SILVICULTURA

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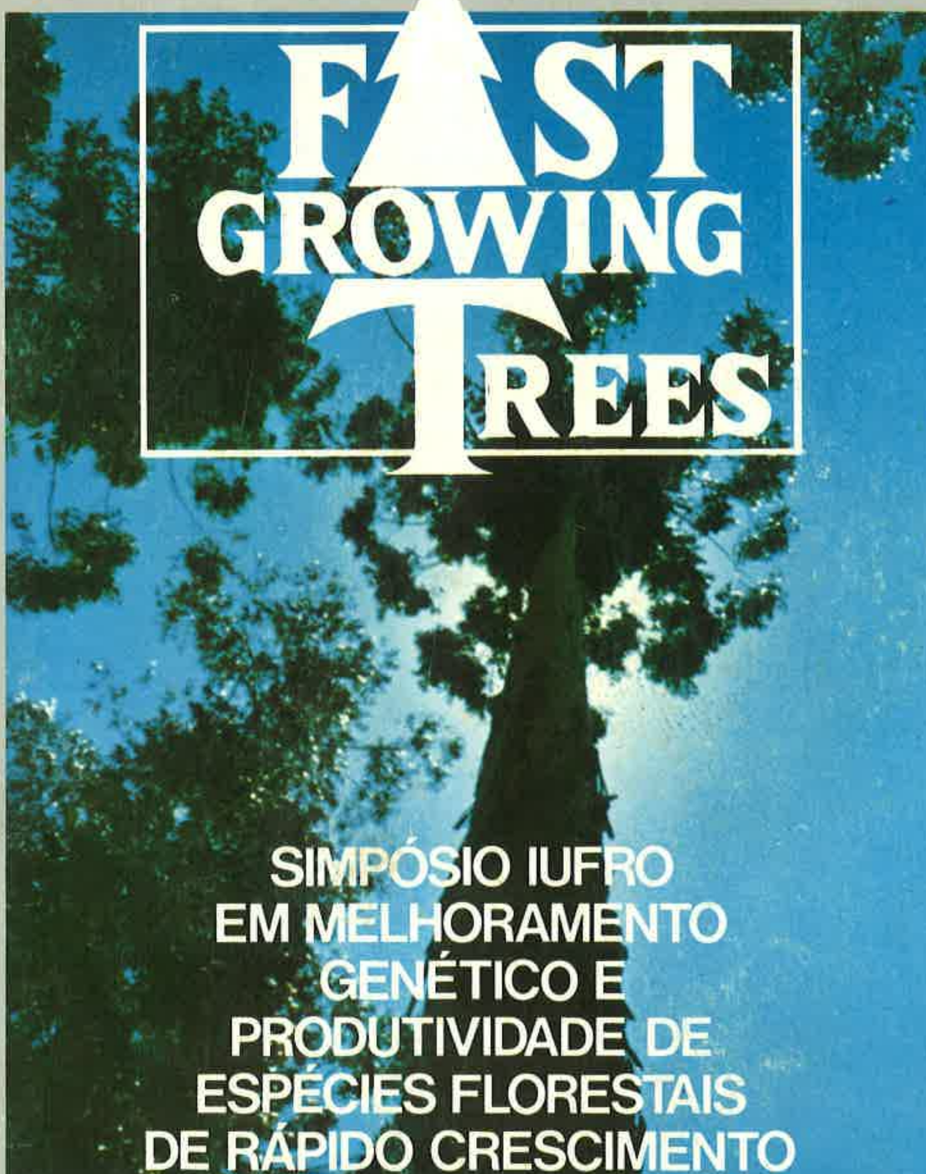
International Union of Forestry Research Organizations

IUFRO

SBS



ANAIS

AQUI ESTÁ QUEM CARREGA CANA E TUDO MAIS QUE FOR PRECISO.

Pás-Carregadeiras 930 e 966C.

Na lavoura canavieira, as Pás-Carregadeiras 930 e 966C resolvem o seu problema. Com a caçamba de aplicação geral carregam fertilizantes, adubos e calcários nos caminhões. Com a caçamba especial para material leve, transportam o bagaço de cana para alimentação das caldeiras na usina. Na conservação de estradas, dentro da propriedade agrícola, auxiliam no transporte de terra e cascalho, colaborando, também, nos serviços de aterro. Com garfos, executam toda a movimentação dos estoques de cana dentro do pátio da usina bem como a alimentação da esteira. E a troca da caçamba por um garfo é feita em poucos segundos, por meio de um sistema de engate rápido.

Essa extraordinária versatilidade das Pás-Carregadeiras Caterpillar, aliada à sua eficiência mecânica, permite o trabalho ininterrupto em uma grande variedade de aplicações. E o alto valor de revenda, tradicional nas máquinas Caterpillar, é conseqüência direta de sua reconhecida durabilidade.

Há certas coisas que você só consegue com máquinas Caterpillar, como, por exemplo, contar com o Atendimento CAT PLUS, disponível através dos Revendedores Caterpillar e que começa a resolver os seus problemas mesmo antes da compra da máquina.

Comprove pessoalmente as vantagens das Pás-Carregadeiras 930 e 966C, solicitando uma demonstração em seu Revendedor Caterpillar.

CATERPILLAR

SEMPRE A MELHOR SOLUÇÃO

GRUPOS DE INTERESSE ESPECIAL

GRUPO A
Espécies, Procedências e Melhoramento Genético de espécies tropicais com exceção de eucaliptos.
Coordenador: G. Nikles

GRUPO B
Espécies, Procedências e Melhoramento Genético de eucaliptos.
Coordenadores: L. Pederick e K. Eldridge

GRUPO C
Manejo e Silvicultura de florestas de eucalipto de rápido crescimento, incluindo fertilização.
Coordenador: R. Cromer

ESPECIAL INTEREST GROUPS

GROUP A
Species, Provenance and Genetic Improvement of tropical species with the exception of eucalypts.
Coordinator: G. Nikles

GROUP B
Species, Provenance and Genetic Improvement of eucalypts.
Coordinators: L. Pederick and K. Eldridge

GROUP C
Management and Silviculture of fast-growing eucalypt plantations, including fertilization.
Coordinator: R.Cromer

GRUPOS DE TRABALHO DA IUFRO ENVOLVIDOS NA PROGRAMAÇÃO

GRUPOS	ATIVIDADE
S. 2.02-09	— Procedências de eucaliptos
S. 2.03-10	— Melhoramento genético de eucaliptos
S. 2.02-08	— Procedências de espécies florestais tropicais
S. 2.03-01	— Melhoramento genético de espécies tropicais e subtropicais
P. 2.02-01	— Produtividade em Silvicultura de ciclo curto com eucaliptos de rápido crescimento
S. 1.02-01	— Fertilização Florestal (não oficialmente)

IUFRO WORKING GROUPS INVOLVED IN THE PROGRAM

GROUPS	
S. 2.02-09	Eucalypt Provenances
S. 2.03-10	Breeding Eucalypts
S. 2.02-08	Provenances of Tropical Forest Species
S. 2.03-01	Breeding Tropical and Subtropical Species
P. 2.02-01	Productivity of Short-Rotations Forestry with Fast-Growing Eucalypts
S. 1.02-01	Forest Fertilization (unofficially)

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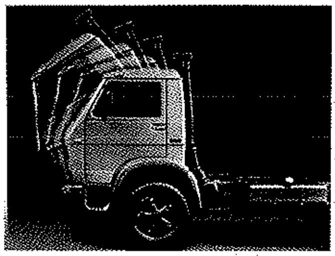
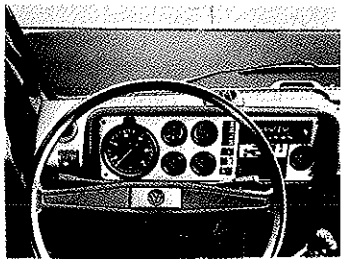
Primeiro, porque tem a garantia internacional da marca Volkswagen.

Segundo, porque reúne o que de melhor existe em tecnologia para caminhões de sua categoria.

Terceiro, porque desde que foi lançado, virou sucesso, pois tem correspondido a todas as expectativas, havendo ainda testemunhos das mais variadas empresas sobre suas comprovadas qualidades.



Cabina. Sua cabina tem o mais alto padrão de conforto e segurança, ampla visão panorâmica, eficiente isolamento termoacústico, ventilação forçada integral, banco de múltipla regulagem, além da cabina basculável que permite acesso imediato ao motor, reduzindo em 60% o tempo de manutenção.



Painel de instrumentos. O caminhão Volkswagen 13-130 oferece o mais completo painel de instrumentos, reunindo todas as informações necessárias para manter o motorista perfeitamente informado sobre o comportamento do seu veículo.

Para os itens de segurança (pressão de ar no sistema de freios; pressão do óleo e temperatura da água) possui tríplice sistema de alerta: sonoro, luzes e instrumentos de medição.

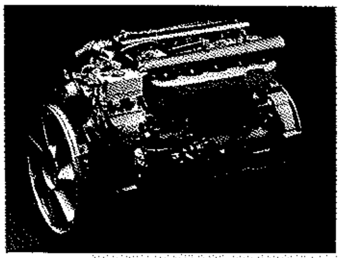
Sistema de freios. O sistema de freios é um do mais modernos existente de ação pneumática comandado por uma válvul de 4 vias que equilibra a pressão de frenagem, atua independentement nos circuitos do freio dianteiro, traseiro, freio motor e freio de estacionamento (spring brake).

Sua capacidade foi dimensionada para atender à eventual instalação

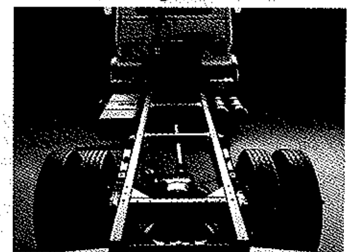
O grande sucesso do caminhão Volkswagen 13-130 confirma que ele é realmente o melhor e o mais avançado de sua categoria.

do 3º eixo auxiliar.

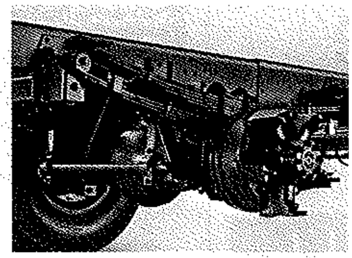
Conjunto propulsor. O conjunto propulsor do caminhão Volkswagen 13-130 é o mais balanceado e resistente disponível no mercado, pois reúne componentes de 3 renomadas empresas do setor automotivo.



Motor MWM D-229.6 de 132 cv DIN (36.6 mkg torque). Caixa de câmbio Clark 280 VHD sincronizada de 2ª a 5ª (redução de 1ª marcha: 8.58:1). Eixos Braseixos com diferencial de redução 6.83:1 (opcional 2 velocidades 6.65/9.13:1) que conferem ao veículo a condição de caminhão mais econômico de sua categoria.



Chassi. Seu chassi de alta resistência aceita adaptação de 3º eixo auxiliar; possui rodas raiadas mais resistentes e leves que as estampadas; é equipado com pneus 10.00×20-14 lonas; dispõe de direção hidráulica integral ZF de alta eficiência.



Suspensão. O caminhão Volkswagen 13-130 é o único de sua categoria que oferece 2 sistemas de suspensão: "Vari Rate", para operações convencionais que não requerem cuidados especiais de transporte; e outro, para operar nas estradas de terra ou asfalto, no transporte de cargas peculiares: vidros, eletrodomésticos, móveis, animais, aves, etc. Com molas longas (1800 mm), esta suspensão é apoiada em mancais flexíveis isentos de lubrificação, amortecedores e barras estabilizadoras dianteiras e traseiras.

Versatilidade. O caminhão Volkswagen 13-130 é oferecido em 4 distâncias de entre-eixos: 3200/3670/4127 e 4686 mm, proporcionando melhor adequação na instalação de equipamentos, mais capacidade volumétrica de cargas em sua plataforma em decorrência da cabina avançada e, conseqüentemente, melhor distribuição de carga por eixo.

Dimensionado para 13 t PBT na condição 4×2 e 21 t PBT em 6×2.

Chame um Concessionário Volkswagen Caminhões e comprove item por item todas essas afirmações de qualidade.

Depois utilize as facilidades de financiamento, leasing e consórcio que a Volkswagen Caminhões põe à sua disposição para equipar sua frota com o que há de melhor e mais avançado em tecnologia de caminhões.

CAMINHÕES

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Relator/Rapporter:
R. M. Brandi

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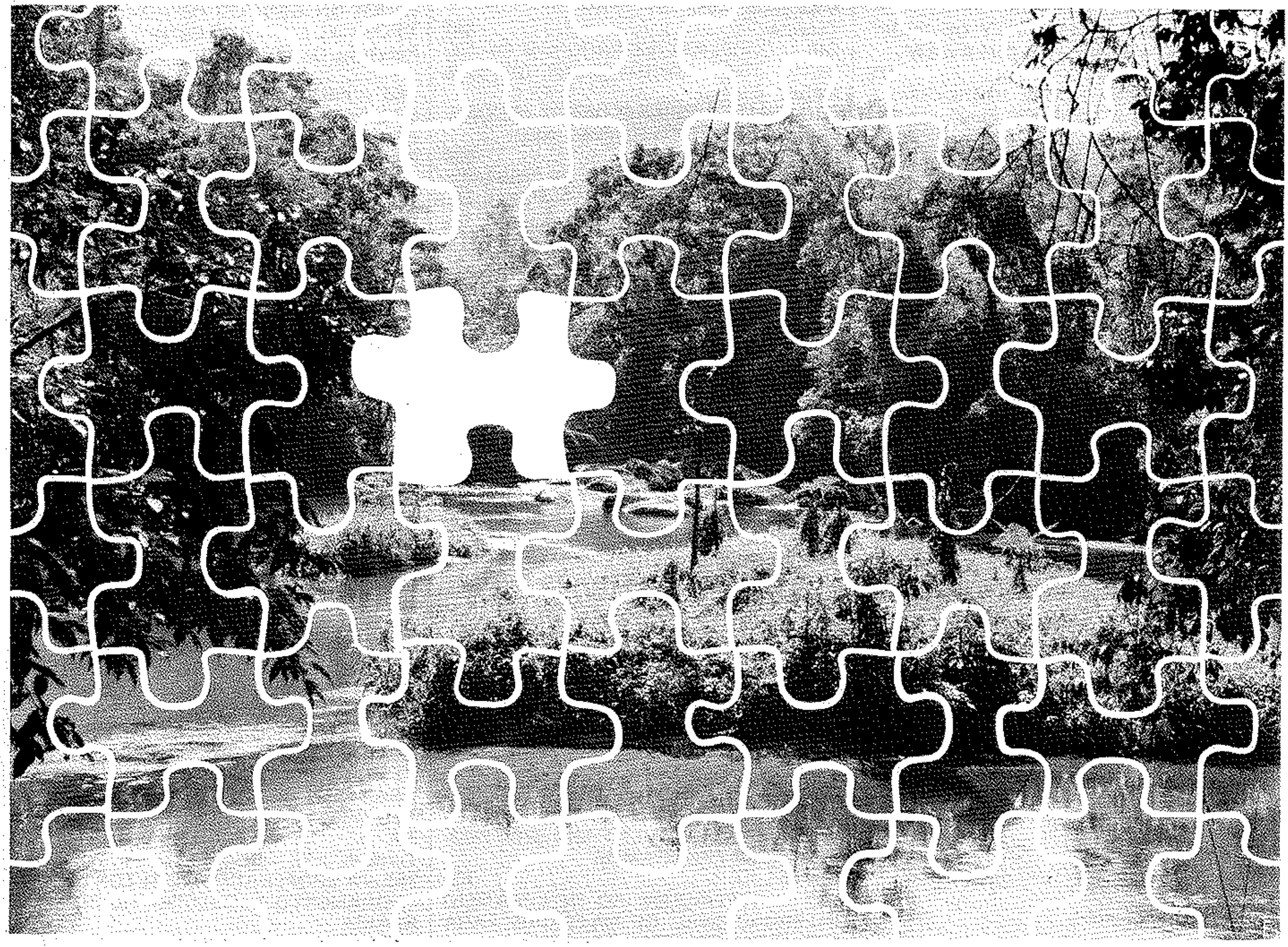

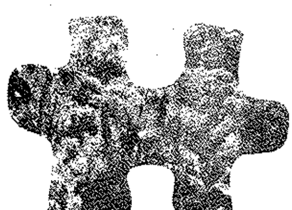

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Cooperação – Nacional, regional e internacional.
Cooperations – National, regional and international.
Coopération – Nationale, régionale et internationale.

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A. P. M. Galvão
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Presidente/Chairman:
C. E. Foelkel
Relator/Rapporter:
L. E. G. Barrichelo

sessão III
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EFEITOS DE ALGUMAS PRÁTICAS SILVICULTURAIS NA BROTAÇÃO DE *Eucalyptus saligna* SMITH.

Eliseu de Souza Baena
. Eucatex Florestal Ltda
Admir Lopes Mora
Gilmar Bertoloti
. Instituto de Pesquisa e Estudos Florestais
Ruy Sanches Osório
. Eucatex S/A Indústria e Comércio.
Brasil.

Resumo

No presente trabalho os autores estudaram aspectos importantes da brotação em *Eucalyptus saligna*. Foram analisadas as correlações entre a altura do corte do sub-bosque e o vigor das brotações, a influência de alguns minerais, assim como a dosagem e o método de aplicação do fertilizante visando à brotação.

Em geral foi observado que o corte à altura de 15 cm, a altura das duas gemas dominantes era maior, e que o número de gemas abaixo de 5 cm diminiu proporcionalmente ao aumento da altura do sub-bosque. Foi também observado que a altura da gema dominante foi significativamente favorecida pela aplicação do fertilizante.

Observações posteriores mostraram que outros aspectos provavelmente devam ser enfatizados num estágio mais avançado de desenvolvimento das brotações.

Summary

In this work the authors started studies about important aspects of budding of Eucalyptus saligna. Thus, the correlation between the height of the cut and the vigor of the coppice shoot is analized; the influence of some minerals as well the dosing and method of application of fertilisers, relative to the budding. The influence of the remaining of better trees was analized, that will permit good volumes for sawmill without damage to the coppice shoots.

In a general way it was observed that with a cut at a height of 15cm the two dominating shoots were taller and that the number of shoots under 5cm decreased proporcionally to the increase of the height of the cut. It was also concluded that the height of the dominating shoots was meaninfully favored by the application of fertilizers.

However, with the observations that follow, after six months have passed, it is probable that new aspects of importance will occur.

I- Introdução

A necessidade de garantir a rebrota dos eucaliptos em segunda rotação através de práticas silviculturais adequadas, reveste-se de grande importância para a definição dos futuros programas de implantação florestal, principalmente para as regiões onde as condições climáticas ou de solo interferem negativamente na regeneração por talhadia (MELLO, 1974).

BALLONI et all (1978) estudando o efeito da fertilização mineral na brotação de touças verificaram que esta técnica proporciona melhores resultados na produção volumétrica dos brotos. Da mesma forma PINHEIRO (1961) e FAO (1956) recomendam que o corte seja feito ao nível do solo. No entanto, em Portugal, o corte é executado de 10 a 15 cm, pois espécies como o E. globulus não formam bons brotos próximo ao sistema radicular e não rebrotam quando cortados ao nível do solo.

