. N°1
Distribution of A.araucana and National Parks with the species in Chile.

5.- Conclusion and Recomendations

The probability is suggested that two, perhaps three, different ecological races of A. araucana exists. This suggestion is based on different climate, substrata and soil characteristics of areas where this species occurs as well as on different behavior of coppice and different development cycles of the Araucaria forest.

Although the species was declared a "natural monument" in 1976, preserving all the forest existing at that moment, today a study of the feasibility of exploitation in some areas, under some specific regulations which assure an adequate regeneration, is under way.

"In situ" conservation of A. araucana exists in Chile by means of six national parks, which all together have 85.000 hectares of forest including the species. However, the northernmost portion of its natural distribution, is not conserved. Probably in all cases, there were intensive exploitation before these national parks were established, especially in the more accessible areas; hence, part of the gene pool of the species has been definitely lost.

There are some new studies under way directed toward the reconnaissance of ecological races, mainly between coastal and inland provenances. The experimental plantings of this study will provide some "ex situ" conservation of A. araucaria genetic resources for future utilization.

Some recomendations were suggested by Veblen and Delmastro (1976) concerning reconnaissance of the real extent of the A. araucana resource and its status; based on this, re-study of the extent and location of the national parks was also recommended.

Future programs of "ex situ" conservation must be complemented by studies on storage and germination properties of the seeds of A. araucana, since results reported in the literature and those found by the authors are not equivalent. Studies on cariotype and development of the germination of Araucaria seeds, have been recently finished in Chile (Cardemil and Varner, unpublished data). These studies also will be of importance for new provenance trials which must be undertaken in the near future.

References

1. Almeyda, E. y Saez, F., 1958: Recopilación de datos climáticos de Chile y mapas sinópticos representativos. Ministerio de Agricultura, Santiago, Chile. 195 pp.
2. Cardemil, L. and Varner, J. Unpublished data. Genetic and developmental studies of the "In Vitro" cultured callus of female gametophyte of Araucaria araucana.
3. CONAF, 1980: Proposiciones para Establecer un Sistema Nacional de Areas Silvestres en Chile. Documento de Discusión. Depto. Conservación del Medio Ambiente. Corporación Nacional Forestal. 55 pp.
4. Donoso, C., Puente, M., Olivares, B. y Cox, F. 1980: Proposiciones para Normar las Actividades de Utilización de Tipos Forestales Nativos en Chile. Documento de Discusión a CONAF. Universidad Austral de Chile, Facultad de Ingeniería Forestal, Valdivia, Chile. 48 pp.
5. FAO, 1974: Report of the Third Session of the FAO Panel of Experts on Forest Gene Resources. Rome. 90 pp.
6. Fuenzalida, P.H., 1965: Clima y Geografía Económica de Chile. Texto Refundido. CORFO, Fundación Pedro Aguirre Cerda.
7. Gajardo,R., 1980: Vegetación del bosque de Araucaria araucana (Mol.) Koch en la Cordillera de Los Andes (Lonquimay, Prov. Malleco). Boletín Técnico N° 57. Facultad de Ciencias Forestales, Universidad de Chile, Santiago.
8. Landrum. R.F. y Nimlos, T., 1975: Gradientes florales y morfología asociada del suelo en la Reserva Forestal de Malalcahuello, Chile. Boletín Técnico N° 35, Facultad de Ciencias Forestales, Universidad de Chile, Santiago.
9. Martínez, O., 1965: Composición del bosque natural andino de la Provincia de Valdivia. Universidad Austral de Chile, Valdivia. 109 pp.
10. Montaldo, P., 1974: La Bio-Ecología de Araucaria araucana (Mol.) Koch. Instituto Forestal Latinoamericano de Investigación y Capacitación. Mérida, Venezuela. Boletín N° 46-48:3-55
11. Nielsen, U., 1963: Crecimiento y Propiedades de la Especie Araucaria araucana (Mol.) Koch. Universidad Austral de Chile, Facultad de Ingeniería Forestal. Tesis de Grado. 77 pp.
12. Oltremari, J., 1979: Institutionalization of National Parks in Chile. Parks Vol 3 N° 4:1-4
13. Peralta, M., 1975: Ecología y Silvicultura del Bosque Nativo Chileno. Suelos. Boletín Técnico N° 31. Facultad de Ciencias Forestales, Universidad de Chile, Santiago. 50 pp.
14. Peralta, M., 1980: Geomorfología, Clima y Suelos del Tipo Forestal Araucaria en Lonquimay. Boletín Técnico N° 57. Facultad de Ciencias Forestales, Universidad de Chile, Santiago.
15. Peredo, H., Osorio, M. y Cerda, L., 1979: Revisión de la Situación Sanitaria de Araucaria araucana en Chile. Trabajo no publicado presentado en Reunión IUFRO sobre el género Araucaria en Curitiba, Brasil.
16. Puente, M., 1980: Utilización de un Bosque del Tipo Araucaria con Criterios de Permanencia. Facultad de Ciencias Forestales, Universidad de Chile. Boletín Técnico N° 57:61-82
17. Quintanilla, V., 1974: La representación cartográfica preliminar de la vegetación chilena. Ed. Universitarias de Valparaíso, Universidad Católica de Valparaíso.
18. SAG, 1970: Plan de Manejo y Desarrollo del Parque Nacional Nahuelbuta. Servicio Agrícola y Ganadero, Depto. de Patrimonio Forestal, Santiago, Chile. 87 pp.
19. Schilling, G. y Donoso, C., 1976: Reproducción vegetativa natural de Araucaria araucana (Mol.) Koch. Ministerio de Agricultura (Chile), Vol 2 N° 3. 121-122
20. Schmidt, H., 1977: Dinámica de un bosque virgen de Araucaria-Lenga en Chile. Bosque 2(1):3-11
21. Schmitthusen, J., 1960: Die Nadelhoelzer in den Waldgesellschaften der suedlichen Anden. Vegetatio 10:313-327
22. Tortorelli, L., 1942: Maderas y Bosques Argentinos. Ed. Acme, S.A.C.I., Buenos Aires.
23. Veblen, T. and Delmastro, R., 1976: The Araucaria araucana Gene Resource in Chile. Forest Genetic Resources Information N° 5, FAO Forestry Occasional Paper /6/112.6
24. Veblen, T.T. (Unpublished). Regulation patterns in Araucaria araucana forest in Chile.
25. Wang, B.S.P., 1975: Tree Seed and Pollen Storage for Genetic Conservation: Possibilities and Limitations. Reprint from the Methodology of Conservation of Forest Genetic Resources, FO:Misc-75-8:93-103
26. Yudelevich, M., Brown, Ch., Elgueta, H. y Calderón, S., 1967: Clasificación Preliminar del Bosque Nativo en Chile. Instituto Forestal, Santiago, Chile. Informe Técnico N° 27 , 16 pp

FAST GROWING TREES

DESEMPENHO, PROBLEMAS E POTENCIALIDADES DAS ARAUCÁRIAS NA REPUBLICA POPULAR DO CONGO

J.C.Delwaulle — M.Chauviere — F.Leccia
Centre Technique Forestier Tropical
CONGO

Resumo

Desde 1968, a República Popular do Congo vem tentando introduzir diferentes espécies de Araucárias nas semanas, dadas às suas qualidades tecnológicas.

Duas espécies *(A. hunsteinii* e *t. cumminghanii) parecem perfeitamente adaptadas* às condições locais; agora, o Congo está pesquisando quais são as procedências mais interessantes a serem introduzidas.

Perto de 55 hectares de Araucárias têm sido plantadas no Congo, de acordo com os métodos usados na Austrália e Nova Guiné. Além disso, um hectare de *A. himsteinii* foi implantado em novembro de 1978.

A técnica de estaquia por esta espécie e seus problemas são descritos neste trabalho.

Com o método de estaquia, e técnicas de reprodução que o CTFT Congo está estudando, a República Popular do Congo espera realizar um grande programa com *Araucárias* nas

PERFORMANCES, PROBLEMES ET POTENTIALITES DES ARAUCARIAS EN REPUBLIQUE POPULAIRE DU CONGO

Summary

Since 1968, People's Republic of Congo has been trying to introduce on savannas, different species of Araucarias which technological qualities are well known.

Two species (A. hunsteinii and A. cunninghamii) seem perfectly adapted to local conditions ; now, Congo is researching what are the most interesting provenances to be introduced.

Nearly 55 hectares of Araucarias has been planted in Congo according to the methods used in Australia and New'Guinea. Besides, one hectare of A. hunsteinii cuttings has been installed in November 1978.

The cutting technique for this species and its problems are briefly described in this paper.

With this cutting method, and the breeding techniques that the CTFT Congo is studying, People's Republic of Congo hopes to realize on savannas a wide afforestation program with Araucarias.

2 - INTRODUCTION

2.1 - Présentation générale

En 1968, le Congo a commencé à introduire différentes espèces d'Araucarias pour tenter de reboiser, en bois d'oeuvre, une partie de ses immenses étendues de savane.

Sur neuf espèces introduites, deux (A. cunninghamii et A.hunsteinii) se sont revélées intéressantes dans nos conditions écologiques et il a alors été envisagé de réaliser des surfaces importantes de plantations.

Cela ne s'est pas revélé possible du fait de la difficulté de s'approvisionner en graines viables. Aussi la recherche forestière s'est elle penché sur la multiplication végétative d'Araucaria hunsteinii et a obtenu quelques résultats intéressants. Dans un avenir proche l'étude de l'amélioration génétique des Araucarias sera abordée.

2.2 - Données écologiques

La plus grande partie des introductions d'Araucarias a été faite dans la vallée du Niari à la station CTFT de LOUDIMA et c'est dans cette station que les essais ultérieurs ont été entrepris.

La station de LOUDIMA (4°11' de latitude Sud, 11°05' de longitude E, 165m d'altitude) est soumise à un climat dont les caractéristiques essentielles sont les suivantes :

	Saison des pluies (Nov. à Mai)	Saison sèche (Juin à Octob.)
Pluviométrie	1100 mm	0
Température	27°C (Avril)	23°C (Sept.)
Hygrométrie	82% (Avril)	70% (Sept.)
Ensoleillement	156 heures/mois (Mars)	70 heures/mois (Sept.)

Deux types de sols peuvent être distingués sur la station :

- Les sols de plateaux, profonds, à forte teneur en argile (de l'ordre de 70%), acides (pH voisin de 5) portent une savane à hautes graminées ou domine l'Imperata.

- Les sols de la terrasse basse, proches de la rivière Niari, ont une teneur en argile plus faible (25 à 30%) sont plus filtrants , plus fertiles et plus riches en bases échangeables.

3 - INTRODUCTION D'ESPECES ET DE PROVENANCES

3.1 - Essais spécifiques

Neuf espèces au total ont été introduites depuis 1968. Les parcelles d'essais ont été mesurées régulièrement et donnent les résultats suivants pour les introductions les plus anciennes :

Espèce		Année plantation Novembre ou Décem.	Age, dernière mensuration	Hauteur (mètres)	% présents
A.hunsteinii	PL	1968	11 ans 5 mois	16,6	Parcelle éclaircie
"	TB	1968	" "	17,8	" "
A.cunninghamii	PL	1968	11 ans 5 mois	17,8	Parcelle éclaircie
	TB	1968	" "	18;8	" "
A. balansae		1973	6 ans 1 mois	2,6	23,3
A. columnaris		1973	" "	4,6	86,4
A. columnaris var luxurians		1973	" "	3,6	88,1
A. laubenfelsii		1973	" "	1,4	11,1
A. rulei		1973	" "	1,8	16,7

PL : Plateau TB : Terrasse Basse

La faible croissance et le faible taux de présence font éliminer A. balansae, A. laubenfelsii, A. rulei et également A. excelsa et A. bidwillii introduits par ailleurs.

Araucaria columnaris semble devoir être adapté mais sa croissance lente (4,5m à 6 ans contre 9m pour A. hunsteinii et A. cunninghamii au même âge) ne nous ont pas encouragé à le réintroduire pour l'instant.

Araucaria hunsteinii et A. cunninghamii se révèlent par contre bien adaptés et présentent une croissance intéressante.

3.2 - Essais provenances

Quatre lots d'A. hunsteinii originaires de Nouvelle Guinée et 16 lots d'A. cunninghamii dont 4 originaires de Nouvelle Guinée et 12 originaires du Queensland ont été introduits au Congo entre 1968 et 1975.

Si l'on ne peut pas mettre en évidence de grosses différences entre les divers lots d'Ai hunsteinii, il semble que certaines provenances australiennes d'A. cunninghamii soient plus performants dans la vallée du Niari que les lots originaires de Nouvelle Guinée. Nous en rendons compte par ailleurs*.

Il faut noter que nos appréciations sur les provenances ont été effectuées à des âges parfois inférieurs à 5 ans et que l'âge d'exploitabilité se situe vers 35-40 ans.

C'est pourquoi nos conclusions ne sont pas définitives et nous continuerons à introduire de nouvelles provenances. C'est ainsi que, fin 1980, seront mises en place une nouvelle provenance d'A. hunsteinii et six nouvelles provenances d'A. cunninghamii.

4 - LES PLANTATIONS D'ARAUCARIAS AU CONGO

41 - La pépinière et ses problèmes

Les graines d'Araucaria perdant très rapidement leur pouvoir germinatif sont semées dès leur réception sur nos stations, ce qui ne correspond pas toujours à la période la plus favorable à une bonne reprise

* Voir J.C. DELWAULLE - Les introductions d'Araucaria cunninghamii sweet en République Populaire du Congo.

et à une éducation normale en pépinière, cette période étant pour le Congo le début de la saison sèche, c'est à dire du mois de Juin au mois d'Août.

Les semis ont été réalisés en s'inspirant des méthodes préconisées en Nouvelle Guinée et en Australie, complétées par des essais faits lors des premières importations de graines.

Les plants, éduqués en pots, sont mis en place sur le terrain au début de la saison des pluies, en Novembre ou Décembre ; ils ont alors passé en moyenne un an en pépinière.

4.2 - Les plantations

La technique de plantation des Araucarias au Congo est la même que celle utilisée pour les Pins.
Jusqu'en 1976 les écartements étaient de 2,5m x 2,5m. Ils sont actuellement de 3m x 3m.

Les Araucarias sont très sensibles à la concurrence ce qui impose de nombreux entretiens au cours des premières années. Le premier entretien a lieu immédiatement après la mise en place des plants. Il est suivi de 2 entretiens la première année, de 2 entretiens la seconde année, de 1 à 2 entretiens la troisième année.

Jusqu'à présent 54 ha d'Araucarias ont été mis en place au Congo dont :

- 0,5 ha en savane côtière de Pointe-Noire
- 0,5 ha à MALOLO — vallée du NIARI
- 53,0 ha à LOUDIMA

4.3 - Les productions

Nous observons, à Loudima, pour A. hunsteinii et A. cunninghamii une croissance d'environ 1,7m par an entre 3 et 11 ans. Cette croissance est très régulière et ne semble pas, pour l'instant, marquer de tendance au fléchissement.

Les accroissements moyens annuels en volume sont des 13 à 14 m^3/ha/an pour A. hunsteinii et de 16 à 18 m^3/ha/an pour A. cunninghamii.

Nous avons noté que la croissance de ces espèces était légèrement moindre chaque fois que la pluviométrie annuelle marquait un déficit. Il faut préciser que, dans leurs aires d'origine, la pluviométrie observée est :

- pour A. hunsteinii 1600 à 1800 mm
- " A. cunninghamii 1000 à 1500 mm.

A. hunsteinii et A. cunninghamii ont une excellente forme : fût très rectiligne, parfaitement cylindrique, petites branches horizontales au départ, absences de fourches. Leur état sanitaire est satisfaisant.

Ces résultats joints aux qualités technologiques reconnues de ces deux espèces nous autorisent à les retenir comme essences bien adaptées à nos conditions écologiques et assurant une production de bois d'oeuvre intéressante.

5 - LA MULTIPLICATION VEGETATIVE DE L'ARAUCARIA HUNSTEINII

5.1 - Problèmes liés aux graines

La grande difficulté que l'on a de s'approvisionner en graines viables (pouvoir germinatif moyen : 10%), le prix de revient important du kilo de graines importées, la jeunesse de nos peuplements commençant à peine à produire des semences, ont fait que nous avons orienté nos recherches vers la multiplication végétative de l'Araucaria. Nos premiers travaux ont été effectués sur A. hunsteinii et les résultats énoncés ici ne sont donc valables que pour cette seule espèce.

5.2 - Mise au point d'une technique de bouturage

La mise au point de cette technique passait par la détermination des paramètres suivantes :

- niveau de développement végétatif de nos boutures
- rôle des régulateurs de croissance
- type d'alimentation en eau
- type de substrat le plus favorable à un meilleur taux de reprise .

Comme nous cherchions, dans un premier temps, à pouvoir produire un grand nombre de boutures afin d'effectuer des plantations extensives, nous avons mis l'accent sur la mise au point de la technique de bouturage à partir d'un petit parc multiplicatif issus de semis, donc de qualité moyenne.

Ce parc (planté à un écartement de 0,5m x 1m) a fait l'objet, à l'âge de 2 ans, en Novembre 1977, de récolte de pousses orthotropes et plagiotropes.

Ce premier matériel a été utilisé pour des essais de bouturage et, les plants ayant bien rejeté, nous avons continué à travailler sur ce parc en bouturant uniquement les rejets orthotropes.

Parallèlement nous avons bouturé des rejets de souches d'arbres abattus sur nos parcelles d'essais.

Les boutures sont amenées en pépinière en milieu humide ; on les prépare en enlevant le plus délicatement possible les feuilles de la base de la tige sur 3 ou 4 cm. Elles sont trempées entièrement pendant une à deux minutes dans un bain antifongique et leur base est plongée dans une solution ou une poudre de talc contenant de l'AIB comme principe hormonal.

Les plants sont mis en pots plastiques contenant un substrat riche et filtrant et sont immédiatement alimentés en eau.

niveau de développement végétatif des boutures

Si, dans un premier temps, nous avons mis en place un matériel végétal relativement âgé (juste avant lignification) à deux verticilles, nous nous sommes efforcés, par la suite, avec succès, de bouturer du matériel plus juvénile et de plus petite taille. Nous en sommes actuellement à bouturer des portions de tiges d'Araucarias (2 ou 3 par verticilles) dès l'apparition des tissus secondaires.

rôle des régulateurs de croissance

Le rôle des hormones de rhizogénèse n'a pas été, pour l'instant, clairement établi. Il semble que l'Acide Indol butyrique ait une légère influence sur celle-ci mais à des concentrations relativement faibles (notamment par rapport à celles exigées par les eucalyptus) et en utilisation par trempage dans une solution aqueuse.

type d'alimentation en eau

Il nous est apparu très vite qu'un arrosage permanent (type mist) était trop abondant pour permettre le bouturage de l'Araucaria. Nous nous sommes attachés à réduire cet arrosage en

utilisant 2 méthodes différents qui donnent des résultats positifs et à peu près identiques.

. arrosage direct au jet 3 à 5 fois par jour
. bouturage sous chassis plastique que l'on ouvre la nuit pour éviter une humidité trop forte à l'intérieur de ces mini-serres.

Les plants sous chassis sont arrosés une fois par jour, parfois moins.

Pour ces 2 types d'alimentation en eau les boutures sont mises sous ombrières pour éviter un échauffement excessif.

Nature du substrat

Des différents essais mis en place, il ressort que le substrat doit être constitué d'un mélange de terre riche micorhizée et de sable ou gravier afin de travailler dans un milieu filtrant.

Pourcentage de réussite

En utilisant ces techniques, nous obtenons des pourcentages de réussite de l'ordre de 40% au bout de trois à quatre mois. Les boutures obtenues en 1978 et 1979 ont été mises en place sur le terrain où leur comportement se révèle aussi bon, sinon meilleur, que des plants issus de semis.

6.3 - Limites de cette méthode

La faible quantité de rejets qui apparaissent sur chaque souche, le fait que nous n'avons pas réussi à lever la plagiotropie des bourgeons axillaires et que nous ne pouvons donc bouturer que les axes orthotropes, font que cette méthode de bouturage n'aboutit qu'à un faible pouvoir multiplicatif de chaque souche ce qui en limite fortement l'intérêt du point de vue application pratique.

Nous nous proposons, dans les années à venir :

- de bouturer le plus grand nombre de sections possible interverticillaires de rejets
- de bouturer des écailles d'axe principal.

Ceci suppose un équipement en matière de culture in vitro qui, nous l'espérons, pourra devenir fonctionnel en 1981.

6 - AMELIORATION GENETIQUE DES ARAUCARIAS

Cette amélioration n'a pas débuté jusqu'à présent mais nous envisageons de mettre en place prochainement un premier verger à graines d'A. cunninghamii. Le processus envisagé sera le suivant :

- mise au point de la technique de greffage
- sélection des plus beaux ortets dans diverses provenances
- taille de ces ortets
- greffe des rejets se développant après recépage
- création de vergers à graines.

On pourra éviter la taille des plus beaux pieds en mettant au point le greffage d'écailles d'axes principaux.

7 - CONCLUSION

La République Populaire du Congo dispose actuellement de deux espèces d'Araucarias très productives et particulièrement bien adaptées aux conditions écologiques locales, en particulier à celles de la vallée du Niari.

L'amélioration de ces espèces pourra se faire :

- grâce à la sélection de nouvelles provenances qui sont et continueront d'être introduites.
- grâce à la création de vergers à graines à partir de greffes de plants particulièrement bien adaptés et très productifs.
- grâce à la multiplication végétative des plus beaux arbres en particulier par bouturage soit d'écailles d'axes principaux, soit de rejets de souches de ces ortets.

L'espérance de valoriser les savanes argileuses du Niari par des plantations de bois d'oeuvres conduites avec une sylviculture assez accélérée, et les résultats prometteurs obtenus jusqu'à présent motivent la poursuite des recherches entreprises en matière d'Araucarias en République Populaire du Congo.

8 - BIBLIOGRAPHIE

CHAUVIERE M. - Les Araucarias dans la vallée du Niari - République Populaire du Congo (CTFT Congo Novembre 1979)

LECCIA F. - Bouturage d'Araucaria hunsteinii, Station de Loudima, 1977-1978 (CTFT Congo Janvier 1979)

NTIMA O.O. - The Araucarias, Fast growing timber trees of the loculand tropics (Commonwealth Forestry Institute - University of Oxford - Octobre 1978).

FAST GROWING TREES

INTRODUÇÃO DA *Araucaria cunninghamii* NA REPÚBLICA POPULAR DO CONGO

J. C. Delwaulle
Centre Technique Forestier Tropical
CONGO

Resumo

A *Araucária cunninghamii* foi introduzido no Congo pela 1ª vez em 1968 mostrando-se bem adaptada às condições ecológicas locais e seu bom desempenho permitiu que a pesquisa introduzisse o máximo de procedências desta espécie, cuja distribuição natural é particularmente extensa.

Sendo esta introdução relativamente recente, apenas indicações gerais podem ser obtidas destes testes de procedência.

LES INTRODUCTIONS D'*Araucaria cunninghamii* SWEET EN REPUBLIQUE POPULAIRE DU CONGO

Summary

Araucaria cunninghamii has been introduced in Congo the first time in 1968. The species has shown well-adapted in local ecological conditions and its good performances led the research to introduce the maximum provenances of this species which natural distribution is particularly wide.

These introductions are relatively recent, only general indications can be obtained now from these provenance trials.

2 - INTRODUCTION

Araucaria cunninghamii a été introduit dans plusieurs régions géographiques du Congo mais il ne s'est adapté et n'a été réellement suivi que dans la vallée du Niari notamment à la station de Loudima.

La vallée du Niari (4° 11' de latitude Sud, 11° 05' de longitude, 165m d'altitude pour la station de Loudima) est soumise à un climat angolais-bas congolais marqué par deux saisons bien tranchées = une saison des pluies d'Octobre à Mai durant laquelle on enregistre en moyenne 1100 mm de pluie et une saison sèche, de Juin à Octobre.

Les températures varient relativement peu mais sont cependant plus fortes en saison des pluies (27,2° C pour le mois le plus chaud) qu'en saison sèche (23°3 C pour le mois le plus froid). L'hygrométrie de l'air demeure élevée toute l'année (brouillards et rosée en saison sèche).

Les sols sont constitués sur des argiles (kaolinites) résultant de l'altération de roches schisto-calcaires. Bien que très riches en argile (50 à 80%), ces sols sont souvent bien structurés et relativement perméables, ce sont des sols acides, avec un pH de l'ordre de 5.

A la station de Loudima, on distingue deux grands types de sols :

- Les sols des plateaux, profonds, à forte teneur en argile, relativement riches, portent une savane à hautes graminées (Imperata, Hyparrhenia, Andropogon) et une flore arbustive réduite.

- Les sols de la terrasse basse, proches de la rivière Niari, ont une teneur en argile plus faible ; ils sont plus filtrants, plus fertiles, plus riches en bases échangeables que les sols des plateaux.

3 - LES PREMIERES INTRODUCTIONS D'ARAUCARIA CUNNINGHAMII

Deux petites parcelles d'Araucaria cunninghamii ont été mises en place à Loudima en Novembre 1968. Les plants étaient issus de graines originaires de BULOLO (Nouvelle Guinée) et avaient subi 1 an d'éducation en pépinière. La plantation a été effectuée à l'écartement 2,5m x 2,5m et chaque trou de plantation a reçu une dose de 150g d'engrais complet 10-10-20.

Une parcelle a été mise en place sur sols de plateaux (parcelle 29.0), l'autre en terrasse basse (parcelle 25.0). Les conditions édaphiques sont donc nettement différentes notamment en ce qui concerne les conditions d'alimentation en eau.

En Avril 1976, ces deux parcelles ont subi une éclaircie et un élagage qui ont abaissé la densité de 1600 à 905 plants/ha, soit un taux d'éclaircie de 43%.

Ces peuplements ont été régulièrement mesurés et nous donnons ci-après les courbes des hauteurs et circonférences moyennes en fonction de l'âge.

On remarquera que les croissances sont très régulières et ne marquent, pour l'instant, aucune tendance significative au fléchissement; il n'y a d'ailleurs aucun arrêt de croissance marqué en saison sèche.

A l'âge de 11 ans 5 mois, les hauteurs moyennes sont de 17,80m sur le plateau et 18,80 m en terrasse basse ; les circonférences moyennes à 1,50m sont respectivement de 56,8 cm et 58,6 cm.

Ces peuplements sont actuellement sains malgré le dépérissement des branches basses accentué par la saison des pluies 1977-1978 qui fut particulièrement déficitaire.

La production moyenne estimée est de l'ordre de 16,3 m^3/ha/an sur le plateau et de 18,2 m^3/ha/an en terrasse basse.

L'excellent comportement de ces parcelles, leur bonne croissance et la réputation des produits nous ont conduit rapidement à effectuer des introductions de provenances.

4 - LES INTRODUCTIONS DE PROVENANCES

Araucaria cunninghamii est originaire de Papouasie N^{elle} Guinée et d'Australie. Son extension en latitude (6° à 30° de latitude Sud) est importante et on le rencontre de 0 à 2500 m d'altitude en Nouvelle Guinée et de 0 à 900 m en Australie.

Une aire naturelle aussi vaste et aussi variée du point de vue écologique suppose des variations importantes de comportement de l'espèce selon les provenances.

C'est la raison pour laquelle nous avons tenté d'introduire le maximum de provenances en 1973, 1974 et 1975 ; les lieux d'origine de ces provenances ont été portés sur la carte figurant ci-après.

4.1 - Les introductions de 1973

Trois provenances : JIMNA MILLER SF 207, ATHERTON 17.9R et IMBIL 13B furent mises en place fin 1973. Le nombre insuffisant des plants des deux dernières provenances ne nous permettent pas de prendre en compte les résultats.

4.2 - Les introductions de 1974

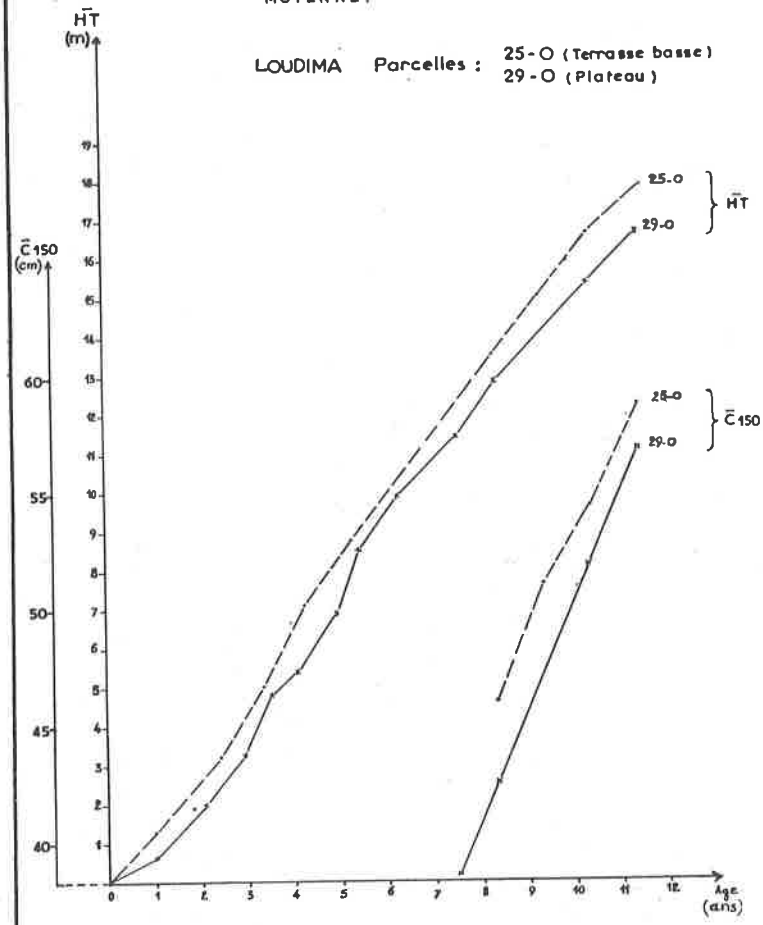
Elles concernent les provenances suivantes toutes originaires du Queensland (parcelle 1U2 de Loudima sur sol de plateau).

COEN	13°	52'	lat S	2 descendances	5 plants
ATHERTON	17°	30'	lat S	2 descendances	100 plants
WHITSUNDAY ISLAND	20°	13'	lat S	13 descendances	63 plants
IMBIL	26°	10'	lat S		100 plants
JIMNA MILLER SF 207	26°	40'	lat S	2 descendances	192 plants
KENILWORTH	26°	40'	lat S	2 descendances	30 plants
BRISBANE	28°	25'	lat S	2 descendances	10 plants

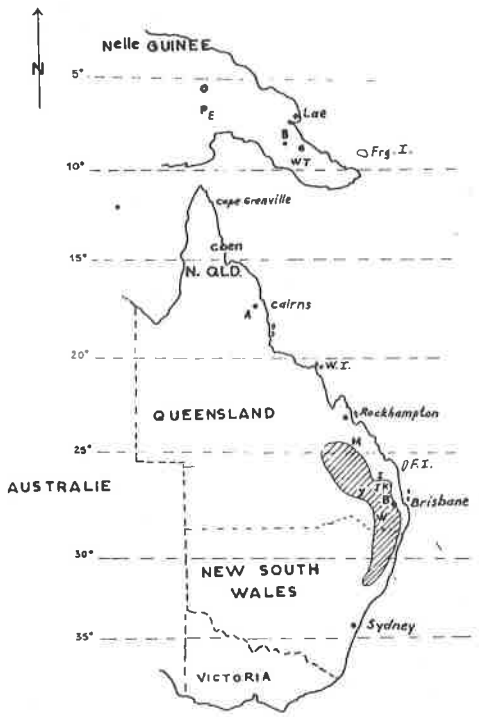
ARAUCARIA CUNNINGHAMII

CROISSANCE EN HAUTEUR ET CIRCONFERENCE MOYENNE.

LOUDIMA Parcelles : 25-O (Terrasse basse)
29-O (Plateau)



Provenances : Araucaria cunninghamii introduites en République Populaire du Congo



Nelle Guinée

O : Okasa
P : Pimaga
E : Erave
B : Bulolo
WT : Woitape
Frg I : Fergusson Island

Nord Queensland tropical

C : Coen
A : Atherton

Massif du Sud Queensland

M : Monto
FI : Fraser Island
I : Imbil
J : Jimna Miller
K : Kenilworth
Y : Yarraman
B : Brisbane
W : Warwick

Centre Queensland cotier subtropical

WI : Whitsunday Island

▨ : Massif du Sud Queensland

Le nombre des plants mis en place, fonction du pouvoir germinatif des graines reçues, est insuffisant pour prendre en compte les provenances COEN et BRISBANE. Notons cependant, qu'à l'âge de 4,5 ans, la provenance COEN a une très bonne croissance (Hm = 7,30m) alors que celle de BRISBANE est mauvaise (Hm = 3,90m).

Les provenances JIMNA MILLER et KENILWORTH quoiqu'originaires du Sud du tropique du Capricorne se révèlent être des provenances intéressantes, de croissance supérieure, à âge égal, à la provenance BULOLO introduite en 1968.

Les provenances ATHERTON et IMBIL ont une croissance plus faible mais leur comportement demeure bon.

4.3 - Les introductions de 1975

Elles concernent les provenances suivantes (parcelle 21 V de Loudima, en terrasse basse).

OKAPA (Nouvelle Guinée)	5°	30'	lat S	(?)	78 plants
BULOLO RIVER GORGE B659 (N.G)	7°	15'	lat S		134 plants
COEN 10238 (Queensland)	13°	42'	lat S	6 des.	102 plants
COEN 10239 (Q)	13°	52'	lat S	6 des.	48 plants
MONTO 19N (Q)	24°	20'	lat S		41 plants
FRASER ISLAND (Q)	25°	30'	lat S	2 proven.	15 plants
YARRAMAN (Q)	26°	50'	lat S		41 plants
WARWICK (Q)	28°	10'	lat S		397 plants

Ces provenances ont été mises en place en Novembre 1975 mais il faut remarquer que les plants originaires du Queensland avaient 21 à 24 mois de pépinière alors que ceux originaires de Nouvelle Guinée n'avaient que 12 mois de pépinière.

A l'âge de 4 ans les deux provenances COEN se révèlent être les meilleures (6,25m et 6,40m pour les provenances 10238 et 10239 après l'élimination d'une descendance).

La provenance FRASER ISLAND (origine plantation artificielle) semble très bonne mais le nombre de plants introduits est insuffisant.

La provenance MONTO est également très valable.

Les provenances YARRAMAN et WARWICK montrent une croissance nettement plus faible. Il semble que les provenances Nouvelle Guinée aient une croissance plus faible que les meilleures provenances du Queensland même en tenant compte de l'âge des plants lors de leur mise en place.

4.4 - Les introduction futures

En 1976 a été mise en place la première plantation d'extension, couvrant 46,6 hectares) plants issus de graines originaires de BULOLO, gorge chiffaide (Nouvelle Guinée).

En Novembre 1980 nous mettrons en place de nouvelles provenances de Nouvelle Guinée. ERAVE, PIMAGA, OKASA, BULOLO, FERGUSON ISLAND et WOITAPE, provenances ayant fait l'objet de récoltes effectuées sous l'égide de la FAO (financement PNUE).

5 - CONCLUSION

Les premières introductions d'Araucaria cunninghamii au Congo ont montré la bonne adaptation de la provenance BULOLO (Nouvelle Guinée) aux conditions écologiques de la vallée du Niari. La bonne croissance et la qualité du bois nous ont conduit à réintroduire cette espèce.

Les introductions de provenances sont jeunes et il est trop tôt pour en tirer des conclusions définitives. On peut cependant dire que :

- Les provenances de Nouvelle Guinée sont bien adaptées mais il semble que certaines provenances australiennes présentent des croissances plus fortes.

- La provenance COEN, du Nord Queensland tropical est très prometteuse alors que la provenance ATHERTON semble nettement moins bonne.

- Nous manquons de provenances originaires du Centre Queensland côtier. La seule provenance introduite (WHITSUNDAY ISLAND) a un comportement honorable.

- Les provenances du massif du Sud Queensland ont actuellement un bon comportement pour les provenances du Nord (MONTO, FRASER ISLAND, JIMNA MILLER, KENILWORTH) mais elles devront confirmer celui-ci avant que nous n'envisagions d'autres introductions en raison de leur latitude élevée. Les provenances du Sud (YARRAMAN, BRISBANE, WARWICK) ont un comportement nettement moins favorable.

6 - BIBLIOGRAPHIE

CHAUVIERE M :
Les Araucarias dans la vallée du Niari - République Populaire du Congo - CTFT CONGO Nov. 1979.

GRAY B. :
Distribution of Araucaria in Papua New Guinea. Research Bulletin n° 1 - Département of Forests, Bulolo, Papua New Guinea - 1973.

MARTIN B. - QUILLET G. :
Première introduction d'Araucarias de Nouvelle Guinée à Loudima et Malolo CTFT/CONGO Nov. 1970

MOREL J. :
Note sur le territoire de Papouasie et Nouvelle Guinée. Revue Bois et Forêts des tropiques n° 115 - Septembre - Octobre 1967.

NTIMA O.O.:
The Araucarias, Fast growing timber trees of the loculand tropics n° 3-Commonwealth Forestry Institute - University of Oxford - Octobre 1968.

F. A. O. :
Information sur les ressources génétiques forestières n° 8. Document forestier occasionnel n° 78/2 FAO - O.N.U. - 1978.

FAST GROWING TREES

REVISÃO DA DISTRIBUIÇÃO E DO COMPORTAMENTO DA *Araucaria angustifolia* (BERT.) O. KTZE.

O. do A. Gurgel Filho
Instituto de Botânica - São Paulo
BRASIL

Resumo

Da ontogenia de A. angustifolia, quando se globalizam os agentes atuantes e não alienáveis do meio, os grupos estruturais (sinúsias) assumem caráter morfogênico. Dos antigos grupos fitogenéticos, as Araucariaceae ocorrem no hemisfério sul, e o pinheiro brasileiro evidencia-se como espécie heliófila, intolerante, pioneira, segundo determinada teoria da sucessão. Como amparo ao equacionamento da própria Silvica da espécie, componentes biológicas como juvenilidade, senescência e caracteres juvenis são postas em evidência.

Sem descurar do aspecto fitogeográfico envolvendo a zona de ocorrência natural da espécie, citam-se também os pinherais "enclaves": já sob o aspecto ecológico, envolvem-se conceitos de estrutura das populações, de barreiras e competição em comunidades vegetais do ponto de vista sinecológico.

Dentro do mesmo diapasão, o autor, sob concepção própria, estabelece a validade da inclusão do pinhèiral no âmbito da "Silvicultura Temperada", para, ao final, proceder a citação de exigências específicas de ordens e pedológica.

Com um estudo teórico genérico sobre Melhoramento Florestal, procura-se evidenciar não só incidências das variações (biológica, fenotípica, genética, ambiental) nas populações florestais de Araucaria, mas enfatizando a imprescindibilidade do Melhoramento Florestal, cita os objetivos primários e fundamentais, através das técnicas da seleção (massal) da hibridação, da mutação induzida. Conceitos e concepções eletivas, adaptáveis e aplicáveis à A. angustifolia merecem especial destaque com reflexos ao Melhoramento por Objetivos, à eleição de "Árvores Plus" ou "Árvores Elites", com os atributos exigidos, além das exigências quantitativas de material básico. Finalmente, ao discorrer a respeito da semente, a matéria é complementada com a nomenclatura adotada no Estado de São Paulo para semente certificada, semente selecionada, semente identificada.

Para a produção de sementes florestais melhoradas de A. angustifolia, são revistos os conhecimentos básicos específicos ou afins, bem como aqueles próprios da morfologia floral.

Estudando a metodologia do melhoramento florestal da A. angustifolia, o autor sem se repetir, visualiza os campos e os meios de ação, e num esforço de afirmação de propósito, propõe o Programa de Melhoramento da Araucaria, optativamente em duas fases, mas compreendendo duas (2) etapas. A tecnologia, da mais imediata à mais remota da obtenção de semente, seria através de "Seed Source" Naturais, de Áreas artificiais, Produtores de Sementes e Pomares Clonais.

A silvicultura de A. angustifolia é longamente abordada, com menção de três especificidades em campos de pesquisa: a) Caracterização silvicultural do pinheiro brasileiro, em povoamento artificial puro coetâneo, compreendendo o período de 22 anos; b) Evidências de raças geográficas cujo experimento precessor estabelecera-se em 1954; c) Propagação Vegetativa, com um espectro de 23 anos.

Sem permanecer só no estágio acadêmico, discutem-se aspectos de manejo, de rentabilidade, de viabilidade e de racionalização do uso do material básico (semente melhorada). Sobre este último enfoque, textualmente: "Graças a este novo material genêtico, básico, selecionado, tais sementes estariam gerando ou configurando um outro estágio florestal, a 3a. floresta de Araucaria angustifolia, realmente racionalizada".

A viabilidade econômica da A. angustifolia constituindo florestas artificiais, se problemática no momento, dependerá a sua afirmação dos ganhos e avanços genêticos obtidos, aliados ao elenco de medidas compreendendo toda a silvicultura da espécie, e também das medidas outras prescritas e complementares. No intuito de conceder ao trabalho uma feição realística, são apresentados, em conclusão, dois módulos, que na verdade são dois Programas de Trabalho para com a A. angustifolia, com ênfase ao Melhoramento e imediata produção de sementes melhoradas.

REVIEW OF DISTRIBUTION AND BEHAVIOUR OF *Araucaria angustifolia* (BERT.) O.KTZE.

Summary

The recent contributions that emerged especially towards the end of the last decade and the beginning of 1980, concerning research made both, in the enclave zones, and in the core of the Araucaria Region, generate and make possible the consolidation of a set of models carried out under the promising scientific and technological policy for Araucaria angustifolia (Bert.) O. Ktze. in Brazil.

The discussion of the aspects and effects of management, profitability, viability and rationalization of use of the basic material (improved seeds) of man made forests is based on proper experimentation into the silvics of Araucaria angustifolia (silvicultural characterization, geographical races or ecotypes, vegetative propagation, propagulum), and the review of the specific literature, which led the author to state that a new forest stage is being generated in the context of the Temperate Silviculture: "Due to this new, selected basic material, such seeds would be generating or configuring a new forest stage, the 3rd Forest of Araucaria angustifolia actually rationalized.

The premise of the 3rd Forest of Araucaria, although seemingly utopic, presents a realistic and defined outline confirmed by the existence of 560.000 ha of mixed and pure (21%) dissentaneous natural woods. Therefore, what is really taking shape is a great stock or source of germplasmas which is a gene resource of incalculable potenciality, even for the establishment of germoplasma banks.

A generic theoretical study about Forest Improvement shows not only the incidence of variations (biological, phenotypical, genotypical, environmental) on the forest populations of Araucaria, but also establishes the primary and fundamental objectives for its application through techniques of selection of hybridation and induced mutation. Elective concepts adaptable and applicable to A. angustifolia deserve special attention focusing on Improvement by Objectives, Selection of Plus Trees or Elites Trees with necessary attributes, besides the quantitative requirements of basic material.

As far as the methodology of Forest Improvement is concerned, the author visualizes the spectrum of the activities and proposes the Program for Araucaria Improvement to he optionally developed in 2 phases: from the most immediate to the most remote in the obtaining of seeds; i.e., from the Natural Seed Sources to the Artificial Areas of Seed Production.

The economic viability of A. angustifolia in the formation of man made forest, if problematic at the moment, will depend on the genetic advances, as well as on a set of other prescribed and complementary measures.

INTRODUÇÃO

A cosmogonia que incide sôbre as essências nativas, se bem dissecada, perderia a feição mítica e passaria a aparentar-se ou a fluir-se como menos complexa e inacessível, revertendo-se tangível, e com este novo enfoque, a própria Araucaria angustifolia (Bert.) O. Ktze. abarcada, beneficiar-se-ia, sob o reflexo de um efetivo plano ou programa de inplantação.

Enquanto prosseguem distorsões teóricas e filosóficas e operacionais acêrca dos "modus operandi" e "modus fascienái", já na órbita florestal a progressão devastadora das matas naturais assoma caráter aflitivo, extinguindo ou reduzindo sensivelmente as bases e os recursos filo e ontogenético.

Desta sorte, do alentado trabalho apresentado ao "IUFRO MEETING", em Curitiba (Gurgel Filho, 1980) neste segundo Simposio da IUFRO, já em São Pedro, Estado de São Paulo, revisam-se os conceitos, enfatizam-se os princípios e reiteram-se as metodologias de ação.

Como se asseverara, o trabalho que se apresenta estruturou-se de forma a propiciar uma visão eclética e abrangente da problemática, não tergiversando em abordar aspectos ontogenéticos, fitogeográficos, ecológicos generalizadamente, com intuito superior de situar a pontecialidade e o estágio atual da conífera.

Por outro lado, pela índole impressa, delongou-se sobre os princípios e as técnicas de Melhoramento Florestal, com reflexos e indicações à produção de sementes melhoradas de Araucaria angustifolia.

A pesquisa silvicultural, ênfase total atribuira-se visando as peculiaridades da sua evolução e comportamento sob as condições de povoamento puro coetâneo, as respostas aos métodos de propagação vegetativa e os resultados alcançados na detecção ou evidências de raças geográficas, englobando, nesta expressão, proveniências e ecótipos.

Sempre presente não a utopia, mas a realidade da 3a. floresta de Araucaria angustifolia, o autor estrutura e submete para a ponderação dos pesquisadores e empresários, um programa cifrado em 21 pontos, cuja exequibilidade, viabilidade, realidade, só se corporifica rão ante a criação de um organismo próprio, permanente, atuante, atuante, com recursos adequados, humanos e materiais.

Sem dúvida, pode aparentar-se pretensiosa natureza do trabalho, mas por outro lado, é de se crer que abarca e encarna a aspiração geral, tangível, como já se asseverara, de alcançar e obter uma araucáriacultura rentável e competitiva.

ASPECTOS FITOSSOCIOLÓGICOS

A área de dispersão natural, ou a zona de ocorrência natural do pinheiro brasileiro se atualmente não mais o é, fora contudo bastante expressiva, assumindo, nos estudos fitogeográficos a denominação da "Região das Matas de Araucaria" (Hueck 1972) "Araucarilandia" (Hoehne, 1930) e floresta aciculifoliada (Romariz, 1974).

Da controvérsia oriunda da delimitação geográfica da zona de dispersão desde Martius, neste trabalho adota-se aquela estabelecida por Hueck (op. ct.) de sorte a circunscrever, a grosso modo, região de matas da Araucaria entre os paralelos 18º a 30º de latitude sul e 43º a 57º de longitude oeste de Greenwich. Isto todavia não significa que sobre toda a região continuadamente ocorre a espécie, mas, há enclave cujas coordenadas geográficas representam os limites extremos.

Atualmente, mediante a disponibilidade de dados de sensores remotos a detecção e consequente delimitação das áreas naturais com Araucaria angustifolia em toda a região Sul Brasileira, tornar-se-á muito mais acurada. Por outro lado, a uniformização e padronização dos métodos e sistemas de interpretação, como propõem Anderson et alli (1979) favorecerá a celeridade não só do zoneamento a nível nacional, como a resultante da emergência de amplos programas de uso da terra, consentâneos com as exigências ou decorrências da deterioração ambiental.

Assertivas drásticas, às vezes proferidas por eminentes especialistas, de que "o pinheiro não quer ver o mar", ou "os pinheiros nunca são vistos nas encostas para o mar" pecam pela agressividade intrínseca do pensamento. Com efeito para recente experimento implantado pelo autor, foram coletadas sementes no município de Lauro Müller, no Estado de Santa Catarina, à latitude de 28º30' sul, longitude 49º24' W de Gr., altitude de 198 metros, em sítio relativamente próximo à orla marítima atlântica (Gurgel Filho, 1973b).

Walter (1973) em abono, exemplifica: "da relatividade filogenética dos velhos grupos de coníferas, a família Podocarpaceae e o gênero Araucaria ocorrem somente no Hemisfério Sul, enquanto que a grande família Pinaceae e proximamente toda a Taxodiaceae ocorrem no Hemisfério Norte; a Cupressaceae, entretanto tem sido encontrada disseminada em todos os continentes".

Particularizando o comportamento, diz Rizzini (1971): a Araucaria angustifolia, não apresenta regeneração natural na floresta onde vive, podendo, com frequência, colonizar o campo, evidenciando-se como espécie hilófila, o que no vocabulário dasonômico corresponde à essência da luz, ou intolerante, ao ainda essência robusta. Está ausente da área central da floresta atlântica, ocorrendo, contudo, em várias partes dessa área, porém acima do limite arboreo, isto é, nas zonas campestres serranas. Isto indica que, à semelhança de diversas espécies de Pinus, ela é uma espécie pioneira; dá início a condições silvestres, permanecendo nela como planta emergente, e na sucessão ocorrente, completado o seu ciclo, desaparece ente a criação de condições ambientais hostis (sic. sombra) para a sua regeneração e desenvolvimento. Nas matas mais secas do planalto, o pinheiro brasileiro domina completamente, gerando povoamento, coetâneos ou dissetâneos, puros ou mistos, associando-se à imbuia (Ocotea porosa Benth.Ver) (Angeli, 1957) ao mate (Ilex paraguaiensis St. Hil) além de cedro (Cedrela fissilis Vell.) entre outras; nas matas mais úmidas registram-se Podocarpus lambertii Klotz, Dicksonia sellwiana (Preis) Hook, ou seja xaxim.

Corroborando a teoria da sucessão com a característica do pinheiro como planta pioneira, heliófila, Hueck (1953) afirma ter "observado que em todas as partes onde a floresta de araucárias margina o campo, a floresta penetra na estepe, fenômeno este a que foi prestado muito pouca atenção na literatura fitogeográfica".

Com ênfase, este autor (Hueck, op. cit) assevera que a floresta insinua-se nas planícies abertas, sem árvores, lentamente, mas com grande regularidade; concomitantemente, ao examinar o comportamento dos maciços de pinheiro nativos como comunidades vegetais, estabelece a paisagem da sucessão, que apresentada, focaliza e faz visualizar as respectivas fases evolutivas, morfogênicas e ontogenéticas do processo.

Na verdade, dentro da tônica esposada pelo autor desta monografia sobre a Silvica da Araucaria, os grandes estágios de sucessão e das interfases em particular, têm o valor humanístico. Com efeito, a quelas condições denotadas na chamada paisagem de sucessão já ocorreram em tempos pretéritos, e hodiernamente, pela degradação ou modificação do ambiente restrito ou amplo envolvente, pela anti-economicidade aparente, não poderiam assumir relevância no painel de debates.

A silvicultura atual, tão competitiva, tão empresarial, tem os seus módulos e parâmetros específicos e identificados, que outras fórmulas são válidas para fins de melhoria de condições de vida entre outros aspectos, mas não como alternativa de rumo econômico.

GENÉTICA E MELHORAMENTO

Nas populações florestais, como adverte Brewbaker (1969) o melhorista há que inteirar-se das concepções de tipos de variabilidade ocorrentes tanto em uma população generalizadamente, quanto no indivíduo particularizadamente (Variação Biológica; Variação Fenotípica; Variação Genética e Herdabilidade).

A seleção artificial difere da natural em diversos e importantes aspectos; primeiramente, a seleção artificial é aplicada em um conjunto escolhido de condições ambientais. A seleção natural ocorre, em geral, em populações grandes, nas quais predomina cruzamentos ao acaso ou não controlados. A seleção artificial, por sua vez, é efetuada frequentemente com um número pequeno de indivíduos selecionados e com cruzamentos controlados.

Na expressão célebre do melhorista, o problema mais importante da seleção artificial não é identificar o que pode ser eliminado, mas sim o que deve ser mantido para a continuação do melhoramento.

As tendências definidas e as prescrições científicas para o Melhoramento Florestal, não se configuram como tecnologias recentes, seus contornos já se fixaram há quase meio século. A propósito, lembram-se os pioneiros Melhoristas Florestais como Lindquist, Larsen, Wright, Mckay, Righter, Gustafson entre muitos outros.

Os métodos de melhoramento (Gurgel, 1963,1964) de um modo geral podem ser reunidos em três grupos: seleção, hibridação e mutação induzida, esta última compreendendo a mutação gênica e a mutação cromossômica ou poliplodia. Ainda sob este título, incluem-se os métodos de reprodução vegetativa, da aclimatação, do teste de clones e do teste de progênies.

Na seleção, utilizam-se as variações hereditárias já existentes nas plantas procurando os melhores indivíduos (Gurgel Filho, 1953 Dorman, 1952; Gurgel Filho 1962b; Lindquist, 1948; Larsen, 1956; Wright, 1962). Este processo torna-se muito mais eficiente quando combinado com outras técnicas como o teste de progênie, em virtude de ser a principal arma que o melhorista tem em mãos, para avaliar o resultado do seu trabalho, e constituir também um método de melhoramento. A propósito, convêm lembrar que a seleção é limitada nos seus fins, ao passo que a hibridação e a mutação indizidas abrem outras perspectivas.

No caso específico das Aracárias, o especialista, o silvicultor e o melhorista amalgamados, conseguirão, sem dúvida, obter gerações melhoradas, com expressivos ganhos ou avanços genéticos, tanto do ponto de vista quantitativo, quanto qualitativo, redundando, em suma, no aumento da produtividade e consequente maior rentabilidade econômica.

Amparado em ampla e bem fundamentada literatura, assoma e emerge, que a predominância de gens favoráveis é obtida através de um trabalho programado, calcado nos diferentes métodos de seleção.

Especificante cabe mencionar os diferentes fatores ou ocorrências que atuam e afetam a seleção, codificados:

a) Intensidade de seleção;
b) Propriedades genéticas da população;
c) Condições da biota;

d) Fatores mecânicos, físicos e antrópicos.

Da evidência emanada caberiam apenas conotações ligadas ao último item (d) compreendidos como preparo do solo, manipulação de insumo, época e continuidade do plantio, enfim técnicas e cuidados visando à uniformidade da cultura, ou do experimento, ou da área produtora de sementes.

Registram-se ainda as mensões ao uso de delineamentos estatísticos adequados no controle dos métodos de melhoramento, da conveniência do estudo da interação genótipos - locais, e da repetição dos experimentos por anos consecutivos.

Por último, ressalta-se que a taxa de elevação das freqüências gênicas dependem, entre outros fatores, da variabilidade genética presente na população original, do método de seleção empregado, do tamanho da população, da precisão da avaliação dos genótipos, do ambiente, das correlações genotípicas-fenotípicas, entre outros eventos.

Finalmente, cabe repetir, como tônica das preocupações do experimentador, a utilização de delineamentos estatísticos consentâneos e adequados, capazes de propiciarem meios eficientes, seguros e de alta confiabilidade aos resultados derivados da longa e exaustiva pesquisa, apanagio dos trabalhos florestais. O fim último da seleção, se quantificado em valores econômicos a lapsos relativamente curtos, todavia, torna-se quase intangível, face ao progresso científico e às exigências tecnológicas.

METODOLOGIA DO MELHORAMENTO FLORESTAL DA ESPÉCIE

Os parâmetros de melhoramento atribuídos às espécies Florestais em geral e coníferas em particular, com as extrapolações requeridas, conferem subsídios valioso aos estabelecimento da metodologia a ser posta em execução. (Gurgel Filho et al, 1962b).

Como primeiro ponto pacífico, seria a seleção massal, concomitantemente à eleição, marcação e definição das Árvores Plus.

As extensas florestas remanescentes ou mesmo os relictos existentes dentro da zona de dispersão, ainda serão o manancial dos trabalhos iniciais do Melhoramento. Sabiamente subdivididas em parcelas, com os recursos oriundos dos Inventários de toda a sorte, emergirão os indivíduos em número suficiente, dentro das exigências da Genética, também identificados ao nível de eventuais ecótipos.

As técnicas da qualificação das Árvores Plus são facilmente assimiláveis, com a exigência primária e única da atribuição da tarefa de tanta responsabilidade e tão grande magnitude e equipes de irrestrita confiabilidade.

A propagação vegetativa (Gurgel Filho, 1959, 1959a,1967a,1970) não constituirá óbices intransponíveis havendo que aprimorá-la e diversificá-la.

A propósito de cruzamentos inter-específicos (A. araucana e A. angustifolia) Tesdorf (1956, 1961) registra os êxitos alcançados na metodologia e sempre a predominância de plantas do sexo feminino.

As hibridações e as polinizações controladas futuras naturais ou artificiais poderão ser alcançadas com relativa facilidade, dado o caráter, da Araucaria, de planta dióica. Ultrapassada a fase dos cruzamentos intra-específicos, poder-se-ia testar a exequibilidade de cruzamentos inter-específicas especialmente com a Araucaria araucana, que, pertencendo à mesma Secção Columbea, talvez demonstre compatibilidade.

Os testes de progenie, as secgergações denotadas, as análises acerca das gerações F_1, F_2, são técnicas já dominadas. Tanto o melhorista como o dasônomo, encontrarão na concepção das "Caracteres Juvenis" (Gurgel Filho, 1953) elemento hábil para predicções várias acerca do comportamento biológico em estágios de idade mais avançados.

Muitos outros problemas poderão desafiar, como a conservação de sementes; culturas de meristemas ou amplamente cultura de tecidos; manipulação de gemas e sementes; descobrimento do grau ou do coeficiente de herdabilidade dos caracteres a serem melhorados; estudos da fisiologia vegetal; conservação do pólem, além de outros detalhamentos, sem olvidar os Bancos Genéticos ou Centros de Germoplasma.

Sem excesso de otimismo, na atualidade há elementos técnicos, e de pesquisas disponíveis, possibilitando a ereção de um vigoroso e realístico Programa de Melhoramento de Araucaria.

Sintetizando o que fora evidenciado, as primeiras realizações consubstanciar-se-iam:

1 - Locação dos povoamentos florestais naturais da zona "core" da ocorrência natural.
2 - Locação dos povoamentos florestais naturais das zonas adjacentes;.
3 - Locação dos povoamentos florestais naturais das zonas individualizadas representativas enclaves não compreendidas em áreas contiguas ocorrentes na região sul.
4 - Locação e individualização dos povoamentos florestais artificiais mais representativos.
5 - Arranjamentos estatísticos básicos para definições de ecótipos ou raças geográficas.
6 - Reconhecimento, em todos os casos, das variações biológicas de origens fenotípica, ambiental e genética.
7 - Seleção massal e eleição de "Árvore Plus".
8 - Experimentação dasonômica fundamentada em premissas estatísticas e de genética das populações.
9 - Estabelecimento de Áreas Produtoras de Sementes.
10 - Desenvolvimento dos processos de propagação vegetativa.

Concomitantemente ou na fase posterior:

1 - Hibridação natural intra-específica.
2 - Hibridação artificial (Polinização controlada) intra-específica.
3 - Testes de progenies.
4 - Pomares de sementes. (Seed orchards).
5 - Pomares clonais.
6 - Hibridação inter-específica.
7 - Culturas de tecidos (meristemas).
8 - Centros de Germoplasmas.
9 - Técnicas silviculturais.
10- Avaliação e Re-programação.

SILVICULTURA

Se a Silvicultura conforme Gayer, apresentada por Azevedo Gomes (1947) tem por objetivo criar povoamentos satisfazendo as necessidades do mercado de acordo com a capacidade criadora do solo, e conduzi-los a um desenvolvimento determinado para os entregar à produção, abarca na verdade dois estágios distintos, ou sejam: aquele representado pelos maciços naturais e aquele outro referente aos maciços artificiais.

Para uma e outra situação, o silvicultor tem que se prê- munir de conhecimentos e tecnologias adequadas capazes de o levar a resultados auspiciosos. Ainda mais, num e noutro caso, há que saber as potencialidades da natureza, impedindo a destruição de ecossistemas ou num sentido mais amplo, mantendo as biogeocenoses (Gurgel Filho, 1978a; Gurgel Filho, 1977).

Talvez só nesta década de 70, tenha se difundido o conhecimento do valor do material básico selecionado, portador de cargas genéticas de alta potencialidade.

Tal evolução do uso e do valor genético das sementes implica - ría numa nova tecnologia de cultivo, ou numa outra atuante tecnologia silvicultural.

Graças a este novo material genético, a este material básico selecionado, tais sementes estariam gerando ou configurando um outro estágio florestal, que, plagiando o melhorista, dir-se-ia a 3a. floresta, no caso particular, da Araucaria angustifolia.

Com efeito, da primária, nativa ou 1a. floresta de pinheiro, formaram-se e constituiram-se as florestas artificiais, ora classificadas, arbitrariamente como 2a. floresta.

Na verdade e lamentavelmente a 2a. floresta, artificial, de pinheiro, não logrou obter os benefícios e os ganhos genéticos que as espécies exóticas os obtiveram. Se preocupações e conhecimentos técnicos e científicos existiam e proclamavam a necessidade e mesmo a imprescindibilidade do uso de sementes melhoradas, na realidade não ecoaram nos meios empresariais e tão pouco haveria disponibilidade quantitativa.

À 3a. floresta de pinheiro que se reserve melhor sorte.

A comunidade científica já está cônscia, e que é mais importante, possue meios e conhecimentos de realização e de produção de sementes melhoradas para o presente; à comunidade empresarial já está caracterizado o valor sócio-econômico de uma floresta oriunda de sementes selecionadas, representando um índice bem mais elevado de rentabilidade.

Da conjugação das duas correntes de pensamento, desde já, através de uma herculeo trabalho amparado na seleção massal, poderão,para o próximo reflorestamento, serem colocadas no mercado,pinhões de qualidade superior àquelas dos que são atualmente comercializados.

Todavia, a 3a. floresta, ancorada em sementes de qualidade superior não reverterá os ganhos econômicos acenados derivados de avanços genéticos, se, concomitantemente não houver uma renovação silvicultural. Desta sorte, da qualidade do "site" ao corte final há muito o que ser reformulado, ponderando todas as fases interme diárias.

As exigências nutricionais do pinheiro, como já se discutira precisam ser atendidas, se objetiva-se o êxito da cultura. Prevalecentemente a escolha do local, há que ponderar a compatibilidade com as condições topo-climáticas

As técnicas de alfobre ou da semeadura direta no campo, seguidos dos tratos culturais, tem que ser consentâneos ao valor do material básico.

Espaçamento ou compassos convenientes, preparo do solo adequado, tratos silviculturais estruturam-se num harmônico contexto:.

A 3a. floresta tem que compatibilizar-se com um Ordanamento florestal eclético, definindo desde logo os objetivos da produção com a consequente eleição do Regime Florestal.

Esta é a visão que tanto o silvicultor quanto o empresário necessariamente precisam possuir para fazer juz à qualidade do material. Não se trata de nenhuma utopia, mas de autêntica visão realística, já rotineira, tanto para certas evoluídas eucaliptoculturas, e pinoculturas do Brasil, quanto das florestas em geral do mundo.

A 3a. floresta de Araucaria que há de se impor, nada mais depende para os seus primórdios de implantação definida, do que a mobilização de uns poucos recursos materiais e tecnológicos.

Sendo a 3a. floresta que se inicia sobretudo uma floresta de Rendimento, obviamente elevará a Araucaria angustifolia ao concerto de espécie econômica ao reflorestamento.

A racionalização que se defende para a 3a. floresta de Araucaria, que na realidade será o 3º estágio da araucariacultura, longe de envaidecer ao pesquisador e experimentador, apenas o motiva, na esperança derradeira de salvaguadar uma espécie indígena, uma espécie autóctone, com potencialidade econômica.

PESQUISA E EXPERIMENTAÇÃO

a) Caracteres silviculturais

O Projeto 2/52-SR, implantado em 1952, pertinente à Araucaria angustifolia (Bert.) O. Ktze., sob o delineamento de blocos casualizados 3 X 4, cujos tratamentos revelavam-se pelos compassos em quadra de 1,0m X 1,0m, 1,5m X 1,5m e 2,0m X 2,0m, com áreas individuais por planta respectivas de 1,00m², 2,25m² e 4,00m², proporcionou a constatação desde os seus primórdios da sensibilidade desta espécie indígena, tanto para as condições da densidade do povoamento puro equiânio quanto para a fertilidade do solo (Gurgel Filho, 1957).

Com efeito, conforme se relatara em trabalho anterior (Gurgel Filho, 1969) ao cabo do 3º ano da instalação, o compasso em quadra de 1,0m, já se demonstrava exíguo para a continuidade do normal e harmônico crescimento em diâmetro das plantas integrantes.

A evolução do crescimento do pinheiro brasileiro sob o espaçamento de 1,5m X 1,5m, embora se manifestasse ser mais acentuada comparativamente aquele de 1,0m em quadra, todavia ao 6º ano as suas médias de diâmetro (DAP) situavam-se do ponto de vista estatístico, distintas ao nível de 5%, e inferiores, quando cotejadas com as oriundas, do compasso de 2,0m.

Aflora pois a informação de que compassos estreitos, exigindo desbastes precoces no intuito de que não seja perburbado o normal e harmônico desenvolvimento das plantas poderão tornar-se antieconômicos. Ademais, se o material retirado pelo desbaste, no caso especial do pinheiro brasileiro, não se transformar em fonte de renda como "Árvore de Natal" (Gurgel Filho, 1960) não subsistem razões outras para a adoção de compassos estreitos, já que a derrama natural processou-se satisfatoriamente para os três compassos pesquisados, por volta do 5º ano.

A manutenção de parcelas testemunhas dentro do Projeto nº2/52--SR - já sob outra configuração estrutural de modelo estatístico - - veio demonstrar que a estagnação para o tratamento 1m X 1m, atingiu a "climax" entre o 8º e 9º anos, com pronunciada ocorrência de mortalidade natural.

Com a finalidade de globalização para o estudo específico da ontogenia do pinheiro brasileiro - com base nos dados da presente experimentação - aos 20 anos de idade, o povoamento está a apresentar um incremento médio volumétrico da ordem de 11,67m³/ha/ano, com casca e área basimétrica de 19,04m²/ha.

A influência da fertilidade, determinando nas condições presentes diferenças de crescimento das ordens de 14% para as médias de

diâmetro a 30% para a altura, é corroborada não só por trabalho de Speltz (1963) quando registra que na Fazenda Monte Alegre, Paraná, "a altura média dos plantios em solos de campo é 5 vezes menos ou 19%, comoarada com os da mata, e, a do cerrado representa a metade, ou 50%, como também Gurgel Filho (1976) em pesquisa efetuada (Projeto 20/54/SR) na própria Estação Experimental de Santa Rita do Passa Quatro.

Cotejando as expressões dendrométricas elementares derivadas de ambos os experimentos, as médias de diâmetro e altura pertinentes ao Projeto 20/54-SR, aos 20 anos de idade - ponderadas as identidades de metodologia e material (Gurgel e Gurgel Filho, 1965) Fundação de Pesquisas Florestais, 1978; Mattos, 1972; - superam aquelas correspondente do Projeto 2/52-SR, respectivamente em 12% para a altura e 14% para o diâmetro.

Não obstante os continuados desbastes ocorridos, ainda se evidencia, na população remanescente, acentuada heterogeneidade do material, cujos limites de amplitude entre árvores para o diâmetro são bastante amplos, chegando ou ultrapassando a proporção de 1:2. Tal evento induz a necessidade indiscutível da efetivação de um rigoroso trabalho de seleção, já com o intuito da homogenização, já com vistas ao vigor, compreendendo, implicitamente a velocidade do crescimento da espécie.

As aparentes disparidades aparentes entre frequências observadas e frequências esperadas, conforme as equações de regressão constantes do presente trabalho, assumem aspectos de consonância e coerência, presentes os eventos: 1º - o estudo matemático torna-se estruturamente válido ao período cogitado, e como bem adverte Pimentel Gomes (1971) as extrapolações que se projetam podem tornar-se perigosas, cabendo ao pesquisador extrema cautela na manipulação dos dados biológicos; 2º - as inerências do estudo dasonômico processado, mantendo e detectando as características biométricas e biométricas e dendrológicas das plantas aos diferentes estratos de dominância, incluindo portanto as "dominadas", sem dúvida perturbou as expressões das médias de crescimento do povoamento, no que tange ao normal e harmônico desenvolvimento da espécie.

Em última análise, o que aflora, em têrmos conclusivos, sintetiza-se:

1º - Espaçamento estreitos, exigindo desbastes precoses, caracterizam-se por serem anti-econômicos, a não ser no caso especial e particular de mercado para "Árvore de Natal".

2º - A compatibilidade de culturas agrícolas intercalares (Sistema Taungia) concomitantemente a adoção de compassos mais amplos, deve ser examinada, no superior intento econômico do empreendimento.

3º - A efetividade do melhoramento genético da espécie é medida inadiável que se impõe, visando a obtenção de populações homogêneas e de expressivo vigor.

4º - Com base na presente pesquisa, mediante racional e adequado ordenamento florestal, aliado a material básico evolutivo (melhorado geneticamente) será possível obter expressivos ganhos dendrométricos em relação aos atualmente registrados, dentro das condições da presente pesquisa.

b) Raças geográficas (Definições gerais)

1) O experimento preliminar, realizado em uma zona neutra quanto às proveniências, forneceu subsídios conclusivos, evidenciando pois a ocorrência de raças geográficas em pinheiro brasileiro. Aliás tal experimento, ante às evidências, fora a matriz impulsionadora da exoerimentação mais ampla, com o objetivo de detecção de eventuais raças geográficas. (Gürgel Filho et al, 1965).

2) O experimento nacional. Ainda que os experimentos que compõem a programação, estejam atualmente com cerca de 13 anos de idade, os espécimes alcançando expressões dendrométricas de 15 ou mais metros de altura, e diâmetro (DAP) de 0,25m, a fixação de conclusões definitivas não se aparente oportuna pelos motivos: necessidade de completar as análises estatísticas de crescimento dendrométrico, com interpretação sob certos parâmetros, entre outros, tais como, internodios, forma de árvore, germinação (Glaser, 1963) disposição angular dos ramos com o fuste, sobrevivência, frutificação, resistência a pragas e moléstias, vigor, adaptabilidade, forma do fuste ("tape"), espessura de cas, comprimento de fibras, densidade básica. Só após uma avaliação tão global quanto possível, é que poderão ser formuladas as conclusões definitivas acerca da identificação e individualização de ecótipos, (Gurgel, et al,1973).

3) O experimento regional. As mesmas observações gerais do ítem b, são válidas para este estudo de 5 proveniências. (Gurgel Filho, 1973b).

Somente como resultado do estudo da análise bioestatística dos pinhões, constata-se, em caráter conclusivo final, que existem diferenças em dispersão, entre as amostras, por procedência, quando examinadas em relação ao tamanho de semente (comprimento conjuntamente com a largura).

c) Silvica

Das espécies indígenas a A. angustifolia é uma raras que têm como característica botânica o inerente tipo de ramificação monopodial, ou monopódico, ou racemoso, assegurando a individualização de um único caule bem definido (fuste). Só este caráter já assegura uma grande possibilidade florestal à essência, viabilizando a formação de povoamentos florestais homóclitos ou monotípicos e equiânios; como planta de luz, sem qualquer criptotolerância, suporta desde o período formativo a plena exposição à radiação solar.

A teoria esposada de que o pinheiro é planta invasora, invadindo as formações adjecentes à mata, não é a terapêutica aconselhada para a recuperação florestal de Araucaria, pelas principais razões: a) prováveis êxitos pequenos derivados da semeádura natural, já por condições agressivas e inóspitas do meio ambiente, já pela voracidade ante ao consumo alimentar, restando pois um número talvez insignificante de propágulos; b) número atual relativamente pequeno de matrizes; c) característica morfológica do diásporo, impedindo-o a transportes naturais a longas distâncias; d) ataque dos "seedlings" a plantas jovens naturais; e) acirrada competição natural intra e inter-específica, dificultando a sobrevivência e o crescimento normal; f) flagrante descompasso entre as áreas de formação expontânea da floresta e o desmatamento.

Ademais, registra-se em Cerena (1966): uam tendência para uma maior mortalidade do que um incremento anual expresso por ano, pode ser esperado nessas velhas florestas de Araucaria, especialmente considerando que a regeneração natural é de muito pouca importância nessas florestas primerias. Devido ao déficit constante e progressivo originado pelo corte sobre o valor do incremento anual de madeira, será impossível obter o equilíbrio, somente pelas forças da natureza.

Se as reservas existentes já não são extensas e com árvores em muitos casos próximos à decreptude, tão pouco a prescrição de um ordenamento florestal de Rendimento Sustentado (Gurgel Filho, 1974), tendo como modelo, por exemplo "cortes salteados" ou "jardinados" (Gomes e Coutinho, 1958) ou "selection method" seria solução florestal-econômica viável.

Por outro lado adverte que sendo uma espécie de luz (intolerante) as condições da floresta temperada natural heteróclita sombreada, com o próprio docel florestal gerado, acrescido do subosque, po de tornar inóspito o ambiente; assumiria então aquela conhecida clássica sucessão, citada pela literatura, entre os gêneros Picea spp ("spruce") e Fagus spp (beech) "mutatis mutandis", entre Araucaria em perecimento, talvez em função do fator luz em mínimo e outra ou outras espécimes tolerantes, já na condição de dominantes.

Não resta outra alternativa, se o intuito é implántar a araucariacultura, senão, sem mais tergiversações enveredar, firmemente para o reflorestamento artificial.

Surgem daí similitudes e contrastes não só dentro da araucaria cultura, quando também em confronto com a pinocultura e eucaliptocultura.

Duas alternativas para rebaixamento do custo da formação de floresta de Araucaria seriam: a) semeadura direta, uma vez confirmada a abundância de sementes, ou o preparo de mudas em recepiente mais econômicos (Glazer, 1963), b) a cultura intercalar agrícola (Gurgel Filho, 1962) gerando benefícios recíprocos quando racionalmente planejada. Uma terceira alternativa, já para a floresta em idade jovem, seria o pastoreio, a cultura silvo pastoril; sem os excesso denotados, como fonte adicional de recursos.

Por fim, entre outras, a exploração do mercado de "Árvores de Natal", aos povoamentos mais densos, seria outra fonte geradora de recursos (Gurgel Filho, 1960) a curto e médio prazos. Óbvio, que para outras culturas florestais, mormente Pinus spp. e Eucalyptus spp. muitas das alternativas propostas também são passíveis de aplicação; desta forma o diferencial de rentabilidade inter-específico, poderia não ser muito afetado.

Em análise última, o que propiciará a existência de uma araucariacultura será a existência de um mercado específico, com ofertas justas, aliado a uma floresta monotípica rentável, em função de elevados incrementos anuais.

Mais uma vez então se justifica a necessidade, a evidência de uma tecnologia avançada, abarcando desde o material básico (semente germoplasma) medeando pela eleição de solos adequados e sítios corrigidos e adequadamente preparados incidindo no plantio, nos compassos corretos, e nos tratos culturais, dalongando-se no manejo (Soares, 1969) ultimando-se no corte final.

Não seria outra coisa que o proclamado conceito da 3a. floresta Araucaria angustifolia.

PROGRAMAS TECNOLÓGICOS

Módulos Restritos

Talvez por estratégia, apliquem-se módulos restritos ao melhoramento da Araucaria angustifolia, a exemplo de trabalhos anteriores (Gurgel Filho, et alli, 1978) consubstanciados e analizados neste trabalho.

a) levantamento das populações naturais
b) seleção massal nas populações naturais ("Seed Source")
c) determinação das árvores "plus" ou árvores "elites"
d) desenvolvimento da tecnologia da propagação vegetativa
e) plantio de florestas originárias de populações selecionadas (item b)
f) adequação de regiões florestais, de espaçamentos, compreendendo toda a técnica silvicultural, da semente ao corte final.

Módulo abarcante

Concomitantemente ao módulo restrito, objetivo de implantação imediata, aplicar-se-ia o módulo abarcante nas inter-faces:

a) áreas produtoras de sementes naturais ou artificiais de árvores selecionadas fenotipicamente.
b) instalação de pomares de sementes
c) testes de progenies
d) pomares clonais (Propagação vegetativa extensiva)
e) polinização aberta
f) polinização controlada (conhecimento prévio de biologia e fisiologia da floração)
g) hibridação intra-específica, com ênfase às proveniências e tantativa à inter-específica (campatibilidade)
h) sementes melhoaradas (identificadas e selecionadas)
i) sementes certificadas
j) pesquisas de conservação da semente
l) seleção por objetivos: densidade básica, comprimento de fibra, expessura da casca, originária e primariamente
m) técnicas silviculturais: manejo da semente, preparo, fertilização e calagem dos solos; plantio; tratos culturais; desbastes, corte final (macanização)
n) conservação do pôlen e conhecimento da sua área de dispersão (Palinologia)
o) culturas de tecidos (meristemas)
p) centro de Germoplasmas da Araucaria angustifolia.

A exeqüibilidade de tais programas de Ação, só será assegurada mediante a existência de um organismo atuante, permanente, supervisor, para o impulsionamento dos trabalhos, constantes avaliações e adaptações segundo os ditames da dinâmica das operações.

REFERÊNCIAS BIBLIOGRÁFICAS

ANDERSON,J.R.;HARDY,R.E.;ROACH,J.T.;& WITMER,R.E. Sistema da classificação do uso da terra e do revestimento do solo para utilização com dados de sensores remotos."s.l.", 1979.

ANGELI,J. Árvores do Paraná.Curitiba, Instituto Paranaense de Botânica, 1957. 285 p.

BREWBAKER,J.L. Genética na agricultura.São Paulo,EDUSP,1969.217 p.

CERENA. Inventário do Pinheiro do Paraná. Curitiba, 1956.40 p.

CERENA. Inventário do Pinheiro do Paraná. Curitiba, 1966.140 p.

DORMAN,K.H. Hereditary variation as the basis for selecting, superior forest trees. Station Paper, N.Carolina,n.15, 1952. PRODEPEF, n.11, 1978, 66 p.

GOMES,A.M.A.& COUTINHO,F.B.N. Pinhais jardinados. Lisboa,Serv.Flor. Aquícolas, 1958. 53 p.

GOMES,M.D.A.& COUTINHO, Silvicultura.Lisboa,Liv.Sá de Costa, 1947. 239 p.

GURGEL,J.T.A. A genética florestal em alguns países da Europa Ocidental.Silv.S.Paulo, 1/2:229-264, 1963.

GURGEL,J.T.A. A genética e a realidade do melhoramento florestal. Silv.S.Paulo, 3:81-100, 1964.

GURGEL,J.T.A.& GURGEL Fº,O.A. Genética e melhoramento de essências florestais.São Paulo,Melhoramentos,s.d.p. 187-227.
GURGEL Fº,O.A. Árvore de natal.S.Paulo Agric., 2(24):54-57,1960.
GURGEL Fº,O.A. Biologia do crescimento dos povoamentos florestais puros coetâneos e as ilações ao desbaste.Rio de Janeiro, IBDF, 1973.
GURGEL Fº,O.A. A conservação da floresta.Rio de Janeiro, Fundação Getúlio Vargas, 1978. (no prelo).
GURGEL Fº, O.A. Contribuição à silvicultura das espécies florestais nativas.São Paulo,Instituto Florestal, 1976.
GURGEL Fº,O.A. Cotejo dendrométrico e econômico entre o Pinus elliotti Eng.e a Araucaria angustifolia (Bert.) O.Ktze."s.l.",1959. 6 f. Pub. mimeog.
GURGEL Fº,O.A. Curso de Silvicultura.Recife,Universidade Federal de Pernambuco,Conv.SUDENE/UFRPE, 1975.v.1.
GURGEL Fº,O.A. Contribuição ao entendimento do "site". (1979) não publicado.
GURGEL Fº,O.A. Desbastes florestais.Silv.S.Paulo,1(1):127-148,1962.
GURGEL Fº,O.A. Desenvolvimento das essências em cultivo experimental.São Paulo,Instituto Florestal, 1971.(publ.mimeo.)
GURGEL Fº,O.A. Dimorfismo dos ramos em pinheiro brasileiro e outras coníferas.In:CONGRESSO NACIONAL DE BOTÂNICA,19., 1970.Anais. Fortaleza, 1970.
GURGEL FILHO, O.A. Forest Problems of the genus Araucaria.IUFRO. Curitiba, Brasil. 29-68.1980.
GURGEL Fº,O.A. Essências indígenas.Silv.S.Paulo, 9:47-62,1975.
GURGEL Fº,O.A. Estudo do crescimento de algumas essências do cerrado. São Paulo, 1953.61 p. Tese.Doutorado.
GURGEL Fº,O.A. Estudo crítico do espaçamento em Pinus elliotti. Silv. S.Paulo,4:235-258, 1966.
GURGEL Fº,O.A. Florestas nativas e rendimento sustentado.Brasil flor. 1974.
GURGEL Fº,O.A. Incidências da densidade do estoque e da estrutura dos povoamentos florestais puros coetâneos de coníferas sobre o valor comercial da produção.B.Técn.Inst.Flor.,n.4,1973, 44 p.
GURGEL Fº,O.A. Influência da semente em Araucaria angustifolia(Bert.) O.Ktze. In:SIMPÓSIO BRASILEIRO DE REFLORESTAMENTO DA REGIÃO DA ARAUCARIA, 1., Curitiba, 1963.Anais.Curitiba,IKPC,1963.p.189-191.
GURGEL Fº,O.A. Métodos de enxertia para o pinheiro brasileiro visando a formação de pomares de sementes.Silv.S.Paulo,6:153-155, 1967.
GURGEL Fº,O.A. Parques Nacionais e reservas equivalentes.Recursos Naturais.Meio ambiente e poluição.1ª parte."s.l.",SUPREN,IBGE, 1977. 23-24.
GURGEL Fº,O.A. Plantio do eucalipto consociado com milho.Silv.S.Paulo, 19:85-102, 1962.
GURGEL Fº,O.A. Projeto A/73 ecótipos do pinheiro brasileiro.São Paulo Instituto Florestal, 1973.p. 2324.
GURGEL Fº,O.A. A propagação vegetativa de espécies florestais.Rev. Agricultura, 34(1): 13-30; 34(2): 119-130, 1959.
GURGEL Fº, O.A. Propagação vegetativa de Pinus elliotti Eng.var. elliotti Silv.S.Paulo, 6:127-139, 1967.
GURGEL Fº,O.A. Raças geográficas em pinheiro brasileiro.Araucaria angustifolia (Bert) O.Ktze.In:CONGRESSO FLORESTAL BRASILEIRO, 1., Curitiba, 1968. Atas do.Curitiba,PIEP,1970.1º Comissão.Trabalho n.8.
GURGEL Fº,O.A. Silvicultura temperada. 1979.60 p. (não publicado).
GURGEL Fº,O.A. Sobre o crescimento do pinheiro brasileiro (nota prévia). Rev.Agric., 32(2):79-82, 1957.
GURGEL Fº,O.A. Três espécies florestais utilitária.In: SECSÃO ANUAL SBPC,28.,Brasília, 1976.Anais.Brasília,SBPC, 1976.
GURGEL Fº,O.A. et allii.Espécies indígenas (experimentação).São Paulo Instituto Florestal, 1974.
GURGEL Fº,O.A. et allii.Espécies exóticas (experimentação).São Paulo, Instituto Florestal, 1974.
GURGEL Fº,O.A. et allii.Seleção de fenotipos em culturas de Pinus elliottii Eng.Silv.S.Paulo, 1962.p. 149-150.
GURGEL Fº,O.A. Ecotipos no pinheiro brasileiro.In:REUNIÃO ANUAL DE SBPC, 23., Curitiba, 1971.Anais.
GURGEL Fº,O.A. Teste de procedências de Eucalyptus e Pinus spp. no Estado de S.Paulo.B.Técn.Inst.Florestal,São Paulo,n.28,1978. 40 p.
GURGEL Fº,O.A.& GURGEL J.T.Caracterização de ecótipos para o pinheiro brasileiro,Araucaria angustifolia (Bert)O.Ktze.Silvicultura S. Paulo,9: 127-132, 1973.
GURGEL Fº,O.A., GARRIDO L.M.A;& RODRIGUES NETTO,S.M. Características silviculturais e biométricas do crescimento de algumas essências da zona temperada. In:CONGRESSO FLORESTAL BRASILEIRO,3., Manaus, 1978.
GURGEL Fº,O.A. & PISANI,J.F. Análise bioestatística de pinhões de cinco diferentes proveniências.Silvicultura S.Paulo,9:73-85, 1975.
HOEHNE,F.C.Araucarilandia.São Paulo,Sec.Ind.Comércio, 1930.200 p.
HUECK,K. Distribuição e habitat natural do pinheiro do Paraná.B. Botânica,USP, n.10:5-24, 1953.
HUECK,K. As florestas da América do Sul.São Paulo.Ed.Univ.1972,466 p.
LARSEN,C.S.Genetic in silviculture.Edinburg,Olover and Boyd, 1956.
LINDQUIST,B.Genetics in Swedish forestry practice. 1948.
MATTOS,A. O pinheiro brasileiro. São Paulo,Grêmio Politécnico,1972. 200 p.
RIZZINI,C.T. Árvores e madeiras úteis do Brasil.São Paulo, EDUSP, 1976,294 p.
RIZZINI,C.T. Tratado de fitogeografia do Brasil.São Paulo. EDUSP, 1976,327 p.
ROMARIZ,D.A. Aspectos da vegetação do Brasil.Rio de Janeiro, IBGE, 1974,59 p.
SOARES,R.V. Desbaste em Araucaria angustifolia (Bert.)O.Ktze.In:CONGRESSO FLORESTAL ARGENTINO, 1., Buenos Aires, 1969. Actas Buenos Aires,Servicio Nacional Florestal, 1971.
TESDORFF,H.A. araucana (Mol)K.Koch e A.angustifolia (Bert.)O.Ktze.Z. Forstgenetik und Forstplansezuchtung,5:79-84, 1956.
TESDORFF,H.A. araucana y.A.angustifolia.In:REUNIÃO REGIONAL DE CONIFERAS, 1., Buenos Aires, 1961,Proceedings.Buenos Aires; Assoc. For.Argent., 1961, p. 12-21.
WALTER,H. Vegetation of the earth.London, Univ.Press, 1973.237 p.
WRIGHT,J.W. Genetics of forest tree improvement.Rome,FAO,1962.399 p.
WRIGHT,J.W. Hibridaciones entre especies y razas Rome,FAO, 1963.

FAST GROWING TREES

MANEJO DO KAURI NEO–ZELANDÊS *(Agathis australis)*

J. C. Halkett
New Zealand Forest Service
NEW ZEALAND

Resumo

A área de ocorrência natural original das florestas de Kauri (*Agathis australis* Hort ex Lindl.) na Nova Zelandia tem sido substancialmente reduzida pela exploração e transformação das áreas. Todavia existem ainda hoje 60.000 ha de florestas contendo povoamentos de segunda rotação que se originaram naturalmente após a destruição da floresta primária.

A exploração do Kauri era sem controle até a criação do N.Z. Forest Service em 1921. Os trabalhos de pesquisa demonstraram que a espécie tem considerável potencial para manejo. Em 1973 uma política revisada do manejo do Kauri foi estabelecida, objetivando principalmente perpetuar a espécie.

Áreas significativas de florestas idosas de Kauri foram conservadas como reservas biológicas. Somente poucas florestas foram zoneadas para produção de madeira, limitante a 1.000 m^3 anuais de toras para serraria. Os métodos culturais objetivaram preliminarmente promover o crescimento e a expansão das florestas de segundo ciclo, nas quais irá se basear o futuro suprimento de toras. O plantio de mudas vem sendo feito como suplementação à regeneração natural.

A variação em crescimento entre procedências não foi intensivamente estudada na área de ocorrência natural do Kauri. Todavia há indicações de diferenças fenológicas em mudinhas de diferentes regiões. Dois distritos de procedências (zonas sementeiras) foram bem demarcados e o intercâmbio de mudas entre os distritos não é mais permitido.

Os clones de Kauri são colhidos em fevereiro-março. O rendimento em mudas para plantio por kg de sementes limpas chega atingir 5.000. Deve-se colher sementes suficientes para suprir as necessidades e atenuar as amplas flutuações na viabilidade das sementes.

MANAGEMENT OF NEW ZEALAND KAURI, *Agathis australis*

Summary

The original area of kauri (Agathis australis Hort. ex Lindl.) forest in New Zealand has been substantially reduced by logging and land clearing. However, there now exists about 60 000 hectares of forest containing stands of second-crop kauri which has arisen fortuitously following the destruction of the primeval forest cover.

Exploitation of kauri was unrestricted until the formation of the N.Z. Forest Service in 1921. Research work showed that the species had considerable management potential. In 1973 a revised kauri management policy was introduced, aimed primarily at perpetuating the species.

Significant areas of old-growth kauri forest have now been set

aside in biological reserves. Only a few kauri forests have been zoned for timber production, currently rationed to 1000m^3 of sawlogs annually. Silviculture is primarily intended to promote growth and expansion of second-growth forest, from which future supplies of sawlogs will be obtained. Planting of nursery-raised seedlings is done to supplement natural regeneration.

Provenance variation in tree growth has not been intensively studied over the natural range of kauri. However, there are indications of phenological differences in seedlings from different regions. Two provenance districts (seed zones) have been recognised and the interchange of seedlings between districts is not permitted.

Kauri cones are collected in February-March. Yields of 5 000 plantable seedlings per kilogram of unwinnowed seed are obtained. Sufficient seed needs to be collected to accommodate wide fluctuations in seed viability.

NEW ZEALAND'S KAURI FORESTS

The New Zealand kauri, Agathis australis Hort. ex Lindl., is the southern-most species of the genus, the other 12 species of Agathis being concentrated in the tropics (Whitmore, 1977). Before the colonisation of New Zealand by Europeans in the 19th century there were close to 1.5 million hectares of forest containing kauri. Kauri was not dominant throughout these forests, though there were some extensive tracts of country where it was the only tree species in the forest canopy.

Most of the original kauri forest has been exploited or destroyed. After logging no attempt was made to provide for the establishment of a future timber crop. Large expanses of both pristine and cut-over forest were burnt and cleared for settlement.

By 1975 the total resource of old-crop kauri (circ. 500-1000 years-old) had been reduced to only about 6 000 hectares, the largest areas being in Waipoua and Warawara State Forests. Some gigantic trees exist in these remnants.

There now exists considerable areas of immature or second-crop kauri forest. These stands have arisen fortuitously following the destruction of the primeval forest cover. The area now clothed with second-crop kauri forest, or scrubland containing regenerating kauri, exceeds 60 000 hectares (Lloyd and Guild, 1976).

FOREST MANAGEMENT POLICY

With the formation of the New Zealand Forest Service in 1921 some measure of control over kauri exploitation was introduced. A policy of forest acquisition, particularly of areas containing regeneration, was also put into action.

Early research work did indicate that, of all the indigenous softwoods in New Zealand, kauri was the most amenable to silvicultural tending. The relatively long history of research and stand manipulation by the Forest Service illustrated the considerable management potential of kauri and this led the Government in 1973, to approve a revised kauri management policy. This policy has as its objective the perpetuation of kauri as a species both in natural stands (whether healthy or not) and as managed forests. Gene conservation is implied in the policy. The Forest Service formed a Kauri Management Unit to implement this policy through a series of prescriptions which aimed to:

1. Reserve further large representative areas of mature and immature kauri and kauri associations in forest sanctuaries.
2. Manage the remaining kauri areas as healthy stands with production of logs incidental to achieving the prime aim of management.
3. Reduce the permissible annual cut to the lowest level consistent with economic, social and legal constraints.
4. Acquire, where possible, areas of kauri regeneration not already in Crown ownership.
5. Reinstate a programme of artificial establishment of kauri.
6. Intensify research into the silviculture and ecology of kauri.

CURRENT MANAGEMENT PRACTICES

Silviculture

About 40% of the kauri area in State forests, and appreciable areas in scenic reserves, have been set aside as soil and water or flora and fauna reserves to safeguard environmental and ecological values. It is also recognised that kauri forests are important as a tourist attraction, and for recreation. In the other State-owned kauri forests zoned for sustained timber production, objectives of management operations are:

- to rehabilitate areas where the forest cover has been depleted by the activities of man;
- to substantially reduce the regeneration phase for kauri and other softwoods (this phase is generally reckoned to extend from seed germination until such time as the developing saplings are able to penetrate the surrounding hardwood overstorey);
- to stimulate the regenerative ability and growth of mature and second crop kauri stands.

Enrichment planting, using 3-year-old potted kauri seedlings is undertaken on suitable sites where natural regeneration is sparse or non-existent. Silvicultural tending of kauri and associated softwoods (podocarps) is carried out where young trees are growing beneath moderate to dense hardwood overstories. Tending involves liberating selected softwood saplings by ring-barking the surrounding overtopping vegetation (Beveridge, 1977).

Some limited areas of mature and second-crop forest are recognised as having a wood production potential and have been demarcated for sustained timber production. Timber production activity is confined to less than 1% of the kauri estate, and is currently rationed to about 1000 m^3 of sawlogs annually.

The utilisation of kauri forests for timber will ultimately be centred on second-crop stands. This shift in wood production emphasis, from the present selective logging of old-growth kauri to harvesting in younger stands, cannot proceed until the management strategy and logging method best suited to the advanced tending needs of this forest type have been fully developed. To this end a recent utilisation trial involving helicopter log extraction was conducted.

Provenance Variation

Kauri is confined to northern regions of New Zealand (Fig. 1) north of latitude 38°S, and has a fragmented distribution and only a limited capability for seed dispersal. Research to date has not shown much evidence of provenance variation. However, studies currently in progress have demonstrated that, under controlled environmental conditions, there are phenological differences between seedlings raised from seed collected from the northern and southern extremities of the natural range of kauri (I.L. Barton pers. comm.).

Because of the possibility that appreciable genetic differences may exist between provenances, seed collection zones were instituted in 1978. Two provenance districts, based upon ecological separation, are recognised. These are the North Auckland Peninsula; and the Coromandel Peninsula, including Great Barrier Island (See Fig. 1). Seedlings raised from seed gathered in each of the two provenance districts are used for re-afforestation work only in that district.

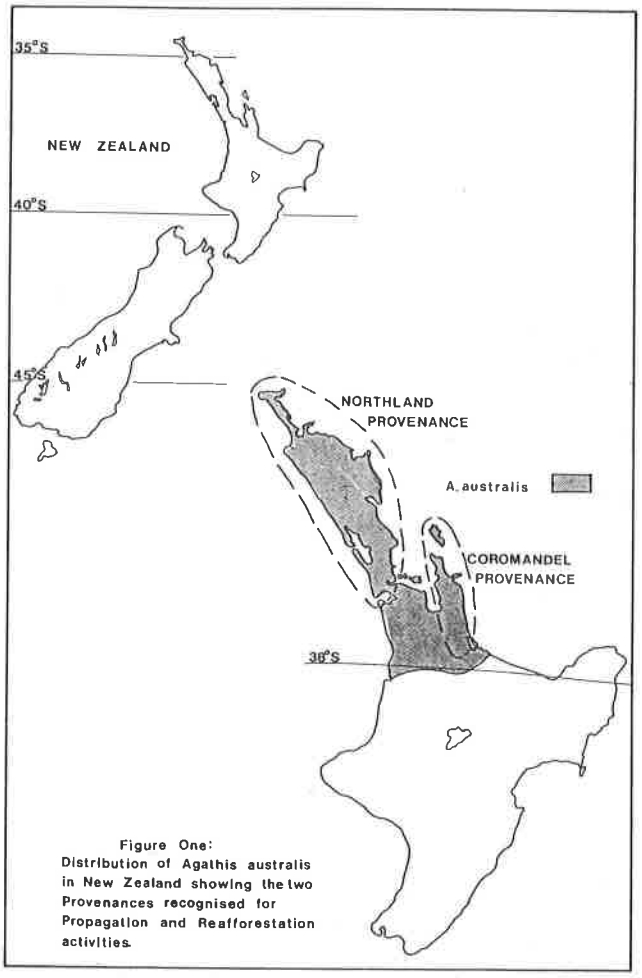


Figure One:
Distribution of Agathis australis in New Zealand showing the two Provenances recognised for Propagation and Reafforestation activities.

Seed Collection Procedure

Cones are collected in the late February-March period, starting just before it is anticipated that cone disintegration is about to occur. Location and observation of suitable seed trees begins in early February. Cones are collected by climbing trees over 30 cm diameter and generally up to 60-70 cm diameter. Seed trees vary from poles with a narrow conical crown, to semi-mature stems with enlarged branches and a rounded crown. Large mature trees are not climbed as cone collection from these trees is too hazardous. Seed taken from very young trees has a very low viability rate.

Experience indicates that about 5 000 plantable seedlings can be expected from each kilogram of unwinnowed seed. To accommodate annual fluctuations in seed viability, loss of viability during handling, transportation and storage, and also to accumulate a reserve in case of very poor seed years, an endeavour is made to collect about twice the annual nursery requirement.

Gathered cones are laid out on trays in a warm, well ventilated shed and left for a few days until they begin to break up. The top and bottom portions of the cones rarely contain sound seed and may be removed and discarded before cone disintergration is complete. The assortment of cone scales and seed is separated, first through a 12 mm sieve which removes the cone scales and then through a 5 mm sieve which removes the bulk of the remaining trash from the seed.

As the viability of kauri seed deteriorates rapidly it is essential that the period of time between cone collection and delivery of seed to the nursery or seed store is kept to a minimum. Seed can be successfully stored for many years at 5°-10°C if first reduced to a moisture content of 6% (Preest, 1979).

LITERATURE CITED

Beveridge, A.E., 1977: Notes on the silviculture of kauri. New Zealand Institute of Foresters (Inc.) Forestry Handbook, pp. 125-130.

Lloyd, R.C. and Guild, D.W., 1976: The role of forestry in the development of the Northland region. New Zealand Journal of Forestry, 21(2), pp. 175-194.

Preest, D., 1979: Seed storage of several New Zealand indigenous trees. Part I - Kauri (Agathis australis). New Zealand Journal of Forestry Science, 9(3), pp. 337-343.

Whitmore, T.C., 1977: A first look at Agathis. Tropical Forestry Papers No. 11, 54 pp. Unit of Tropical Silviculture, Commonwealth Fo restry Institute, University of Oxford.

FAST GROWING TREES

PRODUÇÃO DE SEMENTES, VARIAÇÃO GENÉTICA E CONSERVAÇÃO DA *Araucaria hunsteinii* KSCHUM EM PAPUA NOVA GUINÉ

N. H. S. Howcroft
Forest Research Station, Bulolo
PAPUA NEW GUINEA

Resumo

Devido aos estudos exploratórios de coleta de sementes efetuados entre 1972 e 1979, a área ecológica da *A. hunsteinii* em Papua Nova Guiné vem se tornando melhor conhecida. A variação genética entre algumas populações foi detectada, muito pouco se sabe sobre a variação genética em toda a área de ocorrência da espécie, e nenhum teste de procedência foi implantado com sucesso para testar o potencial de qualquer procedência.

O interesse internacional em *A. hunsteinii* como uma espécie exótica para plantação está aumentando, todavia a perda de viabilidade, durante a armazenagem e transporte, restringiu seu uso como exótica e o estabelecimento de plantações em larga escala, e limita também a implantação de testes de procedências.

A pesquisa na direção desses problemas foi recentemente elaborada, e estudos posteriores em relação à armazenagem são esperados para este ano.

O fornecimento de sementes para uso local e exportação é feito com base em populações naturais de Bulolo-Wau, e continuará sendo feito com base nessas fontes. Espera-se que a exploração madeireira atual desses povoamentos possa efetuar no futuro o rendimento anual de sementes.

Tanto a conservação genética *in situ* como *ex situ* são necessárias; no estado atual a conservação *ex situ* parece ser a mais prática medida, porque algumas populações são de difícil acesso, e não há atualmente garantia de que a conservação de populações *in situ* possa ser efetiva em áreas de exploração madereira.

SEED PRODUCTION, GENETIC VARIATION AND CONSERVATION OF *Araucaria hunsteinii* KSCHUM IN PAPUA NEW GUINEA

Summary

Due to exploration, and seed collection work between 1972 and 1979, the ecological range of A.hunsteinii in Papua New Guinea has become better known. Although genetic variation between some populations has been noted, very little is known of the genetic variation over the whole species range, and no provenance trials have been successfully established to test the potential of any provenances.

Overseas interest in A.hunsteinii as an exotic plantation species is increasing, however serious losses in seed viability, during storage and transportation, have restricted its use as an exotic species for large scale plantations, and prevented the establishment of provenance trials. Research into these problems has been recently carried out and further studies into seed storage are expected this year.

Seed supplies for local use and export come from the Bulolo-Wau natural stands, and although seed supplies will continue to come from these sources, it is expected that the current logging of some of these stands could affect future annual seed yields.

Both in situ and ex situ stands are needed, but at present ex situ conservation is seen as the best practical means of conservation, as some stands are difficult to reach, and there is no present guarantee that in situ conservation stands can be effectively protected from logging in some areas.

INTRODUCTION

Araucaria hunsteinii K.Schum, commonly known as Klinkii pine, is the second indigenous Araucaria species of economic importance to reforestation in Papua New Guinea. Its wood qualities are excellent and its form superb. The species has apparently performed well in trials overseas, and has shown considerable promise as an exotic plantation species (Pers.comm.).

A plantation area of more than 4,057 hectares has been established with A.hunsteinii in the Bulolo region, and, as with A.cunninghamii, it is the only commercial plantation of the species in Papua New Guinea. The A.hunsteinii plantation is based on stock produced from seed collected from the natural stands at Bulolo and Wau, however some plantings with stock of the Garaina provenance were also made in the late 1970's. A seed production and genetic improvement programme, started in the early 1960's to provide seed for future plantations, is mainly based on the Bulolo gene pool.

Exploration and provenance seed collections, carried out in the 1970's, have greatly increased our knowledge of the ecological range of this species, and some stands, not previously known, have only recently been located. Local information suggests that at least one other stand exists that has not been explored. As far as is known, A.hunsteinii is restricted to Papua New Guinea (Gray, 1973, Howcroft 1978). There is a need for further exploration, and as only a small number of A.hunsteinii populations have been sampled for seed (Howcroft, 1978), and provenance trials have not been successfully established, there is a need for further seed collections.

Since exploration and provenance seed collections have started, there has been an increase in overseas requests for seed of A.hunsteinii, both for the establishment of plantations, and for provenance research. In view of the increasing interest in A.hunsteinii, this paper briefly outlines the present knowledge on natural distribution, flowering and genetic variation, the seed production, collection and storage operations, and tree breeding programme. The conservation of genetic resources and the problems in the maintainance of seed viability during storage and transportation are briefly discussed.

D I S T R I B U T I O N

The distribution of A.hunsteinii and environments it inhabits in New Guinea, have been broadly described by Gray (1973) and Howcroft (1978). The species occurs in scattered stands over a wide range of Papua New Guinea within an area 142°74'E to 150°01'E and from 5°11'S to 10°11'S (Gray 1973). It is found naturally from 520 to 2,100 metres above sea level and differences in edaphic conditions between some localities where A.hunsteinii occurs, have been noted. Climatic conditions also vary over the species range. A.hunsteinii is not known to occur in Irian Jaya.

F L O W E R I N G

A.hunsteinii plantation trees at age 12 years have been observed to produce female flowers, but no male flowers have been observed. However some plantation trees have produced light cone crops with viable seed at age 15 years indicating that some male flowers are produced around age 12 years. It is not known if male and female flowering occurs before age 12 years. Trees from 19 years of age onwards are capable of producing heavy crops of cones with viable seed.

As with A.cunninghamii, periods of up to 4 years between abundant crops of male and female flowers, have been observed in the natural stands. During some years, two sets of cone crops have also been noted on A.hunsteinii trees.

The species goes through a series of developmental phases, and once it has produced its mature foliage, a zonation of sexuality commences. In young trees, male flowers are produced in the lower one third of the crown and the female flowers on the branches of the two upper whorls. By the time the trees are 30 years old, the male and female flowering zones begin to overlap, each occupying half the total length of crown. In old trees the male and female flower zones extend over three quarters of the total length of green crown, and cone crops have been collected throughout the entire length of the crowns of trees in natural stands.

The time of flowering for A.hunsteinii varies from one locality to another. Over its entire natural range, flowering occurs from August to November.

Grafted clones of seed trees of the Garaina provenance have been successfully wind pollinated by natural stand trees at Bulolo. The natural stand trees are located 0.1, 0.2 and 0.7 kilometres away from grafts. It is likely that cross pollination would occur between other provenances if placed next to each other, therefore when establishing ex situ conservation plantations it would be best to isolate all provenances by considerable distances from each other.

Some incomplete observations have been made on female flower and cone development of A.hunsteinii. The results suggest that the period of development is similar to that of A.cunninghamii.

S E E D P R O D U C T I O N

The major source of A.hunsteinii seed for local use, and for general export, are the natural stands within the Bulolo-Wau region. As with general collections of A.cunninghamii, these collections are carried out and processed by the Area Forestry Office staff at Bulolo. Provenance seed collections for research purposes are collected and processed by research staff at Bulolo. Climbers, seconded from the Area Forestry office, assist the Research Section in these collections.

According to Department records, the annual green cone crop weights, collected between 1960 and 1964, ranged from 7,620 kilograms to 22,679 kilograms (White and Cameron, 1965). No dry seed weights were given, but using a working ratio of 15:1, the estimated seed yields, for these green cone weights, would be around 544 to 1,512 kilograms. Annual requirements from 1965 onwards were estimated at 1,360 kilograms of dry seed (White and Cameron 1965). Local seed requirements will be less for the 1980-81 period and it is planned to collect only 100 kilograms of seed.

At present, the plantation trees are not producing cones in sufficient quantities to justify any efforts to collect them, and the clonal orchard is not expected to be productive until the late 1980's. Until these areas become commercially productive, all future collections are expected to be made from the natural stands, to supply local and export orders.

C O N E C O L L E C T I O N, S E E D E X T R A C T I O N A N D P R O C E S S I N G.

Seed development, maturation of cones and seed collection, have been covered in some detail by White and Cameron (1965).

Assessment of A.hunsteinii cone crop size, and location of suitable stands for seed collections in the Bulolo region, are carried out in July and early August. During this period random samples of cones are collected, and the seeds sampled to measure embryo lengths, to determine the state of maturity, ripeness and time of collection. When 20% of the seed sampled have embryos with a length of 13-16^{+}mm, collection commences as soon as possible. Cones ready for collection, when split, also have a brown zone extending from the core towards the distal portion of the seed scale, covering two thirds the length of the scale. Seed collections usually start about mid August and often continue into October.

The cone crops are collected by climbing, and transported to Bulolo forestry station for seed extraction. The cones reach their final stage of ripening and fragment, on large wire bottomed trays, in a large well ventilated shed.

A cone contains 1,175 seed scales of which the middle two thirds contain the viable seed. Individual cones can yield more than 455 good seed (39%) in an average year. The full seed are easily detected by their shape, weight and firmness. These are sorted from the sterile scales and dewinged. Seeds are sufficiently dry, and ready for storage, 3-4 weeks after extraction. These are treated with fungicide and sealed in containers for storage under refrigeration.

SEED STORAGE AND VIABILITY

Facilities, to store A.hunsteinii seed under refrigeration, are located at Bulolo. These are capable of holding 7,680 kilograms of seed in cold storage at temperatures between 3^{o} to 4^{o}C.

In the last few years, problems have been encountered in maintaining high viability during cold storage, and during transportation to overseas destinations. Results from a series of trials, as part of a recent study on the cold storage problem, indicate that temperature fluctuations in cold storage, and prolonged cold storage, contributed to low viability (Arentz, in Press.). This could be more pronounced if the initial moisture content of the seed was low (Arentz, in Press.). However, on the basis of observations made in this study, it is believed possible, for overseas buyers to obtain seed of high viability, providing the seed was sent fresh, without being cold stored, and providing the seed arrived at its destination quickly.

Because earlier attempts to send viable, cold storage, provenance seed overseas have failed, an attempt has been made to try to provide fresh seed for overseas trials. Between August and October 1979, seed of four provenances was collected and dispatched overseas in October 1979. Graded samples of sound seed from each batch were tested for viability 2 weeks after the date of dispatch to obtain an indication of what seed viability might be on arrival (Table 1).

The tests are not experimentally sound, as there are no replications or controls, but they do provide some interesting figures (Table 1).which might be useful as tentative guidelines in timing dispatch of each fresh collection of seed. The results support the idea of dispatching fresh seed, but indicate that will be extremely difficult to dispatch provenance seed batches, with a reasonable chance of arriving at their destination with high viability, as each batch will have a different length of exposure, depending on when and where it was collected.

The differences between provenances, in time of cone ripening and collection, make it exceedingly difficult to provide very fresh seed of all provenances at the one time. At present it is felt, that either individual seed batches be dispatched separately, and soon after seed extraction, or the batches be cold stored, until all provenances are on hand for dispatch. Currently, arrangements are being made to carry out further studies into maintaining high viability in cold storage, and during transportation over long distances. These studies are expected to start this year in conjunction with the annual seed collections.

PROSPECTS FOR PROVISION OF SEED

As with A.cunninghamii, the main commercial source of A.hunsteinii seed in Papua New Guinea, is expected to be the natural stands, in the Bulolo-Wau region of the Morobe Province. The commercial logging is expected to have wiped out most of the larger accessible stands in the next five years, and seed collecting will be restricted to scattered pockets of the species, the large stands in the Mac Adam National park, and a stand conserved in a local nature reserve. Whereas before, when seed years were poor, the seed requirements could be met by wide range seed collecting throughout the Bulolo-Wau region. The chances of doing this in future years are being reduced. Although it is impossible to predict what the overall effect of logging will be, on future seed production, it is anticipated that seed will still be available to meet local requirements and overseas export requirements.

Future alternative seed sources, after the mid 1980's are seen to be the Bulolo-Wau plantations, the clonal seed orchard and the natural stands at Garaina.

In the interests of Overseas countries wishing to import A.hunsteinii seed, they should insist on receiving only freshly collected seed. To assist Provincial and national forest office staff who collect and dispatch the seed orders should be placed by May, accompanied by import permits. This enables staff to estimate the annual seed requirements, and to arrange export permits and passage for the seed consignments.

Until such times as seed viability can be maintained successfully during cold storage and transportion, the prospects for supplying seed for provenance research seem rather doubtful.

GENETIC VARIATION

Very little is known about the genetic variation over the ecological range of the species. Field observations record a glaucous variety (Howcroft, 1978) and more recently, differences between provenances, in crown formation and bark characters, have also been noted. In the nursery, differences in hypocotyle length and diameter have been noted.

Within the Bulolo and Garaina populations, and in particular the plantations of the Bulolo provenance, a certain amount of phenotypic variation has been noted in branch size and internode length. These differences show up between grafted clones, and are features taken into consideration during candidate seed tree selection.

To date, there is nothing to suggest that there are differences between provenances in stem form, and over the known range of the species, it seems that stem form is always straight and without any form of defect.

One attempt has been made to establish a provenance trial at Bulolo, in the Morobe Province. The trial was completely destroyed by rodents, 6 months after establishment. Depending on the availability of suitable land, another attempt may be made in 1981 to establish a new trial.

GENETIC IMPROVEMENT

A programme for genetic conservation, improvement and seed production, started at Bulolo around 1964-5. The programme's aims were to establish clonal orchards of seed trees selected from the natural stands, and from the plantation stands. In all, 40 seed trees have selected from the natural stands, and from the plantation stands. In all, 40 seed trees have selected from the natural stands and 95 seed trees from the plantations. Seed tree selection is continuing.

Three small clone banks have been established by grafting. A clonal orchard, started in 1970, is now 60% completed. To date more than 90 clones have been established in the orchard. The final number of clones to be established will be between 150 and 200.

TABLE 1

RESULTS OF GERMINATION TESTS WITH PROVENANCE SEED BATCHES COLLECTED AND DISPATCHED 1979.

PROVENANCE	LATITUDE	LONGITUDE	QUANTITY OF SEED SOWN *	NUMBER OF SEED SOWN	DATES CONES BROUGHT IN FOR PROCESSING	TIME OF SEED DISPATCH OVERSEAS	TIME LAPSE BET. PROCESSING TO DISPATCH.	% GERMINATION**
Bulolo	7°11'30	146°39'00	2200 gm	4,000	Mid Aug-early Sept	30th Oct	±56 days	6.5
Garaina	7°54'00	147°10'30	313 gm	605	18th September	30th Oct	43 days	15.5
Jimi Valley	6°33'00	145°24'00	1600 gm	800	29th September	30th Oct	32 days	31.5
Pindiu	6°29'00	147°32'00	2070 gm	4,000	16th October	30th Oct	15 days	50.4

* Actual weights of the total number of seeds sown. Smaller seed weights were due to insufficient large quantities for testing, but are more or less representative of the quantity dispatched overseas.

** Seed sown 2 weeks after dispatch of seed.

A seedling seed orchard has been established from seed of selected seed trees. These will also be used for progeny testing. Due to current changes in work priorities, it is unlikely that further progeny tests will be carried out in the near future, although they are required. As with the A.cunninghamii programme, expansion of the programme will cease, for the time being, after the clonal orchard has been completed.

CONSERVATION

A.hunsteinii is not regarded as an endangered species but it is endangered in parts of its geographic range (Howcroft 1978). The land tenure systems, in Papua New Guinea, make it extremely difficult to conserve any threatened population of this species, and ex situ conservation is seen as the only means of preserving these genetic resources.

At present only two in situ conservation stands have been secured. These are located at Bulolo, in the Mc Adam National Park area and in the Mt Susu nature reserve.

Several remnant pockets, of advanced natural regeneration, have also been conserved for seed production at Bulolo, but it is likely that these will eventually be logged.

It is hoped that some small ex situ conservation stands will be established at Bulolo in the near future. The success of this programme will largely depend on availability of land.

ACKNOWLEDGEMENT

The author thanks Dr.H.Roberts, Dr.F.Arentz, and Mr J.Simpson, for their help and advice in the preparation of this paper. Appreciation is expressed to Mrs A.Vilamur for typing the paper.

This paper is produced with the permission of the Director, Office of Forests, Papua New Guinea.

REFERENCES

Arentz, F.(In Press.). Some factors affecting viability of Klinkii Pine (A.hunsteinii) in storage. Seed Sc. and Technology.

Gray, B.(1973). Distribution of Araucaria in Papua New Guinea Research Bulletin No.1. Department of Forests, Papua New Guinea.

Howcroft, N.H.S. (1978). Exploration and Provenance seed collections in Papua New Guinea 1976/77. Araucaria cunninghamii Lamb. and Araucaria hunsteinii K.Schum. Forest genetic resources. Information No.8. FAO.

White, K.J. and A.L.Cameron (1965). Silvicultural techniques in Papua New Guinea in Forest Plantations Bull. No.1. Department of Forests. Division of Silviculture, Port Moresby.

FAST GROWING TREES

PRODUÇÃO DE SEMENTES, VARIAÇÃO GENÉTICA E CONSERVAÇÃO DA *Araucaria cunninghamii* AIT EX LAMB EM PAPUA NOVA GUINÉ

N. H. S. Howcroft
Forest Research Station, Bulolo
PAPUA NEW GUINEA

Resumo

Desde 1972 a área ecológica da *Araucaria cunninghamii* em Nova Guiné vem se tornando melhor conhecida através dos estudos exploratórios e coleta de sementes. A variação genética entre as procedências de Papua Nova Guiné vem se tornando mais evidente em ensaio, e o interêsse em *A. cunninghamii*, como espécie exótica para plantações, vem crescendo.

O suprimento de sementes para uso local e exportação é feito com base em populações de Bulolo-Wau, e, mesmo com a redução dos povoamentos naturais pela exploração, as perspectivas para o fornecimento local e exportação ainda assim são boas. O fornecimento de sementes para pesquisa está sendo limitado pela perda de viabilidade durante a armazenagem e o transporte. Há necessidade de pesquisas neste setor. Sente-se que devem haver instalações, para armazenagem das sementes, controladas pela pesquisa visando dar amparo a estudos re

lativos aos problemas das sementes e dar suporte para o fornecimento de sementes a nível experimental. Ajuda financeira seria necessário para construir estas instalações.

A conservação dos recursos genéticos *in situ* é difícil de ser aplicada. Até o presente duas áreas foram preservadas; no momento a conservação *ex-situ* parece ser a mais prática como meio de preservar os recursos genéticos de Papua Nova Guiné.

SEED PRODUCTION, GENETIC VARIATION AND CONSERVATION OF *Araucaria cunninghamii* AIT EX LAMB IN PAPUA NEW GUINEA

Summary

Since 1972 the ecological range of Araucaria cunninghamii in New Guinea has become better known through exploration and seed collection. Genetic variation between Papua New Guinea provenances is becoming more evident in trials and interest in A. cunninghamii as an exotic plantation species is on the increase.

Seed supplies for local use and export come from the Bulolo-Wau andinspite of the reduction of the natural stands by logging, future prospects for the provision of seed for local and export use are expected to be good. Provisions of provenance seed for research purposes is being hindered by losses in viability during storage and transportation. Research is required into this problem. It is felt that seed storage facilities controlled by Research are required to aid research into seed problems and to assist in the provision of seed for research. Financial Overseas aid would be required to establish these facilities.

In situ conservation of genetic resourcesiare difficult to apply. To date only two areas have been preserved.at present, Ex situ conservation is seen as the best practical means of preserving Papua New Guinea genetic resources.

I N T R O D U C T I O N

Araucaria cunninghamii Ait Ex Lamb is an economically important reforestation species in Papua New Guinea. It has considerable promise as an exotic plantation species (Nikles, 1979).

The only commercial plantation of this species, in Papua New Guinea is established at Bulolo, and consists of more than 3550 hectares. It is largely based on seed introduced from the natural stands nearby. A seed production and genetic improvement programme at Bulolo, implimented in the early 1960's to provide seed fot future plantations, is based on the Bulolo gene pool.

Little was known of the ecological range of New Guinea A.cunninghamii, and no provenance research started in Papua New Guinea, until exploration and seed collections were carried out in the 1970's (Gray 1973, Howcroft 1977). Studies in Australia indicate that many Northern Mainland Australian and Papua New Guinea resources show exceptionally fast early growth and could have some potential (Nikles, 1977). Because of the rather wide ecological range of A.cunninghamii in New Guinea, it is felt that the use of other provenances may increase the economic potential of the species as a plantation exotic.

Concurrent with exploration and seed collection there has been an increase in Overseas interest in Papua New Guinea A.cunninghamii, and present indications are that this interest is growing, and demands for bulk seed and seed for research could be expected to increase. In view of this distribution, flowering, seed production and storage, genetic variation, improvement and conservation are briefly discussed, together with problems in the maintenance of seed viability during storage and transportation.

D I S T R I B U T I O N

The distribution of Araucaria cunninghamii, and the environments it inhabits in New Guinea, have been described by various authors in some detail (Boland et al 1977, Gray 1973, Howcroft 1977, 1978, 1979 and Nikles 1973, 1977. Generally speaking, A.cunninghamii occurs spordically over a wide range in New Guinea, including two insular occurances near 1°S (near Sausapor, Irian Jaya) and 10°S (Fergusson Island, S.W. Papua New Guinea). It is found naturally from near 60 metres to nearly 2,800 metres above sea level and occurs on a wide range of edaphic conditions and in a wide range of edaphic conditions and in a wide range of climatic conditions. Thus it is to be expected that patterns of v variation in morphology and growth occur within the natural range of this species in New Guinea.

F L O W E R I N G

Seedling trees of New Guinea A.cunninghamii begin to produce female flowers and infertile cones as early as 6 years of age. Male flowers have been observed on 20 year old trees. In all cases the male flower crops were not abundant. From casual observations it seems that abundant male flower crops can be expected from age 25 years onwards, and in both natural and plantation stands, it has been noted that there have been periods of up to 4 years between abundant crops of male and female flowers. Currently, 1980 appears to be a good year. As observed by Nikles (1973) with Australian A.cunninghamii, the New Guinea races go through a series of developmental phases where there is a zonation of sexuality within the crown with the lower one third bearing males, a central transition zone for flowers of both sexes and the upper crown bearing females. The zone of male flower production extends the entire length of the crown as trees reach senescence.

Flowering time varies from one locality to the other (Howcroft, 1977), and there have been indicators that sometimes several flowering flushes may occur throughout the year. Over its natural range flowering occurs from May to October. Observations of female flower and cone development, on clones in orchards, suggest that the period of development for female flowers and cones is similar to that of the Australia species as described by Nikles (1973), however further observations are needed to confirm this.

S E E D P R O D U C T I O N

Although A.cunninghamii seed for local use has been collected from a number of sources in the past, natural stands of the Bulolo/Wau region in the Morobe Province are the major source of seed to meet local and export requirements. Such collections are usually made and processed by the Area Forestry Office staff at Bulolo. Provenance seed collections for research purposes are collected and processed by research staff at Bulolo, with assistance from climbers seconded to that section from the Area Forestry Office.

In the period between 1950 and 1967 the local demand for A.cunninghamii seed was large. Departmental records indicate that annual dry weight collections were around 4,536 kilograms and went as high as 12,608 kilograms. These collections were for local reforestation and to a lesser extent for export. The seemingly excessive amounts were meant to tide the Department over to the following year's nursery sowing programme in case the following seed crop year

failed, such as occurred at Bulolo in 1959. After the 1967/68 period, local demands declined rapidly due to the Department's policy to change from planting A.cunninghamii to A.hunsteinii The last large collection of 3,782.5 kilograms of seed was made in 1977 to meet small local seed requests and overseas demands. In 1979 a total to 148 kilograms of cones, yielding 56 kilograms of seed, was collected for export and research purposes. Future collections are anticipated to be only for Overseas export, and these will be from the Bulolo-Wau region.

CONE COLLECTION, SEED EXTRACTION AND PROCESSING.

Assessment of A.cunninghamii cone crops commences in July and continues to the end of August. Cone crops vary in quantity and quality from one locality to the other, and as the terrain is steep, and distances from seed trees to points of contact with transport to home base considerable, it is essential that the best localities for collection be determined and the condition of the cone crops be assessed before collection starts. The cone crops commence to ripen in August at Bulolo but general collection of the main crops usually start in September.

At Bulolo, the cone crops are collected by climbing the large maiden stand trees with the aid of climbing irons. No ground collections are carried out except in special circumstances. The cones reach their final stage of maturity on large metal trays in a specially designed, well ventilated seed shed, where they are air dried, ripen and fragment. The seeds are graded, the middle one third of the cone holds the seeds of best potential for viability. These are treated with fungicide and sealed in containers for storage under refrigeration. Generally the processing of cones and seeds takes approximately three weeks.

Up until the last collections, it has been the general practice to store most A.cunninghamii seed in copra sacks as per instructions in the 'Silvicultural Techniques Handbook' (White and Cameron 1965). Recent studies conducted by J.Simpson at Bulolo indicate that sealed containers are better than copra sacks for cold storage of seed of this species. (Simpson 1980, In Lit,).

SEED STORAGE AND VIABILITY

The only Araucaria seed storage facilities in Papua New Guinea are located at Bulolo which is the only centre of large scale Araucaria reforestation in the country. The storage facilities consist of four large refrigeration units, two of which are used especially for storage of A. cunninghamii seed and jointly have a carrying capacity of 16,300 kilograms of seed. Both general and provenance research seed collections are stored in these units at 12°C. Higher temperatures reduce viability.

In recent years temperature fluctuations have been encountered. In many instances these have gone undetected, resulting in serious loss of viable seed. Currently arrangements are being made to purchase and install an alarm warning system which will enable this problem to be corrected on time.

Difficulties have been encountered in international seed export. Seed batches have given variable germination results. For example, germination estimates of four particular provenances collected between August and November 1974 dispatched to Australia in February 1975 and sown in August 1975, indicated that loss in viability ranged from 90 to 14 percent. By 1977 germination figures for samples of these batches still in cold storage were still much better than those achieved in that consignment. These disappointing and expensive results have limited the wide spread establishment of plantations of this species in other countries and hindered the progress of provenance research. Germination losses such as mentioned suggest that even over short distances a high proportion of seed will die. Thus it could be expected, that over longer distances, losses could be greater due to the longer exposure to temperature fluctuations whilst in aircraft and in transit areas.

A recent expaeriment (J. Simpson, pers. comm.) has indicated that seed, cold stored for 50 weeks and stored for 21 days at room temperature, did not drop in viability significantly. This again points to travelling conditions, and possibly treatment upon arrival, as probable factors influencing viability. Other factors that cannot be ignored, and which the research section sees needs for improvement in Papua New Guinea, are the implementation of pre-harvest assessments of crop viability and increased and increased and improved seed testing.

Although a technique exists whereby a pre-harvest estimate of potential viability and crop size can be made, no such estimates are made, and the available quantity and the potential quality of each annual crop is not known until after collection and nursery germination tests are carried out. Part of this problem here lies in the present lack of sufficient skilled technical staff to impliment and to ensure continuity in the use of such a technique. Time, logistics, and lack of staff, are also factors hindering the use of this technique for provenance research

In good seed production years it is possible to obtain anaverage viability of 60 percent and many annual crops have been recorded to give 40 percentviable seed. However annual seed requirements for A.cunninghammi in Papua New Guinea. are calculated on a standard estimate of 36 percent dry fertile seed from green cones and a working ratio of 1.36 kg of green cones to 0.45 kg of dry seed (White and Cameron 1965, Ntima 1968), so that for every kilogram of dry seed (4,000 seeds), approximately 1440 seedlings are likely to be obtained. Since batches of seed with initially high viability can lose viability in excess of 50 percent in overseas dispatches it is suggested that overseas countries should base their calculations on a estimated yeild of 4,000 fertile seed to 5 kilograms of fresh seed. Provenance collections in storage for five years or more will need at least 3 to 4 times the above mentioned weight.

PROSPECTS FOR PROVISION OF SEED

At present it is likely that the main commercial source of A.cunninghamii seed in Papua New Guinea for the next 10 years will come from the accessible natural stands in the Bulolo-Wau region of the Morobe Province. In spite of the steady reduction of the areas of the natural stands by commercial logging, the prospect for obtaining large quantities of seed to meet local and export requirements appear to be quite good. In view of the problems of transporting cold stored seed over long distances, it is felt that in the interest of overseas countries wishing to import A.cunninghamii seed from this source, that they insist on receiving only freshly collected seed. To assist provincial forest office staff who make these collections, and national forest office staff who handle the final dispatch details, it is essential that reaquests are submitted by May accompanied by import permits, so that provincial staff can assess the total requiremants and prepare for that year's collection, and the national forest office staff prepare export permits and arrange the best passage for the seed consignments.

Fresh collections of seed from different provenances are required if further research in this field is to be pursued successfully. Seed of different provenances have

been in cold storage at Bulolo since August 1974 and recent tests indicate that viability has dropped to 12% and below. Quantities of this seed required for any attempt to establish provenance trials would need to be 20 kilograms at least, for each provenance. Since supplies are low for some provenances the number of recipients would be restricted.

Because of the distances needed to be travelled, and the time involved, to collect seed for provenance research, only a limited number of populations can be sampled in any one year. It is therefore essential to store provenance seed batches until adequate numbers of populations are represented for trials. Taking into account the present problems with storage and the need for research, there is a need for separate seed storage facilities under the direct control of the Research section, if the prospects for the provision of seed for research and provenance research are to be successful. Then Overseas aid to establish these facilities would be required. The structure of the facilities should be such that they would cater for the storage of seed of other research species as well as Araucaria and would be available to researches within and from other countries.

G E N E T I C V A R I A T I O N

Three trials comparing Papua New Guinea provenances have been established since provenance seed collections commenced in the 1970's. Two were established at Bulolo in the Morobe Province in 1974 and 1976 and a third at Sirunki in the Enga Province of the Western Highlands in 1977. Unfortunately the life of these trials is expected to be short due to damage and mortality either from illegal gardening, feral pigs, white ants or drought, and further larger, better desgined trials will be required. Never the less in the short period they have been established some interesting observations have been made from them.

Differences between Australian and New Guinea provenances as noted by Nikles (1977) for growth rate, crown form, morphology, foliage and bark, are becoming more evident within the oldest trial and in arboretum plantings at Bulolo. Survival and growth differences between three provenances have been demonstrated in the oldest Bulolo trial (Fig. 1). The Bumbu provenance represented in this trial is located in an area subjected to drier weather than most other provenances known and it may be possible this provenance, is more tolerant to extremes in dry periods than others.

G E N E T I C I M P R O V E M E N T

A programme for genetic conservation, seed production and genetic improvement was started at Bulolo in 1963. To achieve these objectives it was planned to selected seed trees from the natural stands and establish them in clonal orchards, and select seed trees of superior form and growth etc, from the plantations at Bulolo and establish clone banks and orchards with these. Extension of this programme to the highlands and establishment of seedling seed orchards was also envisaged for the future.

By 1970, the programme, although behind schedule due to staff changes, had achieved the establishment of three clone banks. The grafting of th e first clones in the main orchard commenced that year. The programme aimed at establishing a broad base using more than 100 trees. To date more than 125 seed trees have been selected and some 87 clones successfully established. Over 79 percent of the orchards grafting stations are occupied and it is anticipated this orchard will be completed by 1981.

All grafted areas have clones producing male and female flowers. Male flower production is generally light and often confined to just a few clones, and at present insufficient to make seed collections worthwhile.

Although progeny testing is required, present changes in work priorities demand that present tree improvement research be down graded and therefore progeny testing will not be carried out for sometime. Expansion of the programme will cease for the time being but the initial ground work has been done which may help future improvement work.

C O N S E R V A T I O N

The conservation of genetic resources in situ of A.cunninghamii is difficult to apply in Papua New Guinea (Howcroft 1977). In Bulolo, stands of A.cunninghamii are conserved in Mac Adam National Park, while more recently field staff of the Area Forestry office at Bulolo have managed to conserve a small stand for seed production within a logging area 2 kilometres from the National Park. No other in situ conservation stands exist in Papua New Guinea.

Some attempts have been made to establish ex situ conservation stands at Bulolo and four provenances, Erave, Oksapmin, Pimaga and Wutung, are represented. Extensions to some of these are planned and it is hoped that several other provenances can be established.

The remoteness of many of the natural stands, in areas of low population density, will help preserve them, but for some stands, their size and accessibility to areas of development make them potential targets for logging, followed by garden development. Ex situ conservation stands are urgently needed to preserve these. However, although the remoteness of some stands may protect them, it is felt that difficult and expensive access to some of these stands is also a reason for the establishment of ex situ gene pools of these provenances, so that they will become more readily available.

R e f e r e n c e s

Boland, D.J., Davidson, J. and Howcroft, N.(1977). Eucalyptus deglupta Blume and Araucaria cunninghamii Lambert Provenance seed collections in Irian Jaya, Indonesia, 3 - 17 June 1975.

Gray, B.(1973). Distribution of Araucaria in Papua New Guinea Research Bulletin No.1 Department of Forests, Papua New Guinea.

Howcroft, N.(1977). A review of Araucaria cunninghamii Ait. ex Lambert in Papua New Guinea and Irian Jaya. Paper to IUFRO Workshop, Brisbane 1977.

Howcroft, N.H.S. (1978). Exploration and provenance seed collections in Papua New Guinea 1976/77. Araucaria cunninghamii Lamb and Araucaria hunsteinii K.Schum. Forest genetic resources Information No.6 FAO.

Howcroft, N.H.S. (1979). Data sheet on Araucaria cunninghamii Aiton ex Lambert Forestry Occasional Paper - Forest Genetic Resources Information - No.9. FAO

Nikles, D.G.(1973). Biology and genetic improvement of Araucaria cunninghamii Ait. in Queensland, Australia. In "Selection and breeding to improve some tropical conifers" (Burley, J. and Nikles, D.G. eds.). Volume 11. CFI, Oxford and Dept. of For., Queensland, 304-334.

Nikles, D.G.(1977). Status of Exploration, evaluation, use and conservation of genetic resources of Araucaria cunninghamii Ait. (Hoop Pine). Paper to IUFRO Workshop Brisbane 1977.

Nikles D.G.(1979). Realised and Potentine gains from using and concsrving genetic Resources of Araucaria. paper to IUFRO meeting Curitiba, Brazil October 1979.

Ntima, O.O. (1968). Fast growing timber trees of the Lowland tropics No.3 The Araucarias. Comm. For. Inst. Oxford.

White K.J. and A.L. Cameron (1965). Silvicultural techniques in Papua New Guinea Forest Plantation Bull. No.1 Department of Forest. Division of Silviculture. Port Moresby.

ACKNOWLEDGEMENTS

I thank Dr.H.Roberts, Mr.J.Godlee, Mr.A.Hay and Mr.J.Simpson For their help and advice in the preparation of this paper.

Appreciation is expressed to Mrs.A.Valimur, Mr.S.Kalogo and Miss E.Gewa for their assistance in the typing of this paper.

POTENCIAL DE CRESCIMENTO DO *Agathis* EM UGANDA

P. K. Karani
Kampala
UGANDA

Resumo

As duas espécies de Agathis que foram testadas tiveram bom comportamento, muitas mais poderiam ser ensaiadas se houvesse possibilidade de obter sementes. A produção de mudas em viveiro é fácil e o crescimento das espécies no campo é aceitável. Todavia o crescimento inicial é lento e subtamente supera o da Araucaria. O Agathis apresenta excelente forma do tronco e boa derrama natural. Como as árvores irão, preliminarmente, ser usadas na laminação, espera-se que em função da boa forma das árvores, os resultados serão bons. As duas espécies, até o momento, parecem ser tolerantes à competição, com pouco efeito no acréscimo diametral. Cones femininos já vem ocorrendo em árvores aos 18 anos, mas os conídios masculinos ainda não foram observados.

GROWTH POTENTIAL OF *Agathis* IN UGANDA

Summary

The two species of Agathis which have been tested have been successful, many more would have been tried if seeds had been obtained.The species are easily raised in the nursery and growth in the field has been acceptable.Although they start slowly growth catches up with that of Araucaria.Agathis has got an excellent stem form and is self pruning. As trees are likely to be grown for peeler logs, they would give the best results as regards stem form. The two species so far tested seem to be tolerant to crowding with little effect on diametre increment. Female cones have already been produced by trees now 18 years old but no male flowers have so far been observed.

INTRODUCTION

Agathis macrophylla and Agathis robusta were first introduced to this country in 1962.The seed of the former species was obtained from Vanikolo, British Solomons Island,while that of the later came from Queensland, Australia. All the trials have been small due to lack of sufficient seed but Agathis robusta has been planted in larger plots of up to 0,4 ha. in area.Sites of trial have been natural high forest or derived graselands.Such sites have high preciptation witch is well distributed throughout the year. Altitude ranges from about 670 to 2400 metres above sea level.Although not all possible sites have been tested enough trials have already been carried out to give the species enough coverage.

NURSERY STAGE

Agathis seeds have been treated like those of Araucaria,that is they are sown imediately after arrival and seedlings are pricked out into polythene tubes 8-10cm diametre and 15 cm.long. As there was not previous experience of handling Agathis plants were kept in the / nursery for one year only and were still under 30 cm. tall. This necessitated many more weedings after planting in the field, other wise there were no specific problems of handling the raised seedlings.

PERFORMANCE IN THE FIELD

Agathis has been tested on a variety of sites as mentioned above and growth has so far been acceptable.However, growth is slow at the start,but a height increment of about 1 m.per year has been realised on most sites. Rapid growth seems to occur after five years,when increment of dominant trees has been as high as 1,5m per annum.The two species so far tested i.e. Agathis macrophylla from Vanikolo and Agathis robusta from Queensland seem to grow at the same rate. Mean diametre increment 1,3 c.has also been achieved. Both species need tending up to three years if good performance is to be achieved.This is specially necessary because natural forest sites usually have a lot of weeds and especially climbers, which have to be cut back regularly. Compared with Araucaria, Agathis is rather slow, but after 10 years it has been noted that growth catches up with that of Araucaria cunninghamii. It is also a genus that seems to tolerate crowding as can be seen in the table below. In this table it will be noted that standing basal area is quite high, yet the trees have maintained a reasonable diametre increment.

One of the most important cahracteristics of Agathis, is its stem form.Trees grow straighy-, are self pruning with cylindrical bole and small crowns.The presence of small crowns with small branches which are regularly shade may explain why so much basal area build up can be attained with little effect on diametre / increment.The oldest trial plots are now over 18 years and it is now that large branches which appear to be part of the permanent crown are beginning to form.

Like Araucaria, Agathis is being developed as a genus which might produce peeler logs for plywood and possibly veneer production. If the present excellent stem form continues as it has started, then logs produced by such species will almost likely yield the best logs for that purpose.The two species so far tried have given excellent results and there is a need for more trial plots on relatively large scale.Seed of this genus is difficult to procure and efforts to get it from South East Asia have not been successful.

Although oldest plots are now over 18 years only female flowers have been observed,male cones have not yet been produced. It is possible that stands have not been thinned to allow production of large crowns for seed production. This step is now being taken to ensure future seed supply.

CONCLUSION

Limited trials of two species can grow well where rainfall is well distributed and that they produce excellent stem form. Further trials on larger scale are necessary if seed can be procured.

CRESCIMENTO E DESEMPENHO DAS ESPÉCIES DE ARAUCÁRIA EM UGANDA

P. K. Karani – M.A. Chaudhry
Kampala
UGANDA

Resumo

Sob responsabilidades do Enteble Botanic Gardens e Kampala City Council, as espécies de Araucária foram introduzidas neste país como plantas ornamentais, em 1930.

Desde meados de 50, o Departamento Florestal tem feito muitos testes, objetivando encontrar espécies e procedências adequadas para uso em escala comercial na produção de madeira para serraria. Embora 6 espécies de Araucária tenham sido introduzidas, apenas três, *A. augustifolie, A. cumminghanii* e *A. hunstenia,* foram testadas extensamente; as outras continuam apenas como ornamentais.

O crescimento e o desempenho geral da *A. cunminghanii* e *A. husnstenii* continuam aceitáveis mostrando incrementos diametrais médios de 1.5cm por ano e a altura 1,1m. por ano.

A. angustifolia começa bem e cresce razoavelmente pelos primeiros 10 a 15 anos, após o que começa a declinar, mostrando que não se adapta às nossas condições climáticas.

A. cunminghanii é aceitável, porém ocorre a formação de muitas folhas. Para ser adotada em larga escala, é necessário um trabalho técnico de melhoramento genético.

GROWTH AND PERFORMANCE OF ARAUCARIA SPECIES IN UGANDA

Summary

Araucaria species were first introduced in this country as ornamentals in early 1930's. Entebbe Botanic Gardens and Kampala City Council are responsible for early introductions. Since mid 1950's there has been a lot of trials by the Forestry Department with the object of finding suitable species and provenances for large scale establishment of plantations in order to grow peeler logs. Although as many as six species of Araucaria have been introduced, only three, namely A. angustifolia, A. cunninghanii and A. hunstenii, have been tested extensively; others continue to be grown as ornamentals.

Growth and general performance of A. cunninghanii and A. hunstenii continues to be acceptable with a mean annual diameter and height increment of 1.5 cm. and 1.1 m. A. angustifolia starts well and grows reasonably well for the first ten to fifteen years, thereafter it begins to decline, this shows that it is unsuitable for our climatical conditions. Whilst growth and performance of A. cunninghanii is acceptable its stem form leaves a lot to be desired. If it is accepted as a large scale timber species for providing peeler logs, it will need improvement so as to get well formed stems. A. hunstenii, though a slow starter, has so far grown well and has the best stem form requiring no improvement. The oldest trials are now twenty years, but have not started producing seeds. Although some trees have been observed to produce female flowers at the age of twelve years no male flowers have yet been seen. Establishment of plantations of A. cunninghanii and A. hunstenii have been curtailed by lack of seed as imported seed is expensive.

INTRODUCTION

The Araucaria species were first introduced in Uganda by Entebbe Botanic Gardens and Kampala City Council around 1930's. The oldest trees of Araucaria cunninghanii, A. Bidwillii and A. angustifolia are found in Entebbe Botanic Gardens. The origin of the seed from which plants were raised is not mentioned, but it could have come from South Africa. Later other species like A. cookii, A. excelsa and A. hunstenii were also brought mainly as ornaments. However the Uganda Forest Department started extensive trials of many species which included Araucarias in late 1950's and early 1960's. A. cunninghanii, A. angustifolia and A. hunstenii were the main species widely introduced into the country. As the genus is largely found in the wet subtropical areas of the Southern hemisphere the trials were mainly planted in the South and West of the country where precipitation and vegetation are similar. Trials have largely been on small plots used during elimination stages, but the early growth was quite promising and larger plots up to 0.4 ha have been planted. Almost all the seed of A. cunninghanii came from Queensland, Australia, although we have at one time got it from South Africa and Papua New Guinea. Seed of A. angustifolia came from Uplands, Konya and that of A. hunstenii was obtained from Pupua New Guinea.

NURSERY STAGE

The seeds have always been airfrioghted into the country except for those which came from Kenya, and sawing takes place as soon as the seed arrives and certainly within 72 hours of its arrival. This precaution is taken because the seeds lose viability very quickly under our hot climate and no attempts have been made to store it. As soon as the radicles are out transplanting into polythene tubes is carried out. The polythene tubes are 8 – 10 cm in diameter and 15 cm long. Large tubes are used to give the plants a relatively large volume of soil as they are kept in the nursery up to 18 months before planting in the field. Unlike Pinus and Cupressus, Araucaria seedlings are relatively slow growing and take about one and hald times the period given to the former.

Appendix

Growth data of A. cunninghanii

Ssese Islands		Kibale		Entebbe		Mpanga		Nagojje		Kityerera	
$\bar{h}$	$\bar{d}$	$\bar{h}$	$\bar{d}$	$\bar{h}$	$\bar{d}$	$\bar{h}$	$\bar{d}$	$\bar{h}$	$\bar{d}$	$\bar{h}$	$\bar{d}$
(12.9)		(27.0)		(21.0)		(17.0)		18.0)		(13.4)	
13.7	23.1	24.0	34.0	24.6	30.3	17.0	27.3	29.0	23.6	16.0	23.0

Key

$\bar{h}$ = Mean height in metres, $\bar{d}$ = Mean diameter in centimetres.

(12.9) = Age in years of the crop when the trial was assessed.

Entebbe is 0° 03'N, 32° 28'E. Altitude 1146 m a.s.l. Previous vegetation - Natural forest.

Kibale is 0° 39'N, 30° 23'E. Altitude 1463 m a.s.l. Previous vegetation - Natural forest.

Mpanga is 0° 12'N, 32° 18'E. Altitude 1250 m a.s.l. Previous vegetation natural forest.

Ssese Islands is 0° 20'S, 32° 19'E. Altitude 1158 m a.s.l. Previous vegetation natural forest.

Nagojje is 0° 27'N, 32° 53'E. Altitude 1189 m.a.s.l. Previous vegetation natural forest.

Kityerera 0° 21'N, 33° 33'E. Altitude 1158 m.a.s.l. Previous vegetation natural forest.

*** *** ***

GROWTH AND PERFORMANCE IN THE FIELD

Planting of Araucaria has been on sites that have carried natural forest where weed growth and competition is high. The purpose of using large tubes and keeping seedlings in the nursery for a long period is to get plants that are 30 - 35cm. tall with a good root system that can stand the competition. Growth is slow for the first two years and weeding has to be done frequently for that period. Short lived climbers are particularly dangerous as they may smother plants, they have to be removed constantly say once every four months during the first year. After two years, growth is generally good and a mean annual height increment of 1.2 - 1.5 m has been attained up to 20 years by A. cunninghanii and A. humstonii. The later species is the slowest starter of all the Araucarias and needs more tending up to three years. Its growth thereafter is enhanced and catches up with A. cunninghanii.

Araucaria angustifolia

This species is one of the earliest arrivals in Uganda and was first planted in Entebbe Botanic Gardens in 1934, many more trial plots have since been established by the Forestry Department. Although it survives quite well its performance is a bit disappointing; for the first 10 years it grows normally and puts on small but acceptable height increment of about 1 m. per annum, thereafter the increment becomes very small and some trees begin to die, the remaining ones simply survive without putting on any appreciable growth. Its stem is reasonable, trees have umbrella shaped crowns with regular branch whirls. On some sites trees tend to develop nodal swellings. The species has been tested on very many sites and the results are almost the same. It has shown that it cannot be considered for large scale plantation development. It is unsuitable for our hot climate as it originates from a subtropical climate. It should be noted that extensive provenance trials of the species have not been carried out, may be such trials could reveal a provenance t at is more suited to our environment than what has already been tested.

A. cunninghanii

A. cunninghanii is another early arrival which has also been tried on very many sites. Its growth and performance has been good and its growth rate is acceptable. It has been grown in the open as well as under the canopy of overwood in enrichment planting trials. Its stem form leaves a lot to be desired, trees have long internodes, twisted stems and nodal swellings. The older trees twenty years and over have developed basal swellings and sweeps. Araucaria species are being developed so as to produce peeler logs for plywood and match making industries. Despite the fact that growth rate of this species is good and peeling tests have shown good results, its stem form will have to be improved if the species is to be planted on a large scale for peeler log production. Its growth and production potentials are so good that more funds should be spent on tree improvement.

A. cunninghanii provenance trial

There has so far, been one trial in order to improve the stem form characteristics of the species. The trial is being carried out at Kifu Forest. The site is at 0° 27'N and 32° 45'E. It includes four provenances all found in Queensland, Australia. The fourth was just labelled Queensland and its actual origin is unknown. The altitude of the site

is 1158 m. above sea level. The soil is sundy-loam tending to clay-loam on the upper reaches and is well drained. Rainfall is about 1270 mm annually and is well distributed throughout the year.

The design is simple randomised block with four provenances replicated in four blocks. Unfortunately two of the blocks were cultivated after planting leaving the other two with less tending. The results of the recent assesament of diameter and height are shown in the table below.

Mean height and mean dbh of A. cunninghanii at Kifu

Seed origin	Mean height (m)	Mean diameter (cm)
Queensland	10.7	12.2
Monto	13.7	15.2
Gympie	11.8	13.9
Murgon	13.4	14.6

Analysis of variance on height and diameter data reveals significant differences between provenances which are due to block differences only, which is an effect of cultivation. The crop has already closed the canopy and this effect is tending to disappear. Stem form is so far the same together with long internodes and basel sweeps. It is probably too early to recognise differences between the four provenances.

A. hunsteni

A. hunsteni was introduced into this country in the early 1960's; Its growth rate has been acceptable and the species has already been included among the species to be developed for large scale planting. It is comparatively a slower starter than A. cunninghanii, but it has the best stem form of all the Araucaria species so far grown in the country. It has a straight and cylindrical stem with a long well shaped crown, covering the entire tree in the young stage up to 15 years of age where the staned has been kept open. The species is characterised by light green juvinile leaves tending to greenish white near the tip. The mature leaves become dark green with a bluish tinge and sharp prickle at the tip of the leaf. All the seed used for the trials so far carried has been obtained from Papua New Guinea.

The potentiality of this species is quite high and large scale planting is being limited by lack of seed. Like other Araucaria species, female flowers are regularly being produ ced by trees ten years after planting, but no male flowers have been seen. It is therefore difficult to say whether non-production of seeds is due to young age of the crop or unsuitability to our environment.

It has been noticed in Uganda Pinus patula does not produce male cones when planted where the environment (mainly low altitude) is unsuitable for its optimum development. Could this be the same with araucarias?

CONCLUSION

The species of Araucaria that have been extensively tested show that A. cunninghanii and A. hunstenii grow quite well and their growth rate and performance is acceptable for the purpose they would be grown in a large scale i.e. production of peeler logs for plywood and match making industries. The stem form of A. cunninghanii is poor and will need improvement before the species qualifies for timber plantations. Limited peeling tests indicate that this species has acceptable wood qualities for match making and plywood industries. A. hunsteinii has so far produced the best sten form requiring no improvement. Large scale establishment of plantations of the species has been curtailed by lack of less costly seeds. A. angustifolia appears unsuitable for large scale planting, on all sites where it was expected to grow.

FAST GROWING TREES

DISTRIBUIÇÃO, VARIAÇÃO GENÉTICA, MELHORAMENTO GENÉTICO E CONSERVAÇÃO DA *Araucaria cunninghamii* AITON EX D.DON.

D.G.Nikles – R.S.Newton
Department of Forestry, Brisbane, Queensland
AUSTRALIA

Resumo

A distribuição da *Araucaria cunninghamii* Aiton ex D. Don é descrita sumariamente. Muita enfase é dada à grande amplitude latitudinal (0°S a 31°S), altitudinal (nível do mar a 2.745 m), climática, edáfica, bem como à distribuição altamente disjunta na área de ocorrência natural. Mapas foram incluidos representando 60 procedências Australianas, incluídas nos testes em Queensland, envolvendo as principais ocorrências. Citações relativas a mapas publicados representando ocorrências em Papua Nova Guiné e Irian Jaya também são apresentados.

Uma breve revisão dos resultados de vários testes de procedências estabelecidos em Queensland, entre 1956 e 1972, mostra grande variação genética ao nível de regiões e procedências dentro de região. Os resultados de numerosos testes de progênies em Queensland mostram grande variação entre famílias, indicando que a variação genética entre árvores dentro de população é também muito importante. Consequentemente há uma grande oportunidade para o melhoramento genético da espécie. Um programa de melhoramento avançado, para este objetivo, foi delineado em Queensland.

A grande variabilidade existente na espécie torna imperativo que cuidadosa atenção deva ser dada à procedência e ao tamanho da amostra quando da introdução da espécie. Há indicações que a análise de homoclimas seja uma ferramenta útil como uma primeira aproximação na escolha das melhores fontes de sementes para as introduções, mas algumas popula

ções do sul e do norte parecem combinar rápido crescimento e ampla adaptabilidade. Várias populações, mas não todas, de origem insular ou pequenas populações do norte apresentam crescimento muito lento. Portanto, os resultados dos ensaios de procedências, incluindo os poucos estabelecidos no exterior, estão começando a dar subsídios para a identificação das procedências promissoras.

No exterior, onde as procedências do Sul de Queensland são as mais adequadas, considerações deveriam ser feitas em relação à importação de sementes das numerosas plantações derivadas de árvores plus, que foram selecionadas e que estão tendo suas progênies testadas.

A conservação dos recursos genéticos está recebendo cuidadosa atenção na Austrália e Papua Nova Guiné. A espécie não está em perigo como um todo, mas algumas populações estão em risco em Nova Guiné e no Centro Norte de Queensland. Alguns estudos e coletas de sementes estão sendo feitas nas áreas consideradas em risco. Uma cópia da ficha de dados usada nessas coletas para compilar as informações das ocorrências possivelmente em risco na Austrália foi também anexada.

DISTRIBUTION, GENETIC VARIATION, GENETIC IMPROVEMENT AND CONSERVATION OF *Araucaria cunninghamii* AITON EX D.DON

Summary

The distribution of Araucaria cunninghamii Aiton ex D. Don is described briefly. Emphasised are its great latitidinal (almost 0°S to 31°S), altitudinal (sea level to 2745 m), climatic and edaphic ranges, as well as its highly disjunct distribution. Maps are included which show the locations of 60 Australian provenances, included in trials in Queensland, representing the main occurrences. Reference is made to published maps of the numerous occurrences in Papua New Guinea and Irian Jaya.

A brief review of results of several provenance trials established in Queensland between 1956 and 1972 shows there is great genetic variation at the levels of region and provenance within region. Also, results of numerous progeny trials in Queensland show great variation among families indicating that tree-to-tree genetic variation within populations is also very important. Consequently there is great opportunity for genetic improvement of the species. The advanced breeding programme for this purpose in Queensland is outlined.

The demonstrated great variability of the species also makes it imperative that careful attention be given to provenance and sample size when introducing the species. There are indications that homoclimal considerations are a useful first approach when choosing seed sources for introductions, but some southern and northern populations appear to combine rapid growth and broad adaptability. Several, but not all, insular and small northern populations are very slow growing. Thus, results of provenance trials, including the few established overseas, are beginning to aid identification of promising provenances.

Where overseas the south Queensland provenances are well adapted, consideration could be given to importation of seed from the numerous plantation plus trees that have been selected and which are undergoing progeny testing.

Conservation of the genetic resources is receiving attention in Australia and Papua New Guinea. The species is not endangered as a whole, but some populations are at risk in New Guinea and in central-north Queensland. Some exploration and collection in the putatively endangered areas are in progress. A blank copy of the record sheet used to compile information on possibly endangered occurrences in Australia is included.

INTRODUCTION

Araucaria cunninghamii Aiton ex D. Don has the most extensive range of the 19 highly-disjunctly distributed species of the genus, occurring from just south of the equator to 31°S.[1] The species is of great economic importance in Australia and Papua New Guinea where over 45 000 ha of plantations have been established (mainly in sub-tropical south east Queensland), and planting continues at the rate of about 800 ha per year. As shown in this paper and earlier publications (example, Nikles and Reilly 1972), A. cunninghamii is very widely adaptable, is highly variable genetically and produces high yields of excellent timber (Smith and Eccles 1979) as a plantation species. It is particularly well suited for planting in moderately to highly fertile soils in the subtropics and low-latitude tropics, where certain New Guinea and north Queensland provenances are very promising (see papers presented to Session A III of IUFRO Symposium, Brazil, 1980).

In view of increasing interest in this excellent species for use in exotic plantations (FAO 1979), it is important to stress that the species is distributed over a great range of environments and it exhibits great genetic variation among and within provenances. Therefore seed sources for introduction should be chosen carefully, both as to provenance and intensity of sampling within provenance. In some cases, consideration should be given to introducing seed from the very large number of plus trees (including some locally-proven superior genotypes) which have been selected in the advanced tree breeding programme in south east Queensland.

This paper mentions the breadth of natural distribution of A. cunninghamii, reports on studies of provenance and family variation, outlines the tree breeding programme in Queensland and briefly discusses conservation of genetic resources.

NATURAL DISTRIBUTION

The extensive natural distribution and ecological range of A. cunninghamii in eastern Australia, Papua New Guinea and West Irian have been described and illustrated in considerable detail by Nikles 1973, 1978; Howcroft 1978, 1979; and Gray 1973. Many Australian occurrences are indicated in Figures 1 and 2.

In Papua New Guinea it ranges in elevation from about 500 m to 2745 m. (An occurrence at about 60 m is now thought to be a planted stand.) It has numerous discontinuous occurrences in Papua New Guinea (though it is less scattered than A. hunsteinii K. Schumann). There are relatively few, widespread occurrences in Irian Jaya where it reaches almost to the equator and ranges in elevation from about 2000 m to 400 m or less. The latitudinal range in New Guinea is approximately 0°30'S to 10°12'S.

In eastern Australia the present range of A. cunninghamii is highly discontinuous and between about 12°S (Shelburne Bay) and 31°S (Macleay River) where it is found from sea level to just over 1000 m. Surprisingly, its scattered occurrences in tropical north Queensland are at somewhat lower elevations than those which it reaches in cool subtropical mountains of southern Queensland and northern New South Wales. Its main distribution, however, is in subtropical south east Queensland -northern New South Wales between 24° and 29°S in the low mountains and foothills (to about 900 m) on the edge or within rainforest.

This very extensive natural distribution, encompassing 0°30'S to 31°S, and sea level to about 2800 m, includes a great range of climatic and edaphic conditions. It experiences annual dry seasons of varying severity in Australia and periodic severe droughts, especially in non-coastal localities. The species is well known for its great drought hardiness (and wind firmness) once established. In New Guinea it experiences higher rainfalls (1929 mm to 4787 mm - Howcroft 1979) than in Australia, but the Papua New Guinea provenances also appear drought hardy. Coastal and insular occurrences in eastern Australia are subject to periodic severe cyclones to which well-established trees are very resistant. Although A. cunninghamii extends into the cool non-coastal mountains (1000 m or so) of south Queensland and northern New South Wales, it is frost-tender when planted in the open. The species is very sensitive to fire and must be protected throughout all stages of life.

It occurs on a great range of soils and parent materials in Australia, from calcified dune and insular sands and coastal sandstones through acid volcanics and mixed metamorphics to rich basic volcanics and alluvial deposits, provided the derived soils are well drained with high aggregate porosity in all cases. In Papua New Guinea stands occur on loam, clay, sand or peat soils derived from breccias, agglomerates, coralline or limestone formations, lacustrine deposits or old volcanic deposits (Howcroft 1979). Its nutritional requirements for good growth in dense stands are relatively high. Consequently, for example, it does not succeed as a plantation species on the markedly infertile coastal lowlands of south Queensland (where subtropical Pinus species thrive after P fertilisation) unless heavily fertilised with both N and P or underplanted to Pinus.

[1] Nikles (1979a) listed the distributions and mature heights of the 19 species which occur in S. America (2), New Caledonia (13), Norfolk Is. (1) and Australia - New Guinea (3). An amended version of his Table 1 is included in the present paper as Appendix 1.

PROVENANCE VARIATION

Nikles 1979b outlined the First and Second Series of provenance trials planted in Queensland in 1936-1956 (6 trials) and 1970-1972 (10 trials in south Queensland and 6 in central-north Queensland) respectively. (Two trials have also been established in northern New South Wales.) He reviewed results and presented some new data from the First Series, and from two south Queensland trials of the Second Series. These results are briefly summarised here, and new information is presented from 8.5 year results of one of the north Queensland trials.

First Series

These 6 trials (5 at Imbil and one at Yarraman) comprised a relatively narrow range of south Queensland sources (14 in all) between 24°30'S and 28°S, plus one population from Papua New Guinea (Bulolo). Some details of environments of the trial sites are given below.

Location	Latitude (°S)	Longitude (°E)	Elevation (m)	Rainfall (mm)	MTCM[2]
Imbil	26°30'	152°38'	105	1170	5.4
Yarraman	26°50'	152°00'	428	817	3.9

Individual trials were last assessed in detail at ages varying from 16 to 28 years. The main conclusions regarding provenance growth rates are as follows.

1. The most promising provenances for growth were Jimna (26)[3], Emu Vale (34) and Kalpowar (13) with Gallangowan south (28) and Head of River (Brisbane R.) (1) also of considerable interest.

2. Slow-growing provenances were Imbil (29, 30) (in three out of four trials), Kilkivan[4], Mary's Creek[4] and Elginvale (25).

3. Provenances with intermediate growth rates were Goodnight Scrub (9, 10), Bulburin (15), Benarkin (7), Yarraman (6) and Gallangowan north (24).

4. No distinct pattern of provenance variation for growth was discernible (fast- and slow-growing populations were traceable to the same regions).

5. The Bulolo, PNG population (from lat. 7°17'S) was ill-adapted in the one trial in which it was included (at Imbil). (Similarly, south Queensland provenances have performed poorly in Papua New Guinea (Howcroft 1979)).

Second Series

This Series comprises (1) trials planted at 12 localities in Queensland and northern New South Wales in both 1970 and 1971 with 25 common provenances; (2) a further 15 provenances in a Supplementary trial at each of two of these localities; (3) 12 to 20 provenances at each of 6 localities in central and north Queensland planted in 1971 and 1972; and (4) plantings of mostly PNG and north Queensland sources at Kuranda and Danbulla in 1977, 1978 and 1980 (Table 2; Figures 1 and 2). The provenances included in (1) sample most of the range throughout Queensland and northern New South Wales, while those in (2) and (3) include additional north Queensland and PNG provenances. Most provenances are represented by 6 separate, open-pollinated families each year for usually 12 families per provenance. Others are bulk lots.

Imbil and Yarraman plantings of 1970-71

The three trials reported by Nikles 1979b were those planted at Imbil (two) and Yarraman in 1970-71, the same localities as used in the First Series. Conclusions of the study of 8.5 year results of these three trials were as follows.

1. All four provenances derived from southern lowland stands within a 50 km radius of Brooweena (west of Maryborough) were consistently fast-growing at both localities. These were Goodnight Scrub (9), Miva (12), Woocoo (11) and Thunder (23)[5]. (Note that the Goodnight Scrub provenance had shown only intermediate growth rate in the First Series).

2. Other fast-growing provenances at both or one locality were:

Yarraman (6) (both localities)
Polmaily (14) (both localities)
Bunya Mts (3) (both localities)
Jimna (26) (both localities)
Head of River (1) and Squirrel Creek (2) (at Imbil only)

Of these provenances, Jimna and Head of River were found to be fast-growing in the First Series also, while Yarraman was intermediate. (The other provenances were not represented in the First Series). Fast-growing provenances in the Supplementary trial at Imbil were: Imbil (29), Noosa (39), Mt. Mee (37), Head of R. (1), and Goodnight Scrub (9).

3. Provenances which had shown fast growth in the First Series but only intermediate or poor growth in the Second Series were Gallangowan (28), Gladfield (18) (near Emu Vale) and Kalpowar (13).

4. Provenances which showed slow growth in both Series were Imbil (30) and Elginvale (25); while Benarkin (7) was intermediate in both Series.

5. Slow-growing provenances in the Supplementary trial at Imbil were: Alford (43-45), three central Queensland insular populations[6] (S. Molle - 32, Brampton - 36 and Magnetic - 42), Ellerbeck (44) and Deongwar (5).

6. Therefore there was both some concordance and some discordance of results of the two series. Again no clear pattern is evident. However, a greater understanding should emerge when the tenth year results for all 16-locality trials (of both planting years) are available within a few years.

Kuranda planting of 1971-72

During 1980, 8.5 year data for the trial planted at Kuranda in 1972 were analysed, and the main results are reported here because the trial is of considerable interest: it is located within the tropics, and it includes several "new" central and north Queensland provenances as well as some Papua New Guinea and southern ones (Table 3). The trial was planted on a freshly cleared rainforest site at Kuranda (16°45'S, 145°37'E, 427 m a.s.l., 2057 mm with a short dry season in late winter-spring).

Each provenance is represented by 6 open-pollinated families with the following exceptions: Gladfield (18) and the two New Guinea sources (53-1, 53-2) are bulks; Collaroy (20A), Carminya (20B), Brampton (36), Hann (22B) and Gillies (22A) each have 3 families; and Magnetic Is. (42) has only 2 families. There are three replications of 36-tree plots with 6 progeny per family per plot.

A summary of results obtained to date is presented in Table 3, and some of these results are shown graphically in Figure 3 (8.5 year mean tree volumes against recent height increment).

The following conclusions can be drawn at this stage:

1. All provenances have shown high survival rates (not tabulated) and the best provenances have grown well at just less than 1 m per year on average.

2. There is very large variation of growth rate among provenances. For example, the mean volume of the best 4 provenances is 154 per cent of the trial mean indicating that provenance selection could be a very important source of genetic gain.

3. The outstanding provenances for growth are Goodnight Scrub (9), Coen 2 (41-2), Okasa 1 (53-1) and Jimna (26). It is of interest to note that Goodnight Scrub (9) especially, and Jimna (26), are fast-growing at Kuranda (lat. 16°45'S), as well as at Imbil (26°30'S) and Yarraman (26°50'S). The Coen provenance is also known to be fast growing at other northern and central Queensland sites in the Second Series of trials, and in Congo also (pers. obs.). Likewise the New Guinea provenances (here represented by Okasa (53) are fast-growing at other tropical test sites in W. Malaysia, Sabah and Congo (pers. obs.).

4. It is perhaps surprising to note that two south Queensland provenances (Goodnight Scrub and Jimna) and two greatly dissociated provenances (Coen 2 and Okasa of north Queensland and Papua New Guinea) comprise the fastest-growing 20 per cent of provenances at Kuranda (tropical locality). Similarly several provenances of equal, intermediate growth derive from very widely dispersed regions.

---

[2] Mean minimum temperature of coldest month in °C. (Average of daily minimum temperatures for July). Light to moderate frosts can occur at both localities, but Yarraman is colder.

[3] Numbers in parentheses refer to the locality numbers in Table 1 to which these First Series collections are approximately equivalent.

[4] Respectively 26°10'S, 26°20'S; 152°20'E, 152°33'E; and 400 m, 300 m.

[5] See Table 1 for provenance details.

[6] However, one other central, insular population (Whitsunday - 55) has grown very well in other trials.

5. There is a great deal of apparent variation among provenances within region. For example the two Coen and PNG samples are significantly different in volume; as were Tierawoomba, Collaroy, Carminya and Cathu (all from the Mackay region); Jimna and Thunder; Ellerbeck and Hann. This may indicate provenance effects, but more likely is a result of great variation among families within provenance regions e.g. Coen 1 and Coen 2 were random subsamples of a 14-tree collection.

6. The insular sources Brampton (36), Magnetic (42) (and S. Molle in another study) are again very slow-growing. The slow growth of these and other samples of very small north Queensland populations, e.g. Gillies 1, 2 and Ellerbeck, may be due to inbreeding. Further indirect evidence of this comes from the fact that Whitsunday Island (55) provenance (from a very large insular population) is quite fast growing in another local study.

INDIVIDUAL VARIATION

Genetic variation among mature individual trees within populations is being studied in two types of trials - (1) progeny tests of plus trees selected within plantations at high intensity for seed orchard and breeding purposes, and (2) combined provenance-progeny trials in which open-pollinated families from trees selected at very low intensity in natural stands are used as the basis of provenance studies. The oldest studies of type (2) were planted extensively in 1970, 1971 and 1972 as the Second Series of the provenance trials mentioned in the previous section. Results of measures carried out at ages 4.5 and 8.5 years have not yet been analysed at the family-within-provenance level.

Many single- and multi-site progeny studies of type (1) have been planted at several localities in south, central and north Queensland since 1956. Early results of growth and

Table 1. Some details of Australian and Papua New Guinea *Araucaria cunninghamii* provenances represented by progeny in Australian provenance trials of the 1970s /1

No.	Collection Locality: Name	Reserve /2	Lat. (°S)	Long. (°E)	Elevation (m a.s.l.)
1	Head of the River	SF329/673	26°32'	152°10'	450
2	Squirrel Ck.	SF343	26°37'	152°15'	520
3	Bunya Mts.	NP603	26°52'	151°36'	640
4	E. Nanango	SF618	26°42'	152°04'	450
5	Deongwar	SF528	27°20'	152°20'	450
6	Yarraman	SF379	26°52'	152°00'	450
7	Benarkin	SF283	26°55'	152°09'	440
8	Bustard Head	SF 86	24°11'	151°50'	5
9	Goodnight Scrub - General	SF169	25°15'	151°55'	120
10	Goodnight Scrub - Tea-Tree	SF169	25°15'	151°55'	120
11	Woocoo	SF287/676	25°27'	152°10'	400
12	Miva	SF301	25°54'	152°25'	200
13	Kalpowar	SF 95	24°39'	151°20'	600
14	Polmaily	TR 99	24°22'	151°25'	600
15	Bulburin	SF 67	24°32'	151°30'	540
16	Winder	SF809	27°14'	152°40'	400
17	Cressbrook	TR209	27°05'	152°30'	400
18	Gladfield	SF405	28°00'	152°22'	1050
19	Wiangerie & Melcombe	SF735	28°30'	152°55'	900
20A	Collaroy	-	21°57'	149°07'	365
20B	Carminya	-	21°44'	148°50'	365
21A	Dryander	TR216	20°16'	148°34'	200
22A	Gillies 1, 2	SF700	17°11'	145°41'	670
22B	Hann	-	17°03'	145°20'	800
23	Thunder	SF632	25°55'	152°12'	300
24	Callangowan - Beauty Spot	SF298	26°24'	152°20'	650
25	Elginvale	SF154	26°30'	152°12'	650
26	Jimna	SF137/207	26°42'	152°20'	600
27	Sheep Station Ck.	SF792	26°48'	152°30'	400
28	Callangowan - Toomcul	SF298	26°24'	152°20'	650
29	Imbil - Beauty Spot	SF135	26°30'	152°42'	120
30	Imbil - Coonoon	SF135	26°30'	152°42'	120
31	Kandanga	SF435/124	26°24'	152°36'	200
32	South Molle Is.	NP275	20°15'	148°40'	30
33A	Papua New Guinea	-	7°17'	146°45'	1160
33B	Papua New Guinea	-	7°17'	146°45'	1160
34	Emu Vale	SF400	28°25'	152°24'	1000
36	Brampton Is.	NP488	20°50'	149°20'	30
37	Mt. Mee	SF893	27°06'	152°35'	450
38	Fraser Is.	SF 3	25°00'	153°15'	210
39	Noosa	NP340	26°25'	153°07'	10
40	Brooklana, Clouds Ck	-	30°22'	152°40'	1030
41	McIlwraith, Coen 1, 2	TR 9	13°52'	143°17'	350
42	Magnetic Is.	NP456	19°08'	146°53'	170
43, 45	Alford, Melcombe	SF283/735	28°15'	152°30'	1220
44	Ellerbeck	SF461	18°15'	145°55'	250
45	Melcombe	SF735	28°20'	152°35'	1000
46	Mebbin	-	28°25'	153°10'	250
47	Dorrigo	-	30°22'	152°40'	1030
48	Tierawoomba	-	21°45'	149°05'	400
50	Ellerbeck	SF461	18°15'	145°55'	250
51A	Cathu	SF652	20°48'	148°29'	300
52	Bulolo, PNG	-	7°17'	146°45'	1160
53	Okasa 1, 2, PNG	-	6°32'	145°37'	1400
54	Dryander	TR216	20°16'	148°34'	200
55	Whitsunday Is.	NP113	20°14'	148°50'	30
56	Marlborough	TR 55	22°45'	149°50'	200
57	Cawarral	NP893	23°14'	150°35'	100
58	Cape Flattery	-	15°00'	145°20'	150
59	Bluewater	-	19°13'	146°27'	120-240
60	Harveys Range	-	19°25'	146°25'	420
61	Captain Billy Ck.	-	11°39'	142°50'	15
62	Lankelly Ck.	-	13°52'	143°17'	330
63	Upper Stewart River	-	13°52'	143°17'	330
64	Pandanus Ck.	-	13°52'	143°17'	330
65	Cliffside, PNG	-	7°15'	146°45'	1100
66	Wau, PNG	-	7°15'	146°45'	1200
67	Bulolo, PNG	-	7°17'	146°42'	1160
68	Pimaga, PNG	-	6°30'	143°30'	1000
69	Bumbu, PNG	-	5°55'	145°45'	1500
70	Elaro, PNG	-	7°25'	146°40'	2000
71	Oksapmin, PNG	-	5°09'	141°36'	1500
72	Okasa, PNG	-	6°32'	145°37'	1400
73	Erave, PNG	-	6°39'	143°57'	1500

/1 For details of provenances included in earlier plantings see Reilly (1974)

/2 SF - State Forest
TR - Timber Reserve
NP - National Park

stem form to 8.5 years of some of these have been reported (Nikles 1979c). Highly significant differences in height, height increment, DBH, volume, stem straightness and internode length have been found among both open-pollinated and full-sib families. Unpublished studies also show great genetic variation among grafted clones of plus trees in stock-scion incompatability, growth rate, branch thickness and branch angle, internode length, cone production, etc. Genetic variation of growth and stem straightness among full-sib families from plus trees and comparison to routine control stock for one typical field study are illustrated in Figure 4. Note the variation among families, their generally superior stem straightness, and the superior growth of many compared to routine stock R.

These results illustrate the fact that large genetic gains should be obtainable through such improvement methods as mass selection, intensive selection of superior phenotypes plus cloning of them in seed orchards, mass pollination techniques and mass cloning of superior trees.

Recently, three more progeny studies have been assessed. These are an open-pollinated progeny study planted at both Imbil and Yarraman, and a control-pollinated trial at Yarraman.

The open-pollinated trials (No. 385-2A and No. 385-2B) and the full-sib trial (No. 2194) each comprise 35 families from plus trees and a routine control stock at each locality. Design consists of 6 replicates of 10-tree line plots. The OP families of studies 385-2A and 385-2B derive from different numbers of plus trees selected at Imbil (24), Yarraman (5) and Kalpowar (6). The full sibs of trial 2194 comprise 8 crosses among 13 Imbil plus trees and 27 crosses among 9 Yarraman plus trees. The control stock varied at the two locations - at Imbil it comprised open-pollinated progeny of mildly selected plantation crop trees (stock R); at Yarraman it was from a local natural population (stock N). The latter performed relatively poorly.

Table 4 shows the composition of the three trials and genetic gains realisable through (1) mass selection (re-using seed of all families) and (2) progeny-test selection of the

Table 2. Some details of locations of provenance trial sites in Australia

Locality name	State forest (no.)	Lat. (°S)	Long. (°E)	Year of planting /1
Yarraman	SF 289	26°50'	151°50'	1, 2
Gallangowan	SF 673	26°30'	152°15'	1, 2
Imbil	SF 135	26°30'	152°42'	1, 2, 4
Goodnight Scrub	SF 169	25°15'	151°55'	1, 2
Bulburin	SF 67	24°32'	151°30'	1, 2
Gladfield	SF 405	28°00'	152°22'	1, 2
Byfield	SF 865	22°45'	150°40'	1
Conondale	SF 788	26°48'	152°35'	1
Beerburrum	SF 611	26°55'	152°55'	1
Head of the River	SF 329	26°32'	152°10'	1, 2
Sunday Ck	SF 792	26°48'	152°30'	1, 2
Pikapene	NSW	29°00'	152°38'	1, 2
Toonumbar	NSW	28°34'	152°45'	1, 2
Conway	SF 299	20°20'	148°45'	3
Cathu	SF 652	20°48'	148°32'	2, 3
Kuranda	SF 1073	16°45'	145°35'	2, 3, 4, 5
Ravenshoe	SF 251	17°40'	145°35'	2, 3
Mt Spec	SF 268	19°01'	146°02'	2
Danbulla	SF 185	17°10'	145°35'	3, 6

/1 1 = 1970-71, 2 = 1971-72, 3 = 1972-73, 4 = 1976-77, 5 = 1977-78, 6 = 1979-80

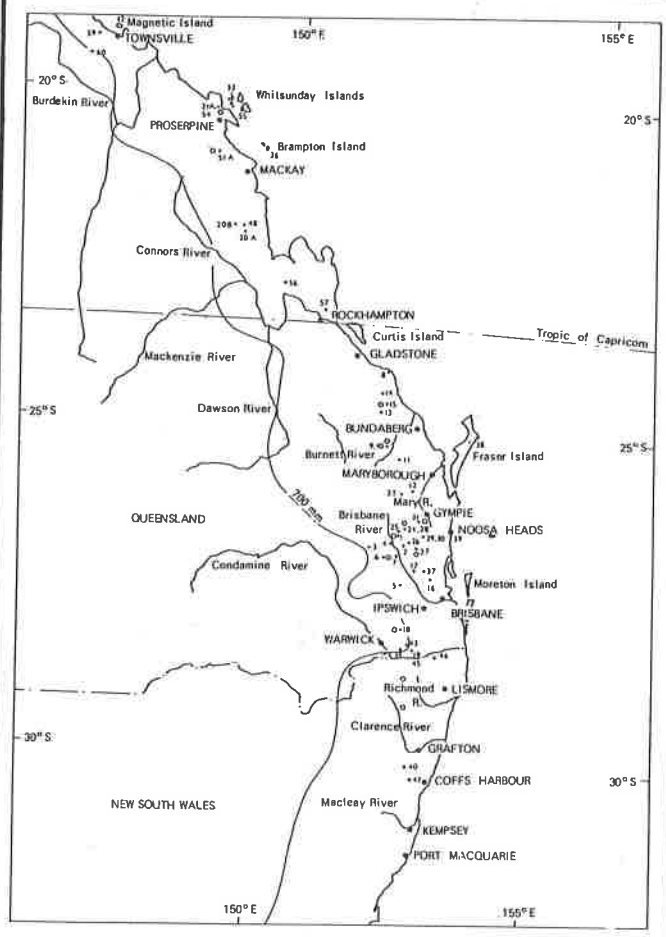


Figure 1. *A. cunninghamii* seed collection localities (e.g. • 32) and major provenance trial sites (o) in southern part of Australian range

Table 3. A. cunninghamii provenance means for growth based on 8.5 year data from Kuranda trial

Provenance Name	No.	DBH (cm)	Prov. no.	Ht. (m)	Prov. no.	Ht. inc. 4.5 to 8.5 yr (m)	Prov. no.	Mean tree volume (m^3)
Okasa 1 (PNG)	53-1	11.74	9	7.15	26	3.76	9	.0336
Coen 2	41-2	11.39	26	6.87	9	3.54	41-2	.0326
Goodnight	9	11.16	41-2	6.83	41-2	3.30	53-1	.0317
Jimna	26	10.74	53-1	6.62	14	3.27	26	.0305
Coen 1	41-1	10.17	14	6.22	18	3.20	41-1	.0235
Tierawoomba	48	9.98	20B	6.10	16	3.07	53-2	.0235
Okasa 2	53-2	9.92	18	6.10	53-1	2.94	18	.0233
Polmaily	14	9.81	23	5.92	23	2.84	14	.0231
Gladfield	18	9.79	53-2	5.92	20B	2.82	48	.0221
Thunder	23	9.59	48	5.85	53-2	2.57	20B	.0210
Carminya	20B	9.53	41-1	5.71	41-1	2.45	23	.0200
Hann	22B	9.24	16	5.71	48	2.37	16	.0196
Winder	16	9.19	51	5.03	22B	2.28	22B	.0188
Cathu	51	8.31	20A	4.95	51	2.22	22A-2	.0150
Gillies 1	22A-1	8.17	22B	4.90	22A-2	2.18	51	.0145
Gillies 2	22A-2	8.16	22A-2	4.76	20A	2.11	22A-1	.0128
Collaroy	20A	7.80	22A-1	4.47	22A-1	1.84	20A	.0126
Ellerbeck	44	6.79	42	3.81	42	1.45	44	.0084
Magnetic Is.	42	6.41	36	3.52	36	1.37	42	.0083
Brampton Is.	36	5.52	44	3.45	44	1.18	36	.0064
$\bar{x}$		9.32		5.61		2.63		.0208
Signif.		***		***		***		***
5% LSD		1.63		1.06		0.64		.0084

Table 4. Composition of three 8.5-year-old progeny studies at Imbil and Yarraman and potential genetic gains by mass selection

Study location & number	Progeny type	No. of[1] families	Control[2] stock	Potential genetic gains (%)[3] Straightness		Volume	
				All families	Best 12 families	All families	Best 12 families
Yarraman 2194	Control pollinated	35	N	18.4	20.5	45.0	64.0
Imbil 385-2A	Open pollinated	35	R	17.9	20.6	0.0	0.3
Yarraman 385-2B	Open pollinated	35	N	13.5	18.7	25.3	39.0

[1] Open- or control-pollinated families from plantation plus trees

[2] "N" - from local natural stand; R from plantation "crop" trees

[3] Compares means of progeny and control stock

Appendix 1. Distribution and mature height of the 19 accepted species of Araucaria[1]

Species[1]	Botanical authority	Region of occurrence	Country, island or province	Approx. range Latitude (°S)	Approx. range Elevation (m)	Approx. ht. mature tree (m)
angustifolia	(Bertoloni) O. Kuntze	South America	Argentina, Brazil	18 - 31	250 - 1663	40
araucana	(Mol.) K. Koch		Argentina, Chile	37 - 40	600 - 1700	40
bernieri	Buchholz	S.W. Pacific	New Caledonia	22 ca.	0 - 700	35
bidwillii	Hooker		Queensland	27 ca., 16.30	100 - 1100	45
biramulata	Buchholz		New Caledonia	22 ca.	200 - 1150	16
columnaris	(Forster) Hooker		New Caledonia	22 ca.	0 - 50	50
cunninghamii	Aiton ex D. Don		E. Australia, New Guinea	0.03-31	0 - 2800	65
heterophylla	(Salisb.) Franco		Norfolk Is.	29	0 - 300	55
humboldtensis	Buchholz		New Caledonia	22 ca.	700 - 1600	15
hunsteinii	K. Schumann		Papua New Guinea	5 - 10	520 - 2100	85
laubenfelsii	Corbasson		New Caledonia	22 ca.	400 - 1160	50
luxurians	(Brongn. et Gris) de Laubenfels		New Caledonia	22 ca.	0 - 200	45
montana	Brongn. et Gris		New Caledonia	22 ca.	200 - 1400	40
muelleri	(Carr.) Brongn. et Gris		New Caledonia	22 ca.	150 - 1170	20
nemorosa	de Laubenfels		New Caledonia	22 ca.	0 - 10	15
rulei	F. Muell.		New Caledonia	22 ca.	150 - 1150	50
schmidii	de Laubenfels		New Caledonia	22 ca.	1500 - 1630	30
scopulorum	de Laubenfels		New Caledonia	22 ca.	0 - 300	20
subulata	Vieillard		New Caledonia	22 ca.	300 - 1000	50

[1] After de Laubenfels 1972.

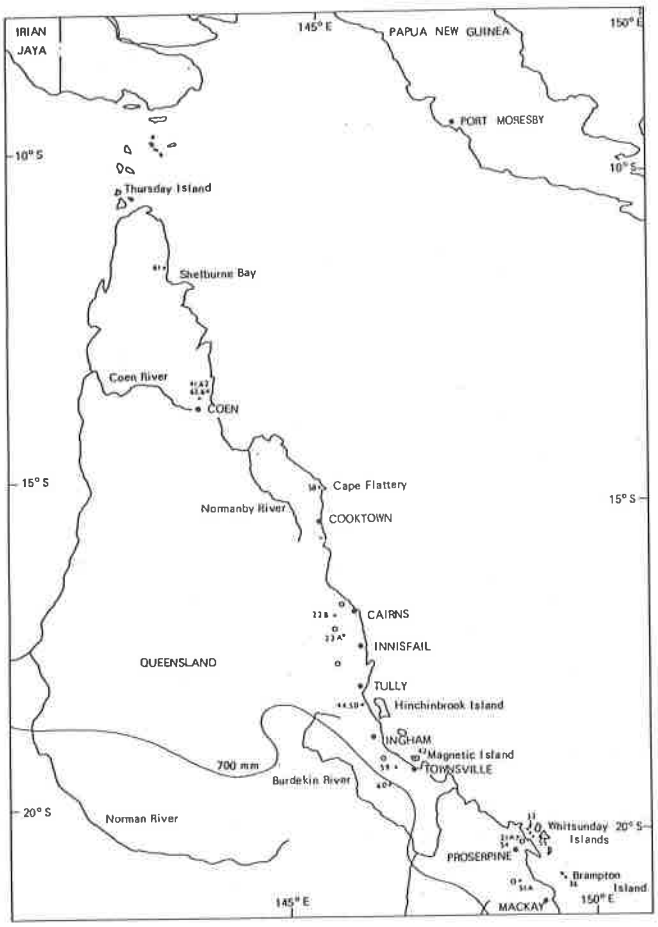


Figure 2. *A. cunninghamii* seed collection localities (e.g. • 32) and major provenance trial sites (o) in northern part of Australian range

best 1 in 3 families per test. Clearly, significant gains in stem straightness are obtainable through mass selection alone and these are not greatly increased by applying progeny test selection at the rate of 1 in 3. This confirms results of all other progeny studies with A. cunninghamii i.e. phenotypic selection for stem straightness is very effective (Nikles 1979c).

Genetic gains in volume can also be large using mass selection, especially after controlled pollination of plus trees, and large increases in gains can be added through progeny test selection as suggested by the results at Yarraman. At Imbil, the plantation-derived control stock grew rapidly and no significant gain in volume appears achievable in the population unless intense progeny test selection (at about 1 in 6) is practised. Again, these results for genetic variation of growth rate confirm previous reports (e.g. Nikles 1979c) of the feasibility of breeding for increased growth.

IMPLICATION OF VARIABILITY

The numerous studies of variation of economic traits carried out in Queensland show that it is great at all levels - regional, provenance-in-region, families-in-provenance and among individuals of families. This shows that when introducing the species for possible future use in plantation forestry and breeding, a range of provenances, each represented by seed from a large number of individuals, should be collected.

In addition, the genetic quality of local seed can be greatly enhanced through skilful mass selection and any of the more elaborate methods of tree breeding. Furthermore, in some circumstances it could be very advantageous for an organisation interested in this species to import seed from the best south Queensland plus trees if the S. Queensland provenances are appropriate.

GENETIC IMPROVEMENT

The genetic improvement programme with A. cunninghamii in south Queensland is based on several hundred intensively-selected plus trees. These and "seed production areas" are now used as sources of open-pollinated seed pending the time when clonal seed orchards established at Imbil (1965-1968) and Yarraman (1970-1972) come into heavy seed production. These seed sources are adequate because the planting programme is relatively small (about 750 ha per year) and seed yield per tree is high in "good" years.

Establishment of clonal seed orchards with this species requires the use of propagules taken from the main stem of the plus trees in order to obtain orthotropic growth of ramets (Nikles 1973).

The clonal seed orchards established in this way have been very slow to reach the stage where heavy crops of pollen are produced (some 15 years after grafting). This is thought to be due to the fact that the propagules were taken for convenience from near the top of the old plus trees i.e. in the "female zone" (Veillon 1976). Female flowers are produced abundantly within a few years, so mass pollination has been used in order to utilise the large numbers of female flowers produced, especially in years of abundant flower production. This procedure also enables use of selected pollen parents, but it is inevitably more expensive than natural pollination.

This experience suggests that propagules for grafting should be taken from the "male zone" of the plus trees; it is considered that resultant ramets are likely to produce both male and female flowers contemporaneously within a much shorter time, though this hypothesis has not yet been properly tested.

Future strategy for genetic improvement of A. cunninghamii in Queensland will depend on the results of the 10-year assessment of the provenance trials (Second Series) in 1981 and 1982, of recent work on interprovenance crossing, on the economics of mass pollination for the reproduction of proven, high-yielding families, as well as on progress in current studies of organ culture (Burrows 1980). There are indications that crossing of proven superior southern genotypes with selected northern provenances (e.g. Coen) may give heterosis for yield. Certainly there appears to be ample opportunity to broaden genetic bases and possibly to broaden adaptability and achieve needed increase in growth rate most effectively using the mass pollination technique for provenance crossing. Further exploration of provenance crossing will be greatly facilitated in Queensland during the 1980s when the many provenances in the numerous trials will begin to produce female flowers at locations convenient for the crossing work using pollen from the best genotypes of the first-stage breeding programme.

CONSERVATION

The species is not endangered as a whole, but some populations are at risk in parts of its geographic range, especially in New Guinea (Howcroft 1979) and in central-north Queensland where the natural populations may be very small in area and number of individuals, located on land with insecure tenure or endangered by fire and cyclone. Clearing for agriculture and logging have severely depleted accessible and commercially-viable natural stands throughout the range of A. cunninghamii. Consequently both in situ and ex situ conservation need to be considered. The following discussion relates to conservation of Australian occurrences; Howcroft 1979 (and other papers) has described the situation in Papua New Guinea, while little information is published of the position in Irian Jaya.

In situ Conservation in Australia

In many areas in Australia, natural regeneration is abundant, if not within the rainforest where light and moisture supply may be limiting, then in more open patches and on edges. Furthermore, patches or extensive areas of natural forest containing A. cunninghamii remain in reserves of various kinds (National Parks, Scientific Areas and firebreaks within State Forests, Timber Reserves, etc.) and on private lands. Pressure for cutting remaining accessible stands may decrease as significant areas of the older plantations are harvested beginning in the early 1980s.

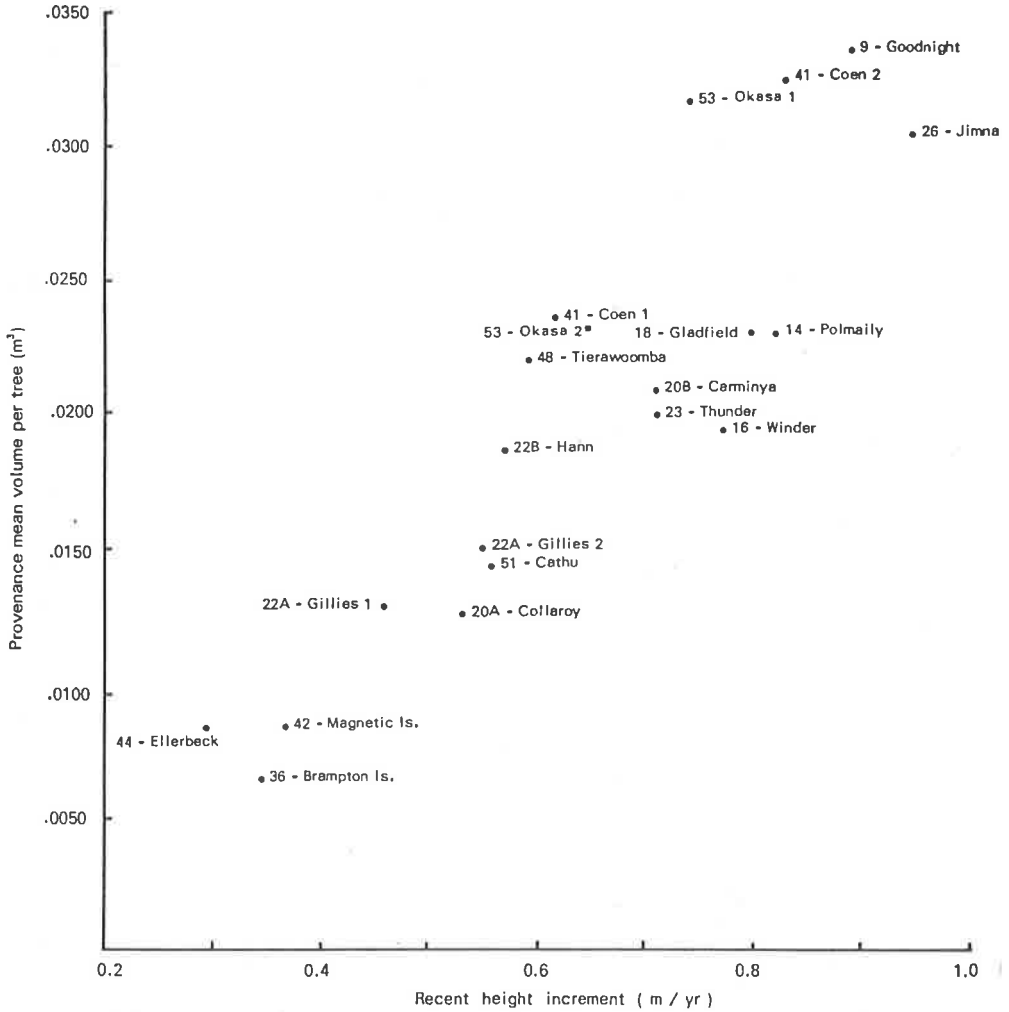


Figure 3. Distribition of provenance means for 8.5 year mean volume per tree and recent height increment in *A. cunninghamii* trial at Kuranda.

No formal survey, aimed at describing the distribution and determining and implementing conservation needs, has yet been undertaken. However, records are being compiled gradually of the many small and scattered occurrences in central and north Queensland where some populations are endangered. A record sheet for entering details of such populations has been designed and used (Appendix 2). It is proposed to complete such records for a considerable number of occurrences, to map them, to identify occurrences at high risk and to formulate conservation action based on a study of the information obtained. This could include such action as declaration of a reservation, provision of fire protection, decision to secure a large seed collection when opportune for ex situ conservation, etc.

Ex situ Conservation in Australia

Much of the genetic resource of A. cunninghamii in the southern part of its range has been collected and planted in the 40 000 ha of plantations established in south-east Queensland and northern New South Wales. For example, 67 per cent of the 33 south Queensland provenances listed in Table 1 are well represented in plantations. Further, substantial provenance resource stands (PRSs sensu Nikles and Newton 1980) have been established for a further eight central-north Queensland and Papua New Guinea provenances in the 1970s. However this means that somewhat uncertain in situ conservation is the only present means for protection of the gene resources of a considerable number of central-north Queensland occurrences. Furthermore, the routine plantations and PRSs are satisfactory means for ex situ conservation only while they are retained. In view of the anticipated escalation of plantation clear falling in the 1980s, reservation of some plantations is being considered to ensure continuing ex situ conservation where necessary.

ACKNOWLEDGEMENT

The authors acknowledge the collaborative work of D.I. Nicholson, especially on exploration and collection of the genetic resources and establishment and management of provenance trials in north Queensland. Numerous other colleagues have contributed to the collections and the establishment and maintenance of provenance and progeny trials in Queensland and New South Wales.

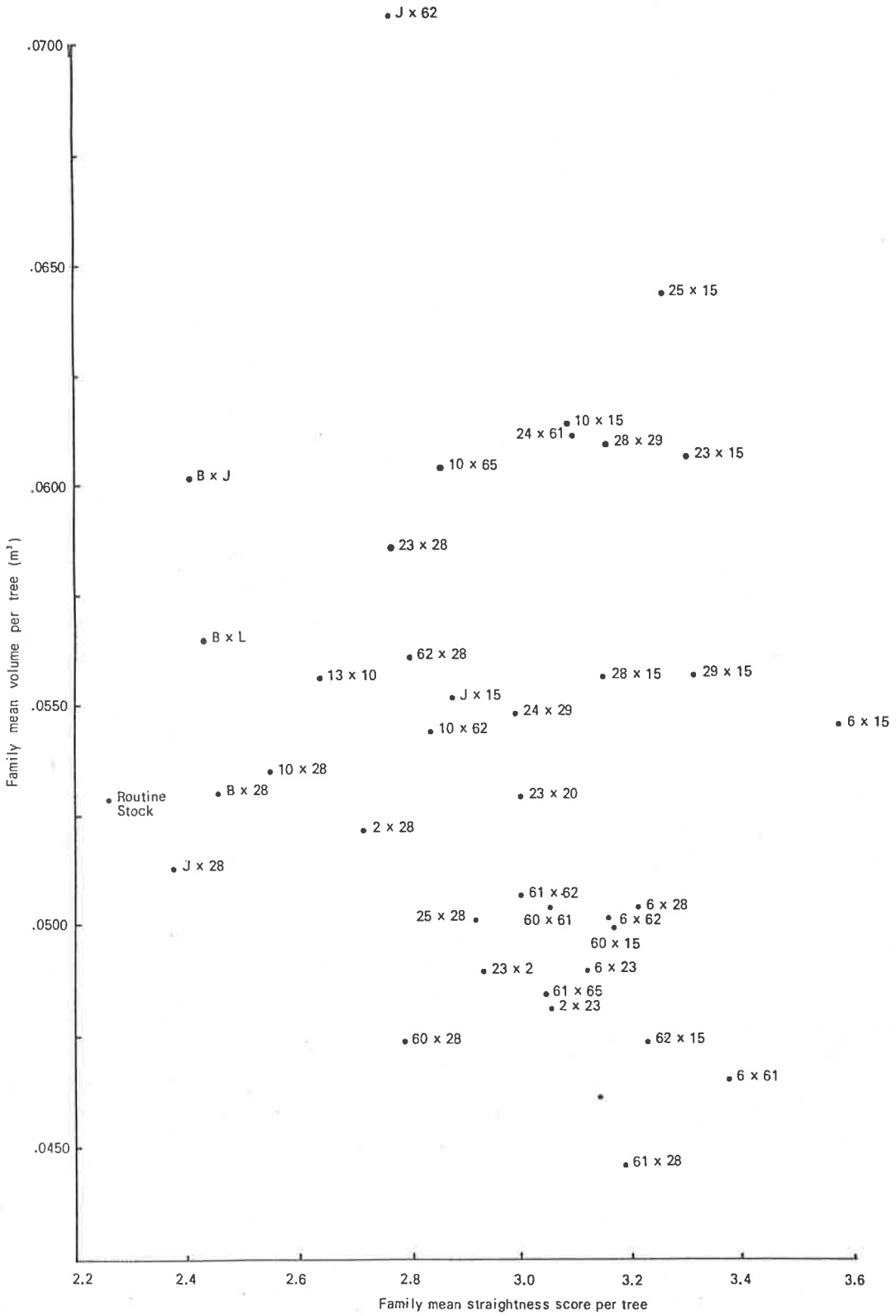


Figure 4. Distribution of means for 8.5 year volume and straightness per tree of routine plantation stock and families from controlled crossing of plus trees (J x 62, 25 x 15, 23 x 15, etc.) at Imbil.

Appendix 2. Record sheet for entering details of *A. cunninghamii* (hoop pine) occurrences in Qld.

Description of Hoop Pine Occurrence No. _____

Location

SF ..... TR ..... Other .....

Lat. ..... Longit. ..... Elevation .....

Map reference ..... Parish .....

Nearest met. station ..... Ann. rainfall .....

Sketch attached ? YES ..... NO ..... (give source of information)

Remarks (Tenure etc.) .....

.....

Ecology

Forest type[1] .....

Associated spp. .....

.....

Topography ..... Aspect .....

Parent material (Supply representative hand specimen)

.....

(Soil profile description to be attached please)

The pine stand or occurrence and flowering-fruiting

Area (ha) ..... No. mature trees (estimate) .....

Stand density ..... Health .....

Maturity status .....

DBH largest trees ..... Height .....

Regeneration (hoop) frequency 0.2 - 1 m ..... 1 - 2 m .....

Seed cones present? YES ..... NO .....

Stages of seed cones ..... Seed viability .....

Stage of develop. of male cones .....

Opportunity for seed collection .....

Management

Current status .....

Logging history .....

Likely future management .....

Preservation status

Fire history .....

Risk of depletion by fire .....

Other damage history (e.g. cyclone) .....

Present viability of stand .....

Action required .....

Action taken .....

---

[1] Webb's structural classification.

Other Comments relevant to preservation or conservation through
(a) seed collection (b) in situ

(a) .....

.....

(b) .....

.....

Date of inspection ..... Name of inspector .....

Date of completion of this record ..... Signature .....

Guidelines on questionaire preparation

Tenure:	Reserve of some kind - give details incl. reserve no. VCL Private property Leasehold etc.
Seed cones:	May be second year (final year) or first year; may be at the "flowering" stage
Occurrence no.:	Will be filled in by Brisbane HQ
Additional notes:	If useful additional information is available please detail separately.

* This section would be annotated as various things were done, such as "seed collected in 19___ and x ha of stock planted at _____ in 19___.

REFERENCES

Burrows, G. 1980: Organ culture of Araucaria cunninghamii Ait. ex D. Don. Paper for IUFRO Symposium and Workshop, Brazil, August, 1980.

FAO, 1979: Genetic improvement of tropical lowland conifers. FO:MISC/79/15. 86 pp. FAO, Rome, 1979.

Gray, B. 1973: Distribution of Araucaria in Papua New Guinea. Research Bull. No. 1, 56 pp. Papua New Guinea Department of Forests, Port Moresby.

Howcroft, N.H.S. 1978: A review of Araucaria cunninghamii Ait. ex Lambert in Papua New Guinea and Irian Jaya. Proc. Joint IUFRO Workshop S2.02-08 & S2.03-01, Brisbane, 1977. 2: 827-847. CFI, Univ. of Oxford, England.

Howcroft, N.H.S. 1979: Data sheets on species undergoing genetic impoverishment. Data sheet on Araucaria cunninghamii Ait. ex Lambert. Forest Genetic Resources - Information 9: 9-14.

de Laubenfels, D.J. 1972: Flora de la Nouvelle Caledonie et Dependances - Gymnosperms. Museum National D'histoire Naturelle.

Nikles, D.G. 1973: Biology and genetic improvement of Araucaria cunninghamii Ait. in Queensland, Australia. Proc. Joint IUFRO Workshop S2.02-08 & S2.03-01, Gainesville, Fla., 1971. 2: 304-334. CFI, Univ. of Oxford, England.

Nikles, D.G. 1978: Status of exploration, evaluation, use and conservation of genetic resources of Araucaria cunninghamii Ait. (hoop pine). Proc. Joint IUFRO Workshop S2.02-08 & S2.03-01, Brisbane, 1977. 2: 859-869. CFI, Univ. of Oxford, England.

Nikles, D.G. 1979a: Realised and potential gains from using and conserving genetic resources of Araucaria. Paper for IUFRO Meeting on "Problems of Araucaria Silviculture", Curitiba, Brazil, October 1979.

Nikles, D.G. 1979b: Review of hoop pine (Araucaria cunninghamii Ait.) provenance studies - impact on future plantings and preservation of seed sources. 19 pp. Proc. Research-Routine Conf., Gympie, 1979. Queensland Department of Forestry, Brisbane.

Nikles, D.G. 1979c: Variation among hoop pine families and estimates of genetic gains realisable. 19 pp. Proc. Research-Routine Conf., Gympie, 1979. Queensland Department of Forestry, Brisbane.

Nikles, D.G. and Newton, R.S. 1980: Inventory and use of "provenance resource stands" of Pinus caribaea Mor. var. hondurensis Barr. and Golf. in Queensland. Paper for IUFRO Symposium and Workshop, Brazil, August, 1980.

Nikles, D.G. and Reilly, J.J. 1972: Management and genetic improvement of the native Araucaria cunninghamii Ait. in Queensland. Paper for 7th World Forestry Congress, Argentina, 1972. 25 pp. Queensland Department of Forestry, Brisbane.

Reilly, J.J. 1974: Geographic variations of hoop pine. Research Paper No. 4. 34 pp. Queensland Department of Forestry, Brisbane.

Smith, W.J. and Eccles, D.B. 1979: The wood properties, quality and utilisation of hoop pine (Araucaria cunninghamii Ait.). 25 pp. Proc. Research-Routine Conference, Gympie, 1979. Queensland Department of Forestry, Brisbane.

Veillon, J-M, 1976: Architecture of the New Caledonia species of Araucaria. In, Tomlinson, P.B. and Zimmerman, M.H. (eds). "Tropical trees as living systems": 233-245. Cambridge Univ. Press.

DISTRIBUIÇÃO, VARIAÇÃO E USOS DOS RECURSOS GENÉTICOS DE ARAUCÁRIAS NO SUL DO BRASIL

J.Y.Shimizu – Y.M.M.de Oliveira
Unidade Regional de Pesquisa Florestal Centro-Sul
Colombo, Paraná
BRASIL

Resumo

Araucária angustifolia (Bert.) O. Ktze é a única espécie do seu gênero que ocorre no Brasil, sendo as maiores populações concentradas no estado do Sul e a grandes altitudes onde predominam temperaturas baixas e chuvas abundantes e bem distribuídas.

Reservas naturais tem sido drasticamente reduzidas pela derrubada de árvores há mais de 1 século, tanto para exploração de madeira como p/ uso da terra para agricultura.

Estudos genéticos tem revelado um padrão discontinuo de variação através da area natural de distribuição. As raças geográficas mais promissoras em termos de crescimento em regiões específicos, tem sido identificados através de testes de procedência. Os mais recentes esforços para preservar o valor genético das araucarias esta sendo tentado através da formação de populações base de procedência as quais conterão de variabilidade genetica original representativa de cada raça geográfica.

DISTRIBUTION, VARIATION AND USES OF ARAUCARIA GENE RESOURCES IN SOUTHERN BRAZIL

Summary

Araucaria angustifolia (Bert.) O.Ktze is the only species of its genus to occur in Brazil. The major populations are concentrated in the southern States, on the highlands where cool temperatures and abundant and well distributed rainfall predominate.

Natural stands have been drasticaly reduced in extension due to continuous fellings for over a century for timber exploration as well as to make room for agricultural crops.

Genecological studies have revealed a discontinuous pattern of variation through the natural distribution range. Geographic races of most promissing growth for specific regions have been identified through a number of provenance tests.

The most recent effort to preserve the valuable genetic resources is aimed at the formation of provenance base populations, which will hopefully contain the original genetic variability, representative of each geographic race.

Introduction

Known by other names such as "pinheiro brasileiro" (Brazilian pine), "pinheiro-do-paraná" (Paraná pine)or just araucaria, Araucaria angustifolia (Bert.) O. Ktze is the only Araucaria species to occur in Brazil. It has played an extremely important role in the country's economy. Straight trees with almost cylindric boles, reaching 30 to 50 m in height and 2 m in diameter at breast height were commonplace in the Southern States.

The species provides high quality timber for general construction, frame work, furniture, veneer, pulp and many other uses.

Araucaria wood in form of sawn timber and veneer was, for a long period, one of the most important items of Brazilian exportation.

The original araucaria forests covered an estimated area of 200 000 km^2 (GOLFARI, 1971) of which, part is in the province of Misiones in Argentina. The major formations are in the States of Paraná and Santa Catarina, where intensive logging continues to present days. Extensive areas of natural araucaria forests were turned into endless fields of coffee, wheat, soya beans and other crops, as a result of the timber exploration and the expansion of agriculture. Thus, many of its valuable geographyc races are believed to be extermined.

The need to preserve this valuable gene resource has led many Brazilian forest research institutions into a joint programme on gene conservation.

Natural Distribution

Araucaria angustifolia occurs naturally through the southern and southeastern Brazil, extending from the latitudes of 19°30'S to 31°30'S and longitudes of 41°30'W to 54°30'W, including also part of the province of Misiones in Argentina (GOLFARI, 1971). The species thrives on deep fertile soils within the climatic types classified, according to the Köppen's system, as "Cfa" and "Cfb"(humid sub-tropical without dry season and mild to hot summer).

Such climatic types are predominant through the southern highlands where araucaria forests are concentrated. Within the given range of latitudes, these types of climate are found from lower altitudes in the south and progressing to higher altitudes to the north. Following a similar pattern, natural stands of araucaria are found as a general rule, from 500 m above sea level in the south to over 2000 m as the populations extend northward to the States of São Paulo, Rio de Janeiro and Minas Gerais. Exceptions to these altitudinal limits are also found, especially in the south, where the species occurs at altitudes of about 300 m in São Martinho and Tenente Portela (MATTOS,1972) and as low as 250 m (PITCHER, 1975) and 198 m (GURGEL FILHO & PISANI, 1975) in Lauro Müller, near the coast of Santa Catarina. As mentioned by MAACK (1968), A. angustifolia extends to altitudes lower than 500 m only where cool air flows from the highlands towards the valleys.

Normal mean temperatures in the araucaria region are 20 to 21°C in the Summer and 10 to 11°C in the Winter (OLIVEIRA,1948).

Not only cool to mild temperatures but also plenty of rainfall through the year is required by the species. Annual rainfall figures ranging from 1270 to 2494 mm (GOLFARI, 1971)are usual but not less than 1000 mm (HUECK, 1972). A.angustifolia is intolerant to water deficit and this is the main reason for its restriction to altitudes above 800 m in the northern section of its distribution range (GOLFARI, 1971), where they occur in small spots scattered along the more humid portions of the mountain ranges.

The distribution pattern of A. angustifolia is well illustrated by HUECK (1972)(Fig. 1). The extensive forests, concentrated on the southern highlands, are frequently interrupted by spots of natural grasslands. As explained by KLEIN (1960), they are remnants of a vegetation type which predominated during a dryer period, previous to the formation of araucaria forests.

Variation

Although not very noticeable at first sight, A. angustifolia

presents some morphological variation which might be, to some extent, associated to the environmental conditions. Trees growing on high and cold flatlands in Santa Catarina, on shallow lithosol near São Joaquim, were reported by GOLFARI (1971) as being larger in diameter and disproportionately shorter (around 10 m in height) than the trees on warmer sites with deeper soil, where they reach over 30 m in height.

The size of the seeds also varies remarkably. CASTRO (1959)

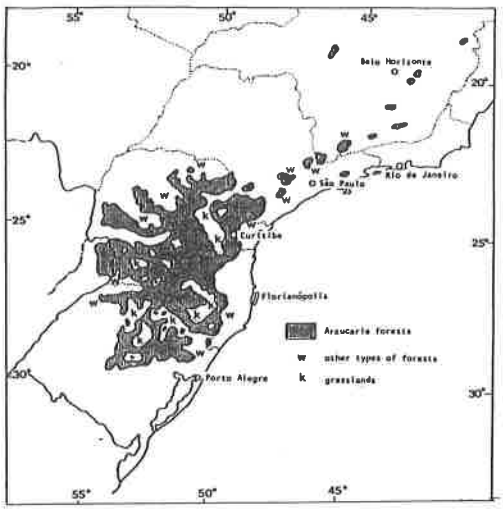


Fig. 1. Natural distribution areas of Araucaria angustifolia (from HUECK, 1972).

has shown that, seed size, when measured by its length, is associated to the altitude of its source between 500 and 1580 m. Smaller seeds were produced by stands from higher altitudes. On the other hand, the latitude of the seed source was shown by BANDEL (1966), to be more important than altitude to the variation of the seed weight. In his study, seed weight increased with increase in the latitude of the sources.

Other types of variation exist whose pattern of distribution or the association to specific environment is not yet clear. REITZ & KLEIN (1966) described them as 9 varieties and one form of the species as follow:

a) A. angustifolia var. elegans (Hort.) Reitz & Klein.
(Branches slender and numerous; needles smaller and closely inserted).

b) A. angustifolia var. sancti josephi Reitz & Klein.
(Kernels ripe in February and March)

c) A. angustifolia var. caiova Reitz & Klein.
(Kernels ripe in June and July)

d) A. angustifolia var. indehiscens Mattos.
(Kernels smaller, ripe from September to January but do not fall by themselves off the cone).

e) A. angustifolia var. angustifolia
(Kernels red, ripe in April and May)

f) A. angustifolia var. nigra Reitz & Klein
(Kernels dark-red almost black before drying)

g) A. angustifolia var. striata Reitz & Klein
(Kernels red with darker longitudinal stripes)

h) A. angustifolia var. semi-alba Reitz & Klein
(Kernels with white tip before drying)

i) A. angustifolia var. alba Reitz & Klein
(Kernels white or yellowish before drying)

j) A. angustifolia for. monoica
(Strobili male and female on the same tree)

Of all these variants, the type variety seems to be by far the most frequent. For practical purposes, A. angustifolia is expected to mature between March and May.

Several experiments for the study of the species racial variation have been established in Brazil and Argentina. A test planted in Santa Rita do Passa Quatro, SP, (GURGEL & GURGEL FILHO, 1973) showed remarkable differences between 3 widely distributed seed sources. At 12.5 years of age, volume production of Capão Bonito provenance was 49% and 68% greater than Campos do Jordão and Lages provenances respectively. In a larger experiment involving 23 provenances planted in Tres Barras, SC (GURGEL & GURGEL FILHO, 1968), better growth was obtained with seeds from São Paulo and southern Minas Gerais than from Paraná, Santa Catarina and Rio Grande do Sul. Campos do Jordão provenance produced larger number of branches and was more susceptible to frost, while Irati provenance showed a peculiar yellowish-green needles.

Growth differences among provenances have been quite discontinuous through the sampled area. Correlations of this character with the environmental factors at the seed sources have not been consistent. Growth was significantly correlated with longitude and annual mean temperature but not with annual rainfall, altitude or latitude, in a test planted in Puerto Libertad, Argentina (FAHLER & DI LUCCA, 1979), while in southern São Paulo, Brazil (SHIMIZU & HIGA, 1979), only the latitude at seed source was correlated to height growth up to six years of age. This experiment showed further that growth differences among provenances and the correlation of height growth with latitude of seed source tend to decrease with age.

Only in some cases (BALDANZI et al., 1973; FAHLER & DI LUCCA, 1979) have the local provenances performed as well as the best in the group; in others (GURGEL & GURGEL FILHO, 1968; SHIMIZU & HIGA, 1979; MONTEIRO & SPELTZ, 1979) they have not shown outstanding growth. Thus, the optimality of the local race for early growth can not be generalized for the species.

Negative correlations between altitude at seed source and growth at 3.5 years (KAGEYAMA & JACOB, 1979) and at 2 years of age (SHIMIZU & HIGA, 1979) were statistically significant. However, it is likely to reflect mostly the effect of seed size on early growth; low altitude sources having larger seeds (CASTRO, 1959), would grow more than those from higher altitudes. The effect of seed size on the growth rate of A. angustifolia was shown by GLASER & OLIVEIRA (1972). Seeds larger than 6 cm in lenght resulted in plants growing 18% more than those derived from seeds smaller than 3.9 cm in length and 16% more than those derived from the mixture of all sized seeds, at the fourth year after planting.

Uses of Araucaria angustifolia Gene Resources

Araucaria forests have been the main source of high quality timber for construction, frame work, furniture, veneer, pulp and other uses.

Sawn timber and veneer have been exported to several countries for a long period; at times they were rated second only to coffee in exported value.

The araucaria reserves in the State of São Paulo were exhausted in the period between 1930 and 1940 (KRUG, 1964). As estimated by MAACK (1968), 7.4 million hectars of natural araucaria forest existed in the State of Paraná, of which only 34% was left by 1950 and 28% by 1960. The remnants in the State were further reduced to 433 580 ha (MACHADO, 1975) in 1967 and 316 620 ha (FUPEF/IBDF, 1978) in 1977, the latter being only 4.3% of the original area.

Araucaria timber production in all States increased from 1.5 million cubic metres in 1945 to 3.3 million in 1950. From that year to 1966, the output was steady around 2.8 million cubic metres a year. Then until 1972, it decreased to an annual

output of 1.8 million cubic metres (PARANÁ, 1976).

Reforestation with araucaria was done at first by a few companies as well as by the federal government. Close to 90 000 ha had been planted by 1979, according to the estimates from several sources.

A. angustifolia is not considered a fast growth species in Brazil. Volume increments in mature natural stands were estimated to a maximum of 2.11 m^3/ha/year (MUNIZ, 1966), while in planted stands, it varied greatly depending on the site quality. Inside bark volume increment in planted stands varied from 2.56 m^3/ha/year in the poorest sites to 14.48 in the best sites in a survey by HOOGH (1978). The same variable compared in different sites by SPELTZ (1973) revealed growth increment varying from 1.1 m^3/ha/year on grassland area to 10.8 m^3/ha/year on forest soil.

Due to such growth behaviour, plantation rates declined sharply in the last years to not more than 300 ha a year, giving place to the introduced Pinus elliottii, P. taeda and Eucalyptus which are less site demanding and have higher growth rates.

Population improvement

As investments in reforestation with A. angustifolia has become less attractive due to its slower growth rate as compared to Pinus and Eucalyptus species, efforts for population genetic improvement of the species have been insipient.

A few planted or natural stands have been maintained for seed production areas by the Brazilian Institute for Forestry Development (IBDF) and some companies as well.

Further experiments for the study of provenance and progeny variations are under way, in connection to the formation of genetic base populations for improvement work, under the coordination of the Brazilian Working Group on Forest Tree Improvement. These will hopefully lead to a more precise mapping of the seed zones, if important differences among provenances are maintained through the rotation age. Also other important facts on population structure and patterns of variation at different levels may be known.

Seed collections from natural stands have been organized through joint effort by the main forest research institutions in the araucaria region.

Seed procurement, their sources and storage problems

Procurement of araucaria seed has become harder in the last years, due to continuous fellings of mature, seed bearing natural stands. Moreover, bumper seed crops occur at times only in limited areas. Much of the seed fallen off the trees are eaten by wild and domestic animals and people as well.

Large scale production of planting stock has, therefore, frequently depended on supplies from distant natural stands.

Seed supply from a bumper crop to be sown in the following years has not been feasible due to storage problems. Seed viability declines sharply from 100% to almost 0% in 3 to 4 months if adequate storage facility were not available. By keeping the seeds in plastic bags at low temperatures (0 to 5°C), viability was maintained between 70 and 90% after 4 month storage (PRANGE, 1964).

Vegetative propagation

Several methods of vegetative propagation have been tried with A. angustifolia. Neither air-layering nor rooting of hormon treated cuttings, tried by BANDEL (1966), did lead to any promissing result. Certainly, a number of factors must be taken into account and carefully controlled. Rooting sucesses of 25 to 26% was reported by TESDORFF (1969) with cuttings taken from 12 year-old trees and treated with 0.5%, 1.0% and 2.0% solutions of indol-butyric-acid.