Em trabalhos conduzidos pela Champion, foram encontrados os seguintes resultados para o E. grandis:

Corte	Nº de gemas
5 cm	1,8
5-10 cm	2,6
5-15 cm	4,1

Sendo assim, a Eucatex S/A Ind. e Comércio, devidamente assessorada pelo IPEF - Instituto de Pesquisas e Estudos Florestais, procurou estudar em um conjunto de ensaios, a indução de brotos nas touças de E. saligna com 6 anos de idade, e seu posterior desenvolvimento através da aplicação de várias formas e doses de fertilizantes, como também do corte raso a diferentes alturas.

Por outro lado constatada a crescente escassez de madeiras duras no Estado de São Paulo e o grande consumo desse material pela Eucatex S/A Indústria e Comércio, para confecção de "pallets", embalagens, construções internas, etc., passou a empresa a partir de 1975 a selecionar as melhores árvores dos povoamentos, reservando-as para posterior aproveitamento em serrarias de sua propriedade.

Considerando-se, no entanto, o futuro aproveitamento também de madeira proveniente da brotação em segundo e terceiro corte, foram levantadas dúvidas sobre eventuais prejuízos das árvores remanescentes sobre aquela brotação, devido à concorrência de luminosidade e nutrientes.

Assim, um ensaio foi instalado com o intuito de determinar a densidade ideal de remanescentes, que não traga prejuízos significativos às futuras explorações propiciando volumes consideráveis para serraria.

Os critérios para a montagem dos ensaios, bem como, as considerações gerais sobre os resultados são apresentados a seguir:

SUB PROJETO A

DENSIDADE POPULACIONAL DE ÁRVORES REMANESCENTES DE EUCALYPTUS saligna Smith VISANDO PRODUÇÃO DE MADEIRA PARA SERRARIA E EFEITOS SOBRE A BROTAÇÃO DAS TOUÇAS

1- Material e Métodos

Em um plantio de Eucalyptus saligna, procedência Rio Claro-SP, situado em Salto de Pirapora-SP com latitude 23º 42', longitude 47º 34' e altitude 755-775m, efetuou-se um estudo sobre o número de árvores remanescentes após o primeiro corte aos 7 anos. Em parcelas de 1,0 ha, foram mantidas 30, 50, 100, 150 e 200 árvores, selecionadas principalmente, pelas características de forma e vigor.

O ensaio foi instalado em blocos ao acaso, sendo que cada repetição apresentava uma condição de fertilidade do solo diferenciada conforme segue:

Bloco I - Fertilidade Baixa
Bloco II - Fertilidade Média
Bloco III- Fertilidade Alta

2- Resultados e Discussões

Um aspecto abordado é a porcentagem de brotação em função do número de árvores por parcela. Os dados encontram-se no Quadro 1.

Quadro I: Porcentagem de falhas de brotação em relação ao número de árvores remanescentes.

Nº de Árvores/ha	Blocos I%	II%	III%	Média %
30	20,4	9,9	8,3	12,9
50	15,6	16,2	6,8	12,9
100	17,4	21,0	12,5	16,9
150	20,9	8,9	27,5	19,1
200	21,3	10,3	12,9	14,8

Média Geral 15,32%

Observa-se que o número de árvores não influenciou a porcentagem de brotação, até o presente.

As medições do incremento das árvores remanescentes e das brotações permitirão determinar o número ideal de árvores para serraria, em função da classe de fertilidade do solo, após 6 anos da instalação do ensaio.

SUB PROJETO B:

INFLUÊNCIA DA ALTURA DA TOUÇA DO *E. saligna* SOBRE O VIGOR E SOBREVIVÊNCIA DA MESMA

1- Material e Métodos

O ensaio foi instalado em 10/78 no município de Bofete S.P. numa floresta de *E. saligna* Smith aos 6 anos de idade com delineamento em blocos ao acaso, contando com 6 tratamentos e 4 repetições.

Os tratamentos empregados foram os seguintes:

Tratamento	Altura de corte (cm)
01	05
02	10
03	15
04	20
05	25
06	30

2- Resultados

Quadro I: Número médio de brotos vivos e mortos por touça e altura média das brotações, aos 12 meses, nos diferentes tratamentos.

Tratamento altura	Nº de brotos vivos			Nº de brotos mortos			ALTURA MÉDIA DOS 2 BROTOS DOMINANTES (M)
	até 5cm	>5cm	total	até 5cm	>5cm	total	
01 - 5cm	4,20	0,0	4,20	1,65	0,0	1,65	5,61
02 - 10cm	2,66	2,45	5,11	1,03	1,14	2,17	5,74
03 - 15cm	2,29	3,26	5,55	1,23	1,25	2,48	6,11
04 - 20cm	2,14	4,74	6,88	0,62	1,33	1,95	5,92
05 - 25cm	1,93	5,12	7,05	1,05	2,02	3,07	5,90
06 - 30cm	1,94	6,47	8,41	0,25	1,57	1,82	6,05

Quadro II: Número total de brotos vivos e mortos nos diferentes tratamentos.

Tratamentos	Nº de brotos vivos			Nº de brotos mortos			Total
	até 5cm	>5cm	total	até 5cm	>5cm	total	
01	700	-	700	43	-	43	743
02	397	339	736	19	28	47	783
03	332	492	824	15	42	57	881
04	276	744	1020	04	35	39	1059
05	239	821	1060	11	52	63	1123
06	209	1039	1248	01	38	39	1287

Quadro III: Número de brotos e perdas por tombamento de acordo com o aumento gradativo da altura de corte.

Diferença de altura	Ganhos em Brotação (Nº)	Perdas por tombamento (Nº)
5 - 10cm	36	04
5 - 15cm	124	14
5 - 20cm	320	- 04
5 - 25cm	360	20
5 - 30cm	548	- 04

Quadro IV: Porcentagem de brotos vivos e mortos em cada tratamento.

Altura	% brotos vivos		% brotos mortos		Nº de touças que não brotaram	TOTAL DE TOUÇAS INICIAIS
	até 5cm	5cm	até 5cm	5cm		
5cm	94,21	-	5,79	-	3 = 1,8%	168
10cm	50,70	43,30	2,43	3,58	4 = 2,5%	162
15cm	37,68	55,85	1,70	4,77	2 = 1,2%	163
20cm	26,06	70,25	0,004	0,03	1 = 0,6%	165
25cm	21,28	73,11	0,009	0,05	1 = 0,5%	170
30cm	16,24	80,73	0,0007	2,95	3 = 1,8%	166

3- Discussão dos Resultados

O número médio de brotos que permaneceram vivos, até 12 meses após o corte, foi superior à média geral do ensaio (6,20), apenas nas parcelas onde a altura de corte foi maior que 15 cm, ou seja, nos tratamentos 4, 5 e 6, os quais mostraram 6,88; 7,05 e 8,41 brotos por touça respectivamente (quadro I).

SIMÕES (1972), também constatou que a altura a que se processa o corte tem ação sobre o vigor da brotação, como também na sobrevivência das touças. Essa mesma observação foi comprovada por BALLONI, SIMÕES E SILVA (1978), com *E. saligna* de 3 anos de idade.

A altura média dos brotos dominantes, foi maior quando efetuou-se o corte a 15cm (tratamento 3), com 6,11 m, ao passo que nas árvores onde o corte foi realizado a 5cm do solo as brotações atingiram uma altura média de 5,61 m. Apesar desta diferença (50cm), pode-se notar que até o momento desta avaliação (12 meses) não houve grandes diferenças na altura das brotações entre os tratamentos empregados.

Verifica-se também que com o aumento da altura do corte, o número de gemas que permanecem vivos até 5cm foi diminuindo, ocorrendo o inverso para os brotos que estavam localizados acima desta altura. Isto pode ser constatado no quadro II comparando-se os tratamentos 02 e 06, onde nota-se um decréscimo de 397 para 209 no total de brotos vivos até 5cm de altura da touça, ao passo que houve um aumento de 339 para 1.039 brotos vivos acima desta altura.

Nos resultados mostrados no quadro III, fica evidente também que os acréscimos em brotação quando há um aumento na altura de corte são expressivamente maiores comparados às perdas por tombamento. Este fato pode ser comprovado, comparando-se o tratamento 02 (10cm), o qual apresenta 36 brotos a mais que o tratamento 01 (5cm) com apenas a perda de 4 brotos (do total geral) causado pelos tombamentos.

Apesar de algumas observações feitas pelo "THE WATTLE RESEARCH INSTITUTE, 1972", enfatizando que brotos dominantes e mais resistentes ao vento formam-se a partir da base do tronco, conclui-se que as alturas superiores a 5cm para o corte raso favorecem em muito a brotação, sem apresentar grandes perdas por tombamento. Contudo, há necessidade de alguns estudos econômicos visando analisar as perdas em volume de madeira quando são deixados no campo tocos com diâmetros e alturas apreciáveis, os quais também tem grande influência na viabilidade de entrada de equipamentos florestais nos talhões em exploração dificultando a retirada da madeira.

A percentagem de touças que não brotaram pode ser considerada normal para a espécie em questão, ficando em torno de 1,4% a média geral de touças mortas após o corte.

SUB PROJETO C:

INFLUÊNCIA DE ALGUNS ELEMENTOS MINERAIS NA BROTAÇÃO DE *E. saligna*

1- Material e Métodos

Este ensaio foi instalado em 02/79 no município de Bofete S.P., numa floresta de *E. saligna* Smith aos 6 anos de idade com delineamento em blocos ao acaso contando com 7 tratamentos e 4 repetições.

Efetuou-se a aplicação de 300g de adubo NPK (10.34.06) por planta, utilizando como fontes a uréia, superfosfato triplo e cloreto de potássio, além da incorporação de 2 ton/Ha de calcário dolomítico.

Os tratamentos empregados foram os seguintes:

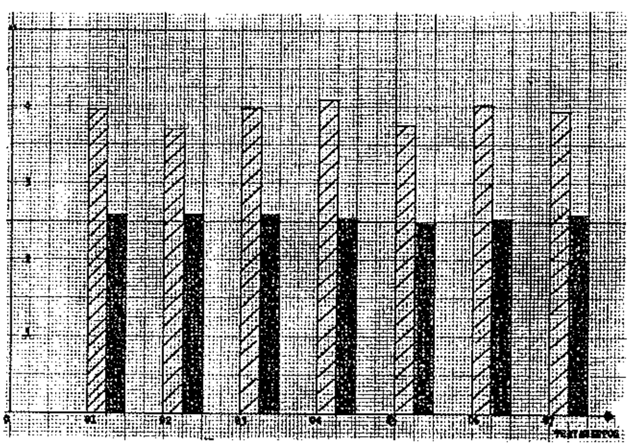
Tratamento	Nutrientes
01	NPK + Ca Mg
02	NPK
03	NP + Ca Mg
04	NK + Ca Mg
05	PK + Ca Mg
06	Testemunha
07	Testemunha com revolvimento na entrelinha

2- R e s u l t a d o s

QUADRO V: Resultado da brotação dos diferentes tratamentos, 06 meses após o corte das árvores.

TRATAMENTOS	TOTAL DE ÁRVORES NO CORTE RASO	TOTAL DE TOUÇAS BROTADAS	TOTAL DE TOUÇAS NÃO BROTADAS	TOTAL DE BROTOS	MÉDIA DE BROTOS POR TOUÇA	ALTURA MÉDIA DOS DOIS BROTOS DOMINANTES
01 - NPK Ca Mg	176	170	06	678	3,98	2,57
02 - NPK	177	170	07	634	3,70	2,58
03 - NP Ca Mg	179	169	12	621	3,97	2,57
04 - NK Ca Mg	159	154	05	635	4,12	2,54
05 - PK Ca Mg	173	168	05	631	3,75	2,49
06 - Testemunha	158	156	03	628	4,01	2,53
07 - Testemunha + Revolvimento	166	158	08	620	3,92	2,59

Gráfico I: Média de brotos por touça e altura média dos mesmos de acordo com os diferentes tratamentos empregados



- Altura Média dos brotos
- Média de brotos/touça

3- D i s c u s s ã o d o s R e s u l t a d o s

No quadro V verifica-se que o revolvimento do solo na entrelinha sem a aplicação de fertilizante (tratamento 07) apresentou média em altura de 2,59m ao passo que nas parcelas com ausências de adubação e sem revolvimento do solo (tratamento 06), a média em altura dos 2 brotos dominantes foi de 2,53 m (apenas 6cm menos que o tratamento anterior).

A maior quantidade de brotos por touça apareceu no tratamento 04 (aplicação de NK Ca Mg) e 06 (ausência de fertilizante e revolvimento do solo), mostrando que esta idade (06 meses) as alterações provocadas no solo, tanto no teor de nutrientes, efetuado pela adubação como também na estrutura física, não foram suficientes para provocar diferenças flagrantes entre os diferentes tratamentos empregados.

A porcentagem média de falhas do ensaio foi baixa não dando grandes diferenças entre tratamentos.

SUB PROJETO D:

ESTUDO DA DOSE DE FERTILIZANTE E MÉTODO DE APLICAÇÃO EM SEGUNDA ROTAÇÃO DE *E. saligna*

1- M a t e r i a l e M é t o d o s

Ensaio instalado em 20.02.79 no município do Bofete S.P., numa floresta de *E. saligna* Smith aos 6 anos de idade com delineamento em blocos ao acaso e parcelas subdivididas, constando de 09 tratamentos e 04 repetições.

Os tratamentos empregados foram os seguintes:

1º - Testemunha;
2º - 200g NPK, aplicado a lanço, na entrelinha sem incorporação, antes do corte;
3º - 400g NPK, aplicado a lanço, na entrelinha sem incorporação, antes do corte;
4º - Testemunha com sulco na entrelinha;
5º - 200g NPK, aplicado em sulco na entrelinha, antes do corte;
6º - 400g NPK, aplicado em sulco na entrelinha, antes do corte;
7º - Testemunha com gradagem na entrelinha;
8º - 200g NPK, aplicado a lanço na entrelinha e incorporada com grade leve, antes do corte;
9º - 400g NPK, aplicado a lanço na entrelinha e incorporada com grade leve, antes do corte.

2- R e s u l t a d o s

Quadro VI: Dados gerais da brotação, 6 meses após o corte.

Nº DO TRATAMENTO	TOTAL DE ÁRVORES NO CORTE RASO	TOTAL DE TOUÇAS BROTADAS	TOTAL DE TOUÇAS NÃO BROTADAS	TOTAL DE BROTOS GERMINADOS	MÉDIA DE BROTOS POR TOUÇAS	ALTURA MÉDIA DOS 2 BROTOS DOMINANTES
01	163	159	04	602	3,56	2,89
02	160	156	04	618	3,96	3,36
03	177	175	02	694	3,96	3,43
04	164	162	02	649	4,01	3,00
05	166	165	01	630	3,82	3,22
06	163	158	05	634	4,00	3,50
07	162	156	06	597	3,87	2,73
08	167	163	04	614	3,18	3,22
09	162	160	02	654	4,07	3,30

3- Discussão dos resultados

Analisando os resultados deste ensaio no quadro VI, verifica-se que a aplicação de 400g de NPK por planta, em sulco na entrelinha (tratamento 6) e 400g NPK por planta, aplicado a lanço na entrelinha (tratamento 3) proporcionaram maior desenvolvimento na altura média dos 2 brotos dominantes, evidenciando que essa quantidade de fertilizante aplicado por muda contribui efetivamente para o maior crescimento das brotações. Apesar disto o tratamento 09 (400g de NPK por planta, incorporado na entrelinha) apresentou altura média dos brotos inferiores à parcela com 200g de NPK, aplicado a lanço na entrelinha, sem incorporação (tratamento 2), com 3,30m e 3,36m respectivamente.

Portanto, isto sugere que a incorporação do adubo ao solo, feito pela grade leve, pode causar dano ao sistema radicular das árvores, refletindo negativamente no desenvolvimento posterior da brotação.

No entanto, ensaios publicados por "THE WATTLE RESEARCH INSTITUTE, 1972", mostram que a escarificação do solo nas entrelinhas reduz a mortalidade das touças e aumenta o vigor e número de brotos produzidos por touça após o corte. O principal efeito da escarificação, nestes ensaios foi o aumento da capacidade do solo na retenção da água da chuva. Também a subsolagem produziu um bom efeito, porém causou problemas com ferimentos no sistema radicular.

Considerando apenas a dosagem 200g por planta, nota-se que o tratamento 2 continua sendo superior aos demais (05 e 08) apesar da pequena diferença em relação à média geral do ensaio.

Os tratamentos que proporcionaram maior número médio de brotos por touça foram os nº 09, 04 e 06 com 4,07; 4,01 e 4,0 brotos respectivamente, mostrando com isto, que a quantidade de adubo aplicado antes do corte não teve influência decisiva na indução à brotação das gemas, pelo menos até à avaliação feita 6 meses após o corte. Esta afirmação pode ser comprovada verificando os resultados mostrados pela testemunha com sulco na entrelinha (tratamento 04) onde brotaram maior número de gemas por touça quando comparadas as parcelas adubadas com 200g por planta, (caso específico dos tratamentos 02, 05 e 08).

A porcentagem máxima de touças que não brotaram ocorreu no tratamento 07 (3,7%), não trazendo, praticamente, nenhum prejuízo aos resultados dos tratamentos empregados.

II- Conclusões Gerais

Diante dos resultados mostrados nas avaliações nos diferentes ensaios conclui-se que:

A) O número diferenciado de árvores remanescentes, de 30 a 200, não afetou a percentagem de brotação, até o presente.
B) Após 6 anos da instalação, haverá indicações do número ideal de árvores remanescentes, sem afetar a brotação, em função da fertilidade do solo.
C) Aumentando a altura do corte verifica-se que o número médio de brotos por touça se eleva drasticamente, sem mostrar grandes perdas por tombamento.
D) A altura média dos brotos dominantes, aparentemente, foi maior no tratamento em que efetuou-se o corte a 15cm de altura.
E) Aumentando a altura do corte, ocorre uma diminuição na brotação das gemas até 5cm do solo.
F) Não foram constatadas diferenças significativas no número médio de brotos por touça 06 meses após a aplicação de fertilizantes e gradagem.
G) A altura dos brotos foi influenciada em muito pelas diferentes dosagens de fertilizantes, utilizados nos tratamentos.

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ESTUDO DA FLUTUAÇÃO POPULACIONAL DAS PRAGAS DE *Eucalyptus spp* DE SEUS PARASITAS PREDADORES ATRAVÉS DE ARMADILHAS LUMINOSAS.

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Resumo

Armadilhas luminosas foram utilizadas para a coleta e identificação dos insetos que normalmente ocorrem em florestes de eucaliptos, durante um período de 2 anos.
O objetivo foi o de se fazer um levantamento dos insetos que aparecem endemicamente, conhecer seus hábitos, seu ciclo evolutivo, etc., de tal forma a permitir um rápido controle biológico no caso de um ataque epidêmico.

Foi observado que para alguns insetos existe normalmente um perfeito equilíbrio biológico, para os quais ocorre um aumento na população dos predadores naturais imediatamente após a ocorrência do ataque epidêmico. São apresentadas ainda informações a respeito da flutuação de algumas outras ordens de interesse florestal.

Summary

Aiming to know the insects that appear endemically in the eucalyptus forests, their habits, evolutive cycle, eto that would permit a rapid biological fight in case of an epidemic, at the present work the authors tried to collect the insects of forestal interest that ocurred during 2 years in such forest. Luminous traps were used.

It was observed that for some insects there was a perfect biological equilibrium, increasing the peaks of population of the natural enemies soon after the plague boom. At the same time information about the fluctuation of some other orders of forestal interest were presented.