Among several grafting methods tested by GURGEL & GURGEL FILHO (1967), the best result (27%) was obtained with veneer side graft.

Similarly to the growth habit of other Araucaria species, grafting of lateral shoots of A. angustifolia results in plagiotropic growth and, if straight growth were desired, orthotropic shoots must be grafted.

The serious limitation of most grafting methods is the small number of orthotropic shoots that each tree usually produces.

The "patch graft" method, as described by NIKLES (1973), was applied sucesfully to A. angustifolia by KAGEYAMA & FERREIRA (1975). The main advantage of this method is that many buds can be obtained from each apical shoot and therefore, the number of grafts per tree can be greatly increased.

Constraints on Progress in Population Genetic Improvement

The main difficulties in promoting genetic improvement in this species arises when breeding is considered. The trees usually produce seed only after 15 or 20 years of age (BANDEL & GURGEL, 1967).

Controlled pollination work on the trees is almost impossible due to the height and large span of the crown. The reproductive organs are produced at the tips of the branches, in the midst of densely packed tufts of prickly needles.

Large amounts of seed is annually lost to cone and seed insects whose behaviour and control methods should be better understood.

Vegetative propagation techniques must be further studied and directed toward a more efficient method.

Very rarely has A. angustifolia been planted in large scale in recent years. Being a very site demanding species, it is rapiddly loosing ground to the introduced Pinus and Eucalyptus species which have higher growth rates. Extensive areas in the araucaria region have also been turned into endless fields of coffee, wheat, soya bean and other crops.

Literature Cited

BALDANZI, G.; RITTERSHOFER, F.O. & REISSMANN, C.B., 1973: Ensaio comparativo de procedências de Araucaria angustifolia (Bert.) O. Ktze. In: CONGRESSO FLORESTAL BRASILEIRO, 2., Curitiba. Anais. FIEP, pp. 123-124.

BANDEL, G., 1966: O pinheiro brasileiro Araucaria angustifolia (Bert.) O. Ktze. ESALQ, Piracicaba. 67pp.

BANDEL, G. & GURGEL, J.T.A., 1967: Proporção do sexo em Araucaria angustifolia. Silvicultura em São Paulo, vol. 6, pp. 209-220.

CASTRO, Y.G.P., 1959: Variação do tamanho de sementes de Araucaria angustifolia (Bert.) O. Ktze. Anuário Brasileiro de Economia Florestal, nº 11, pp. 124-133.

FAHLER, J.C. & DI LUCCA, C.M., 1979: Variación geográfica de Araucaria angustifolia (Bert.) O. Ktze. 26pp. (Presented in the first IUFRO Meeting on the Araucarias, Curitiba - unpublished).

FUPEF/IBDF (FUNDAÇÃO DE PESQUISAS FLORESTAIS DO PARANÁ & INSTITUTO BRASILEIRO DE DESENVOLVIMENTO FLORESTAL), 1978: Inventário florestal do pinheiro no sul do Brasil; Relatório final. Curitiba, 199p.

GLASER, G.R. & OLIVEIRA, J.A., 1972: Influência do tamanho das sementes no desenvolvimento inicial dos povoamentos florestais de Araucaria angustifolia (Bert.) O. Kuntze.

Klabin, Monte Alegre, 12pp. (Presented in the Congresso Florestal Mundial, Buenos Aires).

GOLFARI, L., 1971: Coníferas aptas para reflorestamento nos estados do Paraná, Santa Catarina e Rio Grande do Sul. Boletim Técnico. IBDF, nº 1, 71pp.

GURGEL, J.T.A. & GURGEL FILHO, O.A., 1967: Métodos de enxertia para o pinheiro brasileiro, "Araucaria angustifolia" (Bert.) O. Ktze., visando-se à formação de pomares de sementes. Silvicultura em São Paulo, vol. 6, pp.153-155.

GURGEL, J.T.A. & GURGEL FILHO, O.A., 1968: Raças geográficas em pinheiro brasileiro, Araucaria angustifolia (Bert.) O. Ktze. In: CONGRESSO FLORESTAL BRASILEIRO, 1., Curitiba. Anais. FIEP.

GURGEL, J.T.A. & GURGEL FILHO, O.A., 1973: Caracterização de ecotipos para o pinheiro brasileiro, Araucaria angustifolia (Bert.) O. Ktze. Silvicultura em São Paulo, vol. 8, pp. 127-132.

GURGEL FILHO, O.A. & PISANI, J.F., 1975: Análise bioestatística de pinhões de cinco diferentes procedências. Silvicultura em São Paulo, vol. 9, pp. 73-85.

HOOG, R.J.; DIETRICH, A.B.; AHRENS, S., 1978: Classificação de sítio, tabelas de volume e de produção para povoamentos artificiais de Araucaria angustifolia. Brasil Florestal, vol. 9, pp.58-82.

HUECK, K., 1972: As florestas da América do Sul. Polígono, São Paulo, 466pp.

KAGEYAMA, P.Y. & FERREIRA, M., 1975: Propagação vegetativa por enxertia em Araucaria angustifolia. IPEF, nº 11, pp. 95-102.

KAGEYAMA, P.Y. & JACOB, W.S., 1979: Variação genética entre e dentro de populações de Araucaria angustifolia (Bert.)O. Ktze. 11pp. (Presented in the first IUFRO Meeting on the Araucarias, Curitiba - unpublished).

KLEIN, R.M., 1960: O aspecto dinâmico do pinheiro brasileiro. Sellowia, nº 12, pp. 17-43.

KRUG, H.P., 1964: Fontes de abastecimento atuais e previsão. Silvicultura em São Paulo, vol. 3, pp.333-369.

MAACK, R., 1968: Geografia física do estado do Paraná. M. Roesner, Curitiba, 350pp.

MACHADO, S.A., 1975: Florestas naturais do estado do Paraná. Brasil Florestal, vol. 6, nº 22, pp. 16-23.

MATTOS, J.R., 1972: O pinheiro brasileiro. Grêmio Politécnico, São Paulo, 638pp.

MONTEIRO, R.F.R. & SPELTZ, R.M., 1979: Ensaio de 24 procedências de Araucaria angustifolia (Bert.)O. Ktze. 39pp. (Presented in the first IUFRO Meeting on the Araucarias, Curitiba - unpublished).

MUNIZ, P.J.C., 1966: Inventário do pinheiro no Paraná; Relatório da Coordenação do Projeto de Recursos Florestais. Curitiba, 40pp.

NIKLES, D.G., 1973: Biology and genetic improvement of Araucaria cunninghamii Ait. in Queensland, Australia. In: BURLEY. J. & NIKLES, D.G. ed. Selection and breeding to improve some tropical conifers. Commonwealth Forestry Institute, Oxford, vol. 2, pp. 304-334.

OLIVEIRA, B., 1948: As regiões de ocorrência normal de Araucaria. Anuário Brasileiro de Economia Florestal, nº 1 pp. 185-199.

PARANÁ. UNIVERSIDADE FEDERAL, 1976: Estudo das alternativas técnicas, econômicas e sociais para o setor florestal do Paraná; Sub-programa mercado, anexo IV - Comércio externo de madeiras segundo o porto de embarque, a espécie e o grau de industrialização. Curitiba, 1 vol.

PITCHER, J.A., 1975: Report on an FAO project to establish international provenance trials of Araucaria angustifolia (Bert.) O. Ktze. In: Forest genetic resources information, nº 4, Rome, FAO, pp.59-64.

PRANGE, P.W., 1964: Estudos de conservação do poder germinativo das sementes de Araucaria angustifolia (Bert.) O. Ktze. Anuário Brasileiro de Economia Florestal, nº 16, pp.43-52.

REITZ, R. & KLEIN, R.M., 1966: Araucariáceas. Herbário "Barbosa Rodrigues", Itajaí, 62pp. (Flora Ilustrada Catarinense, fasc. Arau).

SHIMIZU, J.Y. & HIGA, A.R., 1979: Variação genética entre procedências de Araucaria angustifolia (Bert.) O. Ktze. na região de Itapeva - SP, estimada até o 6º ano de idade. 18pp. (Presented in the first IUFRO Meeting on the Araucarias, Curitiba - unpublished).

TESDORFF, J.N.F., 1969: Enraizamientos de las estacas de híbridos de araucaria con ayuda de hormonas. In: CONGRESSO FORESTAL ARGENTINO, 1., Buenos Aires. Actas. pp.290-291.

FAST GROWING TREES

MANEJO E ARMAZENAGEM DE SEMENTES DE *Agathis spp* E *Araucaria spp*

P.B.Tompsett
Royal Botanic Gardens Kew – Surrey
ENGLAND

Resumo

Estudos de armazenagem de sementes são necessários para tornar viável a produção eficiente de mudas para plantações, facilitar o transporte marítimo e armazenar sementes para conservação genética.

Em geral algumas espécies possuem sementes que podem ser secas e, após, armazenadas sob condições frias, enquanto outras espécies têm sementes que morrem ao serem secas; ambos os tipos de sementes são encontrados entre as espécies de *Agathis* e *Araucaria*. Sementes de *Araucaria* com alta quantidade de endosperma e grande tamanho, espécies nativas da América Latina, não podem ser secas. As sementes pequenas de várias espécies de *Agathis* e *Araucaria*, oriundas da área Sudoeste do Pacífico, por outro lado, podem ser secas até cerca de 8% de teor de umidade e armazenadas por longos períodos a temperaturas abaixo de zero; *Araucaria hunsteinii* e possivelmente *A. heterophylla* são exceções e necessitam ser armazenadas úmidas.

Considera-se a necessidade de que maior intensificação de estudos mais detalhados em relação à fisiologia das sementes, para que recomendações práticas para armazenagem possam ser feitas bem alicerçadas.

Coleta dos cones, secagem e limpeza das sementes, remoção das sementes inviáveis e tratamentos antifúngicos são resumidamente discutidos.

HANDLING AND STORAGE OF *Agathis* AND *Araucaria* SEED

Summary

Seed storage studies are needed to enable efficient seedling production for plantations, to facilitate transport overseas, and to store seed for genetic conservation.

In general, some species have seeds which can be dried and then stored under cool conditions, whilst other species have seeds which die when dried; both types are found among the Agathis and Araucaria species. Large, fleshy-seeded Araucarias from South America have seeds which cannot be dried. The smaller seeds of many Agathis and Araucaria species from the South West Pacific area, on the other hand, can be dried to about 8% moisture content and stored for long periods at sub-zero temperatures; Araucaria hunsteinii and possibly A. heterophylla are exceptions and need moist storage.

Emphasis is placed on the need for more detailed seed physiology studies so that firmly based practical storage recommendations can be made.

Cone collecting, seed drying, seed cleaning, removal of inviable seed, and antifungal treatments are briefly discussed.

2 - INTRODUCTION

2.1 Importance in forestry. The distribution of Agathis and its potential for forest plantation have recently been considered in detail by Whitmore (1977) and Bowen and Whitmore (1980). The Araucarias have been introduced into numerous parts of the tropics (e.g. Delwaulle 1980; Karani and Chaudhry 1980), where they have often shown good growth and form (Ntima, 1968).

2.2 Need for seed storage. Storage is needed to preserve germinative capacity between the time of harvest and the time of planting. Delays may occur in transport from the field to the seed centre, and again between the seed centre and the nursery.

Even for seeds where present short-term seed storage techniques are satisfactory, longer storage is desirable for conservation of genetic resources (Burley and Styles 1976). Unless such long-term storage techniques can be developed, the range of forest trees available may be severely diminished.

Since seed handling is an integral part of seed storage, a short review of this topic is included

3 - SEED STORAGE

3.1 General background. Seeds may be divided into two basic types: firstly, those which can be dried and stored in cool conditions, the so-called 'orthodox' seeds; and secondly, those seeds which die when they are dried, the 'recalcitrant' type (Roberts 1973; King and Roberts 1979). Studies at Royal Botanic Gardens, Kew, and elsewhere have shown that both orthodox and recalcitrant seeds are found among Agathis and Araucaria species. However, very few species have been subjected to controlled dessication tests, so there is no sound basis for storage recommendations in most cases

3.2 Seed storage and taxonomy of Araucarias. The taxonomy of Araucarias is relevant in that the 3 major taxonomic groupings appear to follow seed storage characteristics. (1) The South American species A. angustifolia and A. araucana, and the Australian species A. bidwillii, are included in the Colymbea section; the large, fleshy seeds of trees in this group are mostly recalcitrant. (2) A. heterophylla, A. cunninghammii, A. columnaris and the numerous New Caledonian species, comprising the section Eutacta, have much smaller seeds which are probably orthodox. (3) A. hunsteinii, which has been placed in its own Intermedia section by White (1947), has seeds which are of similar appearance to Eutacta seeds but which, like Colymbea seeds, nonetheless do not tolerate dessication.

3.3 Empirical studies. In the absence of detailed publications on basic seed storage physiology, much of the present review concerns results from empirical studies. In these studies there was generally little attempt to define environmental conditions used, so the results are of limited value. However, such investigations provide an indication of provisional storage techniques and form an excellent basis for future research.

3.4 Storage of Araucaria seed. A comparison of the best recorded storage conditions in various studies is given in Table 1. J.A. Simpson (pers. comm.) found air-dried A. cunninghamii seed retained a viability of about 50% at -12°C, whilst seed stored at ambient temperatures fell about 20% during 50 weeks storage. Similarly, Shea and Armstrong (1978) reported that air-dried seed of this species was best stored at temperatures between -9.4°C and -15°C; they concluded that, whilst no difference was found between sealed and open storage, seeds should be sealed to protect against warmer temperatures experienced during refrigeration equipment failures.

Akamine (1951) found that increased storage life of A. heterophylla could be produced by decreasing storage temperature to 7°C, a finding confirmed by Badran et al. (1979), using an X-ray radiography technique. Interestingly, both authors believed that dessicating conditions reduced seed viability; if further studies confirm this effect, the seed cannot be described as orthodox, despite being a member of the Eutacta taxonomic grouping.

Moving on to consider the Intermedia section of the genus, a requirement for moist conditions has been shown for A. hunsteinii by Arentz (1980); seeds at 37% moisture content survived better than those at 30% moisture content. The same author confirmed Havel's (1965) finding that 3.5°C was a better storage temperature than ambient. Most importantly, Arentz reported that cool storage for only short periods can predispose the seed for rapid subsequent deterioration. Consequently seed should be sown immediately after removal from cold storage.

Finally, dessication at 18°C of A. angustifolia seeds, representing the Colymbea section, has shown them to be recalcitrant (P.B. Tompsett, unpubl.); seeds die on reaching a moisture content of 25-30%. Preliminary tests suggest that A. araucana is also recalcitrant. Prange (1964) reported that seeds of A. angustifolia could be kept at 0 - 5°C in glass or plastic containers for four months; seeds of this species have been stored for longer periods at Curitiba, Brazil.

3.5 Storage of Agathis seed. There are few reports on methods for storing Agathis seed; two papers are included in Table 2 with some of the results from work on three species at Kew. Seed storage of Agathis is covered by Bowen and Whitmore (1980) and need not be repeated here. It appears that Agathis species are orthodox in their seed storage behaviour, but further work is needed before seed of all species can safely be transported to different countries for species trials.

4 - SEED HANDLING

4.1 Collection and drying of seeds and cones. The proper timing of seed collections of Araucaria hunsteinii has been related to the size of the embryo in the seed by Havel (1965). A detailed description of methods for collection and processing of cones of this species is given by White and Cameron (1965). Collection is made both under the trees and by climbing and knocking down the cones with long bamboo canes. On arrival at the central seed shed cones are spread on shelves and allowed to break up as they dry. The ends and stalks are discarded and seeds from the central section spread over the shelves. Cones still intact after 10 days are discarded, since seeds in these cones are probably immature. After two to three weeks the air-dried seeds are placed in storage.

In Queensland, A. cunninghamii seed is dried at 45°C for one day. Some seeds are damaged by such high temperatures and should be dried in a cool, shaded location.

4.2 Removing empty and insect-infested seed. A major problem in handling Araucaria and Agathis seed is the removal of inviable seed. Failure of pollination can lead to up to 80% empty Araucaria columnaris seeds on New Caledonia (Y. Bailly, pers. comm.). In Queensland, it has been found that full A. cunninghamii seed can be separated using a current of air flowing at the correct velocity, whilst Badran et al (1977) claim 100% accuracy of separation of empty seeds of A. heterophylla by flotation on a saturated solution of sodium chloride.

Agathis seed is subject to attack by the moth Agathifaga. In Vanuatu the infested seeds are laboriously separated by hand by experienced forestry assistants; as few as five seeds out of 120 may be free of moth infestation in some cones (M. Bennett, pers. comm.). Common (1973) has reported attacks on Araucaria hunsteinii by Tracholena in New Guinea.

4.3 Other aspects of seed handling. Seed size may be a good indicator of germinability; Araucaria angustifolia seeds greater than 5.6g in weight gave significantly better germination than those weighing less than 3.6g (Candido, 1974). Removal of the smallest seeds may consequently improve germination of the seed batch to be placed in storage.

Most Araucaria and Agathis species have 'wings' attached to their seeds, which may be removed to increase the efficiency of handling and storage. In Queensland, Araucaria cunninghamii seed is de-winged by rubber flails in a revolving drum; the wings are removed by passing through specially designed apparatus.

Seeds requiring moist storage might benefit from fungicide application, but Arentz (1980) found no effect of Cuprox or Thiram treatment prior to storage on subsequent viability of A. hunsteinii. Likewise, Thong (1974) discovered no significant influenced of Demosan on seeds and seedlings of A. cunninghammii.

6 - ACKNOWLEDGEMENTS

The author thanks the British Overseas Development Administration for funding and the Forestry Departments of many countries that have provided assistance.

TABLE 1. Best recorded seed storage conditions for Araucaria

Reference	Latin name	Common name	Best recorded Storage conditions		Duration of storage	Germination	Comment
			Temperature	Container			
Prange (1964)	A. angustifolia	Parana pine	0-5°C	Glass or plastic	5 months	70-90%	-
J.A. Simpson* (pers. comm.)	A. cunninghamii	Hoop pine	-12°C	Plastic bags in drums	50 weeks	50%	-
Shea and Armstrong (1978)	A. cunninghamii	Hoop pine	-15°C	Airtight or Non-airtight	100 months	44%	-
Akamine (1951)	A. heterophylla	Norfolk Island pine	7°C	Dessicator	11 months	20%	Stored in 60% r.h.
Badran et al. (1979)	A. heterophylla	Norfolk Island pine	-20°C	Polythene envelope	6 months	-	Results assessed by X-rays
Arentz (1980)	A. hunsteinnii	Klinkii pine	3.5°C	Polythene bags	6 months	75%	Seed moisture content 37%

* Papua New Guinea Forestry Department

TABLE 2 Best recorded seed storage conditions for Agathis

Reference	Latin name	Best recorded storage conditions		Duration of storage	Germination	Comment
		Temperature	Container			
L. Kleinschmidt* (pers. comm.)	A. robusta	-26°C	Screw-top	52 months	66%	
Preest (1979)	A. australis	-10°C	Polythene bags inside screw-cap jars	12 years	57-62%	Seed moisture content 6-10%
R.D. Smith** (pers. comm.)	A. australis	6°C	Foil bags	107 weeks	87%	7% m.c.
R.D. Smith** (pers. comm.)	A. macrophylla	-13°C	Foil bags	114 weeks	30%	8% m.c.
R.D. Smith** (pers. comm.)	A. robusta	-25°C	Foil bags	104 weeks	30%	7% m.c.

* Queensland Forestry Department
** Royal Botanic Gardens Kew

6- LITERATURE CITED

Akamine, E.K., 1951. Viability of Hawaian tree seeds in storage at various temperatures and relative humidities. Pacific Science 5, 34-46.

Arentz, F., 1980. Some factors affecting the viability of Klinkii pine (Araucaria hunsteinii) in storage. Seed Sc. and Technol. 8 (in press).

Badran, O.A., El Lakany, M.H. and Haridi, M.B., 1977. Handling and testing of Araucaria excelsa seed. Alex. J. Agr. Res. 25, 549-556.

Badran, O.A., El-Lakany, M.H., and Haridi, M.B., 1979. Changes in Araucaria heterophylla seed storage as determined by X-ray radiography. Seed Sci. and Technol. 7, 411-422.

Bowen, M.R., and Whitmore, T.C., 1980. The tropical conifer Agathis as a potential plantation tree. Proceedings of the IUFRO symposium on fast-growing trees, Brazil.

Burley, J., and Styles, B.T., eds., 1976. Tropical Trees.Variation, Breeding and Conservation, Academic Press, 243pp.

Candido, J.F., 1974. Efeito do peso das sementes do Pinheiro Brasileiro sobre porcentagem de germinacao de mudas. Brasil Florestal 18, 33-39.

Candido, J.F., 1974. Efeito do peso das sementes do pinheiro Brasileiro (Araucaria angustifolia Bert. O. Ktze) sobre percentagem de germinacao, energia germinativa e deserivolvionento de mudas. Brasil Florestal 18, 33-39.

Common, I.F.B., 1973. A new species of Tracholena attacking Klinkii pine in Papua New Guinea. J. Aust. Ent. Soc. 12, 301-306.

Delwaulle, J.F., 1980. Les introductions d'Araucaria cunninghamii Sweet en Republique Populaire du Congo. Proceedings of the IUFRO symposium on fast-growing tropical trees, Brazil.

Karani, P.K., and Chaudhry, M.A., 1980. Growth and performance of Araucaria species in Ugana. Proceedings of IUFRO symposium on fast-growing tropical trees, Brazil.

King, M.W., and Roberts, E.H., 1979. The storage of recalcitrant seeds. IBPGR Executive Secretariat, FAO, Rome, 96 pp.

Ntima, O.O., 1968. The Araucarias. Fast growing timber trees of the lowland tropics No 3, CFI, Oxford, 139 pp.

Prange, P.W., 1964. E studo de conservacao do poder germinativo das sementes de Araucaria angustifolia. An, Bras. Econ. Flor. Inst. Nac. Pinho. 16, 43-53.

Roberts, E.H., 1973. Predicting the storage life of seeds. Seed Science and Technol. 1, 499-514.

Shea, G.M. and Armstrong, P.A. 1978. The effect of post harvest environmental factors on the longevity of hoop pine seed. Dept. Queensl. Res. Note 24, 4pp.

Thong, H.L., 1974. Germination and seedling survival of Araucaria with Demosan treatment. Malaysian Forester 37, 54-60.

White, C.T., 1947. Notes on two species of Araucaria in New Guinea and a proposed new section of this genus. Commw. For. Rev. 43, 259-260.

White, K.J., and Cameron, A.L., 1965. Silvicultural techniques in Papua New Guinea Forest Plantations. Bulletin No. 1., Office of Forests, Port Moresby.

Whitmore, T.C., 1977. A first look at Agathis. Tropical Forestry Papers No 11, Commonwealth Forestry Institute, Oxford, 54pp.

PROBLEMAS DE INSETOS EM PLANTAÇÕES DE ARAUCARIA NA AUSTRALIA E PAPUA-NOVA GUINÉ

F. R. Wylie
Department of Forestry, Queensland
AUSTRALIA

Resumo

Neste trabalho várias pragas que ocorrem em plantações de *Araucaria* são discutidas, e um número de fatores que podem influenciar seu padrão de ataque, severidade da infestação e injúrias também são relatados. Estes fatores são idade, local, procedência, condições climáticas e inimigos naturais. Há poucas pragas em plantações de *A. bedwillii* e *A. hunsteinii*. Conclui-se que os problemas com insetos encontrados em *A. cunninghamii*, particularmente em Papua Nova Guiné, não deveriam excluir ensaios dessa espécie em outras áreas. A diversificação de áreas de plantio e a manutenção da vegetação adjacente às plantações, são recomendadas para minimizar problemas com os insetos.

INSECT PROBLEMS OF *Araucaria* PLANTATIONS IN AUSTRALIA AND PAPUA NEW GUINEA

Summary

Several insect pests in established plantations are discussed and a number of factors which may influence their pattern of attack, severity of infestation and damage are outlined. These factors are age, site, provenance, climatic conditions and natural enemies. There are few insect pests in plantations of A. bidwillii and A. hunsteinii. It is concluded that insect problems encountered with A. cunninghamii, particularly in Papua New Guinea, should not deter trials of this species in other areas. Diversification of planting fronts and retention of areas of natural vegetation adjacent to plantations are recommended to minimize pest problems.

INTRODUCTION

Three species of Araucaria (A. bidwillii, A. cunninghamii and A. hunsteinii) are native to the Australia/New Guinea region. Araucaria cunninghamii has a wide range in New Guinea, through Queensland, to northern New South Wales, while A. bidwillii and A. hunsteinii have more restricted ranges in south-east Queensland and the highlands of Papua New Guinea respectively (Nikles, 1973, 1978, 1979; Gray 1973; Howcroft 1978). Plantations of these species have been established in Australia (A. cunninghamii 39 000 ha; A. bidwillii 500 ha) and Papua New Guinea (A. cunninghamii 3 550 ha; A. hunsteinii 4 060 ha) (Nikles, 1979). Both A. cunninghamii and A. hunsteinii are of great economic importance in these countries and are receiving increasing attention as exotic plantation species. For this reason it is important to review some of the serious and potentially serious insect problems encountered in established plantations and to examine the possible insect threat to these species as exotics.

INSECT PESTS OF ARAUCARIA IN PAPUA NEW GUINEA

The branchlet mining scolytid Hylurdrectonus araucariae (Coleoptera : Scolytidae) is the most serious pest of A. cunninghamii (hoop pine) in Papua New Guinea. It has caused considerable mortality and growth increment loss in the country's main hoop pine plantations at Bulolo and Wau. The first invasion of these plantations probably occurred in the late 1950's from nearby remnant hoop pine; however, the most active period of dispersal was in the years 1966 to 1970. As at December 1971, the insect had infested approximately 47.5% of the 3 252 ha at Bulolo and 91.0% of the 1 186 ha at Wau* (Gray, 1975). Trees aged between 3 and 15 years were more liable to severe attack than younger or older trees.

Another important pest in the A. cunninghamii plantations is a weevil Vanapa oberthuri (Coleoptera : Curculionidae) which is most active in compartments being thinned or pruned (Barrett, 1967; Gray and Howcroft, 1970). The adult insect lays its eggs in resin flows on the stem; the larvae on hatching tunnel into the cambium and then into the wood. Several secondary insects also contribute to the tree's death by mining into the cambial layer. While only a small percentage of trees are killed annually by V. oberthuri, the level of damage at individual sites can sometimes be extremely high. For example, in an experimental plot in the Bulolo plantations, a tree mortality of 51% among select trees due to V. oberthuri attack was recorded following pruning (Gray and Howcroft, 1970; Gray and Barber, 1974). As with H. araucariae, older and more vigorously growing trees show a lower incidence of infestation by the weevil (Gray and Wylie, 1974). The insect does not breed in very small diameter (< 6 cm) trees.

* The total area of plantation hoop pine shown here exceeds the current establishment total mentioned earlier in the text. In 1972, fire destroyed 833 ha of Araucaria plantations (mostly A. cunninghamii) at Bulolo and Wau (Wylie & Shanahan, 1976).

Minor pests of plantation hoop pine include the termite Coptotermes elisae (Isoptera : Rhinotermitidae) and a caterpillar defoliator Milionia isodoxa (Lepidoptera : Geometridae). No serious pests of Araucaria hunsteinii has been recorded and only C. elisae has been of any consequence (Gray and Buchter, 1969; Gray and Wylie, 1974).

Because of the susceptibility of A. cunninghamii to insect attack, planting of this species at Bulolo/Wau ceased in 1968 while planting of A. hunsteinii (including enrichment planting) was increased.

INSECT PESTS OF ARAUCARIA IN AUSTRALIA

The pine bark weevil Aesiotes notabilis (Coleoptera : Curculionidae) is a pest of A. cunninghamii and A. bidwillii in eastern Queensland. In plantations, attacks by this insect occur through deep bark wounds such as result from pruning operations. On emerging from eggs laid on or near the branch stubs, the larvae tunnel in the cambial region on the bole, invariably causing malformation and in some cases killing the trees. Brimblecombe (1945) showed that adult activity and egg laying is greatest and development most rapid in wet weather during the warmer months. By carring out pruning operations in dry weather in winter and early spring, when the insect is least active, damage by the weevil has been reduced to a.low level.

A potentially serious pest of plantation A. cunninghamii in south-east Queensland is the ambrosia bark beetle Hyleops glabratus (Coleoptera : Scolytidae). This insect mainly infests logging debris, pruning slash or windthrown branches, but occasional stem infestation in standing trees has caused tree death (Yule, 1973).

The longicorn Strongylurus decoratus (Coleoptera : Cerambycidae) is another potentially serious pest of widespread occurrence in south-east Queensland hoop pine plantations. Larvae tunnel longitudinally in branches and leaders (diameter range 1 to 10 cm) and prior to pupation make a transverse, spiral tunnel or 'cut' across the stem. This creates a point of extreme weakness at which breakage occurs due to the weight of the stem or to wind. Since S. decoratus was first observed in hoop pine plantations in 1937, occasional severe damage by this insect has been recorded. Leader attack, in some compartments in the Mary Valley plantations during the years 1962-1970, was of particular concern.

FACTORS ASSOCIATED WITH INSECT ATTACK ON ARAUCARIA

In studies of several of the serious insect pests in Araucaria plantations a number of climatic, silvicultural and biological factors have been found associated with severity of attack and subsequent mortality. While the relative importance of individual factors may vary with pest species, several factors are common to a number of the problems examined. These factors are discussed below.

1. Age of trees

An "age effect" has been noted with insect attack on hoop pine in Papua New Guinea:

(1) Hylurdrectonus araucariae infests severely those trees aged between 3 and 15 years but not those in other age classes (Gray, 1975).

(2) In the Bulolo plantations, Gray and Howcroft (1970) found that trees in age-classes 7 to 12 years were most susceptible to heavy attack by V. oberthuri, and incidence of tree death was higher in these classes.

(3) Older hoop pine trees (22+ years) also appear more resistant to fatal injury by C. elisae (Gray and Wylie, 1974).

(4) In the 26 recorded outbreaks of M. isodoxa on ornamental or amenity hoop pine in the Highlands between 1958 and 1972, the ages of severely attacked trees ranged between 5 and 13 years while younger and older trees were not seriously attacked. During surveys in the Bulolo/Wau plantations, more M. isodoxa larvae were found on trees aged 6-8 years than for any other age class (Wylie, 1976).

In plantations of A. cunninghamii in Australia, this age effect is less noticeable but nevertheless appears present:

(1) Aesiotes notabilis has attacked damaged trees in all age classes, however Brimblecombe (1945) notes that attack is more serious in younger trees and malformation and death more common than in older trees whose bark is tougher and thicker and less prone to wounding.

(2) Hyleops glabratus has caused death of trees ranging in age from 6 - 42 years, but incidence of tree death is highest in younger age classes (Yule, pers. comm., 1980).

(3) Strongylurus decoratus also infests trees aged 4 years and upwards but incidence of leader attack is higher (and commercially more serious) among younger trees.

The reason(s) for this age susceptibility in the case of insects which attack the foliage, may relate to changes in the physio-chemical characteristics of the branchlets as the tree matures. In the case of stem borer attack, the tree's physical size and bark characteristics may be important. Older trees can sustain, without damage, a level of insect infestation that would deform or kill younger trees.

2. Site

Adverse site conditions have frequently been linked with severity of insect attack in hoop pine plantations in both Australia and Papua New Guinea. For example, some of the most serious S. decoratus attack in the Imbil and Mary Valley plantations in Queensland in the 1960's occurred in areas of below average site quality, usually in upper slope positions. In some compartments surveyed there was a gradual reduction in severity of attack as site index increased down the slope. Similar associations have been found in some instances of attack by H. araucariae and H. glabratus. At Bulolo, Gray (1975) found an apparent relationship between the spread and severity of H. araucariae infestation and elevation of the plantations, the insect being less active at lower elevations.

While trees growing on poor or marginal sites are

certainly more prone to insect attack and the effects often more serious than for trees on better sites, severe insect attack is by no means restricted to these poorer sites (as is sometimes inferred by forest managers). Hylurdrectonus araucariae has infested 91% of plantations at Wau and 47.5% at Bulolo across a wide range of site indices, and severe attack by S. decoratus and H. glabratus has also occurred in areas of apparent high site quality.

3. Provenance

Some instances of attack by S. decoratus and H. glabratus on hoop pine in southern Queensland have been attributed, in part, to provenance differences. A number of serious attacks by S. decoratus at Imbil and the Mary Valley in 1968 occurred on provenances foreign to the area, damage being particularly severe in some trial plantings of New Guinea hoop pine which were also attacked by H. glabratus. Again, as with site conditions discussed above, the relationship between severity of insect attack and provenance was not consistent. Local provenances were similarly attacked and considerable variation in damage levels occurred within the same provenance (local or foreign) in different parts of the same plantations.

4. Climatic Conditions

The important influence of climate on insect/host relationships has been demonstrated in many studies of forest pest problems throughout the world. It is generally thought that adverse climatic conditions (particularly rainfall), often acting in concert with poor site conditions, produce stress in trees, thereby increasing their susceptibility to insect attack, and, while the stress persists, hindering their ability to recover from this attack. Frequently, the greater the stress, the higher the infestation and damage levels. Climate can also directly affect insect biology and disease spread.

In the case of Araucaria pest problems, Brimblecombe (1945) demonstrated a relationship between temperature and rainfall conditions and incidence of attack by A. notabilis. Changes in silvicultural practice as a result of these findings has greatly reduced damage by this insect in Queensland plantations. Tree stress produced by fluctuations in rainfall extremes are thought to have contributed to outbreaks of H. glabratus in southern Queensland hoop pine plantations in 1971 (Yule, 1973) and to outbreaks of M. isodoxa in the Papua New Guinea Highlands between 1957 and 1972 (Wylie, 1976).

5. Natural Enemies

Natural enemies appear to play an important role in regulating populations of some insect pests of Araucaria. In plantations, incidence of predation, parasitism or disease among populations of H. glabratus, S. decoratus and M. isodoxa is sometimes high (Yule, 1973; Wylie, 1976). Numerous other pests of Araucaria (particularly Lepidoptera), found in plantations in both countries, have the potential to cause serious damage but appear held in check by the activities of a wide range of natural enemies.

However, in the case of some pest species, natural enemies are not the prime regulating factor in the native forest. Outbreaks of these pests in plantations cannot therefore be attributed to a failure of the insect's natural control agents.

For example, Gray (1975) found an almost total absence of active predators and parasites of H. araucariae in both plantations and natural forests. He attributed the low populations of H. araucariae in natural stands of hoop pine mainly to the difficulty experienced by these insects in locating suitable food and habitat in a diverse plant community with a wide spatial distribution in ages and sizes of host trees. In contrast, the insect would find little difficulty in locating a host in a plantation monoculture where large blocks of trees were of an age class susceptible to attack (such as the Bulolo/Wau plantations).

Attack and rapid population increase of V. oberthuri and A. notabilis in plantations is primarily associated with damage caused during silvicultural operations. In the native forest, their population increase is more likely to be limited by a scarcity of attack sites rather than the activites of natural enemies.

D I S C U S S I O N

Insect problems in established plantations of A. cunninghamii have been more serious in Papua New Guinea than in Australia. It is important for the continued or future use of hoop pine in plantations, as a native or an exotic species, to consider some of the possible reasons for this difference.

(1) Historically, the difference is due primarily to the activities of only one insect pest, H. araucariae. The 1967 decision to cease planting of hoop pine at Bulolo and Wau was based on damage being caused at that time by three insect species - H. araucariae, V. oberthuri and C. elisae. Little was known about these insects in 1967, but a rapid-build up in pest populations had been observed since the early 1960's and incidence of attack and damage seemed to be on the increase. All three insects were regarded as of equal threat to the plantations. A fourth insect, M. isodoxa, which had attacked hoop pine in the Highlands, was also known to occur at Bulolo and Wau.

Research carried out since 1967, by the then newly established Forest Entomology section, evolved a successful control technique for C. elisae and showed that M. isodoxa was of little danger to the plantations. Tree mortality caused by V. oberthuri also proved less severe than expected. Hylurdrectonus araucariae, because of the nature of its attack (particularly its cryptic habits), proved too difficult and costly to control, and remained a major deterrent to continued planting. However, Gray (1975) recommended continued planting of hoop pine in other areas where no natural stands or trees occurred.

This insect has been found only in New Guinea and is unique in the tropics as a branchlet mining scolytid of economic importance.

(2) The host age specificity of several insect pests of A. cunninghamii (particularly H. araucariae) has been mentioned previously. In the 1960's and early 1970's, the majority of plantations at Bulolo and Wau were of an age shown to be susceptible to attack by these insects. There has been an apparent decline in severity of attack as the plantations have aged. It is possible that the more diverse age structure of plantations in Australia has posed a check to the rapid build-up of damaging pest populations.

(3) The pattern of attack and damage by V. oberthuri in Papua New Guinea and A. notabilis in Australia are closely similar. However, there is an important difference in their biology which is mainly related to climatic conditions. Aesiotes notabilis populations are low in dry, cool periods during the year, whereas V. oberthuri is generally active throughout the year in the almost constant warm, wet conditions of New Guinea. Since 1945, certain silvicultural practices in Australian plantations have been altered to take advantage of the natural lull in A. notabilis activity. This has not been possible with V. oberthuri and may explain, in part, the difference in their current pest status.

CONCLUSIONS

1. There have been few serious insect pests of A. bidwillii or A. hunsteinii in the established plantations.

2. Pest problems encountered with A. cunninghamii plantations (particularly at Bulolo and Wau in Papua New Guinea) should not deter trials of this species in other areas.

3. In any future planting of A. cunninghamii (including second rotation) planting fronts should be diversified as much as possible to avoid large blocks of even-age monoculture (this may also apply to the other plantation species).

4. Natural enemies appear to play an important role in regulating populations of some insect pests of Araucaria. For this reason, among others (see Fisher, 1980), it is essential that areas of natural vegetation adjacent to the plantations be retained to promote biological diversity and therefore stability.

ACKNOWLEDGEMENT

I thank Dr B. Gray, C/- Post Office, Beerwah, Queensland (formerly Officer-in-Charge, Forest Research Station, Bulolo, Papua New Guinea) for his helpful criticism of the manuscript.

REFERENCES

Barrett, J.H., 1967: The biology, ecology and control of Vanapa oberthuri Pouill. (Coleoptera : Curculionidae) in hoop pine Araucaria plantations in New Guinea. Papua New Guinea Agric. J. 19(2): 47-60.

Brimblecombe, A, 1945: The biology, economic importance and control of the pine bark weevil, Aesiotes notabilis Pasc. Qld. J. Agric. Sci. 2(1): 1-88.

Fisher, W.J., 1980: Ecology and history of plantations of hoop pine (Araucaria cunninghamii Aiton ex D. Don) at Yarraman, Queensland. Thesis submitted for Master of Natural Resources, University of New England, Armidale. 244 pp.

Gray, B., 1973: Distribution of Araucaria in Papua New Guinea. Research Bull. No. 1, 56 pp. Papua New Guinea Department of Forests, Port Moresby.

Gray, B., 1975: Distribution of Hylurdrectonus araucariae Schedl (Coleoptera : Scolytidae) and progress of outbreak in major hoop pine plantations in Papua New Guinea. Pacific Insects 16(4): 383-394.

Gray, B. and Barber, I.A., 1974: Studies on Vanapa oberthuri Pouillaude (Coleoptera : Curculionidae), a pest of hoop pine plantations in Papua New Guinea. Z. Ang. Ent. 76(4): 394-405.

Gray, B. and Buchter, J., 1969: Termite eradication in Araucaria plantations in New Guinea. Comm. For. Rev. 48(3): 201-207.

Gray, B. and Howcroft, N., 1970: Notes on the incidence, attack, associated insects and control of Vanapa oberthuri Pouillaude (Coleoptera : Curculionidae), a pest of hoop pine, Araucaria cunninghamii D. Don., plantations in New Guinea. Z. Ang. Ent. 66(3): 248-256.

Gray, B. and Wylie, F.R., 1974: Forest tree and timber insect pests in Papua New Guinea. II. Pacific Insects 16(1): 67-115.

Howcroft, N.H.S., 1978: A review of Araucaria cunninghamii Ait. ex Lambert in Papua New Guinea and Irian Jaya. Proc. Joint IUFRO Workshop S2.02-08 and S2.03-01, Brisbane, 1977. 2: 827-847. CFI, Univ. of Oxford, England.

Nikles, D.G., 1973: Biology and genetic improvement of Araucaria cunninghamii Ait. in Queensland, Australia. Proc. Joint IUFRO Workshop S2.02-08 and S2.03-01, Gainesville, Fla., 1971. 2: 304-334. CFI, Univ. of Oxford, England.

Nikles, D.G., 1978: Status of exploration, evaluation, use and conservation of genetic resources of Araucaria cunninghamii Ait. (hoop pine). Proc. Joint IUFRO Workshop S2.02-08 and S2.03-01, Brisbane, 1977. 2: 859-869. CFI, Univ. of Oxford, England.

Nikles, D.G., 1979: Realised and potential gains from using and conserving genetic resources of Araucaria. Paper for IUFRO Meeting on "Problems of Araucaria Silviculture", Curitiba, Brazil, October 1979.

Yule, R.A., 1973: Hyleops glabratus Schedl (Coleoptera : Scolytidae) - a primary pest of Araucaria cunninghamii Ait. plantations. Qld. Dept. For. report; 19 pp.

Wylie, F.R., 1976: The biology of Milionia isodoxa Prout (Lepidoptera : Geometridae), a pest of hoop pine (Araucaria cunninghamii) in Papua New Guinea. M. Sc. thesis, Univ. of Qld., Brisbane - 88 pp.

Wylie, F.R. and Shanahan, P.J., 1976: Insect attack in fire-damaged plantation trees at Bulolo in Papua New Guinea. J. Aust. Ent. Soc. 14(4): 371-382.

sessão IV
session IV
grupo A
group A

FAST GROWING TREES

VARIAÇÕES NO CRESCIMENTO DE PROCEDENCIAS DE *Pinus kesiya* ROYLE EX GORDON E *Pinus merkusii* JUNGH ET DE VRIES EM VIÇOSA, MG, BRASIL

N. F. de Barros e R. M. Brandi
Universidade Federal de Viçosa
BRASIL

Summary

Growth of thirteen provenances of P. kesiya (twelve from the Phillipines and one from Viet Nam) and three provenances of P. merkusii (from the Phillipines) was compared with that of P. caribaea var. hondurensis in nursery and field trials, at Viçosa, MG, Brazil.

At the end of 10 months, nursery-grown seedlings of P. caribaea var. hondurensis showed height and diameter growth superior to all but one provenance of P. kesiya and of P. merkusii. Growth differences were also noticeable among the provenances of P. kesiya. Seedlings of P. merkusii however, grew poorly.

Results 7.5 years after outplanting show that three of the P. kesiya provenances grew as well as P. caribaea var. hondurensis in height and/or diameter. The P. kesiya provenance showing the poorest height growth was about 24% shorter than P. caribaea var. hondurensis. P. merkusii provenances continued to show very poor growth.

1. Introdução

A rápida expansão das industrias florestais nas regiões tropicais e a necessidade de matéria prima que atenda aos requesitos industriais têm feito com que as empresas do setor plantem espécies com elevada taxa de crescimento, principalmente as dos gêneros Eucalyptus e Pinus. Na região Sudeste do Brasil o P. caribaea var. hondurensis tem sido, das espécies de Pinus, a mais plantada. Entretanto, várias procedências desta espécie apresentam árvores com forma indesejável, principalmente pelo aparecimento de "rabo-de-raposa". Assim a possibilidade da existência de outras espécies com igual taxa de crescimento e boa forma deve ser testada.

O Pinus kesiya Royle ex Gordon é uma espécie promissora para programas de reflorestamento nos trópicos, mormente as procedências das Filipinas e Viet Nam (Burley & Turnbull, 1970). O Pinus merkusii Jungh et de Vriese, tem aproximadamente a mesma distribuição natural do P. kesiya, e, como este, é uma espécie em potencial a ser testada nos trópicos. Vários autores (Burley & Andrew, 1971; Iyamabo et alii, 1971; Turnbull, 1971 ab) tem descrito diferenças qualitativas e quantitativas entre procedências de P. kesiya e P. merkusii das Filipinas.

O presente trabalho teve como objetivo determinar o potencial do P. kesiya e do P. merkusii das Filipinas para programas de reflorestamento na região de Viçosa, MG; determinar os melhores lotes de sementes para futuros trabalhos; e descrever algumas diferenças morfológicas entre procedências.

2. Material e Métodos

Os lotes de sementes utilizados neste trabalho foram cedidos pelo Institute of Tropical Forestry, Rio Piedras, Puerto Rico, e fazem parte do "FAO/FRI/CFI International Provenance Trial of Pinus kesiya. Foram também incluidos três lotes de P. merkusii. As procedências de P. kesiya, em número de treze, cobrem toda a distribuição natural da espécie na Filipinas, existindo um lote de Zambia (originalmente do Viet Nam). As procedências de P. merkusii representam duas populações naturais que ocorrem em Zambales e Mindoro na Filipinas. A identificação internacional dos lotes de sementes, as características dos locais de origem e a porcentagem de germinação das sementes logo após a colheita, se acham no Quadro 1.

O teste foi conduzido na região de Viçosa, MG, cuja latitude é de 20°45' S, longitude de 42°51' O e altitude de 652 m. O clima da região é do tipo Cwa, segundo a classificação de Köppen, com temperatura média anual de 19°C e mínima absoluta de 0°C, e precipitação média anual de 1340 mm.

A semeadura foi feita diretamente em sacos de polietileno, com capacidade de 2 kg, em fevereiro de 1972, utilizando-se três sementes por recipiente nas procedências de P. kesiya e seis nas de P. merkusii. O P. caribaea var hondurensis foi utilizado como testemunha.

A inoculação do substrato dos recipientes foi feita com solo obtido de plantações de Pinus de oito anos de idade. As mudas excedentes foram desbastadas dois meses após a germinação deixando-se uma em cada recipiente.

O delineamento experimental foi o de blocos ao acaso, tanto no viveiro como no campo, sendo feitos 14 e 7 repetições respectivamente. Em ambos os casos, a menor unidade experimental foi constituida por três plantas.

O plantio no campo foi feito aos 290 dias após a semeadura num espaçamento de 2,5 x 2,5 metros.

Neste trabalho são apresentados alguns dados dos estágios de viveiro e de campo. Os dados foram submetidos à análise de correlação e análise de variância. Na análise de correlação somente os dados referentes às procedências de P. kesiya foram incluidos devido ser o comportamento apresentado pelo P. merkusii muito distinto ao daquela espécie.

3. Resultados e Discussão

3.1. Estágio de Viveiro

Os dados obtidos no estágio de viveiro se acham sumariados no Quadro 2. A porcentagem de germinação no viveiro variou de acordo com a procedência das sementes e no caso do P. kesiya ela foi significativamente (ao nível de 5%) correlacionada (Quadro 4) com a porcentagem de germinação imediatamente após a colheita (Quadro 1). Quando se considerou as procedências de P. merkusii junto com as do P. kesiya o valor de r foi de 0,76. Acentuada redução na viabilidade das sementes foi observada nos lotes 9264, 9266 e 9233. Embora se possa suspeitar que esta redução seja inerente às procedências, a possibilidade de problemas de armazenamento não deve ser descartada. As sementes da procedência 9233 foram coletadas em agosto de 1968, em Zambia, assim que também a idade das sementes pode ter concorrido para o decréscimo da viabilidade.

As sementes de P. merkusii, à excessão do lote 9275, apresentaram baixa porcentagem de germinação, mas não se observou grande redução na viabilidade das mesmas em relação à época da colheita. Tem sido relatado que sementes de procedências insulares de P. merkusii normalmente apresentam moderada viabilidade.

QUADRO 1 - Procedências de P. kesiya e P. merkusii, de acôrdo com os seus números de identificação e local de origens

Identificação do FRI	Espécie	Latitude(1) °N	Longitude °E	Altitude (m)	Estado de origem	N.º de sementes/g	Germinação após colheita(2) (%)
9254	P. kesiya	18°15'	120°51'	975-1125	Ilocos N.	68	73
9255	" "	17°53'	120°44'	750- 900	Ilocos N.	60	88
9256	" "	17°33'	120°47'	1200-1260	Abra	61	85
9258	" "	16°54'	120°55'	1530-1650	Bontoc	70	79
9261	" "	16°51'	120°45'	960-1100	Benquet	60	82
9262	" "	16°39'	120°51'	2130	Nueva Viscaya	75	70
9263	" "	16°19'	120°51'	1140-1290	Benquet	63	86
9264	" "	16°09'	120°49'	960	Pangasinan	66	82
9266	" "	16°01'	121°10'	900-1080	Nueva Ecija	73	76
9267	" "	16°00'	121°08'	600- 780	" "	76	69
9270	" "	15°32'	120°07'	600- 750	Zambales	60	81
9272	" "	16°20'	120°40'	1500-2100	Benquet	60	84
9233	" "	13°00'S	27°00'	1250	Copperbelt	50	60
9274	P. merkusii	15°45'	120°02'	390- 480	Zambales	44	33
9275	" "	15°47'	120°01'	210- 270	"	46	26
9276	" "	13°03'	120°51'	360- 480	Mindoro	40	43

Fonte: BURLEY & TURMBULL (1970).

(1) Todas as procedências são de latitude N, exceto a 9233 que foi coletada em Zambia (sementes provenientes do Viet Nam).

(2) As sementes de todas as procedências foram coletadas em período entre dezembro de 1968 a abril de 1969, com excessão das sementes do lote 9233 que foram coletadas em agosto de 1968.

QUADRO 2 - Dados sobre o comportamento de procedencias de Pinus kesiya e P. merkusii no estágio de viveiro

N.º da procedência(1)	Germinação (%)	Tempo (dias) para germinar			Mortalidade (%)	N.º médio de cotilédones/muda	Altura (cm) do hipocótilo(2)	Altura (cm) após semeadura			Diâmetro (cm) do coleto-290 dias
		10%	40%	90%				80	200	290	
9254	88	11	13	21	32	8,0	2,4 cd	6,4	24,6	47,2 d	0,77 bc
9255	76	11	13	21	38	6,8	1,9 de	6,9	27,9	54,5 bc	0,88 b
9256	82	11	13	21	35	6,9	2,5 bc	6,8	26,9	50,7 d	0,76 bc
9258	65	13	15	21	44	6,4	2,0 d	6,4	23,0	46,9 d	0,69 c
9261	88	13	15	23	32	6,8	2,5 bc	7,2	26,1	54,1 bc	0,79 bc
9262	67	11	13	21	41	6,0	1,9 d	5,7	22,5	47,8 d	0,75 bc
9263	78	11	13	21	37	7,0	1,8 e	5,8	21,6	55,2 bc	0,76 bc
9264	60	13	13	25	36	6,5	1,8 e	5,6	22,9	48,6 d	0,67 c
9266	56	13	15	21	51	6,8	22 c	6,3	22,7	51,6 cd	0,76 bc
9267	75	11	15	23	38	7,6	2,0 d	5,9	26,8	55,0 bc	0,79 bc
9270	75	13	13	21	38	7,6	2,3 cde	6,4	24,4	58,0 ab	0,84 b
9272	73	11	13	19	39	6,9	2,6 bc	6,6	25,5	53,2 bc	0,85 b
9233	35	11	13	17	48	7,3	2,1 cde	7,3	25,4	51,9 cd	0,81 bc
9274	20	23	35	45	54	8,3	2,3 cde	3,2	7,8	11,8 e	0,28 d
9275	50	17	27	45	29	9,2	2,5 bc	4,1	8,7	13,3 e	0,30 d
9276	34	19	25	45	42	8,3	3,0 ab	4,6	11,0	16,2 e	0,36 d
Caribaea	41	13	19	35	69	6,7	3,4 a	7,5	25,5	62,2 a	1,09 a

(1) Pinus kesiya do n.º 9254 a 9233; Pinus merkusii do n.º 9274 a 9276.

(2) As médias seguidas da mesma letra não diferem entre si ao nível de 5% de probabilidade.

QUADRO 3 - Médias da altura e diâmetro de procedências de Pinus kesiya, P. merkusii a diferentes idades e ocorrência do "fox-tail" na região de Viçosa, MG

Nº da procedência	Altura (m) à idade de 1,5 anos	Altura (m) à idade de 7,5 anos	Diâmetro (cm) aos 7,5 anos	% fox-tail (3,0 anos)
9254	2,4 d(1)	14,0 c	20,4 bcd	5
9255	2,7 bcd	15,2 b	23,2 abc	5
9256	2,6 bcd	14,0 c	20,0 cd	0
9258	2,5 cd	14,5 c	20,1 bcd	5
9261	2,7 bcd	16,1 a	21,7 abc	5
9262	2,5 cd	14,1 c	20,2 bcd	14
9263	2,8 abc	14,8 bc	20,8 bcd	10
9264	2,7 b d	14,8 bc	19,8 cd	0
9266	2,4 d	14,9 bc	21,8 abc	0
9267	2,6 bcd	13,8 c	18,9 cd	0
9270	2,8 abc	15,3 b	20,9 bcd	19
9272	2,7 bcd	12,9 d	20,2 bcd	0
9233	2,5 bcd	13,8 c	18,3 d	5
9274	0,6 e	6,6 f	9,4 e	0
9275	0,7 e	7,6 e	8,4 e	0
9276	0,8 e	7,7 e	7,0 e	0
caribaea	3,0 a	16,0 a	24,2 a	48

(1) Nas colunas, as médias seguidas da mesma letra não diferem entre si ao nível de 5% de probabilidade.

Whitmore & Geary (1971) encontraram que sementes colhidas em Java e Sumatra apresentaram 40,9% e 48,5% de germinação respectivamente.

A porcentagem de germinação do P. kesiya no viveiro foi estreitamente relacionada com a latitude da região de origem das sementes (Quadro 4). Esta alta correlação foi em conseqüência da redução da viabilidade dos lotes 9233, 9264 e 9266 que são provenientes de latitudes comparativamente mais baixas. Uma vez mais, se este fato pode ser tomado como indicativo de ser a perda de viabilidade inerente às procedências é difícil de se concluir dos dados aqui apresentados.

Todas as procedências de P. kesiya apresentaram elevada taxa de germinação (Quadro 2), em comparação com as de P. merkusii. Dos lotes de P. kesiya a melhor taxa de germinação foi apresentada pelo lote 9233, não obstante a baixa viabilidade das suas sementes. Neste lote a germinação foi virtualmente completada em 17 dias. Isto pode ser devido ao tamanho relativamente grande das sementes deste lote (Quadro 1), que assim possuiam maior quantidade de reservas para a germinação. O coeficiente de correlação entre o número de sementes/g e a taxa de germinação ou a altura das mudas de P. kesiya aos 80 dias foi 0,50 e -0,71, respectivamente.

A sobrevivência das plantas no viveiro variou de 46 a 71%, e foi afetada principalmente pela ocorrência de tombamento no período pós-germinação e ataque de lagartas cortadeiras. Outra causa de morte das plantas de algumas procedências foi a ocorrência de uma necrose progressiva dos cotilédones, a partir da extremidade, até atingir o hipocótilo. Este sintoma é similar ao descrito por Geary et alii (1968) em mudas de P. kesiya em Zambia. Neste experimento a procedência 9233 foi a que apresentou maior mortalidade (13%) devido a esse problema. O mesmo sintoma foi observado em menor intensidade em plantas das procedências 9254, 9256, 9258, 9270, 9272, 9274 e 9275. As causas da necrose são desconhecidas, mas o ataque das ráizes por algum patógeno foi sugerida por Geary et alii (1968).

Os lotes de P. kesiya com elevada viabilidade apresentaram menor mortalidade (r= -0,83), reforçando a necessidade de sementes de boa qualidade para a produção de mudas em larga escala.

O número médio de cotilédones em plantas de P. kesiya variou de 6,0 a 8,0. Este número foi inversamente relacionado com a altitude do local de origem das sementes (Quadro 4), sugerindo diferenças entre as populações. Modificações no tamanho das acículas de plantas da espécie, de acordo com a altitude, foram relatadas por Turnbull (1971).

A altura do hipocótilo das mudas de P. kesiya diferiu entre procedências variando de 1,8 a 2,6 cm. Contudo, não houve diferença quanto a esta característica entre as procedências de P. merkusii. Venator (1974) chama a atenção que o comprimento do hipocótilo pode ser influenciado pelo vigor germinativo das semen-

QUADRO 4 - Coeficientes de correlação entre as diversas características da área de origem e das procedências de Pinus kesiya

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Latitude (1)	-															
2. Altitude ( )	0,02	-														
3. % Germ. colheita	0,54	-0,06	-													
4. % Germ. viveiro	0,80	-0,16	0,59	-												
5. % Mortalidade	-0,59	0,20	-0,47	-0,83	-											
6. Nº de cotiledones	-0,09	-0,61	-0,22	0,22	-0,25	-										
7. Compr. hipocótilo	-0,22	-0,15	-0,27	-0,02	-0,01	0,46	-									
8. Alt. viveiro (80 dias)	-0,14	-0,12	-0,11	-0,05	0,05	0,21	0,76	-								
9. Alt. viveiro (140 dias)	-0,09	-0,12	-0,14	-0,04	0,01	0,18	0,61	0,92	-							
10. Alt. viveiro (200 dias)	0,16	-0,36	-0,06	0,27	0,31	0,34	0,42	0,64	0,79	-						
11. Altura-viveiro (290 dias)	-0,33	-0,64	-0,06	0,05	0,05	0,44	0,21	0,32	0,37	0,47	-					
12. Diâmetro-viveiro (290 dias)	-0,07	-0,21	-0,05	0,16	-0,05	0,40	0,26	0,53	0,63	0,63	0,72	-				
13. Nº de ramos-viveiro (290 dias)	-0,09	-0,61	0,31	0,30	-0,18	0,45	0,09	-0,04	-0,04	-0,01	0,69	0,29	-			
14. Alt. campo (1,5 anos)	-0,34	-0,41	0,24	0,01	-0,27	0,08	-0,08	0,09	0,20	0,12	0,56	0,22	0,52	-		
15. Diam. campo (7,5 anos)	0,56	-0,22	0,52	0,43	-0,14	-0,19	-0,18	0,16	0,13	0,10	0,25	0,34	0,27	0,48	-	
16. Alt. campo (7,5 anos)	0,15	-0,48	0,32	0,23	-0,18	-0,14	-0,01	0,12	-0,01	-0,07	0,34	-0,04	0,44	0,46	0,64	-

r(5%) = 0,51
r(1%) = 0,64

tes. No presente trabalho a taxa de germinação foi bastante similar entre os lotes de sementes de P. kesiya, e não foi significativamente correlacionado (r = 0,26) com a altura do hipocótilo. Assim a diferença estatística observada sugere que variação genética pode existir entre as procedências tratadas.

As medições da altura e do diâmetro feitas na época do plantio mostraram haver diferenças estatisticamente significativas entre as procedências de P. kesiya (Quadro 2). A procedência 9270 apresentou altura comparável à do P. caribaea var. hondurensis aos 290 dias. Os piores lotes em termos de altura foram 9254, 9256, 9258, 9262 e 9264. Nenhuma das procedências de P. kesiya ou P. merkusii apresentou diâmetro do coleto comparável ao da testemunha. Entretanto, o P. kesiya foi superior ao P. merkusii.

A idade de 200 dias as mudas de todas as procedências de P. kesiya já tinham alcançado altura adequada para o plantio no campo. Contudo o mesmo não aconteceu com as procedências de P. merkusii, que mesmo aos 290 dias apresentaram altura inferior a 20 cm.

A correlação significativa (r = - 0,64) entre a altura das plantas aos 290 dias e a altitude da região de origem, foi uma indicação preliminar que procedências obtidas em locais com altitude mais similar à de Viçosa, deveriam mostrar melhor crescimento. Este fato foi confirmado no campo como será visto a seguir.

3.2. Estágio de Campo

Os dados do Quadro 3 mostram que as procedências de P. kesiya diferiram muito pouco entre si no crescimento em altura e diâmetro no estágio de campo. A procedência 9261 apresentou crescimento em altura e diâmetro comparável ao do P. caribaea var. hondurensis, sendo portanto a mais indicada para plantios mais extensos na região. À idade de 7,5 anos o pior crescimento foi apresentado pela procedência 9272, que apresentou altura 24% mais baixa do que a procedência 9261 e P. caribaea.

As procedências do P. merkusii continuaram a apresentar crescimento bastante inferior às do P. kesiya, sendo em média 98% mais baixas. Portanto, as procedências de P. merkusii testadas neste trabalho não são recomendáveis para plantios na região visando a produção de madeira.

Em levantamento feito aos 3 anos após o plantio das mudas no campo, ficou constatado que as procedências 9262 e 9270 foram as que apresentaram maiores ocorrências de "fox-tail", com 14 e 19%, respectivamente.

No quadro 4 constata-se que a altitude pode ser um melhor indicador do crescimento em altura de procedências de P. kesiya das Filipinas em Viçosa, do que latitude. O correlação inversa entre altura aos 7,5 anos e altitude sugere que lotes de sementes coletados em áras mais baixas do que aquelas que deram origem às sementes do presente trabalho, poderiam apresentar melhor crescimento em altura na região de Viçosa.

4. Resumo e Conclusões

O comportamento de 13 procedências de Pinus kesiya (12 das Filipinas e uma do Viet Nam) e três de P. merkusii foi comparado com o de P. caribaea var. hondurensis em viveiro e no campo na região de Viçosa, MG.

O delineamento experimental adotado foi o de blocos ao acaso, sendo a menor parcela constituida por três plantas. Foram utilizadas 14 e 7 repetições no viveiro e no campo, respectivamente.

Os resultados da fase de viveiro mostraram que três procedências de P. kesiya das quais uma do Viet Nam, apresentaram acentuada redução na viabilidade das sementes no período de abril de 1969 a fevereiro de 1972. A viabilidade das sementes de P. merkusii foi comparativamente baixa. A taxa de germinação de todos os lotes de sementes de P. kesiya foi elevada, principalmente a do lote do Viet Nam, com 90% da germinação ocorrendo em 25 dias após a semeadura, enquanto que os lotes de P. merkusii necessitaram 45 dias para atingirem a mesma taxa.

O comprimento do hipocôtilo variou entre procedências de P. kesiya sugerindo a existência de variação genética entre as populações testadas.

O crescimento em altura e diâmetro das plantas no viveiro e no campo permitiram concluir que algumas procedências de P. kesiya podem ser indicadas para programas de reflorestamento mais amplos na região de Viçosa. No campo, a procedência 9261 cresceu tão bem em altura quanto o P. caribaea var. hondurensis. Apesar de ter sido constatada diferença estatística entre algumas procedências de P. kesiya em ambas as fases, a procedência com o pior crescimento foi apenas aproximadamente 24% inferior em altura que aquela com a melhor média (2,1 m/ano).

As três procedências de P. merkusii testadas apresentaram baixa taxa de crescimento tanto no viveiro como no campo, sendo, portanto, desaconselhada para plantios mais extensos na região.

5. Literatura Citada

1. BURLEY, J. & ANDREW, I.A. Summary report on needle variation among provenances of Pinus kesiya Royle ex Gordon (Syn. P. khasya Royle; P. insularis Endlicher) grown in Zambia. Section 22. 15th IUFRO Congress Florida. 1971.

2. BURLEY, J. & TURNBULL, J.W. Proposed standard procedures for the FAO/FRI/CFI international provenance trial of Pinus kesiya Royle ex Gordon. Oxford. 1970.

3. GEARY, T.F.; WILLIAMSON, J.G. & PATTINSON, J.V. A bright of pine seedlings in Zambian forest nurseries. Rhod. J. Agric. Res. 6:119-122. 1968.

4. IYAMABO, O.E.; JACKSON, J.K. & OJO, G.O.A. Pine trials in sawanna areas of Nigeria. Section 22. 15th IUFRO Congress. Florida. 1971.

5. TURNBULL, J.W. Pinus kesiya in Philippines distribution characteristics and seed sources. Section 22. 15th IUFRO Congress Florida. 1971a.

6. TURNBULL, J.W. Natural stands of Pinus merkusii in the Philippines. Section 22. 15th IUFRO Congress. Florida. 1971b.

7. VENATOR, C.R. Hypocotyl length in Pinus caribaea seedlings: A quantitative genetic variation parameter. Silvae Genetica 23:130-132. 1974.

8. WHITMORE, J.L. & GEARY, T.F. Pinus merkusii provenance trial in Puerto Rico. Section 22. 15th IUFRO Congress. Florida. 1971.

CRESCIMENTO DE FREIJÓ (*Cordia goeldiana, Boraginaceae*) EM PLANTIOS EXPERIMENTAIS

A. A. Carpanezzi e J.A. Gazel Yared
EMBRAPA/IBDF
BRASIL

Resumo

O trabalho apresenta e analisa resultados de crescimento de freijó (*Cordia goeldiana*) em plantios experimentais localizados em Belterra e na Floresta Nacional do Tapajós, município de Santarém, Pará. Evidencia a influência das condições de luminosidade e da fertilidade química do solo sobre o crescimento da espécie. Mostra que a espécie apresenta resultados satisfatórios em vários sistemas de produção.

Summary

This paper presents and analyses data on growth of freijó (*Cordia goeldiana*) at experimental plots in Santarém, Pará State, Brazilian Amazon. Data show direct influence of soil chemical characteristics and luminosity on tree growth. Satisfatory results were obtained for several kinds of plantations.

INTRODUÇÃO

No Pará, freijó ou freijó cinza (*Cordia goeldiana*) tem se destacado como espécie promissora (YARED *et alii*, 1980; YARED e CARPANEZZI, 1980). Sua madeira é valiosa, com fácil colocação no Brasil e no exterior. Outra espécie, *Cordia alliodora*, é bastante plantada nos trópicos úmidos americanos; embora ocorra e seja explorada no Brasil, somente agora começa a ser investigada aqui.

A experimentação da EMBRAPA contém parcelas de *Cordia goeldiana* em diferentes situações. Há variações nítidas de taxas de crescimento, atribuídas às condições de luminosidade e às características do solo.

Este trabalho visa apresentar taxas de crescimento de *Cordia goeldiana* (algumas inéditas) e analisar as causas de variação.

MATERIAL E MÉTODOS

Os experimentos localizam-se em Belterra e na Floresta Nacional do Tapajós, município de Santarém, Pará. O clima é Ami, segundo Köppen. A temperatura média anual é 24,9°C. A precipitação anual média é 2077 mm; em agosto-novembro chove menos de 60 mm por mês.

O relevo das áreas experimentais é plano. O solo é Latossolo Amarelo Distrófico textura muito argilosa (82-94% de argila total, com pequenas variações entre horizontes). A Tabela 1 mostra perfis com e sem queima na implantação dos experimentos. De modo geral, a queima ocasiona redução de Al e elevação de Ca+Mg, K, P e pH nos horizontes superficiais.

As modalidades experimentais comparadas são:

PS: pleno sol, 1,5 x 1,5 m, com queima na implantação (ver YARED *et alii*, 1980)

R: "recrú" típico (sem queima) em capoeira alta (25 m); 4 x 4 m (ver YARED e CARPANEZZI, 1980)

RM: "recrú" variante "mafuku" (queima de partes vegetais no local das covas) em capoeira alta; 6 x 6 m (ver PRODEPEF, 1976, p.45-47)

L_5: linhas (2 m de largura) em capoeira alta; 10 m (entre linhas) x 5 m

$L_{2,5}$: idem, 10 x 2,5 m

As mudas foram formadas em sacos plásticos, a partir de plântulas de regeneração coletadas em Tomé-Açu, Pará. Os plantios foram realizados no início de 1976.

RESULTADOS

A Tabela 2 apresenta valores de incrementos médios anuais (IMAs) e sobrevivência. Observa-se maior crescimento nos tratamentos mais iluminados (PS, R e RM) e com queima (PS, RM).

DISCUSSÃO

O efeito da luminosidade no crescimento é dado pelo contraste entre plantios em "recrú" (R) e em linhas ($L_{2,5}$ e L_5). A vegetação original e o solo são idênticos. No "recrú" as plantas de freijó são bem mais iluminadas, devido ao manejo intenso da vegetação circunjacente, e têm maior crescimento.

Observações em florestas naturais revelam que a regeneração depende de luz abundante. O fato de que os "recrú" apresentam IMAs satisfatórios indica que a espécie pode ser empregada em condições de sombra leve inicial. Obviamente, a influência atribuída às condições de luminosidade engloba outros fatores associados, como competição radicular, temperatura do solo etc.

Os baixos valores de IMAs de *Cordia goeldiana* nos plantios em linha em capoeira alta (cerca de 25 m) não invalidam a espécie para o sistema, desde que em capoeiras mais baixas. Para a maioria das espécies amazônicas a experiência dos autores sugere que o plantio simples em linhas deve ser restrito a vegetações inferiores a 6-10 m. Acima disto há necessidade de complementar a abertura, através de manipulação da vegetação entre as linhas.

A comparação de IMAs de "recrú" (R) e de "recrú" com "mafuku" (RM) exemplifica o efeito da fertilidade do solo. A diferença entre IMAs de diâmetro nas modalidades RM e PS pode ser explicada pelo espaçamento reduzido de PS (1,5 x 1,5 m). *Cordia goeldiana* tem copa moderadamente ampla (em diâmetro) e raízes superficiais bem desenvolvidas, necessitando espaçamentos maiores para crescimento adequado. A comparação dos IMAs de L_5 e $L_{2,5}$ demonstra a influência dos espaçamentos.

Todas as parcelas experimentais tiveram manutenção escassa, sem dúvida determinando redução no crescimento. Além disso, avanços em melhoramento genético e em fertilização poderão aumentar substancialmente as taxas de crescimento. Por isso, na Tabela 2 foram incluídos valores referentes à seleções dentro das parcelas, procurando dar uma idéia das possibilidades da espécie.

A Tabela 2 revela valores elevados de sobrevivência. A sobrevivência inferior de PS decorre principalmente de que plantas raquíticas, oriundas do espaçamento apertado, foram eliminadas na avaliação. Outros experimentos em Belterra têm confirmado que a sobrevivência raramente é inferior a 90%, desde que sejam empregadas mudas vigorosas, com folhas.

Tabela 1. Análises de solo. Realização: Laboratório de Solos do CPATU-EMBRAPA, Belém

SISTEMA	PROFUNDIDADE (cm)	pH	P ppm	K ppm	Ca+Mg m.e.%	Al m.e.%
R ("recrú" sem queima)	0-15	4,2	1	16	0,2	1,5
	16-26	4,3	1	16	0,2	1,3
	27-42	4,3	1	12	0,1	1,0
	43-58	4,3	1	12	0,1	1,0
	59-110	4,2	1	10	0,1	1,1
PS (pleno sol ; queima normal)	0-16	5,5	2	154	1,9	0,1
	17-30	5,3	1	168	0,7	0,3
	31-55	4,7	1	20	0,2	0,5
	55-103	4,9	<1	21	0,1	0,8

Tabela 2. Crescimento de *Cordia goeldiana* em experimentos na Floresta Nacional do Tapajós e em Belterra.

SISTEMA	IDADE (meses)	IMA H(m)	s	IMA DAP(cm)	s	% SOBREVIVÊNCIA	QUEIMA	PARCELA	FONTE DE INFORMAÇÃO
PS	32	2,06	-	2,05	-	76	sim	normal(5x16) a/	YARED *et alii* (1980)
R	48	1,66	0,13	2,08	0,20	100	não	normal(5x25)	YARED e CARPANEZZI(1980)
R	48	2,04	0,11	2,49	0,20	-	não	seleção 1:3 b/	idem
RM	52	2,21	0,05	2,69	0,11	98	sim	normal(7x28)	Este trabalho
RM	52	2,55	0,08	2,91	0,08	-	sim	seleção 1:2	Este trabalho
L_S	52	1,04	0,14	-	-	97	não	normal(8x17)	Este trabalho
L_S	52	1,37	0,14	1,02	0,14	-	não	seleção 1:2	Este trabalho
$L_{2,S}$	52	0,89	0,06	-	-	98	não	normal(8x35)	Este trabalho
$L_{2,S}$	52	1,13	0,08	0,74	0,08	-	não	seleção 1:2	Este trabalho

IMA = incremento médio anual
H = altura
DAP = diâmetro na altura do peito
s = desvio padrão
a/ = significa 5 repetições com 16 plantas úteis cada. Analogamente para os outros casos.
b/ = significa seleção 1:3, por altura, dentro de cada parcela. Analogamente para os outros casos.

Já há alguns anos, e com intenções comerciais, *Cordia goeldiana* vem sendo utilizada por colonos de Tomé-Açu, Pará, em sistemas agro-florestais, a pleno sol.

CONCLUSÕES

Com base nas informações expostas pode-se concluir que *Cordia goeldiana*:

a. tem IMAs satisfatórios em latossolo amarelo argiloso, mesmo sem queima;

b. responde diretamente, em crescimento, às condições de luz e de fertilidade dos solos; e

c. adapta-se satisfatoriamente à várias modalidades de plantações.

LITERATURA CITADA

PRODEPEF, 1976. *Centro de Pesquisas Florestais da Amazônia. Programação Técnica.* Brasília, 75p. (Série Divulgação, 9).

YARED, J.A.G., A.A. CARPANEZZI e A.P. CARVALHO FILHO, 1980. Ensaio de espécies florestais no planalto do Tapajós. *Boletim de Pesquisa do CPATU.* Belém, (11). Em impressão.

YARED, J.A.G. e A.A. CARPANEZZI, 1980. *Conversão de capoeira alta da Amazônia em povoamento de produção madeireira: o método do "recrú" e espécies promissoras.* CPATU-EMBRAPA, Belém. A publicar.

TRABALHO RECENTE COM PROCEDÊNCIAS DE *Cedrela spp*

G. E. Chaplin
Commonwealth Forestry Institute
Oxford University
ENGLAND

Resumo

Cedrela odorata L. é uma madeira bem conhecida, e uma espécie para plantações, dentro de sua área de ocorrência natural, e é amplamente plantada como exótica. Outras espécies do mesmo gênero dão idéia do seu potencial para plantações. O CFI Oxford está atualmente coordenando coleta de sementes através da área de ocorrência natural do gênero na América Latina. Pode-se antecipar que a distribuição de sementes para testes internacionais de *Cedrela* spp deverá ser iniciada em fins de 1980, e envolverá também três procedências de *Toona ciliata* M. Roem. var. *australis* (F. v. Muell.) C. DC.

RECENT PROVENANCE WORK WITH *Cedrela spp*

Summary

Cedrela odorata L. is a well known timber and plantation tree within its natural range and is widely planted as an exotic. Other species in the genus give indications of potential for plantations. The CFI Oxford is currently coordinating seed collections throughout the natural range of the genus in Latin America. It is anticipated that distribution of seed for an international trial of Cedrela spp. which will include three provenances of Toona ciliata M. Roem. var. australis (F.v. Muell.) C.DC., will commence in late 1980.

INTRODUCTION

Cedrela odorata L. is a well known timber tree within its natural range and has been planted extensively in the Caribbean and Latin America. It is also a species which has attracted considerable attention as an exotic, particularly in Africa. The FAO Panel of Experts on Forest Gene Resources has given C. odorata and its related species the highest priority rating for exploration, evaluation and conservation (FAO, 1977).

The Commonwealth Forestry Institute (CFI) is currently coordinating seed collections for an international provenance trial which will sample the variation in the natural range of C. odorata. The proposed trial will also include some of the less well known but potentially important species, such as C. lilloi C.DC. and C. angustifolia Moc. and Sesse ex C.DC. In addition the trial will provide an opportunity to compare Toona ciliata var. australis (F.v. Muell.) C.DC. with Cedrela which is of particular importance in the neotropics where Hypsipyla grandella Zeller is a major pest of the native Meliaceae. This work, through projects funded by U.K. Overseas Development Administration, forms part of the continuing programme of provenance exploration, seed collection and distribution, and trial evaluation that is in progress at the CFI, Oxford (Kemp, 1973; Greaves, 1978). A detailed account of the current CFI programme with Cedrela has been prepared for the eleventh Commonwealth Forestry Conference to be held in Trinidad (Chaplin, 1980), and some of that information is summarized and included here.

DISTRIBUTION, HABITAT AND BIOLOGY

In a recent revision of the genus, Styles (1980) recognized seven species. The type species Cedrela odorata extends from 26°N in Mexico to as far south as 28°S in northern Argentina. It is a species of both dry and moist lowland forest up to 1200m altitude. C. fissilis Vell. occurs from southern Costa Rica and extends over the lowlands east of the Andes as far south as Argentina. Three highland species have been recognized, C. longuzii C.DC. which occurs from Chiapas in Mexico to Panama above 2000m, C. montana Moritz ex Turcz in north western South America from 1400m and C. lilloi. which extends from Peru into northern Argentina between 800 and 3400m.

One dry zone species, C. salvadorensis Standl., occurs on the dry Pacific slope of Central America. The remaining species recognized in the revision is C. oaxacensis, a tree of small stature with a restricted range in Mexico. The taxonomy of the genus is still incomplete even after the recent revision. The name C. angustifolia has been a continuous source of confusion; this taxon is closely related to C. odorata, with which it may prove to be synonymous.

Throughout the very large range of the genus there is considerable variation in phenology. All of the species are deciduous and in general flowering occurs as the new leaves develop. In Central America C. odorata flowers at the beginning of the rainy season in May and June and the fruits are mature in March and April of the following year. All the species in the genus are monoecious and possess mechanisms to ensure out breeding (Styles, 1972).

PRESENT STATUS OF CEDRELA IN THE NATURAL RANGE

In common with many tropical forest trees, populations of Cedrela are either disappearing or being decimated as the destruction of the natural forest continues. Because of their valuable timber all the species, and particularly C. odorata, are being exploited as part of extensive fellings or by selective logging, whether in virgin forest, secondary forest or agricultural areas. Fortunately Cedrela can regenerate in disturbed sites and is often an important constituent of secondary forest and may often be abundant in agricultural areas. Such populations are, however, limited in extent, genetically degraded and under continuous threat, through exploitation or change in land use.

CFI INTERNATIONAL PROVENANCE TRIALS

During 1967, seed lots of 14 provenances of Cedrela were distributed by the CFI to 21 collaborating countries throughout the tropics (Burley and Lamb, 1971). This trial was exploratory in nature. Three trials were established in the neotropics, but unfortunately the sites chosen were unsuitable for Cedrela and growth rates were depressed. All of the trials were heavily attacked by Hypsipyla grandella. This result emphasises the importance of establishing Cedrela trials on optimum sites to ensure vigorous growth (Whitmore, 1978). A vigorous tree, if attacked by H. grandella, can overcome the damage caused and re-establish apical growth. There is considerable variation between provenances with regard to vigour (Delaunay, 1977), response to H. grandella attack (Melchior and Quijada, 1972).

The current CFI trial will concentrate on C. odorata. The populations of C. odorata in Central America are of particular interest in view of the superior performance of the provenances from Belize and Costa Rica in the initial CFI trial (see e.g. Delaunay, 1978 and Malimbwi, 1978). Other species with potential, such as C. angustifolia and C. lilloi, a high altitude species which is an important timber tree within its natural range, will be included if seed is available. C. angustifolia is a particularly interesting taxon and is reported to have good form and vigour, (Sanchez et al., 1976 and Vega, 1974). Grijpma (1976) reported that it responds to H. grandella attack by re-establishment of leader growth.

EXPLORATION AND COLLECTION, STORAGE AND DISTRIBUTION OF SEED

Various forestry organisations throughout the natural ranges of Cedrela and T. ciliata var. australis have co-operated with the CFI in making provenance collections. The collection procedure has followed standard guidelines regarding number, spacing and quality of the seed trees, (Chaplin, 1979).

In the Central American region provenance exploration and seed collection commenced in 1978. In cooperation with the Forest Services in the region, 11 provenance collections of C. odorata and one of C. salvadorensis have been made.

In 1980 a programme of field work was organized in South America. In co-operation with the national forestry organizations potential seed collection sites were identified during visits to areas where Cedrela occurs.

Two provenance collections of C. tonduzii, three of C. odorata and one of C. angustifolia have already been completed, while others are still in progress. It is anticipated that over 20 provenance collections of Cedrela and 3 provenance collection of T. ciliata var. australis will be available for the trial. International co-operation on the exploration, seed collection and distribution has been an important feature in this work.

Seed is being stored and tested by the seed laboratory of the U.K. Forestry Commission, seed collections that have been received in good condition with moisture contents between 7 and 9% have stored well.

It is expected that distribution to interested countries throughout the tropics for the proposed international provenance trial will commence in late 1980.

REFERENCES

Burley, J., and Lamb, A.F.A. (1971). Status of the C.F.I. International provenance trial of Cedrela odorata (including C. mexicana and C. tubiflora), June, 1971. Commonw. For. Rev. 50(3), 234-7.

Chaplin, G.E. (1979). Provenance collection guide, Cedrela spp. (also available in Spanish). Oxford, Commonwealth Forestry Institute, (Unpublished). 3p.

Chaplin, G.E. (1980). Progress with provenance exploration and seed collection of Cedrela spp. Eleventh Commonwealth Forestry Conference, Trinidad 1980.

Delaunay, J. (1978). Results of an international provenance trial of Cedrela odorata L. seven and a half years after its inception in Ivory Coast. In Nikles, D.G., et al. (eds.). (1978). Progress and problems of genetic improvement of tropical forest trees: proceedings of a joint workshop of IUFRO Working Parties S2.02.08. and S2.03.01. held in Brisbane, Queensland, Australia, 1977. Oxford Commonwealth Forestry Institute. 1066p.

FAO, (1977). Report on the fourth session of the FAO Panel of Experts on Forest Gene Resources. Canberra, Australia 1977. Rome, FAO FO:FGR/4/Rep. 75p.

Greaves, A. (1980). Review of the Pinus caribaea Mor. and Pinus oocarpa Schiede international provenance trials, 1978. C.F.I. Occasional Paper, Commonw. For. Inst., Oxford. No. 12. 89p.

Grijpma, P. (1976). Resistance of Meliaceae against the shoot borer Hypsipyla with particular reference to Toona ciliata M.J. Roem. var. australis (F.v. Muell.) C.DC. in Studies of the shoot borer Hypsipyla grandella (Zeller). In Vol. 3, J.L. Whitmore ed. Misc. Pub. CATIE, No. 1. (Misc. Pub. IICA No. 101). 116p.

Kemp, R.H. (1977). International provenance research on Central American pines. Commonw. For. Rev. 52(1) 55-66.

Malimbwi, R.E. (1978). Cedrela species international provenance trial (CFI) at Kumsamba, Tanzania. In Nikles, D.G. et al. (eds.) (1978). Progress and problems of genetic improvement of tropical forest trees: proceedings of a joint workshop of IUFRO Working Parties S2.03.01. held in Brisbane, Queensland, Australia, 1977. Oxford Commonwealth Forestry Institute. 1066p.

Melchior, G., and Quijada, R. (1972). Notas tecnicas sobre el comportamiento de unas procedencias exoticas de Cedrela odorata comparadas con una de C. angustifolia nativa y plantadas como "stumps" en condiciones de vivero. Boln. Inst. For. Lat.-Am. Invest. Capacit. (IFLAIC), Merida, Venezuela, No. 41/42, pp.57-62.

Sanchez, J.C., et al. (1976). Comportamiento de cinco especies de Meliaceae en Turrialba, Costa Rica. In Studies of the shoot borer Hypsipyla grandella (Zeller). In Vol. 3, J.L. Whitmore ed. Misc. Pub. CATIE. No. 1. (Misc. Pub. IICA No. 101). 116p.

Styles, B.T. (1972). The flower biology of the Meliaceae and its bearing on tree breeding. Silvae Genetica, 21(5). 149-204.

Styles, B.T. in Pennington, T.D. and Styles, B.T. (1980). Meliaceae. Flora Neotropica, New York.

Vega, L. (1974). Influencia de la silvicultura sobre el comportamiento de Cedrela en Surinam. Boln. Inst. For. Lat.-Am. Invest. Capacit. (IFLAIC), Merida, Venezuela, No. 46/48, pp. 57-83.

Whitmore, J.L. (1978). Cedrela provenance trial in Puerto Rico and St. Croix: establishment phase. Research Note U.S.D.A. Forest Service, Puerto Rico. No. ITF 16. 11p.

FAST GROWING TREES

DADOS PRELIMINARES RELATIVOS A *Cariniana pyriformis, Jacaranda copaia, Simarouba amara* E *Vochysia hondurensis*

G.E. Chaplin and P. J. Wood
Commonwealth Forestry Institute
Oxford University
ENGLAND

Resmo

Existem muitas folhosas nos trópicos e subtrópicos que são bem conhecidas como fornecedoras de madeira em sua área de ocorrência natural. Algumas dessas espécies tem certo potencial para plantações. Todavia a experiência silvicultural é limitada. A contínua redução das florestas torna necessário incrementar urgentemente os testes dessas espécies menos conhecidas. A cooperação internacional na coleta de sementes e na organização de testes de procedências, envolvendo mais de uma espécie, é sugerida visando aumentar a disponibilidade de sementes e o conhecimento dessas espécies pouco conhecidas e com potencial. Dados de 4 espécies neotropicais são incluidos no trabalho como bons exemplos do potencial existente em muitas outras espécies.

PRELIMINARY DATA SHEETS ON *Cariniana pyriformis, Jacaranda copaia, Simarouba amara* AND *Vochysia hondurensis*

Summary

There are many hardwoods in the tropics and subtropics which are well known in their natural range as timber trees. Some of these species give indications of potential for plantations. However, silvicultural experience with them is limited. The continued depletion of the natural forest makes the need to increase the rate of screening of these lesser known species more urgent. International co-operation in seed collection and the organization of provenance trials combining more than one species is suggested to increase the availability of seed and knowledge of little known species with potential.

Data sheets of four neotropical species are included as good examples of the promise shown by so many species.

INTRODUCTION

Because of the large variation in tolerance and adaptability of tropical trees and the difficulty in obtaining reliable data on site factors and their interactions, the selection of species for plantations must be based as far as possible on silvicultural experience and not on theoretical grounds alone (Webb, et al., 1980). The utilization and wood qualities of many species in the tropical forests are well known within their respective natural ranges. Some of the species have good growth rates and might be suitable for plantations, yet silvicultural experience with them is often limited and they may be unknown outside of their natural range.

Within the Caribbean and Central and South America the FAO Panel of Experts on Forest Gene Resources have listed twenty-five species that are already important, or are considered to have a high potential, for plantations. Each species has been given an operational priority rating in exploration, evaluation, conservation and utilisation (FAO, 1977). Thirteen of the twenty-five species are conifers, some of which have already received considerable attention (Greaves, 1980a; Greaves, 1980b). There are many hardwood species within the region which have potential for plantations and yet receive scant consideration in provenance testing or species introduction programmes.

As the depletion of the natural forests in the tropics and subtropics continues the genetic resources, on which the future of tree growing will depend, are being steadily diminished. The combination of the reduction of the natural range and the depletion of the populations by removal of the superior phentotypes, results in the loss of potentially valuable provenances. Whereas the pines and some hardwoods regenerate readily on disturbed sites, many hardwood species do not and these are in particular danger.

In this paper four neotropical hardwoods are described. The utilization and wood qualities of these species are well known within their natural ranges, but information concerning their silviculture appears to be limited. Initial silvicultural experience with a species will usually develop within its natural range. These species are good examples of the potential shown by so many less well known tropical trees.

The data sheets of the species that are included here outline their characteristics in note form. Undoubtedly further information is available in unpublished reports, and many foresters have field experience with these species. However, there are serious gaps in the literature, such as information on long term growth rates in plantations, site requirements and silvicultural characteristics.

Seed of these species is often difficult to obtain or in short supply. Many different species are likely to have widely differing site requirements and it is therefore suggested that the most effective way of evaluating them would be to organise international co-operation on seed collection in the natural range, leading to the establishment of provenance trials combining more than one species for particular climate or silvicultural zones.

Cariniana pyriformis Miers.

Family	Lecythidaceae
Synonyms	-
Varieties	-
Venacular	Abarco, chibuga (Colombia), bacu (Venezuela).
Distribution	Northernmost species in genus occurring from Costa Rica through Panama to northern Colombia and into north western Venezuela.
Habit	Up to 40-50m tall, buttressed, evergreen, with exceptionally good form.
Habitat and ecology	Occurs from sea level to 600m, in humid and very humid forests on both poor and fertile soils, with acid reaction. Prefers well drained sites. Mean annual rainfall 2000-4000mm, with no or short dry season. Mean annual temperature 22-30°C. Moderately shade tolerant.
Wood properties	High silica content, reported to saw well and seasons rapidly. Moderately durable. Specific gravity 0.60g/cm^3.
Utilization	In construction, and furniture, suitable for veneer and plywood production. A very important timber species within its natural range, general utility wood.
Silviculture	Little information available. Production estimated, 10-20m^3/ha/an., long term experience lacking. Small scale plantation programmes in Colombia, no references as an exotic. No serious pests reported. Unknown as an exotic.
Seed	1,000 seed/kg. Stores for up to one year when dry, cold and airtight. Conservation stands established in Colombia. Research needed on storage.
Genetic status	Unknown. Exploration of provenances from drier areas.
FAO rating	nil.

Selected references

Anon. (1967). Abarco. Bois et Forets des Tropiques. No. 114. pp.39-42.

Betancur, P.G., and Raigosa, E.J. (1973). Characteristics and germinative properties of seed of Carinana pyriformis. Revista Fac. Nac. de Agronomia. Medellin. 28.2.36-56.

Dijk, K. van. et al. (1978). El suministro de semillas como base de reforestaciones en Colombia. FAO Report, PNUD/FAO/COL/74/005. PIF, No. 13. 44p.

Record, S.J., and Hess, R.W. (1943). Timbers of the New World. New Haven, Yale University Press. 640p.

Venegas Tovar, L. (1978). Distribucion de once especies forestales en Colombia. FAO Report, PNUD/FAO/COL/74/005. PIF. No. 11. 74p.

Webb, D.B. et al. (1980). A guide to species selection for tropical and subtropical plantations. Tropical Forestry Paper Commonw. For. Inst., Oxford. No. 15. 342p.

Jacaranda copaia (Aubl.) D. Don

Family	Bignoniaceae - section Monolobus
Synonyms	Bignonia copaia Aubl.
Varities	J. copaia var. paraensis Huber
Vernacular	Samaraps (Belize). What o'clock (Bahamas), Fotui (Guyana), Gallina (Nicaragua), Para-para (Brazil), Simaruba (Venezuela), Vainillo, Chingali, Guabillo (Colombia).
Distribution	Best known and most widely distributed species in genus. From Belize and Guatemala in Central America to Colombia, Venezuela, the Guianas, Peru, Ecuador, Brazil, Bolivia and Paraguay in South America, and some Caribbean Islands.
Habit	Up to 25m tall, good clear bole, often slender. Good form, compact crown.
Habitat and ecology	From sea level to 1000m, in humid forests, on many soil types including heavy clays, terra firme in Amazon basin. Tolerates poor drainage. Pioneer species, regenerating satisfactorily on degraded sites and mineral soils, may result in even aged stands.
Wood properties	Soft white wood, no distinct heart wood, easily worked and finishes well. Specific gravity (airdry) 0.4 to 0.5 g/cm^3. Perishable in contact with ground or when exposed.
Utilization	General utility wood, light interior construction, excellent pulping characteristics, suitable for flake-type particle board.
Silviculture	No particular problems in nursery reported. Good establishment, overcomes weed competition. Initial growth is rapid with very good form, long term growth data lacking. No serious pests reported in Colombia. Planted on a small scale in Brazil, Colombia and Peru. Apparently not planted as an exotic.
Seed	Reportedly easy to collect with good viability. Research needed on storage. Conservation stands in Colombia.
Genetic status	Wide range hence likely variation. Regenerates on disturbed sites, genetic impoverishment not far advanced.
FAO rating	nil.

Selected references

Combe, J. and Gewald, N.J., eds. (1979). Guia de campo de los ensayos forestales del CATIE en Turrialba, Costa Rica. CATIE, Turrialba, Costa Rica. 378p.

Dijk, K. van. et al. (1978). El suministro de semillas como base de reforestaciones en Colombia. FAO Report, PNUD/FAO/COL/74/005. PIF. No. 13. 44p.

Haygreen, J.G., and French, D.W. (1971). Some characteristics of particle boards from four tropical hardwoods of Central America. Forest Prod. J.21(2), 30-3.

Paula, J.E. de. (1977). Anatomia de madeiras da Amazonia com vistas a polpa e papel. Acta Amazonica 7(2) 273-88.

Peck, R.B. (1976). Seleccion preliminar de especies aptas para el establecimiento de bosques artificiales en tierra firme del litoral Pacifico de Colombia. Boln. Inst. For. Lat.-Am. Invest. Capacit. (IFLAIC), Merida, Venezuela. No. 50, Pp. 29-39.

Record, S.J., and Hess, R.W. (1943). Timbers of the New World. New Haven, Yale University Press. 640p.

Vattimo, I. de (1977). Jacaranda paraensis (Huber) Vattimo stat. nov. (Bignoniacese - secao monolobus P.DC.). Rodriguesia 29(43) 285-97.

Venegas Tovar, L. (1978). Distribucion de once especies forestales en Colombia. FAO Report, PNUD/FAO/COL/74/005. PIF. No. 11. 74p.

Simarouba amara Aubl.

Family	Simaroubaceae
Synonyms	S. opaca Radkl, ex Engl. variant spelling: Simaruba amara
Varieties	S. amara Aubl. var. typica Cronquist (Costa Rica, Lesser Antilles and Brazil). S. amara Aubl. var. opaca Engl. (Belize, Brazil).
Venacular	Marupa, simaruba. Marouba (Trinidad and Tobago), soemaroeba (Surinam), acetuna (Nicaragua), cedro blanco (Venezuela).
Distribution	Throughout Central America, Lesser Antilles and the Guianas, Brazil, Colombia and Venezuela in South America, generally rather rare.
Habit	Up to 30m tall, large crown.
Habitat and ecology	Occurs from sea level up to 850m in moist forest. Tolerates poor drainage and occurs on various soil types.
Wood properties	Soft, yellow-white light timber. Specific gravity .4-.45 g/cm^3. Not durable, insect resistant.
Utilization	Interior construction and furniture, suitable for

	pulpwood, paper production, flake-type particleboard and matches.
Silviculture	Good establishment, fast growth and tolerates weed competition, light demander. Some planting in Trinidad, after 11yr. 25m high. suggested rotation 20-25 years on good deep, well drained sites, the defoliator, Atteva pustuella is potentially a major pest in plantations. In Surinam planted since 1954, by 1964 150 ha, encountered few problems, rotation 40 years. Necessary to prune at early age as no natural pruning occurs. Slow response to thinning in natural forest. Unknown as an exotic.
Seed	No information available.
Genetic status	Variation likely between varieties as well as provenances. Sblection to improve branching habit is necessary.
FAO rating	nil.

Selected references

Combe, J., and Gewald, N.J. (1979) (eds.). Guia de campo de los ensayos forestales del CATIE en Turrialba, Costa Rica. CATIE, Turrialba. 377p.

Cronquist, A. (1944). Genus simarouba. Bull. Torrey Bot. Club. 71, pp. 229-230.

Haygreen, J.G., and French, D.W. (1971). Some characteristics of Particle-boards from four Tropical Hardwoods of Central America. For. Prod. Journal Vol. 21, No. 2, 30-3.

Lackhan, N.P. (1970). Variation in fibre length in a single stem of Simarouba. The Trinidad and Tobago Forester. 12-14.

Marshall, R.C. (1934). Trees of Trinidad and Tobago. Trinidad Government Printer, 101p.

Paula, J.E. de. (1977). Anatomia de Madeiras da Amazonia com vistas a polpa e papel. Acta Amazonica, 7, 2, 273-288.

Schulz, J.P., and Vink, A.T. (1966). Observations on the effect of early pruning on branch development of young soemaroeba (Simaruba amara Aubl.).

Streets, R.J. (1962). Exotic forest trees in the British Commonwealth. Oxford, Clarendon Press. 765p.

Vochysia hondurensis Sprague

Family	Vochysiaceae
Synonyms	Vochya hondurensis Standl.
Varieties	V. hondurensis var. parvifolia (Belize)
Venacular	Corpo, corpus (Mexico); emery, yemeri (Belize); san juan, flor amarillo (Honduras, Guatemala); yemeri, barba chele, (Nicaragua); cedro macho, palo de chancho (Costa Rica).
Distribution	From Oaxaca in southern Mexico, throughout Central America to Panama.
Habit	Large trees with good form. Reported to attain height of 27m and trunk diameter of 60-100cm. Boles straight, clear and cylindrical with distinctive high and compact crown.
Habitat and ecology	From sea level in moist of wet forest to 700m in Belize. Common in second growth forest in Belize on moist, but not swampy, sandy clay soils, tolerates poor sites. Regenerates readily on disturbed sites, may result in even aged stands, with exceptionally good form. Related species are important forest trees producing valuable timber in South America, particularly Brazil and the Guianas.
Wood properties	Pale brown, pinkish brown wood, distinct heart wood, easily worked, but relatively poor machining qualities, takes glue, paint and nails well and polishes to a good finish. Seasons rapidly with moderate degrade. Variable durability, can be readily treated with preservatives. Specific gravity (airdry) 0.5 g/cm^3.
Utilization	General carpentry, exterior siding, boxes etc. Suitable for utility plywood, core stock and low grade particle board. Other species in the genus are important for plywood and sawn timber production in French Guiana.
Silviculture	No information available. Apparently not known as an exotic. Small arboretum plot growing well in Belize.
Seed	Reportedly good germination immediately after collection. Research needed on storage, seed mature in September (Belize).
Genetic status	Regenerates on disturbed sites, abundant within Central America. Genetic impoverishment not far advanced.
FAO rating	nil.

Selected references

Normand, D. (1966). Les Kouali, Vochysiacees de Guyane, et Leurs Bois. Bois For. Trop. No. 110 (3-11). 3-7.

Record, S.J., and Hess, R.W. (1943). Timbers of the New World. New Haven, Yale University Press. 640p.

Schmidt-Hellerau, C. (1977). Die Eignung einiger lateinamerkanischer Holzer zur Herstellung von Aussespanplatten. Holz-Zentralblatt. Vol. 103, 71/72. 1076-77.

Standley, P.C., and Steyermark, J. (1949). Flora of Guatemala. Fieldiana: Botany. Vol. 24, 6. No. 3.

Zeeuw, de, C., and Gray, R.L. (1975). Vochysia hondurensis Sprague (Vochysiaceae). Tropical Timber Information Center, Brief No. 7. 3p.

GENERAL REFERENCES

FAO, 1977. Report of the Fourth Session of the FAO Panel of Experts on Forest Gene Resources. FAO, Rome. FO:FGR/4/Rep. 75p.

Greaves, A. (1980a). A review of the International provenance trials of Pinus caribaea Morelet and Pinus oocarpa Schiede. Paper prepared for IUFRO symposium and workshop on genetic improvement and productivity of fast growing tree species, Brazil 1980. 11p.

Greaves, A. (1980b). Status of the Pinus pseudostrobus Lindl. (including Pinus tenuifolia Benth.) international provenance trial. Prepared for IUFRO symposium and workshop on genetic improvement and productivity of fast growing tree species, Brazil, 1980. 5p.

Webb, D.B. et al. (1980). A guide to species selection for tropical and subtropical plantations. Tropical Forestry Paper, Commonwealth Forestry Institute, Oxford. No. 15. 342p.

FAST GROWING TREES

RESULTADO DOS TESTES DE PROCEDÊNCIAS DE *Cordia alliodora* (RUIZ E PAVEN) CHAM., EM BELIZE, NO PRIMEIRO ANO

H. B. L. Evans
Overseas Develop Administration, London
O. A. Sabido
Forestry Department, Belize
ENGLAND

Resumo

Foram plantadas 7 procedências de *Cordia alliodora* (Ruiz e Paven) Cham. (em ensaios repetidos), em 2 localidades. A sobrevivência variou de 47 a 84% em uma das localidades, e de 43 a 69% na outra. Os dados equivalentes para a altura, aos 12 meses após o plantio, foram 0,61 – 0,96 m e 0,55 – 0,81 m. As procedências de Honduras alcançaram melhor crescimento em altura em uma das localidades, enquanto que dentre todas a melhor sobrevivência foi revelada pelas 2 procedências da Nicarágua.

FIRST YEAR RESULTS OF *Cordia alliodora* PROVENANCE TRIALS IN BELIZE

Summary

Seven provenances of Cordia alliodora (Ruiz and Paven) Cham. were planted in replicated trials on two sites. Survival varied from 47 to 84% on one site and from 43 to 69% on the other. The equivalent figures for height twelve months after planting were 0.61 - 0.96 m. and 0.55 - 0.81 m. The Honduran provenance achieved best height growth on one site, whilst best all round survival was shown by the two Nicaraguan provenances.

Introduction

Cordia alliodora (Ruiz and Paven) Cham., or Salmwood as it is locally known, is native to Belize and is found throughout the country on the better soils up to approximately 800 m. in altitude. Although the species has been known for its useful timber for many years, it has been only recently that wider interest in Cordia alliodora as a potential

Table 1. Details of Cordia alliodora provenances

Local ident. No.	Seed lot No. (CFI number)	Country	Provenance	Latitude	Longitude	Altitude (m)	Mean annual precipitation (mm)
BZ-123	9/77 (K144)	Honduras	Tres Piedras	15° 02' N	87° 04' W	110	1650
BZ-124	10/77 (K151)	Honduras	Finca La Fortuna	15° 36' N	87° 58' W	210	1048
BZ-125	20/77 (K153)	Honduras	San Francisco	15° 40' N	87° 02' W	50	2687
BZ-126	14/77 (K146)	Nicaragua	Estelí	13° 02' N	86° 19' W	800	747
BZ-127	(K152)	Nicaragua	La Pineda	12° 45' N	85° 43' W	750	2300*
BZ-128	10/77 (K145)	Guatemala	Finca El Chilero	14° 23' N	90° 28' W	1300	2000*
BZ-129	20/77	Belize	Silk Grass Forest Reserve	16° 55' N	88° 15' W	80	2502
BZ-130	13/77	Colombia	Valle de Cauca	4° 41' N	76° 46' W	1600	2400
BZ-131	32/77	Costa Rica	Turrialba	9° 53' N	83° 38' W	602	2674
BZ-132	33/77	Costa Rica	Limon	10° N*	83° 10' W*	30	5000
BZ-133	34/77	Costa Rica	San Carlos	10° N*	83° 20' W*	200	4700
BZ-134	1/77	Cote d' Ivoire	CTFT, Yapo	5° 44' N	4° 06' E	80	1600

Table 2. Details of trial sites

	Trial site SR-64	Trial site SR-65
Location:	Silk Grass Forest Reserve	Silk Grass Forest Reserve
Latitude:	16° 55' N	16° 55' N
Longitude:	88° 15' W	88° 15' W
Altitude:	80 m.a.s.l.	40 m.a.s.l.
Site condition:	Moist evergreen broad-leafed forest regrowth, felled and burned	Moist evergreen broad-leafed forest regrowth, felled and burned
Soil:	Well drained sandy clay loam	Poorly drained clay/sandy clay loam.
Mean annual precipitation:	2,148	2,148

Table 3. Monthly rainfall distribution (Melinda)

	J	F	M	A	M	J	J	A	S	O	N	D	Total
Site SR-64	142	77	46	67	111	277	245	264	262	239	253	146	2148
Site SR-65	142	77	46	67	111	277	245	264	262	239	253	146	2148

Table 4. Cordia alliodora provenance trials

Mean height and survival percentage after 12 months, seven provenances

Local ident. number	Seed lot No. (CFI number) and country of origin	Mean height (m)		Mean Survival (%)	
		Site SR-64	Site SR-65	Site SR-64	Site SR-65
BZ-125	20/77 (K153) Honduras	0.96		67	*
BZ-126	14/77 (K146) Nicaragua	0.84	0.75	84	61
BZ-128	10/77 (K145) Guatemala	0.81	0.58	74	43
BZ-130	13/77 Colombia	0.81	0.55	47	47
BZ-131	32/77 Costa Rica	0.76	*	59	*
BZ-134	1/77 Cote d' Ivoire	0.81	0.81	67	54
BZ-127	(K152) Nicaragua	*	0.76	*	69

plantation species has prompted the Commonwealth Forestry Institute, Oxford to initiate a series of international provenance trials, of which the present trials form part.

In October 1977 seeds of 12 provenances of Cordia alliodora were received from the Commonwealth Forestry Institute, Oxford for establishment in trials. In this paper the first year performance of these trials is reported.

Provenances

Details of the provenances are given in Table 1.

Nursery trial sites and experimental design

Seeds were sown in the Research Division nursery at Melinda in November 1977. Sowing was carried out on clay beds 22 m. long by 1.25 m. wide, seeds being sown in lines 5 cm. apart and then lightly covered with sandy loam. Beds were shaded with palm fronds. Watering was carried out early in the morning or in the late afternoon. Two months after sowing, the seedlings were transplanted into polythene bags placed under 50% shade, watering being carried out once daily as before.

Three provenances BZ# 123, BZ# 124, and BZ# 129 (a local provenance) failed to germinate and provenances BZ# 132 and BZ# 133 germinated poorly.

The remaining seven provenances were planted on two sites in Silk Grass Forest Reserve in October 1978. Details of the two sites are given in Table 2, and mean monthly rainfall figures in Table 3.

A randomised block design was used, with six provenances each in 25 tree plots at 2m. x 2m. spacing, replicated six times in trial site SR-64; and five provenances of same size and spacing replicated 4 times in trial site SR-65.

Results

In October 1979 after 12 months in the field, height and survival percentage were assessed. Results for the two sites are summarised in Table 4.

FAST GROWING TREES

TESTES DE PROCEDÊNCIAS DE ESPÉCIES MADEIREIRAS DE ROTAÇÃO MÉDIA EM ZONA DE FLORESTAS DENSAS, DE BAIXA ALTITUDE NA ÁFRICA OESTE E CENTRAL

Jean-Pierre Goudet
Centre Technique Forestier Tropical
FRANCE

Resumo

Os testes de procedências de espécies madeireiras de rotação média vêm sendo dirigidas, essencialmente, às seguintes espécies das zonas de florestas densas na África Central e Oeste:

— *Terminalia superba*	:	Costa do Marfim (1969)
— *Terminalia ivorensis*	:	Costa do Marfim (1972)
— *Cedrela odorata*	:	Costa do Marfim (1969)
— *Cordia alliodora*	:	África Central (1980)
	:	Costa do Marfim (1978)
	:	Congo (1979)
	:	África Central (1980)
— *Gmelina arborea*	:	Costa do Marfim (1978)

As espécies madeireiras de rotação média vêm despertando crescente interesse no programa de plantações nas zonas acima citadas.

Os ensaios de procedência constituem o primeiro estágio da seleção intra específica.

Para uma parte dessas espécies os ensaios estão sendo seguidos por trabalho de seleção individual, principalmente para a *Terminalia superba*.

ESSAIS PROVENANCES SUR LES ESPECES DE BOIS D'OEUVRE A MOYENNE REVOLUTION EN ZONE DE FORET DENSE DE BASSE ALTITUDE EN AFRIQUE DE L'OUEST ET CENTRALE

Resume

Les essais provenances sur les espèces de bois d'oeuvre à moyenne révolution ont essentiellement été orientés sur les espèces suivantes en zone de forêt dense en Afrique de l'Ouest et Centrale :

- Terminalia superba	:	Côte d'Ivoire (1969)
- Terminalia ivorensis	:	Côte d'Ivoire (1972)
- Cedrela odorata	:	Côte d'Ivoire (1969)
		Centrafrique (1980)
- Cordia alliodora	:	Côte d'Ivoire (1978
		Congo (1979)
		Centrafrique (1980)
- Gmelina arborea	:	Côte d'Ivoire (1978)

Une importance de plus en plus grande est accordée aux espèces de bois d'oeuvre à moyenne révolution dans le programme de plantations industrielles dans les zones considérées.