I- Introdução

Nas florestas artificiais as vezes ocorrem surtos de pragas que causam grandes prejuízos às essências florestais não só pela redução da área foliar, como também pelo ataque aos ramos, troncos e raízes. Nestes, além do dano mecânico causado pelo inseto através de galerias e seccionamentos é comum haver infecções por microorganismos que se aproveitam destas vias de penetração para se instalar no hospedeiro, podendo causar até sua morte.

Em condições normais tais surtos não ocorrem, devido principalmente à existência de um equilíbrio biológico reinante nestas florestas. Mas, se por um motivo qualquer, houver um desequilíbrio, certamente ocorrerá uma alta infestação de uma das espécies de inseto nociva ao vegetal, e isto acarretará num grande prejuízo ao produtor despreparado.

Para evitar estas surpresas há necessidade de se acompanhar o que ocorre principalmente com a população de insetos existente nas florestas. Um dos métodos aconselhável para tal estudo é o levantamento populacional das pragas e demais insetos correlacionados através de armadilhas luminosas, já que na grande maioria possuem hábitos noturnos, sendo atraídos pela luz.

QUADRO I   Quadro da flutuação populacional das pragas e de seus parasitos e predadores.

ORDEM		JAN. 78	JAN. 79	FEV. 78	FEV. 79	MARÇO 78	MARÇO 79	ABRIL 78	ABRIL 79	MAIO 78	MAIO 79	JUNHO 78	JUNHO 79	JULHO 78	JULHO 79	AGOSTO 78	AGOSTO 79	SET. 78	SET. 79	OUTUBRO 78	OUTUBRO 79	NOVEMBRO 78	NOVEMBRO 79	DEZEMBRO 78	DEZEMBRO 79	JANEIRO 80	FEVER. 80
	PRECIPITAÇÃO (MM)		83,1	95,2	141,1	149	125,5	29	39,9	74,8	121,7	75,1	1,4	141,3	39,0	3,5	92,0	52,6	152	120,2	63,7	237,5	98,6	215,4	157,2	100,6	183,3
	TEMPERATURA MÍNIMA (°C)		13	15	14	15	12	10	12	5	8	3	0	10	4,5	-1	9,0	10,5	8,0	12,0	10,0	11,0	9,5	14,0	14,0	13,0	15,0
	TEMPERATURA MÁXIMA (°C)		32	34	34	33	31	32	31	29	26	27	27	27	27,0	31,5	30,0	30,0	33,6	32,0	33,0	31,0	32,0	31,0	32,0	30,0	33,0
LEPIDOPTERA	FAMÍLIA ARCTIIDAE Eupseudosoma involuta		11	6	6	18	5	21	8	25	6	7	4	1	4	3	3	1	1	0	2	1	1	2	3	4	4
	FAMÍLIA LYMANTRIIDAE Sarsina violasiens		12	9	11	28	4	111	1	404	200	23	762	17	273	5	1	1	1	0	3	1	2	2	2	4	5
	FAMÍLIA GEOMETRIDAE Thyrinteina arnobia		13	9	20	24	5	34	2	11	8	8	12	6	12	2	7	2	3	3	4	2	1	1	2	1	4
	FAMÍLIA ADELOCEPHALIDAE Eacles sp.		30	37	32	48	15	38	20	23	3	7	5	2	2	4	7	11	14	21	45	7	24	3	9	4	6
COLEOPTERA	FAMÍLIA CHRYSOMELIDAE Costalimaita ferruginea vulgata		437	50	21	135	9	8	1	76	1	0	0	0	0	0	17	8	19	19	17	540	359	342	988	102	86
	FAMÍLIA SCARABAEIDAE Bolax flavoleneatus		1218	153	68	321	13	34	3	36	5	2	1	0	2	0	16	11	42	701	54	619	690	43	3467	903	215
	FAMÍLIA CERAMBYCIDAE		13	3	20	27	31	2	4	3	2	0	0	0	2	0	15	0	17	4	20	20	33	12	58	12	6
	FAMÍLIAS {CARABIDAE, CICINDELIDAE} **		75	84	54	72	6	5	1	49	2	10	3	8	4	15	13	12	17	62	37	13	91	8	21	15	4
HEMIPTERA			15	20	21	42	49	10	20	5	8	9	9	3	4	10	13	16	16	30	41	60	85	34	27	18	16
HOMOPTERA			185	230	156	204	66	77	61	65	32	3	4	0	2	41	24	88	55	164	141	43	73	56	68	36	19
ORTHOPTERA			67	16	59	45	16	14	11	14	10	0	1	0	2	0	1	1	3	41	5	69	39	30	23	16	19
DIPTERA	(90% Tachinidae) *		27	4	16	14	12	8	16	61	45	32	31	7	20	10	27	21	39	18	29	10	13	10	15	9	18
DERMAPTERA	***		4155	178	697	461	610	112	215	9	16	0	1	0	3	3	2	7	53	29	172	1955	2468	750	941	211	193
HYMENOPTERA	***		268	289	137	315	111	169	36	203	92	79	105	65	150	96	56	157	149	250	170	202	165	30	134	32	49

* Díptera - inimigo natural dos Lepidópteros pois são parasitos das lagartas.
** Predadores de outros insetos tanto na fase larval como na fase adulta.
*** Predadores dos Homópteros (cochonilhas, pulgões, etc..).

Fazendo-se amostragens periódicas pode-se chegar ao conhecimento da dinâmica populacional dos insetos e com este conhecimento, pode-se prever um início de surto e portanto determinar qual o melhor método para evitá-lo ou mesmo controlá-lo. Assim, procurou-se no presente trabalho determinar tais flutuações populacionais dos insetos pragas, bem como de seus principais inimigos naturais.

2- Revisão Bibliografica

As armadilhas luminosas, segundo GALLO et al (1970) são aparelhos destinados a atrair e capturar insetos de vôo noturno fototrópicos positivos.

Atualmente tais aparelhos vêm sendo utilizados em larga escala, de acordo com HART SOCK et al (1966) para levantamento de populações, coleta e controle de insetos.

LAWSON e GENTRY (1966) na Carolina do Norte mostram que o uso generalizado de armadilhas luminosas pelas culturas de fumo, acarretaram uma redução de 90% no consumo de inseticidas, no ano de 1963 neste Estado.

CHANDLER (1961) trabalhando com o himenoptero Sphecodogastra texana (cressan) sua flutuação por tratar de uma praga de pinus, em Indiana.

No Brasil os iniciadores dos trabalhos de flutuação de população e levantamento de insetos com o uso de armadilhas luminosas foram WIENDL e SILVEIRA NETO (1967) quando publicaram um resumo sobre as ordens de insetos capturados durante um ano em Piracicaba.

Segundo recomendações feitas por GLASS (1975) há necessidade de se conhecer perfeitamente os hábitos das pragas em relação ao meio ambiente, para se conseguir um controle eficiente das mesmas, utilizando-se de qualquer método, sem afetar o homem nem a natureza.

STEWART e LAM JR. (1970) utilizando armadilhas luminosas para levantamentos de insetos em florestas, obtiveram bons resultados.

FROST (1962) e CARVALHO (1970) pesquisaram a ocorrência e destribuição dos insetos durante todo o ano correlacionando a destribuição de ordens e famílias e depois espécies com os dados meteorológicos.

3- Materiais e Métodos

O levantamento populacional das pragas das essências florestais e de seus inimigos naturais foi realizado através de armadilhas luminosas (Tipo CENA) provido de lâmpada fluorescente ultravioleta de 15 watts, modelo FIST 8 BL marca GE.

A utilização destas armadilhas traz como grande vantagem a fácil substituição do recipiente (3,0 litros) onde estão os insetos capturados.

A armadilha luminosa foi instalada na fazenda Santa Terezinha, Bofete - SP, de propriedade da Eucatex S.A. Indústria e Comércio, próximo ao talhão onde se desenvolve Teste de Progênie de *E. grandis*, local escolhido pelas disponibilidades de energia elétrica e pessoal.

As coletas foram realizadas duas vezes por semana e mensalmente os recipientes foram enviados à Secção de Entomologia do Cena Piracicaba, SP., onde procedeu-se a secagem e posterior identificação dos insetos de interesse na eucaliptocultura.

Foram obtidos, nas regiões do levantamento, dados meteorológicos que permitam estudos e considerações sobre o correlacionamento destes fatores com os dados de flutuação populacional dos insetos.

A duração do ensaio foi de dois anos pois só assim se obtiveram meios de se comparar os dados populacionais com os climáticos, uma vez que as variações são sensíveis de ano para ano.

4- Discussão dos Resultados

Como se observa no quadro I é evidente o equilíbrio biológico entre predadores, pragas e parasitos. O pico populacional dos parasitos (Díptera) que ocorre após o dos hospedeiros (Lepidópteros), já era de se esperar, considerando-se que é necessário a existência da população hospedeira para o desenvolvimento dos parasitos.

A falta de coleta de representantes de um determinado grupo, em certas épocas do ano, indica uma baixa densidade populacional associada ou não a pouca atividade dos indivíduos desse grupo.

5- Conclusões

Após os dois anos de observações concluiu-se que a ocorrência e distribuição dos insetos identificados foi a seguinte:

4.1. Lepidóptera:

4.1.1. *Eupseudosoma involuta*: pico populacional de março a maio.

4.1.2. *Sarsina violasiens*: pico populacional de março a julho.

4.1.3. *Thyrinteina arnobia*: pico populacional em março e abril.

4.1.4. *Eacles*: dois picos populacionais, fevereiro a abril e outubro a novembro.

4.2. Coleóptera:

4.2.1. *Costalimaita f. vulgata*: não foram coletados em junho e julho. Picos populacionais de janeiro a maio e novembro a dezembro.

4.2.2. *Bolax flavolineatus*: picos populacionais de janeiro a março e outubro a dezembro.

4.2.3. Cerambycidae: não foram coletados em julho. Picos populacionais em março, outubro a dezembro.

4.3. Predadores:

4.3.1. Carabidae + Cicindelidae: picos populacionais de janeiro a março e outubro a novembro.

4.3.2. Dermaptera: picos populacionais de janeiro a março e novembro a dezembro.

4.3.3. Hymenóptera: alta incidência durante o ano todo.

4.4. Inimigos Naturais:

4.4.1. Díptera: (Tachimidae 90% dos insetos coletados) ocorrem o ano todo com pico populacional destacado em maio.

4.5. Outras ordens de interesse florestal

4.5.1. Homóptera: picos populacionais em fevereiro, março e outubro.

4.5.2. Hemíptera: picos populacionais em março, novembro e dezembro.

4.5.3. Orthóptera: picos populacionais em fevereiro, março e novembro.

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INSETOS DA ORDEM LEPIDOPTERA ASSOCIADOS COM *Eucalyptus spp* NO BRASIL.

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Resumo

Este trabalho refere-se à ocorrência de insetos lepidópteros em *Eucalyptus* spp no Brasil. Os insetos foram coletados nos estágios imaturos e alimentados em laboratório até a emergência de adulto. As coletas foram feitas em árvores de plantações comerciais localizadas nas seguintes regiões brasileiras: Sudeste, Sul, Centro-Oeste e parte do Nordeste. Quatorze famílias de desfolhadores e duas famílias de brocas foram descritas, envolvendo um total de 58 espécies.

INSECTS OF THE LEPIDOPTERA ASSOCIATED WITH *Eucalyptus spp* IN BRAZIL.

Summary

This paper deals with the occurrence of lepidopterous insects on Eucalyptus spp. in Brazil. The insects were collected as immature stages and reared in the laboratory until adult emergence. The collections were made in eucalyptus trees from commercial plantations located in the following Brazilian regions: Southeast, South, Center West and part of the Northeast. Fourteen Families of defoliators and two Families of borers that total 58 species are reported.

I n t r o d u c t i o n

Since the introduction of Eucalyptus in Brazil, in 1856, many insects have been reported in association with this genus. The insects of the Order Lepidoptera have been found more frequently than any other Order and most of them usually have a native Myrtaceae as a host. On the other hand, there is no record of introduced lepidopterans on eucalyptus in Brazil until now. It is useful to point out the importance of identifying these insects, not only to know their occurrence and distribution but also to provide data for future research on their biology and control.

M a t e r i a l a n d M e t h o d s

The immature stages of the insects (eggs and caterpillars) were collected from eucalyptus of commercial plantations located in the South (States of Rio Grande do Sul, Santa Catarina and Paraná), Southeast (States of São Paulo, Rio de Janeiro, Espírito Santo and Minas Gerais), Center West (States of Mato Grosso, Mato Grosso do Sul and Goiás) and part of the Northeast (State of Bahia) region, brought to the laboratory and placed in petri dishes supplied with fresh eucalyptus leaves until pupation. The pupae were placed in jars covered with cheese cloth until adult emergence. The adults were killed, mounted and labeled according to their host and collection site. In addition it is given in the Results the distribution of the lepidopterans previously recorded on eucalyptus and/or other plants by BERTI-FILHO (1974), MACEDO(1975) OHASHI (1978) and SILVA et al.(1968). A number of live adults were kept for studying the biology whenever it was possible. The larvae of the borers were reared in caged trunks or stems of eucalyptus. The insects were reared at the Department of Entomology, "Escola Superior de Agricultura Luiz de Queiroz", University of São Paulo, in Piracicaba, State of São Paulo. The insects were identified by comparison with specimens in the Museum of the Department of Entomology cited above, but most of the species were sent to the U.S.National Museum in Washington, D.C., U.S.A.

R e s u l t s

The species of the Order Lepidoptera which have been found in association with Eucalyptus spp. are listed below, according to the Family they belong, the host species and distribution. The following abbreviations are used for the States: Alagoas (AL), Amazonas (AM), Amapá (AP), Bahia (BA), Ceará (CE), Espírito Santo (ES), Minas Gerais (MG), Mato Grosso do Sul (MS), Mato Grosso (MT), Pará (PA), Paraíba (PB), Pernambuco (PE), Paraná (PR), Rio de Janeiro (RJ), Rio Grande do Sul (RS), Santa Catarina (SC), São Paulo (SP).

APATELODIDAE

1. Apatelodes sericea Schaus
   Host: Eucalyptus grandis, E.saligna
   Dist.: ES, MG, MS, SP
2. Olceclostera nina Cramer
   Host: Eucalyptus grandis
   Dist.: BA, ES, MG, SP

ARCTIIDAE

3. Eupseudosoma aberrans Schaus
   Host: Eucalyptus citriodora, E.grandis, E.saligna
   Dist.: MG, MS, PR, RJ, SP
4. Eupseudosoma involuta (Sepp)
   Host: Eucalyptus alba, E.citriodora, E.grandis, E.saligna
   Dist.: AL, ES, MG, MS, PA, RJ, SC, SP
5. Idalus agastus Dyar
   Host: Eucalyptus saligna
   Dist.: MG, SP
6. Idalus herois Schaus
   Host: Eucalyptus saligna
   Dist.: BA, SP
7. Lepidokyrbyia vittipes (Walker)
   Host: Eucalyptus grandis
   Dist.: MS, SP

DIOPTIDAE

8. Myonia pyraloides Walker
   Host: Eucalyptus grandis, E.saligna
   Dist.: MG, RS
9. Phaeoclena gyon gyon (Fabricius)
   Host: Eucalyptus grandis, E.saligna
   Dist.: MG, RS, SP

EUCLEIDAE

10. Phobetron hipparchia (Cramer)
    Host: Eucalyptus alba, E.citriodora
    Dist.: MG, MS, SP
11. Talima ieco Dyar
    Host: Eucalyptus grandis, Eucalyptus sp.
    Dist.: SP
12. Talima sp.
    Host: Eucalyptus grandis
    Dist.: SP

GEOMETRIDAE

13. Aeschropteryx incaudata Guenée
    Host: Eucalyptus saligna
    Dist.: SP
14. Anacamptodes sp.
    Host: Eucalyptus grandis
    Dist.: ES
15. Glena sp.
    Host: Eucalyptus grandis
    Dist.: BA, ES, MG, MS, PR, SP
16. Hymenomima extensaria Forbes
    Host: Eucalyptus grandis
    Dist.: ES
17. Melanolophia sp.
    Host: Eucalyptus grandis
    Dist.: SP
18. Oxydia apidania Cramer
    Host: Eucalyptus sp.
    Dist.: MG
19. Oxydia distans perfusa Warr.
    Host: Eucalyptus sp.
    Dist.: SP

20. Oxydia hispata Guenée

Host: Eucalyptus saligna
Dist.: MG, SP

21. Oxydia mundata Guenée

Host: Eucalyptus sp.
Dist.: SP

22. Oxydia sp.

Host: Eucalyptus sp.
Dist.: MG, SP

23. Oxydia vesulia Cramer

Host: Eucalyptus grandis
Dist.: SP

24. Oxydia vitiligata Feld.

Host: Eucalyptus sp.
Dist.: SP

25. Sabulodes caberata Guenée

Host: Eucalyptus citriodora, E.grandis, E.saligna
Dist.: MG, PR, RJ, SC, SP

26. Stenalcidia sp.

Host: Eucalyptus grandis, E.saligna
Dist.: SP

27. Thyrinteina arnobia (Stoll)

Host: Eucalyptus alba, E.botryoides, E.citriodora, E.globulus, E.grandis, E.maculata, E.paniculata, E.resinifera, E.robusta, E.rostrata, E.tereticornis
Dist.: BA, ES, MG, MS, PE, RJ, RS, SP

28. Thyrinteina leucoceraea Rindge

Host: Eucalyptus grandis
Dist.: BA, ES

29. Thyrinteina schadeana Schaus

Host: Eucalyptus grandis
Dist.: BA, ES, SP

30. Thyrinteina sp.

Host: Eucalyptus grandis
Dist.: ES

HESPERIDAE

31. Phocides palemon (Cramer)

Host: Eucalyptus alba, E.citriodora, E.saligna
Dist.: MG, PR, RJ, RS, SP

32. Pyrrhopyge charybdis Hewitson

Host: Eucalyptus alba, E.saligna
Dist.: RJ, RS, SP

LASIOCAMPIDAE

33. Euglyphis sp.

Host: Eucalyptus grandis, E.saligna
Dist.: SP

34. Tolype sp.

Host: Eucalyptus grandis
Dist.: SP

LYMANTRIIDAE

35. Sarsina violascens (Herrich-Schaeffer)

Host: Eucalyptus citriodora, E.grandis, E.saligna
Dist.: MG, MS, RJ, RS, SC, SP

MIMALLONIDAE

36. Mimallo amilia (Stoll-Cramer)

Host: Eucalyptus grandis, E.saligna
Dist.: ES, MG, PE, RJ, RS, SP

37. Trogoptera althera Schaus

Host: Eucalyptus grandis, E.saligna
Dist.: SP

38. Trogoptera salvita Schaus

Host: Eucalyptus sp.
Dist.: SP

39. Trogoptera sp.

Host: Eucalyptus sp.
Dist.: SP

40. Vanenga mera Dognin

Host: Eucalyptus sp.
Dist.: SP

NOCTUIDAE

41. Agrotis ipsilon (Hufnagel)

Host: Eucalyptus spp. (nursery)
Dist.: MG, MS, PE, PR, RJ, RS, SC, SP

42. Spodoptera frugiperda (J.E.Smith)

Host: Eucalyptus urophylla
Dist.: AM, AP, ES, MG, PA, PB, PE, RJ, RS, SC, SP

NOTODONTIDAE

43. Calledema sura Schaus

Host: Eucalyptus grandis
Dist.: SP

44. Disphragis sp.

Host: Eucalyptus sp.
Dist.: SP

45. Meragisa sp.

Host: Eucalyptus grandis
Dist.: SP

46. Nystalea nyseus (Cramer)

Host: Eucalyptus ditriodora, E.grandis, E.saligna
Dist.: MG, RS, SC, SP

PSYCHIDAE

47. Oiceticus spp.

Host: Eucalyptus spp.
Dist.: CE, MG, PE, RJ, RS, SC, SP

RIODINIDAE

48. Euselasia eucerus (Hewitson)

Host: Eucalyptus alba, E.grandis, E.saligna
Dist.: MG, RS, SC, SP

SATURNIIDAE

49. Automeris amphirene (Boisduval)

Host: Eucalyptus spp.
Dist.: MG, SP

50. Automeris complicata (Walker)

Host: Eucalyptus grandis
Dist.: RS, SP

51. Automeris coresus Boisduval

Host: Eucalyptus sp.
Dist.: SP

52. Dirphia multicolor Walker

Host: Eucalyptus grandis, E.saligna
Dist.: SP

53. Dirphia rosacordis Walker

Host: Eucalyptus grandis
Dist.: SP

54. Eacles imperialis magnifica Walker

Host: Eucalyptus spp.
Dist.: AL, ES, MG, PE, RJ, RS, SC, SP

55. Hylesia sp.

Host: Eucalyptus grandis
Dist.: MG, PR, SP

56. Lonomia sp.

Host: Eucalyptus grandis, E.saligna
Dist.: MG, RJ, SP

SESIIDAE (AEGERIDAE)

57. Carmenta sp.

Host: Eucalyptus grandis, E.urophylla - (borer)
Dist.: SP

STENOMIDAE

58. Timocratica albella (Zeller)

Host: Eucalyptus alba, E.citriodora, E.rostrata, E.propinqua, E.saligna, E.tereticornis - (borer)
Dist. MG, PA, PE, RJ, RS, SC, SP

C o n c l u s i o n s

For an introduced species such as Eucalyptus there is a surprisingly high number of native insects on it, belonging to only one Order (Lepidoptera). Concerning the food habits of these insects, there are 56 defoliators and 2 borers. The Family Geometridae represented the highest number of species of defoliators (31). One geometrid species (Thyrinteina arnobia) is reported attacking 11 species of Eucalyptus.

The following species are currently considered serious pests of Eucalyptus spp. in Brazil: Eupseudosoma aberrans Schaus, Eupseudosoma involuta (Sepp), Euselasia eucerus (Hewitson), Sabulodes caberata Guenée, Sarsina violascens (Herrich-Schaeffer) and Thyrinteina arnobia (Stoll).

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FAST GROWING TREES

PRIMEIROS RESULTADOS DE ENSAIO DE ADUBAÇÃO EM PLANTAÇÕES DE *Eucaliptus* EM MADAGASCAR.

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. Tropical au Départament des Recherches Forestières et Piscicoles du CENRADERU.
France.

Resumo

Os experimentos de adubação em plantações de eucaliptos têm sido realizados desde 1970 em Madagascar. Em geral eles são associados a ensaios de métodos de preparo do solo. Os primeiros resultados obtidos evidenciam claramente o interesse de fertilização NPK, assim como a grande importância que se deve dispensar ao combate às ervas daninhas nos primeiros anos. A adubação é desperdiçada se não for associada a um bom preparo do solo para o plantio.

FIRST RESULT ON FERTILIZATION TRIALS GIVEN TO *Eucalyptus* PLANTATIONS IN MADAGASCAR.

Summary

The experimentations on Eucalyptus fertilization given to plantations have been carried on since 1970 in Madagascar. They have generally been associated with trials on soil preparation methods. The first results obtained point out very clearly the interest of NPK fertilization and the prime importance of gramineae destruction during the first years. Fertilization is useless without any careful soil preparation of the plantation.

PREMIERS RESULTATS DES ESSAIS SUR LA FERTILISATION DES PLANTATIONS D' *Eucalyptus* A MADAGASCAR.

Resumé

Les expérimentations sur la fertilisation des Eucalyptus à la plantation ont débuté à Madagascar en 1970. Elles ont généralement été associées à des essais sur les modes de préparation du sol. Les premiers résultats font très nettement apparaitre l'intérêt de la fertilisation NPK et l'importance primordiale de la destruction des graminées les premières années. L'apport de fertilisation est inutile sans un travail du sol soigné à la plantation.

I N T R O D U C T I O N

Si les Eucalyptus ont été introduits depuis très longtemps à Madagascar, les premières expérimentations sur la fertilisation minérale n'ont commencé que vers 1970.

F A C T E U R S D U M I L I E U

Les essais sont mis en place sur les stations ci-après :

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.

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°) - Altitude 920 m - Sols ferrallitiques typiques très désaturés sur migmatites schisteuses.

Mahela

18°57' LS - 48°55' lE - Climat tropical humide type guinéen forestier Madagascar Est (Aubréville) - Pluviométrie moyenne annuelle 3 092 mm - Température moyenne 24° (minima 19°, maxima 28°) - Altitude 30 m - Sols ferrallitiques.

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.

D'une façon générale, les sols sont des sols ferrallitiques lessivés très pauvres en éléments minéraux principaux. Les diagnostics de carence par la méthode des vases de végétation font apparaitre une carence très grave en P, grave à moyenne en potasse, plus ou moins prononcée en calcium, Magnesium et soufre.

E X P E R I M E N T A T I O N S M I S E S E N P L A C E A M A N A N K A Z O

Le premier essai mis en place en novembre 1970 avait pour objet de comparer l'influence du travail du sol (Trouaison - Labour en bande - Sous-solage billonnage - Sous-solage) et de la fertilisation P, PK et NPK (50 g de P205 - 24 g de K20 - 8 g de N en 2 épandages) à la densité de plantation de 2 000 plants et selon un dispositif en blocs. L'essence utilisée était Eucalyptus camaldulensis, graines tout venant récoltées sur des plantations des Hauts Plateaux Malgaches.

Cet essai a montré un effet net du travail du sol et un effet important de l'engrais.

E X P E R I M E N T A T I O N S M I S E S E N P L A C E A U M A N G O R O

Sur Eucalyptus grandis (essai N° 18)

Un essai visant à connaitre l'effet principal de l'apport des éléments P et K (aux mêmes doses que l'essai précédent), leur interaction ainsi que l'effet d'un apport de N en supplément de PK, sur deux types de travail du sol, a été mis en place en 1972. Il y a 4 répétitions, la densité est de 1 850 plants/ha.

Les résultats obtenus à 4 ans ½ sont les suivants :

Travail du sol	Trouaison					Sous-solage billonnage				
Fertilisation	O	P	K	PK	NPK	O	P	K	PK	NPK
h en m	3,0	3,2	4,6	3,8	6,4	4,2	4,7	6,0	6,8	8,5

On y voit clairement l'importance de K, l'intérêt de la fertilisation NPK et la nécessité du travail du sol.

Sur Eucalyptus 12ABL (tereticornis) (essai 34)

Un essai factoriel NPK toujours avec les mêmes doses d'apport, comportant 8 traitements, 4 répétitions, a été réalisé sur trouaison sans entretien à la densité de 3 x 3 m, en 1975. Cette expérimentation fait apparaitre à 4 ans : un effet négatif de l'azote seul, des effets P et K identiques à cet âge, un effet NPK très important, malgré les mauvaises conditions de travail du sol.

EXPERIMENTATIONS MISES EN PLACE A MAHELA

Sur Eucalyptus grandis (essai 2)

Une répétition de l'expérimentation précédente a été mise en place (factoriel 2^3, 4 répétitions) sur labour en bande. Les résultats obtenus sont les suivants :

	N	P	K	NPK	NP	NK	PK	O
h (m) 1 an	0,6	0,9	0,6	1,5	1,0	0,6	0,9	0,6
h (m) 2 ans	1,2	1,5	1,1	2,3	1,8	1,1	1,5	1,1
h (m) 3 ans	1,7	2,2	1,6	3,7	2,6	1,7	2,5	1,6

EXPERIMENTATIONS MISES EN PLACE AU VAKINANKARATRA

Avec Eucalyptus camaldulensis (essai 6), graines tout venant récoltées sur les Hauts Plateaux , un essai sur deux types de travail du sol : sous-solage sarclé et sous-solage billonnage, visant à connaitre l'effet principal des éléments P et K, leur interaction et l'effet d'une fertilisation NPK a été mis en place en 1972. Les doses d'apport sont identiques à celles utilisées dans les autres essais.

Cet essai a mis en évidence l'effet important de P, de K en présence de P et surtout l'effet global de NPK (qui amène un gain de 100 % en hauteur par rapport au témoin).

Avec Eucalyptus camaldulensis également (essai 8), un essai selon le même protocole a été mis en place en 1973 et a donné les résultats suivants :

	Sous-solage billonnage					Sous-solage sarclé				
Fertilisation	O	P	K	PK	NPK	O	P	K	PK	NPK
6 mois, h (m)	0,1	0,1	0,1	0,1	0,2	0,1	0,1	0,1	0,1	0,3
1 an ½, h (m)	0,5	1,1	0,5	1,3	1,7	0,4	0,7	0,5	0,7	1,2
2 ans ½, h (m)	1,1	2,3	1,2	2,8	3,3	0,7	1,1	1,1	1,2	1,8
4 ans, h (m)	2,3	4,1	2,9	5,1	5,4	1,3	1,7	2,1	2,2	3,1

CONCLUSION

Les premières expérimentations sur la fertilisation des Eucalyptus à la plantation ont été très souvent associées à une expérimentation sur le mode de préparation du sol : trouaison, sous-solage, labour en bande ou sous-solage billonnage.

Bien que le recul soit encore insuffisant, quelques indications se dégagent dès maintenant :

- La fertilisation NPK donne toujours les meilleurs résultats. Chaque élément pris séparemment a peu d'action, tout se passe comme si dans ces sols très carencés un seul apport voyait son effet limité par la mise à jour de la carence d'un second élément.
- L'importance de la concurrence des graminées pour la croissance, les premières années du moins, des Eucalyptus est primordiale et l'apport d'engrais est inutile sans un travail soigné destiné à lutter contre la concurrence herbacée.

RESISTÊNCIA DE ESPÉCIES DE EUCALIPTO AO ATAQUE DE *Stiphra spp* (ORTHOPTERA, PROSCOPIIDAE).

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Resumo

Estudou-se o comportamento de espécies de eucalipto ao ataque de Stiphra sp., em três áreas experimentais em Petrolina - Pernambuco. Eucalyptus camaldulensis Dehnh., Eucalyptus nesophila Blakely e Eucalyptus polycarpa F. Muell, foram as espécies menos danificadas pelo inseto. A susceptibilidade de Eucalyptus alba Reinw ex Blume, variou grandemente entre procedências.

Summary

The behavior of species of eucalyptus in relation to Stiphra sp. was studied in three experimental areas in Petrolina - Pernambuco - Brasil. Eucalyptus camaldulensis Dehnh., Eucalyptus crebra F. Muell., Eucalyptus nesoplila Blakely e Eucalyptus polycarpa F. Muell, were the most susceptible species. The susceptibility of Eucalyptus alba Reinw ex Blume varied grately among introductions.

INTRODUÇÃO

Stiphra sp., conhecido vulgarmente por "manê-magro" ou "saltão", causa danos consideráveis a diversas espécies vegetais comumente encontradas no Nordeste, dificultando seu desenvolvimento normal durante o curto período do ano em que a quantidade de água disponível é adequada.

Embora a população deste inseto atinja anualmente níveis bastante elevados, observa-se que nem todas as essências florestais são igualmente atacadas. Bastos (1975) estudou a preferência de Stiphra robusta Leitão, por seis espécies de plantas cultivadas, em condições de laboratório. Moraes et al. (no prelo) listaram as espécies da caatinga mais atacadas por Stiphra sp., em condições de campo.

Em fins de 1979 e início de 1980, notou-se uma grande incidência de

Stiphra sp. em plantios experimentais de eucalipto do Município de Petrolina - Pernambuco. Observando-se uma preferência aparente deste inseto por algumas destas espécies, resolveu-se conduzir este trabalho, a fim de se verificar aquelas mais promissoras em relação à resistência ao ataque de Stiphra sp.

MATERIAIS E MÉTODOS

Este trabalho foi conduzido no Campo Experimental Manejo da Caatinga, do Centro de Pesquisa Agropecuária do Trópico Semi-Árido/Empresa Brasileira de Pesquisa Agropecuária (CPATSA/EMBRAPA).

As observações foram realizadas em três áreas experimentais, instaladas em março de 1979, com o objetivo de se estudar o comportamento geral de espécies e procedências de eucalipto no Nordeste.

Na área 1, os tratamentos foram representados por procedências de Eucalyptus camaldulensis Dehnh, Eucalyptus urophylla S.T. Blake e Eucalyptus grandis W. Hill ex Maiden. Na área 2, os tratamentos foram representados por procedências de Eucalyptus exserta F. Muell, Eucalyptus crebra F. Muell, Eucalyptus nesophila Blakely, Eucalyptus polycarpa F. Muel, Eucalyptus tessellaris F. Muel e Eucalyptus urophylla. Na área 3, os tratamentos corresponderam a procedências de Eucalyptus alba Reinw ex Blume, E. grandis e E. urophylla.

As sementes de todas as espécies estudadas foram procedentes de diferentes regiões da Austrália e do Timor Português, com exceção de E. grandis e E. urophylla que foram procedentes de Rio Claro - São Paulo.

A análise estatística foi feita independentemente para cada uma das áreas, adotando-se o delineamento de blocos ao acaso, em classificação hierárquica (Montgomery, 1976), com oito repetições para as áreas 1 e 2, e três repetições para a área 3.

As avaliações da resistência de cada espécie ou procedência foram realizadas em 3 de março de 1980, tomando-se duas plantas por parcela nas áreas 1 e 2, e quatro plantas por parcela na área 3. Estas avaliações basearam-se nas estimativas visuais dos danos causados por Stiphra sp. a cada planta. Para a análise estatística dos dados, atribuiram-se notas a estas estimativas, como se segue:

Danos	Nota
Nulo	1
Leves	2
Medianos	3
Severos	4

RESULTADOS E DISCUSSÃO

A tabela 1 mostra a resistência relativa das espécies de eucalipto ao ataque de Stiphra sp.

E. urophylla foi uma das espécies mais atacadas nas três áreas experimentais. E. grandis, E. tessellaris e E. exserta mostraram-se também muito susceptíveis ao ataque deste inseto. Por outro lado, E. camaldulensis, E. crebra, E. nesophila e E. polycarpa foram as espécies menos atacadas, cujas plantas apresentavam-se, na maioria das vezes, não danificadas ou com danos leves.

Não se observaram diferenças significativas de susceptibilidade entre as diferentes procedências de uma mesma espécie, com exceção de E. alba. No caso desta espécie, plantas obtidas de sementes procedentes de Mount Garnet, Queensland mostraram-se significativamente menos atacadas por Stiphra sp., que aquelas do Leste de Dili - Timor Português. Embora a metodologia empregada não tenha revelado diferenças estatísticas entre susceptibilidades das diversas procedências de E. camaldulensis, observou-se no campo que a procedência Agnew, Austrália Ocidental, apresentou-se visivelmente mais atacadas que as demais.

Dentre as espécies menos atacadas, E. camaldulensis e E. polycarpa foram citadas por Golfari & Caser (1977) como potencialmente aptas para o tipo climático "árido", ao qual pertence a área onde o presente trabalho foi desenvolvido.

Devido à capacidade destruidora e à ampla distribuição deste inseto, julga-se de toda conveniência que os projetos de plantio de eucalipto no Nordeste levem em consideração a susceptibilidade de espécies ou procedências ao ataque de Stiphra sp. Por outro lado, é interessante se observar que embora este inseto tenha sido constatado por diversos autores no Nordeste (Silva et al., 1957; Arruda & Carvalho, 1969; Bastos, 1975; Cavalcante et al., 1975), as áreas de ocorrências conhecidas até o momento localizaram-se à esquerda do Rio São Francisco, ainda que às vezes próximas à margem deste rio (Moraes et al., no prelo). Após diversas buscas e entrevistas com fazendeiros à direita do rio, não se conseguiu qualquer informação sobre a ocorrência de Stiphra sp. neste lado. Além do mais, com base em Silva et al. (1968), Gregório Bondar, que por muito tempo procedeu a extensivos levantamentos entomológicos no estado da Bahia, aparentemente nunca se referiu a ocorrências deste inseto. Desta forma, parece que o Rio São Francisco tem funcionado como uma eficiente barreira ecológica à disseminação deste inseto que, sendo áptero, tem a locomoção dificultada. Por esta razão, é possível que a utilização de espécies ou procedências promissoras em relação à produtividade, ainda que susceptíveis ao ataque de Stiphra sp., seja viável em áreas contíguas às regiões de ocorrência do inseto, à direita do Rio São Francisco, se cuidados forem tomados para se evitar que esta berreira seja transposta por este inseto.

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Tabela 1 - Resistência relativa de espécies e procedências de eucalipto ao ataque de *Stiphra* sp.

Área 1		Área 2		Área 3	
Procedência	Resistência	Procedência	Resistência	Procedência	Resistência
E. camaldulensis - 1,3A		*E. crebra* - 1,4A		*E. alba* - 2,3A	
Victoria River	1,1a	S.W. Pentland - QLD	1,3a	Mt. Garnet - QLD	1,3c
Cooktown - QLD	1,1a	Torres Cx. Área - QLD	1,4a	S. Cooktown - QLD	1,6bc
N. Chillagoe - QLD	1,1a	*E. nesophila* - 1,8A		Kimberley Área -A.O.	2,3abc
W. Dimbulah - QLD	1,1a	Bleck Point - T.N.	1,4a	N. Maubisse - T.P.	2,4abc
Lennard River - A.O.	1,3a	S. Cooktown - QLD	1,9a	E. of E. Alligator- T.N.	2,5abc
Gilbert River - QLD	1,3a	Melville Isçand - T.N.	1,9a		
Wyabba Ck. - QLD	1,4a	Jimmys Creek - T.N.	1,9a	S. Maningrida	3,0ab
S.W. Katherine - T.N.	1,4a	*E. Polycarpa* - 1,9A		E. Dili - T.P.	3,3a
N. of Beverly - A.O.	1,5a	Melville Bay - T.N.	1,6a	*E. grandis* - 2,5A	
Agnew Rd. - A.O.	1,8a	Roper River - T.N.	1,8a	São Paulo - SP.	2,5a
E. grandis - 2,4B		N.E. Murganella - T.N.	2,3a	*E. urophylla* - 2,8A	
São Paulo - SP.	2,4b	*E. tessellaris* - 2,6B		São Paulo - SP.	2,8a

Tabela 1 - Cont.

Área 1		Área 2		Área 3	
Procedência	Resistência	Procedência	Resistência	Procedência	Resistência
E. Urophylla - 2,6B		Atherton - QLD	2,2a	-	-
São Paulo - SP.	2,6b	Mackay - QLD	3,0a	-	-
-		*E. exserta* - 2,8B			
-		S. Bundaberg - QLD	2,1a	-	-
-		W. Manto - QLD	2,6a	-	-
-		N. Rockhampton - QLD	2,8a	-	-
-		S. Maryborough - QLD	3,6a	-	-
-		*E. urophylla* - 2,8B			
-		São Paulo - SP.	2,8a	-	-

T.N = Territory North | QLD = Queensland | SP.= São Paulo
A.O = Austrália Ocidental | T.P.= Timor Português

* Numa mesma coluna, médias de espécies seguidas da mesma letra maiúscula, e médias de procedências de uma mesma espécie, seguidas da mesma letra minúscula não diferem entre si pelo teste de Tukey (1%).