Les essais provenances cités constituent le premier stade de la sélection intraspécifique.

Pour une partie des espèces citées, ces essais sont actuellement suivis de travaux se rapportant à la sélection individuelle, en premier lieu sur Terminalia superba.

INTRODUCTION

En zone de forêt dense de basse altitude en Afrique de l'Ouest et Afrique Centrale, on note une importance de plus en plus grande accordée aux espèces de bois d'oeuvre "à moyenne révolution" dans les programmes de plantations industrielles. On peut en rappeler brièvement les raisons :

- les espèces considérées ont un "temps de récolte" compris entre 30 et 45 ans environ, ce qui justifie mieux leur utilisation en tenant compte des critères économiques par rapport aux espèces de bois d'oeuvre à "longue révolution" ("temps de récolte" largement supérieur à 70 ans)
- les espèces à longue révolution, telles que les espèces de la famille des Méliacées (en particulier Entandrophragma utile, Entandrophragma cylindricum, angolense, Lovoa trichilioides, etc.) ont des qualités technologiques en général supérieures mais d'une part leur sylviculture s'avère souvent très délicate et d'autre part leur croissance lente en plantation implique des révolutions dépassant 100 années.
- Rappelons néanmoins que parmi les espèces à longue révolution, les principales espèces suivantes semblent susceptibles d'être développées en plantation, sous certaines conditions : Khaya ivorensis et Heritiera utilis en forêt dense humide sempervirente et bien sûr Tectona grandis en forêt dense humide semi décidue.
- Les espèces à moyenne révolution les plus utilisées dans les programmes de plantation en cours (production de bois d'oeuvre) :
- Espèces originaires du Continent africain : les Terminalia (T. ivorensis, T. superba) - l'Obéché ou Samba (Triplochiton scleroxylon) - l'Okoumé (Aucoumea klaineana)
- Espèces originaires d'Amérique centrale : Cedrela odorata Cordia alliodora.
- Espèce asiatique : Gmelina arborea

Dans le domaine de l'amélioration du matériel végétal, les premiers essais ont concerné : pour une grande partie de ces espèces, la mise en place d'essais de provenances (sélection intraspécifique) qui font l'objet de la présente communication. Les essais que nous décrivons se rapportent à :

Terminalia ivorensis
Terminalia superba
Cedrela odorata
Cordia alliodora
Gmelina arborea

Les essais mis en place il y a une dizaine d'années au Gabon avec Aucoumea klaineana n'ont pu être correctement poursuivis.

Les essais d'amélioration concernant le Triplochiton sont orientés vers la sélection individuelle (multiplication par bouturage) compte tenu des problèmes posés par la fructification de cette espèce.

E S S A I S P R O V E N A N C E S S U R T E R M I N A L I A

Les travaux ont débuté en 1969 en COTE D'IVOIRE par la mise en place d'un essai provenances Terminalia superba, suivi en 1972 par un essai provenances Terminalia ivorensis

Essai provenances Terminalia superba en Côte d'Ivoire (1969)

Utilisation actuelle de l'espèce : plantée à l'état pur ou en mélange avec Terminalia ivorensis

Aire naturelle : espèce de forêt dense semi-décidue, en association avec Triplochiton scleroxylon. Aire très vaste s'étendant en Afrique de l'Ouest de la Guinée au Cameroun et en Afrique centrale au Zaïre et en Angola (Hémisphère Nord et Sud).

Origine des graines : essai réalisé à la suite d'une campagne de récolte organisée par le Centre Technique Forestier Tropical.

Lieu d'essai : Côte d'Ivoire, chantier de plantation de Mopri environ 100 km au Nord d'Abidjan - Latitude N : 5°50 - Longitude O 4°55 - Altitude : 80 m. - Sols type ferralitique moyennement désaturé sur granites. - Pluviométrie moyenne annuelle 1300 mm répartie d'Avril à Juillet et Octobre à Novembre. Cinq mois écologiquement secs (Nov. à Mars) Température moyenne annuelle 27°C.

Dispositif d'essai : lattice équilibré avec parcelle unitaire de 100 plants à 5 répétitions. Plantation en Juin 1969 sous forêt empoisonnée à écartement 10 m X 4 m (250 arbres à l'hectare).

Les provenances expérimentées : 16 provenances : voir tableau ci-après :

Pays origine	Station	Longitude	Latitude	Altitude m	Pluviométrie (mm)
Sierra Leone	Nongowe	-	-	-	-
Côte d'Ivoire	Gregbeu	6°47 O	7° N	250	1 500
Côte d'Ivoire	Abengourou	3°30 O	6°4 N	250	1 600
Côte d'Ivoire	Mopri	4°50 O	5°50 N	80	1 400
Ghana	Abofour	1°45 O	7° N	200	1 200
Ghana	Akotao	0°45 O	6° N	170	1 200
Ghana	Amantia	1°09 O	6°13 N	150	1 500
Bénin	Ouedo	2° E	7° N	100	1 050
Cameroun	M'Balmayo	11°30 E	3°5 N	600	1 550
Cameroun	Kumba	9°2 E	4°3 N	350	2 600
Cameroun	Kribi	10°35 E	2° N	100	3 000
R.C.A.	M'Baïki	18°2 E	4°5 N	360	1 500
Gabon	Oyem	11°5 E	1°5 N	650	1 700
Gabon	Mouila	11° E	1°5 S	200	2 300
Gabon	Tchibanga	11° E	2° S	200	1 400
Congo	Niari	12°3 E	3°15 S	50	1 040
Congo	Mayombé	12°5 E	4°3 S	250	2 000

Principaux résultats actuels :

Confirmation de la vigueur remarquable de l'espèce en plantation.

Différences significatives entre les provenances concernant la croissance et vigueur.

A noter les performances médiocres en Côte d'Ivoire des provenances de l'hémisphère Sud (Congo, Gabon) ; il est dommage que cet essai n'ait pu être complété par un essai semblable dans l'hémisphère Sud.

Actuellement, la sélection des provenances les plus vigoureuses permet d'orienter le choix des provenances pour les plantations de type industriel en Côte d'Ivoire, soit les origines C.I. (Gregbeu, Mopri), Ghana (Abofour, Amantia) etc...

La suite actuelle du programme d'amélioration en Côte d'Ivoire se rapporte d'une part à l'étude de la qualité du bois des différentes provenances, d'autre part au démarrage de la sélection individuelle.

Essai provenances Terminalia ivorensis en Côte d'Ivoire (1972)

Utilisation actuelle de l'espèce : plantation à l'état pur ou en mélange avec Terminalia superba.

Aire naturelle : en Afrique de l'Ouest depuis la Guinée jusqu'à l'Est Cameroun. Espèce de forêt dense humide sempervirente et semi-décidue.

Origine des graines : essai réalisé à la suite d'une campagne de récolte organisée par le C.T.F.T.

Lieu d'essai : Côte d'Ivoire, chantier de Mopri : voir essai précédent

Dispositif d'essai : lattice équilibrée à 5 répétitions et parcelles unitaires de 100 plants. Plantation en Juin 1972 sous forêt empoisonnée à écartement 8m X 3,3 (416 arbres/ha)

Les provenances expérimentées : 13 provenances : voir tableau ci-après.

Pays origine	Station	Longitude	Latitude	Altitude m	Pluviométrie (mm)
Côte d'Ivoire	Lovinguié	4°19 O	5°45 N	100	1 500
Côte d'Ivoire	Yapo	4°06 O	5°44 N	100	1 600
Côte d'Ivoire	Abengourou	3°30 O	6°43 N	260	1 300
Côte d'Ivoire	Bamo	4°13 O	5°56 N	80	1 500
Côte d'Ivoire	Mopri	4°50 O	5°50 N	80	1 400
Ghana	Pra Anum	1°15 O	6°15 N	150	1 650
Ghana	Bobiri	1°15 O	6°45 N	150	1 650
Ghana	Krokosua Hills	2°45 O	6°30 N	300	1 650
Ghana	N'Dumari	2°15 O	5° N	150	2 000
Ghana	Mankrang	2° O	7°15 N	300	1 400
Ghana	Tano Anhwia	2°30 O	5°45 N	150	1 650
Ghana	Volta River	0°	6° N	400	1 150
Cameroun	Kumba	9°2 E	4°32 N	350	2 600

Principaux résultats actuels

Confirmation de la vigueur remarquable de l'espèce en plantation;

Différences significatives entre les provenances concernant la croissance et la vigueur.

Utilisation actuelle de l'essai

- définition des meilleures provenances pour la sélection individuelle
- étude de la qualité du bois des provenances expérimentées.
- étude des phénomènes de dépérissement éventuels en fonction des provenances.

Essai complémentaire provenances Terminalia ivorensis au Cameroun (1980)

Sur les stations de Bilik et Belabo, mise en place en avril 1980 d'un essai portant sur 7 provenances de Terminalia ivorensis de Côte d'Ivoire comparées à une provenance de Bilik : liste des provenances de Côte d'Ivoire expérimentées :

origines MOPRI
TIASSALE
YAPO SUD
OUME
GREGBEU
MAN
SAN PEDRO.

ESSAIS PROVENANCES SUR CEDRELA ODORATA EN COTE D'IVOIRE (1969)

Utilisation actuelle de l'espèce :

Importance croissante en plantation à l'état pur sur défrichement mécanisé (en particulier en Côte d'Ivoire)

Origine des graines :

Essai réalisé à la suite d'une campagne de récolte organisée par le Commonwealth Forestry Institute d'Oxford avec le concours des différents pays d'Amérique latine.

Lieu d'essai :

Côte d'Ivoire, chantier de plantation de la Seguié
Latitude : 6°15 N
Longitude: 4°5 O
Altitude : 110 m
Sols type ferralitique moyennement désaturé sur roche mère granitique
Pluviométrie moyenne annuelle 1300 à 1500 mm répartie entre Avril-Juillet et Septembre-Octobre.
5 mois écologiquement secs (Novembre à Mars)
Zone de forêt dense humide semi-décidue
Température moyenne annuelle 27,7° C

Dispositif d'essai :

Blocs complets randomisés avec 4 répétitions, parcelles unitaires de 80 plants. Plantation en Juin 1969 sur terrain intégralement défriché mécaniquement. Ecartement 4 X 4 m.

Les provenances expérimentées :

7 provenances et une origine, Côte d'Ivoire.

N° C.F.I.	Provenances	Station	Latitude	Longitude	Altitude (m)	Pluviométrie en mm
67-7286	Costa Rica 1	-	10° N	85° O	150	1 800
67-7286	Costa Rica 2	-	9°5 N	88°4 O	600	2 500
67-7282	Honduras Belize	Chiquibil	16°4 N	88°5 O	210	1 530
67-7263	Mexique	Matamores	18°3 N	90°4 O	30	1 380
67-7232	Jamaïque	Ste Mary	18° N	77° O	500	2 000
67-729	Cuba	-	-	-	-	1 100
68-8273	Argentine	Misiones	27°3 S	55°2 O	400	1 800
-	Côte d'Ivoire	Comoé	-	-	200	1 900

Principaux résultats actuels :

Très grandes différences, très significatives, entre les provenances au niveau vigueur et forme, en particulier, vigueur remarquable et forme excellente de la provenance Belize Chiquibil. Résultats voisins avec la provenance Jamaïque Ste Mary et Mexique Matamores. Donc très grande variabilité infraspécifique de Cedrela odorata (vigueur et conformation) dans cet essai.

Mauvaises performances de la provenance Côte d'Ivoire et Argentine (normal vu le lieu de récolte)

Utilisation actuelle de l'essai : confirmation des meilleures provenances en vue de la sélection individuelle. Comparaison avec quelques provenances Ghana (Essai 1974 à La Téné), dont on obtient des graines facilement (vergers à graines).

Etude de la qualité du bois des provenances expérimentées :

Il semble selon les premiers résultats, que le bois des Cedrela de plantation en Côte d'Ivoire ait une densité particulièrement faible (à confirmer sur un plus grand nombre d'échantillons).

Par ailleurs, mise en évidence de la nécessité d'une forte densité à la plantation (même pour les provenances les mieux conformées) pour obtenir un bon élagage et un fût droit (densité souhaitable 3 X 3 m)

A noter au Congo (Station de Malolo), la mise en place en 1979 d'essais provenances restreints sur :

- Cedrela odorata : 2 provenances (Ghana et Costa Rica)
- Cedrela augustifolia : 1 provenance (Honduras)
- Cedrela tonduzii : 1 provenance (Costa-Rica)

Excellente croissance initiale pour Cedrela odorata et augustifolia.

A noter en République Centrafricaine la mise en place en 1980 (Station de M'Baiki) d'un essai provenance Cedrela odorata.

ESSAIS PROVENANCES SUR CORDIA ALLIODORA EN COTE D'IVOIRE ET AU CONGO

Essai provenances Cordia alliodora en Côte d'Ivoire (1978)

Utilisation actuelle de l'espèce : seulement plantations expérimentales avant utilisation au stade industriel.

Aire naturelle : en Amérique centrale et du Sud du 25e degré de latitude Nord au Mexique au 25e degré de latitude Sud dans l'état de Misiones. Aire très vaste qui justifie pleinement les essais provenances entrepris.

Origine des graines : essai réalisé à la suite d'une campagne de récolte sous l'égide de la FAO, organisée par le CFI d'Oxford.

Lieux d'essai : Stations de San Pedro, l'Anguédédou, La Sangoué.

	San Pedro	Anguédédou	La Sangoué
Latitude	4°45 N	5°23 N	6°20 N
Longitude	6°38 N	4° O	5°30 O
Altitude	O	O	200 m
Pluviométrie moyenne annuelle	1950 mm	2031 mm	1342 mm
Température annuelle moyenne	26°C	27°C	26°C
Végétation	Forêt dense humide sempervirente	Forêt dense humide sempervirente	Forêt dense humide semi-décidue

Dispositif d'essai :

Blocs complets randomisés ; 3 répétitions ; parcelles unitaires 88 et 70 plants ; plantations mai-juin 1978 sur défrichement intégral. Ecartement 3 X 4 m ; 3,75 X 3,75 m ; 4 X 4 m

Les provenances expérimentées : 11 provenances

N° international	Provenances	Latitude N	Longitude E	Altitude	Pluie mm	Lieux(1) d'essai
9/77	Honduras Tres Piedras	13°02	87°04	110	1850	A
19/77	Honduras Finca La Fortuna	15°36	87°58	210	1048	A - S
20/77	Honduras San Francisco	15°40	87°02	50	2680	A
14/77	Nicaragua Esteli	13°02	86°19	900	-	A - S
18/77	Nicaragua La Pineda	12°45	85°45	750	-	A - S
10/77	Guatemala El Chilero	14°23	90°28	1400	-	A - S
13/77	Colombia valle de Cauca	4°41	75°46	1600	2400	A
33/77	Costa Rica Limon	10°	84°	50	5000	A - S
35/77	Equateur Lago Agrio	1°30	77°	300	3000	A
1/77	C.Ivoire Yapo	5°44	4°06	80	1600	A - S
16/77	Nicaragua Waswali	12°55	85°58	675	-	A - S

(1) A : Anguédédou P : San Pedro S : La Sangoué

Principaux résultats actuels :

Les toutes premières observations montrent que les provenances de Cordia alliodora se différencient à un stade très précoce sur le plan morphologique.

Les inventaires à venir porteront sur la vigueur, la forme, l'état phytosanitaire. Les essais antérieurs de comportement mis en place à Anguédédou (1968-70) ont montré une croissance initiale rapide.

Observations à poursuivre avant l'utilisation de l'espèce au stade industriel en Côte d'Ivoire.

Essai provenances Cordia alliodora au Congo (1979)

Utilisation actuelle de l'espèce : espèce non encore expérimentée jusqu'à cette date.

Origine des graines : essai réalisé avec le CFI d'Oxford, fournisseurs des graines.

Lieux d'essai : stations de Malolo et Loudima

Dispositif d'essai : plantation en layons de 150 m espacées de 10 m (2 layons par provenance). Ecartement des plants sur le layon : 3 m. Plantation en Novembre 1979 (station de Malolo). Sur la station de Loudima, plantation des Cordia en mélange avec le Terminalia ivorensis (1 plant sur 2). Ecartement 10 X 10 m. Plantation en Décembre 1979.

Les provenances expérimentées à Malolo et Loudima :

N° intern.	Provenances	Stations
9/77	Honduras	Tres Piedras
19/77	Honduras	Finca la Fortuna
20/77	Honduras	San Francisco
14/77	Nicaragua	Esteli
18/77	Nicaragua	La Pineda
10/77	Guatemala	El Chilero
13/78	Fidji	Nukurua
17/78	Puerto Rico	Caguas
21/78	Colombie	Ulloa valle
33/78	Nicaragua	Nueva Guinea
30/78	Guatemala	Retalhuleu
51/78	Costa-Rica	Turrialba
52/78	Costa Rica	Limon
53/78	Costa Rica	San Carlos

Observations actuelles: il est encore trop tôt pour donner des commentaires sur ces essais sinon que le comportement actuel des Cordia est très bon, sur le plan de la vigueur en particulier.

A noter en République Centrafricaine en 1980, la mise en place (station de Bimbo) d'un essai provenance Cordia alliodora (5 provenances).

ESSAIS PROVENANCES SUR GMELINA ARBOREA EN COTE D'IVOIRE (1978)

Utilisation actuelle de l'espèce :

Non utilisée en Côte d'Ivoire actuellement en plantation de bois d'oeuvre ; seulement à titre expérimental pour la production de bois de pâte à papier.

Origine des graines : essai réalisé en liaison avec le DAN/FAO Forest Tree Seed Centre qui a fourni les graines.

Lieux d'essai : stations de San Pedro et La Sangoué.

	San Pedro	La Sangoué
Latitude	4°45 N	6°20 N
Longitude	6°38 O	5°30 O
Altitude	O	200 m
Pluviométrie annuelle	1950 mm	1342 mm
Température moyenne annuelle	26°C	26°C
Végétation	Forêt dense humide sempervirente	Forêt dense humide semi-décidue

Dispositif d'essai :

Sangoué : Lattice équilibrée - 4 répétitions
San Pédro : Blocs incomplets équilibrés - 3 répétitions
Ecartements 3,75 x 3,75
4 m x 4 m
Plantation en Juin 78 sur défrichement intégral mécanisé.

Les provenances expérimentées : 13 provenances au total

N° DAN/FAO	Provenances	Latitude N	Longitude E	Altitude	Pluies mm	Lieux d'essais(1)
4002	Thaïlande Muag Lak	14°37	101°07	250	1200	S
4006	Inde Mahilong	23°30	85°30	600	1440	S
4008	Inde Ghotil	17°14	73°57	1000	850	S
4011	Inde Bilaspur	22°23	82°		1500	S
4016	Inde Kundrukutu	20°30	85°20	600	1400	S P
4017	Inde Nongpoh	25°46	91°46	500	2500	P
4020	Inde Gujarat	20°44	73°41	400	2000	P
4024	Inde Karnataka	12°12	76°05	850	1400	S
4027	Inde Tripura B.	23°46	91°34	120	2200	S P
4028	Inde Tripura S.	24°13	92°07	200	2300	S
4030	Inde Assan Odah	26°	93°	100	1800	P
4033	Inde Tarmilnadu	10°27	76°51	600	1700	P
-	Côte d'Ivoire Bamoro	7°50	5°40	300	1100	S P

(1) S : Station Sangoué P : station San Pedro

Observations actuelles : seulement premier inventaire en cours.

POSIÇÃO DO TESTE DE PROCEDÊNCIA INTERNACIONAL DE *Pinus pseudotrobus* LINDL. (INCLUINDO *Pinus tenuifolia* BENTH)

A. Greaves
Commonwealth Forestry Institute
Oxford University
ENGLAND

Resumo

A distribuição de sementes para testes de procedências internacionais de *Pinus pseudostrobus* Lindl. começou em 1976. O teste está sob coordenação conjunta do Instituto Nacional de Investigações Florestais – México e Commonwealth Forestry Institute, UK.

INTRODUCTION

Pinus pseudostrobus Lindl. is indigenous to the cooler and wetter upland sites of Central America and Mexico between 13° 12' N and 26° N. Critchfield considered the species to include the "doubtfully distinct" Pinus tenuifolia Benth. The exploration, evaluation and conservation of both species was assigned first priority status in the Global Programme for Improved Use of Forest Genetic Resources (FAO, 1975; 1977). Since 1970 the Commonwealth Forestry Institute (CFI) and the Instituto Nacional de Investigaciones Forestales (INIF) have made provenance seed collections in Central America and Mexico respectively. The distribution of these provenances for the P. pseudostrobus international provenance trial commenced in 1976 with INIF being responsible for coordinating the experiments in Latin America whilst the CFI coordinates the work throughout Africa and Asia.

SEED COLLECTION AND DISTRIBUTION

Twenty three provenance seed collections were acquired, comprising 14 from Central America and 9 from Mexico (see Appendices 1 and 2), from which seed allocations were made to countries that requested to be included in the trial (see Appendix 3). It was recommended that a randomised complete block experimental design with 5 replications should be used. This well-tried and robust design has proved to be very satisfactory for provenance trials of tropical pines. The advised plot size was 49 trees (7 x 7 rows) at 3m spacing with the outside row used as a boundary and the assessments confined to the inner 25 trees (5 x 5 rows). The wide spacing delays the onset of competition and accentuates differences in crown form. The plot size is sufficient for thinning to be carried out without reducing the number of trees to an unacceptably low level thus prolonging the useful life of the trial.

INTERNATIONAL COOPERATION

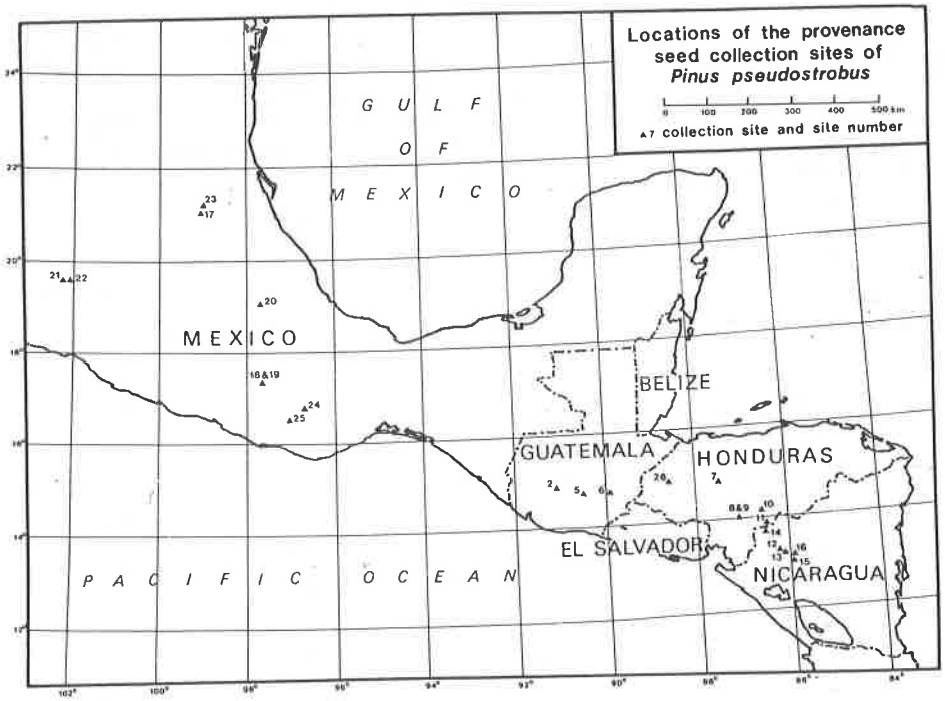
Assessment data have not been published, but the CFI in cooperation with INIF will collate information as it becomes available on behalf of the international provenance trial collaborators, thus facilitating the rapid evaluation of the provenances.

REFERENCES

FAO (1975). Forest Genetics Resources Information No. 4 Forestry Occasional Paper, FAO, Rome 1975/1 68 pp.

—— (1977). Report of the fourth session of the FAO Panel of Experts on Forest Gene Resources, held in Canberra, Australia, 9 11 March 1977. Rome; FAO FO: FGR/4/Rep. 75 pp.

Appendix 1



Appendix 2

SEED COLLECTIONS OF PINUS PSEUDOSTROBUS PROVENANCES

Site No.	Collector's No.	Store No.	Country	Site	Latitude	Longitude	Altitude (m)
PP 2	K 75	10/72	Guatemala	Tecpan	14° 50'N	91° 05'W	2,200
PP 5	K 63	42/71	Guatemala	San Juan	14° 43'N	90° 40'W	1,800
PP 6	K 51	18/73	Guatemala	Jalapa	14° 42'N	89° 57'W	1,300
PP 7	K104	2/74	Honduras	Loma de Ochoa	14° 48'N	87° 30'W	1,200
PP 8	K119	10/75	Honduras	Cofradia	14° 00'N	87° 06'W	1,300
PP 9	K 77	11/72	Honduras	Tatumbla	14° 02'N	87° 05'W	1,600
PP10	K121	20/75	Honduras	La Fortuna	14° 10'N	86° 35'W	1,250
PP11	K122	21/75	Honduras	El Cedro	13° 48'N	86° 35'W	1,100
PP12	K 95	13/73	Nicaragua	Volcan Yali	13° 15'N	86° 11'W	1,400
"	K105	9/74	"	"	"	"	"
PP13	K 50	28/71	Nicaragua	Rafael	13° 12'N	86° 06'W	1,200
PP14	K131	4/76	Nicaragua	Dipilto	13° 43'N	86° 30'W	1,100
PP15	K132	7/76	Nicaragua	Jinotega	13° 02'N	85° 59'W	1,450
"	K149	27/77	"	"	"	"	"
PP16	K133	8/76	Nicaragua	Dantali	13° 08'N	85° 57'W	1,050
"	K172	37/78	"	"	"	"	"
PP17	INIF 343	-	Mexico	Nogales	20° 59'N	99° 14'W	2,250
PP18	INIF 429	-	Mexico	Tlaxiaco	17° 20'N	97° 40'W	2,200
PP19	INIF 438	-	Mexico	Boca del Perro	17° 21'N	97° 40'W	2,000
PP20	INIF 459	-	Mexico	San Salvador	19° 01'N	97° 41'W	2,400
PP21	INIF 476	-	Mexico	Angahuan	19° 30'N	102° 14'W	1,780
PP22	INIF 485	-	Mexico	North Uruapan	19° 31'N	102° 06'W	1,634
PP23	INIF 495	-	Mexico	Minas Viejas	21° 11'N	99° 00'W	2,000
PP24	INIF 500	-	Mexico	San Vicente Lachixio	16° 29'N	97° 05'W	2,200
PP25	INIF 501	-	Mexico	San Pedro el Alto	16° 45'N	96° 45'W	2,600
PP26	K150	30/77	Honduras	Dulce Nombre	14° 52'N	88° 49'W	1,200

Appendix 3

COUNTRIES PARTICIPATING IN THE CFI COORDINATED P. PSEUDOSTROBUS INTERNATIONAL PROVENANCE TRIAL

Australia, Burma, China, India, Morocco, Mozambique, Nepal, Pakistan, Papua New Guinea, Philippines, South Africa, Tanzania, Thailand.

VARIAÇÃO GENÉTICA ENTRE PROCEDÊNCIAS DE DUAS ESPÉCIES DE ACÁCIA NEGRA

(Acacia decurrens E *Acacia mearnsii)*

A. N. Kalil Filho, C. L. S. Pires e W. J. M. de Souza
Instituto Florestal
C. L. de Souza Júnior
EMBRAPA
BRASIL

Resumo

Variação genética de 7 procedências de Acácia Negra, 4 delas de *Acácia decurrens* Wendl (Willd) e 3 de *Acácia mearnsii* de Willd, foi estudada na E.E. de Avaré, Estado de São Paulo. As características incluídas neste estudo foram altura total, DAP, ângulo e espessura dos ramos. Depreendeu-se dos resultados obtidos, que as características altura e DAP das plantas possuem maior variação genética que ângulo e espessura dos ramos entre as procedências de *Acácia mearnsii*, podendo portanto, estes caracteres serem mais facilmente manuseados pelo melhoramento. Estudando-se as correlações entre as características e entre diferentes idades, achou-se correlações positivas e significativas para DAP ao 1º e 2º ano, e correlação negativa e significativa entre altura e espessura dos ramos, para procedências de *Acacia decurrens*. Achou-se correlações positivas e significativas para altura no 1º e 2º ano, DAP ao 1º e 2º ano, DAP para o 1º e 2º anos, ângulo dos ramos e altura e ângulo dos ramos e altura, para procedências de *Acacia mearnsii*.

Summary

Genetic variation of seven provenances of Black wattle, four of them of *Acacia decurrens* Wendl (Willd) and three of *Acacia mearnsii* de Willd, was studied at the Avaré Experiment Station in the Florestry Institute, S. Paulo state. The characteristics included in this study were height growth, DBH, angle of branches and thickness branches. It was showed the ocurrence of a high participation of the genetic variation in the total variance for height growth and DBH only between provenances of *Acacia mearnsii*. Angle and thikness of branches presented a small genetic variation not detected for the analysis of variance, both for *Acacia mearnsii* and *Acacia decurrens*.

Correlations between plant characteristics and between different ages showed positive and significant correlation for DBH between the first and second year, and negative and significant correlation between height and thickness of branches, for provanances of *Acacia decurrens*. Positive and significant correlations were found height between the first and second years, DBH between first and second years, between DBH and height for the first and second years, between height and angle of branches, and between DBH and angle of branches, for provenances of *Acacia mearnsii*.

INTRODUÇÃO

As espécies *Acacia decurrens* (Wendl) Willd e *Acacia mearnsii* De Wild representam a terceira cultura econômica florestal no Brasil, extraindo-se delas o tanino para exportação e consumo interno. Aproveita-se também a madeira para celulose e outros fins.

Pelo fato dessas espécies não possuírem nenhum estudo sobre variação genética para condições brasileiras, justifica-se a apresentação deste trabalho.

MATERIAL E MÉTODOS

O material utilizado consta da Figura 1, mostrado a seguir.

O experimento foi instalado na Estação Experimental de Avaré (SP) no ano de 1977, em delineamento de blocos casualizados com 4 repetições. Cada parcela é composta de 25 plantas, sendo 9 úteis e 16 de bordadura.

Avaré possui latitude 23°03'S, longitude 48°35'W, altitude 751/860 metros, solo RPV e RLV, temperaturas: máxima de 22,0°C, média de 19,0°C e mínima de 15,3°C, e precipitação média anual de 1274 mm.

Foram tomados dados dos seguintes caracteres: altura (H) e DAP em 1978 (1 ano de idade) e 1979 (2 anos de idade), Espessura dos Ramos (ER) em 1979 (2 anos) e Ângulo dos Ramos (AR) em 1979 (2 anos).

A espessura dos ramos considerada foi a média de 4 ramos à altura do D.A.P. Foram medidos os ângulos dos mesmos ramos usados na

mensuraçao da espessura dos ramos, e considerada a média dos ângulos, KAGEYAMA (1977).

O método para cálculo do coeficiente de correlação de Spearman, apresentado por KAGEYAMA (1977), é dado ple fórmula:

$$r_s = 1 - \frac{6\ di^2}{(n-1)\ (n)\ (n+1)}$$, sendo:

r_s = coeficiente de correlação de Spearman;
6 = constante;
di = diferenças entre as posições para as 2 características;
n = nº de valores (procedências para cada grupo).

As procedências 1, 2, 3 e 7 são da espécie *decurrens*, chamada de grupo P_1, e as procedências 4, 5 e 6 são da espécie *mearnsii*, chamada de grupo P_2, estudadas separadamente.

Os testes de significância dos valores de r_s, é feito pelo teste t, dado pela fórmula.

$$t = \frac{r_s\ (n-2)}{1-r_s^2}$$

Foram calculados os coeficientes de Spearman para correlacionar alturas entre o 1º e o 2º ano de idade, D.A.P. entre o 1º e o 2º ano de idade, e entre todas as 4 características, tomadas duas a duas, para o 2º ano de idade.

O esquema utilizado para a Análise de Variância, bem como as Esperanças dos Quadrados médios são apresentados abaixo:

FV	G.L.	Q.M.	E(Q.M.)
Blocos	(B - 1)		$\sigma^{2'} + r\ V_P^2$
Procedências	(P - 1)		
Entre P_1 e P_2	(t - 1)		
P_1	(P_1 - 1)	Q_1	$\sigma^{2'} + r\ V_{P_1}^2$
P_2	(P_2 - 1)	Q_2	$\sigma^{2'} + r\ V_{P_2}^2$
Resíduo	(B - 1)(P - 1)	Q_3	

onde: B = nº de blocos, P = nº de procedências
t = nº de grupos de procedências = 2
P_1 = Procedências nºs. 1, 2, 3 e 7 de *A. decurrens*
P_2 = Procedências nºs. 4, 5 e 6 de *A. mearnsii*
V^2 = Variância genética entre procedências (efeito considerado fixo)
$\sigma^{2'}$ = Variância ambiental (efeito considerado aleatório).

O método para se determinar o coeficiente de determinação genotípica foi apresentado por FONSECA (1978), e consta das seguintes fórmulas:

$$V_{P_1}^2 = \frac{Q_1 - Q_3}{r}\ ; \qquad b_{P_1} = \frac{V_{P_1}^2}{V_{P_1}^2 + \sigma^{2'}}$$

$$V_{P_2}^2 = \frac{Q_2 - Q_3}{r}\ ; \qquad b_{P_2} = \frac{V_{P_2}^2}{V_{P_2}^2 + \sigma^{2'}}$$, sendo

$V_{P_1}^2$, $V_{P_2}^2$ = Variâncias genéticas entre procedências dos grupos P_1 e P_2 respectivamente; (efeito considerado fixo);
b_{P_1}, b_{P_2} = Coeficientes de determinação genotípica para procedências dos grupos P_1 e P_2, respectivamente;
Q_1, Q_2, Q_3 = Quadrados médios dos grupos P_1 e P_2, e resíduo, respectivamente;

r = nº de repetições;
$\sigma^{2'}$ = variância ambiental (efeito considerado aleatório).

O coeficiente de determinação genotípica mostra a quantidade de variância total que é devida a efeitos genéticos entre procedências.

RESULTADOS

A seguir é mostrado o quadro da Análise de Variância para as 4 características.

FV	Q.M. H		Q.M. D.A.P.		Q.M. ER	Q.M. AR
	1º ano	2º ano	1º ano	2º ano	2º ano	2º ano
Blocos	0,43	1,39	0,60	0,91	0,05	7,84
Procedências	5,40**	15,87**	2,90**	10,65**	0,076	102,64**
P_1	1,32	4,17**	0,37	1,19	0,087	23,17
P_2 6	9,08**	24,63**	3,75**	17,52**	0,02	20,63
Entre P_1 e P_1	10,32**	33,46**	8,83**	24,40	0,16	505,11**
Resíduo	0,73	0,76	0,24	0,44	0,038	23,04
CV (%)	25,66	14,75	25,70	16,90	32,80	6,70

H = Altura; D.A.P. = Diâmetro à altura do peito;
ER = Espessura dos Ramos; AR = Ângulo dos ramos.

FIGURA 1.- Procedências e dados locais de Acacia Negra (*Acacia decurrens* e *Acacia mearnsii*)

Espécies		Latitude	Longitude	Altitude (m)
1. *A. decurrens*	Central Sidney Coast - N.S.W. Austrália	34°00'	151°00'E	60
2. *A. decurrens*	Coulburn - N.S.W. - Austrália	34°00'	149°00'E	60
3. *A. decurrens*	Dalby - Q.L.D. - Austrália	27°12'	151°12'E	330
4. *A. mearnsii*	General Câmara - R.S. - Brasil	29°53'	51°12'	
5. *A. mearnsii*	Semente comercial - África do Sul			
6. *A. mearnsii*	Piet Retief-S.E.I.-Transvaal-Africa do Sul	29°45'	31°00'E	1260
7. *A. decurrens*	Mt Frere - Transkey - África do Sul	30°54'	28°59'E	60

TABELA 1 - Coeficiente de correlação de Spearman, entre as 4 características, e para altura e D.A.P. entre o 1º e 2º ano de idade, para o grupo P_1:

Características	H 1º ano	H 2º ano	DAP 1º ano	DAP 2º ano	ER 2º ano	AR 2º ano
Altura 1º ano	-	-	-	-	-	-
Altura 2º ano	0,8	-	-	-	-1**	-0,4
DAP - 1º ano	0,4	-	-	-	-	-
DAP - 2º ano	-	0,8	1*	-	-0,8	-0,8
ER - 2º ano	-	-	-	-	-	0,4
AR - 2º ano	-	-	-	-	-	-

TABELA 2 - Coeficiente de correlação de Spearman, entre as 4 características, e para altura e D.A.P. entre o 1º e 2º ano de idade, para grupo P_2:

Características	H 1º ano	H 2º ano	DAP 1º ano	DAP 2º ano	ER 2º ano	AR 2º ano
Altura 1º ano	-	-	-	-	-	-
Altura 2º ano	1*	-	-	-	0,5	1*
DAP - 1º ano	1*	-	-	-	-	-
DAP - 2º ano	-	1*	1*	-	0,5	1*
ER - 2º ano	-	-	-	-	-	0,5
AR - 2º ano	-	-	-	-	-	-

TABELA 3 - Variâncias genéticas entre procedências (V_{P_1} para o grupo P_1 e V_{P_2} para o grupo P_2) e coeficiente de determinação genotípica (b_{P_1} para o grupo P_1) e b_{P_2} (para o grupo P_2):

Características	V_{P_1}	V_{P_2}	b_{P_1}	b_{P_2}
Altura - 1º ano	0,1475	2,0875	0,1681	0,7409
Altura - 2º ano	0,8600	0,5970	0,5285	0,8910
DAP - 1º ano	0,0325	0,8775	0,1192	0,7850
DAP - 2º ano	0,1875	4,2700	0,2980	0,9065
ER - 2º ano	0,0120	0,0045	0,2380	0,1050
AR - 2º ano	0,0325	0,6025	0,140	0,2690

DISCUSSÃO E CONCLUSÕES

A significância dos valores de F para os caracteres altura ao 2º ano de idade (grupo P_1) e ao 1º e 2º ano de idade (grupo P_2) e DAP ao 1º e 2º ano de idade (grupo P_2) revela a existência de variação genética ao nível de procedências.

Os coeficientes de determinação genotípica, são semelhantes aos coeficientes de herdabilidade, diferindo pelo fato dos tratamentos (procedências) serem fixos e não aleatórios.

Foi observado que os caracteres mencionados acima, cujos valores de F deram significativos, apresentaram altos valores para o coeficiente de determinação genotípica, conforme tabela 3, indicando que esses caracteres são menos influenciados pelo ambiente e que portanto podem ser mais facilmente manuseados pelo melhoramento.

A não significância de F para os caracteres, altura ao 1º ano (grupo P_1) DAP ao 1º e 2º ano de idade (grupo P_2), espessura e ângulo dos ramos ao 2º ano de idade (grupos P_1 e P_2) indica que não foi detectada a existência de variação genetica do nível de procedências.

Foi verificado que esses valores de F não significativos apresentaram coeficientes de determinação genotípica baixos, conforme tabela 3.

De uma maneira geral, os caracteres altura e DAP apresentaram uma variação genética maior que espessura e ângulo dos ramos, para o grupo P_2 de procedências, indicando que podem ser mais facilmente manuseados pelo melhoramento.

Entre os coeficientes de correlação de Spearman, foram significativas ao nível de 5%, as correlações entre DAP ao 1º e 2º ano de idade e altura e espessura dos ramos, para o grupo P_1. Também foram significativas as correlações entre altura ao 1º e 2º ano, DAP ao 1º e 2º ano, DAP e altura para o 1º e 2º anos; ângulo dos ramos e altura , e ângulo dos ramos e DAP, para o grupo P_2.

Estudos posteriores incluindo outras características em outras condições ambientais poderão ser conduzidos para se obterem maiores informações a respeito da variação genética dessas espécies em condições brasileiras.

BIBLIOGRAFIA

Fonseca, T.C., 1978. Estimação de parâmetros visando a seleção de híbridos artificiais de amoreira (*Morus alba* L.) - Dissertação de Mestrado, ESALQ/USP, Piracicaba, SP, 51 p.

Kageyama, P.Y., 1977. Variação genética entre procedências de *Pinus oocarpa* Schiede na região de Agudos - SP - Dissertação de Mestrado, ESALQ/USP, Piracicaba, SP, 83 p.

PROGRAMA DE MELHORAMENTO GENÉTICO FLORESTAL DA EMBRAPA NA AMAZÔNIA BRASILEIRA

M. Kanashiro
EMBRAPA/IBDF
BRASIL

Resumo

Este trabalho trata do programa de melhoramento genético florestal que vem sendo desenvolvida pela EMBRAPA/CPATU, na Amazonia brasileira. Comenta sobre as espécies investigadas, sobre as particularidades envolvidas em trabalhos de melhoramento e as espécies em perspectivas de estudo. Menciona também resultados preliminares sobre propagação vegetativa de freijó (*Cordia goeldiana*) atualmente, espécie de maior interesse na pesquisa florestal.

Summary

This paper deals with the forestry genetic improvement programme that has been develope by EMBRAPA/CPATU in Brazilian Amazon. Commentaries are done about the investigated species, particularaties in improvement works and the species that will be investigate in the future. The paper also relates preliminar results of vegetative propagation in *Cordia goeldiana* (freijó) which the main specie in the forestry research actually.

INTRODUÇÃO

No campo de melhoramento genético florestal, as pesquisas da EMBRAPA/CPATU na Amazônia estão em fase inicial.

Em uma das consultas mundiais FAO/IUFRO sobre melhoramento de espécies florestais, as florestas tropicais receberam consideravel atenção. Ficou clara a necessidade da maioria dos países tropicais desenvolver suas próprias fontes de sementes de espécies de interesse e procedências adequadas. Para tanto é necessário ensaiar uma variada gama de espécies tropicais (BURLEY, 1969).

Na fase inicial de um programa de melhoramento genético florestal os conhecimentos básicos de genética para a seleção de popula

ções de espécies/procedências são imprescindíveis. Outros conhecimentos também são de grande importância como a escolha adequada de delineamentos, a determinação de tamanho das parcelas e a interpretação estatístico-genética dos resultados. Deve-se dar ênfase especial à interação de populações com o ambiente, no que diz respeito a interpretação genética (KAGEYAMA, 1980).

O programa de melhoramento genético florestal da EMBRAPA/CPATU tem como objetivos: a) conhecer as espécies e o comportamento de suas populações, aplicando as informações obtidas aos trabalhos de melhoramento, e b) suprir a necessidade de sementes identificadas, para utilização em plantações e em programas de melhoramento genético.

ESPÉCIES EM ESTUDO

Os trabalhos da EMBRAPA/CPATU vem sendo desenvolvidos no Campo Experimental de Belterra, localizado cerca de 50 Km da cidade de Santarém-PA. A altitude é de 175 m e as coordenadas geográficas são 02°38' S e 54°57' W.

A coleta rotineira de sementes das espécies nativas de interesse é efetuada na capoeira de Belterra e na Floresta Nacional do Tapajós.

Espécies nativas

Embora haja muitas espécies nativas potenciais na região, um número reduzido tais como freijó (*Cordia goeldiana*), morototó (*Didymopanax morototoni*) e castanha-do-Brasil (*Bertholletia excelsa*) representa atualmente quase que a totalidade dos experimentos do programa de melhoramento genético.

Espécies exóticas

O amplo número de espécies nativas não elimina a possibilidade de que algumas espécies exóticas bem adaptadas às condições ecológicas da região sejam aproveitadas de forma adequada.

A investigação destas espécies deve-se ao fato de que os conhecimentos para o seu cultivo e para o aproveitamento de suas madeiras são consideráveis. Estas espécies poderão ser utilizadas na ocupação de terras para as quais não haja espécies nativas de igual potencial produtivo ou aptas às finalidades desejadas.

Entre as exóticas em estudo há espécies/procedências de *Pinus* e *Eucalyptus* e procedências de *Cordia alliodora* da América Central. Este último ensaio vem sendo desenvolvido em cooperação com a Commonwealth Forestry Institute. O interesse por *Cordia alliodora* no Brasil é recente; a espécie tem sido constatada em várias áreas da Amazônia brasileira, como em Ouro Preto (Rondônia), Itaituba e Altamira (Pará).

DIFICULDADES PARA A PESQUISA

A grande dificuldade para a pesquisa no campo de melhoramento genético é a obtenção de sementes de base genética conhecida. Além disto, as sementes da maioria das espécies apresentam períodos curtos de viabilidade, não estando ainda definidos métodos eficazes para sua conservação. Outro problema é que as espécies apresentam flutuações acentuadas quanto a produção de sementes. Como exemplo, na região de Santarém indivíduos de quaruba verdadeira (*Vochysia maxima*) apresentam períodos de boa produção a cada 3-4 anos.

Por outro lado, as dificuldades de acesso na Amazônia pela falta de rodovias dificulta e onera consideravelmente os trabalhos de pesquisa.

ESTÁGIO ATUAL E PERSPECTIVAS

A escolha das espécies em estudo baseou-se na experimentação iniciada em 1974 pelo Projeto de Desenvolvimento e Pesquisa Florestal (PRODEPEF, extinto em 1978). Este projeto instalou diversos ensaios comparativos de espécies nativas, entre outros experimentos.

Embora já se tenha chegado a algumas espécies promissoras como freijó (*Cordia goeldiana*), morototó (*Didymopanax morototoni*) e outras, novos ensaios comparativos são instalados anualmente, para se obter dados sobre outras espécies.

Entre as espécies nativas, freijó é no momento a de maior importância. Suas pesquisas vão desde a produção e conservação de sementes à plantios em capoeiras e a plena luz, incluindo consórcios agro-florestais e silvo-pastoris.

Objetivando conhecer a estrutura genética da população de freijó e possíveis diferenças existentes em função dos locais de sua adaptação, ensaios de progênies e de procedências serão instalados.

Para o ensaio de progênies deverão ser testadas matrizes da floresta natural e de plantações para analisar o desenvolvimento das progênies originadas de duas populações estruturalmente distintas.

No ensaio de procedências deverão ser fixados os critérios básicos de amostragem sobre aspectos como o número mínimo de indivíduos e a distância entre eles, na tentativa de formar lotes representativos da população. A amostragem em florestas naturais não obedece um mesmo critério para todas as espécies, visto que as populações ocorrem de modo diferente. Por exemplo em populações de freijó a frequencia observada é em torno de 0,1 a 0,6 árvore/ha (segundo HEINSDIJK & BASTOS, 1963, citado por RIZZINI, 1971); por sua vez a castanha-do-Brasil comumente supera 3 árvores/ha. Por esta razão a amostragem nos povoamentos de castanha-do-Brasil pode ser mais intensa quando comparada com o freijó.

Em termos de propagação vegetativa conseguiu-se 25% de enraizamento nas estacas de brotação de freijó, sem utilização de hormônios. As estacas adultas coletadas no período que antecede ao florescimento também mostraram ser promissoras ao enraizamento. Novos experimentos deverão ser instalados, utilizando hormônios de enraizamento. Espera-se obter resultados positivos.

Quanto a enxertia, em testes preliminares o freijó apresentou resultados favoráveis, com porcentagem de pegamento de 70% e boa soldadura entre o porta-enxerto e enxerto. Os experimentos seguintes serão montados de maneira a serem analisados estatisticamente.

Os resultados de propagação vegetativa deverão ser empregadas principalmente na conservação genética da espécie (através de bancos de germoplasma) e na produção de sementes melhoradas.

A medida que estudos forem realizados, outras espécies promissoras deverão ser estudadas mais detalhadamente. Citam-se por exemplo, quaruba verdadeira (*Vochysia maxima*), marupá (*Simaruba amara*), tatajuba (*Bagassa guianensis*), tachi branco (*Sclerolobium paniculatum*), angelim pedra (*Dinizia excelsa*) e as meliáceas *Carapa guianensis* e *Swietenia macrophylla*, pelo potencial silvicultural e econômico que as mesmas apresentam (VOLPATO *et alii*, 1972; SUDAM, 1979; YARED & CARPANEZZI, 1980 e observações pessoais do autor).

EXPERIMENTAÇÃO PROGRAMADA

Experimentos instalados em 1980

Ensaios comparativos de espécies nativas a pleno sol - fase eliminatória

Teste de espécie/procedência do gênero *Pinus*

Teste de espécie/procedência do gênero *Eucalyptus*

Teste de procedências de *Cordia alliodora* da América Central

Propagação vegetativa de freijó (*Cordia goeldiana*) através de estaquia e enxertia

Experimentos a serem instalados em 1981

Teste de procedências de castanha-do-Brasil (*Bertholletia excelsa*)

Teste de procedências de morototó (*Didymopanax morototoni*)

Teste de procedências de freijó (*Cordia goeldiana*)

Teste de progênie por polinização cruzada de freijó (*Cordia goeldiana*)

Ensaio comparatico de espécies nativas - fase eliminatória

REFERÊNCIAS BIBLIOGRÁFICAS

BURLEY, J. Metodologia de los ensaios de procedencia de especies forestales. *Unasylva*, Roma, 23(3): 24-28. 1969.

KAGEYAMA, P.Y. *Pesquisa em melhoramento genético no cerrado*. Palestra ministrada no Centro de Pesquisa Agropecuária do Cerrado. Planaltina. 1980. 2p.

RIZZINI, C.T. *Árvores e madeiras úteis do Brasil. Manual de dendrologia brasileira*. São Paulo, 1971. 294 p.

SUDAM, *Pesquisa e informações sobre espécies florestais da Amazônia*. Departamento de Recursos Naturais. Centro de Tecnologia Madeireira, Belém, 1979. 111p.

VOLPATO, E.; SCHIDMIT, P.B. & ARAÚJO, V.C. Estudos comparativos de tratamentos silviculturais *Carapa guianensis* Aubl.(andiroba) *Acta Amazonica*. Manaus 2(3): 75-81. 1972.

YARED, J.A.G. & CARPANEZZI, A.A. *Conversão de capoeira alta da Amazônia em povoamento de produção madeireira: o método do "recrú" e espécies promissoras*. CPATU-EMBRAPA, Belém, 1980 (a publicar).

FAST GROWING TREES

PRODUTIVIDADE DE TRÊS ESPÉCIES FOLHOSAS TROPICAIS DE RÁPIDO CRESCIMENTO, EM SABAH

T. K. Chong
Sabah Softwoods Sdn, Sabah
MALAYSIA

Resumo

A quantidade de madeira de *Albizia falcataria*, *Eucalyptus deglupta* e *Gmelina arborea*, são avaliadas pelo incremento no crescimento e no rendimento, sob condições de clima e de solo similares.

O incremento médio anual, para a idade 3,5 anos é de 5,2 m/ano, para a altura média das dominantes, e de 5,11 cm/ano para o diâmetro médio à altura do peito, em plantações não desbastadas de *Gmelina*. Os dados comparáveis para *Albizia* e *Eucalyptus* são 5,9m e 5,10cm/ano, 4,7 m e 3,37 cm/ano, para a idade de 5 anos.

Os incrementos médios anuais em Área Basal (MAI G) e volume (MAI V) para povoamentos similares são: 3,66 m^2/ha e 21,82 m^3/ha/ano, 4.04 m^2/ha e 30,54 m^3/ha/ano, 2,10 m^2/ha e 13,70 m^3/ha/ano, respectivamente.

A. falcataria é considerada como a espécie mais produtiva, vindo a seguir a *G. arborea* e *E. deglupta*. A densidade de árvores/ha varia de 540 à 1.074 por hectare.

PRODUCTIVY OF THREE FAST GROWING TROPICAL HARDWOOD SPECIES IN SABAH

Summary

The growing stock of Albizia falcataria, Eucalyptus deglupta and Gmelina arborea are assessed for growth increment and yield under similar climatic and adaphic conditions. The mean annual increments to year 3.5 is 5.2m/yr mean dominant height and 5.11cm/yr mean diameter breast height in the unthinned plantations of Gmelina. Comparable figures for Albizia and Eucalyptus respectively are 5.9m and 5.10cm/yr; 4.7m and 3.37cm/yr to the 5th year. Mean annual increments basal area (MAI G) and volume (MAI V) for similar stands are 3.66m^2/ha and 21.82m^3/ha/yr, 4.04m^2/ha and 30.54m^3/ha/yr; 2.10m^2/ha and 13.70m^3/ha/yr respectively. A. falcataria is rated as the most productive species followed by G. arborea and E. deglupta in Sabah Softwoods plantations. Current stockings ranged from 540 to 1074 stems per hectare.

INTRODUCTION

Sabah Softwoods Sendirian Berhad is a joint venture between Sabah Foundation and The North Borneo Timbers Berhad. The objective of the company is to reforest 60,000 hectares of logged-over forest in the Tawau residency of Sabah. The project started in 1974 and a total of 19,443 hectares have been established by May, 1980.

The principle species planted are Albizia falcataria, Eucalyptus deglupta, Gmelina arborea and Pinus caribaea Mor. Var. hondurensis Barr and Golf. Other potential species include Acacia mangium, Araucaria cunninghamii, and Eucalyptus tereticornis. The annual planting target is 4,250 hectares.

SITE DESCRIPTION

Location

The plantation site lies on latitude 4°30'N and longitude 117°35'E. Altitudes vary from 122 - 488 metres a.s.l.

Climate

The climate is wet and warm with a mean monthly maximum temperature of 33°C ± 2° and minimum of 22°C ± 2°. Mean monthly rainfall and daily sunshine hours are shown in Figure 1. Approximate mean annual precipitation is 2200mm and actual amount of bright sunshine ranges from 5.9 to 6.8 hours daily.

Soils

The major class soils are nearly all derived from the same paromt materials of sandstones, mudstones and miscellaneous rocks occuring over undulating to mountainous terrains. Acrisols, Luvisols, Cambisols and Lithosols are recognised as the main soil units in this area as under the classification of the Land Resource Study (see Ref. 1).

Chemical composition of some representative soils in the area is depicted in Figure 2. The soils in general possess good physical characteristics and drainage. Most soils are of the textural class of sandy clay loam and sandy loam the latter of which is more commonly found.

Stocking

The standard planting spacings adapted by the company are 3.28 x 3.28m square for hardwoods and 1.83 x 1.83m for softwoods. The stocking in the sample plots ranges from 540 stems per ha (sph) to 1074.

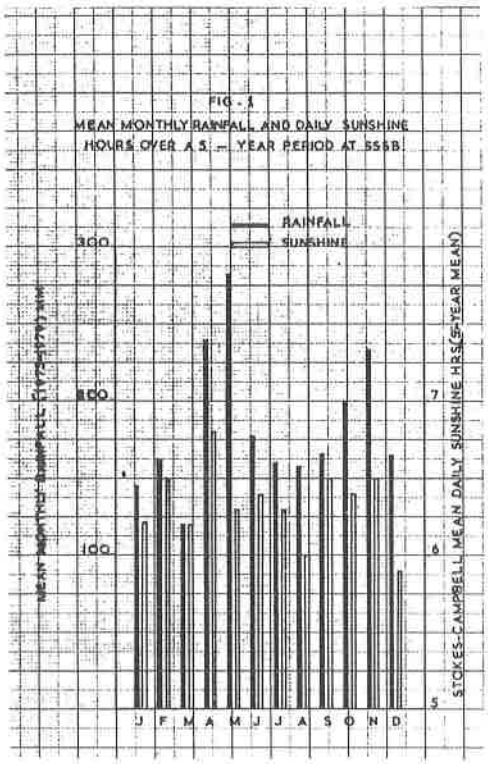
At present, about 83% of A. falcataria, 52% of E. deglupta and 83% of G. arborea plots have stockings of 740 sph and over (740 sph represent 70% of the original stocking at planting). None of the PSP plots have a stocking of below 50% (540 sph) the original stand.

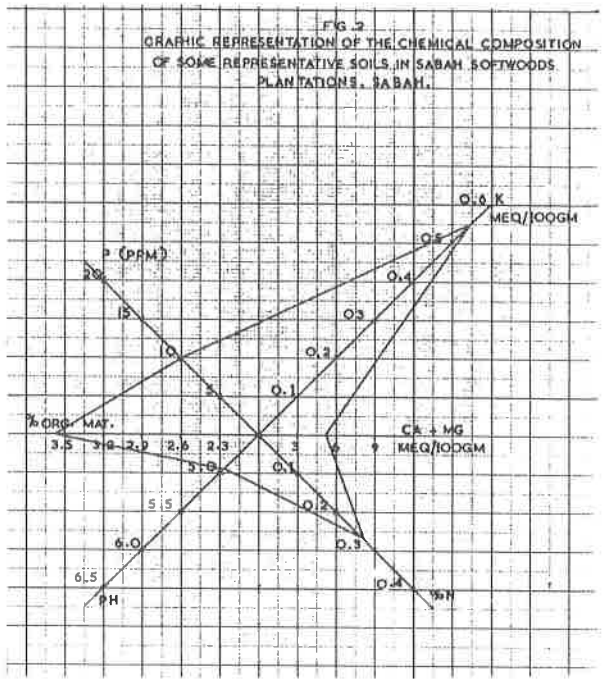
DATA COLLECTION

Permanent Sample Plots (PSPs)

One pair of Permanent Sample Plots are established in about 240 ha of each year's planting in each stratum by species. The plots are 0.05

ha (12.62m radius) and randomly located on a 1 : 10,000 scale map in two stages. Random coordinates are used to select the field number in which the plot would be located and two more pairs of random coordinates to determine the position of the two plots within the selected block. The plot is then defined in terms of a bearing and a distance from an obvious reference point, so that field crews can identify the exact site on the ground. Once located on the ground, the plot centre is marked with a stout belian post (Eusideroxylon zwageri T & B - a member of the Lauraceae with extremely durable wood) sunk deep into the earth.





On first establishment the position of each tree starting due north and nearest the centre post and working clockwise are plotted in terms of a bearing, distance and slope % from the centre posts and trees numbered.

The diameter at breast height (dbh) - 1.3m above ground of each tree is measured and recorded. During the first measurements, usually just over a year after planting, it may not be possible to measure dbh in which case height will be measured instead. The accepted minimum dbh size is about 2.5cm.

Plots are remeasured at approximately yearly intervals. Parameters measured are dbh of all trees and dominant height of 100 trees of largest dbh per hectare or 5 trees per plot. Height is measured by a Suunto PM-5/360 hypsometer and dbh with diameter tapes.

Table I

Species	Country	Age	Sph	MAI Hdom (m/yr)	MAI dbh (cm/yr)	MAI G (m^2/ha)	MAI V (m^3/ha/yr)
A. falcataria	Hawaii islands	To year 4	-	5.2	-	-	-
	Indonesia and Philippines	8-12 yrs.	-	-	5.00-7.00	-	25 - 40
	SSSB, Sabah	To year 5	540 - 1074	5.9	5.10	4.04	30.54
E. deglupta	Keravat,		-	5.1*	3.24	-	-
	Warangoi River,	To	-	4.6*	2.76	-	-
	Wilelo, PNG		-	4.4	2.85	-	-
	Cota Bato	year 4.16	-	4.5	2.63	-	-
	Bislig, Philippines		-	4.4	2.79	-	-
	SSSB, Sabah	To year 5	540 - 1074	4.7	3.37	2.10	13.70
G. arborea	S. E. Sierra Leona (Fox)	To year 3	840	2.4[a]	3.77	2.94	-
	Malawi, Bunda	To year 10	2.74 x 1.83m	-	-	-	10 - 30
	SSSB, Sabah	To year 3.5	540 - 1074	5.2	5.11	3.66	21.82

Note : a = tree height

* = 50 tallest trees/ha

FIG. 3

MEAN DOMINANT HEIGHT (HDOM) AND DIAMETER BREAST HEIGHT (DG)
GROWTH OF ALBIZIA FALCATARIA WITH TIME

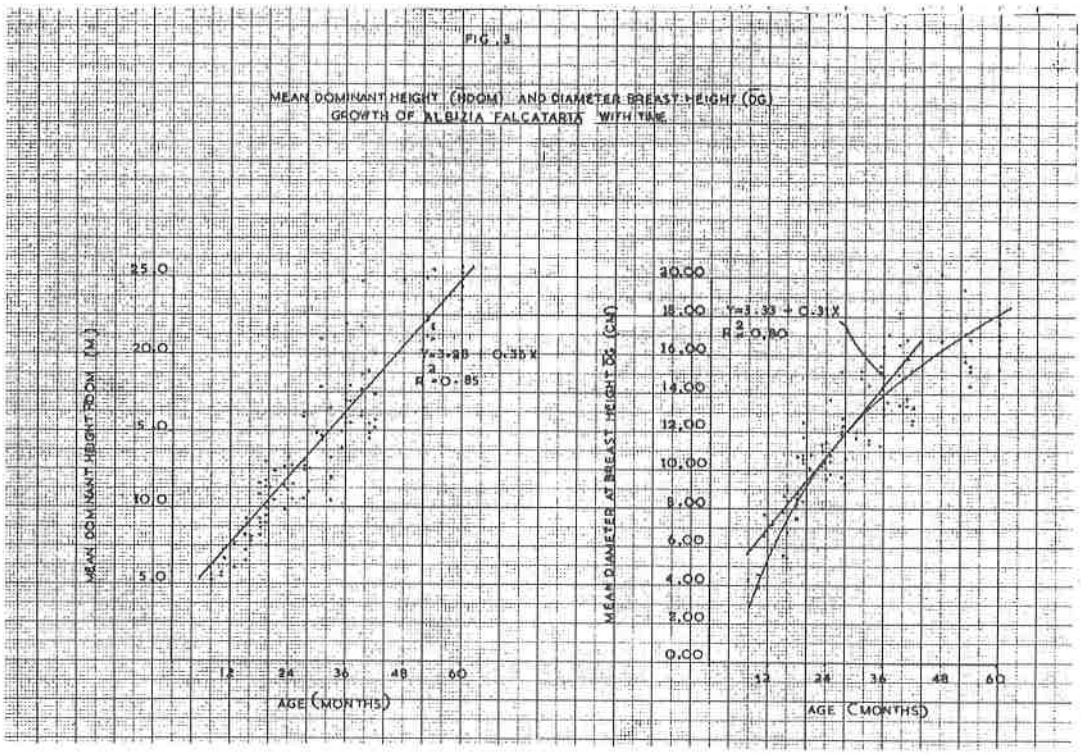


FIG. 4

MEAN DOMINANT HEIGHT (HDOM) AND DIAMETER BREAST HEIGHT (DG)
GROWTH OF EUCALYPTUS DEGLUPTA WITH TIME

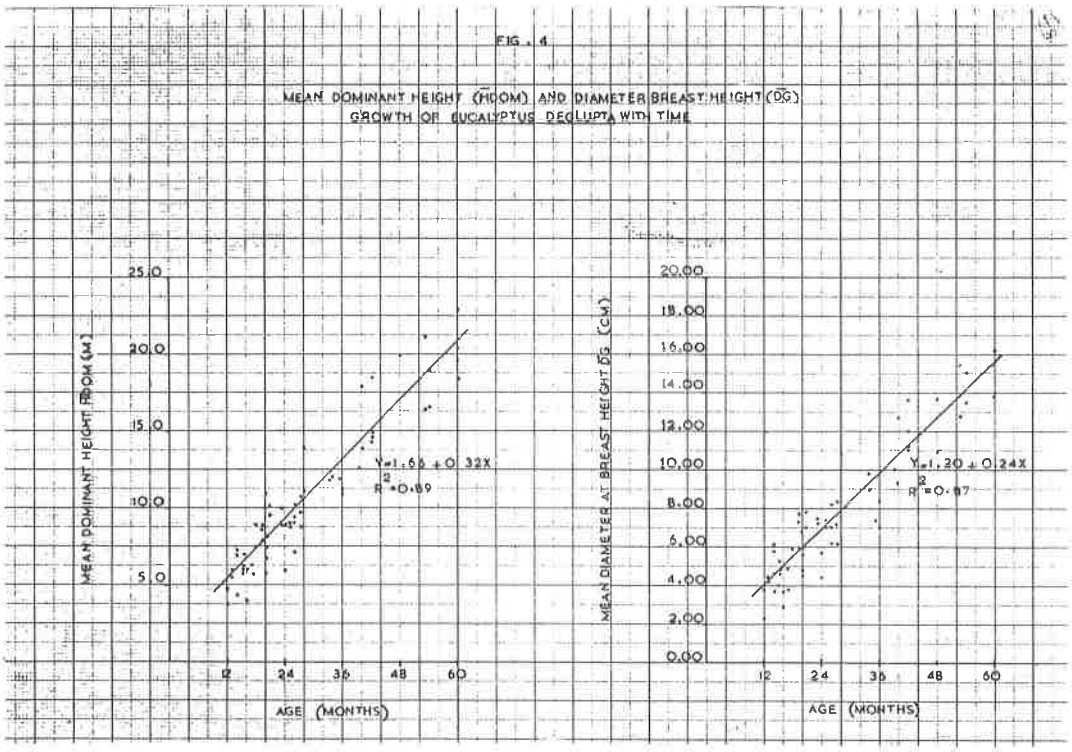


FIG. 5

MEAN DOMINANT HEIGHT ($\bar{H}DOM$) AND DIAMETER BREAST HEIGHT ($\bar{D}G$) GROWTH OF GMELINA ARBOREA WITH TIME

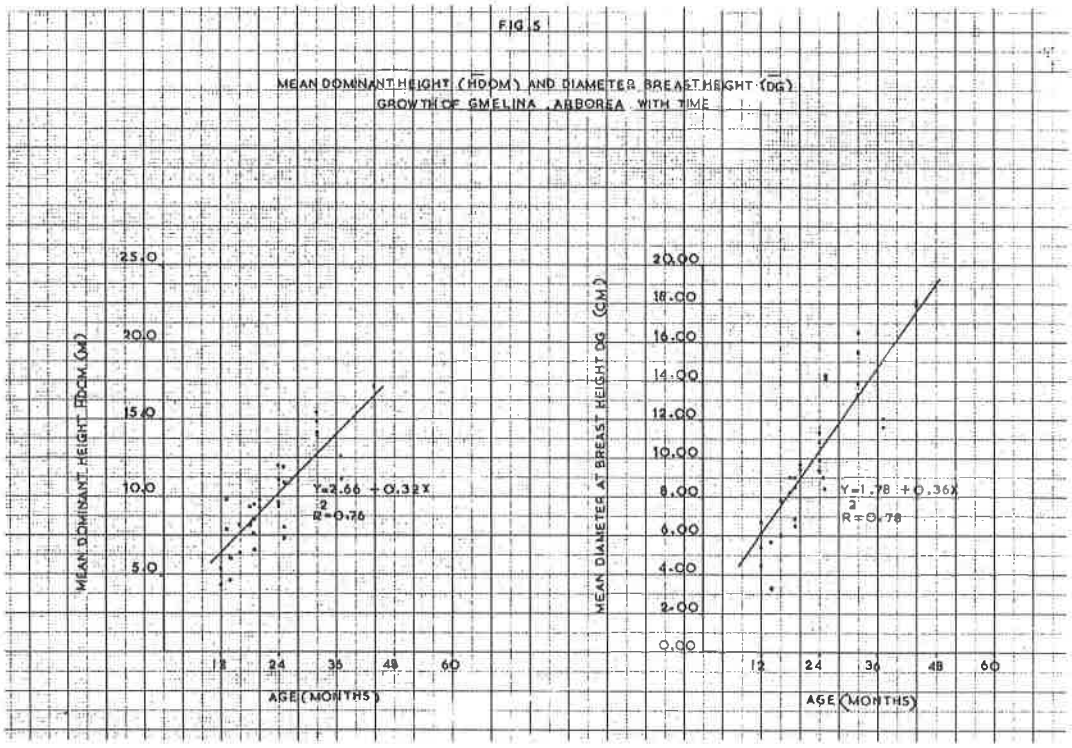
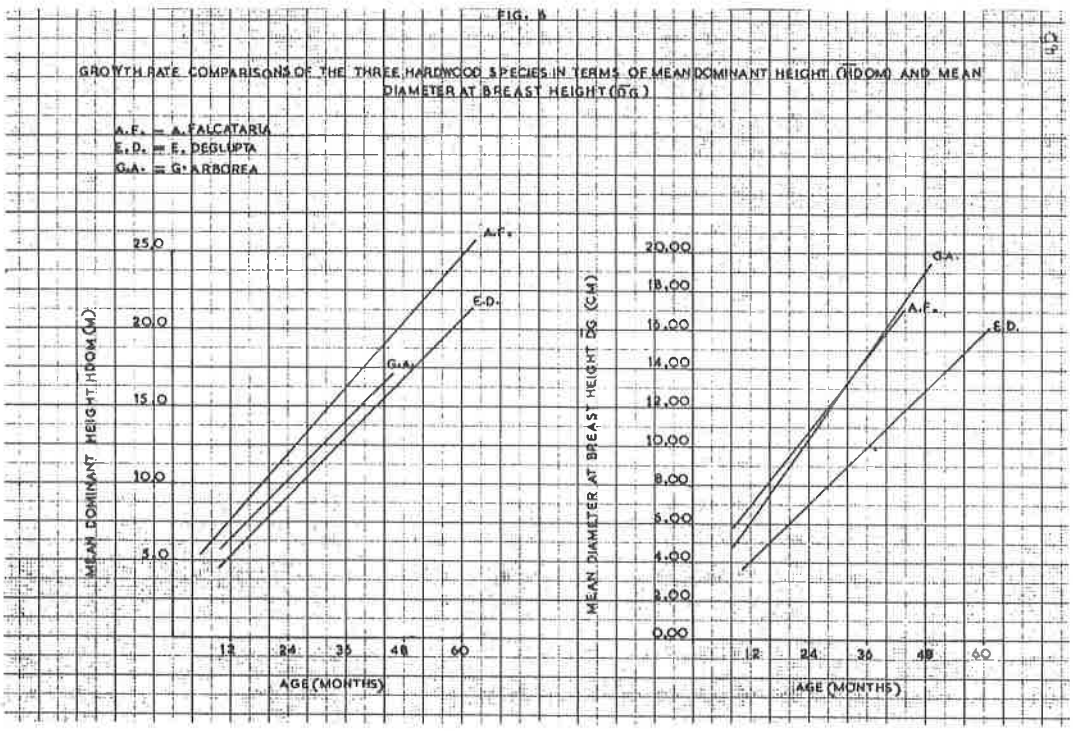
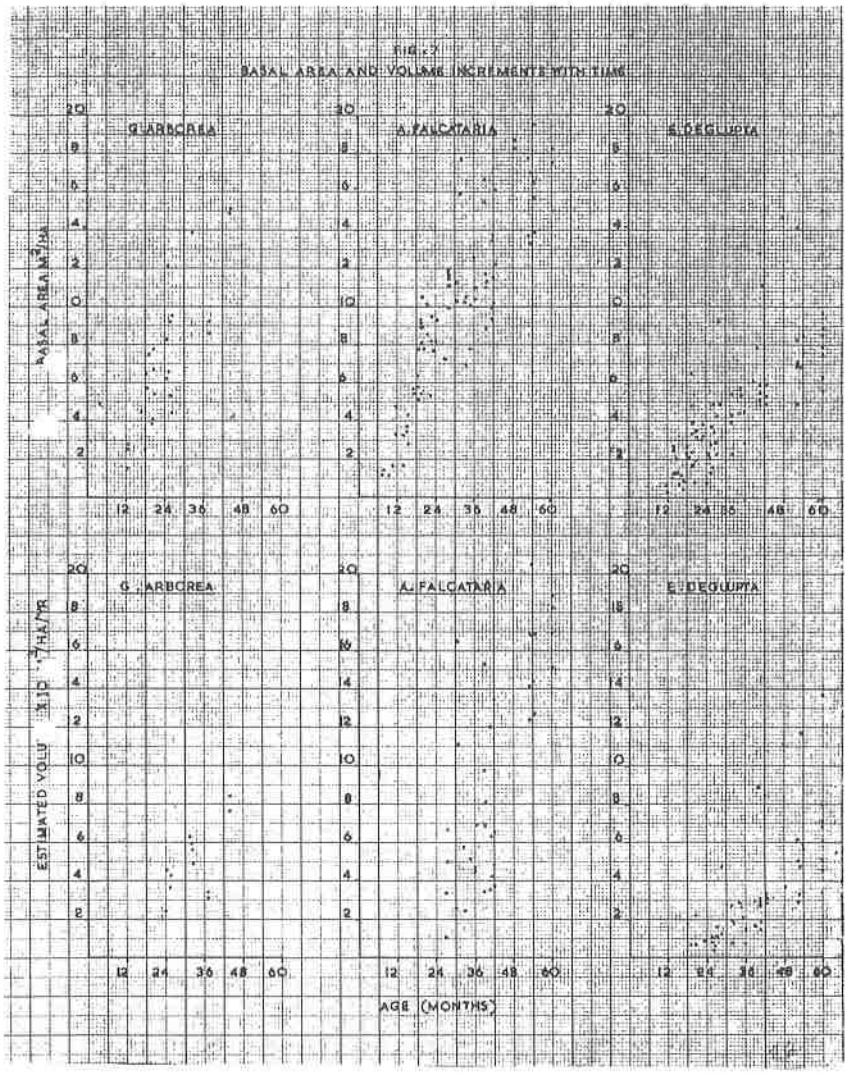


FIG. 6

GROWTH RATE COMPARISONS OF THE THREE HARDWOOD SPECIES IN TERMS OF MEAN DOMINANT HEIGHT ($\bar{H}DOM$) AND MEAN DIAMETER AT BREAST HEIGHT ($\bar{D}G$)

A.F. = A. FALCATARIA
E.D. = E. DEGLUPTA
G.A. = G. ARBOREA





Volume Regression Computation

Sample trees representing a range of tree sizes are felled and individual tree volume computed to a minimum diameter underbark of 7 cm (i.e. pulp vol.). Regression that best fit the collected data were derived from the following models.

$\text{Log}_n V = a + b\log_n D$

$V = a + bD^2$

$V = a + bD^2$ weighted by D^2

$V = a + bD^2H$ " " D^2H

$V = a + bD^2H$

$V = a + bD^2 + CD$

$V = a + bD^2 + CD$ weighted by D^2

$V = a + bD^2 + CH$

$V = a + bD^2 + CH$ weighted by D^2

$V = a + bD^2 + CD^2H$

$V = a + bD^2 + CD^2H$ weighted by D^2

$V = a + bD^2 + CD^2H$ " " D^2H

$\text{Log}_n V = a + b\log_n D + C\log_n H$

These 13 possible regression are then compared by means of the Furnival Index.

RESULTS AND DISCUSSION

The data collected from 42 A. falcataria, 27 E. deglupta and 18 G. arborea PSPs to year - 5 are summarised in Table 1 and presented in Figures 3 to 7.

Mean Dominant Height ($\bar{H}$dom) And Mean Diameter Breast Height ($\bar{d}$g)

Mean annual increments $\bar{H}$dom and $\bar{d}$g of the three species (in alphabetical order) of Sabah Softwoods plantations are 5.9, 4.7 and 5.2m/yr and 5.10, 3.37 and 3.11cm/yr respectively. These growth rates are as good or even better than that of other countries (Table I). Comparative growth rates among the three species are shown in Figure 6. A. falcataria has produced the fastest growth followed by G. arborea and E. deglupta the latter of which tends to be more site selective and growth has in general been quite variable, nevertheless, diameter growth over a period of 5 years is good, better than many of the PNG and Philippine provenances (reviewed by D. Lamb 1976 - see Ref. 3).

The relationship between growth of $\bar{H}$dom and $\bar{d}$g with time is shown in Figures 3, 4 and 5. It seems that the diameter growth of A. falcataria starts to slow down after about 3 years (Fig. 3). Growth is rapid with trees reaching an average $\bar{H}$dom of 16.2, 13.2 and 14.2 metres and $\bar{d}$g of 14.50, 9.84 and 14.74cm respectively at 3 years old for A. falcataria, E. deglupta and G. arborea.

Basal Area (G) and Estimated Yield (V)

The mean annual increment to year 5 is 4.04m^2/ha G and 30.54m^3/ha/yr standing volume for A. falcataria, 2.10m^2/ha G and 13.70m^3/ha/yr V for E. deglupta and 3.66m^2/ha G and 21.82m^3/ha/yr V to year 3.5 for G. arborea. These figures compared well with those from other countries (Table I).

The A. falcataria plantations are the most productive, standing volume in some sample plots have reached 198m^3/ha or MAI V 66m^3/ha/yr. G. arborea plantations are still young and only a few older plots are available for volume estimation, however, yields have been attractive. At 33 months, it produced about 60m^3/ha of wood and at 43 months about 80m^3/ha . Yields of E. deglupta are lower compared to the other two species but wood production on some sites is good, with MAI V of about 27m^3/ha/yr.

CONCLUSION

The fast growth rates and attractive yields from the 5 year old plantatinns at SSSB implies great potential for wood production in Sabah with these three hardwood species. Early vigour in terms of height and diameter increments again indicate suitability for large scale cultivation in managed plantations in this part of the world

REFERENCE

Land Resource Study : 1975 Land Resources Division, Ministry of Overseas Development, Tolworth Tower, Surbiton, Surrey, England KT67DY.

Chinte F. O. : Fast Growing Pulpwood Trees In Philippines. Philippine Foresta 21-26, 29.

D. Lamb : 1976, A Review of Silvicultural Research At The Gogal Valley Tropical Forestry. Research Note SR34.

ACKNOWLEDGEMENTS

The author is grateful to the Forestry Consultant, Mr.T.J.Wormald for his technical assistance on the various aspects of forest research. Many thanks are also due to the Project Manager of Sabah Softwoods Sdn. Bhd., Mr. M.W.McMyn and Mr. Norman Jones, the Project Team Leader of FAO/UNDP for their help and advice in the preparation of this paper.

FAST GROWING TREES

Acacia mangium WILLD – UMA ESPÉCIE PARA PLANTAÇÃO EM CAMPOS DE *Imperata cylindrica* (L) BEAUV. EM SABAH

T. C. Keong
Forest Research Centre, Sandakan
MALAYSIA

Resumo

Em Sabah existem cerca de 902.000 ha de terras degradadas, ocupadas pela *Imperata cylindrica* (L.) Beauv. A *Acacia mangium* Willd. superou o crescimento de *Pinus caribaea* Mor. var. *hondurensis* Barr. e Golf., em tais localidades. Os principais atributos da espécie são: capacidade pra crescer em solos não férteis, rápido crescimento e forma das árvores, razoavelmente boa. As árvores de dez anos têm rendimento de volume com casca, de 439m^3/ha, a madeira é apropriada para serraria, aglomerados de madeira, polpa e produção de papel.

Acacia mangium, WILLD – A PLANTATION SPECIES FOR *Imperata cylindrica* (L) BEAUV. GRASSLAND IN SABAH

Summary

In Sabah, there are about 902,000 ha of degraded land colonised by Imperata cylindrica (L.) Beauv.. Acacia mangium Willd. was found to out-grow Pinus caribaea Mor. var. hondurensis Barr. and Golf. on such sites. The chief attributes of the species are an ability to grow on infertile sites, rapid growth and reasonably good form. Ten-year old trees have yielded an over-bark volume of 439 m^3/ha. The wood is suitable for sawn-timber, particle board manufacture and pulp and paper making.

Introduction

The Sabah Forest Inventory 1969 - 72 carried out by Forestal International showed that on the west coast of Sabah, there is concentration of population and traditional shifting cultivation has left approximately 902,000 ha of degraded land now colonised by Imperata cylindrica (L.) Beauv. (see Fig. 3). Species trials were carried out on many such grassland sites from mid 1950s to select fast-growing species for plantation establishment. It was found that P. caribaea var. hondurensis, P. oocarpa Scheide, P. kesiya Royle ex Gordon and P. merkusii Jungh. and de Vriese grew well on degraded grassland.

A pilot plantation scheme was started in 1966 at Ulu Kukut Forest Reserve situated on the west coast with the objective of planting 80 ha annually to demonstrate the feasibility of establishing plantations of fast growing species in degraded grassland. P. caribaea was chosen as the principal species with pulp as the end product (Pollard, 1969).

A. mangium was introduced in 1967 as a firebreak

species in Ulu Kukut and by 1975 it was apparent that the species was out-growing the Pines on these degraded sites. Viable seeds are available within 24 months after planting and to date approximately 5000 ha have been established with A. mangium.

In 1976, the Sabah Forestry Development Authority (SAFODA) was founded with the mandate of reforesting about 200,000 ha of grassland over a 20 year period. A. mangium is the principal species for planting.

Natural Distribution and Habitat

Pedley (1964, 1975, 1978) reports that A. mangium is native to north Queensland, southern Papua New Guinea and Moluccas Islands. The southern-most limit of its range occurs between Cardwell and Ingham in Queensland at 18° 30'S, 146° 10'E. The northern limit of the range is in Manokwari in Irian Jaya at 0° 53'S, 130° 05'E. The eastern most limit is at 146° 10'E and it is not known whether its western limit extend beyond 124°E. The natural population of the species therefore covers a range in latitude greater than twenty degrees; its range in longitude is about eighteen degrees (See Fig. 1).

Besides the taxonomic work by Pedley, there has been little or no work done on the species. In April, 1980, the writer visited the natural Acacia forest in Queensland and Papua New Guinea together with N. Jones, Team Leader of the FAO/UNDP Seed Source Establishment Project in Sabah, to obtain first hand knowledge of A. mangium in its natural habitat.

In Queensland, A. mangium is generally found along the coast at low elevation of 500 m. (B. Hyland, C.S.I.R.O., Atherton has also collected specimens at Gadgarra, 720 m elevation). Its occurrence spreads from north of Ingham up to Gordon-vale. But the species has not been recorded around Cairns. This observation was made by D. Nicholson and V. Moriarty.* North of Cairns, it occurs along the Daintree River, around Mossman and up to the Claudie River.

Recently, J.P. Stanton, Wildlife and National Park Department, Cairns, Queensland reported A. mangium to be present at Cape York Peninsular on the eastern side of the Iron Range. Seeds and herbarium specimens were also collected at the junction of the Jardine and Mc-Henry Rivers by A. Irvine, C.S.I.R.O., Atherton, Queensland.

A. mangium is a component of the Australian open-forest or rainforest margin. It occurs on the margin of mangrove communities and often found along creeks and rivers. It appears to spread inland along watercourses into foothills and low ridges of the coastal range.

Generally, A. mangium is present as small groups of trees on riverbanks. Occasionally, it is present in dense stands on low ridges as in Rex Range and Dagmar Point. Near Muenga, in a state forest, it has developed into a fairly even-aged stand well away from rivers and creeks. The occurrence of disturbance in the past such as fire could had stimulated the growth of these stands. It was observed that sites disturbed by burning, roadwork and etc, were regenerated with A. mangium in abundance.

Frequently, A. mangium is associated with A. crassicarpa A. Cunn. ex Benth., A. aulacocarpa A. Cunn. ex Benth., A. flavescens A. Cunn. ex Benth. and A. cincinnata F. Muell. Of these Acacias, A. aulacocarpa, A. crassicarpa and A. cincinnata grow to tree-size with a single bole while A. flavescens is generally a small shrubby tree.

North of the Torres Strait, in the Western Province of Papua New Guinea the land inundated by the Fly, Oriomo, Morehead and Bensbach Rivers is low-lying and poorly drained. In these areas, A. mangium is often found growing with Melaleuca Blanco spp., Eucalyptus L'Herit. spp., Banksia Bruce spp., and Pandanus Rumph. ex Linn. spp. A. crassicarpa, A. aulacocarpa and A. auriculiformis A. Cunn. ex Benth. are also present. Mangrove forests follow the coast and further inland Pterocarpus indicus Willd., Nypa fruticans Wurmb., Caryota no Becc. etc. were seen along the banks of the Oriomo River. Where the rainforest gives way to grassland, A. mangium is often associated with A. auriculiformis, Melaleuca spp., Eucalyptus spp., Banksia spp. and Pandanus species. Near Bensbach, large trees of A. crassicarpa, A. aulacocarpa and A. auriculiformis were often seen together with A. mangium. Generally, the form of these Acacias were better than those seen in Queensland.

The ground flora beneath A. mangium is usally dominated by grasses. It was interesting to note that I. cylindrica which colonises degraded land in Sabah, is also a major component of the ground flora in the natural habitat of A. mangium. Ground fires seem a characteristic of A. mangium forests as indicated by scorching of the bark. Regeneration is commonly seen on disturbed sites and seedlings appear to be intolerant of dense shade. Fire possibly plays a vital ecological role in creating disturbed sites for the establishment of A. mangium.

The species is also found in Irian Jaya and the Moluccas Islands. Herbarium specimens at Lae, Papua New Guinea had been collected from Merauke, Manokwari and Job Island in Irian Jaya and Aru, Seram, Taliabu and Sanana Islands of the Moluccas groups (See Fig. 1). Most Specimens were collected from trees growing in grassland or secondary forests but the Merauke and Manokwari collections were from primary forests; all are at low elevations.

Characters of the living tree

In its natural habitat, A. mangium often reaches a height of 30 m with a bole of 15 - 20 m; two trees growing along the Tully-Mission Beach Road, Queensland measured 83 and 88 cm in diameter and their estimated height was 40m. Fluting is generally present in the lower bole. Bark is furrowed longitudinally and the surface colour varies from shades of brown to fawn. The crown is globular with branches often self-pruned in older trees.

Seed availability and storage

A. mangium in Sabah usually starts to flower when trees are about 18 months old and viable seeds can be harvested within 24 months of planting. Fruiting is generally heavy but seed extraction is tedious as the pods are entwined together. There are approximately 50,000 seeds per kilogram. Seeds appear to store well in air-tight containers in refrigeration.

Performance in grassland

To date, most planting of A. mangium has been carried out by SAFODA in abandoned shifting cultivated areas colonised by I. cylindrica which is an extremely competitive grass and is difficult to eradicate. Generally, land

* Forest Dept, Atherton, Queensland and Australian Tropical Plant Supplies, Julatten, Queensland, respectively.

preparation involves manual slashing of the grass before planting. Under such conditions canopy closure usually takes place within 2 years.

A 10-year old plot at Sibuga Forest Reserve planted on degraded red-yellow acrisol originally covered in I. cylindrica, with 2.4 m x 2.4 m spacing attained on over-bark DBH of 20 cm and mean height of 23 m. The basal area was 41.6 m^2/ha and the overbark volume up to 10 cm top was 439 m^3/ha (Tham, 1979). Unfortunately, the plot was felled soon after measurement.

Figure 2 shows that A. mangium outgrew P. caribaea var. hondurensis grown adjacently at Gum Gum Forest Reserve with red-yellow luvisol. The P. caribaea was planted 11 months before the A. mangium. The height of 2 year old A. mangium approaches that of 3 years old P. caribaea. After 2 years, A. mangium superceded P. caribaea in height. The increment in girth in A. mangium is slow in the initial stage but this also superceded that of PCH after the fifth year.

In grassland, P. caribaea requires regular weeding in the first 2 years after planting, whereas little or no weeding is required with A. mangium which rapidly grows taller than the grass eventually suppressing it.

A mycorrhizal fungus of the genus Thelephora (L.T. Hong*, pers. comm.) and nodules are associated with the roots of A. mangium. It is likely that impoverished grassland soil is being improved by A. mangium and later the land maybe suitable for planting other tree species or agricultural crops.

Wood properties and uses

The sapwood of natural grown timber is pale yellow-brown, the heartwood brown often with streaked bands. Air-dry density is 690 kg/m^3. For structual purposes, green material is classified as strength group S5 and seasoned material as SD5 (E. Bolza*, pers. comm.).

In Australia, A. mangium is marketed together with A. aulacocarpa, A. cincinnata, A. implexa Benth. and A. melanoxylon R. Br. ex Ait. as blackwattle (W.J. Smith **, pers. comm.).

Plantation material of different ages from Gum Gum Forest Reserve were used for timber, particle-board making and pulp and paper manufacturing tests. Seven year old material used for particle-board tests had good properties from a mix consisting of 70% Albizia falcataria (L.) Fosberg and 30% A. mangium and excellent board properties from 100% A. mangium (Anon, 1976). An assessment of 9 year-old A. mangium for use in the production of unbleached and bleached sulphate and unbleached neutral sulphite semi-chemical pulps indicated that A. mangium wood and wood plus bark are extremely promising. It is suitable for the manufacture of a wide range of unbleached paper and paper-board products such as linerboards, bags and wrapping papers and multi-wall sack papers. It is also adequate for the production of a variety of bleached grades and in particular writing and printing papers (Logan and Balodies, 1979).

Tan (1979) dealing with 10 year Gum Gum Forest Reserve material reported that the air-dried density is 624 kg/m^3 and the timber is easy to saw, can be planed, drilled and sanded very well on standard woodwork machines. Early collapse in kiln seasoning was common but could be recovered by steaming; otherwise the timber seasoned quite satisfactorily. It can be treated by full-cell pressure impregnation method with satisfactory loading and penetration of preservative. He concluded that the olive brown heartwood has a potential to be utilised in a range of general purposes and as decorative timber in furniture and joinery making.

A.W. Bochner * (pers. comm.) also referring to 10-year old material commented that the mechanical properties compare favourably with such woods as red alder, aspen, basswood, yellow poplar, sycamore and cottonwood; possible applications include door frames, clears for window parts and mouldings, cabinets, furniture parts and sliced veneer.

Work planned

Currently, selection work on seed stands and candidate plus trees are being carried out in Sabah. Plans are being made to introduce seeds from different locations in Papua New Guinea, Queensland and possibly Indonesia to widen the genetic base.

Acknowledgement

The writer would like to thank Mr. Haji Ali Hassan, the Conservator of Forests, Sabah for his approval of the visit to Queensland and Papua New Guinea. The advice and support of Mr. A.J. Hepburn, National Team Leader, FAO/UNDP MAL/78/009, Seed Source Establishment and Tree Improvement Project is grateful acknowledged.

My thanks are due to the Department of Forests of Papua New Guinea and Queensland for their cooperation in providing transport and technical assistance in the field.

For helpful comments and advice, I would like to thank Mr. N. Jones, Team Leader, FAO/UNDP MAL/78/009.

I would like to compliment Miss Helda Laurencius for her typing of the manuscript and Miss Lee Len Tay for her drawing of the figures.

Last and not least, many thanks to Mr. D.I. Nicholson who sent the first batch of A. mangium seeds, without which this paper will not be written.

References:

Anon., 1976: Manufacture of Experimental Flat Pressed and Thin Ribbon Particle-board. Bisonwerke, Bahne & Greten Gmb H & Co. KG. Springe. Unpublished. 3 pp.

Logan, A.F. and Balodis, W., 1979: The pulping and papermaking characteristics of Acacia mangium. C.S.I.R.O., Division of Chemical Technology, Melbourne. 32 pp. Unpublished.

* Forest Research Institute, Kepong, Malaysia.

* C.S.I.R.O., Melbourne, Victoria.
** Forest Department, Brisbane, Queensland.

* Research and Development Technical Information Centre, Weyerhaeuser Co., U.S.A.

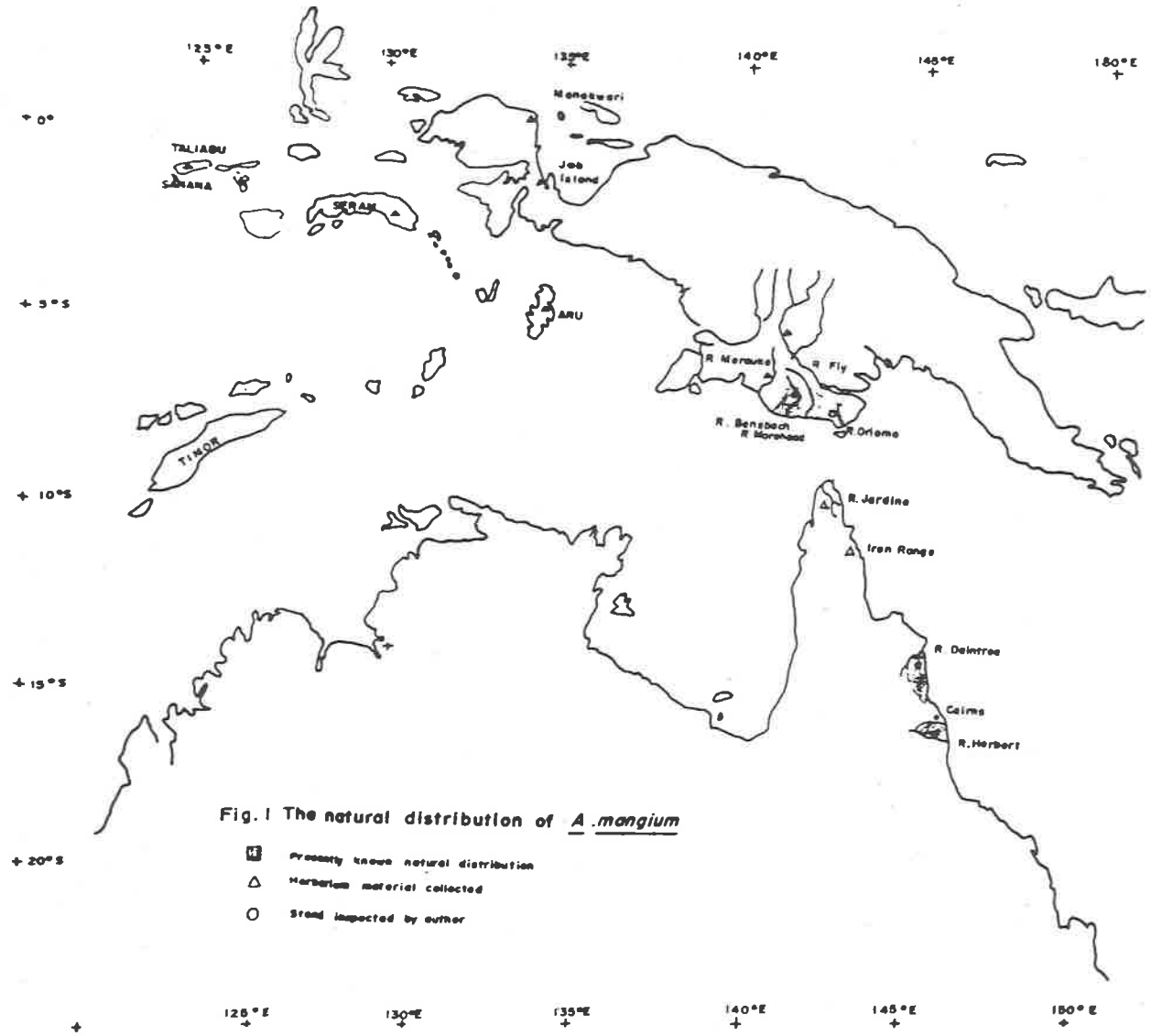
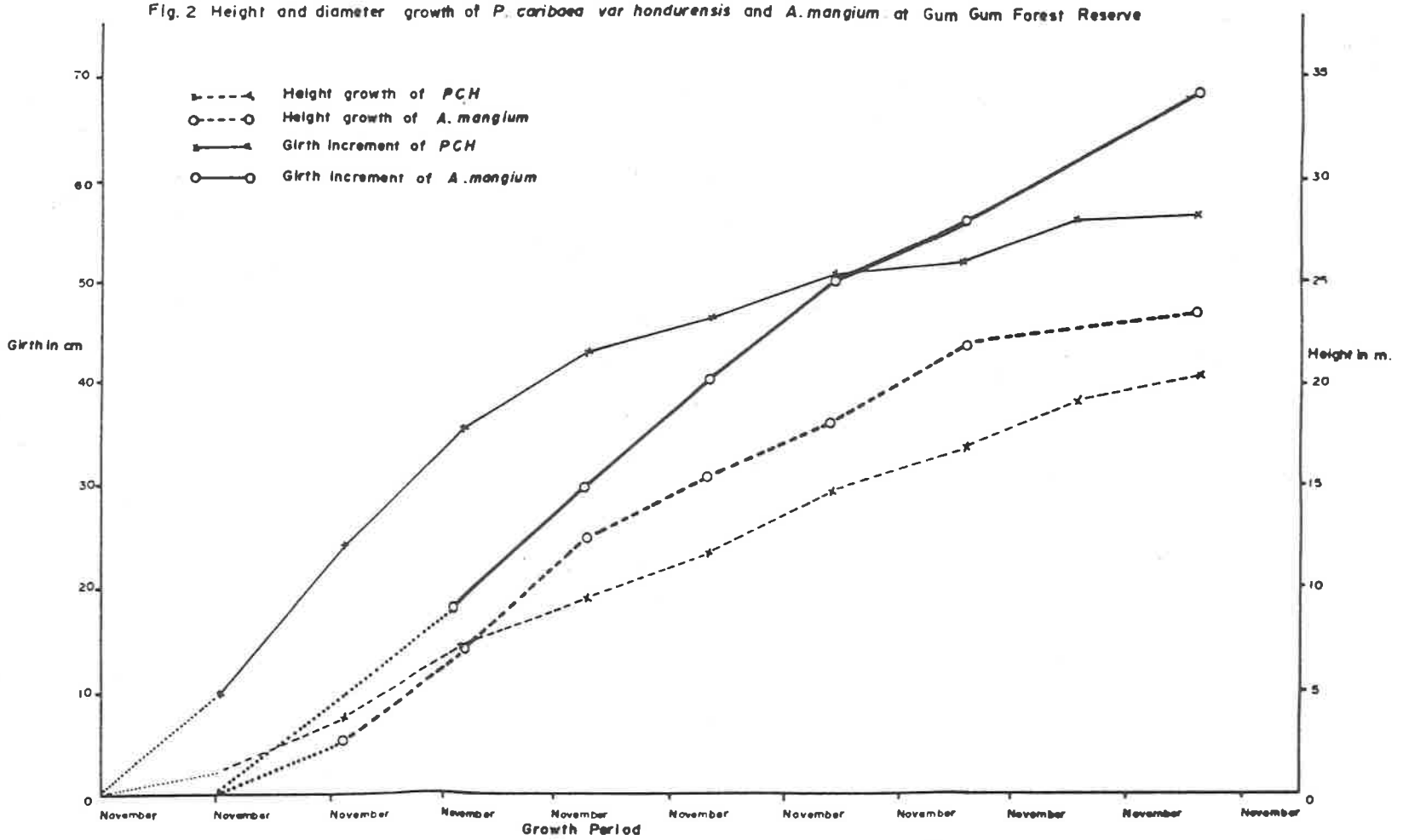


Fig. 1 The natural distribution of *A. mangium*

- Presently known natural distribution
- △ Herbarium material collected
- O Stand inspected by author

Fig. 2 Height and diameter growth of *P. caribaea var hondurensis* and *A. mangium* at Gum Gum Forest Reserve



Pedley, L., 1964: Notes on Acacia, chiefly from Queensland, I. Pro. Royal Soc. of Queensland; Vol.LXXIV. No. 6; pp. 53 - 60.

Pedley, L. 1975: Revision of the Extra-Australian species of Acacia subg. Heterophyllum. Contributions from Queensland Herbarium No. 18, Queensland Herbarium, Dept. of Primary Industries, Brisbane. pp. 14 - 15.

Pedley, L., 1978: A revision of Acacia Mill. in Queensland. Austrobaileya, Vol. 1, No. 2, Queensland Herbarium, Dept. of Primary Industries, Brisbane. pp.170-171.

Pollard, J.F., 1969: Ulu Kukut Plantation 1966-69. Laporan Penyelidik Hutan Negeri Sabah 1969. Forest Department, Sandakan, Sabah, Malaysia. pp. 114 - 118.

Tan, Y.K., 1979: The properties of Acacia mangium from Sabah Research Plantation. Timber Research and Technical Training Centre. For. Dept., Sarawak, Malaysia.

Tham, C.K., 1979: Trials of Acacia mangium Willd. as a plantation species in Sabah. For. Gen. Res. Info No. 9 FAO/UN For. Occ. pap. 1979/1. pp. 32-35.

FAST GROWING TREES

VARIAÇÃO FENOTÍPICA EM POVOAMENTOS NATURAIS DE *Pinus roxburghii*

P.K.Khosla, S.S.Sagwal and D.K.Khurana
Himachal Pradesh Agricultural University
T. S. Sareen
Panjab University
INDIA

Resumo

A variação fenotípica, quanto aos dados de crescimento, comprimento das axículas densidade, teor de umidade e porcentagem de turpentina de morfo-tipos de axículas coloridas de *Pinus roxburghii* Sargent, revelaram que as formas verde escuro até verde, sai mais dotadas nas características relacionadas à produção de madeira, enquanto que os tipos de coloração diluídas possuíram as vantagens da madeira leve, e porcentagem máxima de turpentina. Uma variação não significativa dessas características dentro dos morfotipos, mostra a estabilidade genética delas. A variação clinal em povoamentos naturais, considerando-se: altura, diâmetro, comprimento das axículas, e a relação tronco limpo/altura total das árvores foi significativa à P/0,01.

A variação de árvore para árvore foi também significativa para a altura, diâmetro dentro dos povoamentos, clines altitudinais e regiões.

Correlações positivas entre altura, diâmetro, altura e comprimento das axículas, é que tornam possível a seleção de árvores "plus" com base no comprimento e cor das axículas.

PHENOTYPIC VARIATION IN NATURAL STANDS OF *Pinus roxburghii*

Summary

The phenotypic variation on growth data, needle length, specific gravity, moisture content, and turpentine percentage of needle colour morphotypes of Pinus roxburghii Sargent revealed that dark-green to green forms superceeded in traits related to timber production while the dilated types possessed the advantage of light wood and maximum turpentine oil percentage. Non-significant variation of these traits within morphotypes show their genetic stability. Clinal variation in natural stands with regard to height, diameter, needle length and clear bole/total height ratio were significant at P/0.01. Tree to tree variation was also significant for height and diameter within stands, altitudinal clines and regions. Positive correlations between height and diameter and height and needle length lend support to base selection of plus trees on needle length and colour.

INTRODUCTION

Pinus roxburghii Sargent occupies a narrow belt around 28 - 30° N and is distributed all through the Himalaya, occurring in more gregarious form in the Western Himalaya (600 - 2400 m). The species is reputed for timber production and resin yield and its ambitious afforestation targets are in progress in Himalayan states in India. The species possesses a high incidence of spiral grain. Champion (1925) reported the genetic inheritance of twisted fibres. Khosla et al. (1978) recommended to make separate initial selections for timber and resin yield because of observed poor stem quality in high resin yielders. The current studies on phenotypic variation of needle colour morphotypes (adopted from Khosla et al., 1978) and growth data on straight grained trees from natural stands were made to base field criteria for the selection of fast-growing trees.

EXPERIMENTAL METHODS

The needle colour variation was categorised into five types namely, dark-green, green, yellowish-green, greenish-yellow and yellow (Khosla et al., 1978). The data on height, diameter, ring width, needle length, specific gravity, moisture content and turpentine percentage were examined from five trees (40 ± 5 yrs) each at seven sites around 30° 55' N and 77° 21' E, excepting yellow type where the data were representative of five trees only. The analysis of variance was computed to know the significance of differences between and within morphotypes.

For phenotypic variation in natural stands the sampling was limited to 30° 75' to 32° 60' N and 75° 60' to 78° 10' E. The straight grained dominant and co-dominant trees from even aged stands (100 ± 10 yrs) belonging to dark green to green types were marked. The main variables in the study comprised six regions (river banks), two altitudinal clines (600-1400 m and 1401 m and above), 23 provenances, three stands within each provenance and three trees each falling in diameter classes, ⁄50 cms, 51 to 60 cms and above 60 cms, within each stand for a total of 207 trees. The mensurational data were taken for height, diameter, needle length and bole/total height ratio. Assuming a complete random model for analysis of variance 22 degree of freedom for treatments were further split into orthogonal components, three having one degree of freedom each, one having two degrees of freedom, two having five degrees of freedom each and one carrying seven degrees of freedom.

RESULTS AND DISCUSSION

The phenotypic variation as analysed from five needle colour morphotypes (dark-green, green, yellowish green, greenish-yellow and yellow) revealed that there were significant differences between morphotypes at P/0.01 level, excepting specific gravity which revealed diversification only at P/0.05 level (Table 1). The non-significant differences between types support the genetic fixidity of these morphotypes. Mergen (1958) attributed needle colour variation to be genetically controlled. Venkatesh and Thapliyal (1977) reported chlorophyll mutants in the seedling progeny of Pinus roxburghii.

A perusal of table 1 reveals that dark green and green forms are more productive in wood yield. This may be on account of recession in the needle length from dark green to greenish yellow forms, affecting the photosynthetic activity and total organic production in turn. The yellow type with relatively longer needles may be a biological adaptation to balance the heavy dilution of chlorophyll (Khosla et al.,1978) since leaf area and its exposure are essential factors to determine the photosynthetic rate. Specific gravity, moisture content and turpentine percentage gave a reverse trend in these forms. To achieve economic gain in wood quality the objective should be to breed trees falling within darkgreen and green types, and for pulp and paper and turpentine oil yield, diluted chlorophyll types are recommended.

The height of the trees in natural stands showed significant inter and intra-stand and clinal variation (Table 2) with predominance of dominant trees at low altitudes (600-1400 m) than stands distributed in the higher limits of its range and clines. The differential growth rate as an attribute to altitudinal clines was observed in Ponderosa and Jeffrey pines (Callaham and Liddicoet, 1961). Within regions the non-significant differences implied that species may be preferential to site requirements (geology and soil conditions) that even wide apart physiographic zones showed parallel expression for height. Puri (1950) reported that quartzite at 2700 m above sea level carries Pinus roxburghii and alluvium at 1500 m bears exclusively Cedrus deodara, showing more altitude is not essential for distribution of conifers in the Himalaya.

The significant tree to tree variation with regard to height and diameter stemmed from higher genetic diversity in these traits. Diameterwas significant within regions, clines and within trees but non-significant within stands. The cultural conditions of the crop in stands such as spacing, pruning ability and biotic inferences influence the diameter. Traits for height and diameter growth are not necessarily inherited in the same pattern (Stephenson and Synder, 1969).

The needle length and bole/total height ratio were significant at all levels, excepting within stands. The needle length which tended to be uniform within stands support the rigidity of morphotypes since the trees examined in this study belonged to dark green and green types. The positive correlation of height with needle length (r=0.74) and height and diameter (r= +0.40) are suggestive of strong diagnostic value of needle length in identifying plus trees among promising natural stands of the taxon.

Table 1: Levels of statistical significance for various characters studied.

Characteristic	Regions	Clines	Stands	Trees
Height	2.24	25.25**	4.52*	15.96**
Diameter	19.18**	107.36**	2.34	231.82**
Needle length	119.68**	862.04**	7.32**	1.76
Clear bole/total height ratio	29.00**	294.00**	3.29*	0.79

* = Significant at 5% level,

** = Significant at 1% level.

LITERATURE CITED

Callaham, R. and Liddicoet, A.E., 1961: Altitudinal variation at 20 years in Ponderosa and Jeffrey pines. Jour. Forestry, 59, pp.8214-8201.

Champion, H.G., 1925: Contribution towards a knowledge of twisted fibres in trees. Indian For. Rec., Vol.II, Pt.2.

Khosla, P.K., Sareen, T.S., Sharma, J.C. and Khurana, D.K., 1978: Intra-specific variation in Pinus roxburghii Sargent - Growth and Wood characteristics in needle colour types. Abstract. In Proc. Nat. Symp. Plant and Animal Genet. Res., New Delhi.