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O OÍDIO EM MUDAS DE EUCALIPTO

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Resumo

Estudo do parasitismo de Oidium sp em mudas de eucalipto, no Estado de São Paulo - Brasil. Os sintomas manifestam-se principalmente no ápice das plantas e nas folhas mais novas, em forma de manchas esbranquiçadas que, em estádio mais avançado adquirem coloração marrom avermelhada. O fungo é ectoparasita obrigatório e apresenta conídios de 26,00-35,75u x 13,00-19,50u, sendo a germinação favorecida pela presença de água livre. A patogenicidade de Oidium sp é comprovada em condições de casa de vegetação em Eucalyptus "urophylla" S.T. Blake, E.citriodora Hook, E.grandis Hill ex Maiden, E.maculata Hook, E.punctata DC, E.resinifera Sm, E.robusta Sm, E.saligna Sm e E.tereticornis Sm. Nestas mesmas condições, E.umbra R.T. Baker, não apresentou sintomas de ataque.

Summary

The parasitism of Oidium sp on eucaliptus seedlings are described in São Paulo - Brazil. The symptoms are located mainly on tips of plants and on the newest leaves with white spots that acquire brown colour in more advanced stage. The fungus is an obligate ectoparasite and its conidia has 26,00-35,75u x 13,00 - 19,50u. Its germination seems encouraged by free water. The patogenicity of Oidium is confirmed by tests in greenhouse conditions on Eucalyptus "urophylla" S.T. Blake, E.citriodora Hook, E.grandis Hill ex Maiden, E.maculata Hook, E.punctata DC, E.resinifera Sm, E.robusta Sm, E.saligna Sm and E.tereticornis Sm. In this same conditions, E.umbra R.T. Baker doesn't reveal symptoms.

I n t r o d u ç ã o

O primeiro relato de Oidium sp em eucalipto no Brasil, foi feito por STEVENSON (1926), sem contudo ter definido, as espécies tanto do patógeno como do hospedeiro, bem como da sua sintomatologia. Em 1959, constatou-se a ocorrência de Oidium sp em mudas de Eucalyptus tereticornis Sm., em São Paulo. Como a incidência não atingiu níveis danosos, o material foi apenas herborizado no Instituto Florestal do Estado de São Paulo. Em 1976 e 1977 surgiu o primeiro surto de importância econômica em Cascavel-PR, em viveiros de E.citriodora Hook e E.viminalis Labill, causando perdas de até 50% das mudas. Em 1978, o surto se repetiu em São Paulo-SP em mudas de E.citriodora Hook.

M a t e r i a l e m é t o d o s

Germinação dos conídios

Os testes em condições de laboratório foram conduzidos a fim de se estudar a germinação dos conídios de Oidium sp. Utilizou-se o método de observação em lâminas escavadas, contendo suspensão de conídios e mantidas por um período de 12 horas em condições de luz contínua, a 25° C e 100 % de umidade relativa (U.R.).

Patogenicidade

Para se testar a patogenicidade de Oidium sp., foram desenvolvidos 3 métodos:

a) Pulverização com suspensão de esporos - foram pulverizadas 40 mudas de E.grandis com uma suspensão de esporos ($3,1 \times 10^4$ esporos/ml) e mantidas a 100 % U.R.

b) Inoculação de contato - inoculação através do contato entre folhas sadias e infectadas. Foram inoculadas 40 mudas de E.grandis em ambiente a 100 % U.R.

c) Inoculação natural - quarenta mudas de E.grandis foram colocadas entre plantas de E.saligna e E.citriodora já infectadas pelo fungo e mantidas em condições de casa de vegetação.

Paralelamente, junto à mesma fonte de inóculo, foram semeados Eucalyptus "urophylla" S.T. Blake, E.citriodora Hook, E.grandis - Hill ex Maiden, E.maculata Hook, E.punctata DC, E.resinifera Sm, E.robusta Sm, E.saligna Sm, E.tereticornis Sm e E.umbra R.T. Baker.

R e s u l t a d o s

Germinação dos conídios

Após 24 horas de incubação os conídios de Oidium sp tiveram o o seguinte comportamento:

Substrato	sem germinar %	germinado %	apressório %
água livre	80,69	15,08	4,23
BDA	97,57	2,43	0,00

Patogenicidade

O método "a" de inoculação através de pulverização mostrou resultados positivos após 45 dias, quando as plantas começaram a apresentar os sintomas típicos da doença.

Já o método "b" de inoculação através de contato apresentou efeito em 21 dias.

A inoculação natural, método "c", em ambiente infectado, foi a mais eficiente, pois aos 10 dias, as mudas de E.grandis apresentaram início de sintomas da doença. Trinta dias após a semeadura, plântulas de algumas espécies de Eucalyptus já apresentavam seus folíolos infectados. De todas as espécies testadas, apenas o E.umbra não exibiu sintomas de ataque.

Sintomatologia

Os sintomas e sinais do parasitismo de Oidium sp em Eucalyptus evidenciam-se primeiramente na página superior, no limbo das folhas medianas, até o ápice da planta. Constam, inicialmente, de um tênue crescimento micelial esbranquiçado que se alastra radialmente.

Em estádio mais avançado, este crescimento micelial torna-se mais espesso, passando a desenvolver-se na face inferior das folhas. As partes atacadas adquirem coloração marrom avermelhada, tornando-se enrugada e deformada. As plantas apresentam dificuldades no crescimento, sendo as mais novas mais susceptíveis chegando até a secar e morrer.

Etiologia

O micélio do fungo é formado por hifas hialinas, septadas, com diâmetro de 6,0 a 6,5u. Desenvolve-se em todos os sentidos - principalmente na direção radial.

Os conídios se formam em cadeias de até 5 células sobre conidióforos livres. Estes conídios apresentam a forma oval ou elíptica, com os bordos truncados como barris, com dimensões que se aproximam daquelas encontradas por outros autores, como mostra a FIGURA 1.

AUTORES	COMPRIMENTO (u) <	COMPRIMENTO (u) >	LARGURA (u) <	LARGURA (u) >
GRASSO ap. MAGNANI (1964)	22,00	27,00	14,00	18,00
GLASSCOCK & ROSSER (1958)	24,00	30,00	15,00	18,00
BRANDENBURG ap. MAGNANI (1964)	26,00	31,00	16,00	20,00
MAGNANI (1964)	21,00	26,30	13,10	15,70
Oidium sp estudado	26,00	35,75	13,00	19,50

FIGURA 1 - Dimensões máximas e mínimas dos conídios de Oidium sp estudadas por diferentes autores.

C o n c l u s ã o

Os estudos morfológicos do parasita indicam que se trata de um fungo do gênero Oidium.

Quanto a germinação dos conídios, em presença de água livre, existe uma porcentagem maior de germinação, e um desenvolvimento mais vigoroso dos conídios, tendo alguns um início de formação de apressório enquanto que em meio de BDA, foi possível notar apenas os primórdios do tubo germinativo.

Dos três métodos de patogenicidade testados, o melhor resultado foi obtido quando não se utilizou 100 % U.R.

Pelo teste de patogenicidade todas as espécies de eucalipto apresentaram-se susceptíveis ao fungo com excessão do E.umbra.

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FERTILIZAÇÃO MINERAL EM PINUS E EUCALYPTUS

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Resumo

Experimentos de fertilização em São Simão, São Paulo, Brasil, com *Pinus caribaea* var. *bahamensis*, indicam que, a partir dos 7 anos e até a última mensuração aos 10 anos, seus incrementos ocorrentes volumétricos vêm acusando respostas significativas, para o tratamento básico.

Eucalyptus citriodora e *Eucalyptus tereticornis* têm apresentado, desde a segunda até a décima mensuração (1979), incrementos correntes significativamente superiores aos da Testemunha. Novas mensurações deverão mostrar o limite etário dessa superioridade.

Eucalyptus tereticornis vem alcançando acréscimos acima do limite mínimo econômico proposto por MITSCHERLICH.

Summary

Researchs on fertilization in São Simão, S. Paulo, Brazil, with *Pinus caribaea* var. *bahamensis* have showed that its volumetric annual increments from 7 to 10 years have been significantly different, in the case of the basic treatment.

Eucalyptus citriodora and *Eucalyptus tereticornis* have showed volumetric annual increments significantly higher than control treatment, during 10 years after fertilization. New mensurations will show the limit of age for that superiority.

Eucalyptus tereticornis has exceeded the minimum economic limit proposed by MITSCHERLICH.

I n t r o d u ç ã o

Toda pesquisa que se faça no campo da fertilização mineral, deve merecer especial destaque, não só por estar provado, no caso de determinadas essências, haver aumento substancial no volume de madeira, através dos adubos, BETTER crops (1958) ap. VEIGA (1977), como também porque se opera provavelmente, por alguns anos, modificação na fertilidade do solo, com reflexos no crescimento diametral e em altura, sob uma mesma densidade, como se ali houvesse "site" mais adequado, VEIGA (1976), fazendo com que o incremento corrente se mantenha maior do que nas parcelas-Testemunha durante determinado período de tempo, além de que as futuras árvores resultarão de mudas mais saudáveis, livres possivelmente de grande número de distúrbios fisiológicos, TEIXEIRA (1954) ap. VEIGA (1976).

M a t e r i a l e M é t o d o

Espécies: *Pinus caribaea* var. *bahamensis* Barr. et Golf., *Eucalyptus tereticornis* Sm e Eucalyptus citriodora Hook.

Local: Estação Experimental de São Simão, com características edafo-climáticas citadas em VEIGA (1975).

Data de início: dezembro de 1969.

Delineamento estatístico: blocos ao acaso, com 5 tratamentos sob 4 repetições.

Espaçamento: 2,50 x 1,60 m

Dados coletados: alturas, diâmetros, incrementos, áreas basais, fatores de forma e volume.

Fórmula volumétrica: usou-se a de VEIGA ou seja, $V = \frac{2}{3} g.P$, sendo a área basal a 1,30 m e P a altura do ponto-guia de PRESSLER, a partir do colo, VEIGA (1978).

Área da parcela: 168 m^2.

Área do experimento: 6.992 m^2.

Tratamento básico (C) em função da análise do solo: 31 gramas de Salitre do Chile + 51 gramas de Fosfato de Araxá + 56 gramas de Superfosfato simples + 135 gramas de Cloreto de potássio.

Os tratamentos A, B, D resultaram da diminuição ou aumento gradativo das doses em 4 gramas.

E: testemunha, sem adubo.

R e s u l t a d o s

O *Pinus caribaea* var. *bahamensis*, aos 10 anos apresenta: a) fatores de forma (0,42 a 0,46) indicando aproximar-se de parabolóide semicúbico; b) áreas basais (34,50 a 37,95 m^2) caracterizando "sites" relativamente bons; c) incrementos de 21,958 a 25,163 m^3/ha/ano; d) diâmetros de 17,00 a 18,10 centímetros; e) alturas de 14,69 a 15,03 metros; f) fenótipo bom.

Dois aspectos se evidenciam: essa Conífera não vem apresentando respostas nos primeiros anos, sendo que entre 7 e 10 anos seus incrementos correntes, no caso do tratamento básico, se mostram significativamente diferentes da Testemunha.

Referentemente aos eucaliptos, dada a sua sensibilidade a nutrientes, mantêm-se, a partir da segunda dendrometria anual até 1979, com incrementos correntes significativamente superiores aos da Testemunha (ver Quadro II).

O *Eucalyptus tereticornis* (ver Quadro I), embora com baixos volumes (118,730 a 133,360 m^3/ha) chega a suplantar o limite mínimo econômico, segundo método de MITSCHERLICH ap. ANDA (1971) assim calculado:

$$X = \frac{Q}{2} + \frac{36.000}{s} \log \frac{A.P.W.}{q.Q}$$

Os fatores de forma desses eucaliptos indicam figuras de transição entre cone e parabolóide semicúbico. Suas áreas basais inferiores a 25 m^2/ha acusam capacidade produtiva potencial inadequada. E, no *Eucalyptus citriodora* os volumes não atingem 100 m^3/ha, com a Testemunha abaixo de 30 m^3/ha.

D i s c u s s ã o

Há um ponto a discutir: o *Pinus caribaea* var. *bahamensis*, talvez porque suas plantas tenham sofrido trauma ante o afluxo da micorriza ou talvez pela lentidão de aproveitamento do fosfato insolúvel, o fato é que a Conífera levou anos para dar respostas favoráveis, como se antes estivesse armazenando.

Quanto ao *E. tereticornis*, a despeito da baixa capacidade produtiva potencial, suplantou o limite mínimo econômico, ressaltando, assim, o valor da adubação.

C o n c l u s õ e s

1. Os autores indicam a Estação Experimental de São Simão como local com razoáveis possibilidades ante o plantio do *Pinus caribaea* var. *bahamensis*, pelo menos até sua primeira idade de estagnação teórica.

2. Ressaltam a significância dos incrementos correntes dessa Conífera, nos últimos anos, para o tratamento básico.

3. Comprovam o efeito significativo, residual, da adubação em *Eucalyptus* desde 2 anos até 10 anos (última dendrometria) e ressaltam o acerto da eleição das doses NPK em função dos valores detectados pela análise do solo.

- QUADRO I -

Dados dendrométricos em ensaios de fertilização, aos 10 anos
Local: São Simão

Espécies	Tratamento A			Tratamento B			Tratamento C			Tratamento D			Tratamento E		
	F	G	V	F	G	V	F	G	V	F	G	V	F	G	V
Pinus c. var. *bahamensis*	0,45	35,02	231,213	0,42	37,95	239,578	0,46	36,61	251,629	0,43	35,84	219,584	0,45	34 50	228,069
E. tereticornis	0,36	21,36	118,730	0,36	22,78	121,370	0,37	22,66	131,690	0,37	22,770	133,360	0,43	10,75	55,470
E. citriodora	0,39	18,19	89,520	0,35	19,30	84,360	0,40	19,21	97,740	0,36	18,11	79,410	0,39	7,51	29,660
I C A	14,420 m^3			20,980 m^3			22,820 m^3			24,490 m^2			6,490 m^3		

A, B, C, D, E: Tratamentos
F: Fator de forma
G: Área basal/ha
V: Volume/ha
I C A: Incremento volumétrico entre 9 e 10 anos.

QUADRO II

Pinus caribaea var. *bahamensis*

IDADE	A INCREMENTOS (m^3)	B INCREMENTOS (m^3)	C INCREMENTOS (m^3)	D INCREMENTOS (m^3)	E INCREMENTOS (m^3)
7 - 8	61,498	63,241	69,496	51,506	63,939
8 - 9	50,623	47,613	51,184	48,398	48,127
9 -10	42,684	44,250	51,111	43,898	41,459

Eucalyptus citriodora

IDADE	A INCREMENTOS (m^3)	B INCREMENTOS (m^3)	C INCREMENTOS (m^3)	D INCREMENTOS (m^3)	E INCREMENTOS (m^3)
7 - 8	31,001	30,719	34,958	27,373	12,728
8 - 9	11,780	14,150	14,780	13,110	3,360
9 -10	15,190	10,220	13,000	9,880	4,270

Eucalyptus tereticornis

IDADE	A INCREMENTOS (m^3)	B INCREMENTOS (m^3)	C INCREMENTOS (m^3)	D INCREMENTOS (m^3)	E INCREMENTOS (m^3)
7 - 8	31,560	39,890	36,420	35,080	13,600
8 - 9	22,410	17,120	20,070	24,420	9,300
9 -10	14,420	20,980	22,820	24,490	6,490

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sessão IV
session
grupo C
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ABSORÇÃO DE MACRONUTRIENTES E MICRONUTRIENTES PELO *Eucalyptus grandis* (HILL, EX-MAIDEN) EM FUNÇÃO DA IDADE.

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Resumo

Foram coletadas amostras das folhas, ramos ativos e inativos, ponta, meio e base do caule, de plantas de *E. grandis* (Hill, ex-Maiden), com 1 até 7 anos de idade em povoamentos situados sobre Latossol vermelho-amarelo, barro arenoso, no Horto Florestal de Mogi-Guaçu, SP, pertencente a CHAMPION PAPEL E CELULOSE S.A., visando obter dados para estabelecer equações para o crescimento e extração de nutrientes em função da idade da planta, bem como exportação dos mesmos pelo caule.

Os resultados obtidos mostraram que: As maiores acumulações de N, P,K, Mg e S nas plantas ocorreu nas folhas; As plantas atingiram a máxima quantidade de nutrientes nas seguintes idades (anos): P=6,1; N, K, Ca, Mg, S, B,Cu, Fe e Mo=7,0, Mn=6,3; Os nutrientes mais extraídos e exportados, em ordem decrescente, foram: Ca > N > K > S > Mg > P. - Mn > Fe > B > Cu > Zn > Mo; Mais de 98% do fósforo acumularam até 6 anos de idade, e para os demais nutrientes as quantidades acumuladas aumentaram com o envelhecimento das plantas; O magnésio foi o nutriente mais exportado em porcentagem do total extraído pelas plantas, vindo a seguir em ordem decrescente: P > Ca > K=S > N; Entre os micronutrientes em porcentagem de extração pela planta o Mo foi o mais exportado, vindo a seguir em ordem decrescente Zn, Cu, Mn, B e Fe.

UPTAKE OF MACRO AND MICRONUTRIENTS BY *Eucalyptus grandis* (HILLEX-MAIDEN) AT DIFFERENT AGES.

Summary

Leaves, stems plus bark and braches of *E.grandis* (Hill, ex-Maiden) from one year up-to seven years old, situated on a soil type "latossol vermelho-amarelo, barro arenoso" (Orthox) belonging to the Champion Paper and Celulose Company at Mogi-Guaçu, SP, Brazil, were collected. The materials were analysed for N,P,K,Ca,Mg,S,B,Cu,Fe,Mn,Mo and Zn by, conventional methods.

The authors concluded: The maximum dry matter yield occurs at the age of 6.7 years old tree; The maximum heighest occurs with 7 years old tree and the maximum diameter (measured at 1.30 m. from ground), after 7 years; The leaves presents the heighest concentration of N,P,K,Mg,S,B,Fe,Mn and Zn; The maximum quantities of nutrients were detected at the following age of the: P=6.1 years; N,K,Ca,Mg and S-7.0 years. B,Cu,Fe,Mo-7 years, Zn - 5.4 years; The nutrients were extracted and exportated by the tree at the following order: Ca > N > K > S > Mg > P. Mn > Fe > B > Cu > Zn > Mo; Six years old tree accumulated more than 98% of the total of P and Mn; Among the macronutrients Mg accounted for the heighest exportation by the tree, succeeded by P > Ca > K=S > N; The micronutrients were exported in the following order: Mo > Zn > Cu > Mn > B > Fe.

Introdução

Por se constituir uma essência florestal de grande importância, o gênero *Eucalyptus* tem merecido a atenção de diversos pesquisadores na área da nutrição mineral, principalmente nos países onde essa espécie é bastante difundida.

Muitos autores sugerem as possibilidades econômicas na exploração dos solos de cerrado pela silvicultura, devido às condições que oferecem para minimizar os custos de produção. Entretanto, a baixa fertilidade apresentada nesses solos, têm levado ao aparecimento de problemas de ordem nutricional nas florestas implantadas.

No Brasil HAAG *et alii* (1963), analizando folhas de *E. alba* e *E.grandis* com 2 anos de idade, concluiram que essas duas espécies são mais exigentes em Ca, N e K, do que Mg e P para o seu crescimento.

LUBRANO (1970), investigando teores de nutrientes em algumas espécies de *Eucalyptus* em várias estações florestais na Itália, notou que a extração de nutrientes guardava uma estreita relação com a velocidade de crescimento das espécies, e que o maior conteúdo de nutrientes se achava presente nas plantas mais jovens, figurando em primeiro lugar o K seguido pelo N e P.

TEMES (1970), trabalhando na Espanha com *E. globulus* em diferentes idades e cultivados em solos arenosos e pobres em nutrientes, observou que havia uma tendência para acumulação de Cu e Zn nas folhas dos ramos superiores, e havia uma tendência para a acumulação de B nas folhas dos ramos inferiores.

Material e Métodos

Foi utilizada a espécie *Eucalyptus grandis* (Hill, ex-Maiden), cujas sementes foram originárias de Bonville Coff's Harbour - Austrália, e procedente de Mogi-Guaçu, São Paulo, Brasil. O material vegetal foi coletado no dia 03/11/1978 no Horto Florestal pertencente a Champion Papel e Celulose S.A., no município de Mogi-Guaçu, S.P., num solo classificado como "latossol vermelho-amarelo, barro arenoso", de acidez média e baixa fertilidade.

As árvores foram divididas em folhas, ramos ativos e inativos, e o caule foi dividido em três partes, sendo a primeira retirada da superfície do solo até o DAP - diâmetro da altura do peito - (base), e o restante dividido em 2 partes iguais (meio e ponta). Os ramos inativos foram considerados aqueles que estavam sem folhas, com aspecto de secos, mas presos à planta.

Todas as partes foram pesadas, e retirou-se uma amostra representativa para cada uma delas, para serem analisadas quimicamente para N, P, K, Ca, Mg e S; B, Cu, Fe, Mn, Mo e Zn, obedecendo a metodologia citada por SARRUGE e HAAG (1974).

Resultados e Discussão

Crescimento

Os dados referentes ao crescimento das plantas, traduzidos pela acumulação de matéria seca, altura das plantas e DAP (diâmetro da altura do peito), encontram-se na Tabela 1.

A expressão matemática do crescimento foi obtida através da análise de regressão, cujas equações correspondentes encontram-se na Tabela 2.

Para meio e base do caule ajustou-se equações de regressão linear, mostrando aumento de peso com o envelhecimento da planta, sendo que aos 7 anos de idade o peso estimado foi de 98.610,87 g para meio do caule e 18.524,88 g para base.

Ajustou-se regressão do 2º grau para ramos inativos e diâmetro (DAP), sendo que para o primeiro, a máxima acumulação de matéria seca foi de 3.047,53 g aos 4,3 anos de idade e para o segundo diâmetro máximo de 16,51 cm aos 7,3 anos de idade (estimado).

Para altura das plantas, ramos ativos, ponta do caule e planta inteira, ajustou-se equações de regressão cúbica com máximo acúmulo aos 7,0; 6,0; 6,7 e 6,7 anos de idade respectivamente.

Nitrogênio

As quantidades de nitrogênio acumuladas pelas diversas partes e na planta inteira, em função da idade, encontram-se na Tabela 3. O teste F mostrou diferenças na acumulação de nitrogênio para todas as partes e para a planta inteira, sendo ajustadas equações de regressão que aparecem na Tabela 4.

Aos acúmulos de nitrogênio nos ramos ativos, no meio e na base do caule e na planta inteira, em função das idades, ajustou-se equações de regressão linear, registrando aumento com a idade das plantas, e acúmulo estimado em 361,19 g aos 7 anos de idade.

Para ramos inativos, ajustou-se equação quadrática com acúmulo máximo de 5,92 g aos 4,2 anos de idade.

Ao caule da ponta, ajustou-se equação de regressão cúbica com valor máximo de 116,37 g aos 6,2 anos.

As folhas apresentaram acumulação de nitrogênio em função da idade das plantas, segundo equação de regressão de grau superior a 3. O valor máximo observado foi de 88,47 g aos 6 anos de idade.

Fósforo

As quantidades de fósforo acumuladas pelas diversas partes e na planta inteira, em função da idade, encontram-se na Tabela 5, e as respectivas equações de regressão, na Tabela 6.

Tabela 1. Peso da Matéria Seca (g), Altura e Diametro (DAP) da parte aérea de *E. grandis* em função da idade (anos). Média de 4 repetições.

IDADE	Matéria Seca							ALTURA (cm)	DAP (cm)
	FOLHAS	RAMOS		CAULE			TOTAL		
		ATIVOS	INATIVOS	PONTA	MEIO	BASE			
1	2663,8	2522,0	189,2	249,3	886,2	1569,0	8079,5	469,8	4,8
2	3272,0	2936,0	2035,3	4008,6	9299,6	4693,6	26245,1	1142,5	8,8
3	4856,2	3771,0	1435,5	8435,4	15715,9	8673,2	42887,2	1184,0	12,0
4	2475,0	2182,1	3565,5	14537,7	41280,4	8975,2	73265,8	2046,2	12,7
5	2464,2	3968,5	3133,3	21977,5	54316,4	13524,4	99384,4	2212,5	13,7
6	4673,9	9846,6	2418,6	50892,7	106346,0	18898,6	193076,3	2628,0	17,8
7	2719,3	4061,7	972,1	36511,6	89201,7	15976,8	149463,2	2645,0	15,9
DMS TUKEY(5%)	2619,9	4804,5	3246,6	7074,8	39446,0	6104,1	53205,6	238,5	2,4

Tabela 2 - Equações de regressão, coeficiente de determinação (R^2), ponto de inflexão do acúmulo de crescimento (Y) da parte aérea de *E. grandis* em função da idade (anos=X).

CRESCIMENTO	EQUAÇÕES	R^2	PONTO DE MÁXIMO X	PONTO DE MÁXIMO Y	PONTO DE INFLEXÃO X
				gramas	
FOLHAS	n.s. até 3º grau	-	-	-	-
RAMOS ATIVOS	$Y = 7228,6018 - 5768,5787X + 1867,6620X^2 - 154,6743X^3$	43,3	6,0	6444,34	4,0
RAMOS INATIVOS	$Y = -1889,3585 + 2282,5394X + 263,8296X^2$	78,0	4,3	3047,53	-
CAULE DA PONTA	$Y = 12725,5407 - 23080,0267X + 8464,3835X^2 - 671,2233X^3$	87,3	6,7	41176,52	4,2
CAULE DO MEIO	$Y = -25799,0757 + 17772,8494X$	89,4	-	-	-
CAULE DA BASE	$Y = -596,2535 + 2731,5900X$	91,4	-	-	-
TOTAL	$Y = 59934,2530 - 70703,9910X + 28122,4860X^2 - 2276,2430X^3$	91,0	6,7	164028,54	4,1
				centímetros	
ALTURA	$Y = 219,8928 + 243,5019X + 81,0565X^2 - 9,4097X^3$	95,9	7,0	2668,70	2,9
DAP	$Y = 1,1642 + 4,2205X - 0,2901X^2$	94,1	7,3	16,51	-

Tabela 3 - Quantidades de nitrogênio (g) acumuladas pela parte aérea das plantas de *E. grandis* em função da idade (anos). Média de 4 repetições.

IDADE	FOLHAS	RAMOS		CAULES			TOTAL
		Ativos	Inativos	Ponta	Meio	Base	
1	57,30	10,33	0,57	1,05	2,22	3,36	74,82
2	75,11	11,43	4,96	16,76	17,72	6,77	132,76
3	85,76	14,75	3,19	47,03	28,90	16,09	195,72
4	48,80	6,39	7,44	33,81	62,62	11,71	170,77
5	49,25	12,04	5,09	59,15	60,99	17,37	203,89
6	88,47	34,61	4,25	175,12	142,22	28,04	472,72
7	46,48	13,78	2,12	84,45	116,39	22,90	286,13
DMS TUKEY(5%)	40,51	22,12	6,35	48,87	60,15	9,72	40,51

Tabela 4 - Equações de regressão, coeficiente de determinação (R^2), ponto de máximo e ponto de inflexão do acúmulo de nitrogênio (g = Y) em função da idade (anos = X) na parte aérea das plantas de *E. grandis*.

PARTES DA PLANTA	EQUAÇÕES	R^2	PONTO DE MÁXIMO		PONTO DE INFLEXÃO
			X	Y	X
Folhas	n.s. até 3º grau	-	-	-	-
Ramos ativos	$Y = 7,0478 + 1,9288X$	20,7	-	-	-
Ramos inativos	$Y = -2,6630 + 4,1014X - 0,4897X^2$	70,4	4,2	5,92	-
Caule da Ponta	$Y = 60,2218 - 75,9807X + 28,7106X^2 - 2,4186X^3$	66,1	6,2	116,37	4,0
Caule do Meio	$Y = -27,5055 + 22,2720X$	86,7	-	-	-
Caule da Base	$Y = 0,5393 + 3,6592X$	82,7	-	-	-
Total	$Y = 30,6858 + 47,2150X$	62,3	-	-	-

Tabela 5 - Quantidades de fósforo (g) acumuladas pela parte aérea das plantas de *E. grandis* em função da idade (anos). Média de 4 repetições.

IDADE	FOLHAS	RAMOS		CAULES			TOTAL
		Ativos	Inativos	Ponta	Meio	Base	
1	3,42	0,79	0,008	0,12	0,30	0,31	4,96
2	3,44	0,99	0,069	1,36	1,18	0,61	7,64
3	3,96	1,83	0,061	3,35	2,61	1,18	13,00
4	2,40	0,69	0,106	4,70	9,22	1,13	18,24
5	2,92	1,28	0,170	5,35	5,43	1,11	16,27
6	4,42	2,25	0,072	12,66	8,92	1,89	31,93
7	2,36	0,94	0,028	7,30	10,63	1,60	21,15
DMS TUKEY(5%)	2,04	1,72	0,180	3,44	4,58	0,97	6,71

Tabela 6 - Equações de regressão, coeficiente de determinação (R^2), ponto de máximo e ponto de inflexão do acúmulo de fósforo (g=Y) em função da idade (anos=X) na parte aérea das plantas de *E. grandis*.

PARTES DA PLANTA	EQUAÇÕES	R^2	PONTO DE MÁXIMO		PONTO DE INFLEXÃO
			X	Y	X
Fôlhas	n.s. até 3º grau	-	-	-	-
Ramos ativos	n.s. até 3º grau	-	-	-	-
Ramos inativos	$Y = -0,0857 + 0,0957X - 0,0111X^2$	68,2	4,3	0,12	-
Caule da Ponta	$Y = 3,4049 - 4,5928X + 1,9511X^2 - 0,1703X^3$	79,8	6,2	9,34	3,8
Caule do Meio	$Y = -1,3279 + 1,6990X$	76,3	-	-	-
Caule da Base	$Y = 0,2120 + 0,2265X$	82,7	-	-	-
Total	$Y = 8,8667 - 6,4753X + 3,4282X^2 - 0,3157X^3$	80,8	6,1	25,27	3,6

Tabela 7 - Quantidades de potássio (g) acumuladas pela parte aérea das plantas de *E. grandis* em função da idade (anos). Média de 4 repetições.

IDADE	FOLHAS	RAMOS		CAULES			TOTAL
		Ativos	Inativos	Ponta	Meio	Base	
1	13,66	6,40	0,16	1,16	3,11	4,20	28,69
2	18,72	9,40	0,99	14,88	15,43	5,96	65,37
3	35,93	7,73	0,81	17,20	17,14	14,03	92,83
4	17,12	5,97	1,47	30,74	52,71	9,98	117,98
5	15,67	11,30	1,09	40,88	46,66	8,54	124,15
6	27,72	22,65	0,80	76,85	98,18	19,25	245,47
	18,97	11,30	0,28	67,09	85,52	9,66	192,82
DMS TUKEY(5%)	20,02	18,09	1,76	29,12	78,58	5,02	118,36

Tabela 8 - Equações de regressão, coeficiente de determinação (R^2) e ponto de máximo do acúmulo de potássio (g=Y) em função da idade (anos=X) na parte aérea das plantas de *E. grandis*.

PARTES DA PLANTA	EQUAÇÕES	R^2	PONTO DE MÁXIMO X	PONTO DE MÁXIMO Y
Folhas	n.s. até 3º grau	-	-	-
Ramos ativos	$Y = 4,2798 + 1,5995X$	36,8	-	-
Ramos inativos	$Y = -0,5751 + 0,9015X - 0,1115X^2$	83,8	4,0	1,25
Caule da Ponta	$Y = -13,7990 + 12,3356X$	90,7	-	-
Caule do Meio	$Y = -17,6437 + 15,7952X$	88,0	-	-
Caule da Base	$Y = -0,6044 + 4,9905X - 0,4564X^2$	44,0	5,5	13,04
Total	$Y = -2,3714 + 31,5684X$	84,5	-	-

Tabela 9 - Quantidades de cálcio (g) acumuladas pela parte aérea das plantas de *E. grandis* em função da idade (anos). Média de 4 repetições

IDADE	FOLHAS	RAMOS		CAULES			TOTAL
		Ativos	Inativos	Ponta	Meio	Base	
1	18,56	11,22	2,02	0,91	1,68	2,37	36,77
2	12,18	9,70	10,26	7,29	7,99	4,47	51,90
3	30,40	29,31	15,76	30,04	42,26	20,49	168,18
4	13,90	9,09	27,53	45,88	80,09	29,62	206,11
5	13,45	9,49	8,23	30,38	36,17	13,49	111,20
6	31,60	67,84	17,61	123,03	195,38	83,04	555,07
7	17,49	27,01	6,93	159,61	196,99	50,55	424,00
DMS TUKEY(5%)	17,18	31,21	29,17	52,03	119,72	35,19	173,35

Tabela 10 - Equações de regressão, coeficiente de determinação (R^2) e ponto de máximo do acúmulo de cálcio (g=Y) em função da idade (anos=X) na parte aérea das plantas de *E. grandis*.

PARTES DA PLANTA	EQUAÇÕES	R^2	PONTO DE MÁXIMO	
			X	Y
Folhas	n.s. até 3º grau	-	-	-
Ramos ativos	Y= 2,8380 + 5,1356X	26,8	-	-
Ramos inativos	Y= -10,1185 + 13,8403X - 1,6317X^2	56,5	4,2	19,23
Caule da Ponta	Y= -39,1716 + 23,9765X	73,0	-	-
Caule do Meio	Y= -56,2910 + 34,0932X	78,1	-	-
Caule da Base	Y= -12,9455 + 10,5235X	61,9	-	-
Total	Y= -79,6895 + 65,3956X	69,1	-	-

Tabela 11 - Quantidades de magnésio (g) acumuladas pela parte aérea das plantas de *E. grandis* em função da idade (anos). Média de 4 repetições.

IDADE	FOLHAS	RAMOS		CAULES			TOTAL
		Ativos	Inativos	Ponta	Meio	Base	
1	5,78	1,78	0,19	0,27	0,51	0,63	9,16
2	5,43	2,36	1,04	3,44	2,94	1,51	16,37
3	7,26	4,04	1,12	8,92	10,21	4,39	35,93
4	3,58	1,00	0,99	9,35	17,37	2,24	34,54
5	4,88	3,18	0,94	15,29	11,73	2,70	38,72
6	7,38	12,23	0,71	54,92	41,08	9,40	125,72
7	5,10	4,77	0,25	36,69	37,68	5,72	86,22
DMS TUKEY(5%)	3,22	6,29	1,25	16,04	34,44	5,45	47,00

Tabela 12 - Equações de regressão, coeficiente de determinação (R^2), ponto de máximo e ponto de inflexão do acúmulo de magnésio (g=Y) em função da idade (anos=X) na parte aérea das plantas de *E. grandis*.

PARTES DA PLANTA	EQUAÇÕES	R^2	PONTO DE MÁXIMO		PONTO DE INFLEXÃO
			X	Y	X
Folhas	n.s. até 3º grau	-	-	-	-
Ramos ativos	Y= 0,2135 + 0,9951X	32,5	-	-	-
Ramos inativos	Y= - 0,2877 + 0,7301X - 0,0941X^2	86,9	3,9	1,13	-
Caule da Ponta	Y= 19,2904 - 23,7153X + 8,0314X^2 - 0,5950X^3	77,0	7,1	42,80	4,5
Caule do Meio	Y= - 8,5421 + 6,3326X	80,1	-	-	-
Caule da Base	Y= - 0,5496 + 1,0744X	57,7	-	-	-
Total	Y= -15,1511 + 16,1684X	70,3	-	-	-

Tabela 13 - Quantidades de enxofre (g) acumuladas pela parte aérea das plantas de *E. grandis* em função da idade (anos). Média de 4 repetições.

IDADE	FOLHAS	RAMOS		CAULE			TOTAL
		Ativos	Inativos	Ponta	Meio	Base	
1	5,19	2,28	0,11	0,18	0,48	1,21	9,44
2	6,09	2,36	1,44	2,86	4,63	3,99	21,37
3	10,36	3,67	1,16	6,57	21,77	12,46	55,98
4	5,32	2,84	4,82	9,80	36,38	4,96	64,12
5	3,98	3,17	1,51	22,72	67,55	10,52	109,46
6	10,92	8,74	1,90	39,78	85,89	12,23	159,47
7	4,43	2,27	0,95	21,06	47,64	6,42	82,77
DMS TUKEY(5%)	6,08	6,09	3,97	17,95	110,22	18,54	110,12

Tabela 14 - Equações de regressão, coeficiente de determinação (R^2), ponto de máximo e ponto de inflexão do acúmulo de enxofre (g=Y) em função da idade (anos=X) na parte aérea das plantas de *E. grandis*.

PARTES DA PLANTA	EQUAÇÕES	R^2	PONTO DE MÁXIMO		PONTO DE INFLEXÃO
			X	Y	X
Folhas	n.s. até 3º grau	-	-	-	-
Ramos ativos	n.s. até 3º grau	-	-	-	-
Ramos inativos	$Y = -0,0198 + 2,2285X - 0,2615X^2$	47,3	4,2	2,76	-
Caule da Ponta	$Y = 22,1123 - 29,2256X + 10,4831X^2 - 0,8943X^3$	85,8	6,0	30,98	3,9
Caule do Meio	$Y = -12,2095 + 12,4929X$	72,3	-	-	-
Caule da Base	n.s.	-	-	-	-
Total	$Y = -6,7212 + 19,6307X$	67,6	-	-	-

Tabela 15 - Quantidades de boro (mg) acumuladas pela parte aérea das plantas de *E.grandis* em função das idades (anos). Média de 4 repetições.

IDADE (anos)	FOLHAS	RAMOS		CAULES			TOTAL
		Ativos	Inativos	Ponta	Meio	Base	
1	77,96	34,90	3,77	3,01	8,48	11,36	139,49
2	50,72	36,39	27,02	40,38	71,78	38,13	292,12
3	100,63	17,79	21,91	60,45	63,57	52,78	313,13
4	78,42	30,06	44,96	91,72	161,78	47,55	426,81
5	81,00	59,64	30,98	155,79	277,03	81,34	685,78
6	102,15	105,74	34,71	426,92	569,40	110,51	1349,44
7	64,52	33,16	11,64	243,08	410,83	107,10	870,33

Tabela 16 - Equações de regressão, coeficiente de determinação (R^2), ponto de máximo (PM) e ponto de inflexão (PI) do acúmulo de boro (mg = Y) em função da idade (anos = X) na parte aérea de *E. grandis*.