Khosla, P.K., Sagwal, S.S. and Khurana, D.K., 1980: Selection of plus trees (growth form) in Pinus roxburghii Sargent. Proc. Second For. Conf., Dehradun.

Mergen, F., 1968: Genetic variation in needle colour characteristics of Slash pine and in some of its hybrids. Silv. Genet. Vol.1, pp.1-9.

Puri, G.S., 1950: The distribution of conifers in the Kulu Himalayas with special relation to geology, Indian. For., Vol.76, pp.144-153.

Stephenson, G.K. and Synder, E.B., 1969: Genetic variation key to superior trees. U.S.D.A. South. For. Expt. Stn. Handbk., 12 pp.

Table 2: Growth and wood characteristics in five morphotypes of P. roxburghii

Morpho-types	Height (m)	Diameter (cms)	Ring width (m)	Needle length (cm)	Specific gravity	Moisture content	Turpentine percentage
DG	12.31 ± 0.73	28.80 ± 2.52	4.4 ±0.05	28.18 ± 1.37	0.60 ±0.014	38.78 ± 7.78	18.0 ±0.63
G	11.83 ± 0.93	24.11 ± 2.12	3.9 ± 0.21	21.67 ± 1.35	0.60 ±0.032	36.50 ±5.19	18.8 ± 0.58
YG	11.38 ± 0.61	22.10 ± 1.42	3.4 ±0.25	19.12 ± 2.42	0.58 ±0.039	34.96 ± 4.08	18.6 ± 0.41
GY	10.10 ± 0.39	20.18 ± 0.52	3.0 ± 0.23	15.20 ± 0.97	0.57 ±0.024	35.04 ± 6.16	21.0 ± 1.09
Y	7.92 ± 0.70	14.00 ± 0.98	2.0 ±0.00	20.00 ± 2.82	0.44 ±0.056	47.65 ± 2.75	24.0 ± 0.52
F-value within/ between.	3.16/474.12**	4.18/128.98**	NT	2.07/47.83**	3.46/15.12*	2.36/17.95**	2.90/17.70**

* - Significant at 5% level; ** - Significant at 1% level; NT - Not-tested,

DG = Dark-green, G = Green, YG = Yellowish-green, GY = Greenish Yellow and Y = Yellow

VARIAÇÃO FENOTÍPICA DOS PARAMETROS NUTRICIONAIS EM *Grewia optiva*

P.K.Khosla
Himachal Pradesh Agricultural University, Solan
R. N. Pal and S. S. Negi
Indian Veterinary Research Institute, Palampur
P. S. Kaushal
Conifer Research Centre, Simla
INDIA

Summary

Biochemical analysis of leaf forage of Grewia optiva Drummond was undertaken from six trees each from four provenances distributed in the sub-Himalayan tract. The leaves were analysed for the proximate principles - crude protein, ether extract, crude fibre, nitrogen free extract, total ash and minerals-calcium and phosphorus. Nylon bag dry matter digestibility was also estimated. Inter and intra-provenance variation was observed in all the traits. The correlations of crude protein with other nutritional parameters are suggestive to opt for tandem method of selection over selection index method where several traits were evaluated simultaneously.

INTRODUCTION

Grewia optiva Drummond is distributed in North-West Himalayas from Indus to Nepal ascending to 1,800 m (Gamble,1902). The species produces a nutritious forage (18-21% crude protein), possessing the digestibility of high order i.e. 72% (Sen and Rey, 1964), and was selected for screening high nutritive trees from the natural populations (30° 55' - 31° 36' N and 76° 20' - 77° 99' E) from sub-tropical region in the Western Himalayas. The aim was also to deduce correlations as markers of phenotypic selection between different traits while making a choice between tandem and selection index methods for producing strains that contain rich biochemical compounds.

EXPERIMENTAL METHODS

Grewia optiva occurs in restricted patches forming a countable number of trees, thereby, random selection of six mature trees from four provenances each of approximately same age, comparative growth and crown size and having a mean girth of 80-100 cm was made. Leaf samples were analysed for the proximate principles - crude protein, ether extract, crude fibre, nitrogen free extract, total ash and minerals-calcium and phosphorus (AOAC, 1970). Nylon bag dry matter digestibility (NB DMD) on 48 hr. rumen fermentation was estimated according to Monson et al. (1969). The analysis of variance and correlations between various traits were worked out (Panse and Sukhatme, 1967).

RESULTS AND DISCUSSION

The average data on the dry matter content of fresh forage, the chemical composition of dry matter and its NB DMD in the four

Table 1: Average dry matter in fresh forage, chemical composition of dry matter and NB DMD in the four provenances.

Parameters	Mean data on provenances A	B	C	D	Overall average	F-Value
Dry matter % (fresh forage)	48.72	52.81	44.43	50.08	49.01	**
Crude Protein	19.53	17.87	19.77	18.47	18.91	**
Ether Extract	5.09	5.07	4.74	4.70	4.90	**
Crude Fibre	20.48	20.56	20.30	21.10	20.61	**
Nitrogen Free Extract (NFE)	43.10	43.86	43.55	43.83	43.59	NS
Total Ash	11.82	12.65	11.67	11.88	12.00	**
Ca	3.54	3.89	3.32	3.44	3.55	NT
P	0.20	0.23	0.26	0.22	0.23	**
NB DMD %	67.33	62.13	58.29	58.95	61.68	NT

NS - Not-significant; ** P<0.01; NT - Not-tested;
A to D indicate four provenances.

Table 2: Correlations (r value) of various parameters

	C.P.	C.F.	E.E.	N.F.E.	T.Ash	Ca	P	Cellulose	NB DMD
D.M.	-.48	-.1069	-.0075	.475	.0449	.2216	-.2034	.155	.1286
C.P.		-0.009	-.1661	-.5227	-.4397	-.436	-.1018	.0337	.2499
C.F.			.3036	-.5239	-.0097	-.1008	-.2829	-.2829	-.4029
E.E.				.0139	-.0922	.0316	.0026	-.0705	.2635
N.F.E.					-.2445	-.1237	.0609	-.1223	.0431
T.Ash						.83	.6162	-.0197	-.1466
Ca							.2797	-.2042	-.0211
P								-.1371	.0002
Cellulose									-.1359

localities are given in Table 1. In fresh forage the differences between localities in dry matter content were highly significant ($P<0.01$). Likewise, locality differences in crude protein, ether extract, crude fibre, total ash and phosphorus were also significant ($P<0.01$). In one of the localities (C) the forage was more succulent due to appreciable increase in crude protein and phosphorus and fall in crude fibre in the dry matter. The variation was non-significant in NFE in all the provenances. In case of calcium content and NB DMD, the significance of difference was not calculated as the data in the four provenances, tested by Bartlett's homogeneity test, were found to be heterogenous.

The analysis of variance showed that there were significant inter and intra-provenance variation of nutritive traits in the forage of this species. Burley (1975) reported the biological differences in foliage nutrients of wild populations. The desirable traits determining the nutritive value of Grewia optiva are crude protein, phosphorus and NB DMD while undesirable traits are crude fibre, total ash, cellulose and calcium. The occurrence of high calcium content in the foliage reduces the nutritive value of forage as it widens the requisite calcium/phosphorus ratio because the level of phosphorus in the forage is very low. There is, thus, need to evolve a strain which is rich in crude protein and possesses balanced nutritive contents of calcium and phosphorus.

The correlations worked out for different nutritional parameters are presented in Table 2. Crude protein content which is considered to be most vital in determining the nutritive value of any fodder showed negative correlations with all the characters excepting cellulose and NB DMD. These negative correlations with undesirable characters are statistical markers of tandem selection based on crude protein alone. The moderate nature of negative correlations of crude protein with calcium ($r=0.436$) is appreciable because of the deleterious effect of forage due to observed wide gap between calcium and phosphorus contents. The positive correlation of crude protein with NB DMD ($r=.24$) indicates its concomitant response as a desirable fodder.

A perusal of these correlations indicated that for selection of high nutritive trees for future breeding programme, it is important to screen trees on the basis of high crude protein alone since it is difficult to measure several traits directly in selection index method. Weissenberg (1976) suggested the importance of phenotypic correlations as valuable aids for phenotypic selections. The recommendation to adopt tandem selection based on crude protein in case of Grewia optiva shall prove to be valuable and time saving while evaluating the progeny of superior nutritive trees or chemical analysis of large number of trees from different provenances.

LITERATURE CITED

A.O.A.C., 1970: Official methods of analysis. 11th Ed. Assoc. of Offic. Chem., Washington, D.C.

Burley, J., 1976: The application of biochemical methods. In 'A Manual on species and provenance Research with particular reference to the Tropics, eds. J. Burley and P.J. Wood. Tropical Forestry Pps. No. 10. Department of Forestry, C.F.I., Oxford, pp. 31-36.

Gamble, J.S., 1902: A manual of Indian Timbers, London, 868 pp.

Monson, W.G., Lowrey, R.S. and Forbes, I. Jr., 1952: In vivo nylon bag vs in Vitro digestion: Comparison of two techniques for estimating dry matter digestibility of forages. Agron. Jour., Vol. 61, pp. 587.

Panse, V.G. and Sukhatme, P.V., 1967: Statistical methods for agricultural workers, I.C.A.R., New Delhi, 371 pp.

Sen, K.C. and Ray, S.N., 1964: Nutritive value of Indian cattle feeds and the feeding of animals. I.C.A.R., Bull. No. 25, New Delhi.

Weissenberg, K. Von, 1976. Indirect selection of improvement of desired traits. In Modern Methods in Forest Genetics. Proc. in Life Sci., ed. J.P. Miksche. Springer-Verlag, Berlin, pp. 217-228.

FAST GROWING TREES

INTERAÇÃO PROCEDÊNCIA/LUGAR EM EXPERIMENTOS COM *Populus ciliata* WALL. EX ROYLE

D. K. Khurana and P.K.Khosla
Himachal Pradesh Agricultural University, Solan
INDIA

Resumo

Um amplo teste de procedência com *Populus ciliata* Wall. ex Royle, foi conduzido com 84 clones originários de nove procedências, compreendidas entre as latitudes de 31°6' a 32°29'N. Sete desses clones promissores foram, mais tarde, testados em 3 localidades altitudinais, a fim de se avaliar a sua interação e adaptabilidade ao local. Houve diferenças significativas entre os clones, o que sugeriu uma ampla diversidade genética. A espécie conduziu-se bem nas condições temperadas mais frias do interior do Himalaia.

PROVENANCE/SITE INTERACTION TRIAL ON *Populus ciliata*

Summary

A range wide provenance trial on Populus ciliata Wall. ex Royle was conducted with 84 clones sampled from nine provenances falling with 31° 6' to 32° 29' N. Seven of these promising clones were further tested at three altitudinal sites to find out their site-interactions and adaptability. There were significant differences amongst clones suggesting wide genetic diversity. The species thrived well in cooler temperate conditions of the inner-Himalaya.

INTRODUCTION

Populus ciliata Wall. ex Royle popularly known as Himalayan poplar is a common component of temperate region in the burnt forests, ravines and river basins from 1300 to 3500 m (Puri, 1960). It is commonly distributed in the western Himalaya and offers a wide spectrum of eco-phenotypic variation irrespective of sex (Khosla et al., 1979, 1980). The species serves as a nurse crop for the silver fir (Abies spp.) regeneration (Wiart, 1977). The fast growth rate and light wood of this species makes it a choice tree of higher elevations to meet the increasing shortage of wood for packaging. The multifold utility of this species, therefore, warrants for the development of fast growing clones. Since the difference in performance between different clones is an important phase of genetic improvement programme (Wilcox and Farmer, 1967), a provenance clonal trial and subsequently a site-interaction trial was laid to explore the genotypic potential of selected provenances under different environmental conditions.

EXPERIMENTAL METHODS

A clonal trial on 84 collections from nine provenances (76°10' to 77°13' E and 31°6' to 32°29' N), comprising of the phenotypically superior ortets was laid at Shilli (altitude 1500 m, annual rainfall 200 mm). The ramets were raised in random blocks. The data on height and diameter were mensurated annually while specific gravity was analysed after two years of age. Seven of these

promising clones were further tested for site-interaction studies at three sites - high hills (2000 m) at Manali (32°15' N 77°10'E), mid-hills (1500 m) at Shilli (30°55' N 77°9' E) and low-hills (500 m) at Dhaulakuan (30°33' N 77°9' E). The material in this case comprised of pooled best performing ramets in each provenance and were evaluated for height and diameter in the randomised block design. The best ramets were pooled to utilise large variance components of family and clone (Ying and Bagley,1976). The analysis of site-interaction studies was computed using population means (Andrew and Wright,1976).

RESULTS AND DISCUSSION

The nine provenances tested in range wide trial (31°6' to 32°29' N) revealed significant differences between clones and provenances (Tables 1, 2). Gahar provenance attained more than 1 cm (1.13) diameter and 1 m (1.24) height increase per annum. The populations from Theog closely matched it. Balsun provenance which produced 1 m height increase per year lagged behind to give similar diameter increase. The maximum average height (1.5m) and diameter (1.6cm) per year were given by T9 ortet from Theog provenance while one of the ramets topped with height and diameter increments of 1.75 m and 2.07 cm respectively. However, all the ten ortets of Gahar provenance were uniform in their expression, implying that the genotype has established an equilibrium to site conditions. Specific gravity also showed significant inter and intra-provenance differences and was minimum in Theog and Kumarsain (0.38) and maximum in Diyar provenance (0.47).

The significant intra and inter-provenance differences are indicative of genetic diversity of high order which may be attributed to obligate wind pollination and light and cottony seeds which are carried over to otherwise isolated sites bearing the species. The heterogeneity of this nature may be a biological potential for its adaptation to varied environments. Rohfeldt and Lester (1969) made a similar observation that pioneer species maintain genetic diversity to occupy habitats different from their parents.

The perusal of tables 3 and 4 revealed that the phenotypic expression of provenances were strongly influenced by altitudinal clines. There were better phenotypic expressions in the temperate region of inner Himalaya, all the clones produced growth increment of 1 m height and 1 cm diameter. This was followed by mid-hills while lower elevations were unsuitable for the commercial exploitation of this species. The low mean square values of site x population interaction explain the genetic stability of these provenances to cool and temperate conditions as none of the provenances at mid-hills and low hills deviated to match their expression in the high hills. Dhir and Mohn (1974) attributed this type of response to strong site effect and source - site interaction. Pauley and Perry (1954) postulated that source-site interaction was related to photoperiod, winter temperature and hardiness. It is concluded that this species may not profitably descend in the low-hills but can successfully be exploited in the cooler places in the high-hills and to lesser extent in the mid hills.

Table 2: Data on analysis of variance of provenance trial.

Source of variation	Level of significance		
	Height	Diameter	Specific gravity
Between provenances	365.20**	39.24**	22.00**
Between clones	537.00**	79.53**	85.72**
Between replications	1.40 NS	0.41 NS	0.55 NS
Interactions	26.40**	8.88**	10.55**

** Significant at 1% level.
NS Non-significant.

Table 3: Data on genotype - site-interaction trials.

Provenance	Height in metres			Diameter in centimetres		
	Dhaulakuan	Shilli	Manali	Dhaulakuan	Shilli	Manali
Gahar	0.84	0.97	1.00	0.34	0.95	1.25
Diyar	-	0.84	1.14	-	0.90	1.46
Kumarsain	0.81	0.96	1.00	0.33	0.91	1.28
Theog	0.73	0.89	1.08	0.32	0.95	1.18
Balsun	0.64	1.03	1.22	0.27	1.03	1.36
Chhutri	0.63	0.95	1.07	0.30	0.92	1.32
Brehi	0.69	1.01	-	0.33	1.01	-

Table 4: Data on analysis of variance of genotype site-interaction trials.

Source of variation	Level of significance	
	Height	Diameter
Between provenances	0.15 NS	1.00 NS
Between sites	25.00**	537.88**

** Significant at 1% level.
NS Non-Significant.

Table 1: Data on the range of variation in provenance trials.

Provenance	Altitude	Height per year (m)		Diameter per year (cm)		Specific gravity	
		Range	Mean	Range	Mean	Range	Mean
Gahar	1800	0.70-1.91	1.24	0.70-1.90	1.13	0.30-0.60	0.39
Diyar	2100	0.55-1.35	0.87	0.50-1.60	0.83	0.35-0.69	0.47
Balsun	1800	0.25-1.62	1.04	0.15-1.40	0.81	0.33-0.50	0.39
Theog	2200	0.60-1.71	1.10	0.50-2.10	0.95	0.30-0.54	0.38
Kumarsain	1900	0.24-1.82	0.79	0.15-1.68	0.55	0.29-0.51	0.38
Chhutri	2300	0.60-1.41	0.90	0.50-1.40	0.82	0.33-0.62	0.43
Brehi	1900	0.62-1.71	0.82	0.40-1.10	0.75	0.33-0.47	0.39
Kandi	2000	0.25-0.77	0.45	0.20-0.35	0.28	-	-
Kalatop	2500	0.13-0.45	0.25	0.15-0.35	0.29	-	-

L I T E R A T U R E C I T E D

Andrew, I.A. and Wright, H.L., 1976: Evaluation - assessment and analysis. In J.Burley and P.J.Wood (ed.) - A manual of species and provenance research with particular reference to the tropics. C.F.I., Oxford, PP.108-130.

Dhir, N.K. and Mohn, C.A., 1974: Growth and flowering of NC-99 Cottonwood seed source in Minnesota. Minn. For.Res. Notes No.253, 4 pp.

Khosla, P.K., Dhall, S.P. and Khurana, D.K., 1979: Studies in Populus ciliata Wall. ex Royle I. Correlation of phenotypic observations with sex of trees. Silv.Genet., Vol.28(1), pp.21-23.

Khosla, P.K., Kaushal, P.C. and Khurana, D.K., 1980: Studies in Populus ciliata Wall. ex Royle II. Phenotypic variation in natural stands. Silv. Genet., Vol.28(6).

Pauley, S.S. and Perry, T.O., 1954: Ecotypic variation of the photoperiodic response in Populus. J.Arnold Arbor., Vol.35, pp. 167-188.

Puri, S.S., 1960: Indian Forest Ecology. Vol.I. Oxford Book and Stationery Co., New Delhi.

Rehfeldt, G.E. and Lester, D.T., 1969: Specialization and flexibility in genetic systems of forest trees. Silv. Genet. Vol.18, pp. 118-123.

Viart, M., 1977: Silviculture of temperate and semi-temperate forests - A technical account of a study tour made in India (Oct. 5 to Nov.18, 1976).

Wilcox, J.R. and Farmer, R.E.Jr., 1967: Variation and inheritance of juvenile characters of Eastern Cottonwood. Silv. Genet.,Vol.16(5-6), PP. 162-165.

Ying, C.C. and Bagley, W.T., 1976: Genetic variation of Eastern Cottonwood in an Eastern Nebraska provenance study. Silv.Genet., Vol.25(2)., PP.67-88.

FAST GROWING TREES

ENRAIZAMENTO DE ESTACAS A SERVIÇO DE PLANTAÇÕES DE *Terminalia superba* MELHORADAS GENETICAMENTE, NA REPÚBLICA POPULAR DO CONGO

J. P. Koyo
C. T. F. T.
CONGO

Resumo

Terminalia superba ou *Limba* é uma das espécies florestais mais exploradas na República Popular do Congo. Assim é que as pesquisas florestais congolesas vêm conduzindo estudos sobre melhoramento genético e enraizamento de estacas dessa espécie com sucesso, visando estabelecer plantações industriais.

LE BOUTURAGE AU SERVICE DES PLANTATIONS AMELIORES DE *Terminalia superba* EN REPUBLIQUE POPULAIRE DU CONGO

Summary

Terminalia superba or Limba is among the most exploited forest species in People's Republic of Congo. So, the Congolese forest research has successfully undertaken studies about genetic improvement and cutting techniques of this species for the purpose of industrial plantations.

2 - INTRODUCTION

Le genre Terminalia de la famille des Combrétacées compte en Afrique intertropicale deux espèces de forêts humides et semi-decidues : Terminalia ivorensis ou Framiré et Terminalia superba ou Limba.

L'aire naturelle de ces Terminalia longe la côte Ouest d'Afrique en une bande, distante d'environ 100 km du littoral, allant de la Guinée jusqu'en Angola.

A l'intérieur de l'aire de l'espèce Terminalia superba, il existe d'importantes variations dans la qualité du bois. Les provenances de l'hémisphère nord, appelées "Fraké", présentent, une forte proportion de coeur noir. Par contre celles de l'hémisphère sud nommées "Limba" sont très appréciées et ont été jusqu'ici les plus exploitées.

Au Congo, jusqu'en 1966, le Limba a représenté plus de 50% de la production nationale en grumes.

La diminution rapide des réserves a conduit les forestiers à réaliser, entre 1950 et 1961, 6 500 ha de plantations de Limba au Mayombe.*

Dans le but de mettre en place des plantations améliorées de Limba, la recherche forestière s'est attachée à :

- répérer les phénotypes les plus intéressants de cette essence ;
- conserver ces phénotypes dans des parcs à clones ;
- mettre au point une technique de multiplication végétative du Limba
- multiplier par bouturage des arbres +
- réaliser des plantations d'extension à partir des plants bouturés.

3 - SELECTION DES MEILLEURS PHENOTYPES DE TERMINALIA SUPERBA DU SUD-CONGO

A la suite d'un inventaire forestier, effectué au Sud-Congo, inventaire couvrant environ 3 Millions d'ha, nous avons obtenu un financement nous permettant d'effectuer le repérage d'un certain nombre de Limbas phénotypiquement supérieurs.

La première phase de l'opération a concerné le choix des 10 provenances les plus intéressantes et les mieux réparties sur toute l'aire de l'espèce afin de profiter au maximum de la variabilité génétique. Dans chacune de ces provenances 100 beaux phénotypes, devant servir de semenciers, ont été sélectionnés sur des critères suivants :

- rectitude et cylindricité du fût ;
- bon élagage et absence de bosses ou chicots ;
- bon état sanitaire ; pas de coeur noir ;
- contreforts peu élevés ;
- pas de fourche ou de baïonnette ;
- diamètre compris entre 40 et 80 cm.

A l'intérieur des 100 specimens sélectionnés par provenance, les 10 plus beaux ont été retenus pour constituer les arbres d'élite. Deux critères ont été privilégiés lors de cette sélection, sans pour autant négliger les autres :

a) - Conformation de l'arbre : cette donnée englobe la forme de l'arbre, son état végétatif, la décroissance métrique sur le diamètre. Elle caractérise la qualité commerciale de l'arbre, et peut-être son utilisation éventuelle.

b) - Potentialités de croissance : les carottes radiales prélevées au-dessus des contreforts ont servi pour estimer l'âge des arbres plus retenus par comptage des cernes.

* Mayombe : Zone forestière montagneuse située à environ 50 km de la côte congolaise se prolongeant au S - E. au Zaïre et au Cabinda.

	Provenances									
	Mayom: bp	Loubotsi	Passi-Passi	Divenié	Loufoula	Mossendjo	Léboulou	Sibiti	Boko Songo	Kimongo
Nombre total de clones représentés en 1980	10	10	6	7	6	3	7	10	6	8

4 - CONSTITUTION DE PARC A GREFFE D'ARBRES +

Des campagnes de récolte de greffons sur ces arbres + ont eu lieu en Août et Septembre des années 1975, 1976, 1977 et 1978. La récolte s'effectue en tirant à la carabine les branches d'arbres plus sélectionnés. Les mois d'Août et Septembre correspondent dans les conditions du Sud-Congo au prédébourrement du Terminalia superba.

Le matériel ainsi récolté est immédiatement acheminé dans des glacières à la station CTFT de Loudima où le greffage est effectué le lendemain de la récolte sur des porte-greffes de Terminalia superba tout venant âgés de 2 - 3 ans éduqués en pépinière.

Sur 100 clones sélectionnés, 73 ont ainsi pû être greffés et sont, représentés dans le parc à greffe de Loudima.

On peut actuellement estimer à 371 le nombre total de greffes vivantes dans le parc.

5 - MISE AU POINT DES TECHNIQUES DE BOUTURAGE DE REJETS DE GREFFE

Le parc à greffe d'arbres plus est notre source de matériel amélioré destiné à la multiplication végétative pour laquelle une technique de bouturage a dû être mise au point.

5.1 - Recépage des greffes

Chaque année en saison de pluie le parc à greffe est recépé 3 à 4 fois. Les premières tailles commencent début Janvier et se poursuivent jusqu'en Avril-Mai. La taille est pratiquée à environ 1m du sol et laisse porte-greffe et greffe complètement nus.

Les rejets deviennent bouturables au bout de 4 à 6 semaines.

5.2. - Bouturage des rejets de greffe

Le bouturage des rejets de greffe du Terminalia superba pose beaucoup de problèmes du fait de la maturation physiologique du matériel induit, l'aptitude à la rhizogenèse d'une espèce végétale étant d'autant plus grande que le matériel utilisé est plus juvénile.

Les conditions de bouturage les plus intéressantes en 1979 ont été :

- Bouture 4 feuilles ; matériel herbacé
- Type d'arrosage : mist
- Hormone : Rootone 10 pure (3,9% d'acide naphtyl 1 acétique).

Sur 1 617 boutures tentées, 181 ont été réussies soit un taux de 11,2%.

Ces boutures issues du parc à greffe sont le matériel de base pour la mise en place de parcs multiplicatifs. A l'heure actuelle le C.T.F.T. dispose de trois parcs multiplicatifs et d'un test clonal.:

- Parc multiplicatif 1976 à N'Boku-N'Situ (Mayombe) : au total 14 clones représentés par 51 pieds ;
- Parc multiplicatif 1978 à N'Boku-N'Situ : au total 27 clones représentés par 246 pieds ;
- Parc multiplicatif 1979 à Loudima : au total 38 clones représentés par 258 pieds :
- Test clonal : 6 clones en 20 répétitions selon un dispositif monoarbre dans le Mayombe.

6 - BOUTURAGE DES REJETS DE BOUTURES

Le bouturage de rejets de boutures s'effectue à N'Boku-N'Situ depuis 1978 à partir du parc multiplicatif 1976. Les conditions de bouturage ainsi que les taux de réussite sont très différents de ceux du bouturage des rejets de greffe.

On passe en effet de 11,2% de réussite pour les rejets de greffes à 50 - 60% pour les rejets de boutures. Ce qui démontre suffisamment l'effet réjuvénilisant de la séquence greffe - bouture - bouture.

Conditions de bouturage :

- Bouture 4 feuilles ; matériel herbacé
- Types d'arrosage : mist ou chassis. Le chassis convient mieux du fait de la simplicité de fabrication et d'installation et surtout il ne nécessite pas un personnel hautement qualifié et une surveillance permanente.
- Hormones : à l'opposé des boutures de rejets de greffe, les hormones utilisées pour les boutures les rejets de bouture sont à faible concentration d'AIB.
- Substrat : les sols sableux filtrants ainsi que l'horizon humifère A_1 des sols forestiers sont les plus intéressants.

Le sevrage intervient après 21 jours et dure deux semaines.

7 - PLANTATIONS SEMI-INDUSTRIELLES

A partir de 1981, on disposera de deux parcs multiplicatifs capables de produire potentiellement 8000 à 9000 boutures sélectionnées. Il s'agit :

- du parc 1976 qui est entré en production depuis 1978. Il peut produire environ 1000 boutures sélectionnées par an.
- du parc 1978 qui sera recépé pour la première fois en 1981. Il devra fournir près de 7000 à 8000 boutures sélectionnées par an.

L'Office Congolais des Forêts (O.C.F.), organisme chargé du reboisement au Congo, disposera en 1981 d'environ 8000 à 9000 boutures d'arbres plus.

A l'écartement de 10m x 10m. Cela représente 80 à 90 ha de plantations de Limba sélectionnés.

8 - CONCLUSION

Le Congo dispose à présent d'un nombre relativement élevé de clones d'arbres plus de Limba. Les techniques de bouturage étant quasiment

au point, l'Office Congolais des Forêts pourra envisager dès 1981 la mise en place de plantations d'extension avec du matériel particulièrement performant.

Les recherches sur le bouturage d'autres essences de forêt dense, notamment Aucoumea klaineana, sont en cours d'expérimentation au CTFT-Congo. Dans quelques années, il sera fort probable que le Congo entreprenne, à l'image de ce qui a été fait pour le Limba, des études d'amélioration génétique des essences telles que Aucoumea klaineana (Okoumé), Entandrophragma spp etc... en vue d'asseoir par la suite des programmes d'extension en ces essences.

9 - BIBLIOGRAPHIE

CENTRE TECHNIQUE FORESTIER TROPICAL, 1974 :
Fiche technique du Limba - Fraké. Revue Bois et Forêts des Tropiques n° 158, pp 33 - 49.

CENTRE TECHNIQUE FORESTIER TROPICAL, 1976 :
Choix et Repérage de semenciers en vue de la création de plantations industrielles au Congo C.T.F.T.. Nogent-sur-Marne, 26 pp.

GROULEZ. J., 1958 :
Les peuplements artificiels de Terminalia superba dans le Mayombe français C.T.F.T. Congo, B.P. 764 - POINTE-NOIRE.

GROULEZ, J., 1961 :
Le Centre de reboisement en Limba du Mayombe. CTFT/Congo B.P. 764 Pointe-Noire, 26 pp.

LETOUZEY, R. 1970 :
Manuel botanique forestière Afrique tropicale tome 2A. C.T.F.T. Nogent sur Marne, pp. 112 - 117.

MAILLARD, D., 1978 :
Bouturage du Limba et de diverses essences de forêt dense. C.T.F.T./Congo - B.P. 764 - POINTE-NOIRE, 59 pp.

Ministère des Eaux et Forêts de la République Populaire du Congo, 1974 :
Projet de forêt artificielle de Limba. Ministère des Eaux et Forêts, 81 pp.

RICHERT, D., 1979 :
Campagne de bouturage de Limba Station de Loudima. C.T.F.T/CONGO B.P. 764 - POINTE-NOIRE, 16 pp.

FAST GROWING TREES

ESTUDO DA VARIAÇÃO EM *Triplochiton scleroxylon* K. SCHUM. — ALGUNS CRITÉRIOS PARA A SELEÇÃO CLONAL

D. O. Ladípo
Forestry Research Institute of Nigeria, Ibadan
NIGERIA
R. R. B. Leakey and F. T. Last
Institute of Terrestrial Ecology, Midlonthian
SCOTLAND

Resumo

Clones de *Triplochiton scleroxylon*, uma importante folhosa de rápido crescimento, originária do Oeste Africano, têm sido plantados em ensaios de campos, utilizando-se métodos efetivos de propagação de estacas de caules juvenis, baseadas em modificações das técnicas normais de horticultura. Essas plantações clonais representam a diversidade da espécie desde Cameron até Serra Leão.

Neste estudo clones foram derivados de mudas produzidas de sementes obtidas em colheitas feitas através da Nigéria e Experimentos instalados com repetições, e envolvendo parcelas de uma única árvore, na Reserva Florestal de Onigambari, mostram, aos 18 meses, que clones de um mesmo lote ou de lotes diferentes de sementes diferem significativamente, em: 1) crescimento em altura; 2) diâmetro dos caules; 3) número dos ramos primários; 4) número dos ramos primários por m do caule principal

A STUDY OF VARIATION IN *Triplochiton scleroxylon* K. SCHUM. — SOME CRITERIA FOR CLONAL SELECTION

Summary

Having successfully evolved methods for propagating juvenile stem cuttings, by modifying standard horticultural techniques, clones of Triplochiton scleroxylon, a valuable fast growing West African hardwood, have been planted in field trials. These clonal plantations represent the diversity of the species from Cameroun to Sierra Leone. In the present study clones were derived from seedlings grown from seed collections made throughout Nigeria. Replicated experiments with single tree plots, done at Onigambari Forest Reserve show, after 18 months, that clones from the same and different seedlots differ significantly in:- (i) amounts of height growth, (ii) stem diameters, (iii) numbers of primary branches, and (iv) numbers of primary branches per m of mainstem. Mean heights of c. 3.1 m were decreased to 1.7 m when spacings within and between rows were widened from 2.4 to 4.9 m.

INTRODUCTION

Triplochiton scleroxylon K. Schum., a large tree of considerable economic importance (Redhead, 1971: Leakey et al., this volume) has, like several other indigenous W. African hardwoods, been heavily exploited for its timber, Obeche.

Without an active programme of regeneration the resource has inevitably become depleted with a probable loss of genetic variation. To conserve what remains and to facilitate the future cultivation of 'improved' clonal planting-stock (Longman, 1976; Heybroek, 1978) two collaborative projects were established, one in 1971 at the Forestry Research Institute of Nigeria, Ibadan, and the other in 1974 at the Edinburgh (Bush) station of the Institute of Terrestrial Ecology (Longman et al., 1979). By modifying techniques widely used for the vegetative propagation of woody perennials, successful techniques have been developed for rooting juvenile cuttings of T. scleroxylon (Howland, 1975 a, b, c; Leakey et al 1975 and in litt). This has allowed the production of large quantities of clonal material from seeds collected throughout Nigeria, Cameroun, Ghana, Ivory Coast and Liberia (Bowen et al., 1977). Since 1975 substantial experimental plantings have been made at six widely separated locations in the lowland forest zone of Nigeria. However, the main effort has been centred upon the Onigambari Forest Reserve, near Ibadan, where detailed investigations have been started to elucidate the criteria for clonal selection of commercial planting stock.

Table 1. Accession numbers and Nigerian location of individual tree (half-sib) seed collections used for the production of clones planted in four experiments at Onigambari Forest Reserve, near Ibadan, Nigeria in 1975.

Accession numbers of seedlots	Origin of seedlots				Accession numbers of clones (used as subscript to seedlot number).
	Location	Latitude °N	Longitude °E	Rainfall zone (mm)	
137	Olokemeji, Oyo State.	7.21'	3.32'	1,300 - 1,500	2, 4, 5, 9, 10, 11 & 12
139	Olokemeji, Oyo State.	7.21'	3.32'	" "	2, 3, 4, 5, 6, 9, 11 & 12
140	Onigambari, Oyo State.	7.12'	3.52'	" "	1, 2, 3, 4, 6, 9, 10 & 11
142	Omerelu, Ondo State.	5.17'	6.55'	2,000 - 2,500	1, 3, 4, 6, 7, 10, 11 & 12
144	Igho Ora, Ogun State.	7.27'	3.18'	1,000 - 1,300	1, 4, 5, 7, 9, 10 & 11
145	Bolorunduro, Ondo State.	7.09'	5.37'	1,300 - 1,500	2, 6, 8, 9, 10, 11 & 12
161	Owo, Ondo State.	7.02'	5.43'	" "	1, 3, 4, 5, 7, 9 & 12
166	Azukala, Anambia State.	7.02'	6.27'	" "	1, 2, 3, 6, 8, 9, 11 & 12
175	Igbado, Ogun State.	6.49'	4.52'	1,500 - 2,000	1, 2, 3, 5, 6, 7, 8 & 10
176	Ilugun, Oyo State.	7.24'	3.44'	1,000 - 1,300	1, 3, 4, 6, 9, 10 & 11
177	Ilugun, Oyo State.	7.21'	3.39'	1,300 - 1,500	2, 4, 5, 6, 8, 10 & 11
224	Ede, Oyo State.	7.42'	4.26'	" "	1, 3, 4, 7, 9, 10, 11 & 12
225	Ede, Oyo State.	7.42'	4.26'	" "	1, 2, 3, 4, 8, 9, 10 & 12
226	Akure, Ondo State.	7.15'	5.10'	" "	1, 3, 4, 5, 6, 7 & 8

Fig. 1. Variation in height after 18 months, of seven clones of each of 14 seedlots (half-sib) of Triplochiton scleroxylon collected from different locations when planted at a spacing of 2.4 m within and between rows, at Onigambari Forest Reserve, Nigeria. (----- , mean height of seedlot; L.s.d. (p = 0.05) for individual clones and seedlot means are 0.54 and 0.18 m respectively).

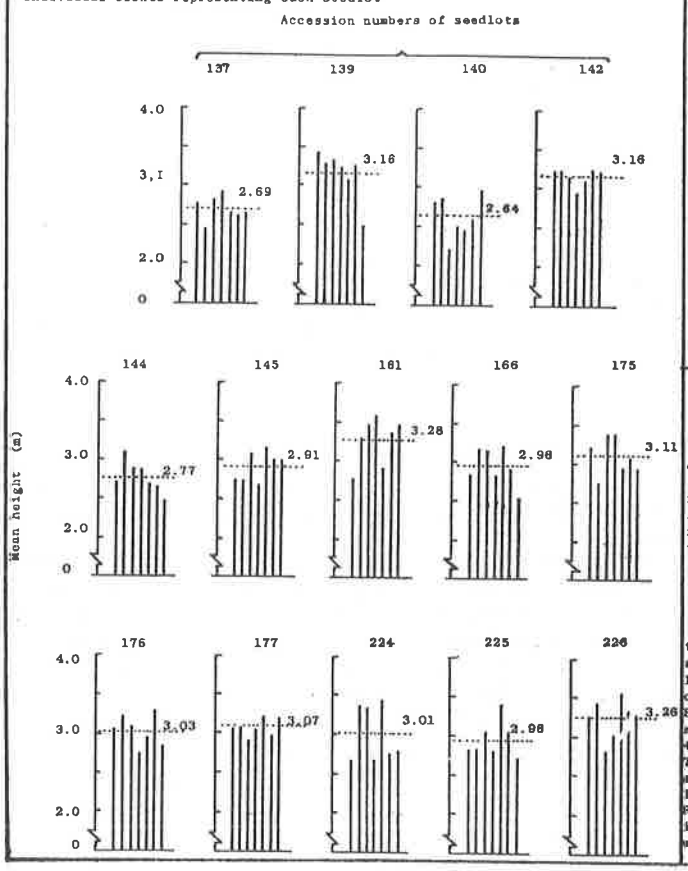


Table 2. Probable mean effects of different spacings on tree heights (m) of seven clones of T. scleroxylon 18 months after planting.

Clone No.	Plant spacing 2.4 m	Plant spacing 4.9 m
139/3	3.29	1.97
139/4	3.32	1.52
140/9	2.47	1.37
144/1	2.71	1.65
175/5	3.28	1.73
177/10	2.96	1.65
224/10	3.43	2.16
Mean	3.06	1.71

N.B. Data for 2.4 m spacing are means of experiments 3/75, 4/75 and 5/75; those for 4.9 m relate to 7/75.

EXPERIMENTAL SITE

Four experiments were planted in 1975, at Onigambari, where rain mainly occurs in March-June and August-October amounting to c. 1500 mm yr^{-1}, and where the freely draining topsoil with good base accumulations overlies crystalline rocks of undifferentiated Basement Complex with intrusions of gneiss, quartzite and schist (Onweluzo et al., 1976). Before planting, the existing secondary forest was cleared with the removal of sawlogs and the burning of brushwood, this inevitably introduced some small-scale site variation.

MATERIALS AND METHODS

Up to 12 clones were prepared from each of 14 half-sib seed collections taken from individual trees at a range of Nigerian locations with different annual amounts of rain (Table 1). Rooted cuttings, established from juvenile leafy cuttings, were potted and tended in the shade for 3 months, to a height of c. 0.3 m before four experiments were planted in June and July 1975. Experiments 3/75, 4/75 and 5/75, which had 2, 12 and 12 randomized blocks of single tree plots respectively, were arranged to assess the differences between 4 to 8 usually unrelated clones planted at a spacing of 4.9 m; while experiment 7/75, spaced at 2.4 m, ambitiously attempted to assess the differences between seven clones of each of 14 different seedlots arranged in 9 randomised blocks. Irrespective of experiment, survival six months after planting exceeded 95%. Regular assessments of growth, including branch characteristics, were made at intervals of 1 to 3 months, their frequency being greater during wet weather when growth was rapid.

RESULTS AND DISCUSSION

Growth of T. scleroxylon cuttings, propagated from 'juvenile' stockplants, was similar to that of comparable seedlings (Howland & Bowen, 1977). However, their rates of growth seem to be strongly affected by spacing with mean heights in the closely spaced experiments 3/75, 4/75 and 5/75 being 3.1 m after 18 months compared with 1.7 m in the widely spaced experiment 7/75 (Table 2), i.e. a difference of 79%. This difference, however, was lost after 48 months, presumably due to competition effects between trees at the close spacing.

In experiment 7/75 the mean heights of trees from different seedlots differed significantly, ranging from 2.65 m for seedlot 140, the shortest, to 3.28 m for seedlot 161, the tallest (Fig. 1); and comparable differences were found for stem diameter and numbers of branches. These parameters, like heights, could not, however, be systematically related to the location of the source trees whether considered in terms of latitude, longitude or annual rainfall. As was found with the temperate Picea abies (L.) Karst. (Kleinschmidt, 1974), variation between seedlots was not as great as the variation among clones of the same seedlot. The ten tallest T. scleroxylon clones, which were located in 6 of the 14 seedlots, ranged from 3.38 to 3.61 m compared with a mean height for all trees of 3.00 m. Thus, by selecting 1 tree in 10 there is a chance of a potential height gain of 16.5%; this falling to 12.2 and 6.0% if the selection intensity falls to 1 in 4 or 1 in 2 respectively. These potential gains are small in comparison with the 40% gains achieved by selecting "elite" clones of P. abies, but Kleinschmidt was screening an infinitely greater number of clones, (21,000), picking only one in a thousand. Furthermore, the present study only examined the gains obtained in the period before crown-interlock and this may not reflect the benefits accruing after canopy closure.

While height growth is important it is likely that many aspects of form may be more strongly inherited, and thus more easily selected. What then are the characteristics of the ideal T. scleroxylon clone? While this question can not yet be answered, evidence is accumulating to suggest that branching habit, which is very variable in T. scleroxylon, may in fact interact with vigour under certain circumstances. Thus in experiments 3/75, 4/75 and 5/75 the tallest clones viz. 166/8, 224/10 and 139/9 were also those with the fewest primary branches per m. of mainstem (Table 3). However, the relative sizes of these primary branches differed greatly. It seems that photosynthates are apportioned differently in different clones and that this might significantly affect their harvest indices (proportions of harvestable to total growth), this perhaps being manipulated by planting at different spacings. One undesirable branching characteristic of T. scleroxylon is the development of strong erect branches from the basal 10 cm sections of the stem, and consequent formation of multi-stemmed trees. Howland & Bowen (1977) for instance, noted that the mean number of stems per tree in clones 166/1 and 144/1 were 2.70 and 1.05 respectively. These differences which doubtless could be minimized by appropriate silvicultural practices, probably reflect genetic differences in the ability of the leading shoot to suppress branch growth. Indeed Leakey & Longman (1979) found, in small double-stemmed plants, that the ability of one shoot to assert dominance and form a leader was strongly clonal.

In summary it has been found, despite major site variations, that rates of height growth and branch production, and the evolution of canopy architecture differ among different clones. But will the desirable early traits persist and be of value at later stages of stand development; or will the relative merits of different clones of this fast growing tropical hardwood change as competition factors become more important? Such changes have been found in some slow-growing temperate hardwood plantations (Sziklai, 1974). If, however, late growth compounds any differences arising in early growth, then it should be possible to select clones on their early growth characteristics. Of these, branching habit seems important and this is presumably related to apical dominance, which in T. scleroxylon is known to differ markedly between clones (Leakey, in press). Thus it may perhaps be possible to predict, at a very early age in the nursery, the relative merits of clones, by a knowledge of their apical dominance. Studies of this nature are currently in progress and already correlations have been found between the patterns of dominance in small potted plants and the branching habits of the same clones in plantation. The details of these very encouraging investigations will be published elsewhere.

ACKNOWLEDGEMENTS.

We wish to acknowledge the contributions made by many Nigerian and British colleagues to the projects funded by the U.K. Overseas Development Administration and supported in the field by the Forestry Research Institute of Nigeria. In particular we are indebted to Dr. M. R. Bowen who contributed greatly to the establishment and assessment of these experiments.

REFERENCES

Bowen, M. R., Howland, P., Last, F. T., Leakey, R. R. B. & Longman, K. A. (1977). Triplochiton scleroxylon : its conservation and future improvement. F.A.O. Forest Genetic Resources Information No. 6, 38-47.

Heybrook H. M., (1976). Primary considerations : multiplication and genetic diversity. 3rd World Consultation on Forest Tree Breeding, Unasylva, 30, 27-33, 49-50.

Howland, P. (1975a). Vegetative propagation methods for Triplochiton scleroxylon K. Schum. Proceedings of Symposium on Variation and Breeding of Triplochiton scleroxylon K. Schum., Ibadan, Nigeria, pp. 99-109.

(1975, b) Variation in rooting of stem cuttings of Triplochiton scleroxylon K. Schum. Ibid, pp. 110-124.

(1975, c). Current management techniques for raising Triplochiton scleroxylon K. Schum. Ibid, pp. 125-129.

Howland, P. & Bowen M. R. (1977). Triplochiton scleroxylon K. Schum & other West African Tropical hardwoods. West African Hardwoods Improvement Project Research Report 1971-1977, Forestry Research Institute of Nigeria, Ibadan, Nigeria, 154 pp.

Kleinschmidt, J. (1974). A programme for large-scale cutting propagation of Norway Spruce. New Zealand Journal of Forest Science, 4, 359-366.

Leakey, R. R. B. (in press). Physiological approaches to the conservation and improvement of Triplochiton scleroxylon - a West African timber tree. Proceedings of ITE Woodland and Forest Ecology Meeting, Monks Wood, Novembe

Table 3. Variations in height, stem diameter and lengths and numbers of primary branches, after 18 months, among clones of T. scleroxylon from the same and different seedlots. Experiments planted at a spacing, within and between rows, of 4.9 m.

	Accession numbers of clones*	Stem diameter 10 cm from base (cm)	Plant Height (m)	No. of primary branches	No. of primary branches/m. of mainstem length	Total primary branch length	Mean primary branch length
	142/10	6.2	1.86	17.5	9.3	10.4	55.0
Expt.	166/8	5.3	2.08	10.9	5.1	6.6	55.9
3/75	175/1	5.4	1.90	19.7	9.9	12.6	55.8
	175/5	6.3	1.73	15.6	8.6	11.3	64.2
	177/10	4.8	1.55	13.7	9.1	6.6	46.4
	LSD (p=0.05)	1.3	0.41	5.3	1.8	5.2	16.0
	139/4	4.0	1.52	13.1	8.2	6.0	41.0
Expt.	140/4	4.8	1.69	12.4	7.2	7.8	58.5
4/75	140/9	3.7	1.37	12.1	9.3	5.3	42.6
	144/1	3.7	1.57	13.2	8.5	4.0	32.1
	224/10	5.8	2.16	13.9	6.3	9.3	61.8
	225/3	4.3	1.49	11.1	6.9	5.6	45.9
	LSD (p=0.05)	0.8	0.24	3.3	1.6	2.6	9.3
	139/3	5.6	1.97	12.9	6.2	8.6	60.0
Expt.	139/9	5.8	2.25	14.5	6.1	10.1	63.1
5/75	144/1	4.8	1.73	14.1	8.1	7.2	47.6
	224/1	5.3	1.75	11.7	6.5	7.6	61.3
	LSD (p=0.05)	0.7	0.21	2.9	1.0	2.8	8.9

*142/10 - 142 refers to seed collection; 10 designates clone within a seed collection.

Leakey, R. R. B. & Longman, K. A. (1979). Reproduction, conservation and improvement of some tropical hardwoods. Fifth Annual Report ITE Project 248, to Overseas Development Administration, 48 pp.

Leakey, R. R. B., Chapman, V. R. & Longman, K. A. (1975). Studies on root initiation and bud outgrowth in nine clones of Triplochiton scleroxylon K. Schum. Proceedings of Symposium on Variation and Breeding Systems of Triplochiton scleroxylon K. Schum, Ibadan, Nigeria, pp. 86-92.

Leakey, R. R. B., Chapman, V. R. & Longman K. A. (in litt.). Physiological studies for tropical tree improvement. Factors affecting root initiation in cuttings of Triplochiton scleroxylon K. Schum.

Leakey, R. R. B., Ojo, G. O. A., Oji, N. O. & Ladipo D. O. (this vol.) Triplochiton scleroxylon : a tropical hardwood for plantation forestry. Proceedings of IUFRO Symposium and Workshop on Genetic Improvement and Productivity of Fast Growing Tree Species, SÃo Paulo, Brazil, August 1980.

Longman, K. A. (1976). Conservation and utilization of gene resources by vegetative multiplication of tropical trees. In Tropical Trees : Variation, Breeding and Conservation. Eds. Burley J. & Styles B. T., Academic Press, London, pp. 19-24.

Longman, K. A., Leakey, R. R. B., Howland, P. & Bowen, M. R. (1979). Physiological approaches for utilizing and conserving the genetic resources of tropical trees. Proceedings of 3rd World Consultation on Forest Tree Breeding, Vol. 2, Canberra, Australia, 1977 pp. 1043-1054.

Onweluzo, B. S. K., Fagbenra, J. A., Aluko, A. P., and Orimoyegun, S. O. (1976). Forest Soils. Report for the 4th National Soil Correlation Committee Meeting Ibadan, 7 pp.

Redhead, J. F., (1971). The timber resources of Nigeria. Nigerian Journal of Forestry, 1, 7-11.

Sziklai, O. (1974). Juvenile - Mature correlation. Proceedings of IUFRO Meeting Stockholm, pp. 217-235.

FAST GROWING TREES

A APLICAÇÃO DO ÁCIDO GIBELÉRICO A-3 EM ENXERTOS DE *Cypressus* VISANDO A AUMENTAR A PRODUÇÃO DE FLORES

W. E. Ladrach
Carton de Colombia S.A., Cali
COLOMBIA

Resumo

Três ensaios envolvendo a aplicação de giberelina em *Cupressus lusitanica* Mill. foram efetuados visando melhorar a floração. Repetidas pulverizações de ácido giberélico A-3 na concentração 100 ppm em álcool etílico demonstraram ser eficientes para aumentar a produção de flores e cones em enxertos de dois anos de idade. Esta técnica mostrou ser valiosa no aumento da produção de pôlen para polinizações controladas em pomares clonais de sementes.

THE APPLICATION OF GIBERELLIC ACID A-3 TO *Cypressus* GRAFTS FOR INCREASED FLOWER PRODUCTION

Summary

Three trials of gibberillin application on Cupressus lusitanica Mill. were conducted to improve flowering. A repeated foliar mist application of A3 at 100 ppm in ethyl alcohol was found to improve both flower and cone production in two year old grafts. This technique will be valuable for increasing pollen production for controlled crosses in a grafted cypress seed orchard.

INTRODUCTION

Gibberellin is a phyto-hormone or plant hormone that retards vegetable growth and induces flowering, especially in the families Taxodiaceae and Cupressaceae, according to studies by Kato et al. Nashizume (1967), Pharis (1976) and others. This hormone is produced by the fungus Giberella fujikuroi. There are several kinds on the market that promote flowering, among them are A3, A4, A5, A7, and A9. The least expensive and easiest of these to obtain, in addition to being the most highly recommended for Cupressaceae is A3. For these reasons this type was selected for study on Cupressus lusitanica.

With the establishment in Colombia of a seed orchard of Cupressus lusitanica there is a need for high flower production in order to make controlled crosses between selected trees. Some select trees will surely have low flower production and since cypress pollen production is certainly much lower than that of most pines, the application of gibberellin is very important. Additionally, inducing flower formation may allow for a larger seed crop from the clones in the seed orchard.

PROCEDURE

Initial study was begun in 1976 using 0, 50, 100 and 200 ppm. of A3 in ethyl alcohol. Cypress grafts two years old at two different locations were treated by injecting the solutions in 1/4 inch holes drilled in the tree bole at differing heights of 0, 50, 100 and 130 centimeters. The hole were drilled to the center of the tree at a 40°angle and only one hole and one centration were used for each tree, using four replications of single tree plots in a split plot design. Flower counts were made periodically during the following year.

Also during 1976, the foliage of one year old potted nursery seedlings was misted nine times with 5 c.c. of the four concentrations of A3. (At the 0 concentration no ethyl alcohol was applied.) Four-tree plots with three replications in a randomized block design were employed in this trial. Flower counts were made at the same times as in the previous trial.

In 1978 a continuing study of foliar applications of gibberellin A3 in ethyl alcohol was established using two year old grafts of eight select seed orchard cypresses. Each family was considered a replication in a randomized block, split plot design planted in the field with single tree plots. Major plots were number of applications (5) and subplots were concentrations of 100 or 200 ppm A3, applied at the rate of 5 c.c.solution misted onto each tree. Again, flower counts were made during the first year.

RESULTS AND DISCUSSION

The 1976 trials where gibberillin was injected into the tree bole showed no observable differences in flower or cone production during the year after treatment. Nearly all trees had some light flowering, which is normal for three year old cypresses. K. A. Longman recommended that much higher concentrations be tried for injections, between 10-100 mg. hormone/ml.alcohol, since this has worked in many species of Cupressaceae and Taxodiaceae (personal communication).

The 1976 foliar applications to one year old potted seedlings gave excellent male flower production during the first year. Maximum male flower production occurred six months after hormone application and with the 200 ppm. concentration, but declined considerably at the end of one year (Table I). Female flower production was nil during the same period.

The 1978 foliar applications to two year old cypress grafts gave suprisingly good flowering responses. Masculine and femenine flowering both increased as well as cone formation (Table II). In this trial the 100 ppm solution increased female flower and cone production more than the 200 ppm solution, but there was no significant difference in male flower production between the two concentrations of gibberillin. Applying the phyto-hormone once a month resulted in better flower and cone production than applications bimonthly or weekly.

A yellowing or foliage burn was observed after misting the trees with ethyl alcohol. The burn was more pronounced with 6 applications than with only one, but the percent of trees burned did not vary significantly with the time between applications nor with the gibberillin concentration (Table II). The burn was not fatal to any tree but it was still noticeable a year after the hormone application.

CONCLUSIONS

The phyto-hormone, gibberillin A3, is definitely valuable in inducing both male and female flower production in Cupressus lusitanica. Foliar applications have proven successful and will be valuable in increasing pollen production for experimental controlled crosses. It is quite probable that gibberillin will be useful in increasing seed production in operational seed orchards but the techniques for accomplishing this still lack refinement.

TABLE I. MALE FLOWER PRODUCTION PER TREE IN ONE YEAR OLD CYPRESSES MISTED WITH GIBBERILLIN A3 IN ETHYL ALCOHOL

EVALUATION DATES	CONCENTRATION OF GIBBERILLIN 0	50ppm	100ppm	200 ppm
Nov. 23 (1976)	0	0	0	0
Mar. 4 (1977)	0	48	84	96
Mar. 15	0	38	69	84
Apr. 1	0	45	82	223
Apr. 18	0	44	77	264
Apr. 25	0	45	80	286
May 2	0	36	72	278
May 16	0	20	18	236
May 30	0	22	16	171
June 13	0	17	11	27
July 11	0	7	13	0
Nov. 2	0	7	9	92

MISTING DATES*

Nov. 23 (1976)
Nov. 26
Nov. 29
Dec. 2
Dec. 5
Dec. 8
Dec. 13
Dec. 15
Dec. 20

*/ 5 c.c. of alcohol solution was applied to each tree except the control, which received no solution.

TABLE II. FLOWER AND CONE PRODUCTION PER TREE IN TWO YEAR OLD CYPRESS GRAFTS MISTED WITH GIBBERILIN A3 IN ETHYL ALCOHOL

TREATMENT	DOSIS/TREE 1/ SOLUTION	TOTAL A3	FLOWER COUNT AT 1 YEAR MALE	FEMALE	CONES	TREES BURNED 2/
	ppm	Mg.				%
No Treatment	0	0	0	0	0	0
1 Misting One Time	100	.005	144	7	4	12
	200	.010	50	1	2	0
6 Mistings Once a week	100	.030	116	15	35	86
	200	.060	184	10	9	62
6 Mistings Once every 2 weeks	100	.030	365	28	33	79
	200	.060	411	12	10	57
6 Mistings Once a month	100	.030	1299	19	56	85
	200	.060	621	9	15	85

1/ A dosis was 5 c.c. solution in ethyl alcohol, wetting all foliage on the tree.

2/ Burn was usually not severe but was noticeable and many trees still showed yellowing after one year.

LITERATURE CITED

Hashizume, H. 1967. Experimental induction of female flowers in young Japanese larch (Larix leptolepis Gordon) J. Jap. For. Soc. 49:405-408.

Kato, Y.I., Miyake y Ishikawa, 1958. Induction of flower bud by gibberellin in Criptomera japonica. J. Jap. For. Soc. 40:35-36

Pharis, R.P. 1976. Manipulation of flowering in conifers through the use of plant hormones. Rep. Modern Methods in Forest Genetics. pp. 65-282.

FAST GROWING TREES

RESULTADO DE UM ENSAIO DE ESPÉCIES/PROCEDÊNCIAS DE PINHEIROS AOS DOIS ANOS

W. E. Ladrach
Carton de Colombia S. A., Cali
COLOMBIA

Resumo

Um estudo de procedências de pinheiros foi estabelecido em 1977 com 11 espécies de coníferas e um total de 42 procedências, envolvendo repetições em 4 localidades da Colombia.

Após 2 anos foram detectadas diferenças importantes relacionadas à procedência em *P. oocarpa*, *P. Kesiya* e *Cupressus lusitanica*, *P. caribaea* e *P. tenuifolia* são outras espécies promissoras para reflorestamento na área de Popayan. Uma correlação entre o crescimento de *P. oocarpa* em Popayan e a altitude e precipitação anual da região de origem na América Central, foi encontrada através da análise de regressão múltipla (r^2 = 52%).

TWO YEAR RESULTS OF A PINE SPECIES AND PROVENANCE TRIAL

Summary

A pine provenance study was established in 1977 with 11 conifer species and 42 provenances, and with replications on four sites in Colombia. After two years, important differences were found due to provenance in Pinus oocarpa, P. keslya and Cupressus lusitanica. P. caribaea and P. tenulfolia are other promising species for reforestation in the Popayan area.

A correlation between the growth of P. oocarpa in Popayan and the altitud and annual precipitation of the origin of the provenance in Central America was obtained through multiple regression (r^2 = 52%).

INTRODUCTION

In 1969 The Commonwealth Forestry Institute initiated a research project on provenance trials of Central American pines, with support from FAO (Kemp, 1973). The first provenance tests in this project were established in 1971 and by 1976 more than 40 tropical countries were involved in these trials (Styles, 1976).

Carton de Colombia, S.A., entered the study of provenances of tropical pine species in 1976 with a visit to Central America, with the interchange of seed with other forest entities and with the receipt of seed classified by provenance from C.F.I. in the same year. In 1977 a study of conifer provenances was established with plots in the Departments of Cauca, Valle, Antioquia and Bolívar. (Table I).

TABLE I. SITE DESCRIPTIONS FOR THE 1977 PINE PROVENANCE TRIAL IN COLOMBIA

ITEM	LA ARCADIA FARM	AGUACLARA FARM	SEMINARY OF MEDELLIN	BAJO DE OSO FARM
Municipality	Popayán	La Cumbre	Medellín	San Jacinto
Department	Cauca	Valle	Antioquia	Bolivar
Latitude	2°30' N	3°40'N	6°15' N	9°50' N
Longitude	76°40' W	76°40' W	75°40' W	75°5' W
Altitud ASL, meters	1750	1450	1935	250
Annual Rainfall, mm.	1950	1200	1600	1200
Number of species	7	3	3	7
Previous Vegetation	Cypress Plantation	Eroded Field	Cypress Plantation	Old Field
Site Preparation	Plow, Disc	Disc	Burn, Scalp	Disc
NPK 10-30-10 gm./tree	50	50	-	50
Borax gm./tree	5	5	-	5
No. of Provenances	25	12	23	25
Trees/Plot	10	36	7	10
Replications	3	1	4	3
Spacing, Mts.	2.5 x 2.5	3.0 x 3.0	2.8 x 2.8	2.5 x 2.3

TABLE II. TWO YEAR SUMMARY OF THE 1977 PINE PROVENANCE TRIAL IN COLOMBIA

SPECIES	CODES		PROVENANCE[1]				TOTAL HEIGHT (mts.)			SURVIVAL %		
	Oxford	Others			Altitude	Rainfall mm/year	La Arcadia	Seminary	Aguaclara	Arcadia	Seminary	Aguaclara
P. oocarpa	K49		Mtn.Pine Ridge	Belice	700	1558	4.4	2.8	2.4	93	71	86
" "	K114		Mal Paso, Zacapa	Guatemala	1000	1800	3.2	1.8	1.6	90	60	80
" "	K113		Pinalon, Zacapa	"	1350	937	2.8	1.6	1.2	90	75	88
" "		444	Santiago, Zacapa	"	1250	1650		2.0			79	
" "	K111	447	Pueblo Viejo, Huehuetenango	"	1800	1036	1.8	1.8	.9	93	64	63
" "	K126	-	Jalapa	"	1150	1818	2.1			67		
" "		448	Cocotan, Chiquimula	"	950	?300		1.7			75	
" "	K102		Valle Bonito, Comayagua	Honduras	900	1134	2.7	1.8	1.0	100	72	94
" "	K99		Pimientilla, Comayagua	"	750	1134	2.9	1.7	1.3	97	50	91
" "	K98		San Juan, Intibaca	"	1300	1261	2.9	2.1	.8	90	82	75
" "	K78	405	Campamento, Olancho	"	800	1272		2.1			75	
" "		441	Teupasenti, El Paraiso	"	950	1200		2.2			75	
" "	K116		Dipilto, Nueva Segovia	— Nicaragua	1200	1134	3.5	2.1		100	71	
" "	K117	455	Cusmapa, Madriz	"	1250	1474		2.0			82	
" "	K103		Bonete, Leon	"	950	922	2.9		1.2	97		86
" "	K101		Yucul, Matagalpa	"	900	1394	4.4	2.6	1.7	90	71	97
P. kesiya		11712	Dalat	S.Vietnam			2.5			67		
" "		9256		Is.Filipinas			2.6			87		
" "		417	Tilasicara	" "				2.6			78	
" "		9268		" "			2.4			60		
" "		722	Chichele	Zambia			3.2			95		
" "		6665	Huerto Semillero	Rodesia			2.9	2.0	1.4	90	78	80
P. caribaea			Lanquin, Alto Verapaz	Guatemala			3.3			100		
" "			Peten, Poptun	"			3.0			93		
" "		PC62		Honduras			3.1			97		
P. tenuifolia			Ocaña, Siguatepeque	Guatemala	1800	1450	3.6			100		
P. pseudostrobus		G1		"			2.4			93		
P. patula		PP5	Sable, Transvaal	Sud Africa			3.4		1.2	93		88
C. lusitanica		C5	Seminario, Medellín	Colombia	1900	1600	3.7	4.0		97	90	
" "		109	San José	Costa Rica			3.5	4.0			96	
" "		K194		Kenya			2.1	3.7			90	
" "		K191		"				3.4			93	
" "		K183		"			2.6	3.2			93	
C. lindleyi				Mexico			1.6	2.6			82	

1/ Provenances of the pines according to Greaves, (1979)

TABLE III THREE MONTH SURVIVAL, BAJO DE OSO FARM, 1977 PINE PROVENANCE TRIAL

SPECIES	CODE	PROVENANCE	COUNTRY	SURVIVAL* %
P. caribaea		Gran Bahama	Is. Bahamas	77
P. caribaea		Peten, Poptum	Guatemala	60
P. taeda	PT 604	CCA, Florida	Estados Unidos	60
P. oocarpa	K 102	Valle Bonito, Comayagua	Honduras	57
P. caribaea	62		Honduras	53
P. caribaea	3		Cuba	52
P. oocarpa	K 116	Dipilto, Nueva Segovia	Nicaragua	50
P. elliottii	PE 116	CCA, Alabama	Estados Unidos	50
P. oocarpa	K 111	Huehuetenango	Guatemala	43
P. oocarpa	K 114	Mal Paso, Zacapa	Guatemala	43
P. caribaea	2		Cuba	43
P. kesiya	6665		Rodesia	43
P. caribaea		Lanquin, Alto Verapaz	Guatemala	43
P. oocarpa	K 113	Pinalon, Zacapai	Guatemala	33
P. oocarpa	K 49	Mtn. Pine Ridge	Belice	33
P. cubensis			Cuba	33
P. oocarpa	K 99	Pimientilla, Comayagua	Honduras	33
P. oocarpa	K 103	Bonete, Leon	Nicaragua	32
P. oocarpa	K 98	San Juan, Intibuca	Honduras	23
P. taeda	22-23	G.P., Florida	Estados Unidos	23
P. kesiya	9256		Is. Filipinas	7
P. occidentalis			Cuba	3
P. oocarpa	K 101	Yucul, Matagalpa	Nicaragua	3
P. kesiya	11712	Dalat	S. Vietnam	0

*/ At six months of age there were a lot weeds in the plots and only a few P. caribaea survived. With the recommendation of Dr. J. Burley the study was abandoned at this time.

PROCEDURE

The study includes 11 species of conifers with 42 provenances in the following proportions:

Species	No. Provenances
P. oocarpa	16
P. kesiya	6
P. caribaea	6
P. tenuifolia	1
P. pseudostrobus	1
P. patula	1
P. taeda	2
P. cubensis	1
P. occidentalis	1
P. elliottii	1
C. lusitanica	6

The study was measured at the end of one year and also at two years, with the exception of the Bajo de Oso farm which was evaluated for survival at 3 months of age.

Analyses of variance were calculated for total height and survival (transformation by arc-sin) for each site separately, and classified by Duncan's multiple range test (Q=5%) for the variables that were significant in the analysis of variance at the 5% level or better. For P. oocarpa several multiple regressions were tested between the parameters of the site of provenance in Central America and the two year growth in Colombia.

RESULTS AND DISCUSSION

The two year summaries by species and farm can be found in Tables II and III. Using Duncan's multiple range test the provenances were put in descending order by total height for the Seminary of Medellin and La Arcadia (Table IV).

Pinus oocarpa provenances from Yucul, Nicaragua, and Mountain Pine Ridge, Belize, were always the tallest. In the Seminary of Medellin the cypresses were taller than the pines but at La Arcadia there was no apparent superiority of one group over the other. The plot in Bajo de Oso was abandoned during the first year due to poor survival.

The analyses of variance for total height were highly significant for the Seminary and La Arcadia and the separation of the provenances by Duncan's multiple range test was very distinct (Table IV). The analysis of variance for survival was significant for two of the three sites analyzed, but there was no appreciable separation by Duncan's multiple range test; in other words, survival varied so much within provenances that the differences between provenances were not distinguishible.

Analysis of Variance by Provenance	Height	Survival
Seminary of Medellin, 2 years	.001	.05
La Arcadia, 2 years	.001	NS
Bajo de Oso, 3 months	-	.01

NS = not significantly different
.05 = significant at 5% level
.01 = very significant at 1% level
.001 = highly significant at 0.1% level

In the Bajo de Oso farm under a severe dry period, P. caribaea had the best survival in general, but other species also were in the upper part of the list (Table III). Nevertheless, using 70% as a minimum acceptable survival guide, only one provenance of P. caribaea was acceptable at 3 months of age and none was after 6 months.

Overall, the survival at La Arcadia and Aguaclara was better than for the Seminary but since all seedlings came from the Cali nursery, the transportation effect was harder on the seedlings sent to Medellin than for the other farms nearer to Cali. In any case, the survival was above acceptable limits in all three farms.

The variation in growth of P. oocarpa by provenance is great. In La Arcadia after two years the tallest provenance was 4.4 meters and the shortest 1.8 meters, a difference of almost two and a half times. The proportion was similar in the Seminary of Medellin as well.

The behavior of P. caribaea in La Arcadia at 1750 meters ASL was better than anticipated at this altitude, since P. caribaea is a low altitude species in its natural habitat. P. tenuifolia, another species that is still not utilized commercially, is growing very well in this trial.

Among the eight provenances of P. oocarpa that were planted in La Arcadia, The Seminary and Aguaclara, it was observed that although growth varied between sites, the relationship of growth between provenances was nearly the same for all three sites. In other words, the tallest provenances at one site were the tallest at the other two sites, in general. In the Seminary, there were two notable exceptions: the provenances of P. oocarpa from San Juan, Honduras, and Huehuetenango, Guatemala, were proportionally better at the Seminary than in the other two areas.

Several multiple regressions were tested between the parameters of the origin of provenances of P. oocarpa in Central America and the growth and survival of the trees planted in Colombia. The only correlation found significant was between the total height of the trees in La Arcadia and the altitude and annual precipitation of the site of origin of the provenance, with a coefficient of determination (r^2) of 52%, which is good for this type of comparison:

$$\text{Total height (mts.)} = .007936X_1 + .008058X_2 - .0000077X_1X_2 - 5.2147$$

where X_1 = Altitud ASL(mts.) of the provenance
X_2 = Annual Rainfall (mm.) of the provenance

Within the limits of the original data, this tends to indicate that the best provenances of P. oocarpa for the region of La Arcadia (altitude 1750 mts. and annual precipitation 1950 mm.) are those with altitudes less than 1000 meters ASL and with annual precipitations over 1200 mm. A similar correlation was also found in Sao Paulo by Kageyama (1977)

Among the plots of the Seminary of Medellin and La Arcadia a difference in growth rate was observed between the pines and cypress. By provenance, the pines are taller in La Arcadia than in the Seminary, but for the cypresses, those of the Seminary are always taller than those of La Arcadia.

The poor behavior of the pines on the Atlantic Coast is not a condition unique to this study. In 1975 P. caribaea, P. oocarpa and P. kesiya were planted in the Arboretum in La Gloria farm, Department of Atlantico. There was no survival after one year, but weed control was not good either. Another trial of pines established in the same area in 1978 has the optimum of site preparation and weed control including some irrigation during the first dry season. After one year only one provenance of P. caribaea has over 70% survival but the average seedling height of this is just 28 centimeters.

CONCLUSIONS

1. P. oocarpa varies greatly according to provenance and the outstanding provenances tested are those of Mountain Pine Ridge, Belize, and Yucul, Nicaragua. In general, the provenances from low altitudes with high annual precipitation grow best on the Popayán mesa.

2. P. kesiya also varies considerably in growth due to provenance and of the few provenances tested the majority are of less than average growth for the pines in these trials.

3. P. caribaea shows a good potential for the Popayan mesa, although in its place of origin it is a low altitude species.

4. P. tenuifolia is another promising species for the Popayan area.

5. Compared with the pines, C. lusitanica has superior growth in the Seminary of Medellin and is growing well in La Arcadia farm also. This species varies a great deal by provenance.

6. The same provenance of pine is always taller in La Arcadia than in the Seminary. To the contrary, the same provenance of cypress is always taller in the Seminary than in La Arcadia, which demostrates considerable ecological differences between these two sites.

7. The relationship within provenances of pines and cypress is proportional for the Seminary, La Arcadia and Aguaclara in that the tallest provenances in one site are, in general, the tallest in the other and vice-versa, although there are some exceptions.

8. In the Atlantic Coast, with three pine species tests initiated since 1975, there has still not been found a species or provenance of pine that shows promise for commercial reforestation.

9. The effect of the provenance for P. oocarpa appears to be more critical in the Aguaclara farm which is a difficult site, than on milder sites.

LITERATURE CITED

Greaves, A. 1979. Descriptions of seed sources and collections for provenances of Pinus oocarpa. Commonwealth Forestry Institute, Oxford, Tropical For. Papers No. 13. 144 p.

Kageyama, Paulo Yoshio 1977. Variação genética entre procedencias de P. oocarpa Schiede na região de Agudos, Sao Paulo. Tesis de Mestre em Genética e Melhoramento de plantas. Universidade de São Paulo, Piracicaba, 83 p.

Kemp, R.H. 1973. International Provenance research on Central American pines. Commonwealth Forestry Review 52 (151): 55-66.

Styles, B.T. 1976. Studies of variation in Central American pines. I. the identity of Pinus oocarpa var. ochoterenal Martinez. Silvae Genetica 25, 109-18

FAST GROWING TREES

VARIAÇÃO DO CRESCIMENTO DE DIVERSAS PROCEDÊNCIAS DE CIPRESTES APÓS DOIS E TRÊS ANOS DE CRESCIMENTO

W. E. Ladrach
Carton de Colombia S. A., Cali
COLOMBIA

Resumo

A base genética do cipreste *(Cupressus lusitanica Lo)*, na Colômbia, não é muito ampla, por isso seria aconselhável tentar-se ampliá-la através da importação de novas procedências, de outros países. Nos ensaios feitos nos Departamentos de Cauca e Antroquia, agora com 2 e 3 anos de idade, algumas procedências melhoradas da Costa Rica e Quênia estão crescendo tão bem ou melhor que árvores selecionadas na Colômbia. O contrário ocorre com as procedências comerciais oriundas do México, Portugal e Itália, que não estão se comportando bem.

A seleção das árvores progenitoras será feita dentro das melhores procedências, a fim de melhorar as bases genéticas do cipreste na Colômbia.

GROWN VARIATIONS OF SEVERAL PROVENANCES OF CYPRESS AFTER TWO AND THREE YEARS GROWTH

Summary

The genetic base of cypress in Colombia is not very broad and it is advisable to try to amplify this base by importing new provenances from outside the country. In trials made in the Departments of Cauca and Antioquia which now are two and three years of age, some improved provenances from Costa Rica and Kenya are growing as good as, or better than, select trees from Colombia. To the contrary, the commercial provenances from Mexico, Portugal and Italy are not developing well. Parent tree selections will be made from within the best provenances in order to improve the genetic base of cypress in Colombia.

INTRODUCTION

It has been impossible to obtain any precise data bout the first sources of cypress seed in Colombia because it has been planted as an ornamental for at least a century. Nevertheless, seed importations were made at the beginning of the century to initiate the plantations at Piedras Blancas in Antioquia, although specific data about this seed could not be located either. The great majority of the Cupressus lusitanica plantations in Colombia today are directly or indirectly derived from seed from the original plantations in Piedras Blancas. More recently, there have been some additional importations of cypress seed in small quantities from Guatemala.

Since many of the earliest plantations were made in this manner, it is important to continue testing new provenances of C. lusitanica and to compare these with land races already established within the country in order to maximize potential growth and also to widen the national genetic base of this species. With respect to the tree improvement program, these new provenances will serve as well for making additional selections for new cypress seed orchards.

PROCEDURE

Seed was obtained from 15 select trees in Kenya with the courtesy of Dr. Fred Owino and Mr. P. O. Wanjawa of E.A.A.F.R.O. and through N.C. State University, Raleigh. In addition, seed was received from 9 select trees in Costa Rica through Dr. Les Holdridge of the Centro Cientifico Tropical, San José. Additional cypress seed was obtained from commercial sources in Portugal, Italy, Mexico

TABLE I. SITE DESCRIPTIONS FOR CYPRESS PROVENANCE TRIALS

Farm	La Arcadia	Seminario	Los Guaduales
Municipality	Popayán	Medellín	Cajibío
Department	Cauca	Antioquia	Cauca
Establishment	June,1977	July, 1977	November, 1975
No. of Provenances	23	8	9
No. of Trees/rowplot	10	7	6
No. of Replications	3	4	4
Spacing, Mts.	2.5 x 2.5	2.8 x 2.8	2.8 x 2.8
Latitude	2°30' N	6°15' N	2°30' N
Longitude	76°40' W	75°40' W	76°40' W
Altitude ASL, Mts.	1750	1935	1750
Pricipitat. mm./year	1950	1600	1950

TABLE II. TOTAL HEIGHT OF CYPRESS AT TWO YEARS, LA ARCADIA FARM

Species	Code	Provenance	Total Height Mts.	Duncan's Multiple Range, Q= 5%
Cupressus lusitanica	106	San José, Costa Rica	4.24	
C. lusitanica	PA2	" "	3.95	
C. lusitanica	109	" "	3.73	
C. lusitanica	K191	Kenya	3.39	
C. lusitanica	K196	"	3.12	
C. lusitanica	C5	Medellín, Colombia	3.03	
C. lusitanica	K183	Kenya	2.98	
C. lusitanica	K194	"	2.94	
C. lusitanica	K190	"	2.86	
C. lusitanica	K198	"	2.81	
C. lusitanica	K192	"	2.71	
C. sempervirens		Neusa, Colombia	2.64	
C. lusitanica	K197	Kenya	2.63	
C. lusitanica	K189	"	2.48	
C. lusitanica	K154	"	2.46	
C. lusitanica	K185	"	2.41	
C. lusitanica	K150	"	2.28	
C. lindleyi		México	2.07	
C. lusitanica	CLI-1	Italia	2.06	
C. lusitanica	CLP-1	Portugal	1.85	

TABLE III. TOTAL HEIGHT OF CYPRESS AT TWO YEARS, SEMINARY OF MEDELLIN

Species	Code*	Provenance	Total Height Mts.	Duncan's Multiple Range, Q=5% *
Cupressus lusitanica	109	San Jose, Costa Rica	4.0	
C. lusitanica	C5	Medellin, Colombia	3.9	
C. lusitanica	K194	Kenya	3.7	
C. lusitanica	K191	"	3.4	
C. lusitanica	K183	"	3.2	
C. lusitanica	K198	"	2.9	
C. lindleyi		Mexico	2.6	

*/ The analysis is for the conifer provenance trial with 23 provenances and 4 replications. Only the cypresses are shown in this table.

TABLE IV. TOTAL HEIGHT OF CYPRESS AT THREE YEARS, LOS GUADUALES FARM

Species	Code	Provenance	Total Height Mts.	Duncan's Multiple Range, Q= 5%
Cupressus lusitanica	C8	Medellin, Colombia	3.07	
C. lusitanica	106	San Jose, Costa Rica	2.85	
C. lusitanica	109	" "	2.76	
C. lusitanica	PA2	" "	2.68	
C. lusitanica	C5	Medellin, Colombia	2.67	
C. lusitanica	T1	Medellin, Colombia	2.32	
C. lusitanica	SR 3	San Jose, Costa Rica	2.04	
C. lusitanica	SR 2	" "	2.03	
C. lusitanica	SR 5	" "	1.51	

and Guatemala. As a comparison, seed from Colombian cypress was also used in the tests.

Three different trials have been planted, two in the Department of Cauca and one in Antioquia. Some of the Costa Rican and Kenyan provenances did not germinate and are not represented in the field. Planting details are listed in Table I.

During 1979 the trial in Los Guaduales farm was measured after three years, and the trials in La Arcadia and the Seminary were measured after two years. Analyses of variance were made for a randomized block design and Duncan's multiple range test (Q=5%) was also calculated for the analyses of variance significant at the 5% level or better.

RESULTS

Differences in total height by provenance were significant, but differences in survival were not.

Analysis of Variance by Provenance

Tract	Height	Survival
La Arcadia	.001	N.S.
Seminary of Medellin	.001	N.S.
Los Guaduales	.01	N.S.

.001= Highly significant

.01 = very significant

N.S.= not significant

In la Arcadia farm, the three cypresses from Costa Rica grew better than the rest and two of the Kenyan cypresses were taller than select tree C5 from the Seminary which has been proven good in progeny tests. The cypresses from Mexico, Italy and Portugal did not do well. The two year range in heights varied from 1.85 meters minimum to 4.24 meters maximum (Table II).

In the Seminary of Medellin there were not as many provenances represented but the relationship between these was similar to that of La Arcadia. One provenance from Costa Rica was best, tree C5 of Colombia next, and the Kenyan provenances afterwards (Table III). Growth by provenance was better in the Seminary than in La Arcadia in all cases.

On Los Guaduales farm six Costa Rican provenances were compared with local select trees C5 and C8, as well as local commercial seed (T1) (Table IV). The relationship between provenances is very similar to that of La Arcadia with the same three Costa Rican provenances being the best. The national select trees C5 and C8 are also doing well and better than the commercial check seed. The other three Costa Rican provenances are not growing well. Overall, this trial as three years of age is not doing well compared with La Arcadia and the Seminary of Medellin.

DISCUSSION

The good growth of some of the Costa Rican and Kenyanprovenances shows the potential to improve our local genetic base by testing and incorporating new provenances into our commercial plantations. The next step in the process is to select the best individuals from within the best provenances to be grafted into the cypress seed orchard.

In Kenya, Dyson (1978) found differences between provenances similar to those in this report. At five years or age in Muguga, Kenya, the Costa Rican cypress was taller than Kenyan cypress, but the Mexican provenances were even with the Kenyan provenances. In another study at four sites in East Africa and 2 years 11 months old, the Kenyan provenances were better than those of Mexico.

The growth of the trial at Los Guaduales is very inferior to the growth in La Arcadia and the Seminary of Medellin. It is postulated that this is due to the competition between the cypress and the commercial grasses, in this case yaraguá.

LITERATURE CITED

Dyson, W.G. 1978. An East Africna Provenance trial of Cupressus lusitanica Hill. Proc. Third World Consultation on Forest Genetics, Canberra, Australia.

FAST GROWING TREES

GANHOS GENÉTICOS COM *Cypressus lusitanica*, AO LONGO DE SEIS ANOS DE MELHORAMENTO GENÉTICO, NA COLOMBIA

W. E. Ladrach
Carton de Colombia S.A., Cali
COLOMBIA

Resumo

Um programa de melhoramento de cipreste foi iniciada pelo Carton de Colombia SA, em 1973, e tem o apoio e a cooperação de diversas entidades e organizações nacionais. Os objetivos do programa são: melhorar árvores resistentes aos insetos e melhorar a adaptação dessas espécies às diferentes condições ambientais; aumentar a taxa de crescimento, melhorar a forma da árvore e produzir madeira que melhor se adaptar aos produtos finais.

Até a presente data, 43 das melhores árvores cipriste foram selecionadas no país, e em 1977 o primeiro pomar de sementes florestais foi plantado na Colômbia. Testes de progênie foram plantados desde 1975, e após 3 anos os resultados desses testes são bastante promissores e a superioridade geral das progênies de árvores selecionadas, quando comparadas às sementes comerciais não selecionadas é de 50% em volume e 13% em altura total.

GENETIC GAINS WITH *Cypressus lusitanica* THROUGH SIX YEARS OF TREE IMPROVEMENT IN COLOMBIA

Summary

A cypress tree improvement program was initiated by Carton de Colombia in 1973 and has the support and cooperation of several national entities and organizations. The objectives of the program are: To develop insect and disease resistant trees, improve the adaptation of this species to different environments, increase the growth rate, improve tree form and develop wood that is better suited to the final products.

To date, 43 of the best cypress trees have been selected in the country and in 1977 the first forest seed orchard was established in Colombia. Progeny tests have been planted since 1975 and after three years the results of these tests are very promising. The overall advantage of the progeny of select trees compared with commercial unselected seed is 50% by volume and 13% by total height.

INTRODUCTION

Cypress is a species originally from Guatemala and Mexico and it grows naturally between 2,300 and 3,300 meters altitude. Due to the great variety of form in cypress, different botanists had called the tree by different names: C. benthami Endl, C. coulteri Fobes, C. glauca Lamarck, C. knightiana Knight & Perry ex Gordan and C. Tindleyi Klotzch ex Endl. Today the general consensus of the botanists is that all these names refer to the same species, C. lusitanica Mill (Harcharik & Vaccarone, 1974).

Cypress is a species that has been used as an ornamental in Colombia since the past century. In addition, cypress was one of the first species used for reforestation at the beginning of the twentieth century.

Colombia has 88,000 hectares of trees planted through 1979 and among the species planted, C. lusitanica is the most common with 35,000 hectares. Today there are sufficient mature plantations of this species to justify an intensive selection process with the purpose of improving the genetic base population.

In 1973 Carton de Colombia, S.A., initiated a genetic improvement program with Cupressus lusitanica (Gutierrez & Ladrach, 1978). This program is the product of a joint effort of several companies and Colombian institutions, including INDERENA, Reforestadora del Cauca, C.A.R., the Secretary of Agriculture in Antioquia, the Public Utilities of Medellín and Pereira, and the Archdiocesis of Medellín among others. These entities have cooperated in the location of candidate trees, the establishment of progeny tests or have made available their plantations for the selection of trees for the program.

SYSTEM OF EVALUATION OF THE TREES IN THE FIELD

The tree selection for this program has been carried out principally in the Departments of Antioquia (Medellín) and Cundinamarca (Bogotá) where the most plantations over 12 years of age, required for this selection, are to be found. It was decided to limit the tree selection to five physical or phenotypic criteria:

1) Resistance to disease and insect attack

2) Tree volume

3) Bole straightness

4) Crown form

5) Wood quality

In the process of field selection, a trained forest ranger makes an initial check of a given plantation, selecting the best trees and marking them. Afterwards, the ranger and a forester trained in tree grading return to the stand. The forester makes an inspection of the preselected trees with the ranger and decides which are those worth grading. The trees to be graded are called "candidates". Simultaneously with the field grading and tree measurements, wood samples are extracted to take to the lab. Later, points are awarded to the tree for each of the characteristics of the tree and the wood. With all the field and laboratory data in hand a grading sheet is filled in for the tree. The candidates that are good in all five categories are selected to be used in a seed orchard. When a tree has been accepted it is then called a "select tree".

The field evaluation of the tree is basically a comparison between the candidate and the five best nearby dominantes. The height and diameter is also measured for the five check trees, and they are used as a comparison for grading the form of the candidate tree. In the laboratory the wood of the candidate is also graded in comparison with the wood of the five check trees. The evaluation system takes into account the following norms as well: the candidate tree has to be taller than, have more volume than and also have higher density wood than the average of the five check trees. The candidate tree can have no indication of disease or insect attack to be graded.

The characteristics of the candidate tree are registered by means of a point system. A perfect tree in every sense and superior to the five best checks would be said to be 100% better or have 100 points on an emperical scale.

To date there are 43 trees selected of C. lusitanica in Colombia. According to the number of hectares reviewed and the number of trees per hectare, a selection intensity of approximately one tree in 82,000 has been achieved. In addition, there have been two selections made of trees resistant to the defoliator Glena bisulca and one selected free of the striped canker in a plantation that has over 50% infestation.

Once the best cypresess were selected according to our grading system (Table I), they were reproduced asexually by grafting; 1800 grafts of the 30 clones to be included in the first orchard were made so that we would have at least 50 ramets of each clone necessary for planting in the seed orchard. These grafts were made using a side veneer grafting technique in the Popayan nursery under partial shade conditions. For these 1800 grafts the average take or success was 92%.

According to the seed orchard requirements established by Kellison (1969), a site was selected on the farm, La Arcadia, near Popayan. The ecological data for this site are listed in Table II. A seed orchard of five hectares was considered sufficient to supply improved seed for the planting of 2000 hectares per year and it is expected that the seed production will begin in two years, in 1982. In Kenya, Owino (1975) gives a production of 0.7 kilos per tree per year for cypress orchards at 10 years of age; this figure has been our reference point since there is no other data on seed orchard production of this species in the world.

The planting design was developed by N.C. State University by computer where the distribution of the clones has the following advantages:

1) When roguing of undesirable clones is initiated, there will not be large open areas left in the orchard.

2) The grafts or ramets of the same clone are separated by at least two trees of different clones to avoid self pollination.

The site was prepared by plowing and discing and the trees were planted in May of 1977. Total cost of establishment of the orchard was US$12,000, including land, grafting, planting and other costs. The orchard is now three years old and some grafts already have seed

OPEN POLLINATED PROGENY TESTS

The sequence of the progeny tests can be seen in Figure 1. The initial step in progeny testing was to collect seed from the mother tree in the field where the pollen that fertilized the female flowers came from unimproved wild sources.

The first of these tests was established in 1975 on three different sites. Another study was established in 1977, also on three sites. This study has more progeny than the previous one and is on different forest sites.

First Year Results

At the end of the first year there were large variations between the tests on the six sites as well as between progeny on each site (Table III). In general, the progeny of the select trees were superior to the comercial seed (T-1) but in the two tests in the Department of Antioquia the commercial check was in the upper half of the progeny distribution. Certain progeny such as C5, C27, C46 and C53 are nearly always in the tallest lots, regardless of the study location (Explanation of codes in Table I). In other cases as with C61 and C65, which had been selected at 3000 meters a.s.l. in Neusa, their growth was good at Neusa but was poor in tests at lower altitudes. Tree C8 which was selected in the Seminary of Medellín is doing well in tests in the Departments of Cauca and Risaralda but poor in Antioquia where the parent tree was selected.

By analysis of variance the differences in height between progeny were significant in four of the six tests at the end of one year. Survival, on the other hand, was not significantly different in any of the tests, and was good in general with very few trees lost.

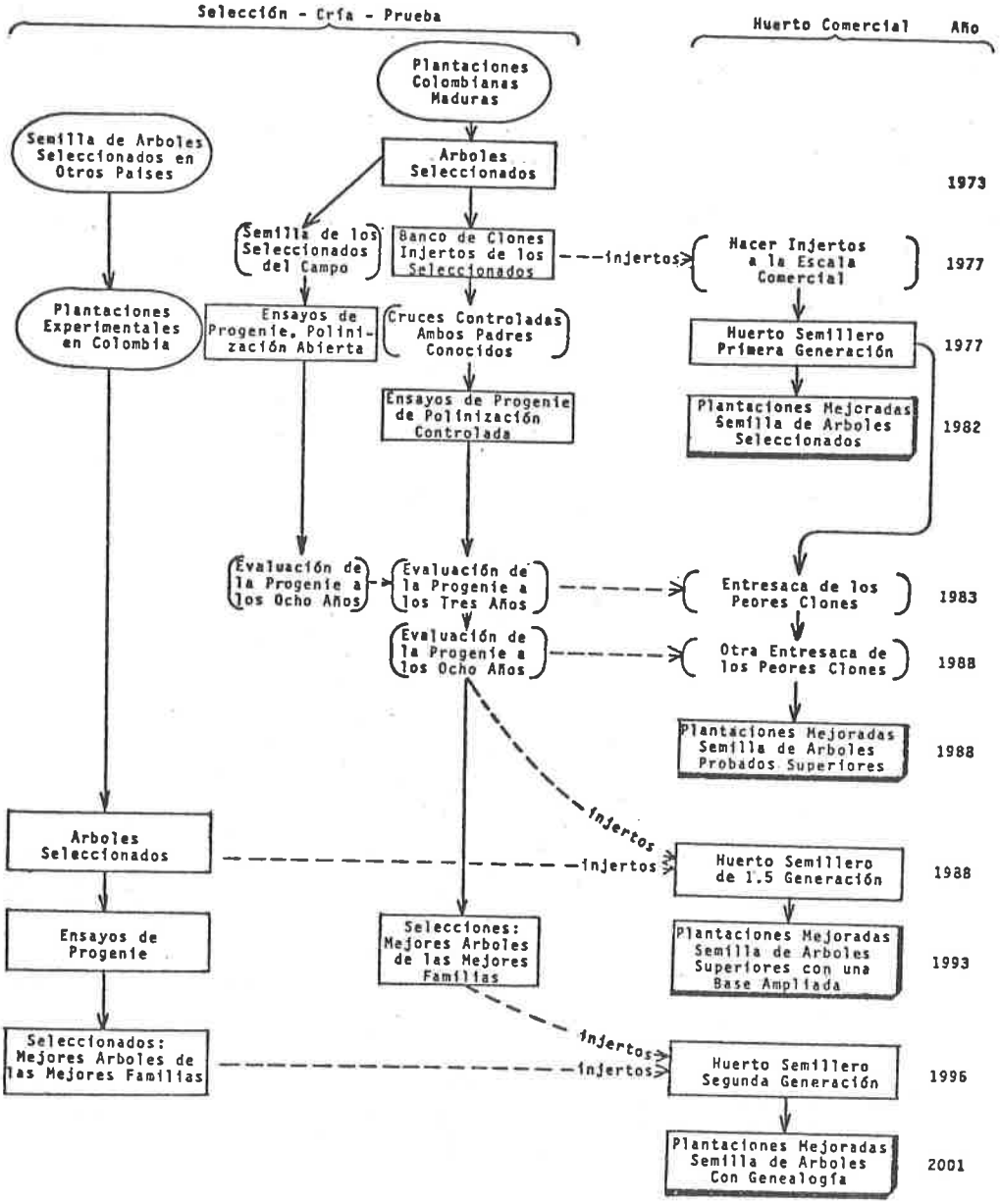
Third Year Results

The analyses of variance were significant the third year for height, volume and straightness between progeny, but not in crown form nor survival (Table IV). Tree height in the farm La Laguneta which was not significant the first year did show statistical differences the third year, which implies that the differences between the progeny are increasing with time.

Differences between progeny heights are not very great, but the differences in volume are substantial. For example, in the Rionegro tests, the commercial check (T-1) in fifth place in total height (Table IV), falls to seventh place in volume. In other words, the selection of parent trees with good volume as well as good height is reflected in the differences in these two data.

In the evaluation of tree straightness between progeny, the order of the trees for straightness was very similar to the order for volume and height: the tallest and biggest trees were in general the straightest. However, at three years of age it is still difficult to evaluate this characteristic and these values could change somewhat as the trees become older.

FIGURE 1. CYPRESS GENETIC IMPROVEMENT PLAN FOR TWO GENERATIONS



In Table V the average progeny data is compared to the commercial check trees for those parameters and tests that had a significant analysis of variance at the 95% level or better. This comparison gives a good idea of the gain that exists in the progeny tests to date. The difference is greater for volume than for height or straightness at three years of age and the differences by site are great. Since all the progeny are not as tall as the commercial checks, the gain for just the progeny greater than the check vs. the commercial check is always greater than the gain for the average of all the progeny. For example, the average volume difference at three years is 50% for all the progeny but is 70% better for just those that are better than the checks.

The results of these trials are very similar to those of progeny tests with Cupressus lusitanica in Tanzania at seven years of age. Dyson and Raunio (1977) found that the height, volume and bole straightness had significant correlations between families, but crown diameter and survival were not correlated with the progeny; the same has occurred in these tests.

Dyson (1969) estimated a genetic advantage of 50% in volume to be feasible through the selection of cypress in East Africa, compared to commercial seed stand seedlings. Such a difference in Kenya in young progeny seemed very high, as in the progeny tests in Colombia, and Paterson (1966) expected that the differences would diminish with the age of the studies. To the contrary, when the studies reached ten years of age they revealed differences between progeny of equal magnitude (Dyson and Raunio, 1977).

TABLE I. LIST OF TREES SELECTED FOR THE CYPRESS SEED ORCHARD WITH FIELD SCORES.

Tree	Age	DBH	Height	Volume	Score							Farm &
					Volume	Straightness	Crown	Disease 1/		Wood 4/	Total	Department
	Years	cms.	mts.	mts.^{3}								
Optimum	-	-	-	-	30	25	15	10		30	100	
C-4	22	46.0	25.6	1.634	13	15	0	-		(1)	27	Piedras Blancas Antioquia
C-5	13	29.2	15.6	.408	26	20	4	-		4	54	Seminario "
C-7	13	25.1	22.3	.430	37	10	6	-		12	65	" "
C-8	13	34.7	20.5	.749	25	11	6	-		3	45	" "
C-10	9	26.6	21.6	.467	11	23	12	10	2/	1	57	La Vía "
C-17	10	26.9	24.5	.541	16	5	8	10	2/	3	42	" "
C-25	13	21.6	16.5	.239	9	15	2	-		2	28	El Pinal "
C-27	13	31.2	25.5	.753	13	15	8	-		2	38	Seminario "
C-43	13	32.7	23.1	.750	8	15	3	-		8	34	El Pinal "
C-44	13	30.9	23.4	.679	12	15	0	-		21	48	" "
C-46	13	28.3	22.2	.542	9	22	12	-		(5)	38	Seminario "
C-49	16	29.0	28.0	.715	13	15	3	-		3	34	Córcega "
C-57	16	29.5	23.5	.622	18	15	3	-		6	42	" "
C-59	16	32.0	24.0	.746	15	15	0	-		13	43	" "
C-61	16	30.0	22.0	.603	6	10	7	-	3/	8	31	Neusa Cundinamarca
C-65	16	34.5	22.0	.794	7	15	2	5		19	48	" "
C-66	20	33.0	22.0	.728	34	22	5	-		10	71	Vuelta del Cerro "
C-70	13	31.2	24.0	.716	26	15	13	-		7	61	Seminario Antioquia
C-75A	13	31.4	19.5	.583	16	15	4	-		(4)	31	" "
C-78	14	26.9	18.0	.400	11	15	0	-		10	36	Piedras Blancas "
C-79	14	26.9	21.0	.465	7	10	2	-		(1)	18	" "
C-83	18	26.4	18.0	.385	24	15	3	-		(3)	39	" "
C-85	16	33.5	24.5	.834	10	15	10	-		(5)	30	Córcega "
C-89	16	30.0	25.5	.697	13	15	7	-		5	40	Córcega "
C-90	16	36.0	23.0	.903	26	15	3	-		3	47	Córcega "
C-95	50	81.0	44.0	8.669	18	10	1	-		2	31	San Cristobal Cundinamarca
C-97	50	70.0	37.0	5.448	16	20	8	-		36	80	" "
C-99	50	63.0	43.0	5.129	10	15	14	-		3	42	" "
C-100	50	86.0	43.0	9.550	78	20	6	-		9	113	" "
C-103	50	58.0	45.0	4.550	4	20	10	-		4	38	" "

1/ Tree selected in an area with disease or insect attack

2/ Tree resistant to the defoliator Glena bisulca

3/ Tree free of the striped canker with 50% of the stand attacked

4/ An evaluation of wood density plus fiber length; some trees had fiber lengths greater than the regional average of 2.9 mm., but still less than that of the five check trees, which is considered acceptable. Thus there are some negative values in this column.

TABLE II. ECOLOGICAL DATA FOR THE CYPRESS SEED ORCHARD

Altitude above sea level	1.750 Mts.
Average annual temperature	17.5°C.
Maximum average annual temperature	24.3°C.
Minimum average annual temperature	13.0°C.
Absolute maximum temperature	31.0°C.
Absolute minimum temperature	8.0°C.
Average annual precipitation	1.949 mm.
Average annual days of rainfall	214
Rainy seasons: Two, Feb.to Jun. & Sept.to Dec.	
Average evaporation	437 mm.
Average relative humidity	75%
Minimum average relative humidity	36%
Hours of sun during the year	1.830
Dry season:	June to Sept.
Driest month: August with rainfall of	36 mm.
Wettest month: September with rainfall of	320 mm.
Winds of June to September from the South west	
Coordinates of the orchard:	2°30' lat.N x 76°40' long. W.
Soil pH:	4.5 - 5.5

Ecological classification according to Holdridge:

Humid premontane forest in transition to a humid lower montane forest.

TABLE III TOTAL HEIGHT OF THE CYPRESS O.P. PROGENY AT ONE YEAR OF AGE.

Los Guaduales Cauca		La Arcadia Cauca		Rio Otún Risaralda		Rionegro Antioquia		Seminario Antioquia		Neusa Cundinamarca	
Tree	*	Tree	**	Tree	N.S.	Tree	**	Tree	N.S.	Tree	**
C-46	.95	C-43	1.88	C-14	.62	C-27	.84	C-46	1.94	C-65	.60
C-8	.88	C-5	1.88	C-8	.60	C-46	.84	C-53	1.94	C-46	.58
C-10	.84	C-75A	1.82	C-27	.53	C-5	.78	C-27	1.94	C-53	.58
C-27	.79	C-7	1.81	T-1	.51	C-2	.76	T-1	1.92	C-78	.54
C-5	.78	C-14	1.79	C-5	.50	C-53	.74	C-5	1.88	C-79	.49
C-14	.69	C-10	1.78	C-10	.47	T-1	.74	C-44	1.86	C-5	.46
T-1 1/	.67	C-70	1.78			C-12	.73	C-7	1.85	C-61	.46
		C-53	1.77			C-69	.71	C-78	1.83	C-70	.45
		C-8	1.76			C-9	.70	C-70	1.82	C-27	.43
		C-27	1.74			C-31	.70	C-8	1.73	T-1	.41
		T-1	1.73			C-3	.69	C-79	1.72	C-44	.39
		C-44	1.64			C-7	.68	C-75A	1.70		
		C-46	1.58			C-14	.68	C-66	1.67		
		C-78	1.53			C-21	.67	C-13	1.58		
		C-65	1.52			C-50	.66				
		C-61	1.52			C-8	.61				
		C-79	1.47			C-56	.60				
		C-66	1.15			C-38	.52				
Average mts.	.80		1.68		.54		.70		1.81		.49

*/ Análisis of variance significant at the 95% level

** Análisis of variance significant at the 99% level

N.S. Análisis of variance notsignificant.

1/ T-1 is a commecial check.

TABLE IV. SUMMARY OF CYPRESS O.P. PROGENY AFTER THREE YEARS

Total Height in Meters

Los Guaduales Tree	Height Mts.	99% 1/	Río Otún Tree	Height Mts.	95%	Rionegro Tree	Height Mts.	99%
C-8	3.2		C-14	4.2		C-27	4.9	
C-46	3.1		C-8	4.0		C-46	4.7	
C-27	3.0		C-27	3.9		C-14	4.1	
C-10	2.9		T-1	3.7		C-5	4.1	
C-14	2.8		C-5	3.5		T-1	3.8	
C-5	2.7		C-10	3.2		C-53	3.8	
T-1 2/	2.2					C-7	3.6	
						C-8	3.6	
						C-21	3.4	
						C-56	3.4	

Volume per Plot in Cubic Centimeters

Tree	Cm.^{3}	99%	Tree	Cm.^{3}	N.S.	Tree	Cm.^{3}	99%
C-46	5228		C-14	11722		C-27	14649	
C-8	5111		C-8	9419		C-46	10656	
C-10	4244		C-27	8494		C-14	7788	
C-5	3579		T-1	8162		C-53	6467	
C-27	3216		C-5	7173		C-5	6121	
C-14	2762		C-10	4384		C-7	5757	
T-1	2496					T-1	4815	
						C-8	4065	
						C-21	3278	
						C-56	1927	

Straightness on a Scale of 1 to 6 Points

Tree	Score	99%	Tree	Score	99%	Tree	Score	N.S.
C-8	3.8		C-8	5.6		C-27	3.7	
C-46	3.8		C-27	5.4		C-46	3.2	
C-27	3.7		C-5	4.9		C-21	3.1	
C-14	3.6		T-1	4.8		C-14	3.1	
T-1	3.6		C-10	4.5		C-8	2.9	
C-5	3.4		C-14	4.4		C-5	2.8	
C-10	3.2					C-53	2.7	
						C-7	2.7	
						C-21	2.7	
						C-56	2.6	
						T-1	2.6	

1/ The percentage refers to the analysis of variance: N.S. = not significant; 95% and 99% indicate significance levels. The vertical lines connect values that are not significantly different by Duncan's multiple range test (Q=5%).

2/ T-1 is a commercial check.

TABLE V PERCENT GAIN FOR CYPRESS O.P. PROGENY COMPARED WITH THE COMMERCIAL CHECK 1/

Age	Parameter	Site	Percent Gain: Progeny Greater than Check	Percent Gain: All Progeny
3	Volume.	Los Guaduales	61	61
		Rionegro	78	40
		Average	70	50
3	Height	Los Guaduales	34	34
		Río Otun	9	2
		Rionegro	17	4
		Average	20	13
3	Straightness	Los Guaduales	3	0
		Río Otun	10	3
		Average	6	2
1	Height	La Arcadia	4	(3)
		Neusa	24	21
		Average	14	9

1/ Only those trials with a significance level greater than 95% for the analysis of variance were included in these calculations.

LITERATURE CITED

Dyson W.G. 1969. Improvement of stem form and branching characteristics in Kenya Cupressus. Proc. Second World Consult. Forest Tree Breeding. I.U.F.R.O. Washington, D.C. 1:303-316.

Dyson, W.G. and A.L. Raunio 1977. Revised heritability estimates for Cupressus lusitanica in East Africa. Silvae Genetica 26 (5-6): 193-196.

Gutierrez, M. y Ladrach W. 1978. Iniciación de un programa de mejoramiento genético de Cupressus lusitanica y Pinus patula en Colombia. INFLAIC, Mérida. Bol. 53: 3-20

Harcharik, D.A. y E. Vaccarone. 1974. An annotated bibliography of Cupressus lusitanica. FAO, Rome. 64 pp.

Kellison, R.C. 1969. Seed orchard concepts, establishment, managment and yield. FAO/N.C. State Tree Improv. Train. Center. Lecture Notes. School of For. Res., N.C.S.U. Raleigh. p. 144-150.

Owino, F. 1975. Que se ha aprendido a través de 60 años de experimentación con C. lusitanica en Africa Oriental. Informe de Inv. For. No. 11, Cartón de Colombia.

Paterson, D.N. 1966. Crude estimates of genetic gains from plus trees selected in E. Afr. tree breeding programme. E. Afr. Agr. & For. Res. Orgn. Forest Tech. Note 18.

FAST GROWING TREES

Triplochiton scleroxylon — UMA FOLHOSA TROPICAL PARA PLANTAÇÕES FLORESTAIS

R.R.B.Leakey, F.T.Last and K.A.Longman
Institute of Terrestrial Ecology, Midlothian
SCOTLAND
G.O.A.Oji, N.O.O.Oji and D.O.Ladipo
Forestry Research Institute of Nigeria, Ibadan
NIGERIA

Resumo

Em função das populações naturais de *Triplochiton scleroxylon* na Nigéria estarem em perigo, resultante da intensa exploração a que a espécie foi submetida, métodos de reflorestamento potenciais vem sendo pesquisados.

Métodos de manutenção da viabilidade das sementes, produzidas irregularmente, também estão sendo desenvolvidos; técnicas de propagação vegetativa, comuns à horticultura, vem sendo aplicadas, tornando possível a multiplicação de clones. Essas técnicas juntas formam a base essencial de um programa de reflorestamento, que seria mais intensificado se fosse possível predizer a forma adulta das árvores a partir do crescimento juvenil.

Triplochiton scleroxylon — A TROPICAL HARDWOOD FOR PLANTATION FORESTRY

Summary

Because the natural stocks of Triplochiton scleroxylon in Nigeria were in danger as a result of severe exploitation, reliable methods of re-afforestation have been sought. Methods of sustaining the viability of erratically produced seed have been evolved; additionally the application of vegetative propagation techniques, commonplace in horticulture, has enabled the repeatable production of clones. Together these techniques form the essential basis of a programme of re-afforestation which would be strengthened if it were possible to predict mature form from early growth.

Introduction

Triplochiton scleroxylon K. Schum (Sterculiaceae) is a deciduous tree native to West Africa, where it is widely regarded as a colonizer. It reaches heights of 50 m. and girths approaching 6 m., producing a light (380 kg/m^3) hardwood, Obeche, used locally for construction, match splints and plywood. Between 1958 and 1966, Obeche accounted for 65% of Nigeria's round-wood exports: it is now no longer exported.

Lack of a predictable supply of viable seed prevented, until recently, the regular establishment of plantations. However, as a result of two projects sponsored by the U.K. Overseas Development Administration, the situation has changed. One was started at the Forestry Research Institute of Nigeria (FRIN) in 1971 and the other at the Institute of Terrestrial Ecology (ITE) near Edinburgh, in 1974. The former was focussed on fruit development, seed

storage, and the provision by vegetative propagation of clonal planting stocks of known quality (Jones & Howland, 1974). The second project was concerned with physiological factors concerned in the management of stock-plants providing cuttings for propagation, and with early selection criteria (Longman et al., 1979).

Natural distribution

T. scleroxylon occurs in a narrow band from Sierra Leone in the west to Central African Empire in the east (Fig. 1). It is most abundant in Nigeria, Ghana, and Ivory Coast, where it forms 13% of trees ≥61 cm (2 ft) g.b.h. and > 20% of those ≥183 cm (6 ft) g.b.h. (Hall & Bada, 1979). It occurs naturally mostly on ferruginous soils derived from Basement Complex and in localities with <1,800 mm rain per year falling at two times of the year - April/July and Sept./Oct. Optimal temperatures for the growth of T. scleroxylon range from 25°C to 35°C (Hall & Bada, 1979).

Seed availability and storage

T. scleroxylon flowers irregularly, it being most intense in the months following exceptionally severe short dry seasons in July and August (Jones, 1974; Howland & Bowen, 1977). Nonetheless, some flowers are produced in most years. Out-of-season flowering has occurred on mature grafts in forest nurseries (Howland & Bowen, 1977) and on juvenile stocks in tropicalized glasshouses in Edinburgh, U.K. (Leakey & Longman, 1979). In both instances viable seed was produced following cross-pollinations.

At room temperature, seeds remain viable for only 2-3 weeks, but with drying to 8% moisture, and storage at -18°C, they remain viable for at least 18 months (Bowen et al., 1977; Howland & Bowen, 1977). Saplings from seeds collected and germinated in February are usually ready for planting in June.

Provenance differences

Provenance trials, limited by lack of viable seed, were planted in 1972 and 1974 at Gambari, Sapoba and Ukpom Bende Forest Reserves. Data obtained so far, suggest that growth from Nigerian seed, collected from the drier parts of the Dry Lowland Rain Forest, differs from that of saplings from the wetter parts (Jones, 1975). Observations on collections of T. scleroxylon taken from countries in addition to Nigeria, have still to be made. However with isolated pockets at the eastern, western and northern limits of its range, appreciable differences are predicted.

Vegetative propagation

In the absence of reliable sources of seed, rooted cuttings provide alternative planting stocks indistinguishable from seedlings as regards form, height and branching habits (Howland & Bowen, 1977), at least in the early years after establishment.

The optimal environmental and hormonal requirements for rooting a range of T. scleroxylon clones have been identified (Leakey et al., 1975: in litt.), with subsequent development of practical techniques for stimulating root production within 2-8 weeks (Howland, 1975 a,b,c).

Clone differences

With vegetative propagation, it has been possible to multiply a range of clones so far derived only from natural crosses. About 0.25 million trees, established from rooted cuttings of T. scleroxylon, have been planted in gene banks and clonal trials in Nigeria. Three years after planting it has been possible to detect appreciable differences between clones when assessing heights, stem diameters and branching characteristics (Howland et al., 1978); these trials are being supplemented by other experiments aiming to identify reliable methods of early selection, a problem akin to that incurred when selecting among seedling populations.

Pests and pathogens

Caterpillars of Anaphe venata and hoppers of Xonocerus variegatus can cause extensive defoliation, while the psyllid, Diclidophlebia eastopi causes leaf roll. Although the effects of these types of damage on performance should be assessed it is known that these insect pests can be controlled by insecticides, but perhaps more profitably, tropical foresters should consider the value of "mixed-cropping", as employed by agriculturalists, to minimize the build-up of population explosions. Developing fruits are often seriously damaged by Apion ghanaense and infected by the smut fungus Mycosyrinx spp., both of which deleteriously affect seed viability (Ashiru, 1975; Odeyinde, 1975; Jones, 1976). Recently a stem streak and rot seeming to originate from unoccluded scars of shed branches has been observed.

Prospects

The heavy exploitation and earlier intermittent attempts to establish small T. scleroxylon plantations reflect its attractiveness and importance. Lowe (1973) reported that T. scleroxylon had unusually narrow crowns which were slow to close canopy, yet signs of competition appeared relatively early. Ball (1975) developed models for growth, stocking density, yield and financial returns. Using mean annual diameter increments of 1.9 cm for years 0-15 (falling to 1.1 by 25 years) and initial stocking density of 625 stems/ha, thinned to a final crop of 90 after 50 years, he predicted mean annual volume increments of 7.2 - 8.1 m^3 ha^{-1}. This, like Lowe's (1973) assessment may underestimate the potential of the species because of the limitations of the sample and the scanty knowledge of appropriate silvicultural practices. Notwithstanding, planting programmes are currently in progress in Nigeria, Ivory Coast and Ghana, but T. scleroxylon has rarely been grown outside its natural range. Experience suggests that stands of T. scleroxylon are likely to benefit from weeding during the first three years after planting, weeding decreasing losses, increasing girth and accelerating canopy closure which occurs, with subsequent self-pruning of branches, about four years after planting at 2.5 m.

With a ready method of building-up stocks of vegetatively propagated clones it is now feasible to consider the transfer of stocks within and beyond the natural range of T. scleroxylon as has happened when exploiting coniferous and other broad-leaved trees. However, the ability to countenance extensive plantations should be tempered by a calculated consideration of the range of clones to be used. In turn, the choice of clones should be guided by an ability to predict mature form from characteristics that can be observed at an early stage, a facet of research that should be accorded priority if resources being allocated to the re-establishment of T. scleroxylon are to be maximised. It would be foolish to use a restricted range of virtually unselected clones simply because they are easy to root. However evidence presented by Ladipo et al., (in this volume) suggests that the problem of selection is unlikely to prove insuperable.

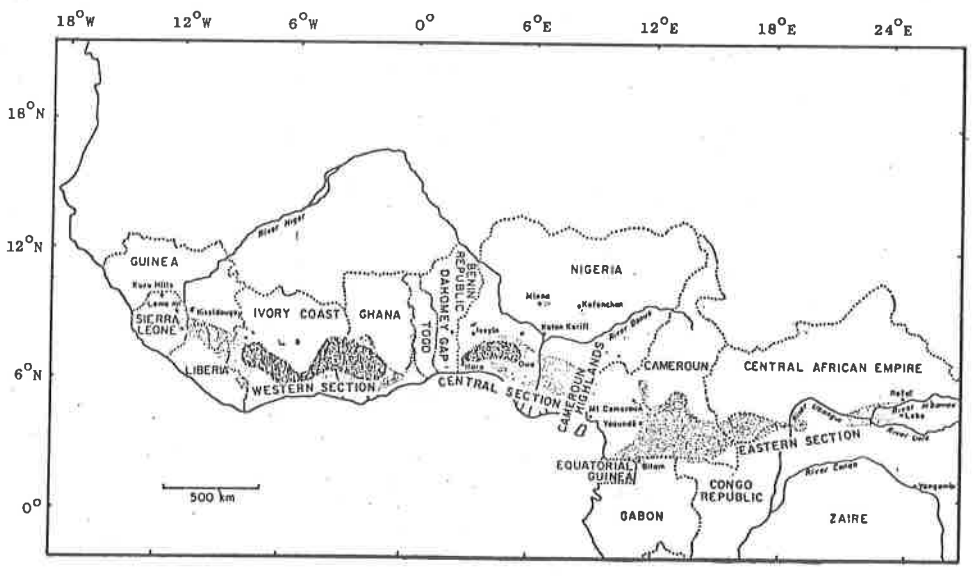


Fig. 1. The distribution of Triplochiton scleroxylon (stippled). Areas of greater abundance (heavier stippling). - After Hall & Bada (1979).

The help of Dr. M.R. Bowen is gratefully acknowledged.

References

Ashiru, M.O., (1975). Some aspects of work on insect pests of leaves and fruits of Triplochiton scleroxylon K. Schum. Proceedings of the Symposium on Variation and Breeding Systems of Triplochiton scleroxylon. K. Schum, Ibadan, Nigeria, 42-52.

Ball, J.B., (1975). A reassessment of the potential of Obeche in plantations. Internal report, F.A.O. Forestry Development Project Nigeria.

Bowen, M.R., Howland, P., Last, F.T., Leakey, R.R.B., & Longman, K.A., (1977). Triplochiton scleroxylon: its conservation and future improvement. FAO Forest Genetic Resources information No. 6, 38-47.

Hall, J.B., & Bada, S.O., (1979). The Distribution and ecology of Obeche (Triplochiton scleroxylon). Journal of Ecology, 67, 543-564.

Howland, P., (1975 a). Vegetative propagation methods for Triplochiton scleroxylon K. Schum. Proceedings of the Symposium on Variation and Breeding Systems of Triplochiton scleroxylon K. Schum, Ibadan, Nigeria, 99-109.

Howland, P., (1975 b). Variation in rooting of stem cuttings of Triplochiton scleroxylon K. Schum, Ibid, 110-124.

Howland, P., (1975 c). Current management techniques for raising Triplochiton scleroxylon K. Schum, Ibid, 125-129.

Howland, P. & Bowen, M.R., (1977). Triplochiton scleroxylon K. Schum. and other West African tropical hardwoods. West African Hardwoods Improvement Project, Research Report 1971-1977, Forestry Research Institute of Nigeria, 154 pp.

Howland, P., Bowen, M.R., Ladipo, D.O. & Oke, J.B., (1978). The study of clonal variation in Triplochiton scleroxylon K. Schum. as a basis for selection and improvement. Proc. joint workshop IUFRO working parties S2.02-08 and S2.03-1, Brisbane, 1977 (Eds: Nikles, D.G., Burley, J., & Barnes, R.D.) Oxford, U.K., Commonwealth Forestry Institute 898-904.

Jones, N., (1974). Records and comments regarding the flowering of Triplochiton scleroxylon K. Schum. Commonwealth Forestry Review, 53, 52-56.

Jones, N., (1975). The distribution of Triplochiton scleroxylon K. Schum. with special reference to Nigeria. Proceedings of the Symposium on Variation & Breeding Systems of Triplochiton scleroxylon K. Schum, Ibadan, Nigeria, 8-18.

Jones, N., (1976). Some biological factors influencing seed setting in Triplochiton scleroxylon K. Schum. In:- Tropical Trees: Variation, Breeding and Conservation (Eds. Burley J. & Styles B.T.), Academic Press, London, 125-134.

Jones, N., & Howland, P., (1974). West African hardwoods improvement project. Commonwealth Forestry Review, 53, 190-194.

Ladipo, D.O., Leakey, R.R.B., Longman, K.A., & Last, F.T. (In this volume). A study of variation in Triplochiton scleroxylon K. Schum.: some criteria for clonal selection. Proceedings of IUFRO Symposium & Workshop on Genetic Improvement & Productivity of Fast Growing Tree Species, São Paulo, Brazil.

Leakey, R.R.B., Chapman, V.R., & Longman, K.A., (1975). Studies on root initiation and bud outgrowth in nine clones of Triplochiton scleroxylon K. Schum. Proceedings of the Symposium on Variation and Breeding Systems of Triplochiton scleroxylon K. Schum. Ibadan, Nigeria, 86-92.

Leakey, R.R.B., Chapman, V.R. & Longman, K.A. (in litt.). Physiological studies for tropical tree improvement and conservation. Some factors affecting root initiation in cuttings of Triplochiton scleroxylon K. Schum.

Leakey, R.R.B., & Longman, K.A., (1979). Reproduction, conservation and improvement of some tropical hardwoods. Fifth Annual Report ODA/NERC Contract R3454.

Longman, K.A., Leakey, R.R.B., Howland, P., & Bowen, M.R., (1979). Physiological approaches for utilizing and conserving the genetic resources of tropical trees. Proceedings of 3rd World Consultation on Forest Tree Breeding. Canberra, 1977, Vol. 2, 1043-1054.

Lowe, R.G., (1973). Plots in managed plantation crops in the high forest zone of Nigeria. Research Paper (Forest Series) No. 17, Forestry Research Institute of Nigeria.

Odeyinde, M.A., (1975). Observations on the smut infection of flowers and fruits development of Triplochiton scleroxylon, K. Schum. Proceedings of the Symposium on Variation & Breeding Systems of Triplochiton scleroxylon K. Schum, Ibadan, Nigeria, 53-59.

FAST GROWING TREES

Acacia auriculiformis A. CUNN. EX BERTH — ESPÉCIE DE RÁPIDO CRESCIMENTO PARA OS TRÓPICOS

J. R. Luton
Office of Forests, Port Moresby
PAPUA NEW GUINEA

Resumo

Acacia auriculiformis A. Cunn ex Berth é originária do Sul da Papua Nova Guinê (PNG) e Norte da Austrália, tendo sido utilizada em florestamento de pastagem degradadas em PNG. A forma das árvores é pobre, porém, árvores retas podem ser encontradas. Produz sementes intensamente e estão sendo feitas colheitas de árvores superiores. É possível a hibridação com *A. mangium*. A coleta de sementes por procedência está sendo planejada.

Acacia auriculiformis A. CUNN. EX BERTH — PROMISSING FAST-GROWING SPECIES FOR THE TROPICS

Summary

Acacia auriculiformis A. Cunn. ex Berth originates in South Papua New Guinea (PNG) and Northern Australia and has been used in afforesting degraded grasslands in PNG. It is frequently of poor form, though straight specimens can be found. It seeds profusely, and collections are being made from superior trees. It may prove possible to produce a hybrid with A. mangium. Provenance seed collections are planned.

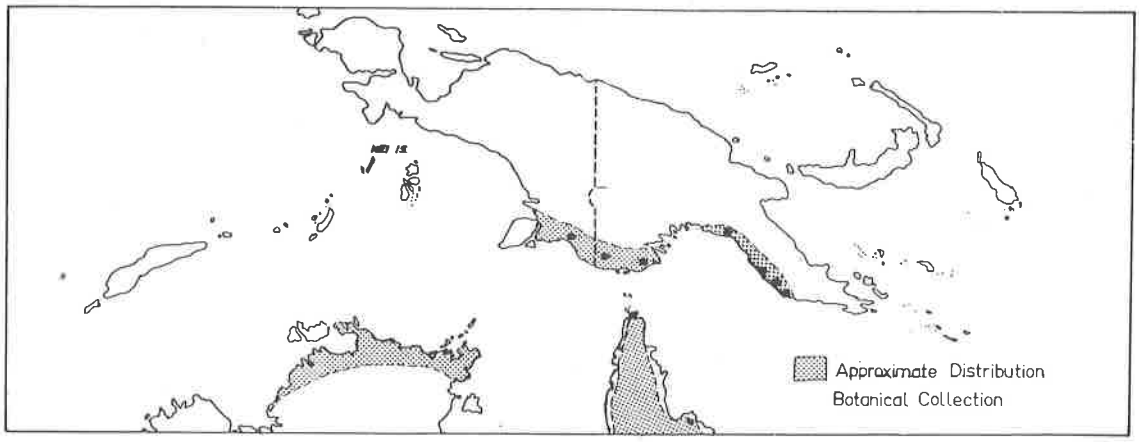
Growth Data - Papua New Guinea

Site	DBH (cm)	Dominant Height (m)	Age	Stems/ha	Stems Assessed
Kunjingini					
Ripped Only	7.3	9.9	5¼	1390	60
Ripped, Ploughed and Mounded	7.8	11.7	5½	1410	67
Ripped Only	6.8	8.0	6½	880	57
Ripped, Ploughed and Mounded	14.7	20.8	7½	680	22
Ripped, Ploughed and Mounded	19.4	11.7	8½	695	5
Madang					
Bunked/Burnt	19.5	16.5	6	32	5

Pulping Characteristics

CSIRO Division of Chemical Technology has carried out several tests of the pulping characteristics of Acacia auriculiformis for Papua New Guinea by different pulping processes. Results for unbleached kraft pulp and neutral sulphate semichemical (NSSC) pulp were very promising (Logan and Phillips, 1977), however later tests with groundwood impregnated billets (G.I.B.), cold soda semichemical pulps and refiner chemical pulps were not (Logan and Hannsen, 1979). The unbleached kraft pulp yield was excellent with satisfactory strength projecties. However, the NSSC pulp was of such high quality that it could be substituted for kraft pulps in any end products (Logan, pers. comm, 1980).

DISTRIBUTION OF ACACIA AURICULIFORMIS A. Cunn. Ex. Berth



Natural Distribution

Verdcourt (1979) gives the distribution of Acacia auriculiformis as in Eucalyptus savannah, woodland and forest edge on South coast of the island of New Guinea, (Map) in Queensland and the Northern Territory of Australia north of 14°s and Kei Island. In Papua New Guinea its distribution is on the savannahs along the Papuan coast.

Acacia auriculiformis A. Cunn. ex Berth. - Promising Fast-growing Species For the Tropics.

Evidence of Promise

Acacia auriculiformis is used for amenity plantings in many countries. Growth data is readily available for Malaysia, Tanzania, Papua New Guinea and India. Interest in the species in Papua New Guinea was stimulated by the great success in reforesting a degraded grassland along the Sepik River (Lamb, 1975), and by early reports from CSIRO on pulping qualities (Logan and Phillips, 1977). Interest elsewhere will obviously be stimulated by Sabah's experience with Acacia mangium and the National Academy of Science's report Tropical Legumes: Resources for the Future (1979).

Early plantings of Acacia auriculiformis were known for their bad form and multiple leadering. However, in a very superficial survey along the road outside Port Moresby it was not difficult to find straight specimens with single leaders.

In Papua New Guinea aside from urban amenity plantings, Acacia auriculiformis was first used in forestry as a reclamation species in a degraded grassland system. First plantings, including Pterocarpus indicus, Tectona grandis, Delonix regia, Bauhinia spp, Pinus patula and Adenanthera pavonina were basically ad hoc and not too successful (Lamb, 1975). Subsequent plantings included site preparation, first by ripping, then by ripping and mounding. 1978 growth data for these plantings show that careful site preparation increases growth, mounding appears to yield an additional improvement in growth over ripping. However, an assessment just carried out showed total mortality in part of the site. The mortality occurred in trees of the same physiological age over the last two years and arises down slope where there is an abrupt line with healthy trees above and dead trees below. Studies have begun to identify the causes of this abrupt decline. Site preparation on the Madang site consisted of clearfelling, bunking and burning. It is a low hill area with fairly good drainage. The heavy mortality and consequent low stocking was due to a complete lack of tending for several years. Growth at Kunjingini sites was assessed using a 1 to 2% sample of circular plots (3.4m radius) and rectangular plots (36m^2).

Seed Availability and Ease of Storage

Acacia auriculiformis seeds profusely in Papua New Guinea. At present seed is available only from trees of unknown origin and the major constraint to wider availability is the difficult access to stands in the Western Province. It is hoped that large collections from different areas and from straight, single-stemmed trees will become available sometime in 1980. Block plantings from these seeds will be arranged in Papua New Guinea, and hopefully, seed made available for distribution to interested countries under the FAO seed scheme.

Seed collected in 1973 and stored in airtight plastic jars in an air conditioned laboratory was still viable six years later. However, pregermination by scarification of the test at the cotyledon end or immersion in just boiled water many be necessary.

Provenance Variation

No studies of provenance variation have been conducted, but the spacing trial planted in 1979 at Kunjingini has two seed sources. Morphological investigation will take place in 1980.

Proposal for Development for International Use

The major drawback of Acacia auriculiformis appears to be its variable but often bad form and double to multiple leader habit.

Papua New Guinea intends to mount collections from the straightest trees with single stems to begin research to the causes of these bad characteristics and begin a breeding program to ameliorate them. An additional possibility may be to cross Acacia auriculiformis with Acacia mangium which is noted for much better form.

A putative "hybrid" separated by L. Pedley in Sabah, however had Acacia mangium taxa with Acacia auriculiformis bad form (N. Jones, pers. comm. 1980).

Provenance collections will be mounted at the same time, initially defining provenance very narrowly to mean from distinct patches of savannah and later expanding the definition to broader localities if no differences are evident from provenance trials. These collections, under partial funding of FAO will yield seed for distribution to interested countries for provenance trials. They will also be used to create seed production areas in Papua New Guinea for further breeding.

Acacia auriculiformis Bibliography

Banerjee, A.K. 1973a. Plantations of Acacia auriculaeformis (Benth.) A. cunn in West Bengal.. Indian Forester 99:533-540

_____. 1973b. Nutritional experiment in sand culture of Acacia auriculaeformis (Benth.) A. cunn. Indian Forester 99:691

N.W. Hansen and A.F. Logan, 1978. Pulping Project on Papua New Guinea Hardwoods. Progress Report No.3, CSIRO Division of Chemical Technology, South Melbourne, Australia. 17pp. + tables.

_____ and _____, 1979. Pulping Project on Papua New Guinea Hardwoods. Progress Report No.4. CSIRO Division of Chemical Technology, South Melbourne, Australia. 19pp. + tables.

Lamb, D. 1975. Kunjingini Plantations 1965-1975. Tropical Forestry Research Notes SR.24. Department of Forests, Port Moresby, Papua New Guinea. 17 pp.

Logan, A.F. and F.H. Phillips. 1975 Pulping Studies on Tropical Hardwoods. Progress Report No.7. CSIRO Division of Chemical Technology, South Melbourne, Australia. 19 pp. + tables.

_____ and _____. 1977. Hardwood Species for Reforestation in Tropical Areas. Paper presented at 18th Forest Products Research Conference, Melbourne, May 1977. 5 pp.

_____ and N.W. Hansen. 1979. The Potential of Young Tropical Hardwoods for High Yield Pulping. Paper presented at 19th Forest Products Research Conference, Melbourne 1979. 3pp.

National Academy of Sciences. 1979. Tropical Legumes: Resources for the Future. Washington, D.C. 331 pp.

Nicholson, D.I. 1975. A note on Acacia auriculiformis A. Cunn ex Benth. in Sabah. Malaysian Forester 28 (3): 243-244.

Phillips, F.H. and A.F. Logan and V. Balodis. 1979. Suitability of tropical forests for pulpwood. Tappi 62 (3): 77-81

Pedley, L. 1975. Contributions From the Queensland Herbarium No.18 Revision of the extra-Australian species of Acacia subg Heterophyllum.

_____. 1978. A revision of Acacia Mill. in Queensland Austrobaileya 1

Ratnasabapathy, M. 1974. Acacia auriculaeformis and Casuarina equisetifolia - the urban invaders. Malayan Nature Journal 28: 18-21.

Sastroamidjojo, J.S. 1964. Acacia auriculiformis A. Cunn. Rimba Indonesia 9 (3): 214-225.

Streets, J.R. 1962. Exotic Trees in the British Commonwealth Clarendon Press, Oxford.

Verdcourt, B. 1979. A Manual of New Guinea Legumes. Botany Bulletin No.11. Kristen Press, Madang, Papua New Guinea.

Vietmeyer, N.D. 1979. Tropical tree legumes: front line against deforestation. Ceres September 10 October: 38-41.

FAST GROWING TREES

PLANTAÇÕES DE FRAMIRÉ *(Terminalia ivorensis)* NA COSTA DO MARFIM

H.F.Maitre and B. Mallet
C.T.F.T.
COSTA DO MARFIM

Resumo

Framiré *(Terminalia ivorensis)* espécie indígena é usada há 50 anos em reflorestamentos na Costa do Marfim, a pleno sol ou sob floresta eliminada por envenenamento. Essa espécie é muito sensível à competição, que causa primeiro uma perda de crescimento, e depois a eliminação das árvores dominantes. A morte total dos ponteiros, que tem afetado algumas parcelas, parece estar ligada à uma interação entre os fatores ambientais locais, e um fenômeno de auto inibição acrescida de uma competição intensa.

Esta espécie proporciona grande produção de polpa e de madeira de serraria, necessitando para este último objetivo de — 70 árvores por hectare, após os 30 anos — métodos silviculturais adequados, conduzem rapidamente ao número final de árvores por hectare desejado nas plantações.

LE FRAMIRÉ *(Terminalia ivorensis)* DE PLANTATIONS EN CÔTE D'IVOIRE

Resume

Le Framiré (Terminalia Ivorensis) est une espèce indigène en Côte d'Ivoire utilisée depuis près de 50 ans en Côte d'Ivoire dans les reboisements, en plein découvert et sous forêt empoisonnée. Cette essence héliophile, est très sensible à la concurrence qui se traduit rapidement par une réduction de croissance, puis par une élimination des arbres dominés. Le dépérissement massif observé dans quelques parcelles semble lié à une interaction entre les facteurs stationnels et un phénomène d'autoinhibition exacerbés par une concurrence intense. Cette essence à forte productivité, tant papetière qu'en bois d'oeuvre devra subir pour ce dernier objectif visant la production de 70 pieds par hectare à partir de 30 ans, une sylviculture ramenant rapidement les peuplements à densité définitive.

Le Framiré (Terminalia ivorensis) est une Combretacée présente dans l'ensemble de la zone forestière de Côte d'Ivoire qui a très tôt attiré l'attention des forestiers du fait de la qualité de son bois et de sa forte croissance en plantation.

Les premiers peuplements ont été mis en place vers 1930 suivant différentes méthodes : Taungya, semis sur culture, layons sous forêt... La réussite sylvicole de ces premières réalisations a donné à cette espèce une place prépondérante au sein des reboisements menés par la Société d'Etat chargée des Reboisements (S O D E F O R) qui de 1966 à 1975 a pu effectuer 3000 hectares en zone de forêt sempervirente et 2000 en secteur semi-decidu, selon la méthode du "sous-bois" (400 plants à l'hectare sous forêt empoisonnée).

1. Le comportement en plantation

Cette essence généreuse en graines peut être multipliée aussi bien par semis direct sur sol dénudé que par plants en stumps ou élevés en sachets, mais il est préférable d'utiliser ces derniers.

Sa bonne conformation, son excellent élagage naturel et l'étalement rapide des verticilles couvrant le sol, confèrent à cette essence héliophile la possibilité d'être plantée à des écartements relativement importants.

Développement aérien

Quel que soit le type de plantation, la hauteur du Framiré en peuplement est de 8 mètres à 3 ans, de l'ordre de 18 mètres à 6 ans et peut dépasser 20 mètres à 8 ans. Cette essence atteint sa hauteur finale très rapidement vers 12 - 15 ans et à partir de ce moment le verticille supérieur prend de plus en plus d'importance, ses branches maîtresses grossissent et s'étalent alors que les verticilles inférieurs se dessèchent et disparaissent progressivement. Ce n'est qu'entre 20 et 30 ans que le houppier est constitué d'un seul verticille et qu'il acquiert son aspect tabulaire. La hauteur finale du peuplement varie entre 30 et 35 mètres en fonction de la station.

Ce rapide développement du houppier fait qu'à l'âge de 8 ans les parcelles à 230 tiges à l'hectare arrivent à fermer le couvert.

Par ailleurs, des parcelles de 14 ans forment une voûte continue pour 180 tiges à l'hectare. Les verticilles s'imbriquent les uns dans les autres à forte densité et les arbres dominés présentent une nette réduction de la cime.

Développement racinaire

Le système racinaire du Framiré est constitué lors du jeune âge par un pivot central puissant rapidement relayé par un système traçant très superficiel dont sont issues des racines de faibles diamètre qui s'enfoncent à la verticale à une profondeur comprise entre 0,3 et 1,2 mètres.

L'examen, après mise à nu, des systèmes racinaires de Framirés en plantation donne l'impression d'un entrelacement des racines superficielles entre arbres voisins; mais un examen plus attentif fait apparaître une tendance pour chaque individu à prospecter toute la surface disponible et à se constituer un cercle racinaire propre et c'est de l'importance de cet espace vital ainsi colonisé que dépend la situation hiérarchique de l'arbre au sein du peuplement.

La superficie concernée par le système racinaire traçant d'un jeune arbre poussant sans contraintes est d'environ 19 m^2 à l'âge de 3 ans et 38 m^2 à 5 ans.

Les arbres d'élite des plus vieux peuplements prospectent individuellement de l'ordre 110 m^2 à 21 ans et peuvent dépasser 200 m^2 à 30 ans.

Phénomènes de concurrence

La compétition intense entre individus en plantation pure est la conséquence logique du rapide développement tant aérien que racinaire du Framiré. Les phénomènes de concurrence se manifestent notamment par un ralentissement de la croissance en diamètre.

Les résultats des principaux dispositifs d'étude ont montré que ces phénomènes démarrent brutalement quatre ans après plantation, aussi bien dans les parcelles à plein découvert que dans les placeaux sous forêt empoisonnée et ceci pour tous les Framirés dont le voisin immédiat se trouve à moins de 4 mètres de distance. Cette compétition s'étend à l'âge de 5 ans aux individus distants de 5 mètres et c'est à partir de 7 ou 8 ans qu'elle peut se manifester au sein des peuplements à 230 tiges à l'hectare (équidistance : 6,6 mètres).

Faute d'interventions opportunes la croissance annuelle en diamètre du Framiré sous forêt empoisonnée atteint péniblement 2 cm par an lors des 10 premières années.

Pour les plantations pures en plein découvert (plus vigoureuses), l'écart de croissance annuelle en diamètre à 8 ans entre les différents peuplements, éclaircies ou intouchés, est flagrant : cette croissance est de 2,6 cm pour les parcelles à 570 tiges/hectare, 3 cm pour 380 tiges/ha, 3,4 cm pour 230 tiges/ha et de 3,9 cm par an pour les parcelles ayant cru hors concurrence à 115 tiges par hectare.

Pour les 70 plus grosses tiges à l'hectare, cette croissance devient 3,6 cm pour 570 tiges/ha, 3,8 cm pour 380 pieds/ha, 4 cm pour 230 pieds/ha et 4,2 cm par an à 115 tiges par hectare.

Des plantations à faible densité de Framiré en mélange avec du Fraké ou du Cedrela ont été réalisées, mais sont trop jeunes pour donner des résultats significatifs.

En ce qui concerne les vieilles plantations ayant bénéficié d'une densité de l'ordre de 150 tiges à l'hectare à l'âge de 15 ans, une élimination progressive des arbres les moins vigoureux (et dominés) a été constatée jusqu'en fin de révolution. La centaine d'arbres survivants constituent, tout de même, un peuplement encore trop dense dont l'hétérogénéité des diamètres est la preuve patente : le diamètre peut varier du simple au double pour les 60 plus gros arbres à l'hectare. Seuls les arbres d'élite (60 à 80 selon les parcelles) maintiennent une croissance annuelle de l'ordre de 2 cm sur le diamètre pendant les 30 premières années.

En mélange avec du Teck, le Framiré à plus de 100 tiges par hectare forme vers 30 ans un étage dominant et bien venant, mais de croissance réduite (1,5 cm/an sur le diamètre) du fait de la très forte concurrence intra et interspécifique à laquelle il est soumis.

Phénomènes de dépérissement

Les arbres dominés en sur nombre au sein des parcelles adultes après une phrase d'arrêt de croissance sur plusieurs années, disparaissent progressivement du fait d'un dépérissement caractérisé par une descente de cime suivie d'un dessèchement du houppier et par des attaques secondaires d'insectes (scolytes et cerambicydes) et de champignons de pourriture.

En forêt de Yapo, un dépérissement de même type a cependant entraîné la disparition totale, en moins de cinq ans, de l'ensemble des arbres de deux parcelles de 20 et 30 ans installées sur culture ayant évolué à forte densité (plus de 350 tiges à l'hectare à l'âge de 15 ans).

Un tel dépérissement, fort préoccupant, a fait l'objet d'études approfondies qui n'ont pas mis en évidence d'agent causal d'origine parasitaire, mais qui ont fait ressortir une perturbation du cycle des éléments minéraux et de l'azote sous plantation, ainsi qu'un trouble physiologique d'ordre nutritionnel chez les arbres dépérissants.

Par ailleurs, l'étude en milieu contrôlé de la décomposition dans le sol des racines de Framiré a permis de déceler un effet nettement dépressif de celle-ci sur la croissance et sur la nutrition azoté de jeunes plants de cette essence.

Ces résultats ne peuvent à eux seuls constituer une explication suffisante à un tel phénomène. Quoique encore mal élucidé, il pourrait être lié à l'action combinée de facteurs de station défavorables, d'une concurrence intense mettant les arbres en position de faiblesse et d'une perturbation de la nutrition et de la croissance sous l'action des racines et de la litière en décomposition.

Enfin, l'inventaire général des plantations de Framiré de Côte d'Ivoire a montré que ce phénomène de dépérissement massif reste très localisé et que les premiers peuplements réalisés arrivent à présent à taille d'exploitabilité.

Il est à signaler que le passage accidentel d'un feu aussi léger soit-il entraîne le dépérissement des surfaces parcourues.

2. Sylviculture

De ce qui précède il découle que les interventions en éclaircie ne sont pas des actions facultatives. Pour produire du bois d'oeuvre, il est indispensable d'assurer le développement harmonieux des peuplements de Framiré par le jeu des éclaircies, en prévenant l'effet de la concurrence en plantation serrée.

Plantations sous forêt empoisonnée

Le système de plantation, malgré une bonne reprise, entraîne irrémédiablement de nombreuses pertes du fait des dégâts provoqués par les chutes tardives de branches et de troncs d'arbres empoisonnés. (Les phénomènes de courbure souvent constatés lors du jeune âge ne concernent qu'une faible proportion d'arbres grêles devant être éliminés à la première éclaircie). Les éclaircies ne peuvent donc être que sélectives et doivent permettre d'éliminer les arbres mal conformés chétifs ou blessés ainsi que les arbres vigoureux qui entravent par leur présence la croissance d'arbres d'élite. La première éclaircie doit avoir lieu au sein des peuplements de 4 ans dont le diamètre moyen atteint 11 centimètres et pour lesquels il subsiste 300 à 350 tiges à l'hectare issues des 400 plants mis en place. Cette éclaircie ne doit laisser que 200 arbres bien répartis et dégagés de toute concurrence.

La seconde et dernière éclaircie doit être réalisée vers l'âge de 8 à 10 ans (taille moyenne : 20 cm de diamètre) en ramenant le peuplement à densité quasi définitive, environ 100 tiges à l'hectare pour assurer la présence de 60 à 70 arbres exploitables en fin de révolution.

Cette intervention doit être précédée d'un dégagement complémentaire au niveau du recrû, des essences indésirables (Parasoliers...) des arbres morts ou ayant résisté à l'empoisonnement et des lianes, afin de réduire les risques de bris et de clore le programme d'entretiens en donnant aux Framirés sélectionnés le plus de chances possibles d'évoluer dans de bonnes conditions jusqu'à la récolte finale.

Plantations en plein découvert

Dans de telles conditions, la rapidité de couverture du sol par les jeunes plants de Framiré permet d'envisager des équidistances de plantation de l'ordre de 4 à 5 mètres en tout sens.

Une première éclaircie sélective doit ramener la densité aux alentours de 250 tiges à l'hectare dès que la moyenne des arbres présente un diamètre compris entre 14 et 17 cm vers l'âge de 4 ans.

Trois ou quatre ans plus tard, la surface terrière ayant dépassé 12 m^2/hectare (diamètre moyen correspondant : 25 cm), la seconde éclaircie ne doit laisser que les 150 meilleurs individus à l'hectare.

La troisième éclaircie qui n'est pas encore parfaitement définie doit avoir lieu entre 12 et 15 ans afin de mettre le peuplement à densité définitive (80 à 90 arbres à l'hectare dont 60 à 70 individus à mener à terme et 20 autres en tant que remplissage de sécurité).

Le nombre escompté d'arbres exploitables, 60 à 70 à l'hectare, en apparence très faible, est dicté non seulement par l'extension racinaire et aérienne du Framiré, mais aussi par le fait qu'une surface terrière de l'ordre de 20 m^2/ha constitue en dépit de l'âge un plafond rarement atteint par cette essence notamment pour la production de bois d'oeuvre.

3. Production

En ce qui concerne la production papetière (découpe inférieure correspondant à 15 cm de circonférence), les différentes parcelles à haute densité ont montré qu'il est illusoire de réaliser des plantations de plus de 600 plants à l'hectare. Par ailleurs, la production au bout de huit ans est sensiblement la même pour des équidistances de mise en place allant de 4 à 5 mètres en tout sens.

La production moyenne annuelle est sur les huit premières années de : 20 m^3/ha/an. Il est possible d'escompter, en toute sécurité, une production de l'ordre de 250 m^3 en quinze ans.

Quant à la production de bois d'oeuvre, certaines parcelles ayant atteint la taille d'exploitabilité, il est possible d'avancer des chiffres de production réalistes. A partir de 35 ans une production de 290 m^3 de bois fort est déjà acquise et ne peut être qu'améliorée par application des règles d'éclaircie précédemment exposées; ce qui permettra d'homogénéiser la taille des arbres constituant le produit final.

Cette production de bois fort qui correspond à une découpe de 7 cm de diamètre en fin bout, représente en fait 230 m^3 de volume fût (diamètre minimum en fin bout : 30 centimètres) apte à produire du bois d'oeuvre.

Les nombreux dispositifs et plantations de Terminalia Ivorensis réalisés en Côte d'Ivoire ont montré qu'il s'agit d'une essence à forte productivité, tant en pâte à papier qu'en bois d'oeuvre, dont la qualité a été récemment confirmée dans des peuplements arrivant à âge d'exploitabilité.

Les études sur la concurrence intraspécifique et les phénomènes de dépérissement indiquent que des méthodes sylvicoles appropriées sont indispensables pour mener à terme des peuplements de Framiré pour la production de bois d'oeuvre.

Les plantations doivent être ramenées à densité définitive avant 15 ans, soit environ 90 tiges à l'hectare pour 60 à 70 arbres exploitables en fin de révolution : cette densité pourra être atteinte à partir de plantations pures, ayant subi une sylviculture énergique et bien suivie, ou à partir de plantations à faible densité de Framirés en mélange avec une essence compatible, comme le Fraké.

L'application de ces méthodes fera du Framiré une essence pilote en bois d'oeuvre à moyenne révolution et devrait lui rendre la place qu'il mérite au sein des programmes de plantations forestières en Côte d'Ivoire.

BIBLIOGRAPHIE

BELIGNE, V., 1980 : Le Framiré : Dispositif de conduite des peuplements de la Téné. CTFT - (en cours).

BERNARD REVERSAT. 1975 : Recherches sur les cycles biogéochimiques des éléments minéraux majeurs en milieu forestier Sud équatorial. ORSTOM.

BRUNCK, et MALAGNOUX, M. 1976 : Note sur le dépérissement du Framiré et ses relations avec la nutrition minérale des plants. CTFT.

DE NEEFF et BONNET MASIMBERT. 1971 : Le Framiré : essai d'enracinement sous deux types de couverts à Mopri et à l'Abbé. Essai de cinq types de plants. CTFT.

DE NEEFF. 1975 : Le système racinaire du Framiré. CTFT.

GOUDET. 1968 : Etude de la croissance de parcelles anciennes de Framiré en forêt de Yapo.

GOUDET et DE NEEFF. 1971-1974 : Etude des phénomènes de courbure dans les plantations de Framiré. CTFT.

GUINAUDEAU. 1966 : Etude des parcelles de Framiré (Terminalia Ivorensis) à Yapo et à l'Aké Befiat. CTFT.

MAITRE H.F. et BELIGNE, V. 1980 : Etude des plantations de Framiré de l'Abbé. Règles d'intervention en éclaircie. CTFT.

MALAGNOUX, M. et DE NEEFF. 1972-1974 : Récolte et étude de Framiré en cours de dépérissement. CTFT.

MALAGNOUX, M. 1977 : Projet de plantation du Framiré en mélange. CTFT.

MALLET, B; DIDIER de ST. AMAND - Juin 1979 : Etude par analyse en composantes principales de l'action d'extraits aqueux et de résidus de litière et racines de Framiré sur la croissance et la composition minérale de jeunes plants de cette espèce. CTFT - ORSTOM.

MALLET, B. et DIDIER de ST AMAND. Juin 1980 : Etude comparative des effets d'une addition au sol de broyats de litière et de racines sur le comportement de jeunes Framirés. CTFT - ORSTOM.

WENCELIUS, F. et DE NEEFF. 1973/: Essais d'éclaircies dans les jeunes plantations de Framiré de la SODEFOR. CTFT.

Etude de la concurrence pour les plantations de Framiré de l'Abbé. CTFT.

FAST GROWING TREES

ÁREAS ECOLOGICAMENTE APTAS PARA PLANTIO DE TRÊS ESSÊNCIAS FLORESTAIS NO ESTADO DE SÃO PAULO

M.A.R. Nahuz, V.A.Alfonso, A.I.P. da Costa, J.P.Chimelo, G.J.Zenid e E.R.P.Jara
Instituto de Pesquisas Tecnológicas – IPT
BRASIL

Resumo

Através de pesquisa bibliográfica, foram levantados dados que indicam que as três espécies estudadas -Leucaena; Gmelina e Mimosa scabrella - possuem um crescimento acelerado, o que as torna potencialmente promissoras como fonte de biomassa para fins energéticos. Foi realizado, em primeira aproximação, o zoneamento ecológico do Estado de São Paulo para aquelas espécies, que é apresentado em forma de mapas.

INTRODUÇÃO

Este trabalho foi desenvolvido dentro do projeto "Potencial de Biomassas Vegetais para Fins Energéticos" pelo Instituto de Pesquisas Tecnológicas do Estado de São Paulo S.A. - IPT em convênio com a Companhia Energética de São Paulo - CESP, à qual o IPT e os autores agradecem a gentileza de permitir a divulgação deste trabalho.

O presente trabalho pretende caracterizar as espécies leñosas Leucaena, Gmelina e Mimosa scabrella como espécies de rápido crescimento, através de dados da literatura; apresentá-las como fontes promissoras de biomassa para fins energéticos, assim como apresentar, em primeira aproximação, o zoneamento ecológico do Estado de São Paulo para estas espécies.

MATERIAIS E MÉTODOS

Materiais

- Leucaena leucocephala (Lam.) de Wit. - IPIL-IPIL
- Gmelina arborea Roxb. - GMELINA
- Mimosa scabrella Benth. - BRACATINGA

Métodos

A caracterização das espécies como de crescimento rápido é feita através de dados de incremento em altura, diâmetro e volume, obtidos na literatura específica. Da mesma maneira foram coletados dados que permitem avaliar a potencialidade das três espécies como fonte de material energético, segundo a literatura.

O zoneamento ecológico está baseado nas condições ambientais naturais em que vive cada espécie, em particular naqueles fatores considerados limitantes para a sua adaptação. Estes fatores são os seguintes:

Leucaena -

- altitude máxima de 500 m.
- pluviosidade média anual de 500 a 1.700 mm.

Gmelina -

- pluviosidade média anual de 1.500 a 2.300 mm.
- temperatura média anual de 18 a 35ºC.

M.scabrella -

- altitude máxima de 500 m.

TABELA 1

DADOS DE CRESCIMENTO - Leucaena leucocephala

Variedade	Idade (ano)	DAP (cm)	Altura (m)	Lotação (Nº árvores/ha)	IAM* m^3/ha/ano	Localidade
Salvador - K 8	0,5	-	4,1	-	-	Havai
	2,0	-	9,1	-	-	Havai
	2,0	8,8	5,7	2.488	30,7	Filipinas
	2,5	8,7	4,2	6.908	48,8	Filipinas
	2,5	9,2	2,4	44.444	236,7	Filipinas
	6,0	-	16,8	-	-	Havai
Salvador - K 28	2,0	15,2	9,8	-	-	Havai
	2,0	10,1	3,4	2.488	23,8	Filipinas
	2,5	10,1	2,4	44.444	311,9	Filipinas
	4,0	15,0	15,0	-	-	Havai
	7,0	13,0	-	3.643	45,5	Filipinas
	7,0	16,0	7,4	2.774	45,7	Filipinas
	8,0	37,0	13,0	-	-	Filipinas
Salvador - K 67	2,0	8,8	4,6	2.408	24,9	Filipinas
	2,5	8,4	2,3	44.444	203,9	Filipinas
Salvador - K 22	2,5	8,0	2,6	44.444	204,6	Filipinas
Peruano	1,0	6,0	4,3	-	-	Filipinas
	1,5	6,0	5,5	16.667	123,1	Filipinas
	2,3	15,0	12,1	-	-	Filipinas
Salvador	4,0	-	12,0	-	-	-
	6,0	31,7	16,6	-	-	Havai
	8,0	40,0	15,0	-	-	Havai

* IAM = Incremento Anual Médio

FONTE: Bawagam e Semana, 1978; NAS, 1977; Benge, 1976; Brewbaker, 1975

TABELA 2

CRESCIMENTO DE Gmelina arborea

Procedência	Idade (ano)	Altura média anual (m)	Diâmetro médio (cm)	Incremento médio anual em volume (m^3/ha)	Volume / hectare total (m^3)
Malásia	1	-	-	-	-
Malásia	2	-	-	-	-
Malásia	3	-	8	-	-
Serra Leoa	3	2,44	11,30	-	-
Malásia	4	-	12,15	-	-
Bangladesh	5	2,50	-	-	-
Malásia	6	-	-	19,0	112
Belize	6	-	29,10	-	-
Serra Leoa	6	2,19	20,40	-	-
Jari (Brasil)	6	-	-	-	-
Malásia	7	3,35	-	36,5	-
Malásia	7	-	-	18,0	130
Serra Leoa	7	2,01	32,00	-	-
Malásia Peninsular	7	-	18,60	-	-
Malásia	8	2,97	-	39,1	-
Malásia Peninsular	8	-	20,20	-	-
Belize	8	-	25,80	-	-
Malásia	9	2,71	-	31,0	-
Malásia	9	-	-	16,0	145
Malásia Peninsular	9	-	21,80	-	-
Jari (Brasil)	10	-	-	-	-
Bangladesh	10	1,74	-	-	-
Malawi	10	-	22,60	30,4	-
Serra Leoa	10	1,50	33,00	-	-
Malásia	11	3,33	-	28,50	-
Malásia	11	-	-	13,00	140
Bangladesh	15	1,32	-	-	-
Bangladesh	20	1,08	-	-	-
Bangladesh	25	0,91	-	-	-
Bangladesh	30	0,79	-	-	-
Bangladesh	35	0,70	-	-	-

FONTE: Douay, 1956; Palmer and Gibbs, 1974; Boulet-Gercourt, 1977; Kalish, 1979

. pluviosidade média anual de 1.250 a 2.500 mm.

. temperatura média anual de 14 a 20°C.

Além destes parâmetros são consideradas as classes de capacidade de uso do solo IVf, VI, VIf e VII, descritas como aptas para reflorestamento (Atlas Regional de São Paulo, 1978), assim como as áreas cobertas por matas nativas, primárias e secundárias, isto é, estas áreas não são computadas como ecologicamente aptas.

Deve-se ressaltar a existência de um certo consenso entre os ecologistas de que o clima é, em geral, um fator limitante na introdução de uma espécie em determinada área muito mais importante que o solo, este determinando muito mais os índices de produtividade que o sucesso ou fracasso do plantio (Victor et al, 1974).

O presente trabalho segue esta mesma linha, pois as classes de capacidade de uso do solo aqui consideradas o são como próprias para o reflorestamento em geral, e não especificamente para as espécies aqui tratadas.

R E S U L T A D O S

Os dados de incremento em volume, altura e diâmetro para Leucaena e Gmelina são mostrados nas Tabelas 1 e 2 respectivamente.

Para melhor entendimento da Tabela 1 deve-se ressaltar que a Leucaena leucocephala é comumente dividida em três tipos básicos: Salvador, Havaiano e Peruano, sendo que a Universidade do Havai possui uma coleção de 341 variedades da espécie numeradas de K 1 a K 341 (NAS, 1977).

Existem poucos dados de crescimento para M.scabrella. No entanto, tem-se que seu crescimento é rápido, chegando a atingir 15 m de altura em 3 anos, observando-se um crescimento intermediário de 5 m em 14 meses e 8 m em 9 anos (NAS, 1979). No Horto Florestal do Estado de São Paulo, em 1929, árvores plantadas por semeadura direta obtiveram um crescimento rápido, atingindo 3,7 m de altura em 6 meses (Hoehne, 1930).

Com relação a Leucaena, o tipo Salvador apresenta uma densidade básica de 0,54 g/cm³ em média, sendo inferior àquela do

T A B E L A 3

DIMENSIONAMENTO DAS ÁREAS DO ESTADO DE SÃO PAULO ECOLOGICAMENTE APTAS PARA O REFLORESTAMENTO COM: Leucaena, Gmelina e M.scabrella

Região-Administrativa	Áreas (ha) por espécie		
	Leucaena	Gmelina	M.scabrella
Região 1: Grande São Paulo	-	53.010	-
Região 2: Litoral	93.360	86.200	101.630
Região 3: Vale do Paraiba	8.370	44.640	8.370
Região 4: Sorocaba	114.350	25.110	49.430
Região 5: Campinas	22.320	119.690	-
Região 6: Ribeirão Preto	150.660	365.490	-
Região 7: Bauru	267.840	-	-
Região 8: São José do Rio Preto	691.920	-	-
Região 9: Araçatuba	1.079.730	-	-
Região 10: Presidente Prudente	940.230	-	-
Região 11: Marilia	337.590	-	-
T O T A L	3.706.370	694.140	159.430

M A P A 1

M A P A 2

M A P A 3

tipo Havaiano que é de 0,70 g/cm³ (NAS, 1977). Em relação ao poder calorífico esta espécie apresenta valores de cerca de 4.600 kcal/kg para o tipo Havaiano e de 4.200 a 4.400 kcal/kg para o tipo Salvador (Bawagan e Semana, 1976).

A madeira da Gmelina possui uma densidade aparente de 0,50 g/cm³ em média, segundo Boulet-Gercourt, 1977. Não são disponíveis dados com relação ao poder calorífico.

Quanto à M.scabrella apresenta madeira com densidade aparente a 15% de umidade de 0,67 g/cm³ (IPT, 1956) e a 12% de umidade de 0,77 g/cm³ (Tomazelli, 1979).

A distribuição espacial das áreas do Estado de São Paulo aptas para reflorestamento com Leucaena, Gmelina e M.scabrella, segundo o zoneamento realizado, são mostrados nos Mapas 1, 2 e 3, respectivamente, sendo que a Tabela 3 apresenta a quantificação destas áreas.

Os tipos climáticos que abrangem as áreas delimitadas são:

. Para Leucaena:

TROPICAL - Quente, Sub-quente e Mesotérmico brando.

TEMPERADO - Sub-quente e Mesotérmico brando.

. Para Gmelina:

TROPICAL - Quente, Sub-quente e Mesotérmico brando.

. Para M.scabrella:

TROPICAL - Sub-quente e Mesotérmico brando.

TEMPERADO (Sub-tropical) - Sub-quente e Mesotérmico brando.

C O N C L U S Õ E S

Pela análise dos dados bibliográficos coletados pode-se admitir em princípio que as três espécies aqui apresentadas possuem de fato um crescimento acelerado, o que as torna atrativas como fonte de energia. Entretanto, são necessárias pesquisas que indiquem seu comportamento em São Paulo, tanto no que diz respeito à sua adaptabilidade ecológica neste Estado, em princípio nas áreas aqui indicadas, como no tocante ao seu crescimento e produtividade nessas condições.

No que concerne ao zoneamento ecológico realizado, vemos pela Tabela 3 que a Leucaena possui uma área potencialmente apta bastante significativa (cerca de 3.700 mil ha), sendo que para Gmelina e M.scabrella as áreas são bem modestas (respectivamente 694 mil e 159 mil ha).

R E F E R Ê N C I A S B I B L I O G R Á F I C A S

BAWAGAN, P.V. and Semana, J.A., 1976. Utilization of Ipil-ipil for wood Philippines, University of the Philippines at Los Baños.

BENGE, M.D., 1976. Bayani (giant Ipil-ipil - Leucaena leucocephala). A source of fertilizer, feed and energy for the Philippines. USAID, Agriculture Development. Series Manila.

BOULET-GERCOURT, M., 1977. Monographie du Gmelina arborea. Bois et Forêts des Tropiques, (172):3-23.

BREWBAKER, J.L., 1975. Giant Ipil-ipil promising source of fertilizer, feed and energy for the Philippines. Manila, USAID. Agriculture Seminar Series.

DOUAY, J., 1956. Gmelina arborea (Roxb.) Monographie. Bois et Forêts des Tropiques (48):25-28.

HOEHNE, F.C., 1930. A bracatinga ou abaracaatinga. Secretaria da Agricultura, Indústria e Comércio do Estado de São Paulo.

IPT, Divisão de Madeiras, 1956. Madeiras Nacionais, Tabela de Resultados de Ensaios Físicos e Mecânicos. Boletim nº 31.

KALISH, J., 1979. Jari Project Unveiled Pulps & Paper International, 37-52.

NATIONAL ACADEMY OF SCIENCES, 1977. Leucaena: Promising Forage and Tree Crops for the Tropics. Washington, D.C.

_____, 1979. Tropical Legumes. Resources for the future. Washington, D.C.

PALMER, E.R. e GIBBS, J.A., 1974. Pulping Characteristcs of Gmelina arborea and Bursera simaruba from Belize. London, Tropical Products Institute.

SECRETARIA DE ECONOMIA E PLANEJAMENTO, 1978. Atlas Regional do Estado de São Paulo. Governo do Estado de São Paulo.

TOMASELLI, I., 1979. Bracatinga - Propriedades Anatômicas, Mecânicas e de Utilização Industrial. Curitiba, FUPEF.

VICTOR, M.A.M. et al, 1974. Viabilidade Cultural do Kiri (Paulownia spp) em São Paulo. São Paulo, Instituto Florestal, Boletim Técnico nº 8.

FAST GROWING TREES

RELATÓRIO SOBRE A OCORRÊNCIA NATURAL E A SITUAÇÃO DA *Acacia mangium* WILLD. NA AUSTRÁLIA

D.I. Nicholson
Departament of Forestry, Queensland
AUSTRALIA

Resumo

A área de ocorrência natural da *Acacia mangium* Willd. na Austrália extende-se irregularmente ao longo da costa leste de Queensland entre as latitudes de 11°15' S a 18° 57' S, normalmente em terras de baixa altitude. Na região entre o Rio Daintree e Ingham é que se encontram as melhores populações; as mais importantes nesta região são descritas no trabalho. A espécie aparentemente necessita altas precipitações mas não é exigente em solos ou condições ambientais seletivas.

Para atender à grande demanda de sementes algumas mudanças nos métodos de colheita foram sugeridas, visando preservar populações específicas, mas em geral acredita-se que a espécie não está sob pressão de extinção.

REPORT ON THE NATURAL OCCURRENCE AND STATUS OF *Acacia mangium* WILLD. IN AUSTRALIA

Summary

Natural occurrences of Acacia mangium Willd. in Australia extend unevenly along the east coast of Queensland from 11°15'S to about 18°57'S, usually in lowland situations. It is known best in the region between the Daintree River and Ingham; important occurrences in this region are described. The species apparently needs high rainfall but is neither soil nor habitat selective.

To meet large orders for seed some changes in collecting methods are suggested to preserve particular stands, but in general the species is not believed to be threatened.

I N T R O D U C T I O N

Considerable interest is being shown in Acacia mangium Willd. by overseas countries, particularly Sabah, and extensive areas are being successfully planted with this species (Tham 1979; National Academy of Sciences 1979). Some aspects of the natural distribution, ecology, botanical features and utilisation of the species are described by Hall et al. (1980).

Because of its potential economic importance and possible depletion through clearing of its native habitat an assessment was made of its natural occurrence and of the viability of the resource. The assessment is reported in this paper.

D I S T R I B U T I O N

Within Australia A. mangium has a discontinuous distribution along the east coast of Queensland from 11°15'S to about 18°57'S,

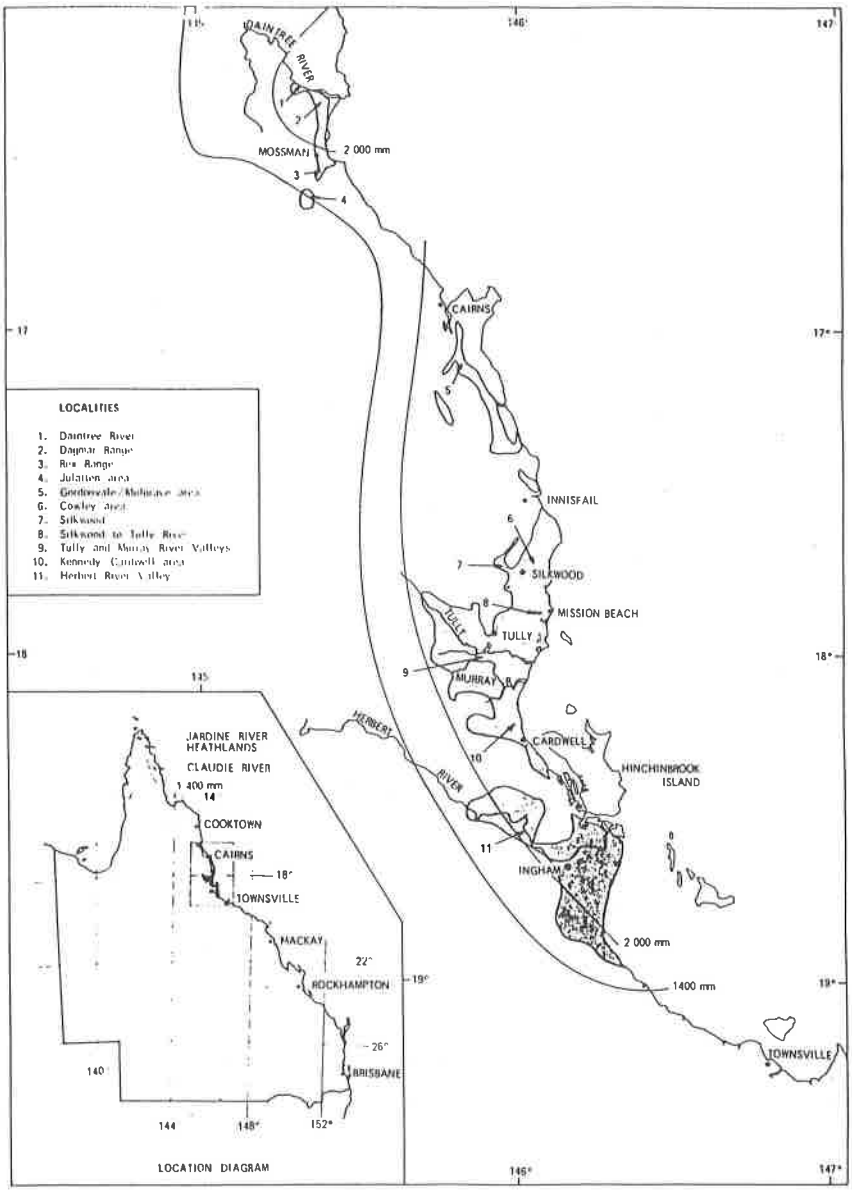


Figure 1. Distribution of *Acacia mangium* in Australia

and from sea level to 720 m altitude (Figure 1). It reportedly occurs on Hinchinbrook Island (Tracey and Webb 1978) and can probably be found on other islands in the region adjacent to the principal mainland occurrences.

In the extensive area between the Daintree River (18°35'S) and Cape York, known stands of A. mangium occur only on the Jardine River (11°15'S), at Heathlands (11°40'S), and in the Claudie River area (12°44'S). Later it is suggested that the gaps in distribution are associated with lower rainfall, but it is probable that further exploration will reveal additional occurrences. Between the Daintree River and its known southern limit the species is of fairly scattered occurrence, except for a 60 km gap between Port Douglas and Cairns. Again this is probably an effect of low rainfall.

A. mangium is typically a low elevation species with only two known areas of occurrence above 100 m. These are a small population (4 trees seen) at 720 m near Gadgarra (17°20'S), and a larger, but diffuse population at about 420 m near Julatten (16°35'S).

OCCURRENCES

A description of the more concentrated occurrences south of the Daintree River is given below. Moriarty (1979) has listed some of these occurrences and his work tends to support the view that the species is widespread in this area, if not always common.

Locality 1. Daintree River (16°16'S 145°20'E). An almost pure stand probably more than a hectare in extent with trees to 30 m high and 45 cm diameter on the banks of the Daintree River and between it and the main road (near Read Creek at about 16°16'S). Two random but typical angle counts gave basal areas of 50 and 60 sq m/ha of A. mangium and about 5 sq m of other species. The stand appears to be even aged. A smaller southern extension of this occurrence is a 7 year old (estimate by a local farmer) stand with tree diameters up to 20 cm.

Locality 2. Dagmar Range (16°18'S 145°22'E). Along the lower flanks of the Dagmar Range. A small stand of about 0.25 ha of well formed trees. This stand occupies what was an old clearing on a track.

Locality 3. Rex Range (16°30'S 145°25'E). A fairly large area of about 20 ha at the base of the Rex Range with scattered trees of A. mangium on low ridges. Most trees are less than 30 cm in diameter, and appear to be young. The rest of the stand gives the same impression. Associated species include Acacia aulacocarpa A. Cunn. ex Benth., A. crassicarpa A. Cunn. ex Benth., Eucalyptus intermedia R.T. Bak., E. tereticornis Sm., E. tessellaris F. Muell., E. pellita F. Muell., and a number of rainforest species such as Flindersia ifflaiana F. Muell., F. bourjotiana F. Muell., Canarium australianum F. Muell., Alstonia muellerana Domin.

Locality 4. Julatten area (16°35'S 145°25'E). Only scattered trees were seen extending from just north of Devil Devil Creek to Sides Creek south of Julatten, and in the Pinnacle Pocket area. This occurrence is noteworthy because of its altitude (420 m).

Locality 5. Gordonvale/Mulgrave area (about 17°10'S 145°48'E). The best stands are in the upper Mulgrave Valley (Goldsborough Road), at the base of Walsh's Pyramid, particularly on the south east side, and on the north east flanks of the Bellenden Ker Range. Contiguous with these occurrences are remnants in the lower Mulgrave and Russell Valleys, and at Pine Creek.

Locality 6. Cowley area (17°40'S 146°02'E). A fairly extensive stand in young open forest west of the Bruce Highway, and on Brown Range. Just to the east of the Bruce Highway there are some large trees standing over a grassy understorey and subject to periodic firing.

Locality 7. West of Silkwood (17°45'S 145°57'E). There are some good stands along the road to Japoonvale and north towards Mena Creek and the northern end of the Basilisk Range. These are mostly ridge occurrences in open forest or associated with disturbed rainforest.

Locality 8. Silkwood to the Tully River (17°45'S to 18°S about 146°E). This large area, which is under intensive agriculture includes foothills and riverine flats and contains some of the best occurrences of the species. Two trees along the Tully to Mission Beach road were the largest seen and measured 83 and 88 cm in diameter with very good boles. The first export of seed to Sabah was collected from a small tree growing with rainforest associates in Lacey's Creek at 17°52'S. This tree has since died.

Locality 9. Tully and Murray River Valleys (about 18°S 145°51'E). Contiguous with locality 8 but extending further west. Particularly good areas occur all along the southern flanks of the Walter Hill Range and are accessible along Jarra Creek Road. Associated species are mostly eucalypts, chiefly E. tereticornis, E. intermedia and E. tessellaris. A. aulacocarpa is also a major element in this area. Further south in this locality the species is more typically riverine, largely as a result of clearing for agriculture, but there are more swampy areas in which A. mangium occurs with sclerophyll elements such as Melaleuca cajaputi Powell and E. pellita.

Locality 10. Kennedy/Cardwell area (about 18°15'S 145°57'E) and extending west to the Cardwell Range. Here A. mangium mostly grows on stream banks which are often wide enough to allow good stands to develop. In these situations, it is generally associated with rainforest species such as Flindersia brayleyana F. Muell. and Cardwellia sublimis F. Muell. Much of this area is included in the Queensland Forestry Department's pine planting programme. Some trees of A. mangium are being felled as a consequence, but a large proportion of the A. mangium occurrence will be kept owing to the policy of retaining streamside vegetation. Some of the more dissected and rocky areas are also being excluded from the plantation scheme and these carry good stands of A. mangium. Associated species in these areas are E. tereticornis, E. tessellaris, E. intermedia, and some rainforest species such as E. bourjotiana, and Deplanchea tetraphylla (R. Br.) F. Muell.

Locality 11. The Herbert River Valley (about 18°30'S to 18°57'S 145°51'E to 146°17'E). From locality 10 there is a narrow strip between the coastal range and the mangroves where A. mangium is mostly confined to creeks in open forest. In the Ingham, Abergowrie area this broadens out into a very extensive occurrence that has been severely reduced through clearing for agriculture. No good stands were seen and it is thought that limiting rainfall may explain its absence or only sporadic occurrence along creeks in much of this otherwise suitable area.

ECOLOGY

Rainfall

All the known occurrences are east of the 1400 mm isohyet and most are east of the 2000 mm isohyet. Only occurrences at the Jardine River, Heathlands, Claudie River, the Julatten area and the southern extremity of the Herbert River Valley (Crystal Creek) apparently receive less than 2000 mm. There may be local rainfall variations in these areas, such that the occurrences of A. mangium receive more than rainfall maps indicate, or alternatively the species may be confined to streamside situations where rainfall would not be so critical. That the species does favour high rainfall is evident from the major concentration in the Mission Beach/ Tully area. It is a possible explanation for the gaps in distribution between Cairns and Port Douglas and in much of the area north of the Daintree River.

Soils

A. mangium occurs on most soils except those derived from basic igneous parent material. The one exception to this seems to be the upper Mulgrave River occurrence on basalt but the soil here is probably influenced by the granite massif just above it. Very good stands develop on both metamorphic and granitic lower slopes, and also on the coastal plain which is mostly quarternary alluvium. A number of boundaries between basic and other rock types were seen which demonstrated a preference for the non-basic rocks. These are usually poor in nutrients which suggests the species is tolerant in this regard.

Habitat

The species occurs in areas just behind the mangrove zone, in seasonal swamp, along streams, on well drained flats, on low ridges and on mountain foothills. It is evidently tolerant of widely different conditions. The foothill occurrence is often conspicuous as a narrow pale green (or yellowish, when in flower) zone extending to about 50 m altitude. It does not occur in mature rainforest but is often found on its margins. Distribution is often linked with distrubance as shown by its common occurrence along tracks and roadsides.

It appears to have little resistance to fire, though some young trees were seen with epicormic shoots on the smaller branches, following fires. Large trees in areas prone to fire usually have defective butts. However, periodic fires, as a broadscale type of disturbance, are necessary on some areas to destroy a rainforest understorey and allow A. mangium to regenerate. Good examples of such a seral stand occur on Jarra Creek Road in locality 9.

PHENOLOGY

South of the Daintree River most trees were in flower in mid-April 1980. Even the higher altitude occurrences were in flower at this time but there were indications that their peak flowering is about two to three weeks later. Mature seed can usually be collected in the period October to December. Little is known of the phenology of the more northern occurrences. A flowering collection was made in July on the Claudie River (12°44'S). Other collections both here and on the Jardine River (11°15'S) had mature fruit in October which is as expected. It could be that these northern areas need a shorter period for fruit development. Stands in south west Papua New Guinea were in flower in early May 1980 (Tham, personal communication) which perhaps indicates that the flowering specimen from the Claudie River may have been atypical.

CONSERVATION STATUS AND SEED SUPPLIES

Despite considerable land clearing where A. mangium occurs, it is not believed to be in any danger of becoming a rare species. However, to ensure seed supplies from particular areas some changes in seed collection methods are necessary. The larger collections of seed have been made after felling the source trees. An effort was made to collect only from trees of good form so it was necessary to have either sophisticated seed collecting gear and experienced men or to fell the trees; the latter course of action has been followed up to the present time.

There is still considerable scope for collecting seed from open grown low crowned trees without elaborate equipment. In general, selection for form and growth in natural stands is usually ineffective because of over-riding environmental effects and the relatively low selection intensity that is practicable. It is suggested, in the case of A. mangium, that only mild selection against obviously malformed trees be made, to ensure that a very broad base of genotypes is included in any particular seed collection. Provenance or source trials can be conducted to identify the superior seed sources. This implies, of course, that the source trees will remain to allow future collections to be made. Felling should thus be avoided.

Though this policy will allow seed to be collected easily from many open grown trees, it will still be necessary to collect from tall trees in some areas. Tree climbing and lopping of branches is the only alternative to felling if bulk collections at reasonable cost are to be made in these stands. Shooting and "rope sawing" are other alternatives suitable for smaller collections.

A C K N O W L E D G E M E N T S

Mr V. Moriarty is thanked for useful discussions on this species, as is Dr D.G. Nikles for valuable comment, especially on the selection of seed trees in wild stands.

R E F E R E N C E S

Hall, N., Turnbull, J.W., Doran, J.C., and Martensz, P. (1980): 'Acacia mangium' Willd. Aust. Acacia Series Leaflet No. 9. Division of Forest Research, CSIRO: Canberra.

National Academy of Sciences, (1979): 'Tropical Legumes: Resources for the Future'. (National Academy of Sciences: Washington, D.C.). 331 pp.

Moriarty, V.K. (1979): Localities for Acacia mangium from seed reconnaissance trip Daintree to Cardwell 21-10-79 to 26-10-79. Unpublished report prepared for Division of Forest Research, CSIRO: Canberra. 3 pp.

Tham C.K. (1979): Trials of Acacia mangium Willd. as a plantation species in Sabah. Forest Genetic Resources Information No. 9. For. Occ. Paper 1979/1 : 32-35. (FAO: Rome).

Tracey, J.G. and Webb, L.J. (1978): Vegetation of Hinchinbrook Island. Qld. Naturalist 22(1-4): 31-37.

FAST GROWING TREES

O PROGRESSO NA SELEÇÃO E MELHORAMENTO DE ÁRVORES INDÍGENAS COMESTÍVEIS PARA A PRODUÇÃO DE ALIMENTO E UTILIZAÇÃO EM AGRO–SILVICULTURA NAS ZONAS FLORESTAIS DA NIGERIA

J.C. Okafor
F.D.I.B. - Forestry Commission, Enugu
NIGERIA

Resumo

Na Nigéria as árvores e arbustos tropicais são utilizados para usos múltiplos, tais como: fontes de alimento, alimentação animal, produtos florestais tais como madeira para combustível, fibras, gomas, tintas, drogas, e como restauradores da fertilidade do solo. Estas plantas ocorrem naturalmente nas florestas tropicais úmidas. Com a crescente taxa de devastação florestal, atingindo um índice de 26.000 hectares por ano, a continuidade da existência dessas plantas, está seriamente ameaçada. Conseqüentemente, há uma grande necessidade de se conservar e aumentar sua utilização. As etapas atingidas nas 4 fases dos estudos atualmente conduzidos na Nigéria, na seleção e melhoramento das árvores comestíveis do país são discutidas:

(1) sua distribuição e papel no sistema de fazenda tradicional.
(2) delimitação de variedades.
(3) Técnicas de propagação.

PROGRESS IN THE SELECTION AND IMPROVEMENT OF INDIGENOUS EDIBLE TREES FOR FOOD PRODUCTION AND AGROFORESTRY IN THE NIGERIAN FOREST ZONES

Summary

In Nigeria, tropical trees and shrubs serve multiple uses as sources of food, animal feed, forest products such as timber, firewood, chewing sticks, fibre, gum, dyes, drugs and as soil fertility restorers. These plants occur naturally in the rainforest. With the increasing rate of deforestation amounting to about 26,000 hectares a year, the continued existence of these plants is seriously threatened. Consequently, there is a great need to conserve and enhance their utilization. The achievements so far made in four phases of study currently undertaken in Nigeria, in the selection and improvement of the country's edible trees are discussed. These studies encompass (1) their distribution and roles in traditional farming system, (2) delimitation of varieties, (3) Propagation techniques, and (4) determination of nutritional values. The paper also reviews the potentials of indigenous edible trees in the agroforestry system of land-use.

I n t r o d u c t i o n

The popularity of exotic fruit trees and vegetables has more or less relegated indigenous shrubs and trees to a status of utter neglect in their research, development and utilization. Hitherto, no consistent effort has been devoted to the study, enumeration and categorization of these plants in relation to the extent of domestication and place in the traditional farming system of Nigeria.

It is wellknown that many of the indigenous shrubs and trees serve multiple uses as sources of food, animal feed, forest products such as firewood, chewing sticks, gums and dyes. Sometimes they yield cash returns to the farmer and may be of some socio-economic importance in addition to contributing effectively to the maintenance of soil fertility (Anakwenze & Ettah 1974; Getahun 1974; Jong et al, 1973; Okafor & Okolo 1974; Okafor 1975b, 1978, Okigbo 1975; Roche 1975a).

Survival of these plants in the wild and the existence of variability among them is seriously threatened by large-scale forest clearing which in Nigeria amounts to 26,000 ha/year (Ola-Adams, 1977). On a worldwide basis, a conservative estimate by Steinlin (1979) puts the rate of dimunition of tropical forest cover at a minimum of 12-15 million hectares a year. There is therefore urgent need for both national and international effort to conserve and further improve these plants before they become extinct.

This paper outlines some of the activities involved and the achievements so far made in the improvement of edible trees and shrubs. It also highlights their current uses and potentials in agroforestry in Nigeria.

STUDIES UNDERTAKEN AND THE ACHIEVEMENTS OBTAINED SO FAR

A brief historical account of the indigenous fruit tree project, which was initiated 11 years ago in parts of the then East Central (now Anambra) State of Nigeria has been given by Okafor (1978).

A number of studies, undertaken since the project began, have yielded results, relevant to the knowledge, selection, improvement and utilization of edible trees and shrubs (see Okafor 1978, 1980a).

Distribution and roles in traditional farming system

The edible woody plants are distributed in the forest, compound farms (close to the homestead) and outlying farms (located at varying distances from the homestead). Major categories of trees and shrubs encountered may be designated as wild, semi-wild or protected and cultivated. The wild plants which are harvested from the forest include Chrysophyllum albidum, Canarium schweinfurthii, Afzelia africana, Dialium guineense, Pentaclethra macr ophylla, Myrianthus arboreus and Vitex doniana. These wild plants are also distributed in the outlying farms where they have initially been protected during bush clearing associated with farming. The semi-wild or protected plants are found in compound farms or relatively nearby outlying farms or fields; they include Afzelia bella var. bella, Irvingia gabonensis, Treculia africana, Elaeis guineensis, Chrysophyllum albidum, Spondias mombin. The cultivated plants are abundant in the compound or home gardens. Examples of these include Dacryodes edulis, Cola acuminata, Elaeis guineensis, Pterocarpus spp. The extent of domestication or status of cultivation, and distribution of the various

species in the forest or traditional farming system are related to their various uses and roles in providing food and other useful products. For instance, important fruit and vegetable trees are often located near homesteads, in compound farms, for easy reach and regular daily harvest of food items.

One hundred and fifty edible woody plants of which 109 are trees have been identified within the Nigerian forest zone, including the derived savanna zone (Okafor, 1980a). Of these, the most important sources of food selected for more detailed study and improvement include Irvingia gabonensis, Treculia africana, Dacryodes edulis, Pentaclethra macrophylla, Chrysophyllum albidum, Dialium guineense, Garcinia kola, Elaeis guineensis, Spondias mombin, Canarium schweinfurthii, Pterocarpus spp., Myrianthus arboreus, Vitex doniana and Ceiba pentandra.

Delimitation of varieties

Within some principal species, varieties have been delimited: For I. gabonensis, two varieties namely var. gabonensis (with sweet edible fruit pulp) and var. excelsa (with bitter inedible pulp); T. africana - three varieties namely var. africana (with large fruit head and glabrous leaves and branchlets), var. mollis (with small fruit head and hairy leaves and branchlets) and var. inversa with small fruit head and glabrous leaves and branchlets); D. edulis - two varieties namely var. edulis (with large cylindrical or ellipsoid fruits) var. purvicarpa with small, conical or more or less spherical fruits); (Okafor 1975a; 1980b, in press; 1980c, in press).

Propagation

Suitable techniques eg. budding, stem cuttings and by seeds have been developed resulting in early fruiting (between 2-4 years) and 'dwarfing' of species, such as I. gabonensis, T. africana, D. edulis, D. guineense, P. macrophylla and Pterocarpus spp. (Okafor 1975b, 1978, 1980a). With budding and stem cuttings mature budwood is used. For propagation by selected seeds adopted in D. edulis, height is controlled by pruning of apical bud, at about 2 m above ground.

Nutritional values

Fruits of T. africana and P. macrophylla are rich in protein (with 17.23% and 28.40%, respectively) while fruits of D. edulis and kernels of I. gabonensis are rich in fats (43.99% and 71.97%, respectively). Fruit pulp of D. guineense is very rich in ascorbic acid. Leaves of Pterocarpus spp., V. doniana, and M. arboreus which are used as vegetables, are also rich in protein (with 30.73%, 22.07% and 20.01%, respectively) (Okafor & Okolo, 1974; Okigbo 1975; Okolo, 1979).

Other uses

Other uses such as fuelwood, timber, tools, utensils, chewing sticks, fibres, dyes, gums, drugs, socio-cultural roles and religious worship have been associated with edible trees. (Okigbo 1975; Okafor 1978, 1980a). Suitability for paper pulp has also been indicated for T. africana.

The above results have indicated potentials in horticulture and agroforestry.

TREES FOR AGROFORESTRY

Agroforestry has been defined "as a sustainable management system for land that increases overall production, combines agricultural crops, tree crops, and forest plants and/or animals simultaneously or sequentially, and applies management practices that are compatible with cultural patterns of the local population (Bene et al 1977; King and Chandler, 1978). Grainger (1980) has stated that "agroforestry systems producing food and fodder as well as wood are becoming the concern of both farmers and foresters and this has created an opportunity for the increasing cultivation of previously un - or under-utilized tree crops capable of yielding a variety of products". The National Academy of Sciences (1975, 1979) in the U.S.A. has focused attention to the great potential of neglected tree crops.

Trees play important roles in the traditional farming system of the humid tropics of Africa (King 1968; Okigbo 1975, 1976; Okafor 1975c). The most important species are legumes which enrich the soil with nitrogen through biological fixation. In addition to their role in restoration of soil fertility, trees serve other purposes such as provision of shade in pastureland, stakes for supporting climbing crops such as yams, cowpeas and conophor, mulch, fodder, and several miscellaneous products.

The main objective of agroforestry is the production of both wood and food, with a balanced emphasis, without soil deterioration. This objective is easily satisfied by the use of multipurpose tree species, which yield good quality timber as well as food. In Nigeria, the concept of agroforestry is not in fact new. All through the years, farmers have always retained economic trees such as food trees during forest and bush clearing, for provision of various useful products. In many cases only tops of small trees are lopped and the stems serve as stakes for climbing agricultural crops. What is therefore required is to systematize and intensify this production system. Thus, edible trees can be planted at a close espacement (2-3 m), for short rotations, as a productive fallow, to replace the non-productive traditional bush fallow. Pulpwood and fuelwood are possible products, in addition to the benefit of soil fertility restoration. Incidental yield of fruits is regarded as by-product. Examples of suitable species are Treculia africana subsp. africana var. inversa (with small fruit head), Pentaclethra macrophylla, and Dialium guineense. Food trees of wood value can also be planted as farm trees, at wide espacement (6-10 m and over) to allow interplanting of arable crops. Similarly, farm trees of budded food trees can also be established at wide espacement of 10 m and over. In each case, species used should not cast heavy shade, and should be amenable to pruning or have the characteristic of natural pruning. Pruned branches could be useful, as structural material, stakes, mulch, browse or firewood. Suitable farm tree species include Elaeis guineensis (oil palm), Irvingia gabonensis (African mango), Pentaclethra macrophylla (oil bean), Dacryodes edulis (Native pear), Chrysophyllum albidum (local star-apple), Garcinia kola (bitter kola), Canarium schweinfurthii, and Spondias mombin (Native hog plum). The variety with large fruit head of Treculia africana (var. africana) can be planted as farm trees, using only adult budded seedlings, to ensure reduced bole length and low fruiting height. The reduction in fruiting height eliminate the serious danger of large fruit heads (which weigh up to 27 kg) from knocking down passersby as is the case when they fall from tall trees (Okafor, 1976a, 1978). The yield of fruits from these farm trees contributes to the available food supply of the traditional farmer and in some cases fetches cash revenue to finance subsequent farming activities.

CONCLUSION

With the ever increasing population pressure, in the humid tropics, coupled with the corresponding scarcity of arable land and the rather unsuccessful efforts in the transfer of the land-use techniques developed in Europe and North America (Steinlin 1979; King and Chandler 1978; King 1979) it is imperative not only to modernize the prevailing, land devastating shifting cultivation, but also to strike a balance between food and wood production, even on the same piece of land, while maintaining soil fertility.

The use of edible tree species offers a vast scope in the combined food and wood production, as they supply direct dietary benefits and/or wood products. By intercroning (mixed cropping) with suitable arable food crops, the trees also give intermittent yield of fruits and wood. If tapped, they therefore hold good promise to ameliorate the food problem in the tropics.

In order to enhance the realization of the contributions of edible trees in the multipurpose land-use production system, advocated in this paper, there are further research needs for in-depth studies of their silvicultural requirements, planting espacements, growth characteristics and species mixtures of various arable crops and trees.

REFERENCES

Anakwenze, F. N. and Ettah, A. E. 1974. The role of forestry in food production in Nigeria. Proc. 5th Annual Conf. Forestry Assoc. Nigeria Jos, 1-6 Dec.

Bene, J. G., Beall, H. W. and Cote, A., 1977. Trees, Food and People IDRC. Ottawa, Ont., 52 pp.

Getahun, A., 1974. The role of wild plants in the native diet in Ethiopia. Agro-Ecosystems, I: 45-56.

Grainger, A., 1980. The development of tree crops and agroforestry systems. Int. Tree Crops Journ I (in press).

Jong, K., Stone, B. C. and Soepadmo, E., 1973. Malasian tropical forest: an underexploited genetic reservoir of edible-fruit tree species. Proc. Symp. Biol. Res. Nat. Dev., Forestry Aspects, pp. 113-121. Malayan Natural History Society.

King, K. F. S., 1968. Agri-Silviculture (The Taungya System). Bull. No. I Dept. For., University of Ibadan, 109 pp.

King, K. F. S. and Chandler, M. T., 1978. The Wasted Lands. ICRAF, Nairobi, 36 pp.

National Academy of Sciences U.S.A., 1975. Under-exploited Tropical Plants with Promising Economic Value (Washington D.C.)

National Academy of Sciences, 1979. Tropical Legumes: Resources for the Future (Washington D.C.).

Okafor, J. C., 1975a. Varietal delimitation in Irvingia gabonensis (Irvingiaceae) Bull. Jard. Bot. Nat. Belg; Bull. Nat. Plantentuin Belg., 45:211-221.

Okafor, J. C., 1975b. The place of wild (uncultivated fruits and vegetables in the Nigerian diet. Proc. Nat. Seminar on Fruits and Vegetables, Ibadan, 13-17 Oct., pp. 153-171.

Okafor, J. C., 1975c. The role of tree crops in traditional farming systems of Eastern Nigeria. Proc. 6th Annual Conf. Forestry Assoc. Nigeria, Calabar, 1-6 Dec.

Okafor, J. C., 1976a. Prospects for large-scale production of Treculia africana (Moraceae). Extension Newsletter, Min. Agric. Nat. Res., Enugu, 2(1), Jan.-Mar.

Okafor, J. C., 1978. Development of forest tree crops for food supplies in Nigeria. Forest Ecol. Manage., 1:235-247

Okafor, J. C., 1980a. Edible indigenous woody plants in the rural economy of the Nigerian forest zone. Forest Ecol. Manage. (in press).

Okafor, J. C., 1980b. Delimitation of a new variety of Treculia africana subsp. africana (Moraceae). Bull Jard. Bot. Nat. Belg., Bull. Nat. Plantentuin Belg., (in press).

Okafor, J. C. 1980c. Varietal delimitation in Dacryodes edulis (Burseraceae). Bull. Jard. Bot. Nat. Belg., Bull. Nat. Plantentuin Belg., (in press).

Okafor, J. C. and Okolo, H. C. 1974. Potentialities of some indigenous fruit trees of Nigeria. Proc. 5th Annual Conf., Forestry Assoc. Nigeria, Jos, 1-6 Dec.

Okigbo, B. N., 1975. Neglected plants of horticultural and nutritional importance in traditional farming systems of Tropical Africa. 4th Int. Symp. Hort. Soc., Kumasi, Ghana, 12-17 Aug. Acta Horticulturae 53, April 1977 p. 131.

Okigbo, B. N., 1976. Role of legumes in small holdings of the humid tropics of Africa. Proc. Symp. Exploiting the Legume - Rhizobium Symbiosis in Trop. Agric. NIFTAL, Univ. Hawaii, Aug. pp. 97-117.

Okolo, H. C. 1979. Chemical analysis of some neglected indigenous woody plants of nutritional importance in the humid tropics of Nigeria. Seminar paper (unpublished). Project Dev. Inst. Enugu Aug.

Ola-Adams, B. A. and Iyamabo, D. E. 1977. Conservation of Natural Vegetation in Nigeria. Environmental Conservation 4(3): 217-226. Autumn.

Roche, L., 1975a. Major trends and issues in forestry education in Africa: a view from Ibadan. Common W. For. Rev., 54:166-175.

Steinlin, H. 1979. Development of new agroforestry land-use systems in the humid tropics. Plant Research and Development 10: 7-17.

FAST GROWING TREES

Jacaranda copaia — UMA ESPÉCIE NEO-TROPICAL DE RÁPIDO CRESCIMENTO E COPA ESTREITA PARA PLANTAÇÕES PARA POLPA EM TERRAS DE BAIXA ALTITUDE

J.R.Palmer
Centro Agronomico Tropical de Investigacion y Enseñanza, Turrialba
COSTA RICA

Resumo

1. As características ecológicas e silviculturais principais do *Jacaranda copaia* (Aublet) D. Don são apresentadas neste trabalho. Dados, (a maioria já publicados), são apresentados em relação à ocorrência na floresta tropical úmida e regeneração natural em áreas após exploração. Um anexo, em formato específico, fornece dados relativos a 31 parcelas experimentais monoespecíficas no Brasil, Colombia, Costa Rica e Peru.

2. *J. copaia* é uma espécie pioneira, dispersa pelo vento, e com capacidade de vegetar em solo mineral pobre e exposto. O crescimento rápido em altura é monopodial, pelo menos nos estágios iniciais de crescimento. A capacidade de vegetar entre emaranhados de cipós e resíduos de exploração é complementada pela excelente desrama natural. A menos que, ou até que, a copa se quebre, o caule permanece efetivamente sem ramos. A copa cônica jovem é formada por folhas opostas, que deixam na região de inserção marca pronunciada na casca quando caeam.

As árvores não atingem grande porte. É uma das espécies arbóreas Amazônicas com mais rápido crescimento em altura e diâmetro. Ela rebrota bem.

Jacaranda copaia — A FAST-GROWING NARROW-CROWNED NEOTROPICAL SPECIES FOR LOWLAND PULWOOD PLANTATIONS

Summary

1. The principal ecological and silvicultural characteristics of Jacaranda copaia (Aublet) D.Don are present. Data (mainly from published literature) are given on occurrence in natural tropical rain forest and in post-logging natural regeneration. An annex provides, in a consistent format, growth data from about 31 monospecific trial plots in Brazil, Colombia, Costa Rica and Peru.

2. J. copaia' is a wind-dispersed pioneer species capable of growing in poor exposed mineral soil. The rapid height growth is monopodial at least in the early stages. The capacity to grow through post-felling climber tangles and logging slash is aided by excellent self-pruning. Unless or until the crown breaks the stem is effectively unbranched. The conical young crown is formed by the 1-2m long bipinnate leaves, which leave a distinctive abscission scar in the bark when they are shed. Although the tree does not usually grow to a large size it is one of the fastest growing of Amazonian tree species in height and diameter. It coppices well.

INTRODUCTION

Jacaranda Juss. is a neotropical genus with about eighty species. The natural range extends from the northern islands of the Caribbean to Argentina. Several species are now widespread as ornamentals in the tropics and subtropics; the large bipinnate leaves have an attractive feathery appearance while the brillant blue-purple-violet flowers are in most species held in erect panicles above the leaves, so that the whole crown appears to

be a mass of flowers. The timber is usually pale coloured, light weight and non-durable under exposed conditions. The trees do not usually grow to a large size. Traditional tropical forest industries have tended to ignore the genus except as a second choice for light boxes and match manufacture. However some of the species have characteristics which make them suitable for pulpwood plantations.

This paper presents information on silviculture and growth of the best known species, J. copaia (Aublet) D.Don. The growth data are regrettably incomplete. Several institutions which have initiated studies on J. copaia over the years have suffered more than usually from inadequate direction, staff and funds. Consequently trial plots have been poorly maintained and/or unmeasured, previously collected data cannot now be located, and there is frequently no system for summarising, abstracting and exchanging data among fellow workers. A monographic treatment of J. copaia is being held back pending more satisfactory data. It is hoped that the presentation of this paper will help to stimulate the exchange of information among those organisations who hold unreleased data.

Record & Hess (1943) give 89 vernacular names for the timber species of Jacaranda. Confusion may arise between the botanical name of this genus in the family Bignoniaceae and the vernacular name jacarandá, applied in Brazil to species of the genera Dalbergia and Machaerium (Leguminosae, Fabaceae).

GEOGRAPHICAL DISTRIBUTION

J. copaia is found from Belize and Guatemala south to Mato Grosso (Río Paca-Nova) in central Brazil. Further south it is replaced particularly by J. ovalifolia R.Br. (better known as J. mimosaefolia D.Don.). J. copaia is a species of gaps and margins of primary lowland tropical rain forest, and of disturbed forests. It is apparently not found above 1000 m altitude in the centre of its range. It is an early arrival on exposed mineral soil and is able to tolerate low levels of nutrients and soil organic matter (Venegas, 1978). However its roots cannot penetrate hard pans and it does not seem to do well in rocky soils. It is sporadically common along roadsides and railways, and in gallery forest beside water courses in savanna areas. In northern South America J. copaia is a conspicuous component of riparian vegetation, especially in the lower reaches of rivers but above saline influence. Detailed distribution of the species has been mapped by Venegas (1978) for Colombia, and similar information should be available from Projeto Flora Amazônica in Brazil.

TREES IN RAIN FOREST

Trees of J. copaia in natural tropical rain forest tend to be taller and more slender than those in secondary vegetation. The tree may fork low down but the individual stems tend to be strongly erect and effectively separate trees. Growth is monopodial; until the crown breaks the self-pruning 1-2m long leaves are the 'branches'. Crown diameter is thus limited by leaf length until the stem begins to branch. In small natural gaps, and at close spacing in plantations, the stem may remain branchless to a height of 15m or more. Total heights of over 25m and diameters to 75cm have been reported. However the tallest trees rarely have large diameters (Record & Hess, 1943).

Summarising a series of reconnaissance forest inventories south of the Rio Amazonas in Brazil, Heinsdijk & Miranda Bastos (1963) reported mean estimated commercial heights of 15.2-18.6m for trees 25- <35cm dbh and 16.3-20.2m for trees 45- <55 cm dbh. Mean stems per hectare ranged from 0.1-1.1 and <0.1-0.4 for the same two diameter classes. Stem frequencies were higher in the more interrupted stretches of forest south and south east of Belém.

Huber (1910) classified J. copaia as a species of the canopy, at heights of 20-30m. Heinsdijk (1957) counted trees >25cm dbh with crowns completely emergent above the general level of the canopy. In the inventory between the Rios Tapajós and Xingú 50.2 per cent of the J. copaia trees were emergent.

The conspicuous erect inflorescences standing proud of the canopy are adapted to bird or insect pollination. Casual observation suggests that peduncles elongate slightly during fruit maturation, enhancing the range of the wind-dispersed seeds from the flag-like capsules.

PHENOLOGY, SEEDS AND NURSERY PRACTICE

Although Vattimo (1977, 1978) has separated J. paraensis (Huber) Vattimo and J. amazonensis Vattimo from J. copaia partly on fruit characters, they are here taken together. In general, flowering is in the dry season and fruiting follows about three months later. For much of Amazônia this means flowering in August-November and fruiting in December-March. Flowering is not closely synchronised in any one area. Some trees are apparently annual in flowering and fruiting while others in the same area are apparently biennial. A more intensive analysis of the phenological data summarised by Alencar et al. (1979) from Reserva Ducke, Manaus, shows that, in four two-year periods:

all five regularly observed trees fruited in 1969/70 and 1973/74;
four of the trees fruited in 1971/72.
three produced only small quantities of fruit in 1976 and two gave none;
none of the five trees fruited in 1975;
one tree halved its period to fruit in 1972/73 and 1973/74.

Dubois (1971), referring to Curuá-Una in east central Amazonia, noted good annual seed production which could be collected in March. The capsules dry and dehisce on the tree and the very light winged seeds are widely dispersed. Seeds must be collected by climbing the tree and clipping off the fruits. This is a disadvantage for large scale use.

Stands of J. copaia are being conserved as seed sources in Colombia (Dijk et al., 1978); 12 trees on private lands in the north of Santander and 25 trees on private and government land at Gaviotas in Vichada.

SUDAM (1979) reported nursery work at Curuá-Una. There are 190-200,000 per kilo, with 70 per cent good seed and 80 per cent germination in 10-35 days. No pretreatment is necessary. Albrechtsen (1976) in a PRODEPEF nursery at Belém obtained 60-70 per cent germination, the first in 18 days, and seedling heights of 20-30 cm in 100-120 days. At Manaus only 12 per cent germination occurred from 2000 seeds (Loureiro, Silva & Alencar, 1979).

The seedlings are taprooted but robust. Wildings can be collected from the forest and grown on in the nursery without difficulty (Pitt, 1961). J. copaia can be planted as potted stock, as stumps (Dubois (1971) left 20+cm of shoot attached) or as striplings, but the last take only 'fairly well' (Pitt, 1961). Bare root stock was tried by Pitt (1961) in sandy savanna at Porto Platón, Amapá, and in sandy flanco soils at Curuá-Una but best survival was only 52 per cent at 2.7 years old.

SILVICULTURE - NATURAL REGENERATION

Information seems to be available only from Curuá-Una, Brazil. Pre-felling inventories showed very few mature trees in virgin forest in compartment 5 (as expected). At 15 months after selective felling and logging and with no silvicultural treatment, a survey for saplings (<3m tall) using $4m^2$ quadrats showed the following (Pitt, 1961):

	closed canopy	25% light	50% light	75% light	full light
Percentage area per ha with each class of illumination	49.2	3.8	14.1	14.4	18.4
Stocked quadrats per ha	32	0	44	44	145
Mean height, m	0.25	-	7	1.15	1.20

Average annual height increments suggested by Pitt (1961) for the same intensities of illumination were:

height increment, m	0.13	0.3	0.3	0.7	1.0

Dubois (1971) suggested considerably faster rates for tended regeneration: $pmai_h$ 2.5-3.0m and $pmai_d$ 2-3cm, as in plantations. Dubois also reported regeneration stocking at 7 years after felling. He counted trees >4m tall:

height class	4.5m	7.5m	8.5m	11.5m	12.5m	Total
stems/ha	3.1	6.3	3.1	3.1	12.5	28.1

The tallest J. copaia, apparently not within the quadrats, was 22m. The capacity of the species to grow through climber tangles and scrub was emphasised by Dubois. The self-pruning habit helps to prevent climbers from dominating the crown.

Pedroso (1973/74) reported results from strip felling experiments in 1960. 4 out of 10 $300m^2$ quadrats contained J. copaia; one tree was the largest among all the species in the natural regeneration in 1970-72:

	stems / ha		mean heights, m			mean diameters, cm		
Quadrat	all spp.	J. copaia	1970	1971	1972	1970	1971	1972
6	400	33	22.5	23.0	23.8	29.0	30.1	31.3
8	333	33	6.1	6.8	7.8	4.7	5.5	6.7
9	633	100	15.4	16.5	17.5	15.6	17.5	18.5
10	800	67	11.6	12.8	17.6	11.2	14.3	16.3

Pitt (1961) recommended the following procedure to secure establishment of the abundant natural regeneration of this species: open the canopy heavily after logging, clean the regeneration after 1-2 years, and favour J. copaia in subsequent 'thinnings'.

SILVICULTURE - ENRICHMENT PLANTING, NURSE TREES & AGROFORESTRY

Pitt (1961) recommended widely spaced (4-5m) group enrichment planting in unstocked areas resulting from intense fires when crown debris is burned after felling and logging. Data from trials at Curuá-Una are not available. In general a relatively low-value timber such as J. copaia cannot be used economically in enrichment schemes unless the matrix into which it is planted can be harvested at the same time as the planted stock.

Pitt (1961) also recommended the light-crowned J. copaia as a potential nurse species for more valuable slower-growing timber crops.

The International Council for Research in Agroforestry (ICRAF, 1980) has prepared a proposal with the Programa Nacional de Pesquisa Florestal (PNPF) and the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) for agroforestry projects in Brazilian Amazônica. The proposal includes the planting of J. copaia (and other timber trees) with perennial and annual agricultural crops.

SILVICULTURE - MONOSPECIFIC PLANTATIONS

Most of the data on J. copaia come from monospecific plots in plantations trials. Results of several of these trials have been reported only once, and comparisons between all the trials are difficult because site indices (or IUFRO dominant heights) have not been given. Further, because of re-numbering of experiments and plots, or through failure to refer to earlier publications, it is seldom clear whether subsequent reports from the same station refer to the same or to different experiments. Tabular summaries, annexed, present mainly published data in a consistent format. Site conditions are generally not included (because of limitations on space in a symposium paper) but may be obtained from the literature or from this author.

Other trials are known to have been established in Brazilian Amazonia, Colombia and Peru but data are not yet available. The plots on clayey soils at Jari Florestal e Agropecuária Ltda. in Pará, Brazil, were established in 1978 and were looking very promising in late 1979.

Loureiro, Silva & Alencar (1979) recommended 4x4m spacing in full light, spot-cleaning round each plant for the first two years, and annual cleaning along the planting lines. However since trees at Curuá-Una took two years to close canopy from an initial spacing of 2.5m, a spacing of 4m will involve considerable under-use of growing space and large weeding costs.

Ledoux (1969) emphasised the importance of good coppicing power in short-rotation pulpwood plantations. This power is well shown by roadside J. copaia which is slashed back and repeatedly regrows. It is resistant to hormonal arboricides applied in a frill girdle (Dubois, 1971).

PESTS AND PATHOGENS

Dubois (1971) views the species with some disfavour because it is liable to an unnamed shootborer at Curuá-Una in Brazil. Correa (1931) noted that a cerambycid bores J. mimosaefolia. The borer of J. copaia does not appear to be widespread. Dubois (1976) reported foliage loss to a herbivorous insect, also unnamed, probably a beetle, in the trials at Trinidade (annex, station 4). Ledoux (1964) found unidentified chalcids in young inflorescences at Mazagão in Amapá, Brazil. No pathological problems have been reported.

ANNEX - GROWTH DATA ON JACARANDA COPAIA & J. PARAENSIS

Data are presented in a constant format of 11 items, supplemented by notes. The sequence of items is:

Station:	location of the plantation or trial plot
p. year:	year of planting
age:	age in years at the time of assessment, to the nearest 0.1 year if known
shade:	approximate percentage of overhead shade at the time of planting
plot size:	number of trees planted (and replanted, if known)
reps:	number of replicates of the plot
spac:	initial spacing of the trees, in metres
height:	mean total height of all surviving trees (unless otherwise qualified), in metres
dbh:	mean over-bark diameter at breast height of all surviving trees (unless otherwise qualified), in cm
surv:	percentage survival from the total of trees planted and replanted
ref:	reference to the source in the literature.

The data are presented in alphabetic order of country. Within Brazil, data are in approximate order of location from east to west, and of date of establishment of the plots within location.

1. Station: Instituto Agronômico do Norte (IAN, now EMBRAPA), Belém, Pará, Brazil.

p. year:	? 1951
age:	8
shade:	0
plot size:	?
reps:	?
spac:	1 x 3m, to allow inter-row mowing
height:	15m
dbh:	19cm
surv:	?
ref:	Lamb, Briscoe & Englerth (1960)
note:	excellent bole form

2. Station: Igarapé-Acú (PRODEPEF), Bragança region east of Belém, Pará, Brazil

p. year:	March 1975	March 1975
age:	1.1	1.1
shade:	0	40-60% in thinned scrub 6m tall
plot size:	36	Anderson group of 13 trees
reps:	5	5
spac:	1.5 x 1.5m	1 x 1m within groups, 10m between groups
height:	0.55m	0.65m
dbh:	-	-
surv:	37.6%	100%
ref:	Dubois (1976	

3. Station: Igarapé-Açú (PRODEPEF), Bragança region east of Belém, Pará, Brazil

p. year:	March 1976	March 1976	March 1976
age:	0.5	0.5	0.5
shade:	0	0	40-60% in thinned scrub 6m tal
plot size:	36	1-tree-plots	1-tree-plots
reps:	5	12	?
spac:	1.5 x 1.5m	3 x 3m	3 x 8m
height:	0.36m	0.30m	0.54
dbh:	-	-	-
surv:	98.8%	91.7%	100%
ref:	Dubois (1976)		

4. Station: Trinidade (PRODEPEF), Bragança region south of Belém, Pará, Brazil

p. year:	March 1975	March 1975
age:	1.1	1.1
shade:	0	40-60% in thinned secondary scrub
plot size:	36	Anderson group of 13 trees
spac:	1.5 x 1.5 m	1 x 1m within groups, 10 m between groups
height:	1.57m	0.65m
dbh:	-	-
surv:	97.5%	96.9%
ref:	Dubois (1976)	
note:	photo 26 in Dubois (1976) shows trees at least 4 m tall in one plot in full light	

5. Station: Fazendinha-de-Fora, Amapá, Brazil

p. year:	? 1975 after strip ploughing of poor sandy soil, savanna	
age:	1.5	2.0
shade:	0	0
plot size:	100 trees + 105 replanted	100 trees + 90 replanted
reps:	1	1
spac:	2.5 x 2.5m	2.5 x 2.5m
height:	0.12m	0.25m
dbh:	-	-
surv:	2%	2%
ref:	Pitt (1961)	
note:	1/2 dessertspoonful of P_2O_5 fertilizer in each planting and replanting hole	

6. Station: Sawmill training centre (now CTM-SUDAM), Santarém, Pará, Brazil.

p. year:	1958	1959
age:	2.7	1.7
shade:	0	0
plot size:	75 trees + 107 replanted	75 trees + 33 replanted
reps:	1	1
spac:	2.5 x 2.5m	2.5 x 2.5m
height:	2.9m	4.1m
dbh:	-	-
surv:	5%	38%
ref:	Pitt (1961)	

7. Station: Service for training and forest research (STPF, CTM-SUDAM) Curuá-Una, Pará, Brazil

p. year:	1958	1958
age:	2.7	2.7
shade:	0	0
plot size:	100 trees + 123 replanted	96 trees + 86 replanted
reps:	1	1
spac:	2.5 x 2.5m	2.5 x 2.5m
height:	4.5m	6.6m
dbh:	?	7 cm* (dominants & co-dominants only)
surv:	42%	52%
ref:	Pitt (1961), *Pitt in Wadsworth (1960)	
notes:	Km 4 poor sandy soil bare root stock	Km 5 better sandy soil bare root stock + striplings photo Fig.3, page 64, Unasylva 15 (2) 1961

8. Station: Service for training and forest research (STPF, CTM-SUDAM) Curuá-Una, Pará, Brazil

p. year:	1959	1959	1959
age:	1.7	1.7	18
shade:	0	0	0
plot size:	21 trees + 9 replanted	28 trees + 19 replanted	?
reps:	1	1	1
spac:	2.5 x 2.5m	2.5 x 2.5m	2.5 x 2.5m

height:	4.1m	4.4m	18.9m
dbh:	-	-	11.7cm
surv:	70%	49%	63% if plot M, 40% if M+
ref:	Pitt (1961); 1977 data (18 years old) from Rollet (1980)		
plot:	M	M+	M or M+
notes:	flanco sandy soil stumps	as for M, with added P_2O_5 stumps	

9. Station: Service for training and forest research (STPF, CTM-SUDAM) Curuá-Una, Pará, Brazil

p. year:	1960	1960	1960
age:	0.7	0.7	18
shade:	0	0	0
plot size:	36 trees	36 trees + 5 replanted	?
reps:	1	1	1
spac:	2.5 x 2.5m	2.5 x 2.5m	2.5 x 2.5m
height:	0.9m	0.9m	14.8m
dbh:	-	-	8.5cm
surv:	97%	78%	81 or 71%
ref:	Pitt (1961); 1977 data (18 years old) from Rollet (1980)		
plot:	M(60) stumps	M(60) striplings	one of the two M(60) plots
notes:	flanco sandy soil		

10. Station: Service for training and forest research (STPF, CTM-SUDAM) Curuá-Una, Pará, Brazil

p. year:	1959	1960	1960	1960
age:	1.7	0.7	0.7	0.7
shade:	0	0	0	0
plot size:	48 trees + 9 replanted	150 trees + 2 replanted	200 trees + 3 replanted	185 trees
reps:	1	1	1	1
spac:	2.5 x 2.5m	2.5 x 2.5m	2.5 x 2.5m	2.5 x 2.5m
height:	4.1m	0.7m	0.6m	0.9m
dbh:	-	-	-	-
surv:	85%	89%	86%	79%
ref:	Pitt (1961)			
notes:	planalto clay soils, plots cleared from felled and burned forest			
	plot E stumps	plot A3 stumps	plot A3 stumps	plot A3 60cm striplings

11. Station: Service for training and forest research (STPF, CTM-SUDAM) Curuá-Una, Pará, Brazil

p. year: 1959; probably Pitt's plot E (see station 10 above)

age:	11	12	13	18 (probably)
shade:	0	0	0	0
plot size:	48 trees + 9 replanted			
reps:	1			
spac:	2.5 x 2.5m			
height:	21.8m	22.1m	23.6m	pmai 1.98m
dbh:	22.6cm	23.8cm	24.4cm	pmai 2.05cm
surv:	?	?	47.4%	?
ref:	Pedroso (1973/74); 1977 data (18 years old) from SUDAM (1979)			
notes:	Pedroso commented that the appearance of the plot was excellent. Growth of the J. copaia was the best of the selection of 17 above-average Amazonian species. SUDAM (1979) also claims periodic mean annual increment in volume of 49.5 m^3/ha/year.			

12. Station: Reserva Ducke, INPA, Manaus, Amazonas, Brazil

p. year:	1964	1964	?
age:	14	14	13
shade:	0	100[1]	0
plot size:	line of 15	line of 15	?
reps:	1	1	?
spac:	2.5 x 5m	2.5 x 5m	3 x 4m
height:	13.7m^2	5.6m^2	10.0m
dbh:	21.2cm	5.2cm	11.4cm
surv:	>80%*	±60%*	89%+
ref:	*Alencar & Araujo (in press); +Loureiro, Silva & Alencar (1979)		
notes:	1. the line was planted into a 'tunnel' formed by cutting the undergrowth palms and climbers in otherwise virgin tropical rain forest. Both lines have been cleaned twice annually		
	2. heights and diameters are means of 10 trees drawn at random from each line		
	3. annual mean height and percentage survival curves cover ages 6-14 years. The curves show a marked change in 1974-75 for all the 20 species reported. This is probably due to changes in measurement procedures and in degree of supervision		
	4. these plots are now identified as J. paraensis, not J. copaia		

13. Station: Reserva Km 60, INPA, Manaus, Amazonas, Brazil

p. year:	1973
age:	1.6
shade:	0
plot size:	?
reps:	?
spac:	?
height:	4.7m (12.5% coefficient of variation)
dbh:	?
surv:	?
ref:	Loureiro, Silva & Alencar (1979)

14. Station: Maderas y Chapas de Nariño, S.A., Nariño, Colombia

p. year:	? 1973
age:	1.5
shade:	0
plot size:	?; first stage ±0.1ha, second stage ±1.0ha, third stage ±2.0ha
reps:	?; trials on 3 soil types (sandy loam, clay & muck), also replicated in time
spac:	3 x 3m
height:	±3m
dbh:	?; rotation of 15 years suggested
surv:	?
ref:	Pack (1976)
notes:	forest logged, clear felled and chopped to prepare trial sites: no burning

15. Station: Prueba de especies forestales (tree species trials), Direccion General Forestal del MAG, Buenos Aires, Puntarenas, Costa Rica

p. year:	? 1975
age:	4
shade:	0
plot size:	13 x 13
reps:	1
spac:	2 x 2m
height:	9m
dbh:	12cm
surv:	?
ref:	Costa Rica (1979)
notes:	a photograph of the plot is given in the report

16. Station: Puerto Almendra, UNAP, Iquitos, Peru

p. year:	1972
age:	2
shade:	0
plot size:	? 15 trees
reps:	4; randomised complete block species trial
spac:	2 x 2m
height:	8m
dbh:	12cm
surv:	?
ref:	Santander, Diaz Restegui & Documet (1974)
notes:	given as Jacaranda sp. (huamanzamana). However it is likely to be J. copaia. Huamanzamana, or huaman-samane, is Dictyoloma peruviana Planch., Rutaceae, a shrubby tree from upland northeast Peru which also has bipinnate leaves and similar wood (Record & Hess, 1943).