PARTES DA PLANTA	EQUAÇÕES	R^2	PONTO DE MÁXIMO		PONTO DE INFLEXÃO	
			X	Y	X	Y
Folhas	n.s.	-	-	-	-	-
Ramos ativos	$131,5264 - 121,1981X + 37,5011X^2 - 3,1372X^3$	62,1	5,7	78,11	4,0	45,53
Ramos inativos	$-19,2213 + 26,6197X - 3,1129X^2$	76,5	4,3	37,89	-	-
Caule da Ponta	$191,4698 - 239,1254X + 83,1626X^2 - 6,7170X^3$	77,1	6,4	306,57	4,1	148,87
Caule do Meio	$-121,8393 + 86,2771X$	81,3	-	-	-	-
Caule da Base	$-1,6806 + 16,4480X$	92,8	-	-	-	-
Total	$-84,9582 + 166,9926X$	73,9	-	-	-	-

Tabela 17 - Quantidades de cobre (mg) acumuladas pela parte aérea das plantas de *E. grandis* em função das idades (anos). Média de 4 repetições.

IDADE (anos)	FOLHAS	RAMOS		CAULES			TOTAL
		Ativos	Inativos	Ponta	Meio	Base	
1	18,81	22,50	0,38	2,45	4,20	6,20	54,56
2	26,06	26,66	8,53	29,53	30,35	9,72	130,86
3	46,81	62,39	10,63	67,62	66,58	33,88	287,91
4	22,02	16,66	16,54	83,68	225,53	24,35	388,81
5	26,71	26,57	19,89	75,54	72,21	20,38	241,30
6	30,40	96,38	8,64	315,10	281,74	42,33	774,60
7	14,60	30,13	3,83	233,54	234,84	23,70	540,63

Tabela 18 - Equações de regressão, coeficiente de determinação (R^2) e ponto de máximo (PM) do acúmulo de cobre (mg = Y) em função da idade (anos = X) na parte aérea das plantas de *E. grandis*.

PARTES DA PLANTA	EQUAÇÕES	R^2	PONTO DE MÁXIMO	
			X	Y
Folhas	$9,6970 + 12,6273X - 1,6859X^2$	40,0	3,7	33,34
Ramos ativos	n.s. até 3º grau	-	-	-
Ramos inativos	$-12,5678 + 13,7323X - 1,6279X^2$	85,9	4,2	16,37
Caule da Ponta	$-66,4085 + 45,4400X$	73,3		
Caule do Meio	$-40,6901 + 42,8676X$	67,5	-	-
Caule da Base	$-7,7616 + 14,2635X - 1,3176X^2$	55,6	5,4	30,84
Total	$-40,0607 + 96,3962X$	70,5	-	-

Tabela 19 - Quantidade de ferro (mg) acumuladas pela parte aérea das plantas de *E. grandis* em função das idades (anos). Médias de 4 repetições.

IDADE (anos)	FOLHAS	RAMOS		CAULES			TOTAL
		Ativos	Inativos	Ponta	Meio	Base	
1	544,68	167,68	16,38	9,05	16,09	13,43	767,31
2	598,35	209,84	127,35	54,02	87,46	22,82	1099,85
3	1099,37	375,32	129,48	160,23	529,58	91,61	2385,60
4	569,38	163,29	427,50	192,37	930,88	147,01	2430,42
5	471,54	263,64	410,37	195,15	267,22	97,71	1705,63
6	868,37	714,64	361,41	760,07	2167,53	350,32	5222,34
7	490,80	189,52	219,55	460,52	1702,36	280,75	3343,50

Tabela 20 - Equações de regressão, coeficiente de determinação (R^2), ponto de máximo (PM) e ponto de inflexão (PI) do acúmulo de ferro (mg = Y) em função da idade (anos = X) na parte aérea das plantas de *E. grandis*.

PARTES DA PLANTA	EQUAÇÕES	R^2	PONTO DE MÁXIMO		PONTO DE INFLEXÃO	
			X	Y	X	Y
Folhas	n.s. até 3º grau	-	-	-	-	-
Ramos ativos	n.s. até 3º grau	-	-	-	-	-
Ramos inativos	47,6506 + 48,5175X	42,7	-	-	-	-
Caule da Ponta	$224{,}0951 - 278{,}4359X + 102{,}5968X^2 - 8{,}0415X^3$	71,8	6,8	546,28	4,2	277,02
Caule do Meio	-465,0687 + 319,8787X	68,6	-	-	-	-
Caule da Base	-85,6262 + 52,2513X	78,1	-	-	-	-
Total	237,2955 + 546,1995X	61,0	-	-	-	-

Tabela 21 - Quantidades de manganes (mg) acumuladas pela parte aerea das plantas de *E. grandis* em função das idades (anos). Médias de 4 repetições.

IDADE (anos)	FOLHAS	RAMOS		CAULES			TOTAL
		Ativos	Inativos	Ponta	Meio	Base	
1	2154,12	652,22	53,24	49,04	95,38	154,92	3158,93
2	1078,27	874,41	514,30	583,85	718,24	299,97	4069,05
3	1607,80	637,01	207,12	1123,64	900,47	425,07	4901,12
4	472,41	201,40	140,58	1517,85	793,56	116,28	3242,08
5	1154,65	937,10	429,45	2819,99	2216,84	716,34	8274,37
6	2265,14	2963,75	210,00	12108,62	4738,45	1215,54	23501,51
7	1075,93	1041,37	81,30	6838,67	1908,38	450,53	11396,18

Tabela 22 - Equações de regressão, coeficiente de determinação (R^2), ponto de máximo (PM) e ponto de inflexão (PI) do acúmulo de manganês (mg = Y) em função da idade (anos = X) na parte aérea das plantas de *E. grandis*.

PARTES DA PLANTA	EQUAÇÕES	R^2	PONTO DE MÁXIMO		PONTO DE INFLEXÃO	
			X	Y	X	Y
Folhas	$4254{,}1245 - 2670{,}3679X + 675{,}0792X^2 - 50{,}3308X^3$	41,5	6,0	1609,54	4,5	1271,09
Ramos ativos	$2657{,}5809 - 2356{,}4499X + 701{,}7602X^2 - 55{,}5633X^3$	40,1	6,1	1783,92	4,2	1028,93
Ramos inativos	$19{,}8189 + 160{,}5774X - 21{,}4207X^2$	22,9	3,7	320,76	-	-
Caule da Ponta	$5926{,}2381 - 7288{,}4023X + 2340{,}6928X^2 - 178{,}6527X^3$	71,6	6,7	8435,58	4,4	3858,80
Caule do Meio	$-489{,}2075 + 528{,}4208X$	53,9	-	-	-	-
Caule da Base	$840{,}8461 - 848{,}2110X + 293{,}4796X^2 - 25{,}3118X^3$	54,0	5,8	855,23	3,9	485,12
Total	$16264{,}7469 - 16132{,}2803X + 5097{,}5884X^2 - 404{,}6792X^3$	63,2	6,3	15766,60	4,2	8442,81

Tabela 23 - Quantidades de molibdênio (mg) acumuladas pela parte aérea das plantas de *E. grandis* em função das idades (anos). Médias de 4 repetições.

IDADE (anos)	FOLHAS	RAMOS		CAULES			TOTAL
		Ativos	Inativos	Ponta	Meio	Base	
1	0,10	0,11	0,01	0,01	0,04	0,04	0,31
2	0,14	0,09	0,10	0,12	0,23	0,14	0,82
3	0,40	0,13	0,05	0,44	0,82	0,41	2,25
4	0,19	0,14	0,68	1,36	1,71	0,52	4,60
5	0,16	0,16	0,16	1,07	2,84	0,98	5,40
6	0,27	0,25	0,20	2,99	3,80	0,82	8,32
7	0,14	0,11	0,09	1,08	3,31	0,60	5,34

Tabela 24 - Equações de regressão, coeficiente de determinação (R^2) e ponto de máximo (PM) do acúmulo do molibdênio (mg = Y) em função da idade (anos = X) na parte aérea das plantas de *E. grandis*.

PARTES DA PLANTA	EQUAÇÕES	R^2	PONTO DE MÁXIMO	
			X	Y
Folhas	$0,0050 + 0,1223X - 0,0146X^2$	28,9	4,2	0,26
Ramos ativos	n.s.	-	-	-
Ramos inativos	n.s.	-	-	-
Caule da Ponta	$-0,3598 + 0,3423X$	53,0	-	-
Caule do Meio	$-0,8856 + 0,6766X$	92,6	-	-
Caule da Base	$-0,0106 + 0,1285X$	67,1	-	-
Total	$-0,8846 + 1,1858X$	79,8	-	-

Tabela 25 - Quantidades de zinco (mg) acumuladas pela parte aérea das plantas de *E. grandis* em função das idades (anos). Médias de 4 repetições.

IDADE (anos)	FOLHAS	RAMOS		CAULES			TOTAL
		Ativos	Inativos	Ponta	Meio	Base	
1	39,22	10,10	0,68	1,82	5,56	4,18	61,56
2	49,72	18,16	2,55	21,36	79,06	4,69	175,56
3	110,55	43,61	5,17	122,00	36,90	27,49	345,71
4	34,91	12,90	14,82	43,63	165,07	8,97	280,30
5	35,53	35,02	6,58	43,92	62,98	13,52	197,55
6	57,10	75,32	3,38	127,05	146,10	18,90	427,86
7	34,21	18,16	2,11	108,37	89,20	23,82	275,86

Para meio e base do caule ajustou-se regressão linear, indicando aumento na acumulação com a idade. Os valores acumulados estimados para 1 e 7 anos foram: para meio do caule 0,37 g e 10,57 g e para base do caule de 0,44g e 1,80 g, respectivamente.

Para ramos inativos, ajustou-se equação de regressão quadrática com um máximo de 0,12 g aos 4,3 anos. Ponta do caule e planta toda, equações de regressão cúbica com valores máximos de 9,34 g aos 6,2 anos de idade e 25,27g aos 6,1 anos de idade, respectivamente.

Com relação às folhas e ramos ativos, as acumulações de P em função da idade da planta foram representadas por equações de regressão de grau superior a 3. Os valores máximos observados foram: 4,42 g para folhas e 2,25 g para ramos ativos aos 6 anos de idade.

Potássio

As quantidades de potássio acumuladas pelas diversas partes e pela planta inteira, em função das idades, encontram-se na Tabela 7. Pelo tesde de F (não incluido) observa-se diferenças no acúmulo de potássio em função das idades, para planta inteira, caules e folhas.

Para todas as partes estudadas e para a planta inteira, em função da idade, ajustaram-se equações de regressão, que aparecem na Tabela 8.

Aos acúmulos de K no ramo ativo, ponta e meio do caule, e para a planta inteira, em função da idade, ajustaram-se equações de regressão linear, mostrando aumento no acúmulo com o envelhecimento da planta. A planta inteira acumulou 218,61 g de potássio em 7 anos de idade.

Para ramos inativos e base do caule, ajustaram-se equações de regressão de 2º grau, com acúmulo máximo igual a 1,25 g aos 4 anos de idade e 13,04 g aos 5,5 anos de idade, respectivamente.

As folhas apresentaram acúmulo de K em função da idade das plantas, segundo equação de regressão superior à cúbica. O valor máximo observado foi de 27,72 g aos 6 anos de idade.

Cálcio

As quantidades de cálcio acumuladas em função da idade das plantas, encontram-se na Tabela 9. Aos efeitos da análise de variância, foram ajustadas equações de regressão, que aparecem na Tabela 10.

As quantidades de cálcio dos ramos ativos, meio e base do caule e para a planta inteira em função da idade são representadas por equações de regressão linear, aumentando a concentração à medida que a planta envelhece. Em plantas com 7 anos de idade, encontra-se um total acumulado, estimado em 448,08 g.

Para ramos inativos ajustou-se equação de regressão quadrática, sendo estimado um acúmulo máximo de 19,23 g, obtido em plantas com 4,2 anos de idade.

Nos ramos ativos, aos 2 anos de idade, a quantidade foi 6,86 g de Ca/kg de ramos ativos.

Magnésio

As quantidades de magnésio acumuladas pelas partes e pela planta inteira em função da idade, encontra-se na Tabela 11. Aos efeitos da análise de variância, foram ajustadas equações de regressão, que aparecem na Tabela 12.

Para ramos ativos, meio e base do caule e para a planta inteira, ajustaram-se equações de regressão linear, mostrando que a acumulação aumenta com o aumento da idade, tendo um acúmulo total aos 7 anos de 92,03 g.

Para ramos inativos, ajustou-se equação de regressão quadrática acusando um máximo de acumulação de 1,13 g aos 3,9 anos de idade.

Para ponta do caule, ajustou-se regressão cúbica com máximo de acumulação de 42,80 g aos 7,1 anos de idade.

Aos 2 anos de idade, registrou-se acúmulo estimado nos ramos ativos de 1,16 g/kg de ramo ativo, sendo que HAAG *et alii* (1963), em *E. grandis* encontraram valor de 2,09 g/kg de ramo ativo, acúmulo bem superior.

Tabela 26 - Equações de regressão, coeficiente de determinação (R^2), ponto de máximo (PM) e ponto de inflexão (PI) do acúmulo de zinco (mg = Y) em função da idade (anos = X) na parte aérea das plantas de *E. grandis*.

PARTES DA PLANTA	EQUAÇÕES	R^2	PONTO DE MÁXIMO		PONTO DE INFLEXÃO	
			X	Y	X	Y
Folhas	n.s. até 3º grau	-	-	-	-	-
Ramos ativos	$11,9048 + 4,6401X$	18,6	-	-	-	-
Ramos inativos	$-7,5130 + 7,9320X - 0,9587X^2$	56,8	4,1	8,89	-	-
Caule da Ponta	$2,1835 + 18,1743X$	46,5	-	-	-	-
Caule do Meio	$24,8268 + 14,8817X$	31,3	-	-	-	-
Caule da Base	$-18,0851 + 26,5275X - 6,6945X^2 + 0,5390X^3$	50,9	3,3	15,92	4,1	15,25
Total	$42,8851 + 137,0115X - 12,6651X^2$	57,0	5,4	327,86	-	-

Aos 5 anos de idade, observou acúmulo estimado de 0,91 g de Mg/kg de ramo ativo; e de 0,52 g de Mg/kg de caule, sendo que LUBRANO (1970), com *E. viminalis*, encontrou teores de 1,28 g/kg de ramo ativo e 0,98 g/kg de caule.

Ao acúmulo de Mg nas folhas em função da idade das plantas ajustou-se equação de regressão de grau superior à cúbica. O valor máximo observado foi de 7,38 g aos 6 anos de idade.

Enxofre

Os dados de acumulação de enxofre nas partes e planta inteira, em função das idades das plantas, estão resumidos na Tabela 13. Aos dados foram ajustadas equações de regressão que aparecem na Tabela 14, para representar as quantidades acumuladas de enxofre.

Para meio do caule e planta inteira foram ajustadas equações de 1º grau, mostrando que a quantidade aumenta com o envelhecimento da planta. Aos 7 anos de idade a planta inteira acumulou 130,69 g de S, quantidade maior que Mg e P e menor que N, K e Ca.

Ajustou-se equação de regressão quadrática para ramos inativos, com um máximo de 2,76 g aos 4,2 anos de idade, e regressão cúbica para ponta do caule, com um máximo de 30,98 g aos 6 anos de idade.

Nas folhas e nos ramos ativos, não foi possível ajustar-se equações de regressão até 3º grau. Os valores máximos observados foram 10,92 g e 8,74 g aos 6 anos, respectivamente.

Boro

Os dados das quantidades de boro acumuladas pelas partes e pela planta inteira em função das idades, estão resumidos na Tabela 15, e suas respectivas equações de regressão na Tabela 16.

Ajustou-se equações de regressão de 1º grau, para meio e ponta do caule e para a planta inteira, observando-se nos 3 casos, que a acumulação aumenta com o envelhecimento das plantas. A acumulação aos 7,0 anos de idade foi de 1.083,99 mg.

Para ramos inativos, ajustou-se equações de regressão de 2º grau, com um máximo de acúmulo de 37,69 mg aos 4,3 anos de idade.

Ajustou-se para ramos ativos e ponta do caule, equações de regressão de 3º grau, onde apresentaram máxima acumulação aos 5,7 e 6,4 anos respectivamente. Para ramos ativos, o ponto de inflexão correspondeu a um acúmulo de 45,53 mg aos 4,0 anos e para ponta do caule 148,87 mg aos 4,1 anos de idade da planta.

Cobre

As quantidades de cogre acumuladas pelas partes e pela planta inteira, em função das idades aparecem na Tabela 17.

Ajustou-se equações de regressão que aparecem na Tabela 18, sendo que para ramos ativos, ajustou-se regressão de grau superior à cúbica. O valor máximo observado foi de 96,38 mg aos 6,0 anos de idade.

Para ponta e meio do caule, e para a planta inteira, ajustaram-se equações de regressão linear com acumulação aumentando com o envelhecimento das plantas. Aos 7,0 anos de idade a planta inteira acumulou 634,71 mg de cobre

Para as folhas, ramos inativos e base do caule, ajustaram-se equações de regressão quadrática, com um máximo de acúmulo de 33,34 mg aos 3,7 anos, 16,37 mg aos 4,2 anos e 30,84 mg aos 5,4 anos de idade respectivamente.

As folhas com 1,0 ano de idade apresentaram teores estimados de 6,61 mg/kg de folha, dados próximos aos obtidos por ROGERS e WESTMAN (1977), com *E. signata* que foi de 5,50 mg/kg de folha. Com 1,5 ano encontrou-se 7,86 mg/kg de folha, sendo que o mesmo autor encontrou teor de 5,50 mg/kg de folha.

Em folhas com 4,0 anos de idade, encontrou-se 10,31 mg/kg de folha, sendo que HAAG *et alii* (1977) com *E. citriodora* encontraram teores menores, 7,00 mg/kg de folha. Pará folhas com 7,0 anos de idade encontrou-se 4,90 mg/kg de folha, sendo que HAAG *et alii* (1976), com *E. grandis* encontraram 6,00 mg/kg de folha, mais elevado que o do presente trabalho.

Ferro

As quantidades de ferro acumuladas pelas diversas partes das plantas, e pela planta inteira em função das idades, encontram-se na Tabela 19.

Ajustou-se equações de regressão, que aparecem na Tabela 20, onde observa-se que para folhas e ramos ativos, as equações ajustadas são de grau superior à cúbica. Para ponta do caule, registrou-se equação de regressão cúbica com acumulação máxima de 546,28 mg aos 6,8 anos de idade e com uma inflexão aos 4,2 anos de idade correspondendo a uma acumulação de 277,03 mg de ferro.

Para as demais partes, ramos inativos, meio e base do caule e para a planta inteira, ajustou-se regressão linear, com aumento na concentração com o envelhecimento da planta. Aos 7,0 anos de idade, a planta inteira acumulou 4.060,69 mg.

Manganês

As quantidades de manganês acumuladas pelas partes e pela planta inteira, aparecem na Tabela 21. Na Tabela 22, aparecem as respectivas equações de regressão.