U T I L I Z A T I O N

Several series of tests have shown that J. copaia can be used satisfactorily, by itself or in mixture with other species, to make soda and kraft pulps, a range of bleached and unbleached papers, and boards. These tests will be summarised in another publication.

L I T E R A T U R E C I T E D

1. Alencar, J. da C.; Almeida, R.A. de; Fernándes, N.P. 1979. Fenología de espécies florestais em floresta tropical úmida de terra firme na Amazônia Central. Acta Amazônica, vol. 9, no. 1, pp. 163-198.
2. Alencar, J. da C.; Araujo, V.C. (in press, 1980). Comportamento de espécies florestais amazônicas quanto à luminosidade.
3. Corrêa, M. Pio. 1931. Diccionário das plantas uteis do Brasil e das exóticas cultivadas. Impresa Nacional, Rio de Janeiro. Volume II, p. 65.
4. Costa Rica. 1979. Informe anual de Dirección General Forestal, Ministerio de Agricultura, San José.
5. Dijk, K.van; Venegas Tovar, L.; Melchior, G.H. 1978. El suministro de semillas como base de reforestación en Colombia. Proyecto Investigaciones y Desarrollo Industrial Forestales (PNUD/FAO/INDERENA/CONIF/COL/74/005), Bogotá, PIF no. 13, p. 12.
6. Dubois, J.L.C. 1971. Silvicultural research in the Amazon. Projeto Escola Nacional Florestal, Curitiba (PNUD/FAO-- FO:SF/BRA 4); FAO, Rome. Technical report no. 3, 192 pp.
7. Dubois, J.L.C. 1976. Centro de pesquisas florestais de Amazônia; programação técnica. Projeto de desenvolvimento e pesquisa florestal - PRODEPEF (PNUD/FAO/IBDF/BRA-45), Brasilia. Série divulgação no. 9, 75 pp.
8. Heinsdijk, D. 1957. The upper story of tropical forests. Tropical Woods, vol. 107, pp. 66-84.
9. Heinsdijk, D.; Bastos, A. de Miranda. 1963. Inventários florestais na Amazônia. Setor de inventários florestais, Serviço Florestal, Ministério da Agricultura, Rio de Janeiro. Boletim no. 6, 100 pp.
10. Huber, J. 1910. Mattas e madeiras amazônicas. Boletim do Museu Goeldi, Belém, no. 6, 1909, pp. 91-225.
11. International Council for Research in Agroforestry (ICRAF). 1980. First report, 1978/79. ICRAF Report no. 002e, p. 14.
12. Lamb, F.B.; Briscoe, C.B.; Englerth, G.H. 1960. Recent observation on forestry in Tropical America. Caribbean Forester, vol. 21, nos. 1/2, pp. 45-59.

13. Ledoux, P. 1964. Lacythis amapaensis Ledoux, hôte de zoocécidie à Tanaostigmatidae (Chalcidoidea) et Jacaranda copaia, hôte de zoocécidie indéterminée, à Mazagão, T. F. Amapá. Lecointea, Belém, no. 2, p. 4.

14. Ledoux, P. 1969. Brotamento de toco, caracteristica prioritaria nos projetos de economia florestal na Amazonia equatorial. Revista de Farmácia e Bioquímica da Amazonia, Belém, vol. 2, no. 4, pp. 291-293.

15. Loureiro, A.A.; Silva, M.F. da; Alencar, J. da C. 1979. Essências madeireiras da Amazônia. Instituto Nacional de Pesquisas da Amazonia (INPA), Manaus. Volume 1, p. 103.

16. Peck, R.B. 1976. Selección preliminar de espécies aptas para el establecimiento de bosques artificiales en tierra firme del litoral pacífico de Colombia. Boletin Técnico del Instituto Forestal Latinoamericano de Investigacion y Capacitacion, Mérida, no. 50, pp. 29-39.

17. Pedroso, L.M. 1973/74. Alguns aspectos sobre o florestamento e reflorestamento na Amazônia. SUDAM Documenta Amazônica, Belém, vol. 5, nos. 1/4, pp. 35-49.

18. Pitt, J. 1961. Report to the Government of Brazil on the application of silvicultural methods to some of the forests of the Amazon. FAO/ETAP, Rome, Report no. 1337, 96+139 pp.

19. Record, S.J.; Hess, R.W. 1943. Timbers of the New World. Yale University Press, New Haven, 640 pp.

20. Rollet, B. 1980. Personal communications.

21. Santander, C.; Diaz Reategui, J.; Documet, L. 1974. Ensayos silviculturales en un bosque tropical húmedo. Reunion internacional sobre silvicultura de bosques tropicales, Cali, Colombia, diciembre 2 a 6 de 1974. IICA Informes de Conferencias, Cursos y Reuniones no. 61, p. III-E-6.

22. SUDAM. 1979. Pesquisas e informações sobre espécies florestais da Amazônia. Centro de Tecnologia Madeireira (CTM), Departamento de Recursos Naturais, SUDAM, Belém. p. 91.

23. Vattimo, I. de. 1977. Jacaranda paraensis (Huber) Vattimo stat. nov. (Bignoniaceae - seção Monolobos P. DC.). Rodriguesia, Rio de Janeiro, vol. 29, no. 43, pp. 285-297.

24. Vattimo, I. de. 1978. Uma nova espécie de Jacaranda Jussieu (Bignoniaceae - seção Monolobos P. DC.). Rodriguesia, Rio de Janeiro, vol. 29, no. 44, pp. 231-243.

25. Venegas Tover, L. 1978. Distribución de once especies forestales en Colombia. Proyecto Investigaciones y Desarrollo Industrial Forestales (PNUD/FAO/INDERENA/CONIF/COL/74/005), Bogotá. PIF no. 11, pp. 25-27.

26. Wadsworth, F.H. 1960. Datos de crecimiento de plantaciones forestales en Mexico, Indias Occidentales y Centro y Sur America. Caribbean Forester, vol. 21, supplement, p. 4-19.

FAST GROWING TREES

ESTUDO DA ADAPTAÇÃO DE ESPÉCIES NATIVAS DE RÁPIDO CRESCIMENTO EM SISTEMA DE PLANTIO "PLENO ABERTO", – REGIÃO DO TRÓPICO ÚMIDO BRASILEIRO

L.M. Pedroso e C.A.C. Lopes

Resumo

Considerações sobre métodos e técnicas silviculturais de regeneração artificial em "Pleno Aberto" com espécies nativas de crescimento rápido passiveis de adaptação no sistema. Informações sobre as espécies testadas na Estação Experimental de Curuá-Una (SUDAM) Pará. Estudos sobre altura, diâmetros médios e outros dados de importância fundamental para se ter a adaptação daquelas espécies na Região.

Summary

Consideratin about sylvicultura methods and artificial regeneration technics to get acclimatized in the Region, native species of fast growing. Reports about proved species in the Curuã-Una Experimental Station (CTM/SUDAM) State of Parã. Studies about height, middling diameter and others important data to a perfect acclimation.

1. INTRODUÇÃO:

A política florestal de um país ou de uma Região, como no caso da Amazônia, deve ter seus alicerces em bases técnicas, tendo como essencial a existência e manutenção de um patrimônio florestal permanente que para se perpetuar, deve ser assistido por um corpo técnico capaz de dar ao mesmo uma orientação constante, segura e efetiva.

A criação de um patrimônio florestal permanente é de primeira importância. Esse patrimônio poderá ser estabelecido à base de florestas naturais existentes ou através do estabelecimento de florestas artificiais. Os fatores primordiais que devem ser levados em consideração para a criação de patrimônio florestal, deve ser principalmente, a prioridade absoluta às essências já reconhecidas nos mercados mundial e local e de um modo menos acentuado àquelas que poderão tornar-se de valor comercial.

Nos programas de produção (adaptação), a regra da escolha das essências de base deve ser respeitada rigorosamente, mesmo que ainda não estabelecidas no mercado, mas que tem mostrado qualidades indiscutíveis através de testes tecnológicos e análises econômicas. O estudo de adaptação das espécies de base devem ser essêncialmente baseado em ensaios de natureza puramente silvicultural - exigências ecológicas, características de crescimento, ausência de pragas e doenças, exigências pedológicas, etc.

Nos trópicos as plantações de floretas, de crescimento rápido, de um modo geral dão resultados excelentes, acontecendo o mesmo com a regeneração natural. Para determinado número de técnicos florestais as plantações artificiais são consideradas dispendiosas no inicio e podem envolver riscos de fracasso originários de causas imprevistas que incluem existência de pragas, ataque de insetos, etc, mas que, como já citamos, procurando ser observado as condições silvlculturais adequadas, podem reduzir a um mínimo todos os riscos. Outra consideração que deve ser levada em conta, que poderá causar fracasso em plantações nos trópicos, de floresta artificial, principalmente, é a falta de planejamento adequado para aquelas atividades.

2. CONSIDERAÇÕES GERAIS:

A pesquisa na Amazônia teve sua origem em 1957, com a criação do atual Centro de Tecnologia Madeireira (CTM), Unidade descentralizada do Departamento de Recursos Naturais (DRN) da Superintendência do Desenvolvimento da Amazônia (SUDAM), cujas finalidades básicas e específicas é a Pesquisa Florestal e o Treinamento de Mão-de-Obra operária para a Industria Madeireira.

A Pesquisa Florestal do CTM está voltada especificamente para as atividades na própria floresta, objetivando o melhor conhecimento de sua composição, através de inventários, desenvolvendo métodos apropriados de corte e arraste e transporte de toras, por meio mecanizado, em substituição a primitivos processos

manuais usados nessas operações, estudando técnicas de manejo que permitam a recomposição da mata nas áreas exploradas, enriquecendo-as com espécies de maior valor comercial, através de Tratos Silviculturais adequados, estudo do comportamento de espéies nativas e exóticas plantadas em "Pleno Aberto" de modo a amenizar o problema de heterogeneidade de Floresta Tropical e Úmida da Amazônia.

Com esses objetivos é que justificou a criação da Estação Experimental de Curuá-Una com as seguintes atribuições:

- Promover o Treinamento de Mão-de-Obra especializada em atividade de Exploração Florestal.
- Promover a Experimentação de Silvicultura Tropical através de plantios de espécies nativas e aclimatação de espécies exóticas de valor comercial.
- Desenvolver trabalhos de condução e manejo florestal.

2.1. ESTAÇÃO EXPERIMENTAL DE CURUÁ-UNA

2.1.1. Área e Localização:

Fica situada a margem direira do Rio Curuá-Una, afluente do rio Amazônas, entre os rios Tapajós e Xingú, a 50km de sua embocadura, sua posição geográfica é equatorial, com 2º23'- latitude sul e 54º24' longitude Oeste.

A atual área de dominio da Estação Experimental é de 1.800 ha, passando brevemente a ser ampliada para 100.000 ha aproximadamente.

2.1.2. Infra Estrutura:

O acesso para a Reserva ocorre atualmente somente por via fluvial.

Existe na base um acampamento com residências para técnicos e trabalhadores, garagem e oficina para manutenção de equipamentos e veículos, um Viveiro Florestal, energia elétrica e água encanada.

Para atender a execução dos trabalhos que vem sendo desenvolvidos na Estação Experimental, temos hoje, aproximadamente 40 km de estradas florestal transitável. (vide fig.nº1).

2.1.3. Aspectos e Condições Climáticas:

Na Estação Experimental assim como em toda a Amazônia, a característica geral do clima é quente e úmido. Entretanto especificamente as condições macro-climáticas de Curuá-Una apresenta:

- Temperatura do ar - Apresenta uma média anual de 26ºC oscilando entre 25,4º a 27ºC.
- A temperatura máxima alcança extremos elevados variando de 30,0ºC, nos meses mais chuvosos e 33,1ºC, nos meses mais secos. A média está em torno de 31,2ºC.
- A temperatura mínima oscila em torno de 21,9ºC, a 23,1ºC, apresentando uma média anual de 22,6ºC.(vide fig. nº 2).
- Umidade relativa do ar - A umidade relativa na Região é de um modo geral elevada uniformemente durante todos os meses do ano. Na Estação Experimental de Curuá- Una há uma variação anual de 78% a 89%, com a média anual de 84%.
- Pluviosidade - A incidência de chuvas é relativamente elevada durante o ano inteiro, entretanto apresentando um nítido período de estiagem de 3 a 4 meses. Os índices pluviométricos mensais variam de 39mm, nos meses de setembro a 358mm, nos meses de março, atingindo um total anual de 2095mm. (vide Fig.nº 2 e nº 3).

2.1.4. Descrição dos Solos:

As áreas de plantio da Estação Experimental de Curuá-Una se dividem em dois (2) grupos: Solos arenosos do Flanco e solos argilosos do Planalto, onde a maior parte das espécies tropicais de valor comercial ocorrem.

As características desses solos são as seguintes:

PLANALTO: Latosolo amarelo, limo argiloso, de camada profunda, com textura pesada, fortemente ácido (PH 4,5-5,0) muito lixiviado, com poucos remanescentes no perfil além da sílica, óxido hidratado de ferro e alumina e argila caolinítica. Apresenta uma fertilidade natural baixa, problema de fixação de fosfato. Uma camada de folhas semi - decompostas cobrem o piso florestal.

FLANCO: Os solos de flanco estão subdivididos em:

Flanco baixo: - Os solos desta área são profundos, bem drenados possuindo textura muito leve, fortemente ácido (PH 4,5 - 5,0), com uma fácil penetração das raízes e de água. Devido sua textura leve além de reduzida fertilidade natural, reduz também a capacidade de reter a água tornando-se desse modo suscetiveis à seca.

Flanco baixo de transição: Neste caso os solos desta área são semelhantes aos descritos acima, apresentando uma textura mais pesada (franco arenoso sobre franco argila arenoso), por esta razão tendentes a serem menos secos. Devido a mudança da textura, já são áreas de solos considerados bem próximo dos solos do Flanco alto, que possuem uma textura mais pesada podendo ser considerados solos originalmente para os estudos de Silvicultura.

Flanco Alto: Os solos desta área possuem muitas características semelhantes aos do Flanco baixo. São solos fortemente ácidos, bem drenados e facilmente penetrados por raízes e umidade. Possuem uma textura ligeiramente mais pesada (franco arenoso transmudando-se em argila no subsolo mais baixo) e são fortemente concrecionários numa profundidade de 100 a 150cm. Apresentam baixa fertilidade e ausência de fixação de fosfato.

3. OBJETIVO:

Dentro dos programas de Silvicultura estabelecidos na Estação Experimental de Curá-Una, um dos objetivos primordiais, ali implantados foi a realização de experimentos e ensaios para verificações em geral:

a) Quais as espécies mais promissoras e

b) Melhor técnica para estabelecê-las.

Especificamente os estudos que ora realizamos visa averiguar o comportamento de espécies florestais de crescimento rápido mais apropriadas para plantios homogeneos nos solos de planalto e flanco, após derrubada total e queima da mata natural.

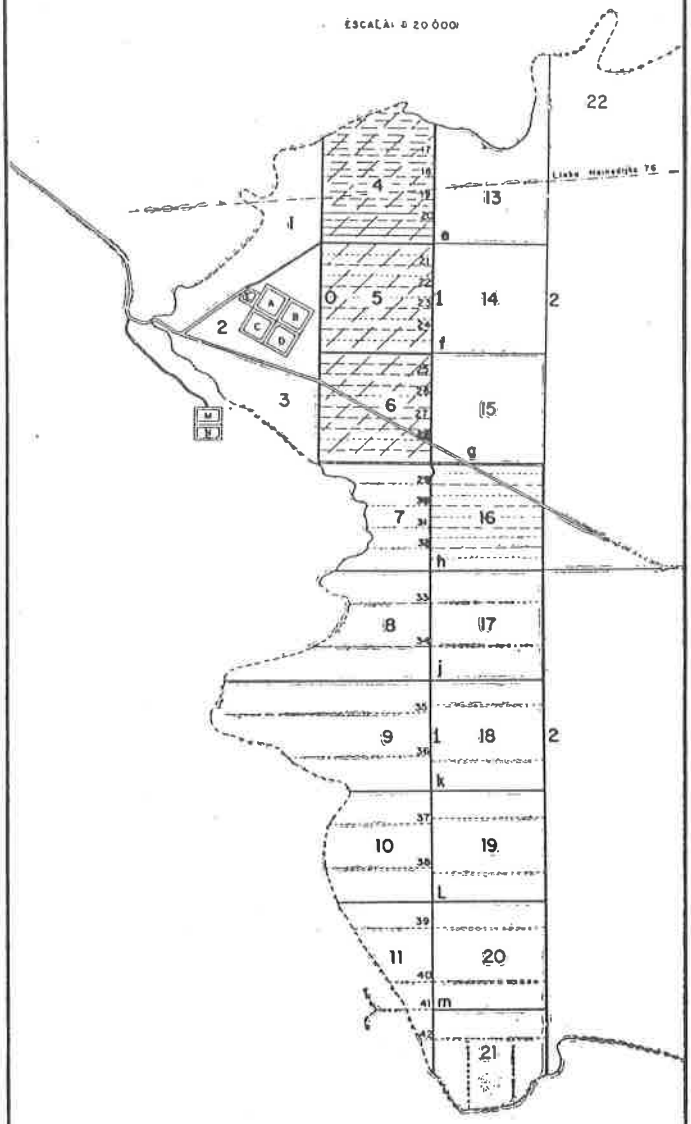
Assim sendo , o presente trabalho apresenta um resumo sobre determinadas espécies que estão sendo testadas, com informações sobre alturas, diâmetro médio e outros dados que fundamentalmente poderão predizer e avaliar o indice de adaptabilidade que alcançaram na área que estão sendo testadas.

4. MATERIAL E MÉTODO EMPREGADO:

Os ensaios silviculturais de que reporta o presente trabalho foram exclusivamente voltados para a análise do comportamento de diversas essências florestais nativas de crescimento rápido, visando entre elas as que melhor se adaptarão às técnicas silviculturais tradicionalmente usadas em reflorestamento.

O método, usando plantios artificiais, pode ser levado a efeito de diversas formas, dependendo de fatores que facilitem a sua adaptação tais como: exigências das espécies quanto ao crescimento, emprego dos produtos finais, fatores econômicos, etc.

FIG.Nº 1 FLORESTA DE CURUÁ-UNA



TALHÃO	ÁREA	TALHÃO	ÁREA
1	80	11	64
2	44	13	104
3	56	14	100
4	1,15	15	100
5	100	16	98
6	97	17	100
7	64	18	100
8	96	19	100
9	152	20	100
10	90	21	85

LEGENDA

- Caminhos e estradas demarcadas
- Caminhos e estradas desmatadas
- Estrada principal
- Linhas de levantamento da regeneração e inventário - Propostas ou cortadas
- 9 Número do talhão
- Linhas de levantamento da regeneração e inventário - Enumeradas
- A, D Canteiros de pesquisas
- Borda do planalto fixada
- Borda do planalto suposta
- Corte de cipós
- Linhas de enriquecimento

FIG. Nº 2

MESES	TEMPERATURA C			INSOLAÇÃO	U.R.	Pp
	Média	Máxima	Mínima	Horas e Decimos	%	mm
J	25,8	30,8	22,7	142,1	85	179
F	25,8	30,8	22,5	105,9	87	275
M	25,8	30,8	22,6	107,6	88	358
A	25,6	30,0	22,8	117,9	88	262
M	25,6	30,3	22,7	146,7	89	293
J	25,4	30,4	22,3	177,5	88	174
J	25,4	31,0	21,9	213,7	86	112
A	26,2	32,0	22,2	243,6	83	50
S	26,7	32,7	22,8	222,9	80	39
O	27,0	33,1	23,0	230,1	78	46
N	26,9	32,6	23,1	149,9	79	85
D	26,5	31,9	22,9	188,6	80	123
ANO	26,0	31,2	22,6	2.091, 5	84	2.096

DADOS CLIMÁTICOS DA ESTAÇÃO DE SANTARÉM VÁLIDOS PARA A ÁREA.

FIG. Nº 3 TEMPERATURA E PLUVIOSIDADE EM CURUÁ, ANOS DE 1958, 1959 E 1960. MÉDIA DA TEMPERATURA MENSAL: 1 Cm, 5º C. A ESTAÇÃO SÊCA É REPRESENTADA PELA PARTE ONDE A CURVA DA PLUVIOSIDADE CAI ABAIXO DA MÉDIA DA TEMPERATURA MENSAL.

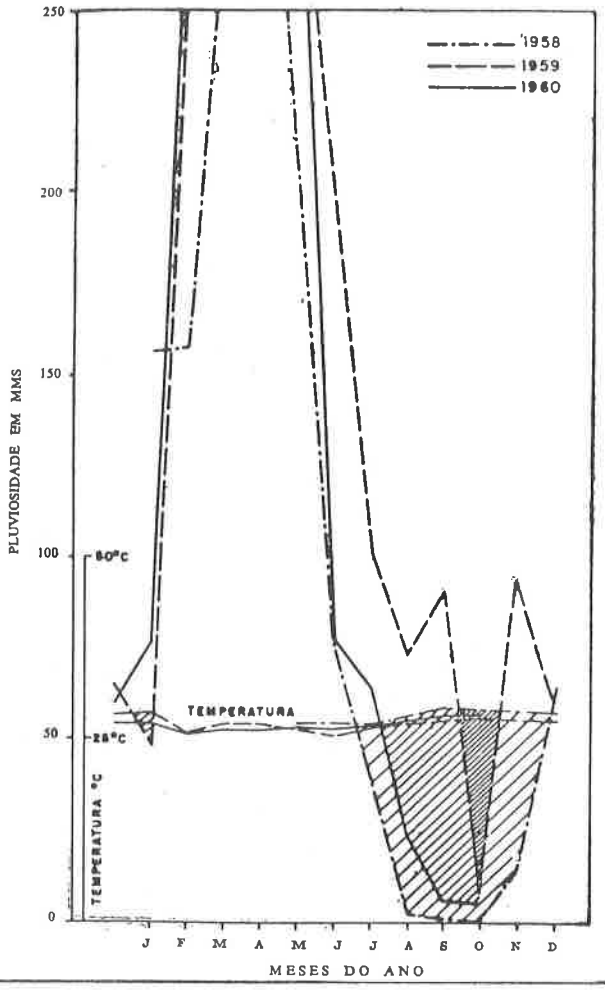


TABELA - I

NOME VULGAR DA ESPÉCIE	NOME CIENTÍFICO	LOCAL DO PLANTIO	ANO DO PLANTIO	ÁREA DA PARCELA (ha)	ESPAÇAMENTO INICIAL (m)	ORIGEM DAS SEMENTES	Nº ATUAL DE ÁRVORES
QUARUBA VERDADEIRA	Vochysia maxima	PL	1959	0,057	2,5x2,5	Curuá-Una	32
ANDIROBA	Carapa guianensis	PL	1959	0,063	2,5x2,5	Curuá-Una	73
PARA-PARÁ	Jacaranda copaia	PL	1959	0,032	2,5x2,5	Curuá-Una	39
MARUPÁ	Simaruba amara	PL	1959	0,030	2,5x2,5	Curuá-Una	39
CUPIÚBA	Goupia glabra	PL	1959	0,034	2,5x2,5	Curuá-Una	22
MOGNO	Swietenia macrophylla	PL	1959	0,063	2,5x2,5	Curuá-Una	40
UCUUBA TERRA FIRME	Virola cuspidata	PL	1959	0,032	2,5x2,5	Curuá-Una	53
PARA-PARÁ	Jacaranda copaia	FL	1959	0,0289	2,5x2,5	Curuá-Una	18
CUPIÚBA	Goupia glabra	FL	1959	0,15345	2,5x2,5	Curuá-Una	143
COPAÍBA	Copaifera multijuga	FL	1959	0,1152	2,5x2,5	Curuá-Una	48
CAJU-AÇU	Anacard.giganteum	PL	1960	0,024	2,5x2,5	Curuá-Una	19
CASTANHA DO PARÁ	Bertholletia excelsa	PL	1960	0,006	2,5x2,5	Curuá-Una	7
FAVA ARARA TUCUPI	Parkia multijuga	PL	1961	0,038	2,5x2,5	Curuá-Una	46
MOROTOTÓ	Didymopanax morototoni	PL	1962	0,006	0,7x0,7	Curuá-Una	9
TATAJUBA	Bagassa guianensis	PL	1962	0,031	0,7x0,7	Curuá-Una	27

TABELA - II

DADOS COMPLEMENTARES DA TABELA I

ESPÉCIE	DIAMETRO (CM)			ALTURA (M)			ABT (m2)	ABM (m2)	VT (m3)	V/Ha (m3)	I/Ha/ANO (m3)	ASPECTO ATUAL DO PLANTIO
	MAX.	MED.	MIN.	MAX.	MED.	MIN.						
QUARUBA VERDADEIRA	48,5	35,5	18,0	27,0	22,2	14,5	3,1668	0,0989	49,2121	863,370	41,113	Excelente
ANDIROBA	42,4	22,9	8,4	22,7	15,8	10,6	2,9971	0,0411	33,148	526,158	25,055	Atac.p/Hipsipilla grand
PARA-PARÁ	41,5	26,2	6,3	33,0	18,7	6,5	2,1077	0,0540	27,590	862,181	41,056	Excelente
MARUPÁ	39,0	26,4	9,5	22,3	17,0	9,0	2,1435	0,0549	25,508	850,255	40,488	Excelente
CUPIÚBA	30,2	23,0	14,6	19,7	16,8	13,8	0,9134	0,0415	10,742	315,929	15,044	Muito bom
MOGNO	28,5	16,8	9,0	18,5	12,9	6,0	0,8895	0,0222	8,032	127,495	6,071	Atac.p/Hypsip.grandela
UCUÚBA TERRA FIRME	28,8	17,8	5,2	21,6	15,2	8,0	1,3242	0,0249	14,090	440,297	20,967	Muito bom
PARA-PARÁ	39,6	29,1	18,0	28,0	22,2	18,2	1,2009	0,0667	18,662	645,744	30,750	Regular
CUPIÚBA	29,5	18,9	6,7	23,7	17,4	7,8	4,0060	0,0280	48,793	317,974	15,142	Regular
COPAÍBA	31,9	18,1	7,5	21,5	14,0	7,2	1,2360	0,0257	12,113	105,146	5,007	Result.não satisfatório
CAJU-AÇU	34,5	25,2	13,0	18,5	15,6	12,8	0,9509	0,0500	10.384	432,660	21,633	Bom
CASTANHA DO PARÁ	35,8	26,5	12,0	19,1	15,5	11,7	0,3860	0,0551	4,188	698,017	34,901	Muito bom
FAVA ARARA TUCUPI	37,5	24,6	10,0	17,3	13,9	6,0	2,1866	0,0475	21,276	559,885	29,468	Muito bom
MOROTOTÓ	28,0	22,7	12,5	23,5	20,7	17,5	0,3642	0,0404	5,277	879,543	48,864	Excelente
TATAJUBA	30,4	18,5	8,5	24,5	17,6	10,7	0,7287	0,0269	8,978	289,560	16,089	Regular

Neste experimento o método usado foi o de plantios uniformes, em condições de abertura total, de espécies florestais de crescimento rápido em solo argiloso e arenoso do Planalto e do Fanco, respectivamente. Tais plantios foram estabelecidos após exploração, destruição completa e queima da mata residual. As espécies estudadas foram plantadas nas mesmas épocas e sob as mesmas condições tanto no Flanco como no Planalto. Estes plantios receberam toda a atenção quanto sua manutenção e tratos silviculturais, como sendo limpeza de capina, raleamento, poda, desbaste, etc.

Para se ter uma análise de comportamento dessas espécies, além do caráter qualitativo, levamos em consideração principalmente os dados dendrométricos, tais como DAP, altura, conformação da copa, qualidade do fuste e o estado de sanidade.

5. RESULTADOS: Vide Tabela I e II.

6. CONCLUSÕES E COMENTÁRIOS:

Os estudos com plantios artificiais de espécies tropicais de crescimento rápido, neste caso, plantios em "Pleno Aberto", na Região do Trópico-Úmido Brasileiro, vem progredindo lentamente, principalmente, com maior justificativa devido a complexidade de sua composição florística.

Os resultados apresentados estão limitados à avaliação do desempenho médio das espécies. Não devem ser considerados como definitivos, quer para as essências que tiveram desempenho bom ou não, visto que alguns fatores de ordem técnica não foram levados em consideração, principalmente por não terem sidos feitos replica

FOTO Nº 1

Plantio de Cupiuba (Goupia glabra), ano 1959 em Solo argiloso do Planalto

FOTO Nº 2

Plantio de Ucuuba da TERRA FIRME (Virola sp), ano 1959, em Solo argiloso do Planalto

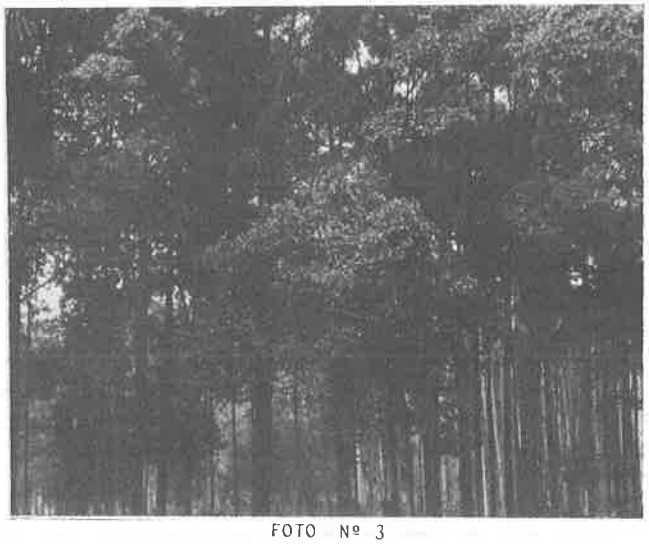


FOTO Nº 3

Plantio de Quaruba verdadeira (Vochysia maxima), ano 1959, em Solo argiloso do Planalto

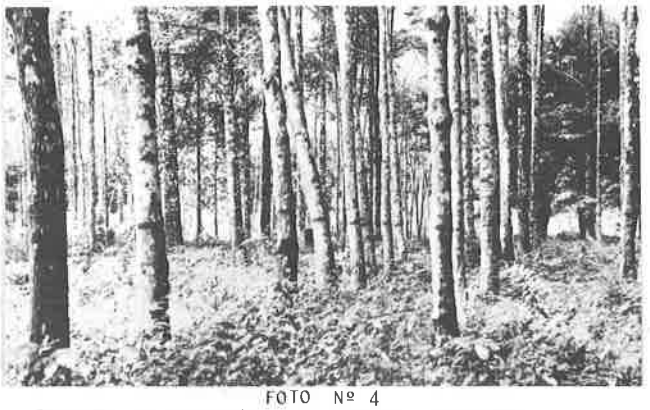


FOTO Nº 4

Plantio de Marupa(Simauba amara), ano 1959, em Solo de Planalto

FOTO Nº 5

Plantio de Andiroba (Carapa guianensis), Ano de 1960, em Solo argiloso de Planalto

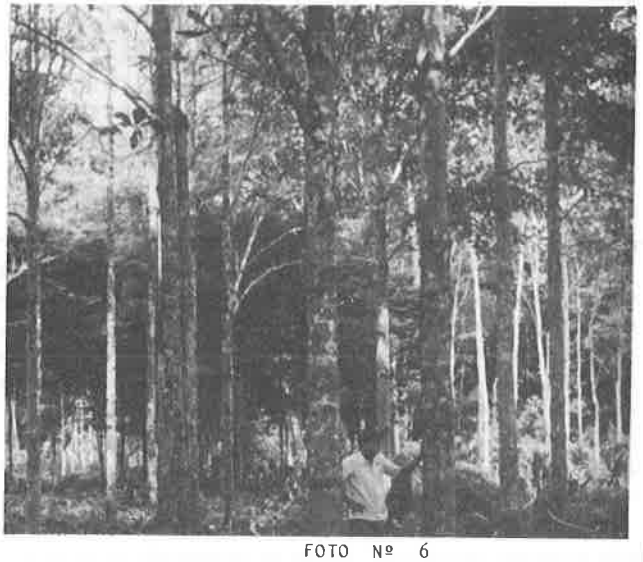


FOTO Nº 6

Plantio de Cajú-açú (Anacardium giganteum), ano de 1960, em Solo argiloso do Planalto.

ções, em número suficiente, assim como também pelo tamanho reduzido das parcelas.

Assim sendo com estes resultados conclui-se reservadamente quais são as espécies que apresentam mais sensibilidade de adaptação dentro das condições e ambiente em que foram plantadas.

7. ILUSTRAÇÃO FOTOGRÁFICA: Vide Anexos I, II e III.

8. FONTES CONSULTADAS:

TAYLOR, Charles J. "Introdução a Silvicultura Tropical.

DUBOIS, J.L.C. - "Silvicultural Research in the Amazon, "Rome, 1971

SUDAM DOCUMENTA - V.5 Out. 1973/set.1974

PEDROSO L.M. - Alguns Aspectos sobre o florestamento e reflorestamento na Amazônia".

PITT, JOHN - Relatório ao Governo Brasileiro sobre aplicação de métodos Silviculturais a algumas florestas da Amazônia. Belém, SUDAM/Diversas documentações, 1969.

JANKAUSKIS J. - "Relatório sobre características Silviculturais de espécies Nativas e exóticas dos plantios da Estação Experimental de Curuá-Una, CTM/SUDAM-Convênio SUDAM / FCAP.

FAST GROWING TREES

ESTUDO DE REGENERAÇÃO NATURAL COM ESPÉCIES TROPICAIS DE RÁPIDO CRESCIMENTO NA REGIÃO DO TRÓPICO ÚMIDO BRASILEIRO

L. M. Pedroso e C.A.C. Lopes

Resumo

Considerações sobre métodos e técnicas silviculturais de regeneração natural com espécies nativas de crescimento rápido passíveis de adaptação no Sistema. Informações sobre espécies testadas na Estação Experimental de Curuá-Una (CTM/SUDAM), Estado do Pará. Estudos sobre alturas, diâmetros médios e outros dados de importância fundamental para a aclimatação das mesmas.

Summary

Considerations about sylvicultural methods and natural regeneration technics, to get acclimatized in the Region, native species of fast growing. Reports about proved species in the Curuá-Una Experimental Station (CMT/SUDAM)State of Pará. Studies about height, middling diameter and others important datas to a perfect acclimation,

INTRODUÇÃO:

A política florestal de um país ou de uma Região, como no caso da Amazônia, deve ter seus alicerces em bases técnicas, tendo como essencial a existência e a aumentação de um patrimônio florestal permanente que para se perpetuar, deve ser assistido por um corpo técnico capaz de dar à mesma uma orientação constante, segura e efetiva.

A criação de um patrimônio florestal permanente é de primeira importância. Esse patrimônio poderá ser estabelecido à base de florestas naturais existentes ou através do estabelecimento de florestas artificiais. Os fatores primordiais, que devem ser levados em consideração para a criação de patrimonio florestal, deve ser, principalmente, a prioridade absoluta às esências já reconhecidas nos mercados mundial e local e de um modo menos acentuado àquelas que poderão tornar-se de valor comercial.

Nos programas de produção (adaptação), a regra de escolha das essências de base deve ser respeitada rigorosamente, mesmo que ainda não estabelecidas no mercado, mas que tem mostrado qualidades indiscutíveis através de testes tecnológicos e análises econômicos. O estudo de adaptação das espécies de base devem ser essencialmente baseado em ensaios de natureza puramente silvicultural - exigências ecológicas, características de crescimento, ausência de pragas e doenças, exigências pedológicas, etc.

Nos trópicos as plantações de florestas, de crescimento rápido, de um modo geral dão resultados excelentes, acontecendo o mesmo com a regeneração natural. Para determinado número de técnicos florestais as plantações artificiais são consideradas dispendiosas no início e podem envolver riscos de fracasso originários de causas imprevistas que incluem existência de pragas, ataque de insetos, etc, mas que, como já citamos, procurando ser observado as condições silviculturais adequadas, podem reduzir a um mínimo todos os riscos. Outra consideração que deve ser levada em conta, que poderá causar fracasso em plantações nos trópicos de floresta, artificial, principalmente, é a falta de planejamento adequado para aquelas atividades.

CONSIDERAÇÕES GERAIS:

A pesquisa na Amazônia teve sua origem em 1957, com a criação do atual Centro de Tecnologia Madeireira (CTM), unidade descentralizada do Departamento de Recursos Naturais (DRN) da Superintendência do Desenvolvimento da Amazônia (SUDAM), cujas finalidades básicas e específicas é a Pesquisa Florestal e o Treinamento de Mão-de-Obra operária para a Indústria Madeireira.

A pesquisa florestal do CTM está voltada especificamente para as atividades na própria floresta, objetivando o melhor conhecimento de sua composição, através de inventários, desenvolvendo métodos apropriados de corte e arraste e transporte de toras, por meio mecanizado, em substituição a primitivos processos manuais usados nessas operações, estudando técnicas de manejo que permitam a recomposição da mata nas áreas exploradas, enriquecendo-as com espécies de maior valor comercial, através de tratos Silviculturais adequados, estudo do comportamento de espécies nativas e exóticas plantadas em "Pleno Aberto" de modo a amenizar o problema de heterogeneidade de Floresta Tropical e Úmida da Amazônia.

Com esses objetivos é que justificou a criação da Estação Experimental de Curuá-Una com as seguintes atribuições:

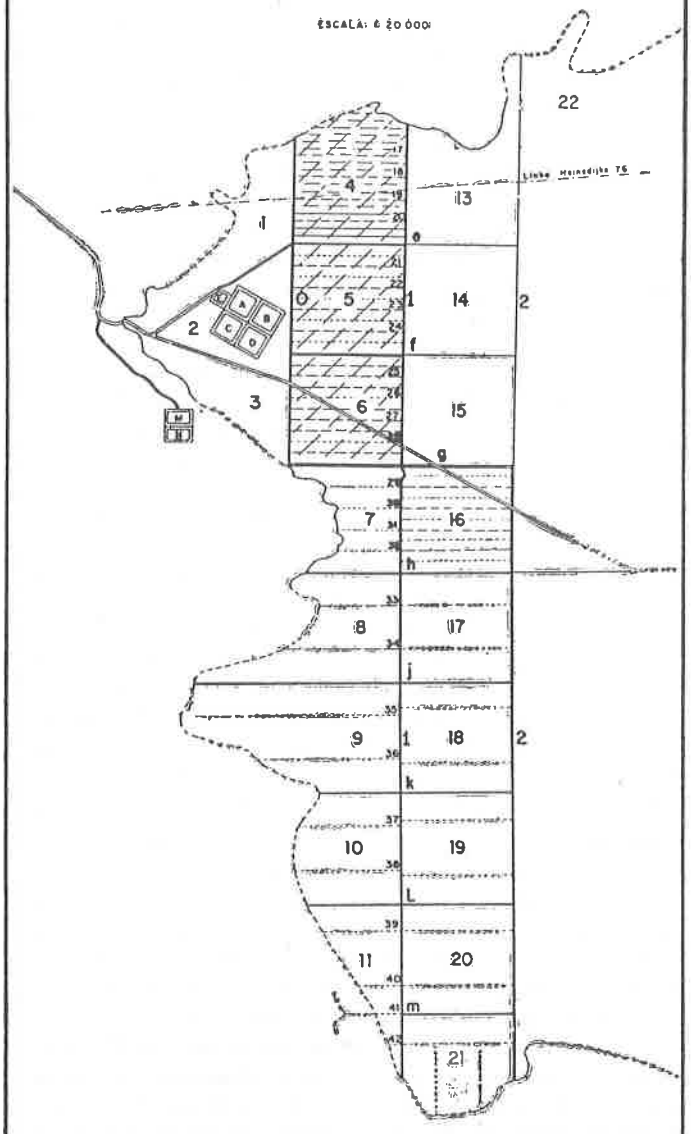
a) Promover o treinamento de Mão-de-Obra especializada em atividade de exploração florestal.

b) Promover a experimentação de silvicultura tropical através de plantios de espécies nativas e aclimatação de espécies exóticas de valor comercial.

c) Desenvolver trabalhos de condução e manejo florestal.

FIG. Nº 1

FLORESTA DE CURUÁ-UNA



TALHÃO	ÁREA	TALHÃO	ÁREA
1	80	11	64
2	44	13	104
3	56	14	100
4	115	15	100
5	100	16	98
6	97	17	100
7	64	18	100
8	96	19	100
9	152	20	100
10	90	21	85

LEGENDA

- Caminhos e estradas demarcadas
- Caminhos e estradas desmatadas
- Estrada principal
- Linhas de levantamento da regeneração e inventário - Propostas ou cortadas
- 9 Número do talhão
- Linhas de levantamento da regeneração e inventário - Enumeradas
- A, D Canteiros de pesquisas
- Borda do planalto fixada
- Borda do planalto suposta
- Corte de cipós
- Linhas de enriquecimento

FIG. Nº 2

MESES	TEMPERATURA C			INSOLAÇÃO Horas e Decimos	U.R. %	P P mm
	Média	Máxima	Mínima			
J	25,8	30,8	22,7	142,1	85	179
F	25,8	30,8	22,5	105,9	87	275
M	25,8	30,8	22,6	107,6	88	358
A	25,6	30,0	22,8	117,9	88	262
M	25,6	30,3	22,7	146,7	89	293
J	25,4	30,4	22,3	177,5	88	174
J	25,4	31,0	21,9	213,7	86	112
A	26,2	32,0	22,2	243,6	83	50
S	26,7	32,7	22,8	222,9	80	39
O	27,0	33,1	23,0	230,1	78	46
N	26,9	32,6	23,1	149,9	79	85
D	26,5	31,9	22,9	188,6	80	123
ANO	26,0	31,2	22,6	2.091, 5	84	2.096

DADOS CLIMÁTICOS DA ESTAÇÃO DE SANTARÉM VÁLIDOS PARA A ÁREA.

FIG. Nº 3 TEMPERATURA E PLUVIOSIDADE EM CURUÁ, ANOS DE 1958, 1959 E 1960. MÉDIA DA TEMPERATURA MENSAL: 1 Cm, 5º C. A ESTAÇÃO SÊCA É REPRESENTADA PELA PARTE ONDE A CURVA DA PLUVIOSIDADE CAI ABAIXO DA MÉDIA DA TEMPERATURA MENSAL.

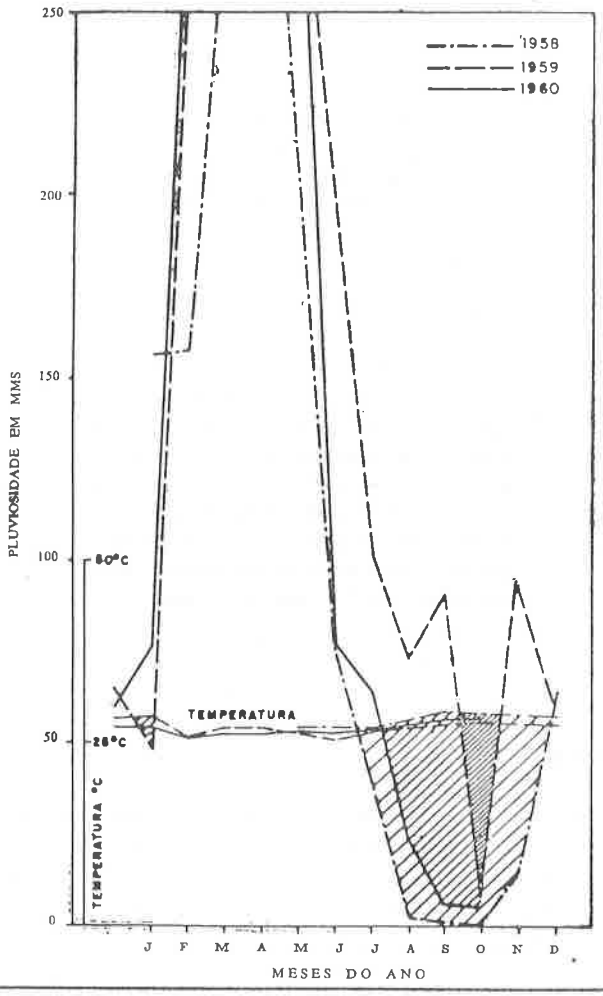


TABELA - I

MÉTODO DE REGENERAÇÃO NATURAL SOB ABRIGO TEMPORÁRIO (T.S.S.)

ÁREA DE ENSAIO (Nº)	OCORRÊNCIA DAS SPP		ÁREA DA PARCELA (m2)	Nº ATUAL POR PARCELA	DIAMETRO (cm)			ALTURA (m)			ASPECTO ATUAL DA ÁREA DO EXPERIMENTO
	NOME VULGAR	NOME CIENTÍFICO			MAX.	MED.	MIN.	MAX.	MED.	MIN.	
1	QUARUBA	Vochysia maxima	600	15	30,6	20,6	8,8	23,2	17,4	12,4	Excelente
	TACHI PRETO F.GRANDE	Tachigalia myrmecophy		4	24,6	16,7	7,4	18,8	16,5	11,9	Bom
	CUPIUBA	Goupia glabra		3	16,8	13,7	9,6	18,8	14,6	11,0	Bom
	MARUPÁ	Simaruba amara		2	40,6	32,8	22,5	23,7	22,2	20,7	Excelente
	MOROTOTÓ	Didymopanax morototoni		2	35,0	33,3	31,6	24,2	21,7	19,3	Excelente
2	QUARUBA	Vochysia maxima	600	25	30,3	18,8	7,2	22,4	16,9	9,2	Excelente
	TACHI PRETO F.GRANDE	Tachigalia myrmecophy		2	29,0	26,6	24,0	20,7	19,6	18,6	Bom
	CUPIÚBA	Goupia glabra		7	17,5	11,8	7,4	16,3	13,4	10,0	Bom
	MARUPÁ	Simaruba amara		2	28,5	24,6	19,9	18,8	18,1	17,5	Excelente
	MOROTOTÓ	Didymopanax morototoni		3	32,4	31,3	29,5	22,8	21,5	19,3	Excelente

TABELA - II

MÉTODO DE REGENERAÇÃO NATURAL EM FAIXA

ÁREA DE ENSAIO (Nº)	OCORRÊNCIA DAS SPP		ÁREA DA PARCELA (m2)	Nº ATUAL POR PARCELA	DIAMETRO (cm)			ALTURA (m)			ASPECTO ATUAL DA ÁREA DO EXPERIMENTO
	NOME VULGAR	NOME CIENTÍFICO			MAX.	MED.	MIN.	MAX.	MED.	MIN.	
1	MOROTOTÓ	Didymopanax morototoni	300	2	37,5	35,9	34,2	21,0	18,0	15,0	Excelente
	PARAPARÁ	Jacaranda copaia		1		17,5			9,6		
	CUPIÚBA	Goupia glabra		19	18,0	13,1	7,5	18,0	14,1	10,2	
2	MOROTOTÓ	Didymopanax morototoni	300	2	38,2	35,2	32,1	21,8	20,6	19,5	Excelente
	QUARUBA	Vochysia maxima		2	27,5	26,4	25,2	21,5	18,6	15,8	
	CUPIÚBA	Goupia glabra		14	23,0	14,9	8,7	19,5	14,8	9,5	
3	QUARUBA	Vochysia maxima	300	3	39,7	35,3	26,9	22,8	21,3	18,5	Muito bom
	CUPIÚBA	Goupia glabra		17	27,5	16,4	9,9	19,9	14,8	11,0	
4	QUARUBA	Vochysia maxima	300	2	42,6	33,1	19,3	21,4	15,9	10,5	Excelente
	MOROTOTÓ	Didymopanax morototoni		1		35,0			21,8		
	CUPIÚBA	Goupia glabra		7	20,9	17,3	12,0	17,5	14,5	6,0	
5	CUPIÚBA	Goupia glabra	300	12	25,0	18,0	8,8	19,2	15,2	10,5	Regular
6	CUPIÚBA	Goupia glabra	300	9	30,8	23,7	17,9	20,1	17,2	14,3	Regular
7	CUPIÚBA	Goupia glabra	300	5	26,0	23,2	17,2	19,7	17,6	14,2	Regular
8	CUPIÚBA	Goupia glabra	300	4	27,0	22,4	16,5	21,0	16,0	11,7	Regular
9	MOROTOTÓ	Didymopanax morototoni	300	1		20,5			20,0		Regular
	CUPIÚBA	Goupia glabra		5	24,9	19,1	14,0	19,5	17,7	16,7	
10	CUPIÚBA	Goupia glabra	300	4	24,9	19,2	16,0	20,5	17,0	14,2	Regular
11	CUPIÚBA	Goupia glabra	300	7	30,4	22,6	11,5	18,8	15,6	8,0	Bom
12	MOROTOTÓ	Didymopanax morototoni	300	2	41,2	39,3	37,3	23,0	22,9	22,8	Excelente
	CUPIÚBA	Goupia galbra		11	32,6	21,2	12,9	20,0	17,2	15,1	
13	PARAPARÁ	Jacaranda copaia	300	1		11,1			10,7		Regular
	CUPIÚBA	Goupia glabra		6	31,2	21,3	9,5	22,5	19,2	14,2	
14	PARAPARÁ	Jacaranda copaia	300	4	30,4	21,4	14,2	23,0	18,2	16,0	Regular
	MOROTOTÓ	Didymopanax morototoni		2	25,3	23,9	22,5	23,0	22,5	22,0	
	QUARUBA	Vochysia maxima		5	11,0	8,7	7,5	12,8	11,0	8,8	
	CUPIÚBA	Goupia glabra		9	28,2	17,4	10,0	20,1	17,0	13,4	
15	PARAPARÁ	Jacaranda copaia	300	2	30,0	24,6	17,8	22,5	19,5	16,5	Bom
	CUPIÚBA	Goupia glabra		21	26,3	21,3	10,3	20,5	18,4	13,2	
16	CUPIÚBA	Goupia glabra	300	21	26,0	18,6	11,0	20,5	17,2	11,8	Regular
17	PARAPARÁ	Jacaranda copaia	300	4	43,3	34,5	28,0	23,5	23,1	22,5	Excelente
	CUPIÚBA	Goupia glabra		5	26,0	18,2	11,0	17,9	14,6	11,7	
18	PARAPARÁ	Jacaranda copaia	300	1		41,6			23,5		Excelente
	CUPIÚBA	Goupia glabra		8	26,7	20,3	11,2	23,5	18,7	11,7	
19	CUPIÚBA	Goupia glabra	300	15	41,3	21,1	13,3	24,0	18,3	15,2	Bom
20	PARAPARÁ	Jacaranda copaia	300	1		29,3			20,3		Excelente
	MOROTOTÓ	Didymopanax morototon		1		28,9			21,6		
	CUPIÚBA	Goupia glabra		10	20,5	14,4	9,2	19,8	15,8	9,5	

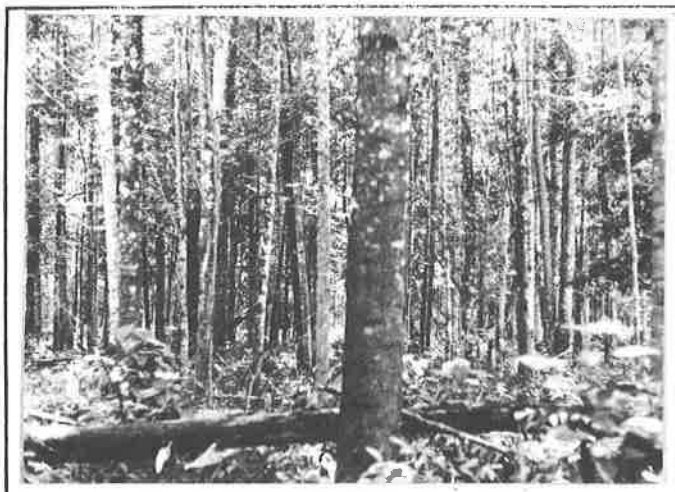


FOTO Nº 1

Regeneração Natural de diversas espécies, resulta do do método de R.N. sob abrigo temporário. Experimento em solo argiloso de Planalto.

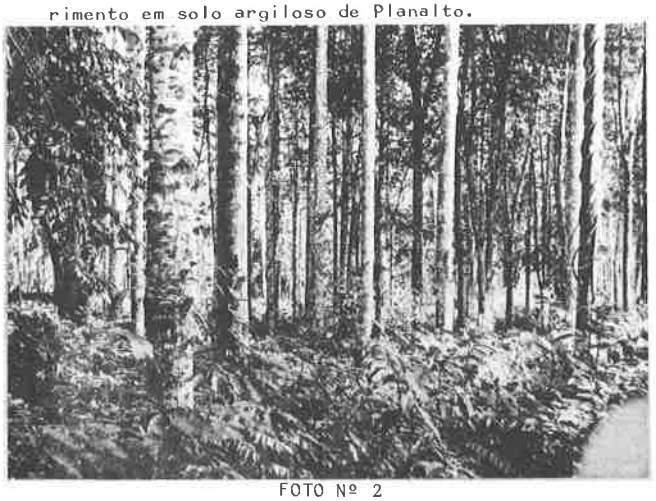


FOTO Nº 2

Regeneração Natural de diversas espécies, resulta do do método de R.N. em Faixas. Experimento em solo argiloso de Planalto.

1. Estação Experimental de Curuá-Una:

1.1. Área e Localização:

Fica situada a margem direita do rio Curuá-Una, afluente do rio Amazonas, entre os rios Tapajós e Xingú, a 50km de sua embocadura, sua posição geográfica é equatorial com 2º23' latitude sul e 54º24 longitude Oeste.

A atual área de domínio da Estação Experimental é de 1.800 ha, passando brevemente a ser ampliada para 100.000 ha aproximadamente.

1.2. Infraestrutura:

O acesso para a reserva ocorre atualmente somente por via fluvial.

Existe na base um acampamento com residência para técnicos e trabalhadores, garagem e oficina para manutenção de equipamentos e veículos, um Viveiro Florestal, energia elétrica e água encanada.

Para atender a execução dos trabalhos que vem sendo desenvolvidos na Estação Experimental, temos hoje aproximadamente 40 km de estradas florestal transitável. (Vide Fig.nº 1).

1.3. Aspectos e Condições Climáticas:

Na Estação Experimental assim como em toda a Amazônia a característica geral do clima é quente e úmido. Entretanto especificamente as condições macro-climáticas de Curuá-Una apresenta:

- Temperatura do ar - apresenta uma média anual de 26ºC, oscilando entre 25,4º a 27ºC.

- A temperatura máxima alcança extremos elevados variando de 30,0ºC, nos meses mais chuvosos e 33,1ºC, nos meses mais secos. A média está em torno de 31,2ºC.

- A temperatura mínima oscila em torno de 21,9ºC, a 23,1ºC, apresentando uma média anual de 22,6ºC. (Vide Fig.nº2).

- Umidade relativa do ar - A umidade relativa na região é de um modo geral elevada uniformemente durante todos os meses do ano. Na Estação Experimental de Curuá-Una há uma variação anual de 78% a 89%, com a média anual de 84%.

- Pluviosidade - A incidência de chuvas é relativamente elevada durante o ano inteiro, entretanto apresentando um nítido período de estiagem de 3 a 4 meses. Os índices pluviométricos mensais variam de 39 mm, nos meses de março, atingindo um total anual de 2095mm. (Vide Fig. nº 2 e nº 3).

1.4. Descrição dos solos:

As áreas de plantio da Estação Experimental de Curuá-Una se dividem em 2 (dois) grupos: solos arenosos do Flanco e solos argilosos do Planalto, onde a maior parte das espécies tropicais de valor comercial ocorrem.

As características desses solos são as seguintes:

PLANALTO: Latosolo amarelo, limo argiloso, de camada profunda, com textura pesada, fortemente ácido (PH 4,5 - 5,0) muito lixiviado, com poucos remanescentes no perfil além da sílica, óxido hidratado de ferro e alumina e argila caolinítica. Apresenta uma fertilidade natural baixa, problema de fixação de fosfato. Uma camada de folhas semi-decompostas cobrem o piso florestal.

FLANCO: Os solos de flanco estão subdivididos em:

Flanco baixo: Os solos desta área são profundos, bem drenados possuindo textura muito leve, fortemente ácido (PH 4,5 - 5,0), com uma fácil penetração das raízes e de água. Devido sua textura leve, além da reduzida fertilidade natural, reduz também a capacidade de reter a água, tornando se desse modo suscetíveis à seca.

Flanco baixo de transição: Neste caso os solos desta área são semelhantes aos descritos acima, apresentando uma textura mais pesada (franco arenoso sobre franco argila arenosó), por esta razão tendentes a serem menos secos. Devido a mudança da textura já são áreas de solos considerados bem próximo dos solos do Flanco Alto que possuem uma textura mais pesada podendo ser considerados solos originalmente para os estudos de Silvicultura.

Flanco alto: Os solos desta área possuem muitas características semelhantes aos do Flanco baixo. São solos fortemente ácidos, bem drenados e facilmente penetrados por raízes e umidade.

Possuem uma textura ligeiramente mais pesada (franco arenoso transmudando-se em argila no sub-solo mais baixo) e são fortemente concrecionários numa profundidade de 100 a 150cm. Apresentam baixa fertilidade e ausência de fixação de fosfato.

OBJETIVO:

A Floresta Tropical natural úmida, com muito poucas exceções, é uma mistura muito complexa, com centenas de espécies de árvores crescendo intimamente juntas, sendo que as espécies comercialmente úteis foram apenas uma percentagem muito baixa.

Regenerar naturalmente a floresta tropical úmida é uma tentativa de converter uma mistura muito complexa de espécies numa mistura mais uniforme, abrangendo a proporção máxima de espécies de alto valor comercial e numa proporção tão pequena quanto possível de quaisquer espécies sem valor ou de valor ainda desconhecido.

Assim sendo os estudos que ora realizamos visa averiguar o

comportamento de espécies florestais nativas de crescimento rápido, através de método de indução de regeneração natural mediante o controle de abertura da copa da mata natural.

Consequentemente apresentamos um resumo com informações sobre dados dendrométricos e outras ocorrências, que apresentam as espécies florestais na área do experimento, através das quais poderemos avaliar o índice de adaptabilidade que alcançaram.

MATERIAL E MÉTODO EMPREGADO:

1. Regeneração Natural Sobre Abrigo Temporário (Tropical Shelterwood System ou T.S.S.).

O experimento sob esta modalidade silvicultural consistiu na abertura do teto da mata (por envenenamento e derruba parcial) 2 anos antes da exploração comercial, a fim de dar condição ao meio para a fixação da regeneração natural. Após este período, foi efetuado a exploração comercial, ficando a regeneração natural de espécies desejáveis que já se encontravam sob a forma de mudas pequenas. Em seguida foi feito o envenenamento parcial das árvores dominantes sem valor comercial. Após estas operações a área foi deixada em abandono e depois de 6 anos foi feita uma verificação da ocorrência de um índice significativo de Regeneração natural. Assim acontecendo, foram feitas as primeiras intervenções silviculturais inclusive o envenenamento total de indivíduos florestais remanescentes, a fim de domesticar a regeneração natural de espécies de valor comercial de crescimento rápido existente. Os resultados hoje verificados são os mais promissores, existindo uma regeneração natural profusa e bem distribuída.

A implantação deste experimento foi conduzida em solo de Planalto com dominância de solo argiloso numa área de 6,25 ha.

Os resultados foram coligidos de 2 áreas de ensaios de 600 m2 cada, representativas de toda a área.

2. Regeneração em faixas por semeadura lateral após exploração comercial, seguida de derrubada total e queima das árvores residuais.

Podemos salientar que esse método é de real importância onde as espécies de luz, pioneiras, são de efetivo valor madeireiro.

Este método foi implantado na Estação Experimental de Curuá Una em região de solo de Planalto. A área submetida a experimentação tem a forma de uma faixa marginada por uma mata original a sotavento, com isso facilitando a semeadura lateral natural. As condições iniciais foram de abertura total ou seja derrubada e queima da mata residual.

Após a queima surgiu uma profusa regeneração natural com uma predominância muito grande de Cupiúbas (Goupia glabra) juntamente com outras espécies comerciais de crescimento rápido, atualmente a área de experimentação apresenta-se com o aspecto de uma plantação artificial densa.

O experimento foi conduzido em uma área de aproximadamente 3 ha e os resultados que estão sendo apresentados foram retirados de pequenas áreas de ensaios representativos.

RESULTADOS: Vide tabelas I e II

CONCLUSÕES E COMENTÁRIOS:

Os estudos dessa natureza podemos considerar como estudos pioneiros, e que devido a complexidade da composição florística das florestas da Região do Trópico Úmido, esta pesquisa vem progredindo lentamente.

Os resultados apresentados limitam-se a avaliação do desenvolvimento médio das espécies ocorrentes. Não devendo ser considerados definitivos, visto que em termos de pesquisas silviculturais, os resultados finais dos sistemas empregados, só poderão ser atingidas depois de um longo período de experiências bem planejadas. Entretanto podemos concluir, através dos resultados, quais as espécies que apresentam mais sensibilidade de adaptação nas condições em que estão sendo experimentadas.

ILUSTRAÇÃO FOTOGRÁFICA - Vide Anexo - I.

FONTES CONSULTADAS:

- PITT, JOHN - "Relatório ao Governo Brasileiro sobre a aplicação de métodos silviculturais a algumas florestas da Amazônia. Belém, SUDAM Divisão de Documentação 1969.
- TAYLOR, Charles J. -"Introdução a Silvicultura Tropical".
- DUBOIS, J.L.C. "Silvicultural Research in the Amazon" Rome, 1971.
- SUDAM DOCUMENTA = V.5 - Out.1973/Set.1974. PEDROSO, L.M. "Alguns aspectos sobre o florestamento e reflorestamento na Amazônia".
- JANKAUSKIS, J. "Relatório sobre características silviculturais de espécies naturais e exóticas dos plantios da Estação Experimental de Curuá-Una - CTM/SUDAM - Convênio - SUDAM/FCAP.

BASES ECOLÓGICAS E ECOGENÉTICAS PARA MELHORAMENTO DA PRODUTIVIDADE DE ESPÉCIE FLORESTAL CHAMADA "PARAISO" (*Melia azedarach,* LINN.)

E. O. V. Pilasi
Universidad Nacional de Misiones, Misiones
ARGENTINA

Summary

This document, has been prepared to outline the knowledges and concerning implications from an ECOLOGICAL PERSPECTIVE, to improve approaches for a Genetic Amelioration Program and Productivity goals Schedule.

In the actual World Forest Situation, to be judged from a network of a Natural Resources Perpetuity, the "high efficiency" of available soils utilization needs exemplarization, with the assistance of FOREST ECOLOGY. A basic bio-economic requirement arises in our time:

Silviculture of forest species, protecting and dynamizing the biogeocoenotical aptitude of a site: ACTUAL AND POTENTIAL ENERGY CONTENT. The "stand-tending" to be replaced by the "site-tending".

The author makes a briefing presentation of the backgrounds, defining MEMORAL LEVELS for an annotated forest species with an outstanding biology at this latitudes, as: industrial wood producer, and an "ECOLOGICAL INDICATOR" reflecting by its short-time behaviour the proper HABITAT HANDLING.

This paper establishes an ecological sequence methodology for habitat fucture characterization.

The author points out a Research Program to promote advanced scientific substantiations.-

Coincidiendo con REHFELDT y LESTER (7), la especie forestal que aquí se estudia, aporta bases de comportamiento útiles hacia el mejoramiento de la productividad forestal, en el marco de la GENETICA ECOLOGICA.

EL PARAISO, es una especie pionera, porque es capaz de disponer su ADAPTABILIDAD hacia la variación ecológica de los sitios y a su vez es especie de avanzada situación en la SUCESION VEGETAL, porque sacrifica su adaptabilidad en favor de la ESPECIALIZACION para condiciones particulares del sitio.

Como refieren los autores mencionados, las mejoras genéticas, estimadas en las características económicamente importantes, NO PUEDEN REALIZARSE, si están acompañadas por una pérdida de las características especiales

EL PARAISO, sobre las dos divisiones ecológicas, que siempre se establecen al analizar los sitios y la vegetación, INTERACCIONA SIGNIFICATIVAMENTE: sobre el macroclima, su productividad es el resultado de su capacidad biológica para dinamizar la energésis de la UNIDAD ECOLOGICA, representada por el clima general y la relación geológico-fisiográfica de un lugar; sobre el microclima, su acción es intensa sobre los intercambios nutricios, sin estar limitada en las variaciones físicas intermedias de los suelos, por las diferencias hídricas en los mismos. TIENE ASI UN PROMISORIO LUGAR EN EL "ENRIQUECIMIENTO Y CONVERSION" DE FORESTALIAS SUBTROPICALES. (8)

Las relaciones hídricas, no solo son el primer escalón del análisis ecológico de los sitios, sino también la división fundamental para la clasificación taxonómica de los tipos forestales, con los cuales puede asociarse en productividad, una especie forestal dada.-

Es una especie, cuyos patrones fundamentales de comportamiento a los distintos ambientes no están debidamente definidos y comprendidos.La total armonía, entre la BIOECOLOGIA del sitio y los REQUERIMIENTOS ESPONTANEOS de la especie, es el REQUISITO EXIGIBLE, toda vez que se intente someterla a una SILVICULTURA INTENSIVA, con miras a un rendimiento sostenido.

Por naturaleza es rústica y acomodaticia, siendo propicio indicar que en la Reserva Forestal Biológica de Garuhapé(Departamento Libertador General San Martin) --conducida por el autor-- dentro de los especios tratados del monte natural, con suelo rojo(latertítico) profundo, han aparecido espontáneamente ejemplares de esta especie.Sobre suelos pedregosos y sitios altos,existen rodales de crecimiento llamativo aunque desuniformes.

Tiene un patrimonio genético capaz de dar las más variadas respuestas a los distintos tratamientos silviculturales y ambientales.

HESSELMAN,indica: "los árboles son más exigentes en luz,cuando crecen en lugares malos,que cuando lo hacen en lugares buenos.

Las observaciones del autor, detectan que en Misiones (26.º Latitud Sur y 55º Long.oeste), como en la región de Cuyo (33º Latitud Sur y 68º Long.oeste), el PARAISO, es amante de la luz aunque en su fisiología influye más acentuadamente la longitud de las noches cálidas, lo que hace que su estado vegetativo sea más prolongado en Misiones que en Cuyo y por lo tanto explicaría porqué en Misiones sufre con las heladas y es más resistente en Cuyo,e inclusive aquí,se rejuvenece por las podas al igual que en Misiones y en ambas regiones degenera en grado vario.

Es válida para esta especie, una observación lograda sobre los eucaliptos.Los representantes de este género botánico, son en su mayoría sensibles a los fríos.Suelen resistirlos cuando por distanciamiento de plantación la estructura superior de las copas mantiene continuidad con el dosel, lo que asegura un mayor grado de endurecimiento de las hojas. Es recomendación del autor, que en el PARAISO, los distanciamientos reducidos lo capacitan biológicamente frente a las bajas temperaturas.

Científicamente está comprobado, tanto en las plantas herbáceas como en las leñosas, que lo importante no es la duración del día, sino la de las noches.Las pasturas degeneran en su mezcla florístico-forrajera donde las noches son largas y cálidas y los árboles forestales crecen sostenidamente en ellas. El PLAN LEÑOSO,de muchos,se vé favorecido por este factor de foto y termoperiodicidad.

A plena intemperie, las especies leñosas ostentan temperamento diferente cuando crecen en las orillas o en el interior de claros del monte natural.Aquí la proporción de sombra --rica en longitudes de onda corta, mientras que recibe sombra con longitudes de onda larga,cuando permanece bajo cubierta protectora-- constituye un factor biofisiológico interaccionante con el requerimiento mínimo RELATIVO DE LUZ que las especies necesitan. (4)(6)

EL PARAISO, tiene un mínimo requerimiento relativo de luz, que lo capacita en mezcla con otras especies forestales de hojas anchas, a predominar en altura;sin embargo su fuste es exigente en media sombra y sus incrementos diamétricos son continuos y uniformes donde, ya sea por su menor distanciamiento de plantación o por la presencia de especies PROTECTORAS O EDIFICADORAS --como se denomina en fitosociología-- la satisfacen en ese requerimiento.

EL PARAISO, por las características estratificadas de su sistema radicular (con raíces profundas, que se benefician de la declinación progresiva de la temperatura del suelo y de raíces superficiales, que progresan con las mayores temperaturas superficiales del mismo) en distanciamientos reducidos de plantación, el INDICE DE SUPERFICIE FOLIAR (ISF) --relación entre la superficie de follaje y la superficie de suelo cubierto por él-- está expresado por una PROPORCION DE SOMBRA SOBRE EL SUELO que impide el calentamiento de las raíces superficiales, CONTROLANDO que la actividad foliar sea también menos prolongada.

El ALMACENAJE NUTRICIO, es también favorable bajo las condiciones ecofisiológicas de los distanciamientos reducidos, protegiendo al vegetal de los fríos intensos medios o tardíos y posibilitando que aún cuando ellos ocurran el vegetal disponga de sus nutrientes propios para asegurar la próxima brotación.

EL RENDIMIENTO DE MADERA, es una consecuencia de esta productividad, sustentada por una influencia directa de la CAPACIDAD GENETICA y FISIOLOGICA de la especie forestal para dinamizar BIOGEOCOENOTICAMENTE el sitio de plantación, rindiendo una BIOMASA equilibrada y sana. Equilibrada, porque su crecimiento bajo las UNIFORMES condiciones, produce UNIFORMIDAD intraespecifica de las cualidades del PLAN LEÑOSO; sana, porque la ECOLOGIA de las enfermedades y aún de epífitas --para los cuales la corteza del PARAISO representa una muy apta influencia FITOCOENOTICA-- comportan estabilidad biocénica.

Los distanciamientos amplios producen excesos de temperatura de la superficie de los troncos con respecto a la que posee la atmósfera circundante.Cuando los diámetros son menores de veinte centímetros y la corteza posee un espesor apreciable de tejido lignificado rugoso, este exceso térmico produce una transferencia de calor hacia el interior del tronco, menor que en el caso de cortezas lisas y delgadas.

Este balance térmico, es el resultado de una ganancia lumínica dentro del HABITAT, el cual GLOBALMENTE gana capacidad para la productividad primaria diferencial del "TIPO FORESTAL". Los organismos adversos al crecimiento vegetal,tienen dependencia sostenida con este proceso de transferencia calórica.

GENETICA - FISIOLOGIA y HABITAT dán ECOGENETICA-ECOFISIOLOGIA y PRODUCTIVIDAD FORESTAL.

La Genética y Fisiología radicular del PARAISO, se peculiarizan comportándose como esquilmante o empobrecedor sobre el ciclaje nutricio de suelos, en distanciamientos amplios de plantación, mientras que una densidad mayor posibilita la absorción de nutrientes desde mayor profundidad, uniformando la CAPACIDAD DE INTERCAMBIO CATIONICO DEL PERFIL EDAFICO y reduciendo la ACTIVIDAD GENNEMATICA de los pies arbóreos. Otro ejemplo concreto para la expresión sintética con sentido ecológico, indicado anteriormente.

Esta expresión, es válida e inaugura una METODOLOGIA BASICA para el MANEJO FORESTAL de cualquier especie leñosa, que a veces se deja en el olvido, por tomar como "INDICADOR" el comportamiento sobresaliente de representantes aislados y juzgar perpetuable en condiciones de plantación forestal.

Así llegamos a través de todos estos umbrales críticos del análisis,a la SIMIENTE, al lugar concreto,de la historia concentrada,de vicisitudes pasadas,por una especie vegetal. Para el PARAISO, es menester, que en cada"localidad"se utilice simiente de los mejores ejemplares,dentro de esa"localidad", como UNIDAD ECOLOGICA ná como UNIDAD GEOGRAFICA.

Cuando se procede así, se logra la BASE GENETICA para una buena respuesta silvicultural.De esto depende la seguridad que los individuos ostenten UNIFORMIDAD FISIOLOGICA en sus reacciones hacia los ESTIMULOS que el HABITAT les imponga.

.De este estudio, el autor recomienda los siguientes pasos, fundamentando científicamente un MODELO DE INVESTIGACION:

(A). Definir la uniformidad genética del material biológico.
- Instalar los estudios bajo diseño estadistico, dada la amplia gama de variabilidades.
- Confeccionar modelos de fertilización, dado que esta especie forestal tiene inmediatas respuestas hacia las distintas capacidades de intercambio de los sitios.
- Realizar estudios de genética ecológica, como única vía para conocer los factores mensurables del habitat y su acción en las reacciones de crecimiento y evolución de la estructura leñosa.
- Realizar estudios sinecológicos, vale decir medir la afinidad de crecimiento y la capacidad de AUTOREGULACION del especio y los componentes del HABITAT en"estaciones" forestales naturales.Las observaciones preliminares del autor, indican que el PARAISO es una magnífica especie pionera y alternativa,para el enriquecimiento de masas forestales naturales empobrecidas.
- Instalar estudios de fotometría ecológica, como medio de co-relacionar la eficiencia genética con la eficiencia fisiológica y el grado de independencia de ambas en el RITMO ESTACIONAL Y PERIODICO. (la eficiencia fotosintética) La diferenciación micrometeorológica de la vegetación, constituye la base para orientar los tratamientos culturales en el ahorro y desarrollo simultáneo de la productividad potencial de toda vegetación con su sitio. (reutilización de los niveles de energía disipada).

REFERENCIAS BIBLIOGRAFICAS

(A) Regonese,A.E. y Garcia,A.L.(1969)

REFERENCIAS BIBLIOGRAFICAS

1. BECKER,G. y LOEBE, I.(1966)
"Hitzeempfindlichkeit Holzzertörender Käferlarven"
Anz.Schädlingsk.34(10) en: IFLAIC Boletin Nr.7,Abril,Mérida(Venezuela)

2. FRESA,R.(1958)
"La presencia de Sphecelema melina en el Paraiso"
Rev. de Inv.Agric.Buenos Aires 12(4),Argentina
en: IFLAIC Boletin Nr.1,Mérida(Venezuela)

3. JONES,T.(1965)
"The economic ecology of some tree-boring beetles of tropical Africa"
en: IFLAIC Boletin Nr.7,Abril,Mérida(Venezuela)

4. HODGES,John D.(1967)
"Patterns of Photosynthesis under Natural Environmental Conditions"
Ecology,Vol.48(2).Reprinted By the Forest Service,U.S.Department of Agriculture,for official use.

5. KUNN,M.(1975)
"Bemerkungen ueber die Bedeutung der Population Genetik und der Ökologischen Genetik als basis fuer Forstgenetische und Forstpflanzenzuchterische Arbeiten" Silvae Genetica 24(4) 118-126 en: IFLAIC Boletin 2222(FA 8/76)
Mérida(Venezuela)

6. MARQUIS,David A.(1965)
"Controlling LIGHT in Small Clearcuttings"
U.S.Forest Service Research Paper NE-39
Northeasterne Forest Experiment Station,Upper Darby,PA.USA.

7. REHFELDT,G.E. y LESTER,D.T.(1969)
"Specialization and Flexibility in Genetic System of Forest Trees"
Silvae Genetica 18(4) 118-123 en: IFLAIC Boleting 1425 A.FA 2/70,Mérida
(Venezuela)

VIDELA PILASI,E.O.(1978)
8. "Breves connotaciones biocecológicas y silviculturales para el PARAISO (Melia azedarach,Linn.) en Misiones"
Contribución para la Subgerencia de Investigaciones Forestales,División Maderas,Celulosa Argentina SA.Buenos Aires,Argentina (inédito)

FAST GROWING TREES

UTILIZAÇÃO DE *Melaleuca quinquenervia* PARA PRODUÇÃO DE BIOMASSA

D.L.Rockwood, L.F.Conde and J.B.Huffman
University of Florida, Florida
USA

Resumo

Resumo dos recentes estudos sobre o potencial da *Melaleuca*, como espécie usada para a produção de biomassa na Flórida. Árvores individuais tem, geralmente características de biomassa adequadas, mas algumas propriedades da casca são indesejáveis. As taxas de produção de biomassa em povoamentos bastante densos variam desde intermediárias até altas.

São apresentadas técnicas de propagação geral para se estabelecer um bom povoamento.

Foram iniciadas plantações para examinar as diferenças genéticas entre e dentro das áreas geográficas; e são apresentados os resultados preliminares. Plantações adicionais serão estabelecidas.

UTILIZATION OF *Melaleuca quinquenervia* FOR BIOMASS PRODUCTION

Summary

Recent studies on the potential for melaleuca as a "biomass" species in Florida are summarized. Individual trees have generally suitable biomass characteristics, but some bark properties are undesirable. Biomass production rates in high density stands range from intermediate to high. General propagation techniques for successful stand establishment are presented. Plantings to examine genetic differences among and within geographic areas were initiated, and preliminary results are given. Additional plantings will be established.

INTRODUCTION

Melaleuca quinquenervia (Cav.) Blake, native to the southwest Pacific area, was originally introduced into Florida in the early 1900's. As a consequence of wide propagation and the species' prolific seeding and adaptability to conditions in south Florida, it is now endemic to large areas (Meskimen, 1962). Aerial surveys indicate that melaleuca is distributed over 4.5 million ha. in 17 south Florida counties, with stands of 30+% melaleuca occurring on 525,000 ha. (Ewel, et al. 1976). Melaleuca is the dominant tree species in three portions, totalling 200,000 ha., of the region.

This abundance of melaleuca has created problems as well as afforded opportunities. Native vegetation has been virtually eliminated from many areas invaded by melaleuca. Many ecologists consider melaleuca a threat to the Everglades due to the species' potential for invading wet areas and possible high water consumption.

A substantial quantity of melaleuca wood is available, but even though a number of uses ranging from pallet stock to tomato stakes to insulation have been presented (Huffman, 1980), the resource is scarcely utilized. Given the present underutilization and need for an alternative to petroleum for electrical generation, one potential application is the use of melaleuca for fuel.

While substantial fuel can be realized from existing stands, the alternative of producing melaleuca fuel in "biomass plantations" has some appeal because melaleuca coppices, is obviously suited to many sites in south Florida, and is reputedly fast growing. This paper summarizes research assessing melaleuca's potential for biomass production, in particular studies examining genetic variation for growth in high density, short rotation, intensive culture systems.

PROCEDURES

Melaleuca biomass was characterized in two field investigations. In May and June, 1978, 14 trees, ranging from 5 to 38 cm. in diameter, in two uneven-aged ("old") stands south of Ft. Myers were felled. During March, 1979, 100 trees, 0.4 to 22.4 cm. in diameter, were sampled in 10 relatively even-aged ("young") stands, 5 each in Lee County and Dade County. In both cases, felled tree biomass was separated into stem, branch, and foliage components. Disks were removed at percentile intervals from the stem and a representative branch, and a foliage sample was retained. Wet weights of the components were determined in the field, and dry weights and energy yields were derived subsequently.

Forty superior phenotypes, trees of above average growth and form, were selected in March, 1979: 18 trees each in southwest and southeast Florida, 4 from south-central Florida. Seed were collected and sown in April, 1979, in containerized planting blocks in a greenhouse. In July, seedlings were outplanted near LaBelle in field designs to evaluate cultural requirements, variation among families, and spacing influences.

RESULTS AND DISCUSSION

The various biomass components of melaleuca have quite different characteristics (Table 1). In both sets of trees, the bark had the highest energy value, over 6,000 calories/gram, but the density of the bark was exceedingly low. Thus, while some 30% of a tree's diameter may consist of bark, the light weight of the bark, plus its high moisture content, detracts considerably from its energy potential. The wood has somewhat typical energy content and acceptable density and moisture content. Branch energy value was somewhat higher than that of the wood, in part at least due to the inclusion of branch bark in the branch sample.

Table 1. Biomass characterization of "old" and "young" melaleuca trees.

Component		"Old" Stands 5-10 cm.	"Old" Stands 11-38 cm.	"Young" Stands
Branches	- % of Wet Tree Wt.	1-5	1-5	6
	- cal./g.	4,668		4,610
Foliage	- % of Wet Tree Wt.	20-35	1-10	8
	- cal./g.	5,248		4,810
Stem Wood	- % of Wet Tree Wt.	45-55	75-85	60
	- cal./g.	4,568		4,400
	- specific gravity	.49		.51
	- % moisture content	135		90
Stem Bark	- % of Wet Tree Wt.	15-25		25
	- cal./g.	6,063		6,160
	- specific gravity	.08		.19
	- % moisture content	285		150

The biomass distribution within a tree was influenced by tree size and stand density (Table 1). Branches usually accounted for a small portion of the total tree biomass. Foliage, actually small twigs and leaves, varied from 35% in small trees in an open stand to a small percentage in the larger trees in the same stand. In the dense "young" stands, the foliage component was also very low. The stem wood contribution was influenced by tree size, with large trees having as much as 85% of the total biomass concentrated in the stem wood in the more open "old" stands, but high stand density, as shown by the "young" stands, can also cause somewhat suitable concentrations of biomass in the stem. In all stands examined, relatively little differences were observed in the proportion of stem bark.

Table 2. Characterization of some natural "biomass" stands.

	A[1]	B[1]	C	D
Estimated Age	3	9	?	?
Trees/ha.	14,950	5,950	158,000	25,200
Mean DBH	2.3 cm.	5.6 cm.	2.0 cm.	6.2 cm.
Mean Height	3.2 m.	8.1 m.	-	-
Dry Tons/ha.	41.4	256.9	41.7	284.1

[1] from Conde and Rockwood, 1979

Biomass production levels in high density stands were certainly adequate and occasionally exceptionally high (Table 2), mostly due to the extreme tree densities that can be tolerated. The per ha. per year equivalent for Stand B of an estimated 28.5 metric tons was a notable rate of above ground biomass accumulation, and several other stands may have exceeded that rate but stand age could not reliably be estimated.

The selection of "superior" phenotypes was undertaken to build on the inherent capability of the species to produce biomass. Trees selected usually had columnar stem form, were exceptionally straight, and were above average size in comparison to "similar-aged" check trees in the immediate vicinity. The differences in size among the sources of selections (Table 3) cannot be considered genetic differences because of likely differences in tree ages and possible site effects.

The sources were also compared for energy content, based on an apparent independence of heat value from tree size for all biomass components. Utilizing the samples from the 10 "young" stands, the energy value of the Southwest and Southeast sources differed only for the bark component.

Table 3. Summary of phenotypic assessments of 38 melaleuca selections and five month survival of progenies of 32 trees and 2 check lots.

Selections			Progeny Performance		
Source	DBH	Height	Source	Mean (%)	Range (%)
Southeast[1/] - Mean	15 cm.	8.2 m.	Southeast	93.2	79-100
Range	6-27 cm.	5.2-13.4 m.			
Southwest - Mean	16	11.5 m.	Southwest	95.3	91-100
Range	8-25 cm.	6.4-15.9 m.			
South-central - Mean	28 cm.	23.2 m.	South-central	94.0	89-96
Range	22-44 cm.	15.0-29.3 m.			
			Unimproved	92.0	89-95

[1/] Number of trees and progenies per source: for selections, 17, 16, and 5, respectively; for progenies, 13, 14, 5, and 2, respectively.

Propagation of progenies of the selections was very successful. Seedlots of all selections except those with "green" capsules had high germination. (We have subsequently achieved good germination of the seedlots after one year of seed storage under non-rigorous conditions.) Conventional greenhouse culture in containers produced healthy, vigorous seedlings suitable for outplanting in 14 weeks.

General cultural requirements for rapid tree establishment and growth should include weed control. The seedlings survived well in competition with herbaceous vegetation and eventually overtopped the vegetation, but early growth was stunted. Nevertheless, many trees were approximately .7 m. in height after six months.

While general survival was good, some differences among progenies were detected (Table 3). Most progenies had survival rates above 94%; only three progenies had rates less than 90%. Source differences were not evident, nor were the progenies detectably better than two unimproved seedlots.

Later observations from the July, 1978, plantings will be necessarily limited. Hog damage, non-discriminant in nature, has terminated several portions of the planting. Spacing and family trials are to be replanted this year.

CONCLUSIONS

Melaleuca appears to have potential as a biomass species in south Florida. Existing stands, spread over a wide area, have sufficient levels of suitable biomass for fuel. "Biomass plantations" could be established on sites currently occupied by melaleuca. Resulting production rates, and succeeding rotations, would result in adequate biomass availability. The additional potential due to the use of selected planting stock is yet to be documented.

LITERATURE CITED

Conde, L. F., and D. L. Rockwood. 1979. Energy plantation potential in Florida. Proc. IFAS Conf. on Alt. Energy Sources for Fla., p. 2-11.

Ewel, J., R. Meador, L. Conde and B. Sedlik. 1976. Studies of Vegetation Changes in South Florida. Dept. of Bot., Univ. of Fla., 119 pp.

Huffman, J. B. 1980. Florida's Melaleuca, A Utilization Status Report and Problem Analysis. Sch. For. Res. and Conserv. Res. Rpt. No. 26, University of Florida, Gainesville, 19 pp.

Meskimen, G. F. 1962. A Silvical Study of the Melaleuca Tree in South Florida. Univ. of Fla. Master's Thesis, 177 pp.

FAST GROWING TREES

O POTENCIAL DE *Casuarina spp* PARA PRODUÇÃO DE BIOMASSA NA FLÓRIDA

D.L.Rockwood, J.B.Huffman and L.F.Conde
University of Florida, Florida
USA

Resumo

Foi iniciada uma pesquisa para a avaliação de *Casuarina equisetifolia* e *C. cunninghaminana* e *C. glauca*, para a produção de biomassa. As propriedades da madeira, taxa de crescimento aparente, e a adaptabilidade são promissoras. Foram efetuadas plantações no Sul da Flórida, os resultados, até agora, não são muito promissores. Trabalho posterior está sendo conduzido.

POTENTIAL OF *Casuarina spp* FOR BIOMASS PRODUCTION IN FLORIDA

Summary

Research to evaluate Casuarina equisetifolia, C. cunninghaminana, and C. glauca for biomass production has been initiated. Wood properties, apparent growth rate, and site adaptability are promising. Outplantings have been established in south Florida, but results are not encouraging to date. Further work is underway.

INTRODUCTION

Australian pines, Casuarina spp., are used in many tropical countries for producing fuelwood (NAS, unpublished). In Florida, C. equisetifolia L., C. cunninghamiana Miq., and C. glauca Sieb. ex Spreng., are naturalized in many southern areas, and extensive stands have developed near the southeast and southwest coasts. No use is now made of the resource; however.

Growth potential of the Australian pines in Florida is considerable (Conde and Rockwood, 1979). Growth rates are generally considered to be good (nearly 2 m./year); undocumented reports of exceptional rates have been received. Many different site types have been occupied by the species, ranging from sandy, coastal areas to frequently wet areas with exposed limestone.

In view of their desirable fuelwood properties, good growth, nitrogen-fixing ability, adaptability to a range of sites, and potential for coppicing and low intensity culture, Australian pines have recently been included in a series of research efforts evaluating candidate species for biomass plantations. Summarized here are activities dealing with energy yields, cultural systems, spacing, and genetic variation for biomass production.

METHODS

Preliminary biomass data were obtained for three felling operations. In all cases, trees were selected to represent the range of diameters occurring in an area. Trees were measured for total height and dbh, and the stem, branch, and foliage components were separated. Each was weighed separately, and disks were removed at the base of the stem and at 1/4, 1/2 and 3/4 points on the stem and on a representative branch. A foliage sample was also retained. All samples were processed in the lab to determine moisture content and specific gravity. In one sample, 11 C. equisetifolia and C. cunninghamiana trees were felled from Naples to south of Ft. Myers. A second collection consisted of 7 C. glauca trees in a dense stand west of Lake Okeechobee. A third sample was composed of 10 C. equisetifolia and C. cunninghamiana west of Homestead.

Twenty-six C. equisetifolia and C. cunninghamiana selections were made in natural stands in southwest and southeast Florida in September, 1978. The selections were based on size relative to neighboring trees and on acceptable form and straightness. Seed were collected and sown in April, 1979, in containers in a greenhouse. Seedlings were outplanted in July, 1979, near LaBelle, in a number of studies. Management trials were established for all combinations of bedding and no bedding and ground rock phosphate at the rate of 1.1 ton per ha. and no phosphate; most studies were established at 1 m. x 1 m. spacing.

RESULTS AND DISCUSSION

The wood properties of Casuarina are acceptable for fuelwood (Table 1). Energy value is not high relative to other exotics studied, but the wood is considerably denser (Conde and Huffman, 1978). Based on preliminary equations we have developed to predict total tree energy yield (Table 2), Casuarina spp. may be expected to yield considerably more energy per tree than other species when tree sizes are equal.

Seed was most easy to obtain, store, and propagate. The yield of seed was exceedingly high on a per cone and per tree basis, and germination after several months of casual cold storage was quite high. Seedlings grew well in containers and were healthy and vigorous at outplanting.

While Australian pines may grow quickly and reach considerable size, as witnessed by many of the selected trees in Table 3, in many situations, successful growth rates are not necessarily achieved. Severe herbaceous competition, particularly from grass, depressed height growth on most plots during the nine months following planting. Initial survival was good, as shown by families in the genotype x spacing trial (Table 4), but the trees essentially just persisted, with most trees being less than .3 m. in height after nine months.

Minimal levels of weedy competition must obviously exist if rapid growth is to be achieved. Study areas that were drier and had less grass had noticeably larger, healthier trees.

Further efforts on evaluating Australian pines are planned. The existing studies will be treated with herbicide to reduce competition, and certain management plots have received sewage sludge or chemical fertilizers. Selection and spacing plots will be reestablished this July on a higher, drier site treated with herbicide.

A number of presumably frost hardy C. cunninghamiana were selected from the north Florida area and will be outplanted this July near Perry on a sandhills site. Such sites may be excellent location for growing Australian pines for biomass, as suggested by the work of Badran and El-Lakany (1977). A related study is in progress on the feasibility of rooting as a means of propagating these trees.

CONCLUSIONS

Casuarina spp. have promise as biomass species for many Florida environments. Growth rates may be good, and wood properties are particularly attractive. The species may be easily propagated by seed. Proper cultural conditions, especially methods of weed control, must still be determined.

Table 1. Summary of biomass properties of Casuarina spp.

	C. equisetifolia and C. cunninghamiana	C. glauca
Stem -		
Wood - % of total biomass	73	77
- specific gravity	.72	.61
- % moisture content	69	89
- cal./g.	4544	4410
Bark - % of total biomass	13	12
- specific gravity	.43	.56
- % moisture content	124	113
- cal./g.	4378	4114
Branches + Foliage		
- % of total biomass	14	11
- % moisture content	125	120
- foliage, cal./g.	4877	4834
- branches, cal./g.	4513	4500

Table 2. Predictive equations for total tree energy yield of Casuarina glauca, Melaleuca quinquenervia, and Eucalyptus grandis.

Equation form: $Y = b_0 + b_1 \cdot D^2 \cdot H$

Y = energy yield in kilocalories
D = dbh in cm.
H = total ht. in m.
b_0, b_1 = regression coefficients

Species	Regression Coefficients b_0	b_1
C. glauca	25,101	119.05
M. quinquenervia	37,698	40.51
E. grandis	-1,000	84.95

Table 3. Characteristics of Casuarina equisetifolia and cunninghamiana selections.

Selection No.	Height (m.)	DBH (cm.)
C. cunninghamiana -		
Southeast		
17	16.8	20
18	18.9	20
19	16.8	22
20	19.2	13
21	19.8	13
22	29.0	27
23	28.7	37
24	29.6	23
25	25.1	24
26	27.1	25
Southwest		
1	15.6	14
3	21.3	20
4	20.4	19
6	22.9	20
10	21.0	21
11	23.2	23
12	16.0	18
13	21.3	18
C. equisetifolia -		
2	22.0	17
5	23.8	21
7	31.4	30
8	29.3	32
9	18.0	14
14	15.6	14
15	13.9	11
16	18.0	15

Table 4. Three-month survival of Casuarina families in the Nelder's plots.

Family	Percent Survival	Family	Percent Survival	Family	Percent Survival
1	90	10	67	20	84
2	84	11	90	21	92
3	76	12	82	22	88
4	80	13	80	23	90
5	94	14	96	24	96
6	69	15	98	25	76
7	100	16	100	26	79
8	92	17	74		
9	94	18	92	Mean	87

LITERATURE CITED

Badran, O. A., and M. H. El-Lakany. 1977. Breeding and improving of Casuarina for shelterbelt plantations in Egypt. Proc. 3rd World Con. on For. Tree Breeding, p. 573-578.

Conde, L. F., and J. B. Huffman. 1978. Energy utilization from biomass - from fuel plantations. Proc. 10th Spring Symp. Fla. Section, Soc. Amer. For., p. 44-64.

Conde, L. F., and D. L. Rockwood. 1979. Energy plantation potential in Florida. Proc. Conf. Alt. Energy Sources for Florida, p. 2-11.

National Academy of Sciences. Firewood Crops: Shrub and Tree Species for Energy Production. (in preparation).

SUSCETIBILIDADE DE ESPÉCIES FLORESTAIS À *Melodogyne javanica* NA REGIÃO SEMI-ÁRIDA DO BRASIL

J.M. dos Santos
CPATSA/EMBRAPA
H. D. da Silva
PNPF/CPATSA/EMBRAPA
BRASIL

Resumo

Testou-se a susceptibilidade de dez espécies florestais a Meloidogyne javanica. faveiro (Parkia platicephala Benth.), imbiruçu (Pseudobombax simplicifolium A. Robyns J.), imburana de cheiro (Torresia cearensis Fr. all) e algaroba (Prosopis juliflora D.C.) são hospedeiros susceptíveis. Angico (Andenanthera macrocarpa Engl.) e Leucena (Leucaena sp) mostraram-se não susceptíveis, enquanto que aroeira (Astronium urundeuva Engl.), pau d'arco (Tabebuia impetiginosa Mart.), sabiá (Mimosa caesalpinipholia Benth.) e violeta (Dalbergia cearensis Ducke.) mostraram-se imunes. Nas espécies imbiruçu e imburana de cheiro o nematoide produziu ramificações do xilopódio. Não se constatou efeito do nematoide na sobrevivência de mudas de nenhuma das espécies.

Summary

The forest species were tested with respect to susceptibility to Meloidogyne javanica. faveiro (Parkia platicephala Benth.), imbiruçu (Pseudobombax simplicifolium A. Robyns J.), imburana de cheiro (Torresia cearensis Fr. all) and algaroba (Prosopis juliflora D.C.) are susceptible hosts. Angico (Anadenanthera macrocarpa Eng) and leucena (Leucaena sp) showed up as non-susceptible host, while aroeira (Astronium urundeuva Engl.), pau d'arco (Tabebuia impetiginosa Mart.) and violeta (Dalbergia cearensis Ducke) showed us as immune. In imbiruçu and imburana de cheiro, the nematode produced ramifications of the xilopodium. The nematode had no effect on seedling survivonship.

INTRODUÇÃO

Os nematoides das folhas podem atacar diferentes espécies florestais. Com efeito, Kiyohara, citado por WANG et al. (1975) encontrou Meloidogyne sp. em 25 dos 40 viveiros de espécies florestais examinados no Japão. Nos Estados Unidos, RUEHLE (1964) também constatou essa associação.

Relatos de RIFFLE (1973) por sua vez, dão conta de que larvas de uma espécies não descrita de Meloidogyne penetraram em ectomicorrizas de árvores adultas de Pinus ponderosa, atingindo as raízes, possivelmente, diminuindo a influência de ectomicorrizas como dissuassor biológico para a infecção por outros patógenos.

Meloidogyne javanica (Treub, 1885) Chitwood, 1949, tem sido constatado em diversos pontos da região semi-árida do Brasil, possui larga faixa de hospedeiros e causa sérias perdas econômicas em muitas espécies de plantas. Entretanto, ainda não se conhece a susceptibilidade de espécies florestais do trópico semi-árido a esse nematóide. No presente estudo testou-se a susceptibilidade de espécies nativas e exóticas da caatinga a M. javanica, como etapa preliminar no estudo do envolvimento de fitonematoides no crescimento dessas espécies.

MATERIAL E MÉTODOS

Dez espécies pertencentes a quatro famílias foram testadas quanto a susceptibilidade a M. javanica. Dessas, oito são espéceis nativas da região semi-árida do Brasil: angico (Anadenanthera macrocarpa (Bent) Brenan); faveiro (Parkia platicephala Benth); imbiruçu (Pseudobombax simplicifolium A. Robyns F.); imburana de cheiro (Torresia cearensis Fr. all); pau d'arco (Tabebuia impetiginosa Mart.); sabiá (Mimosa caesalpinipholia Benth.) e violeta (Dalbergia cearensis Ducke.). As exóticas são: algaroba (Prosopis juliflora D.C.) e leucena (Leucaena sp.).

O experimento foi conduzido em condições de viveiro, a céu aberto. As mudas foram produzidas em solo seco ao ar e repicadas 75 dias após o semeio para vasos de plástico com dez litros de capacidade, dotados de orifícios para drenagem, contendo solo tratado com brometo de metila, à razão de 190 cm^3/m^3. Os vasos foram parcialmente implantados no solo para evitar grandes variações de temperatura no seu interior.

Por ocasião da repicagem, fez-se a inoculação das plantas usando-se dez milímetros de uma suspensão de ovos do nematoide, na concentração de 500 ovos/ml, obtida pelo método HUSSEY e BARKER (1973). Após 75 dias procedeu-se uma segunda inoculação, incorporando-se ao solo de cada vaso cerca de vinte gramas de fragmentos de raízes atacadas pelo nematoide. O inóculo foi proveniente de raízes de melão (Cucumis melo L.), coletadas em uma área experimental infestada.

O delineamento estatístico empregado foi inteiramente casualizado, com dez tratamentos, correspondentes às espécies estudadas e cinco repetições cada uma representada por uma planta.

A susceptibilidade das espécies estudadas foi estabelecida com base em TAYLOR e SASSER (1978).

As avaliações foram feitas 115 dias após a repicagem com base na presença de galhas, fêmeas adultas e ootecas no sistema radicular. A sobrevivência foi avaliada até 115 dias após a inoculação inicial. Para se avaliar as possíveis alterações no sistema radicular devido ao ataque do nematóide bem como efeito do nematóide na sobrevivência das plantas. O sistema radicular de plantas inoculadas foi comparado com o sistema radicular de plantas sadias.

RESULTADOS

Os resultados relativos à presença de galhas, fêmeas adultas/ootecas são sumarizadas no Quadro 1.

Constatou-se a presença de galhas e fêmeas adultas nas raízes de Anadenanthera macrocarpa, Parkia platicephala, Pseudobombax simplicifolium, Torresia cearensis, Prosopis juliflora e Leucaena sp. Quanto ao número de ga-

QUADRO 1. Ocorrência de galhas, fêmeas adultas e ootecas de M. javanica no sistema radicular das espécies florestais estudadas.

NOME		FAMILIA	GALHAS	FEMEAS ADULTAS	OOTECAS
COMUM	CIENTÍFICO				
Angico	Anadenanthera macrocarpa	Leguminosae	x	x	
Aroeira	Astronium urundeuva	Anacardiaceae			
Faveiro	Parkia platicephala	Leguminosae	x	x	x
Imbiruçu	Pseudobombax simplicifolium	Bombacaceae	x	x	x
Imburana de cheiro	Torresia cearensis	Leguminosae	x	x	x
Pau d'arco	Tabebuia impetiginosa	Bignoniageae			
Sabiá	Mimosa caesalpinipholia	Leguminosae			
Violeta	Dalbergia cearensis	Leguminosae			
Algaroba	Prosopis juliflora	Leguminosae	x	x	x
Leucena	Leucaena sp	Leguminosae	x	x	

lhas, a análise de variância não revelou diferença significativa entre essas espécies ao nível de 5% de probabilidade. Ootecas foram encontrados em Prosopis juliflora, Parkia platicephala, Torresia cearensis e Pseudobombax simplicifolium. Entretanto, a recuperação de ovos e larvas entre estas espécies, e entre plantas de uma mesma espécie foi altamente variável.

Comparando o sistema radicular de plantas inoculadas e não inoculadas de uma mesma espécie, constatou-se uma acentuada ramificação do xilopodio em Pseudobombax simplicifolium, e Torresia cearensis nas plantas submetidas ao parasitismo do nematóide. Em Astronium urundeuva, Tabebuia impetiginosa, Mimosa ceasalpinipholia e Dalbergia cearensis não se constataram quaisquer alterações. Ademais, também não se observou efeito do parasitismo do M. javanica na sobrevivência de mudas das espécies estudadas.

DISCUSSÃO E CONCLUSÕES

Os resultados obtidos mostraram que Parkia Platicephala, Pseudobombax simplicipholium, Torresia cearensis e Prosopis juliflora são hospedeiros susceptíveis a M. javanica. Anadenanthera macrocarpa e Leucaena sp. são hospedeiros não susceptiveis enquanto que Astronium urundeuva, Tabebuia impetiginosa, Mimosa caesalpinipholia e Dalbergia cearensis são imunes.

Com relação as espêceis susceptíveis, maiores cuidados devem ser tomados na fase de viveiro, visto que Meloidogyne spp. causava maiores prejuizos no início do desenvolvimento das plantas (WANG et al, 1975). Além do mais, as terras disponíveis para o plantio de espécies florestais, na Região Semi-Árida do Brasil, via de regra não foram ainda cultivadas e, por isso, geralmente são pouco infestadas.

LITERATURA CITADA

1. HUSSEY, R. S. & BARKER, K. R. A. Comparison of methods for collecting inocula of Meloidogyne spp. including a new technique. Plant Dis Reptr. 57 (12):1025-1028. 1973.

2. RIFFLE, J. Histopathology of Pinus ponderosa ectomycorrhiza infected with a Meloidogyne species. Phytopathology, 63 (8): 1034-40. 1973.

3. RUEHLE, J. L. Plant-parasitic nematodes associated with pine species in southern forest. Plant Dis Reptr. 48 (1): 60-1. 1964.

4. TAYLOR, A. L. & SASSER, J. N. Biology, identification and control of root-knot nematodes (Meloidogyne species). North Carolina, International Meloidogyne Project, 1978. 111 p.

5. WANG, K. C.; BERGESON. G. B. & GREEN, R. J. Jr. Effect of Meloidogyne incognita on selected forest tree species. Journal Nematology 7 (2): 140-8. 1975.

FAST GROWING TREES

HERDABILIDADE DO CRESCIMENTO EM ALTURA DO *Pinus merkusii* NA INDONESIA

O.H.Soeseno, S.Sastrosumarto and E.Bhakti
University of Gadjah Mada, Yogyakarta
INDONESIA

Resumo

A pesquisa é composta por testes conjugados de providências e progênies de meios-irmãos de *Pinus merkusii* implantados e conduzidos pela Faculdade de Silvicultura, da Universidade de Gadjah Mada, Yogyakarta, Indonésia.

Os objetivos da pesquisa são:

- Estudar e entender o padrão de variação genética em *Pinus merkusii*;

- A obtenção de melhoramento genético na taxa de crescimento, forma das árvores e possivelmente outras caracteirstica, e

- Estabelecer pomares de sementes para produção de sementes melhoradas

O plantio foi feito em três localidades de Java, Indonésia. Este trabalho relata os resultados obtidos um ano após o plantio

Dois aspectos foram explorados:

- O estudo da herdabilidade, e

- a comparação dos progenitores e famílias.

Os resultados mostram que:

- O crescimento em altura de P. *merkusii* pode ser me melhora do através da seleção.

- Os valores da herdabilidade para o crescimento em altura foram significativos.

- Baseando-se nas plantações com um ano de idade não ficou bem claro que os melhores progenitores dão origem ãs melhores famílias.

A STUDY ON THE HERITABILITY OF HEIGHT GROWTH OF *Pinus merkussi* IN INDONESIA

Summary

The research consists of Combined Half-Sib Progeny Tests and provenance Tests conducted by Faculty of Forestry, the University of Gadjah Mada, Yogyakarta, Indonesia on Pinus merkusii Jungh. et de Vries.

The objectives of the research are:

To learn the genetic variation pattern in Pinus merkusii,

To achieve genetic improvement in growth rate, form and possibly other traits, and

To establish seed orchards for production of improved seeds.

The planting was done in three locations in Java, Indonesia.

This paper reports the findings one year after plantings. Two aspects were explored:

To study the heritability, and

To compare the quality distribution of parents and families.

The results show that:

Height growth of Pinus merkusii can be improved through selection.

The rate of heritability on height growth was very impressive.

Based on one year old plantations, it is not yet clear that the best parents produced the best families.

INTRODUCTION

Pinus merkusii Jungh. et de Vries is the only pine species native to Indonesia and the only pine species in the world native to regions within 10 degrees of the equator. Based on the above information, it can be expected that Pinus merkusii is the most certain to grow well and deserves highest priority in planting at the present time in Indonesia. However, it is a fact that many planted trees of Pinus merkusii are crooked. It has been reported elsewhere that genetic improvement in the straightness have been achieved in many other kinds of trees.

Based on the above observations, research has been conducted by Faculty of Forestry, the University of Gadjah Mada, Yogyakarta, Indonesia, working together with the Directorate of Reforestation and Rehabilitation, Directorate General of Forestry, with the objectives:

1. To learn the genetic variation pattern in Pinus merkusii,
2. To achieve genetic improvement in growth rate, form and possibly other traits, and
3. To establish seed orchards for production of improved seeds.

The research consists of combined half-sib progeny tests and provenance tests. The works have been started by selecting plus-trees (based on the superiority of straightness and height growth) and average trees from all areas in Indonesia. The aim is to get a total of 1,000 such trees. The collected seeds from the selected trees will be planted in six locations (three in Java, one each in Sumatra, Kalimantan and Sulawesi). It has been expected that each year a plantation of 200 families being done in each location and hopefully the works will be completed within six years.

When this report was being written, the first year plantations in three locations (Cijambu, West Java; Baturaden, Central Java; and Sempolan, East Java) were approaching two years of age, and showed a great deal of variation in height growth. Hence it was interesting to know whether any genetic improvement could be detected in this early growths. It is expected that similar studies will be conducted annually.

MATERIALS AND METHOD

From the first year plantations, when the plantations were one year of age, measurements of height were conducted. Height data were available for 167 families (with 119 plus trees) in Cijambu, 101 families (with 67 plus trees) in Baturaden and 137 families (with 98 plus trees) in Sempolan. Due to the fact that there were mostly different families which survived in three locations (due to uncontrolled disturbances not related to factors included in the study), separate analysis was conducted for each location. Two aspects were studied:

1. To study the heritability, and
2. To study whether the best phenotype consistently produced the best families.

To meet the second aspect of study, both parents and families were differentiated into four quartiles, and studying the probability of quality distribution of the families.

RESULTS

Height Growth

Table 1 shows the average height (in centimeters) of one year plantations in the three locations.

Table 1. Average height (five trees, one year old) in cm

Location	parent	
	selected	average
Cijambu	70.1	68.4
Baturaden	59.3	59.2
Sempolan	58.8	56.6

It can be seen from the above table that there is no indication of any impressive improvement or difference between the selected and average trees. However, the analysis of variance of the height showed highly significant difference among families for all three locations.

Heritability

Impressive family differences were detected in the study of the heritability. Table 2 presents the rate of the heritability in the three locations.

Table 2. Variance components and the heritability.

Source of Variation	Cijambu		Baturaden		Sempolan	
	VC	H^2	VC	H^2	VC	H^2
Families	71.82	.71	52.83	.77	43.55	.63
Blocks	64.13		8.48		26.36	
Error	174.28		79.39		155.88	

Since the effect of families are significant (the analysis of variance is not presented here), it indicates that genetic improvement on height is possible through selection. The most impressive finding is the high value of H^2, 63% or more.

Parents and Families Qualities Classification

Table 3 shows the relationship between parents and families superiority based on quartile classifications.

Table 3. Differentiation of families of different class (quartile) of parents, in percent.

Families classifications (quartile)	Parents classifications (quartile)			
	First	Second	Third	Fourth
Cijambu				
First	23	16	28	31
Second	17	29	24	28
Third	17	32	27	24
Fourth	43	23	21	17
	100	100	100	100

Baturaden				
First	12	24	44	24
Second	18	41	19	24
Third	29	23	12	29
Fourth	41	12	25	23
	100	100	100	100
Sempolan				
First	42	4	36	20
Second	33	21	16	28
Third	13	54	12	24
Fourth	12	21	36	28
	100	100	100	100

DISCUSSIONS

Height Growth

Looking at the difference between the average height of the families of the selected and the average trees, very little or no improvement was detected. It might be due to the short growth period covered in the study. In fact, the trees have been in the field for a single year. It is also possible that it might be due to different initial height of the plant materials. Although the information regarding the initial heights were available, the study did not try to eliminate the effect due to different initial height of the plant materials.

Heritability

The rates of hertiability shown were very impressive. Based on Table 2, it can be concluded that the genetic factor controlled the height growth up to 71% in Cijambu, up to 77% in Baturaden and up to 63% in Sempolan, and therefore being very little affected by non-genetic factors. In other words it can be said that height growth improvement on Pinus merkusii can be achieved through selection. However, the findings were based on one year old plantations. Further observations and analysis in the future will show whether the conclusion stays that way.

Parents and Families Classification

The main idea of this study is to see the consistency of parents and families classifications. The expectation was that the high quality parents would produce more high quality families. Table 3 showed that the expectation has not been fully satisfied. From the best parents (first quartile) about 25% of the families belong to the first quartile, and more than 40% of the families belong to the worst group. This was true in two locations, Cijambu and Baturaden. The situation was reversed in Sempolan. Again, however, it does not mean that this is what will happen in the future. Further observation will clarify the case.

CONCLUSIONS

The main idea to analyse the available data based on one year old plantations was to report tentative finding regarding the effort to achieve genetic improvement on Pinus merkusii and at the same time to establish seed orchards through a combined half-sib progeny tests and provenance tests conducted in Indonesia by the Faculty of Forestry, University of Gadjah Mada. The tentative conclusions are:-

1. There was indication that height growth of Pinus merkusii can be improved through selection.
2. The value of heritability on height growth were very impressive, ranging from 63% to 77%. This means that height growth was controlled mainly by genetic factors.
3. Based only on one year old plantations, the results of the study did not give the impression that the best parents produce mainly the best families. This was true at least in two locations, Cijambu and Baturaden. The third location, though, showed a reversed situation, that is that the best parents mainly produce the best families.
4. Further observations are necessary to clarify the situations.

FAST GROWING TREES

MELHORAMENTO GENÉTICO DO SÂNDALO (*Santalum algum.* L.)

R.A.Srimathi and K.R. Venkatesan
Sandal Research Centre, Bangalore
INDIA

Resumo

1.1. Este trabalho refere-se à espécie *Santalum album*. L., o sândalo do leste da Índia, com alguma relação com as outras espécies de *Santalum*.

1.2. O conhecimento atual da espécie - História, habitat, hábitos, diversidade no crescimento e formação da madeira, sua importância econômica está sendo resumido neste trabalho.

1.3. Um programa para o melhoramento genético relatando objetivos, planos de trabalho presentes e futuros é também apresentado em detalhes.

1.4. Os trabalhos efetuados no Centro de Pesquisas do Sândalo, indicam que a qualidade e a quantidade do cerne são controlados mais por fatores genéticos do que quaisquer outros fatores. Os dois maiores inimigos da espécie, doença e broca do cerne, foram também levados em consideração no programa de melhoramento, conjuntamente com quantidade e qualidade do cerne.

1.5. A estrutura da população da espécie - distribuição, variação, biologia floral, mecanismo de polinização, produção de sementes, regeneração na Índia são também sumariamente discutidos no trabalho.

GENETIC IMPROVEMENT OF SANDAL (*Sandalum album.* L.)

Summary

1.1 This paper deals with the species Santalum album L. the East Indian Sandalwood tree with a brief account of the other species of Santalum.

1.2 The present knowledge of the species - history, habitat, habit, diversity in the growth and formation of wood and its economic importance - is reviewed.

1.3 A programme for the improvement of the sandal tree - the aims, present and the future plan of work - is detailed.

1.4 Work in the Sandal Research Centre indicates that the quality and quantity of heartwood is controlled more by genetical factors rather than by other factors. The two inimical factors viz. the spike disease of sandal and the heartwood borer have also been taken into consideration in the tree improvement programme besides the quantity and quality of heartwood.

1.5 Structure of the population of the species in India, distribution, variation, floral biology, pollination mechanism, seed setting and regeneration are briefly discussed.

2. Introduction:

2.1 Santalum album L. is famous for the East Indian sandalwood oil of commerce throughout the world. The sandalwood has been in use as a cosmetic, medicine and in religious rites from time immemorial. The sandal oil is obtained from the heartwood of sandal tree and is extensively used in the perfumery industry. The sapwood which does not have any essential oil is also used in the manufacture of agarbathis or joss sticks and turnery.

2.2 The sandalwood which was not selling at not more than Re.1/- a kilo prior to the fifties, has been appreciating in its value and during the seventies it reached upto Rs.40/-. In India the wood is more or less a state monopoly as the species is found growing mostly in the government reserved forests.

3. Distribution:

3.1 The genus Santalum which is tropical in distribution consists of nineteen species which are distributed in the south eastern part of the world between 30° and 40° latitude. Out of these four species are found in Australia, eight in Hawaii, one in north Caledonia, one in Juan Fernandez, one in Fiji, one in India and the others in the Islands of Indonesia.

3.2 The most important species among these is Santalum album L., which occurs in South India and some parts of Indonesia. In India, it occurs naturally in the Deccan Plateau covering the states of Karnataka and Tamil Nadu and in small areas in other states.

4. Silvicultural characters:

4.1 Santalum album is a small evergreen tree and is a hemi-root parasite. It is found mostly in the interior parts between elevations of 300 to 1000m, occupying mostly the scrub and dry deciduous jungles. However the species is also found in all kinds of soils at all elevations from sea level to 1800m and between 500mm to 4000mm rainfall. It is capable of regenerating itself profusely through seeds and to a certain through root suckers. This species is fire tender and readily browsed.

5. Phenology:

5.1 The flowering in sandal usually starts at the fourth year. There are two distinct seasons of flowering in sandal but individual trees and populations differ in their flowering - some flower once a year, majority twice a year and a few throughout the year. Seeds setting is profuse in September - November and poor in March - April.

6. Pollination:

6.1 The species is mostly cross pollinated - pollinators being butterflies and bees. In the absence of cross pollination, self pollination also occurs but the fruit setting is poor.

7. Vegetative propagation:

7.1 All methods of vegetative propagation were tried. Stem cuttings using hormones under ordinary field conditions did not produce roots. Under mist conditions rooting was limited to less than ten percent. Root cuttings have given more than twenty percent success but the scope of their application in the field is limited. Tissue culture has produced seedlings in the test tubes. They are yet to be tried in the field on a large scale. Cleft grafting using 10 months to one year old seedlings as stock has given nearly forty percent success. Therefore this method has been selected as the best method for vegetative propagation for the present.

8. Growth:

8.1 Though in its usual habitat it grows very slow, about 1 cm in girth per year, under good soil and moisture conditions certain types of sandal can grow upto 5 cm in girth per year. The heartwood forms at any time between the sixth and twentieth years depending upon the individual trees and or the habitat.

9. Diseases and pests:

9.1 Sandal in its original habitat of South India, is affected by the spike disease which is one of the well known tree diseases of the world. Quite a good deal of work has been done on this disease leading to the publication of more than three hundred papers. Once the tree is affected by the disease, the trees dies within a period of few years. All age classes are susceptible to the disease except the young seedlings. However, the disease does not affect either the formation of the heartwood or the oil content. Various control measures including chemotherapy were suggested but so far there has been no remedy for this disease. Breeding for resistance against the disease though suggested as early as the thirties, has not been done so far.

9.2 Apart from the spike disease sandal trees are known to die due to unknown reasons which are yet to be investigated. Such deaths account for 6-11 percent of the trees.

9.3 Seedlings of sandal die due to seedling disease caused by the combined reaction of soil fungi and nematodes. The tree improvement work and other experiments on sandal are badly affected due to this disease.

9.4 Though several pests are known to attack sandal, many of these do not cause much damage to the trees. The heartwood borer (Aristobia octofasciculata) causes heavy damage to the heartwood by boring vertical tunnels. Very often these tunnels act as points of infection for various wood rotting fungi which further deteriorate the heartwood. It is worthwhile examining if there is any natural resistance in some trees against this borer attack.

10. Variations:

10.1 Plenty of variations exist in sandal with relation to the morphology of leaves, flowers, fruits and seeds etc. which have already been reported and earlier workers have been attempted to classify the species into varieties based on these variations.

10.2 Variations exist in the quality and quantity of heartwood. Taking the depth at which the heartwood is present as an expression of the quantity of the heartwood present, it is found that the depth varies from 0.5cm to 6 cm. Regarding the quality of wood, the colour is found to vary from yellow to dark brown with all shades of yellow and brown. The oil content also varies from 2 percent to 6.5 percent.

11. Tree Improvement Work:

11.1 The Sandal Research Centre which was started in 1977 at Bangalore took up comprehensive research on all aspects of Santalum album. One of the important projects is the "Genetic Improvement of sandal".

11.2 Before embarking on this programme certain fundamental facts about sandal had to be clarified as the earlier literature on sandal contains a lot of controversial matters. The points to be clarified were:

1. The influence of host on the growth and formation of heartwood in sandal:-
   Though many authors favour the view that sandal is an obligate

parasite, a few authors have vehemently contradicted this and stated that it is an autophyte.

2. Heartwood formation: The prevalent notion has been that better heartwood and oil are formed in drier localities with gravelly and stony soils. Troup, however, has expressed his own doubts on this and has cited trees grown in rich soils like river banks having better heartwood formation.

3. The spike disease has been considered as fast spreading and devastating disease and considered to be the prime cause for the depletion of sandal population.

11.3 After a good deal of studies in the field, the following tentative conclusions were arrived at from the points of view of the Tree Improvement Programme of sandal.

1. The hosts do not seem to play any important role either in the growth or the formation of heartwood and therefore this factor has not been taken into consideration in the genetic improvement of sandal.

2. A preliminary survey shows that the formation of heartwood is not dependant upon the age, growth, soil, rainfall, elevation or the host plants. But it seems to be dependent upon the individual traits of the trees as trees growing in the same locality differ from one another both in the quality and quantity of the heartwood produced. The environmental factors seem to be playing only a secondary role.

3. The spike disease by itself is not capable of reducing the sandal population provided the sandal is allowed to regenerate and is reasonably protected from biotic factors like theft, grazing and fire. The disease is also found to be endemic to the southern parts of Karnataka and northern parts of Tamil Nadu and has not spread outside these limits for the past several decades. Even within this region some pockets have remained disease-free and fairly large areas have become free of this disease after having suffered the disease a few decades ago. Therefore, it is expected that these two types of areas may contain trees possessing the quality of disease resistance. Hence, breeding against this disease will be of limited interest confined to the diseased tracts only.

4. More than the disease, one of the important damaging factors is the heartwood borer which is of interest throughout the country

12. Breeding programme envisaged:

12.1 Object: The object of this programme is to produce sandal trees which can yield maximum wood and oil in a short period

12.2 Strategies:

(i) Short term strategy:- envisages identification and selection of superior stands which can be converted into seed production areas in due course. All the seed requirements will be met from these areas until improved seeds are available from the seed orchards.

(ii) Long term:- a. selection of superior 'Plus' trees for the following characters:

1. fast growth
2. maximum heartwood formation
3. maximum oil yield,
4. resistance to spike disease
5. resistance to heartwood borer.

b. progeny testing of these trees and their genetic evaluation.
c. establishment of germ plasm and clonal banks.
d. establishment of seedling and clonal seed orchards.

13. Work already done:

13.1 Selection of seed stands: Three seed stands have already been selected one in Karnataka, one in Tamil Nadu and one in Kerala. More such seed stands are yet to be selected and improvement works undertaken.

13.2 Selection of plus trees: So far 55 trees, 15 trees for fast growth and 40 trees for superior heartwood and fragrance, have been selected. Selection for other characters is under progress.

13.3. Selection for fast growth: Trees for this character are selected only in plantations of known age by taking the measurements of diameter, height and bole height in comparison with the average measurements of the population. Five check trees growing in the close vicinity all around the plus tree selected are also measured for comparison. So far 15 trees have been selected for this character. Some of the trees thus selected have also formed richly scented heartwood at an age of 8 years.

Sandal plantations of known age are very few. In most of the plantations the trees are branched from collar level rendering it difficult for diameter measurements.

13.4 Selection for heartwood and fragrance: Superior trees for the formation of heartwood are selected from (1) Plantations of known age and (2) natural populations.

Trees are evaluated for the quantity and quality of the heartwood by taking cores using Pressler's increment borer. The quantity is assessed by the depth at which the heartwood is formed and the quality by the fragrance. For the sake of uniformity the borings are done only at the breast height. Certain subsidiary characters like the thickness of bark and sapwood and also their colour are being ascertained. By laboratory testing it has been found that the light coloured (light brown) heartwoods are rich in oil content and therefore this character is also considered to be an important character in the selection of plus trees.

13.5 Selection for disease resistance: Selection of the trees for this character are carried out

1. in heavily diseased areas.
2. in areas where the disease had ravaged once but now disease free.
3. in pockets where the disease has never occurred within the diseased area.

Selection of candidate trees has been done in the first two categories at the rate of eleven and six. Selection is yet to be carried out for the third category. It is proposed to multiply these trees by grafting and screening them for disease resistance by one of the efficient methods of disease transmission. The grafting work for multiplication is in progress.

In addition to the above method trees selected in the heavily diseased areas are being tested for resistance by means of in situ grafting with the diseased material. This method of in situ grafting is however not desirable in the other two areas due to the fear of introducing the disease.

In practice it is found that in situ grafting is adifficult task as the grafts are usually damaged by birds, monkeys and some times human beings also and repeated visits to these are costly and time consuming.

13.6 Selection for resistance against borer attack: As the damage due to borer attack in sandal is known recently norms and tests for selection of trees for borer resistance are yet to be formulated.

14. Progeny trials:

14.1 The selected trees have to be tested for their genetical make up. One of the approved methods is by progeny testing Half-sib progenies of individual trees are raised. They are at present only at the nursery stage and some progenies are proposed to be planted out this year.

14.2 It is interesting to find that while the progenies of many trees are more or less uniform for the seedling characters, there is high segregation found in the progenies of some trees. The characters that are under study are (1) vigour, (2) the colour of the hypocotyle, (3) copper colouring of leaves and (4) size, shape and nature of the leaves. The results of these studies are yet to be analysed.

15. Germ Plasm Bank:

15.1 All the available variants of S.album and species of Santalum are proposed to be pooled in a germ plasm bank for future use.

15.2 So far a few phyenotypes have been raised in the nursery. Six species of Santalum S.austracaledonicum from New Caledonia, S.ellipticum from Hawaii, S.spicatum, S.lanceolatum, S.accuminatum and S.murrayanum from Western Australia have been obtained and are being raised in the nursery. These will be planted in the Germ Plasm Bank in due course. Germ Plasm Banks will be established at least in two places.

16. Clonal Bank, Seedling seed orchard and clonal orchard:

16.1 These are proposed to be formed in due course as the material is not yet ready.

17. Conclusion:

17.1 A beginning has been made to attempt improvement of sandal by genetic means. Basic studies like phenology, pollination germination, plus tree selection, vegetative propagation of sandal and progeny trials are under progress.

FAST GROWING TREES

Cordia alliodora (R. e P.) OKEN, UMA ESPÉCIE PARA PLANTAÇÕES

J.W. Stead
Commonwealth Forestry Institute
Oxford University
ENGLAND

Resumo

Cordia alliodora (R. & P.) Oken é uma valiosa árvore produtora de madeira de serraria, na sua ampla região de ocorrência natural, na América Latina. Ela vegeta sob uma variedade de condições ecológicas. Regenera-se facilmente, e produz árvores de boa forma. Em experimentos instalados dentro e fora de sua área de distribuição natural, têm demonstrado rápido crescimento, especialmente nos primeiros anos. Há interesse considerável na avaliação da *C. alliodora*, através de testes de procedências com repetições. O C.F.I., Oxford, está coordenando um programa com tal objetivo. Assim é que sementes de 25 procedências foram distribuídas por 25 países, perfazendo um total de 104 experimentos.

Cordia alliodora AS A PLANTATION SPECIE

Summary

Cordia alliodora (R. & P.) Oken is a valuable timber tree throughout its wide natural range in Latin America. It grows under a variety of site conditions, regenerates easily and produces a tree of good form. Trials both inside and outside the natural range have demonstrated rapid growth especially in the first few years. There is considerable interest in the evaluation of C. alliodora using replicated provenance trials, and the CFI, Oxford, is co-ordinating a programme with this aim. So far seed from 25 provenances has been distributed to 25 countries for a total of 104 trials.

INTRODUCTION

Cordia alliodora (R. & P.) Oken is a well-known timber tree throughout its natural range in Latin America. It is considered by the FAO Panel of Experts on Forest Gene Resources in their Forest genetic resource priorities (by region, species and operation) (see FAO, 1977 pp. 50-71) to have a high importance rating for wood production and to be in need of botanical, genecological, collecting and testing work. The Commonwealth Forestry Institute (CFI), Oxford is coordinating a programme to explore, collect seed and co-ordinate international provenance trials of C. alliodora.

Much of the available information on C. alliodora has been summarised by Johnson & Morales (1972). This paper reviews the potential of the species for plantations and outlines the organisation of the CFI trials.

GEOGRAPHICAL RANGE AND HABITAT

C. alliodora is found over a wide latitudinal range in Latin America. The northern limit is in Sinaloa, Mexico (Lat. 25°N) (see

Pennington & Sarukhán, 1968), and on a recent field visit to Mexico it was found to be common slightly further south (around Lat. 18°N) in eastern Oaxaca and Vera Cruz. The southern limit is in Misiones, Argentina (Lat. 25°S).

Over this very wide range considerable variation can be found in some botanical characters of C. alliodora (e.g. pubescence and flower size) and it has been suggested that two or more taxa may be involved.

C. alliodora also shows a wide range of altitudinal preference, and voucher specimens and/or seed for the CFI project have been collected from areas just above sea level (e.g. Caribbean coast of Honduras (Lat. 16°N) up to 1400 m.a.s.l. in Guatemala (Lat. 14°N) and 2000 m.a.s.l. in Colombia (Lat. 5°N).

The most impressive specimens of C. alliodora are found in areas with moderate to high rainfall (2000-5000 mm p.a.) but in Central America it is also common in drier areas (1000-2000 mm p.a.). It is found growing in a wide variety of edaphic conditions but it grows best on well drained soils.

POTENTIAL VALUE AS A PLANTATION SPECIES

Observation and study of C. alliodora in the natural range suggest that it may be suitable for large-scale plantations. It is wide ranging and grows in a variety of site conditions. It is a good coloniser which regenerates easily and occurs in almost pure stands in natural breaks in the forest, or in areas cleared by man. The tree is self-pruning and has good form, with a straight bole and compact crown, even when open grown. It produces seed in profusion and coppices well. The wood is used locally for a variety of purposes.

Data from small trial plots of C. alliodora show rapid growth especially in the first few years. Trees growing on the Atlantic coast of Costa Rica (rainfall 5000 mm p.a.) at 24 years had an average height of 29.3 m and average D.B.H. of 37.8 cm (Johnson & Morales, 1972). On the Pacific coast of Colombia (rainfall 4000 mm p.a.), trees of C. alliodora, in a species trial, had an average height of 3 m and an average diameter of 12 cm at 3 years (Peck, 1976).

The wood of C. alliodora has not been widely tested and the value of plantation-produced wood for various uses, particularly pulping, is not known. Details of the wood anatomy and physical and mechanical properties can be found in Tschinkel (1966) and Gonzalez et al. (1971). Principal uses are construction of various kinds, furniture, veneer and plywood.

C. alliodora has been shown to be particularly suited to establishment using the taungya system with, for example, maize. In Costa Rica, experiments are in progress with C. alliodora growing over permanent pasture and sugar cane and, with Erythrina spp., over coffee.

Several countries have established trials with C. alliodora as an exotic. Reports on performance vary from good (Cote d'Ivoire, Nigeria) to excellent (Mauritius, New Hebrides, Sierra Leone) to variable (Uganda, Solomon Islands). In some cases larger-scale plantations have been established (Fiji, Sierra Leone).

SEED COLLECTION AND STORAGE

C. alliodora produces vast numbers of seeds but difficulty has been experienced in the collection and storage of viable seed. It has been shown, however, that there is a period of 2-3 weeks before seed-fall when seed can be collected that will maintain reasonable viability, if stored at low temperature and humidity (Tschinkel, 1967).

Seed with good germination has been collected for the CFI International Provenance Trials and stored successfully for the past three years. The method of collection used was simply to shake the mature seed from the trees and collect them in extended sheets. All of the seed collected in this way had germination of 50-70%. The critical factor in storage seems to be the percentage moisture content which should be less than 10%. Seed with a moisture content of 8-9% has maintained good viability. Seed with a high moisture content has suffered in storage e.g. one seed lot with a moisture content of 11.45%, had a percentage germination of 63 when collected, which fell to 31% after only 12 months.

CFI INTERNATIONAL PROVENANCE TRIALS

The CFI has been organising the collection of seed throughout the natural range of C. alliodora for use in provenance trials. So far, 21 provenance collections have been made (14 from Central America and the Caribbean, 5 from South America and 2 exotic collections from Fiji and Cote d'Ivoire).

A first distribution of seed from a few provenances was made in 1977. Since then, seed has been distributed as new collections were received and more countries expressed an interest in planting trials. So far, seed for 104 trials has been sent to 25 countries (see Appendix for a list of the countries involved and the number of trials they have received). Seed of about 12 provenances is still available should anyone wish to establish trials.

Reports on the trials as they develop have been sent to the CFI. Little is known about the silviculture of C. alliodora and participating countries are having to apply standard local techniques to the treatment of C. alliodora in the nursery and field. A comparison of the techniques used and their relative success/failure, will help to define the best methods to use with this species.

From reports so far, 11 countries have established 26 trials in the field, and only four countries have trials one year old. This is a very early stage at which to make comparisons but a pattern is developing. One provenance from Nicaragua and two from the Atlantic coast of Honduras are doing consistently well.

APPENDIX

Countries participating in trials of Cordia alliodora
(the figure in brackets indicates the number of trials allocated)

Belize (3), Brazil (2), China (1), Colombia (INDERENA (5), FEDERCAFE (4)), Congo Republic (1), Costa Rica (2), Ecuador (3), Fiji (4), Ghana (6), Guatemala (2), Honduras (1), India (15), Cote d'Ivoire (2), Liberia (3), Mexico (13), New Hebrides (1), Nigeria (11), Peru (1), Sierra Leone (4), Solomon Islands (4), Sri Lanka (6), Sudan (4), Surinam (1), Trinidad (4), Venezuela (1).

TOTAL: 104 trials in 25 countries.

REFERENCES

FAO. 1977. Report on the Fourth Session of the FAO Panel of Experts on Forest Gene Resources. FAO, Rome. FO:FGR/4/Rep. 75 pp.

Gonzalez-T., M.E., Llach-C., L., Gonzalez-T., G. 1971. Maderas Latino Americanas VII. Características anatómicas, propiedades fisiomecánicas, de secado y tratabilidad de la madera juvenil de Cordia alliodora (Ruiz & Pav.) Oken. Turrialba 21 (3), 350-56.

Johnson, P. and Morales, R. 1972. A review of Cordia alliodora (Ruiz & Pav.) Oken. Turrialba 22 (2), 210-220.

Peck. 1976. Selección preliminar de especies aptas para el establecimiento de bosques artificiales en tierra firme del litoral pacífico de Colombia. Boln. Inst. For. Lat.-Am. Invest. Capacit. (IFLAIC), Mérida, Venezuela. No. 50, 29-39.

Pennington, T.D. and Sarukhán, J. 1968. Arboles Tropicales de Mexico. Instituto Nacional de Investigaciones Forestales (INIF), Mexico. 413 pp.

Tschinkel, H. 1966. Annual growth rings of Cordia alliodora. Turrialba 15 (1), 73-80.

Tschinkel, H. 1967. La madurez y el almacenamiento de semillas de Cordia alliodora (Ruiz & Pav.) Cham. Turrialba 17 (1), 89-90.

INFORMAÇÃO SOBRE O PROGRAMA DE MELHORAMENTO FLORESTAL NA INDONESIA

Ir. Syahir
Directorate General of Forestry
INDONESIA

Resumo

A taxa anual de plantio na Indonésia é de 300.000 ha para reflorestamento e 700.000 ha para florestamento. As espécies principais são *Pinus merkusii* e *Eucalyptus urophylla*. Os programas de melhoramento florestal, incluindo testes de procedências de espécies indígenas e exóticas, são propostos e algumas informações sobre os progressos já obtidos são apresentados.

INFORMATION ON TREE IMPROVEMENT PROGRAMME IN INDONESIA

Summary

Indonesias annual planting targets are 300,000 hectares for reforestation and 700,000 hectares for afforestation. The main species are Pinus merkusii and Eucalyptus urophylla. Tree improvement programmes including provenance trials of indigenous and exotic species are proposed and indications given of progress with the work so far.

BACKGROUND

As consequence of man-made erosion, many areas in Indonesia have become wastelands or poor in condition. Lands in critical condition are given first priority of rehabilitation including reforestation or afforestation.

One of the important factors for successful reforestation and afforestation lies in the availability of seeds in sufficient quantity and of good quality. The needs for seed are very urgent both in quantity and quality. The reforestation target is 300,000 hectares per year and afforestation 700,000 hectares per year.

The main species which has been used in rehabilitating the critical lands mentioned above is Pinus merkusii Jungh et de Vriese. It has shown the ability to grow fast, and achieve high production of valuable wood. Eucalyptus urophylla S.T. Blake is also a promising species for the future.

THE PROPERTIES OF SPECIES

Pinus merkusii Jungh et de Vriese

This pine is an Indonesian native species. Natural distribution is principally in Northern Sumatra i.e. Aceh, Tapanuli and Kerinci.

This species, has been planted in almost all the islands of Indonesia as it can be grown on poor soils and in unfavourable conditions.

The range of altitude is 0-2400m, within hot, humid climatic zone. The mean annual rainfall may vary from 1500-4000mm. Pinus merkusii is commonly called a pioneer species because of its ability to develop in unfavourable conditions especially on heavy-grass land dominated by Imperata cylindrica.

The utilization of this pine includes pulp, matches, boxes, containers, construction and resin production.

Pinus merkusii often grows with a bent trunk, producing much useless compression wood. Tree improvement is therefore proposed to get rid of these defects to obtain high resin production and good wood quality. An increase in production is also expected.

Eucalyptus urophylla S.T. Blake.

This Eucalypt is also an Indonesian native species. It occurs as natural stands principally on the large islands of Flores, Adonara, Lomblen, Pantar, Alor and Wetar.

The range of latitude 8½-10°S and that of altitude 350-2960m. Distribution is within the hot, humid climate zone. The mean annual rainfall is 1400-2400mm and there is a monsoonal pattern of 6-7 months with good rains and 4-5 months of dry to very dry. It commonly grows on basalts, schists and slates, but rarely on limestone.

This species is a fine forest tree up to 55m in height, with diameters, up to 2m and straight boles of a half to two thirds of tree height over most of its range. Towards it maximum altitude it may be a small, guarled shrub only a few metres in height.

The utilization of this Eucalypt includes pulp, construction and fuelwood. Tree improvement is needed to raise the yields obtainable.

ACTIVITIES

Based on the facts mentioned above, tree improvement has been proposed for Pinus merkusii and Eucalyptus urophylla as follows:-

Short-term programmes

To select seed production areas both for Pine and Eucalypts based on good phenotypic quality of their stands.

To carry out provenance trials of Pines and Eucalypts i.e.: provenance trial of Aceh and Tapanuli Strains of Pinus merkusii. International provenance trial between Pinus merkusii, Pinus caribaea and Pinus oocarpa in Lampung - Southern Sumatra (P. caribaea and P. oocarpa grow better than P. merkusii both in the lowland and highlands, but 60% of the P. caribaea produces fox tail). Provenance trials of exotic and indigenous species in South Sumatra using P. merkusii, P. caribaea, P. oocarpa, E. deglupta, E. urophylla (already carried out).

Vegetative propagation trials of Pinus merkusii carried out by bottle grafting, cleft and side grafting. Cleft and side grafting have proved to be highly successful with pines, and with Eucalypts bud grafting is most successful.

Long-term programmes

To select plus trees of Pinus merkusii (some 600 out of 1000 plus trees have been marked and registered).

To establish an open pollinated seedling seed orchard of Pinus merkusii totalling 288 hectares. This has been started at three different places in Java over a six year period. The 1978 planting of 48 hectares involving some 180 plus trees was completed as planned; and a further planting of the same size was completed by April 1979.

To establish clonal seed orchards of Pinus merkusii totallying 200 hectares to be set up at two places in Aceh (Northern Sumatra) over a five year period starting early 1980.

To establish both open pollinated seedling seed orchards and extensive seedling seed orchards of Eucalyptus urophylla totalling 200 hectares to be started in 1980 over a four year period at two places separately in Flores and Timor Island.

O USO DE *Camphosperma* E *Terminalia spp* EM PLANTAÇÕES NAS ILHAS SALOMÃO

B. R. Thomson
SOLOMON ISLANDS

Resumo

Três espécies nativas de florestas úmidas de baixa altitude das ilhas Salomão, *Camphosperma brevipetiolata*, *Terminalia calamansanai* e *T. brassii*, abrangem 70% dos 18.000 ha de plantações estabelecidas em áreas exploradas no período de 1966 a 1979. As árvores têm bom comportamento em solos argilosos ácidos, destacando-se *T. calamansanai* nos solos bem drenados, *T. brassii* em várzeas e vales, e *Camphosperma* em qualquer condição.

Os dados de crescimento indicam que a projeção para se obter toras com 50 cm para serraria ou laminação, em rotação de 20 a 25 anos e espaçamento de 10 m x 3 m, é realista. Porém, a exploração intensiva atual vem propiciando condições para a dispersão do cipó *Merremia* spp, que pode afetar, drásticamente, o crescimento e a forma das árvores.

As copas da *Terminalia* são muito suceptíveis a *Merremia*, que quando da sua ocorrência elimina o potencial da espécie para dar origem a árvores de rápido crescimento e forma excelente. A redução do espaçamento está sendo estudada nas áreas em que a *Merremia* domina.

A produção de sementes em árvores adultas é periodicamente abundante, mas mostra irregularidades. O programa de plantio depende da obtenção de mudas de regeneração natural, após a queda das sementes. A colheita e armazenagem das sementes necessitam de melhores estudos para suprimento local e de outros países interessados.

THE USE OF *Camphosperma* AND *Terminalia spp* IN PLANTATION IN THE SOLOMON ISLANDS

Summary

Three lowland rain-forest species native to the Solomon Islands, Campnosperma brevipetiolata, Terminalia calamansanai and T brassii, comprise 70% of the 18,000 ha plantations established from 1966-1979 on logged areas. The trees perform well on acidic clay soils, notably T calamansanai on well-drained terrain, T brassii in swamps and valleys, and Campnosperma throughout.

Growth data indicate that a 50cm diameter saw-log or peeler is a realistic projection on a 20-25 year rotation, with the current 10mx3m line-planting technique. However, intensive logging in recent years has encoursged spread of Merremia spp vine, which can severely affect the growth and form of the crop. Terminalia crowns are particularly vulnerable to Merremia, which then eliminates their potential as fast-growing trees of excellent form. Closer spacing is under consideration in Merremia dominated areas.

Seeding of mature trees is periodically abundant, but irregular. The planting programme is dependent on collection of natural regeneration after seed fall. Seed collection and seed storage need developed to supply seed for local and overseas use.

INTRODUCTION

Some 18000 hectares of logged rain-forest in the Solomon Islands have been re-planted in the period 1966 to 1979. 70% of this programme has been line-planting with Campnosperma brevipetiolata, Terminalia calamansanai and Terminalia brassii. The Forestry Division, with aid from U.K Overseas Development Administration and New Zealand Technical Assistance, aims to continue re-planting at a rate of 4000 hectares per year.

The choice of these indigenous species for planting was, and is, based on the following criteria:

1) All three species are an important component of current log exports from the Solomons.
2) The trees produce a utility grade timber, useful for a wide range of sawn end-products and veneer.
3) Growth, form and yield, as recorded in research plots and in natural forest, is good compared with many other local and exotic species under trial, and suited to enrichment line-planting.
4) Indigenous species may be less likely to suffer major disease or pest problems in plantation.

DISTRIBUTION

Campnosperma brevipetiolata Volkens ranges from parts of Malaya, Indonesia, Papua New Guinea, east to Micronesia and the Solomon Islands (Kalkman 1959; Van Royen 1964; Whitmore 1966).

In the Western Solomons, the tree is often the dominant component of lowland rain-forests on the acid clay soils of sedimentary or volcanic origin, typical of Santa Isabel, New Georgia and Kolobangara. It is absent from the central islands of Guadalcanal, San Cristobal and Rennell, but re-appears in the far-eastern Santa Cruz group. It is thought that the trees in Santa Cruz are naturally smaller, but there is no provenance testing as yet.

Terminalia calamansanai (Blanco) Rolf. has a scattered distribution from Burma, Thailand, Vietnam to Indonesia, Phillipines, Papua New Guinea, and throughout most of the Solomon Islands, except Rennell (Van Royen 1964; Whitmore 1966). As a tall emergent tree, it is generally found only as a minor component of well-drained lowland forests, but occurred in sizeable stands on the north and north-east slopes of Kolobangara before logging (Whitmore 1974).

Terminalia brassii Exell is restricted to the eastern Papua New Guinea islands of New Britain, New Ireland and Bougainville, and to the western Solomon Islands as far east as San Cristobal. Within its range it is often a dominant tree in swampy lowlands either in pure stands or in association with Campnosperma.

Other local Terminalia spp are potentially of considerable forestry value. T complanata K Schum and T sepicana Diels are both performing well in trial plots (Table 1). In total, 12 species of Terminalia are known from the Solomons (Whitmore 1966), and as many as 30 in Papua New Guinea (van Royen 1964).

GROWTH AND YIELD

The growth rates for the species in trial plots in the Solomons are indicated in Table 1.

Terminalia brassii is able to achieve a M A I of 3.0m height for the first 5 years, and surpass 20m mean height by 9 years. T calamansanai and Campnosperma are slower to start at M A I 2.0m height for 5 years and 20m mean height by 10-12 years. At 12-15 years all three can have formed logs of 30cm end up to 50cm diameter breast height (Table 1).

The Terminalias have naturally excellent form with cylindrical boles, no forks and light branching. Campnosperma is liable to some heavy branching or forks but improves with age and self-prunes well.

For plantation forestry where selective thinnings are practiced, the growth and yields indicated for close-planted plots in Table 1 can be expected. However Solomons forestry is geared to "line-planting" at relatively wide spacing (10mx3m since 1975) with no thinning, intended as a low-cost, low-yield system. The technique aims to produce a crop of 80-100 logs per hectare yielding 140-150m³ per ha and diameter breast-height of 0.5m in 20 years (Marten 1976).

The results from a sample of line-planted plots on different islands indicate the extent to which the girth target of 0.5m dbh for 100 stems per hectare is likely to be achieved (Fig 1).

Campnosperma displays a good consistency with a performance under line-planting equal to thinned close-planted plots. A 20-25 year rotation for 0.5m dbh logs is indicated.

The growth performance of Terminalia brassii at its best is on a par with fast exotic species such as Eucalyptus deglupta and Cleistopholis glauca (Thomson 1980). To date however, its performance in line-planting is well below its potential of 0.5m dbh at 13 years, but still fast enough for a probable 20-25 year rotation.

For T calamansanai there is a wide spread of results. Only some line-plantings will achieve the target. In some plots, the trees have become irreversibly suppressed by surrounding inter-line vegetation.

Experience so far indicates distinct site preferences, particularly for the Terminalias. T brassii, as befits a fresh-water swamp species, is best planted on moist lowland or valley sites of alluvium or volcanic origin, but also does well on shallow coral-derived soils. The site requirements of T calamansanai are

TABLE 1 GROWTH AND YIELD OF CAMPNOSPERMA AND TERMINALIA SPP IN TRIAL PLOTS IN THE SOLOMON ISLANDS

Species	Plot X-No	Location	Age (yrs)	Height (m)	Diam (cm)	Log volume* (m^3) (No)	Plot type
Campnosperma brevipetiolata	172	Baga	15.4	23	40	.90(6)	Close
	475	Gizo	12.4	19	38	.76(10)	Line
	334	Viru	11.6	19	37	.62(17)	Line
Terminalia brassii	179	Baga CP	15.2	29	54	2.41(8)	Close
	332	Gizo	12.1	22	29	1.03(4)	Line
	338	Viru	11.4	21	30	.63(22)	Line
Terminalia calamansanai	467	Gizo	12.9	24	37	.74( )	Close
	476	Viru	12.0	19	29	.44(9)	Line
	506	Allardyce	6.2	11	14	-	Line
T sepicana	688	Kolobangara	4.8	14	17	- -	Close
T complanata	689	Kolobangara	4.8	13	16	-	Close

* Relascope estimates using Newton's Formula by Marten (1980)

TABLE 2 PLANTATION AREAS OF CAMPNOSPERMA AND TERMINALIA SPP IN THE SOLOMON ISLANDS

Plantation Area	Planting Period	Area established to end-1979 (ha) *				
		Camp.	T bras.	T cala.	Other	Total
Gizo	1966-1971	300	-	850	100	1250
Santa Isabel	1967-1974	2000	20	-	10	2030
Santa Cruz	1977-(1979)	100	-	-	2140	2240
New Georgia	1968-(1979)	4560	710	1500	360	7130
Kolobangara	1975-(1979)	1070	540	1390	2360	5360
All	1966-(1979)	8030	1270	3740	4970	18,010

* From information in Management Report for 1979 (Orr 1980), and P I P Reports (Miller 1980)

not yet fully understood. It must have a well-drained site, up to 200m asl, and while it occurs on volcanic clays on Kolobangara it also does well on soils above coral or lime-stone, if they are deep and relatively fertile. By contrast, Campnosperma is equally well suited to well-drained ridges (up to 500m asl), slopes or ill-drained flats, but only on clay soils of low pH, and it will not tolerate coral soil.

USE IN PLANTATION

The use of Campnosperma and Terminalia in Solomons plant-ations is indicated in Table 2.

On Santa Cruz, the locally indigenous Agathis macrophylla (Kauri) is being replanted following logging of the mature Kauri forests. The only significant plantation use of exotic species to date has been on Kolobangara with over 1500ha of Eucalyptus deglupta and some Swietenia macrophylla. E deglupta has mainly been used in a cattle-under-trees project, but the species is now being phased out on account of severe insect attacks, notably from Ambleypelta cocophaga and Oxymagis viti-collis (Bigger 1979). Native tree species are by no means immune to these insects. Ambleypelta bug will also attack the leading shoot of some 2-3year old Campnosperma, but recovery is usually good. Oxymagis shoot-borer has recently been recorded in T calamansanai.

Line plantations are established by poisoning the canopy left after logging, and maintaining the planted lines frequently in the first few years to ensure that the trees compete, usually successfully, with surrounding woody regrowth. However, increa-singly intensive logging operations in the 1970's has resulted in much more soil disturbance and compaction and clearance of the forest canopy than previously which leads to a massive invasion and dominance of Merremia spp vine (Convolvulaceae) following logging. This spreading creeper has large heart-shaped leaves which rapidly cover ground and swamp other vegetation, and will readily climb up to 20-30m on dead or live trees, unless cut back.

Forest establishment operations have largely become a running battle with a large work force attempting to keep Merremia in check by repeated slashing along the lines, and on the planted trees. Campnosperma with its large stiff leaves shows a degree of resistance to being swamped by Merremia, whereas the leading shoots and crowns of Terminalia, especially T calamansanai, are easily damaged by Merremia with severe effects on growth and tree form.

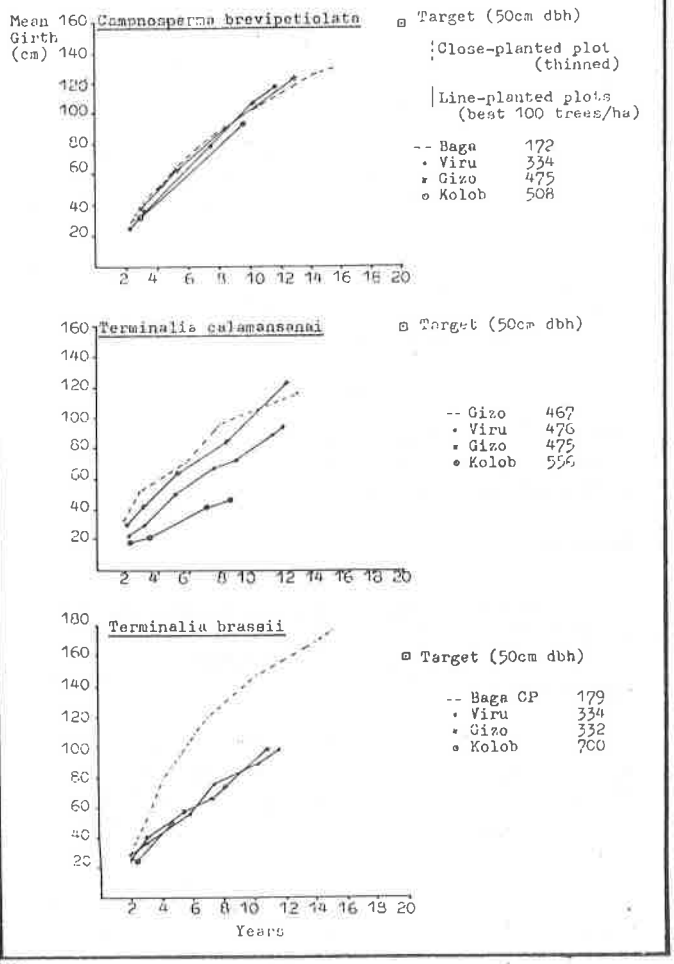
A recent plantation inventory indicates an alarming proport-ion of surviving trees, often over 50%, with forks, broken tops or bent-over stems (Miller 1980). For the Terminalias, with their naturally straight boles, this can be mainly attributed to the ravages of Merremia attack.

Research has recommended the adoption of a closer line spacing of 6mx3m to allow a quicker canopy closure, offering some suppres-sion of Merremia by Campnosperma and T brassii crowns. For the light-crowned T calamansanai there is little advantage in closer spacing, and its continued use may depend on planting in Merremia-free sites. For the worst Merremia areas it may be necessary to revert to close-planting of heavy-crowned species such as Gmelina arborea, Cordia alliodora or Artocarpus integer at 3mx3m spacing to eliminate undergrowth within 1 or 2 years.

SEED COLLECTIONS

Obtaining large quantities of the seed of Campnosperma and the two Terminalia is potentially simple, since mature trees bear seed abundantly. Per kilo of seed, Campnosperma has 20-30,000 seed, T calamansanai has 13-14,000 dewinged seeds, and T brassii has 60-70,000 seeds.

Figure 1 MEAN GIRTH OF CAMPNOSPERMA AND TERMINALIA SPP IN CLOSE-PLANTED AND LINE-PLANTED PLOTS.



However, phenological records show little predictability in the timing of flowering in the non-seasonal rainfall areas of the Solomons. Individual trees may vary in their time of flowering between islands, and even within the same forest area. Instead of seed, the plantations programme relies heavily on bulk collections of natural regeneration following seeding. These "wildings" are then potted on in forest nurseries.

Even when seed collections are achieved, it is known that seed viability is lost quickly unless sown fresh. This does not allow the forest manager much freedom to select the species to match the planting sites. An ODA-financed seed storage study is soon to be undertaken with a view to building up a stored supply to satisfy local and overseas requirements.

The Solomons plantations themselves are a valuable seed source for the future. The Terminalia have produced viable seed at 5-6 years, and Campnosperma at 10 years, though seldom abundantly at this age.

CONCLUSIONS

1) The Solomon Islands have three fast-growing indigenous species, widely tested in trial plots and plantation, which can have a value for other countries in the humid lowland tropics. They are suitable for pulp, sawn timber and veneer.

2) Terminalia brassii grows well in swamps or poorly-drained areas, T calamansanai requires well-drained terrain, and Campnosperma brevipetiolata throughout. Campnosperma is most suitable for the line-planting technique, whereas the Terminalia suffer if competition from weed growth is excessive.

3) When seed storage techniques are developed, collections of seed of Campnosperma and Terminalia spp can be made throughout Solomon Islands, Papua New Guinea, and elsewhere in South-East Asia for species and provenance testing.

ACKNOWLEDGEMENTS

The writer would like to thank A C Orr, Forest Management Officer and F Miller, Forest Officer, of Solomon Islands Forestry Division for contributions to this paper.

Further details on the silviculture and wood quality of these species is available in Forestry Division reports (Marten 1980) and in Fenton, Roper and Watt (1977).

LITERATURE CITED

BIGGER, M., 1979: 1st Report of the Forest Entomologist, June - Dec., 1979. Research Report ENT/1/79, Forestry Division, Solomon Islands (unpubl.).

FENTON, R., ROPER, R.E. and WATT, E.R., 1977: Lowland tropical hardwoods, an annotated bibliography of selected species with plantation potential. F R I, New Zealand For. Service. Publ. Min. Foreign Affairs, New Zealand.

KALKMAN, C., 1959: Timber species of Netherlands New Guinea. Forestry Division, Manokwari, Indonesia.

MARTEN, K.D., 1976: The development of line planting in the Solomon Islands. Research Report, Forestry Division, Solomon Islands (unpubl.).

MARTEN, K.D., 1980: Silvics of species(1) Campnosperma brevipetiolata, (2) Terminalia calamansanai, (3) Terminalia brassii, Research Reports S/2/80, and S/4/80. Forestry Division, Solomon Islands (unpubl.).

MILLER, F., 1980: Plantation Inventory Plot (P I P) Assessments for 1979-80. Internal Reports of Forestry Division Solomon Islands.

ORR, A.C., 1980: Forest Management Report for 1979. Internal Report of Forestry Division, Solomon Islands.

THOMSON, B.R., 1980: The performance of Cleistopholis glauca Pierre in the Solomon Islands. In IUFRO Symp. on Genetic Improvement and Productivity of Fast-growing Tree Species Brazil, August, 1980.

VAN ROYEN, P., 1964: Manual of the forest trees of Papua New Guinea. Part 1 - Combretaceae, Part 4 - Anacardiaceae. Dept of Forests, Port Moresby, Papua New Guinea.

WHITMORE, T.C., 1966: Guide to the forests of the British Solomon Islands. Oxford University Press, U K.

WHITMORE, T.C., 1974: Change with time and the role of cyclones in tropical rain forest on Kolombangara, Solomon Islands. Commonwealth Forestry Institute Pap. No. 46, Oxford.

FAST GROWING TREES

O COMPORTAMENTO DE *Cleistopholis glauca* PIERRE, NAS ILHAS SALOMÃO

B. R. Thomson
SOLOMON ISLANDS

Resumo

Cleistopholis glauca Pierre, espécie nativa de florestas tropicais úmidas e baixa altitude na bacia do Congo, foi implantada em parcelas experimentais nas Ilhas Salomão em 1958 e 1964. O crescimento, forma e aspecto sanitário das árvores, em solos bem drenados, têm sido excepcionalmente bons, o que confirma ensaios africanos anteriores. Aos 20 anos de idade, as árvores da parcela mais antiga tinham 35 metros de altura e 79 cm de diâmetro, crescimento comparável com *Eucalyptus deglupta*, *Gmelina arborea*, e outras espécies exóticas de rápido crescimento, existentes no ensaio.

Cleistopholis glauca é uma espécie bastante promissora para plantações nos trópicos úmidos, onde a polpa e a madeira de baixa densidade sejam aceitáveis.

Testes com a madeira, coletas de sementes, e estrategias para conservação são agora necessárias.

THE PERFORMANCE OF *Cleistopholis glauca* PIERRE IN THE SOLOMON ISLANDS

Summary

Cleistopholis glauca Pierre, native to lowland rain-forests of the Congo Basin, was established in trial plots in the Solomon Islands in 1958 and 1964. The growth, form, and health of the trees on well-drained sites in the Solomons has been exceptionally good, which confirms earlier African trials. At 20 years the oldest plot was 39m height and 79cm diameter, which compares favourably with Eucalyptus deglupta, Gmelina arborea, and other fast-growing exotics on trial. Cleistopholis glauca is clearly a very promising plantation species for the humid tropics, wherever pulp or a light wood is acceptable. Timber trials, seed collections, and conservation strategies are now required.

INTRODUCTION

Seed of Cleistopholis glauca Pierre ex Engl and Diels was sent to the Solomon Islands in 1958 and 1964 from the Forestry Division of INEAC, Yangambi, Zaire (then Belgian Congo). The natural distribution of the species is the lowland rain-forest of the Congo Basin, in Zaire, Congo-Brazzaville and Gabon, and reaching into Central African Republic, Cameroon and Angola-Cabinda (Boutique 1951; Le Thomas 1969). Within this range, the distribution is apparently patchy or discontinuous (Donis 1954).

TRIAL PLOTS IN THE SOLOMON ISLANDS

Seedlings were established in 0.04ha plots ($^1/_{10}$ acre) in four trial areas, at a spacing of 2.4m x 2.4m (8'x8').

Date of Planting	Trial Area		Rainfall (mm)	Elevation(asl)	Soil
12/59	Mt Austen	9°28'S; 159°59'E	2500	150m	Black alluvial loam.
12/59	Rove	9°26'S; 159°56'E	2000	10m	Poorly-drained black alluvium
11/64	Gizo	8°10'S; 156°45'E	3300	50m	Red volcanic clay.
12/64	Baga	7°50'S; 156°25'E	3500	10m	Red-brown clay over coral

Rainfall is non-seasonal at Gizo and Baga, and predominantly seasonal at Mt Austen and Rove. Daily temperatures average 27°C.

For the three adequately drained sites, growth has been fast, even and continuing. At 15 years a mean height of 33m and diameter(dbh) of 48cm was attained (MAI 2.2m height, 3.2cm dbh). One plot was heavily thinned for maximum crown development. At 20 years, the four remaining trees in this plot averaged 39m height and 79cm dbh (Fig 1). Cleistopholis glauca boles are tall and columnar, offering impressive log lengths of 15-20m or more. The form of the species is naturally good with few trees having obvious stem defects, and excellent self-pruning.

The relatively poor performance of the Rove plot indicates unsuitability on seasonally-waterlogged soils of poor drainage.

Optical volume estimates of the standing crop are approximately 30m³ volume per plot for both thinned (Mt Austen) and not-thinned(Gizo) plots (Table 1). This represents 400 m³ per ha, after extrapolating from an increased plot size (0.04 to 0.08ha) to allow for crown spread. Data from Marten(1980) indicates that merchantable saw-log volumes for a 20-year rotation are 0.6 to 0.7 of total tree volumes for this species.

The performance of Cleistopholis glauca compares favourably with other high-yielding exotics on trial in the Solomons. Eucalyptus deglupta can achieve similar growth rates but has lost credibility in the Solomons due to major insect problems (Bigger 1979). Gmelina arborea and Albizia falcataria are much inferior in stem form, while Anthocephalus chinensis loses increment drastically after 5-10 years growth under Solomons conditions. Another Central African exotic, Maesopsis eminii, grew steadily in many plots but has a suspect resistance to strong winds.

EARLY TRIALS IN ZAIRE

In 1941, a plot of Cleistopholis glauca was established in the arboretum at Kisingani(Stanleyville), and its growth recorded up to 1958 (De Fays and Huygen 1957; De Fays 1961). With a standing volume of 476 m³ per ha at 17 years, it considerably exceeded the second-highest yield, a plot of Terminalia superba.

From 1952 to 1960, INEAC forestry trials concentrated on techniques for enriching existing forest by sowing or planting gaps. (Donis 1954; Moyaux 1961; Gaillez 1961; Maudoux 1961, 1967). Of the 20 indigenous species found to be suitable, Cleistopholis glauca was easily the fastest grower, but only approached its potential (e.g. best trees 14-16m at 5 years, Maudoux 1967) when given full overhead light.

More consistent results were obtained from an 11ha plantation spacing trial laid down at Yangambi in 1955. At 2.5years, mean height was 6.1m and dbh 8.6cm. Maudoux and Abeels(1961) recommended 3m x 3m industrial plantations of Cleistopholis glauca for pulpwood.

Trial line planting at 10m x 3m on Kolobangara, Solomon Islands, had a mean height of 7.8m and dbh 10.2cm at 2.5 years. In 1979, 11ha of Cleistopholis plantation was established on Kolobangara.

PHENOLOGY AND SEED PRODUCTION

The flowers and fruits of Cleistopholis glauca are botanically described and illustrated (Boutique 1951; Le Thomas 1969).

Seeding does not seem a problem with this species. Flowering was first observed on 4-year old trees at Mt Austen.

Figure 1 THE GROWTH OF CLEISTOPHOLIS GLAUCA IN TRIAL PLOTS IN THE SOLOMON ISLANDS

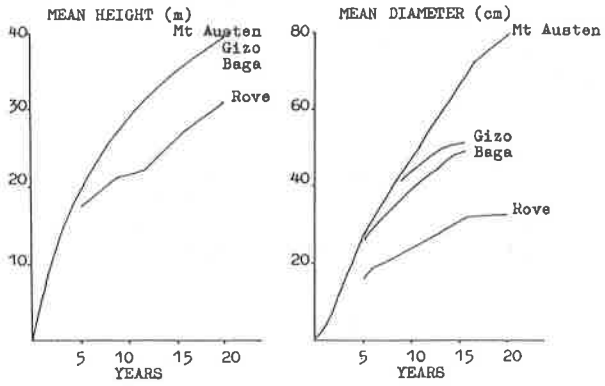


Table 1 OPTICAL ESTIMATES OF STANDING CROP VOLUMES OF CLEISTOPHOLIS GLAUCA AT GIZO AND MT AUSTEN

Plots (0.04ha)	Gizo	Mt Austen
Age of plot	15 years	20 years
No of trees	17	4
Mean diameter(dbh)	49 cm	79 cm
Tree volumes (1)	1.2-2.9m³	6.5-8.9m³
Mean volume	1.91m³	7.40m³
Volume of plot	32.5m³	29.6m³
Estim. Volume per ha(2)	400m³	370m³
Mean Annual Increment	27m³	19m³

(1) Spiegel Relascope estimates of total tree volume using Pressler's Formula $V = ba \times 2/3\ h'$

where V = individual tree volume; ba = basal area; h' = height at which diam. is ½ d b h.

(2) Estimated from greater plot areas of 0.08ha.

There is no consistent season for flowering, and fruits may be found on the tree or ground at any month, although the phenological records from 1968-78 are suggestive of a 7-8 month flowering cycle. Fruits collected from the ground contain 1 or 2 seeds, there being 1200-1500 seeds per kilogram.

Overseas despatches of seed have been made from the Solomons to Sabah (1967, 1978, 1979); Phillipines(1977); CSIRO Northern Territories, Australia (1978); P T International, Indonesia(1978); Kona Botanic Garden, Hawaii (1978); and Fiji (1979).

Sabah reports that Cleistopholis glauca, Albizia falcataria, Eucalyptus deglupta and Acacia mangium are the fastest-growing of their broadleaf species on trial (Sabah, 1977). Seeding of Cleistopholis is also reported there but the fruits are often eaten by bats or birds.

WOOD CHARACTERISTICS

Cleistopholis glauca wood is white, light, and straight grained. Density and strength properties are similar to other light woods, such as Triplochiton scleroxylon and Cedrela odorata. Sallenave(1961) recorded oven-dry specific gravity of 0.3 to 0.4, and modulus of rupture 716 to 842 for several logs from Gabon.

C T F T chemical pulping studies recommended Cleistopholis glauca, Terminalia superba, Musanga cecropioides and Gmelina arborea from 26 species on trial for the manufacture of both corrugated paper and quality printing paper (Petroff, Doat and Tissot 1968; 1969). Pulping trials on the thinnings from the Sabah plot also indicate a good pulp (Tham Chee Keong, pers comm, 1978). The sawn timber has been used for packing and crates in the Congo (Boutique 1951). The closely-related C. patens is known to be suitable for light construction, joinery and core-veneer (INEAC 1955; Irvine 1961; Bolza and Keating, 1972).

RECOMMENDATIONS

It is surprising that Cleistopholis glauca has remained an unknown species for so long to most of the international forestry community. In the 1950's and early 1960's, INEAC researchers stressed its excellent growth and value as a cellulose producer. CTFT pulping studies in the late 1960's confirmed its pulping quality, while the Solomon Islands Trial Plots have demonstrated for years its superior growth and form.

Pilot plantation trials of Cleistopholis glauca should be a priority in the lowland humid tropics, especially for countries like Sabah whose forestry development is geared to pulpwood. For the Solomon Islands and countries aiming for saw-logs and veneer, the essential need is wood quality testing.

The Forestry Division of Solomon Islands would therefore welcome international cooperation in implementing the following proposals:

1) To arrange for maximum seed collections of Cleistopholis glauca from the Solomon Islands to satisfy local and overseas seed requests.

2) To conduct wood quality studies on plantation - grown Solomon Island logs of Cleistopholis glauca to evaluate suitability for light construction, joinery and plywood veneer.

3) To investigate the status and ecology of the genus Cleistopholis in Africa, with a view to in-situ conservation.

4) To arrange for seed collections of Cleistopholis spp in Central and West Africa, with a view to international distribution, provenance trials, and ex-situ conservation.

ACKNOWLEDGEMENTS

This paper is a shortened version of Research Report S/12/80, which is obtainable from Chief Forestry Officer, Ministry of Natural Resources, Honiara, Solomon Islands.

LITERATURE CITED

BIGGER, M., 1979: 1st Report of the Forest Entomologist, June-Dec., 1979. Research Report ENT/1/79, Forestry Division, Solomon Islands (unpubl.).

BOLZA, E. and KEATING, W G, 1972: African timbers - the properties, uses and characteristics of 700 species. Div. of Building Research, CSIRO, Melbourne.

BOUTIQUE, R, 1951: Annonaceae. In: Flora du Congo Belge et du Rusanda-urundi, Vol 2. INEAC, Brussels. pp 300-304.

DE FAYS, E. P., 1961: Observations sur la croissance de Cleistopholis glauca (Pierre) a l'arboretum de Stanleyville. In: 2nd Inter-African For. Conf., Pointe-Noire, 1958. Vol 2, pp 267-268.

DE FAYS, E.P. and HUYGEN, J.P., 1957: Enrichissement des forets ombrophytes heterogenes dans la Province Orientale du Congo Belge. In: Tropical Silviculture FAO Studies No. 13, Vol 2, pp 129-138.

DONIS, C., 1954: Article. In: Proc. 4th World For. Congr. Vol 3, pp 22-56.

GAILLEZ, L., 1961: Les enrichissements de forets au Maniema. In: 2nd Inter-African For. Conf., Pointe-Noire, 1958. Vol 2, pp 402-417.

INEAC, 1955: Atlas anatomique des bois du Congo Belge. Vol 2. Publics. Inst. Nat. pour l'Etude Agron.du Congo Belge (INEAC). Brussels.

IRVINE, F. R., 1961: Woody plants of Ghana. Oxford Univ. Press, London.

LE THOMAS, A., 1969: Annonacees. In: Flore du Gabon, Vol 16 (ed. A Aubreville). Nat. Hist. Mus. Paris.

MARTEN, K.D., 1980: A summary of the performance of the major plantation species in Divisional Trial Plots. Research Report S/1/80, Forestry Division,Solomon Islands (unpubl.).

MAUDOUX, E., 1961: Nouvelle technique d'enrichissement des forets denses heterogenes - la plantation par place aux denses espaces. In: 2nd Inter-African For. Conf., Pointe-Noire, 1958. Vol 2, pp 294-301.

MAUDOUX, E., 1967: Enrichissement en foret dense par la methode des placeaux. Bull. Rech. Agron. Gembloux, 2(4) pp 711-719.

MAUDOUX, E. and ABEELS, P., 1961: Premieres observations sur le Cleistopholis glauca en plantation industrielle a Yangambi. In: 2nd Inter-African For. Conf. Pointe-Noire, 1958.Vol 2, pp 316-318.

PETROFF, G., DOAT J. AND TISSOT, M., 1968: Caracteristiques papetieres de quelques essences tropicales de reboisement. Vol 3. Centre Technique Forestier Tropical (CTFT) Public. 31., Nogent-sur-Marne, France.

PETROFF, G., DOAT J. AND TISSOT, M., 1969: Pates a haut rendement a partic de bois feuillus tropicaux impregnes a la soude. CTFT Public., Nogent-sur-Marne, France.

SABAH, 1977: Annual Report 1973-74, Research Branch, Forest Dept. Sabah. Sandakan, Sabah.

SALLENAVE, P., 1971: Proprietes physiques et mecaniques des bois tropicaux: Deuxieme Supplement. CTFT Public., Nogent-sur-Marne, France.

FAST GROWING TREES

RELATÓRIOS PREMILIMARES SOBRE OS TESTES DE PROCEDÊNCIA INTERNACIONAIS DE *Pinus pseudostrobus* NA ÁFRICA DO SUL

H.A. van der Sijde
South African Forestry Research Institute, Pretoria
REPUBLIC OF SOUTH AFRICA

Resumo

Sobrevivência e crescimento em altura em dois locais do teste foram extremamente variáveis. As procedências mexicanas de crescimento lento apresentaram a melhor taxa de sobrevivência. Sobrevivência e crescimento estavam fortemente correlacionadas com a latitude e altitude das procedências.

EARLY REPORT ON THE INTERNATIONAL PROVENANCE TRIALS OF *Pinus pseudostrobus* IN SOUTH AFRICA

Summary

Survival and height growth at the two test sites was extremely variable, the slow-growing mexican provenances having the best survival rate. Survival and growth were strongly correlated with latitude and altitute of the origin.

INTRODUCTION

Pinus pseudostrobus is well suited to conditions prevailing at intermediate elevations in the mist-belt regions of the summerrainfall area in South Africa. Its growth compares well with that of P. patula, especially when managed on a relatively long rotation for sawtimber production. The main disadvantages of the species are its tendency to fork and the arrangement of its rather heavy branches in distinct wholes. Indications exist, however, that these defects may be less pronounced in some provenances than in others, and it would seem that provenances from the high altitude regions near Mexico City and in Oaxaca are superior to those from low to medium elevations in michoacana. As yet only the latter provenances have been planted to any extent in Southern Africa (Poynton, 1979).
For these reasons it was decided to take part in the international provenance trial of P. pseudostrobus, organised by the Commonwealth Forestry Institute, Oxford.
This paper reports on two trials resp. at Jessievale and Tweefontein. Two other trials are too young to report on.

Provenance representation

Details of the provenances represented in the two trials are shown in Table I.

Description of test sites

Jessievale: Lat. 26° 14' S, Long. 30° 31' E, Alt. 1733 m.
Soil : Deep brown sandy loam.
Slope : 2° south west.
Rainfall: 920 mm/annum.
Climate : Humid-mesothermal, Summer rainfall, severe frost.

Tweefontein: Lat. 25° 03' S, Long 30° 47' E, Alt. 1150 m.
Soil : Deep red loam of dolomitic origin, accasional outcroppings of stone-filled clay soil.
Slope : None.
Rainfall : 1300 mm/annum.
Climate : Humid mesothermal, Summer rainfall, moderate frost.

DESIGN AND MANAGEMENT

For both trials a 4 x 5 lattice design with three replications was used. Plot size in 5 x 5 trees, planted at an espacement of 2,7 x 2,7 m. The Jessievale trial was planted in January and the Tweefontein trial in February 1978.

COLLECTION AND ANALYSIS OF DATA

Jessievale trial. Only a survival count was done 2 4/12 years after planting. The results are shown in Table 2. Survival ranged from 0 to 100 %. All Mexican provenances and all but one extra-Mexican provenance had survival rates of over 50 %. Pinus patula, the species normally planted on similar sites, was amongst the best survivors. Survival was significantly correlated with altitude (n = 0,68**) and lattitude (n_s = 0,81**) of the origin (spearman's Rank Correlation Coefficients), i.e. the northerly and high altitude provenances showed the best survival rates.

Tweefontein trial. A survival count and height measurement was carried out at age 2 3/12 years. The results are shown in Table 2. Survival followed the same trends as at Jessievale. Height growth of the mexican provenances was inferior to that of the other provenances. Height growth was significantly correlated with latitude (n_s = -0,84**) and altitude (n_s = 0,82**) of the origin.

TABLE I : PROVENANCE SOURCE INFORMATION

Stock	Origin	Latitude (N) ° '	Altitude (m)	Mean annual rainfall (mm)
K63	San Juan, Giatem.	14 43 -	1800 -	1500
K75	Tecpan. Guatem.	14 50 -	2200 -	1600
K77	Tatumbla, Hond.Rep.	14 02 -	1600 -	1300
K95	Volcan Yali, Nicarag.	13 15 -	1400 -	1500
K101*	Yucul, Nicarag.	12 55 -	680 -	1395
K104	Loma de Ochva, Hond.Rep.	14 48 -	1200 -	1400
K119	Cofradia, Hond.Rep.	14 00 -	1300 -	950
K121	La Fortuna, Hond.Rep.	14 10 -	1250 -	1300
K122	El Cedro, Hond.Rep.	13 48 -	1100 -	1075
343	Nogales, Mex.	20 59 -	2250 -	-
429	Tlaxiaco, "	17 20 -	2200 -	1000
438	Boca del perro, "	17 21 -	2000 -	1000
459	San Salvador, "	19 01 -	2400 -	-
476	Amgahuan, "	19 30 -	1780 -	790
485	North Uruampan, "	19 31 -	1634 -	790
495	Ninas Viejar, "	21 11 -	2000 -	-
500	San Vicente, "	16 29 -	2200 -	830
501	San Pedro el Alto, "	16 45 -	2600 -	830
P. pat.	Local Seed Orchard Mixt.	-	-	-
P. mont.	Guatemala	-	-	-

* P. oocarpa

DISCUSSION

The generally poor survival of P. pseudostrobus especially in the Jessievale trial, confirms the experience in South Africa that the species is less hardy to frost that P. patula and when young can be killed outright in the colder parts of the highveld (Poynton, 1979). Even the moderately cold site at Tweefontein seems to be too harsh for the extra-Mexican provenances of the species.

TABLE 2 : RANKINGS FOR MEAN SURVIVAL RATE AND MEAN HEIGHT

Jessievale		Tweefontein			
SN	Survival (%)	SN	Survival (%)	SN	Height (m)
495	100	343	99	P.pat.	2.90
459	99	438	96	K101	2.82
343	97	K75	96	K122	2.59
438	95	495	93	K119	2.51
P.pat.	91	429	92	K63	2.45
476	89	459	92	K95	2.35
K75	83	P.pat.	91	K104	2.28
500	67	500	87	K77	2.21
485	65	476	81	K121	2.16
429	63	485	76	438	1.50
501	59	P.mont.	75	K75	1.49
P. mont.	52	501	67	485	1.37
K121	40	K104	65	501	1.34
K101	24	K122	63	495	1.18
K95	16	K95	63	343	1.14
K122	9	K119	60	429	1.10
K77	4	K101	53	500	1.07
K63	1	K63	53	459	0,87
K119	0	K77	48	P.mont.	0,63
K104	0	K121	44	476	0,55

Bars indicate Duncan's New Multiple Range Test at the 5 % level.

REFERENCES

Poynton, R.J., 1979. Tree planting in Southern Africa. Vol. 1, The Pines, Dept. of For., Republic of South Africa.

FAST GROWING TREES

A ESCOLHA DE ESPÉCIES PARA ZONAS ÁRIDAS

P. J. Wood
Commonwealth Forestry Institute
Oxford University
ENGLAND

Resumo

Áreas de importância para plantações florestais localizam-se em zonas que recebem de 250 a 500 mm de chuvas anuais. Muitas espécies apresentam um conhecido potencial para plantio em tais áreas, embora os tipos especialmente adaptados C_4 a CAM, contenham poucas espécies de interesse silvicultural. Das listas de espécies que são de interêsse nem todas são facilmente plantadas, e poucas informações são encontradas sobre variação entre procedências.

Uma publicação recente da FAO/IBPGB contornará esse problema, e futuros testes de procedências são recomendados.

THE CHOICE OF SPECIES FOR ARID ZONES

Summary

Areas of importance for tree planting lie mainly in the zone receiving between 250-500 mm annual rainfall. Many species are of known potential for planting in such areas, though the especially-adapted C4 and CAM types contain few species of forestry interest. Of the lists of species which are of interest, however, not all are easily planted, and relatively little information is available in provenance variation. A recent FAO/IBPGR proposal will remedy this, and further provenance trials are recommended.

THE CLASSIFICATION OF DRY AREAS

The choice of species for dry sites is as complex as the climates and soils that are represented in them. In general it is important to relate potential evapotranspiration to available precipitation, or to calculate a Dryness index to indicate the severity of the conditions for plant growth - see for instance the discussion in Leakey and Last (1980). Deserts are readily recognised by their appearance and vegetation, although the climatic conditions may vary slightly - e.g. in Mediterranean countries an isohyet of 100-150mm is taken to be the limit of "desert", whereas in Australia as much as 600mm may be taken as the limit. It is however, less with the true dessert that our interest in species for planting is concerned, as these are generally of extremely low productivity, and very low human populations, and a useful definition of the zone of importance is a rainfall of 250-500mm which is generally regarded as "semi-arid". Nonetheless many dry zones requiring tree planting may receive up to 800mm of rain annually. Of course, where irrigation or rainfall concentration is possible a desert climate can be effectively altered, and in some desert areas water tables are often within reach of tree roots. Conditions of soil greatly modify the conditions for trees however and the classification of sites is less important than the trial of new species and the evaluation of indigenous ones.

THE ADAPTION OF PLANTS TO ARID CLIMATES

We are here concerned only with woody perennials, although the importance of ephemerals and succulent perennials in dry zone land use and conservation should not be ignored. The characteristics of naturally occuring woody perennials include great resistance to wind, heat and drought; they are generally deep rooting, often deciduous (in winter in climates of winter rainfall regimes), they are able to become dormant during severe periods, and they are often spiny and resistant to browsing.

A particular adaption to dry climates lies in the metabolic process of photosynthesis. Three systems have been detected, known as, C_3, C_4 and CAM. The C_4 or Calvin system is the 'normal' one in plants where CO_2 absorbed through the stomata during the day is transferred rapidly to the chloroplasts. In the C_4 process, CO_2 is absorbed through the stomata, which open at night, and stored in organic acids, from which it is released the following day for photosynthesis, when the stomata are closed. CAM plants can utilise both processes.

Unfortunately, few trees useful for forestry are known to be C_4 or CAM types, but a number of Atriplex spp. and Euphorbia spp. are. For further details see Briggs (1974, 1975) and Adams et al (1978) especially regarding the use of species mixtures.

THE SELECTION OF SITES

The natural occurrence of species depends closely on the types of soil and moisture regime. Clearly, the existence of a species on a certain site type is an indication of its adaptability to that site, but the evaluation of soil and climate particularly at the micro-level is not easy in many areas. Careful site examination is therefore required, coupled with well designed trials.

The main soil conditions which govern species choice are the presence of sands or clays, and the degree and type of salinity. The prevalence of blown sand is a further important factor. In most cases planted trees will have to rely on incoming rainfall, and although the use of run-off irrigation by micro catchments may effectively increase this, deep soils and reasonably reliable rainfall, as in the Negev desert, are important if these systems are to be successful. Irrigation by flooding, trickle, sub surface or sprinkler is possible in very few areas, but where practicable it can effectively lengthen the rainy season, and thus make available species which would normally require higher annual precipitation.

Although details of site requirements of important species are being accumulated slowly, it is important to have such information available in convenient form for planning purposes (see Webb, et al, 1980).

THE SELECTION OF SPECIES

(a) The objectives of planting

A recent study by FAO (1980) proposes a programme on the selection of species for arid zones, which has fuelwood for rural use as its main objective. This is undoubtedly one of the most important problems facing the developing world today. However, other important objectives include the protection and restoration of deteriorating ecosystems, the provision of shade and shelter, and the production of industrial raw material. These objectives should not obscure the possible effects of tree on the planting sites, such as increasing salinity in the groundwater.

(b) The end use of species

The produce from trees in arid and semi arid zones is generally used by rural populations, though occasionally there may be a need for industrial raw material in such areas. Almost all species may be used as fuel, but more account is usually taken of rate of growth than of a species' quality as a fuel. A very simple list of criteria for selection for end use is given by Webb et al (1980), as follows:-

Protection planting: shade, shelterbelts and windbreaks, anti-erosion, dune fixation, agricultural shade, ornamental.

Wood density: light, medium, heavy.

Saw timber use: heavy construction, light construction, boxes, crates and shuttering, furniture.

Roundwood use: transmission poles, building poles, fence posts, fuel and charcoal, short fibred pulp, long fibred pulp, veneers and plywood.

Other products: resins, tannins, fodder, oils and gums, other.

Any final choice of species depends upon further research including literature searches and adequate trials, especially as species planted as exotics often differ considerably in their wood quality from that obtained in natural stands. Thus, a widely accepted fuelwood in one country may prove to be less so in another, and trials of acceptability as domestic fuel are often necessary, in addition to studies on calorific values.

(c) The site requirements of species for trial

A guide to a species' site requirements can be obtained from conditions in natural pupulations, and, better, from plantations. Criteria used by Webb et al (1980) in initial selection of species are as follows, though the relative importance of the different parameters is often difficult to obtain, even through extensive literature study, hence the emphasis on choice of species for trials.

Altitude: in steps of 500m as an initial guide
Mean annual rainfall
Rainfall regime
Length of dry season
Mean maximum, and minimum and annual temperatures
Soils: texture, reaction, drainage, other (including salinity)

The use of mean temperatures can sometimes be misleading, and the ability of a species to withstand occasional frosts or very high temperatures may also be important.

Because of the interaction of so many factors, and because of the lack of detailed site factors for so many sites, it is not possible to give exact site requirements for most tree species, though excellent guidelines on, for instance, tolerance of saline conditions are given by Adams et al (1978) and others. In the dry zones particularly, the use of leguminous species for soil improvement may be beneficial and they may be used in mixtures. Some site characteristics are not permanent therefore, and they may change under the influence of the species planted.

(d) Silvicultural characteristics of species

The characteristics used by Webb et al (1980) include the following:

Size of tree at maturity
Light requirements
Other: coppicing, fire resistance, frost resistance, termite resistance, inter-tree competition in plantations.
Nursery features including seed weight, handling and storage, type of planting stock.

Survival is of primary importance with any tree to be planted, and where trees are to be used in rural development projects, conditions may not be ideal. The planting of seedlings may be a less familiar operation to farmers then direct sowing, and ease of propagation, such as that of Prosopis juliflora through goat droppings, may be more important than

potential productivity. Seed of certain species may require special treatment before sowing in the nursery, and the infestation of seeds with insects, such as Bruchids on Acacia spp. may require special studies and treatment. These problems may be more severe where a species is indigenous, and difficulties over seed procurement of a desired species often lead to the use of unsuitable species, seed of which is readily obtained.

In the nursery, some dry zone species have a characteristically high root/shoot ratio, so that plants of acceptable size possess a long tap root which is easily damaged in pots or beds. This is especially important in farm planting.

Many species possess an ability to coppice which is very important where regular cutting for fuelwood, or lopping for fodder is required. This has an important bearing on the frequency of harvesting and yields. However, yields from unirrigated dry zone plantations are always low, unless roots are able to reach a water table and 7m /ha/year is probably near the upper limit that can be obtained.

(e) Variation and provenance selection

The natural distribution of species from dry zones is often imperfectly known, and only a few provenance trials have been organised. Notable exceptions are of course Eucalyptus camaldulensis, and the more recent seed collections of E. microtheca, E. occidentalis and E. tereticornis made by FRI, Australia which have made a great contribution to increasing productivity in the dry zones (FAO, 1977, 1979). The recent report by FAO (1980) proposes mounting a second phase FAO/IBGR project on genetic resources for the improvement of rural living, and lists in detail sources in eight countries for a cooperative programme. Four genera are represented: Acacia, Azadirachta, Eucalyptus and Prosopis, and the species are listed in Appendix 1. It is noteworthy that despite the great advances made with E. camaldulensis in the past, there is still a need for further provenance testing.

Many lists of species for dry zones have been published, e.g. Ghosh (1977), Synnott (1979), Burley (1979), but not all take account of the ease with which the species can be handled in plantations. For instance, the widespread Balanites aegyptiaca is frequently quoted, but though it is valuable and would undoubtedly repay research, it is not a species that could be used easily for planting by small farmers. Appendix 2 lists the species suggested for areas with a mean annual rainfall of up to 500mm from Webb et al (1980); all these are known to be readily handled in plantations, but the list is not exhaustive. Another recent list from NAS (1980) is given in Appendix 3. Neither of these references, however, gives an indication of provenance variation.

Whilst there is no doubt that the main thrust of future development must be for rural community development, there is also a need for industrial wood, and the Mediterranean pines are of considerable value (see FAO, 1979) particularly Pinus eldarica, which is closely related to P. brutia and P. halepensis but less well known. Future collections of seed particularly from USSR and Afghanistan may show improved performance especially where winter temperatures are low. (see Palmberg, 1975).

There is ample scope for further provenance studies with species for dry zones, even with those that have received study previously.

CONCLUSIONS

Only a few species suitable for plantations in arid and semi arid zones have been adequately explored or tested in provenance trials. New interest has arisen in species that can be handled by small farmers in rural development programmes, especially for fuel and fodder, and many of these are already well established though from limited seed sources. Interest in the natural distribution and provenance variation of these species is developing, especially through FAO/IBPGR. Further exploration in arid and semi arid regions may be expected to yield much more variable material than has been available hitherto, in particular provenances from the extremes of a species range where conditions are most severe. The evaluation of these new provenances (or species) should follow established experimental procedures, but, because in the rural scene, emphasis is on the individual tree or on small woodlots, very small plot sizes for these experiments should give the desired information and reduce research costs.

APPENDIX 1

List of species for FAO/IBPGR programme. Reproduced with permission from FAO(1980). Note the unusual detail devoted to the seed sources.

Species	Distribution
Acacia albida Del.	Senegal, Gambia, Portuguese Guinea, Sierra Leone, Liberia, Ivory Coast, Ghana, Togo, Dahomey, Nigeria and Cameroon, extending north throughout the drier parts of North Africa into Egypt, Israel, Lebanon and Cyprus, and from East Africa (Tanzania, Kenya, Uganda), to Zambia, Transvaal and Natal.
Acacia nilotica (L.)Willd.ex Del.	(including 3 varieties) extends from tropical and sub-tropical West Africa (Senegal, Gambia, Ivory Coast, Ghana, Togo, Dahomey, Nigeria, Cameroon) East Africa (Tanzania, Kenya, Uganda), and North Africa (the Sahel, Egypt) through eastern Sudan and Arabia as far eastward as India.
Acacia senegal (L.) Willd.	(including 2 varieties), characteristic of the drier parts of Somalia, Ethiopia, the Sudan and Chad through to Mauritania, extending west to Senegal, Gambia, Ivory Coast, Ghana, Togo, Dahomey, Nigeria and Cameroon, east to Tanzania, Kenya and Uganda.
Prosopis cineraria (L.) Druce (syn. P. spicigera L.)	India, Pakistan, Iran, Arabian peninsula.
Prosopis alba Gris.	(including one variety), extends from the plains of subtropical Argentina to Uruguay, Paraguay, southern Bolivia and Peru.
Prosopis chilensis (Molina) Stunts	(including 2 varieties), from Peru and Bolivia to Central Chile and north-western Argentina.
Prosopis juliflora (Swartz) DC	(including 2 varieties), from the coastal regions of Venezuela, Colombia and Panama, through Central America to Mexico, as well as in the Antillean Islands (perhaps introduced).
Prosopis nigra(Gris.)Hieronymus	(including 2 varieties), occurs in southern Bolivia, the Gran Chaco of Argentina, Paraguay and western Uruguay.
Prosopis tamarugo F. Philippi	arid mesetas in the northern provinces of Chile
Eucalyptus camaldulensis Dehnh.	a large part of inland Australia, with great climatic and genetic variation.
Eucalyptus microtheca F.Muell.	a large part of central and northern Australia with a separated occurrence on the west coast.
Acacia aneura F. Muell.	inland arid Australia.
Azadirachta indica Juss.	Burma, India (Siwalik Hills; Carnatic region; parts of the Deccan, south of the river Godavari).

NOTE:- A limited number of additional species within the same distribution areas as the above could be considered for the presently proposed phase of the Project, e.g. Acacia tortilis.

APPENDIX 2

Species suitable for dry climates from Webb et al (1980)

Mean annual rainfall (mm)	500
Altitudinal range (m)	1000 to 3500
Protection Planting	Shade and shelter
	OR windbreaks
	OR dune fixation
	OR anti erosion
	OR soil improvement
	OR agricultural shade
	OR ornamental

SELECTED SPECIES

1. Main species:-

111 Schinus molle

24 Marginal species:-

2	Acacia cyanophylla
6	Acacia salicina
11	Albizia Lebbek
19	Callitris clauca
29	Cupressus arizonica
34	Eucalyptus angustifolia
36	Eucalyptus brockwayi
39	Eucalyptus cladocalyx
47	Eucalyptus gomphocephala
49	Eucalyptus intertexta
50	Eucalyptus largiflorens
55	Eucalyptus microtheca
58	Eucalyptus occidentalis
65	Eucalyptus salmonophloia
66	Eucalyptus sargentii
67	Eucalyptus sideroxylon (Inland Victoria Provenances)
80	Parkinsonia aculeata
83	Pinus brutia
88	Pinus halepensis
99	Pinus pinea
107	Prosopis juliflora
108	Prosopis tamarugo
109	Robinia pseudoacacia
114	Tamarix articulata

APPENDIX 3

Species for arid and semi arid regions (NAS, 1979)

Tropical Highlands

Semi-arid regions

Azadirachta indica	A. decurrens	Albizzia lebbek
Prosopsis juliflora	A. nilotica subsp. indica	Tamarindus indica
Acacia albida	A. senegal	Emblica officionalis
	A. tortilis	Tamarix spp.

Arid and Mediterranean areas

A. Native	B. Introduced
Acacia albida	Acacia aneura s.l.
A. senegal	A. cambagei
A. raddiana and A. tortilis	A. brachystachya
A. nilotica and A. arabica	A. saligna
A. seyal	Azadirachta indica
Maerua crassifolia –	Cassia siamea
Tamarix aphylla and T. nilotica	Casuarina equisetifolia
Haloxylon persicum	Eucalyptus camaldulensis
H. salicornicum	E. microtheca
Colophospermum mopane	E. gomphocephala
Prosopis tamarugo	E. occidentalis
Retama raetam	Parkinsonia aculeata
Pinus halepensis	Pithecolonium dulce
Ziziphus spina-christi	P. alba
Balanites aegyptiaca	P. chilensis
	P. cineraria

REFERENCES

Adams, R., Adams, M., Willens, A. and Willens, A. (1978). Dry lands, Man and Plants. Architectural Press, London, England.

Brigge, W.R. (1973). Annual reports of the Director of the Department of Plant Biology, Carnegie Institute, California, USA.

Burley, J. (1979). Choice of tree species and possibility of genetic improvement for smallholder and community forests. Pap. UNU-CMU Workshop on Agroforestry, Chiang Mai, Thailand.

FAO (1977). Report of the fourth session of the Panel of Experts on Forest Gene Resources. FAO, Rome, Italy.

FAO (1979). Forest Genetic Resources Information, No. 9. FAO, Rome, Italy.

FAO (1980). Genetic resources of tree species in arid and semi arid areas. FAO/IBGR. Rome, Italy.

Ghosh, R.C. (1977). Handbook on afforestation techniques. Delhi, India.

Lacaze, (1977). Etude de l'Adaptation ecologique des Eucalyptus etude de provenances d'Eucalyptus camaldulensis Project FAO No. 6.

Proc. 3rd World Consultation on Forest Tree Breeding, Canberra, Australia. 393-409.

Leakey, R.R.B. and Last, F.T. (1980). Biology and potential of Prosopis species in arid environments with particular reference to P. cineraria. J. Arid Environments 3 pp 9-24.

NAS (1980). Fuelwood species. National Academy of Sciences, Washington, D.C., USA. (In press).

Niklas, D.G., Burley, J. and Barnes, R.D. Progress and Problems of Genetic improvement of Tropical Forest Trees pp. 979-994. Comm. For. Inst., Oxford, England.

Palmberg, C. (1975). Geographic variation and early growth in south-eastern semi-arid Australia of Pinus halepensis Mill and the P. brutia Ten. species complex. Silvae Genetica 24, 5-6.

Synnott, T.J. (1979). A report on prospects, problems and proposals for tree planting. UNESCO-UNEP IPAL Project, Nairobi, Kenya.

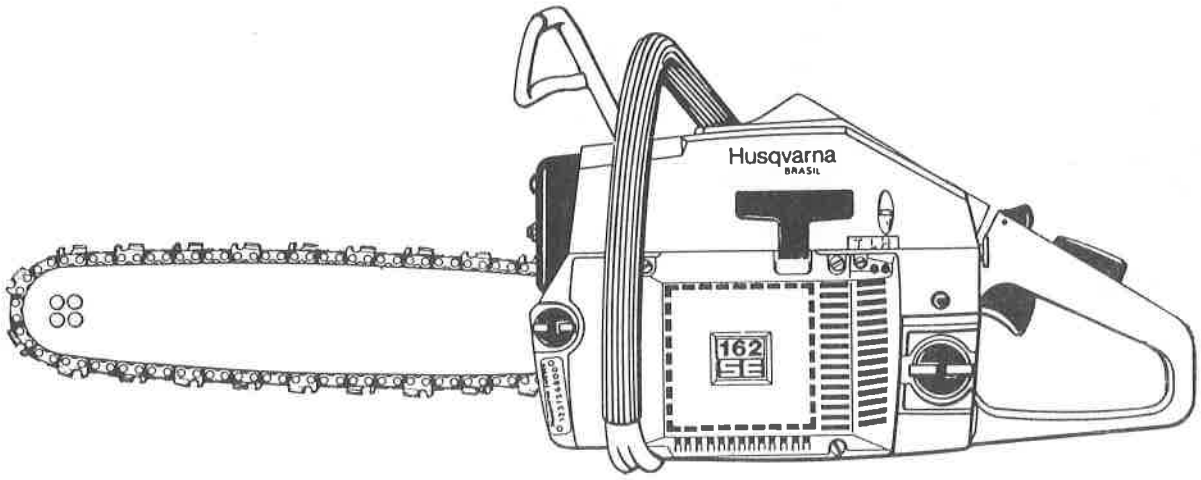
Webb, D.B. (1980). Guia y clave para Seleccionar Especies en Ensayo Forestales de Regiones Tropicales y Subtropicales. ODA, London, England.

Webb, D.B., Wood, P.J. and Smith J.P. (1980). A Guide to Species election for tropical and subtropical plantations. Trop. For. Pap. 15, Commonw. For. Inst., Oxford, England.

Weber, Fred R. (1977). Reforestation in arid lands. Action/Peace Corps/Vita.

Husqvarna

a mais profissional



Husqvarna

Grupo Electrolux

Rua Edmundo de Carvalho, 440
São João Clímaco - São Paulo
Brasil
Telex (011) 22280 ELFA - BR
Tel.(s): (011) 273-3122 e
273-3189 — CEP 04251

DISTRIBUIDORES:

SÃO PAULO:

Soc. Imp. Agro-Assai Ltda.
Rua Santa Luzia, 91
Liberdade - São Paulo - SP
Tel.(s): (011) 32-8916 e
37-3259 — CEP 01513
C. R. Diesel
Av.Imperatriz Leopoldina, 1530
São Paulo - SP
Tel.(s): (011) 261-0974 e
261-6287 — CEP 05305
Tarcisio Oliver de Faria e Cia. Ltda.
Rua Dr. Prudente de Moraes,
s/nº - Itapetininga - SP
Tel: (0152) 71-0599
CEP 18200

Coremag — Comércio e Repr. de Máq. Agrícolas Flor. Ltda.
Rua Amando de Barros, 1704
Botucatu - SP
Tel: (0149) 22-0252
CEP 18600
Djair Sanches
Rua Paraiba, 58
Ribeirão Preto - SP
Tel.(s): (016) 634-3581 e
635-1536 — CEP 14100

RIO GRANDE DO SUL

Coml. de Máqs. Benoit Ltda.
Av. Sen. Alberto Pasqualine,736
Lageado - RS
Tel.(s): (101) 3188 e 2790
CEP 95900
Rizzi & Cia. Ltda.
Rua Feijó Junior, 1132
Caxias do Sul - RS
Tel: (054) 221-7633
CEP 95100
CITRA - Comércio de Tratores, Máquinas e Implementos Ltda.
BR-153 - Km 242 s/no
Erechim - RS
Tel.(s): (054) 321-1719 e
321-1356 — CEP 99700

SANTA CATARINA

Coml. de Peças e Acessorios Tortelli Ltda.
Av. Pres. Vargas, 1548
Lages - SC
Tel: (0492) 22-1566
CEP 88500

Dimitrato — Distr. Trat. Ltda.
Rua Carlos Gomes, 206
Rio do Sul - SC
Tel: (0478) 22-1755
CEP 89160
Auto Tangará Ltda.
Av. Caetano N. Branco, 1223
Joaçaba - SC
Tel. (s): (0495) 22-1230 e
22-0257 — CEP 89600
Coml. Agrícola Tangará Ltda.
Av. Irmãos Piccoli, 386
Tangará - SC
Tel: (0495) 32-1296
CEP 89642
Alderico Kleimpaul
Rua Antonio Vitório Giordani,
34 — Xanxerê - SC
Tel: (0499) 33-0455
CEP 89820

PARANÁ

Comercial Técnica de Motos-serras Ltda. - Motolon
Av. Tiradentes, 230
Londrina - PR
Tel: (0432) 27-0822
CEP 86100
Centro Comercial de Motos-serras Ltda.
Av. 7 de Setembro, 2181
Curitiba - PR
Tel: (041) 222-6205
CEP 80000
Zanella Agromáquinas Ltda.
Av. 24 de Outubro, 1425
Medianeira - PR
Tel: (0452) 64-2180
CEP 85870

Remalosso — Motoserras e Equipamentos Ltda.
Rua Barão do Rio Branco,
1252 — Guarapuava - PR
Tel: (0427) 23-2725
CEP 85100

MINAS GERAIS

Soc. Coml. Minas Gerais Ltda. Casa Vera Cruz
Rua Araguari, 52/54
Belo Horizonte - MG
Tel: (031) 335-5422
CEP 30000

MATO GROSSO

Disnomaq - Dist.Matogrossense de Máqs. Ltda.
Av. Couto Magalhães, 666
Varzea Grande - MT
CEP 78150

AMAZONAS

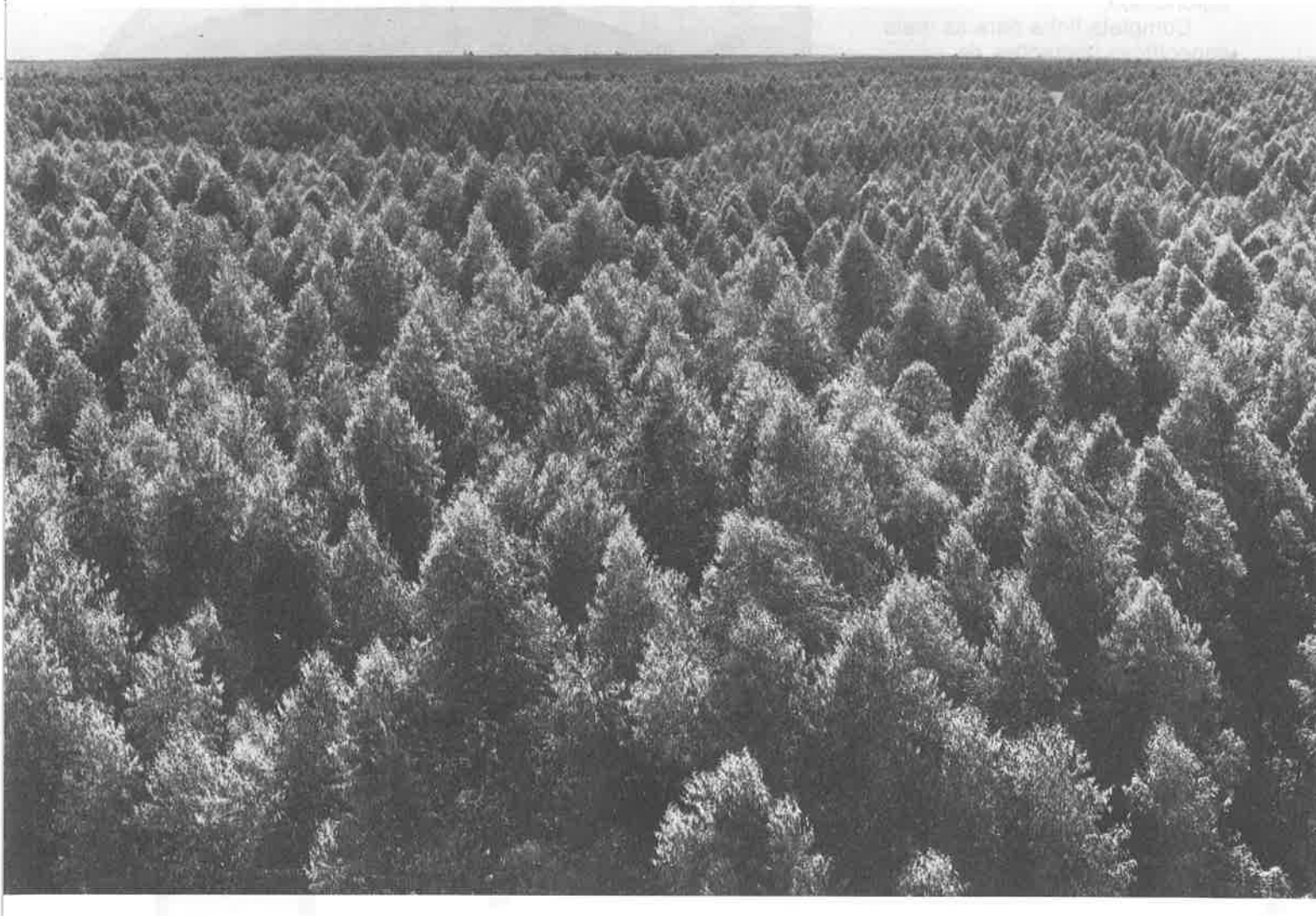
Braga & Cia. Ltda.
Av. João Alfredo, 757
Manaus - AM
Tel.(s): (092) 236-1100,
236-1150 e 236-1200
CEP 69000

ESPÍRITO SANTO

Limaq - Linhares Máquinas Ltda
Av. Marechal Rondon, 2941-B
Linhares - ES
Tel: (027) 264-2530
CEP 29900

Os especialistas em Moto-Serra

A Aracruz planta árvores e o Brasil colhe divisas.



A Aracruz já plantou mais de 100 milhões de árvores no norte do Espírito Santo. E o resultado disto, é que o Brasil tem colhido milhões de dólares em divisas com a exportação de celulose por ela produzida. Só no ano passado, isto representou 145 milhões de dólares, o que colocou a Aracruz entre os 20 maiores exportadores brasileiros.

Mas, além de divisas, o Brasil tem colhido outros benefícios com o trabalho da Aracruz. Por exemplo: mais de 5.000 empregos diretos gerados pelo empreendimento, composto pelas áreas de plantação, fábrica de celulose, unidades químicas, e um bairro – o Coqueiral. Direta e indiretamente, isso beneficia milhares de famílias e a região, que passou a contar com novos atrativos para que outras empresas se instalem ali, graças à infra-estrutura montada para a Aracruz.

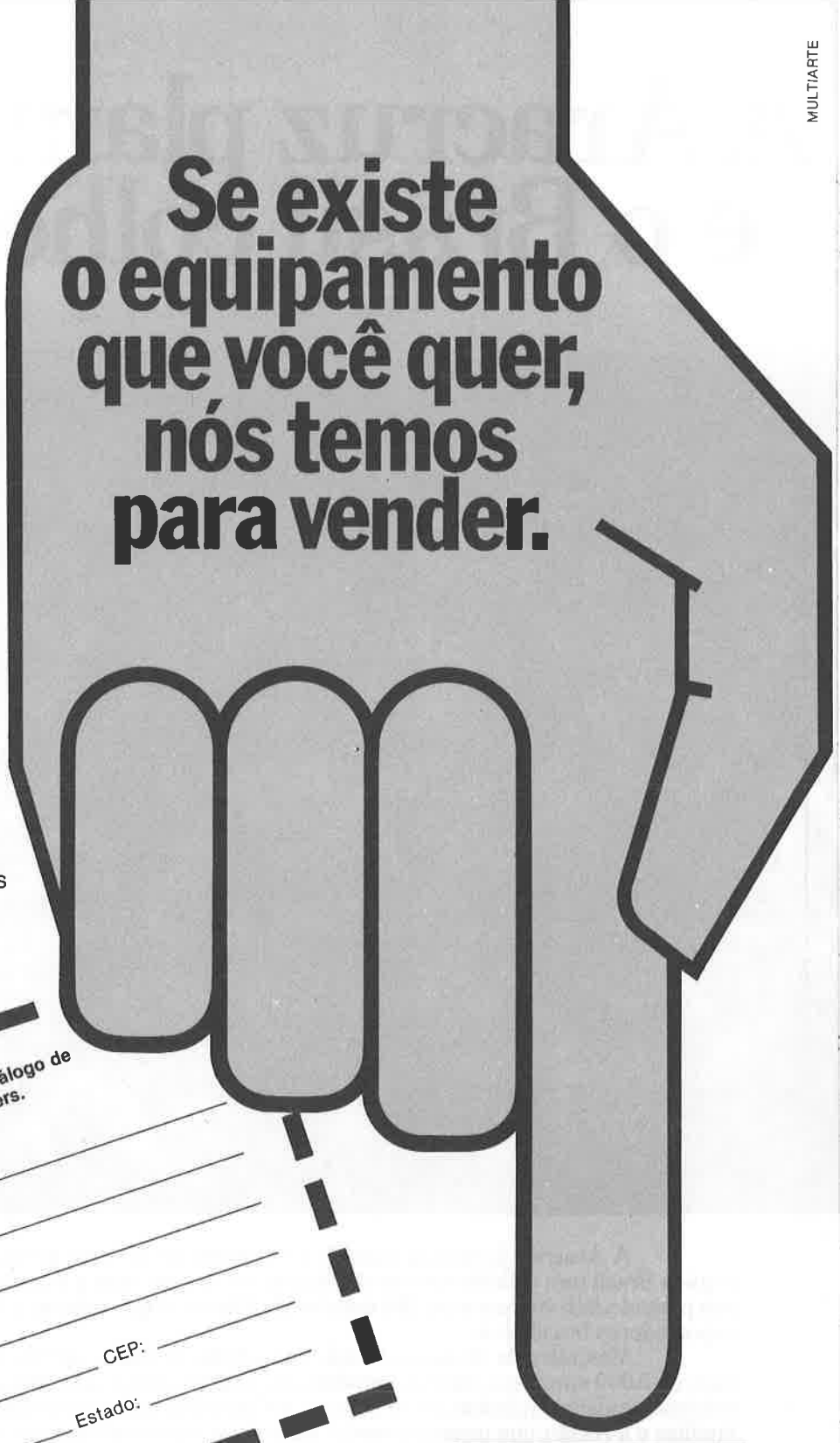
Além dos eucaliptos que abastecem a sua fábrica, para a produção anual de 400 mil toneladas de celulose, a Aracruz já plantou mais de 1 milhão e 600 mil árvores nativas, como jacarandá, peroba, pau-brasil, e 60 mil frutíferas para aumentar a oferta de alimentação da fauna. Na floresta, as pragas e os insetos daninhos são combatidos através de seus próprios inimigos naturais, evitando-se assim, o emprego de produtos químicos.

Tudo isso com a preocupação de proteger a terra, a fauna e a flora da região. Pois, a Aracruz sabe que só consegue colher bons frutos, quem trabalha em harmonia com a natureza.

ARACRUZ CELULOSE S.A.
Raízes brasileiras do progresso.

MULTIARTE

Se existe o equipamento que você quer, nós temos para vender.



Desde os mais variados modelos de moto-serras Stihl, aos mais avançados equipamentos nacionais ou importados para engenheiros florestais e agrônomos.

Completa linha para as mais específicas operações de florestamento, reflorestamento, celulose, aglomerados de madeira e compensados. Equipamentos e acessórios para inventários florestais, cálibres, trenas diamétricas, sondas, trenas para medição de pilha de madeira ou tudo o que você quiser, em estoques para entrega imediata.

A AD Agro Diesel Equipamentos Ltda., distribuidora autorizada da Stihl, especializando-se cada vez mais no atendimento às suas necessidades, foi nomeada representante exclusiva no Brasil da Forestry Suppliers — o maior revendedor de equipamentos para o setor florestal nos Estados Unidos.

Consulte-nos em nossa loja em São Paulo ou em nossos distribuidores regionais, para obter o equipamento mais adequado às suas operações. Teremos muito prazer em atendê-lo, inclusive, com serviço completo de orientação e assistência técnica.

Desejo receber, sem compromisso, o catálogo de equipamentos da Forestry Suppliers.

Nome: _____

Empresa: _____

Cargo: _____

Endereço: _____ CEP: _____

Cidade: _____ Estado: _____

AD-AGRO DIESEL EQUIPAMENTOS LTDA.

Lojas: Alameda Barão de Limeira, 575 - Rua Helvétia, 640 - Escritório: Al. Barão de Limeira, 579 1º andar conj. 12
Fones: 220-3822 — 221-4879 — 223-4164 — 221-6038 — 220-6448 — Telex: 011 - 34754 ADAG

Com os produtos Eucatex você vê quantas voltas pra frente dá este país.

Todos os dias os produtos da Eucatex estão completando uma volta ao mundo. Ou iniciando outra. E quem chega à frente todas as vezes é este país. Com as cores do Brasil, a Eucatex abriu mercado em mais de 55 países: E.U.A., Canadá, Alemanha, França, Bélgica, Holanda, Inglaterra, Peru, Chile, Argentina, México, Venezuela; mais países da África; países do Oriente Médio. Importante é que a cada volta que os produtos Eucatex dão ao mundo, voltam mais divisas para o Brasil e mais oportunidades de trabalho. O crescimento da Eucatex reflete o próprio crescimento do País onde nasceu há 30 anos. Crescendo junto, a Eucatex desenvolveu novos produtos, não pára suas atividades de pesquisas, é incansável na descoberta de novas maneiras de levar mais conforto ao homem. Ela começou com chapas de fibra de madeira, criou forros e revestimentos, passou para outros tipos de matéria-prima - o aço, o alumínio, o plástico, a fibra de vidro - evoluiu, revolucionou. Hoje é uma empresa com uma versátil linha de forros, divisórias, portas, batentes, revestimentos. E descobriu a Vermiculita, um mineral que revolucionou as técnicas para melhorar a agricultura, com largo emprego na construção civil e na indústria. Esse novo investimento da Eucatex não é um simples acaso: é conseqüência natural de uma empresa que todos os dias dá uma volta para a frente em tecnologia.

eucatex

Av. Francisco Matarazzo, 584/612
Tel.: 825-2233 - PABX - SP.

STYROBLOCK DA ISOPOR

novo berço p/reflorestamento fabricado pela Isopor p/ a plantação de mudas de Pinus e Eucalyptus, c/ uso de vermiculita.

Características

Material = Isopor (poliestireno expandido.
Dimensões = 610 x 410 x 165 mm
Peso = + - 260 gramas
Capacidade = 96 mudas
Ref.: PM-1425

Menor preço de transporte
Menor tempo para crescimento
Maior praticidade
Maior rapidez no plantio
Melhor drenagem

MATRIZ: 09700 - S. Bernardo do Campo - SP - Av. Álvaro Guimarães, 207 - Tel. (011) 448.2500 - Telex (011) 4530 ISOP

20000 — Rio de Janeiro - RJ - Rodovia Presidente Dutra, 2769 - Tel. (021) 371.4545/50

50000 — Recife - PE - Av. Mal. Mascarenhas de Morais, 1681 (081) 0633 - Telex (081) 1116 ISON

93000 - São Leopoldo - RS - Av. São Borja, 1700 - Tel. (0512) 92.5144

61900 - Fortaleza - CE - Distrito Industrial do Ceará - Pajuçara - Tel. (085) 225.0891/ 0892

** 80000 - Curitiba - PR - R. João Negrão, 1835 - Tel. (041) 223.0575*

** 66000 Belém - PA - Av. Tavares Bastos, 429 - BL 13 - Conj. 202 - Tel. (091) 231.2619*

** 40000 - Salvador - BA - Av. Estados Unidos, 3 - s/202 - Tel. (071) 242.2018 / 2146*

isopor

INDÚSTRIA e COMÉRCIO de PLÁSTICOS LTDA.

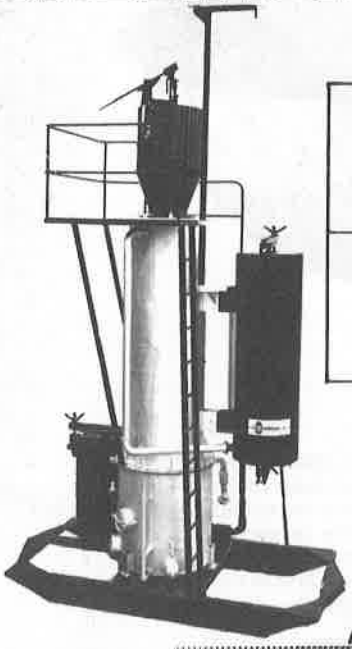
** Representante*

Empresa do grupo BASF

SOCIEDADE BRASILEIRA DE SILVICULTURA
BIBLIOTECA
Nº 01 11 95
Exp. 2

GASEIFICADORES

PARA MOTORES ESTACIONÁRIOS



PARA MOTORES DIESEL
substitui 90% de óleo diesel

PARA MOTORES À GASOLINA
substitui 100% de combustível

UTILIZADO PARA:
Grupo Geradores
Moto-Bomba
para irrigação
Motores diesel
em geral

avimec
Industria e Comercio de Equipamentos Ltda.

Rua Flores da Cunha, 1670
FONES (054) 221.6400, 221.6590 e 221.6790
TELEX: (0542) 521 AVEC BR - 95100 - CAXIAS DO SUL - RS.

TORRE PARA VIGILÂNCIA DE INCÊNDIOS FLORESTAIS

O SEGURO DE SEU PATRIMÔNIO

GRAZIA ESTRUTURAS METÁLICAS LTDA

Rua Ricardo Negrão Filho, 661
Tels. 242-1735 e 243-3644 (DDD 041)
80.000 CURITIBA, PR BRASIL