Para meio do caule, ajustou-se equação de regressão de 1º grau, aumentando o acúmulo com o aumento da idade das plantas, sendo que aos 7,0 anos registrou-se um teor estimado de 3.209,74 mg.

Para ramos inativos, ajustou-se equação de regressão de 2º grau, com um máximo de 320,76 mg aos 3,7 anos de idade.

Para as demais partes e planta inteira ajustou-se equações de 3º grau, registrando um acúmulo máximo, para folhas de 1.609,54 mg aos 6,0 anos de idade; para ramos ativos 1.683,92 mg aos 6,1 anos; para ponta do caule 8.435,58 mg aos 6,7 anos; para base do caule 855,23 mg aos 5,8 anos e para a planta inteira 15.766,60 mg aos 6,3 anos de idade.

Folhas com 7,0 anos de idade acumularam 397,58 mg/kg de folha, dados próximos aos obtidos por HAAG *et alii* (1976), com a mesma espécie na mesma região.

Molibdênio

As quantidades de molibdênio acumuladas pelas diversas partes das plantas, e pela planta inteira em função da idade, estão resumidas na Tabela 23, e as respectivas equações de regressão estão na Tabela 24.

Ao acúmulo de molibdênio nas folhas, ajustou-se equação de regressão quadrática, registrando um acúmulo máximo de 0,26 mg aos 4,2 anos de idade.

Ajustou-se para ponta, meio e base do caule, e também para a planta inteira, equações de regressão de 1º grau, sendo que todas mostraram aumento na acumulação com o envelhecimento da planta. Registrou-se para a planta inteira, teor estimado com 1,0 ano de idade de 0,30 mg; e com 7,0 anos de idade de 7,42 mg.

Zinco

As quantidades acumuladas de zinco nas partes das plantas e na planta inteira, em função da idade, estão resumidas na Tabela 25. As respectivas equações de regressão, encontram-se na Tabela 26.

Para ramos ativos, ponta e meio do caule, ajustou-se equações de regressão linear, onde as quantidades acumuladas, aumentam com o envelhecimento da planta. Aos 7,0 anos de idade, registrou-se 44,39 mg; 115,40 mg e 127,60 mg respectivamente.

Para ramos inativos e planta inteira adaptou-se regressão quadrática registrando-se uma acumulação máxima de 8,89 mg aos 4,1 anos de idade para o primeiro e 327,86 mg aos 5,4 anos de idade para o segundo.

Ajustou-se para base do caule, equação de regressão cúbica com uma acumulação máxima de 15,92 mg aos 3,3 anos de idade e com uma maior velocidade de acumulação (inflexão) aos 4,1 anos de idade.

Folhas com 1,0 e 4,0 anos de idade, apresentaram quantidades observadas de 15,00 mg/kg de folha e 14,2 mg/kg de folha respectivamente, dados próximos aos encontrados por ROGERS e WESTMAN (1977) e por HAAG *et alii* (1977).

Extração de Nutrientes

Entre os nutrientes, o cálcio é o elemento mais extraído, vindo a seguir em ordem decrescente: nitrogênio, potássio, enxofre, magnésio e fósforo. Tanto HAAG *et alii* (1963), no Brasil, como LUBRANO (1970), na Itália, também observaram que o cálcio era o elemento mais extraído, e o fósforo o mesmo.

O nitrogênio foi o nutriente que mais se acumulou nas folhas; e o cálcio nas demais partes das plantas.

Para as quantidades de nutrientes no meio do caule, a idade de máximo acúmulo foi de 7 anos de idade.

Entre os micronutrientes o elemento extraído em maior quantidade foi o manganês, vindo a seguir em ordem decrescente: ferro, boro, cobre, zinco e molibdênio.

O ferro, foi o que mais se acumulou nos ramos inativos, e o manganês nas demais partes das plantas.

Para as quantidades de nutrientes no meio do caule, a idade de máximo acúmulo foi de 7,0 anos de idade.

Exportação de Nutrientes

Na Tabela 17 encontram-se as quantidades de macronutrientes exportados pelo caule das plantas com 7 anos de idade. As quantidades exportadas por ha, são baseadas na produção da cultura em volume real com casca, conforme VEIGA (1972), o qual acusou 355,44 m^3/ha.

Observa-se para todos os nutrientes, altas porcentagens de exportação pela cultura, sendo o magnésio o mais exportado do total extraído. Para todos os nutrientes o cálcio foi o mais exportado em quantidade; 580,38 kg/ha.

Na Tabela 15, encontram-se as quantidades de micronutrientes exportados pelo caule das plantas com 7,0 anos de idade.

Observamos para todos os nutrientes altas porcentagens de exportação pela cultura, sendo que o molibdênio foi o mais exportado do total.

Conclusões

Crescimento

- A produção máxima de matéria seca ocorre nas plantas com 6,7 anos de idade.

- A maior produção de matéria seca para meio e base do caule ocorre aos 7 anos de idade, e para ponta do caule aos 6,7 anos de idade.

- A altura máxima ocorre aos 7 anos de idade, e o diâmetro máximo ocorre depois dos 7 anos de idade das plantas.

Extração de Nutrientes

- Os nutrientes N, P, Ca, Mg e S acumulam, respectivamente, 13,0%; 14,4%; 16,8%; 17,6% e 15,0% da quantidade total extraída, por ano.

- Mais de 98% do fósforo são acumulados até 6 anos de idade.

- O cálcio é o nutriente mais extraído, seguido, em ordem decrescente de: N, K, S, Mg e P.

- Os nutrientes B, Cu, Fe e Mo, acumularam respectivamente 15,4%; 15,2%; 13,5% e 16,1% da quantidade total extraída por ano.

- Mais de 98,0% do manganês é acumulado até 6,0 anos de idade; 99,4% do zinco aos 5,0 anos de idade.

- O manganês é o nutriente mais extraído, segudio em ordem decrescente; Fe, B, Cu, Zn e Mo.

Exporção de Nutrientes

- Em porcentagem da extração pela planta, o magnésio é o nutriente mais exportado através do caule, vindo a seguir, em ordem decrescente: P, Ca, K=S, N, Mo, Zn, Cu, Mn, B e Fe.

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FAST GROWING TREES

INFLUÊNCIA DE FLORESTAS IMPLANTADAS DE *Eucalyptus* E *Pinus* SOBRE AS PROPRIEDADES QUÍMICAS DO SOLO.

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Resumo

Amostras de acículas de *P. taeda* e de folhas de *E. citriodora*, de manta orgânica e de solo, foram coletadas de dois povoamentos, localizados no município de Piracicaba - SP, Brasil.

Foram determinados quantidades de nutrientes (kg/ha) acumulados na manta orgânica, bem como foi estudada a contribuição de cada espécie na quantidade de manta orgânica formada. Comparou-se ainda, a quantidade de nutrientes (mg) existente em 100 acículas de *P. taeda* e em 100 folhas de *E. citriodora*.

Os autores concluiram: 1) tanto o *Eucalyptus* como o *Pinus* influenciaram positivamente o teor porcentual de carbono do solo nas duas profundidades amostradas; 2) o *Eucalyptus* contribui em maior proporção para enriquecer o solo em potássio e em magnésio; 3) o *Pinus* contribuiu para um acúmulo de alumínio trocável na camada de 10-20 cm do solo; 4) o *E. citriodora* contribuiu para a formação de uma maior quantidade de manta orgânica que o *Pinus taeda*; 5) tanto a espécie folhosa como a conífera contribuiram quantitativamente para o enriquecimento em nutrientes na manta orgânica sob os dois povoamentos; 6) as folhas maduras de ambas as espécies acumularam maiores quantidades de nutrientes, exceção feita para o ferro na conífera e manganês na espécie folhosa que apresentaram acumulações nas folhas senescentes.

INFLUENCE OF MAN-MADE *Eucalyptus* AND *Pinus* FORESTS ON SOIL CHEMICAL CHARACTERISTICS.

Summary

From a grove of *E. citriodora* (20 years) and *P. taeda* (24 years) site on a red-yellow podzolic (Ultisol), at Piracicaba (22°43'S, 47°38'W, elev. 1933 ft., annual precipt 1,170 mm) SP, Brazil, leaves litter fall and soil samples (0 - 10 and 10 - 20 cm depth) were collected. Chemical analysis were run for macro and micronutrients, except for Cl and Mo.

The authors concluded: 1) both forest species hence the organic carbon content in the soil; 2) *E. citriodora* improved the potassium and magnesium contents in the soil; 3) *P. taeda* improved the available aluminium of the soil; 4) the species *E. citriodora* supply higher amounts of litter to the soil that *P. taeda;* 5) both species hence the nutrients content in the litter fall; 6) leaves from *E. citriodora* were consistently higher in nutrients, than the needles from *P. taeda*.

Introdução

As essências florestais apresentam um comportamento diferente das culturais agrícolas, uma vez que contribuem para um maior melhoramento das condições físicas e químicas do solo em que estão implantadas. Suas raízes, atingindo maiores profundidades retiram das camadas inferiores do solo elementos minerais formando os tecidos, que são posteriormente incorporados às camadas superiores do solo, formando a cada ano, uma nova manta orgânica, a qual é transformada em humus por processos biológicos.

CURLIN (1968), relata que a manta orgânica de um solo de floresta, está sujeita a um grande número de fatores, dos quais resultam na sua decomposição até a uma consequente mineralização do material orgânico, e essa decomposição se torna mais rápida quando na manta predomina material foliar.

NYE (1961), estudando a matéria orgânica e a ciclagem de nutrientes em florestas tropical de Ghana, estimou que 9.000 kg de matéria orgânica é decomposta por acre/ano.

HAAG *et alii* (1961), mostraram que através de corte das árvores (*E.alba* e *E. grandis*), a grande maioria dos nutrientes é exportada como madeira: 82% do P; 77% do K e 87% do Ca.

PACÍFICO HOMEN (1961), relata que a quantidade de matéria orgânica deixada no solo pela cultura do Eucalipto é da ordem de 15.000 kg/ha/ano.

MILLER *et alii* (1976), estudando o efeito do nitrogênio na formação da manta orgânica em solos da Escócia, cultivados com *Pinus nigra* var. maritima (Ait.) (Melv.) observaram em um período de 6 anos uma variação na manta orgânica de 15.600 kg/ha na testemunha para 23.820 kg/ha no tratamento que recebeu a dose máxima de nitrogênio (50 kg N/ano).

NEWBOULD & FLOATE (1977), estudando a ciclagem de nutrientes em florestas da Inglaterra, calcularam que existia uma perda do solo de cerca de 1,3 kg de P/ha/ano, dados esses, contrastando com os apresentados por WHITE & HARRISON (citados pelos mesmos autores) que foram para as mesmas condições, de ganho de 0,11 kg de P/ha/ano.

CARPANEZZI (1980), determinou a deposição do material orgânico e de seus nutrientes em dois ecossistemas florestais, mata e *E. saligna*. Observou que a deposição de matéria orgânica na mata (10 t/ha) é sensivelmente superior a do eucalíptol (7 t/ha). As quantidades de nutrientes encontradas na deposição da mata são cerca de nove vezes superior.

O presente trabalho, teve o objetivo de avaliar a contribuição do *P. taeda* e *E. citriodora* no fornecimento das quantidades de nutrientes e alterações no solo.

Material e Métodos

Foram coletadas amostras de dois povoamentos, sendo um de *Pinus taeda* e outro de *Eucalyptus citriodora* de 20 e 24 anos respectivamente, localizados no município de Piracicaba, Estado de São Paulo, que apresenta as seguintes condições climáticas: temperatura média mensal 21°C, altitude 580 m; precipitação média anual: 1.170 mm; latitude: 22°43' sul e longitude: 43°38' oeste.

O solo é classificado como Podzólico Vermelho Amarelo, variação Laras (Comissão de Solos, 1960).

Em cada povoamento foram coletadas amostras de folhas, manta orgânica e de solo. As folhas foram divididas em: novas, maduras e senescentes; a manta em superior e inferior e o solo em duas profundidades: 0-10 e 10-20 cm. Coletou-se ainda, amostra de solos sem cobertura florestal.

As amostras de solos foram analisadas quimicamente de acordo com as recomendações contidas em CATANI & JACINTO (1974).

Nas amostras de folhas e mantas foram determinados os teores de nutrientes, de acordo com a metodologia descrita em SARRUGE & HAAG (1974). Na coleta da manta utilizou-se uma área padronizada de 0,25 m^2. Nas árvores amostradas foram contados os números de galhos, ramos e mediu-se a área da sua copa projetada ao solo.

Quadro 1. Influência da cobertura florestal sobre alguns parâmetros de fertilidade do solo

Parâmetro	Profundidade da amostragem (cm)					
	Pinus		d.m.s. 5%* p/ profundidade	*Eucalyptus*		d.m.s. 5%* p/ profundidade
	0 - 10	10 - 20		0 - 10	10 - 20	
% C	0,78	0,32	0,13	0,84	0,48	-
K^+ emq/100 g	0,10	0,06	0,07	0,33	0,21	0,07
Mg^{+2} emq/100 g	0,30	0,22	0,11	0,51	0,27	0,11
Al^{+3} emq/100 g	0,80	1,26	0,24	1,21	1,23	-

* Teste de Tuckey

Quadro 2. Contribuição das espécies na quantidade da manta orgânica do solo

Espécie	Quantidade de manta formada (t/ha)		
	Superior	Inferior	Total
Pinus	6,95	7,00	13,95
Eucalyptus	2,87	17,11	19,98

Quadro 3. Quantidade de nutrientes (kg/ha) observados na manta sob *P. taeda* e *E. citriodora*

Nutriente	Quantidade (kg/ha) na manta sob	
	P. taeda	*E. citriodora*
N	106,09	212,00
P	5,02	8,91
K	11,84	31,40
Ca	86,92	161,02
Mg	14,23	32,98
S	20,51	32,69
B	0,31	0,57
Cu	0,08	0,25
Fe	20,94	25,19
Mn	11,01	14,74
Zn	0,42	0,86

Resultados e Discussão

No quadro 1, observa-se que tanto o *Pinus* como o *Eucalyptus* influenciaram positivamente no teor de C % orgânico do solo em ambas as profundidades. As espécies contribuiram para que a camada superficial (0 - 10 cm) apresentasse quase o dobro do teor de matéria orgânica que a camada de 10-20 cm. Ambas as espécies florestais tiveram o mesmo efeito.

A presença do *Eucalyptus* enriqueceu o solo em K em ambas as profundidades. De maneira análoga, foi observada a influência das duas essências sobre o teor de Mg nas camadas do solo. As espécies contribuiram para que a camada superficial apresentasse uma concentração mais elevada deste elemento do que a camada subsequente (10 - 20 cm). As espécies folhosas contribuiram mais para elevação do teor de Mg que a conifera, dados estes, concordantes com os de KRAMER & KOSLOWSKY (1960).

O *Pinus* contribuiu para que houvesse um acúmulo de Al trocável na camada de 10 - 20 cm do solo. O *Eucalyptus* apesar de contribuir para uma maior concentração de Al disponível não apresentou nenhum efeito sobre a presença deste elemento quando em confronto com a conifera.

A contribuição das espécies florestais na formação da quantidade da manta orgânica se acha apresentada no quadro 2.

Observando-se os dados, pode-se perceber uma maior contribuição por unidade de área do *E. citriodora* quando comparado com o *P. taeda*. Esses dados são concordantes com os relatados por PACÍFICO HOMEM (1961).

NYE (1961), em condições de florestas equatorial, estimou que 9.000kg de matéria orgânica acre/ano é decomposta em solos de floresta em Chana. MILLER *et alii* (1976), observaram uma grande variação na formação da manta orgânica em solos da Escócia, cultivados com *Pinus nigra*.

No quadro 3, são apresentados os dados referentes às quantidades de nutrientes observados na manta orgânica sob cobertura de *P. taeda* e *E. citriodora*.

Observa-se que houve uma contribuição positiva de ambas as espécies na acumulação de nitrogênio, cálcio, ferro e manganês na manta orgânica, predominando todavia a contribuição da espécie folhosa.

LUNT (1935) e RAPP (1967), relatam que a média de liberação de nutrientes na manta orgânica quando predomina folhas é na seguinte ordem: K >Ca = N.

Quadro 4. Quantidade de nutrientes (mg) existente em 100 acículas de *P. taeda* e em 100 folhas de *E. citriodora*

Espécies	Quantidade (mg) de nutrientes em 100 acículas e 100 folhas										
	N	P	K	Ca	Mg	S	B	Cu	Fe	Mn	Zn
P. taeda											
acícula nova	26,16	2,03	10,07	6,53	3,21	2,81	0,08	0,01	0,22	1,00	0,07
acícula madura	40,03	2,63	12,00	18,75	7,13	4,50	0,11	0,01	0,56	2,62	0,09
acícula senescente	25,52	1,58	13,23	17,96	4,10	3,47	0,08	0,01	0,79	1,34	0,06
Total	91,71	6,24	35,30	43,24	14,40	10,78	0,27	0,03	1,57	4,96	0,22
E. citriodora											
Folha nova	282,08	14,76	250,02	75,44	37,72	19,68	0,60	0,17	1,27	6,79	0,44
Folha madura	476,50	32,20	396,06	238,28	51,52	38,64	1,66	0,23	5,36	23,43	1,06
Folha senestente	280,36	26,08	280,36	264,00	9,78	32,60	1,59	0,18	4,25	27,04	1,04
Total	1.038,94	73,04	926,44	577,72	99,02	90,92	3,85	0,58	10,88	57,26	2,54

No quadro 4, estão comparadas as quantidades de nutrientes em 100 acículas de *P. taeda* e 100 folhas de *E. citriodora*. Observa-se que de uma maneira geral que as folhas e as acículas maduras em ambas as espécies, para a maioria dos nutrientes, acumularam maiores quantidades, exceção feita apenas para o ferro no caso da conífera e do manganês no caso da essência folhosa, que apresentaram maiores quantidades desses nutrientes nas folhas senescentes, e nas acículas senescentes.

Conclusão

1. Tanto o *Eucalyptus* como o *Pinus* influenciaram positivamente o teor porcentual de carbono do solo nas duas profundidades amostradas.
2. O *Eucalyptus* contribui em maior proporção para enriquecer o solo em potássio e em magnésio.
3. O *Pinus* contribuiu para um acúmulo de alumínio trocável na camada de 10 - 20 cm do solo.
4. O *E. citriodora* contribuiu para a formação de uma maior quantidade de manta orgânica que o *Pinus taeda*.
5. Tanto a espécies folhosa como a conífera contribuiram quantitativamente para o enriquecimento em nutrientes na manta orgânica sob os dois povoamentos.
6. As folhas maduras de ambas as espécies acumularam maiores quantidades de nutrientes, exceção feita para o ferro na conífera e manganês na espécie folhosa que apresentaram acumulações nas folhas senescentes.

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PRODUTIVIDADE EM QUEBRA-VENTOS DE *Eucalyptus* NA PROVÍNCIA DO VALE, COLÔMBIA.

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Resumo

Com o aumento no interesse em plantações quebra-vento, torna-se necessário conhecer a estimativa de produtividade em termos de celulose destes plantios. Através da técnica de regressão múltipla, foram desenvolvidas tabelas de rendimento para volume, peso verde e peso seco, baseadas em inventário de mais de 9 km de plantações quebra-vento de eucaliptos. As tabelas desenvolvidas são válidas para as idades de 4 a 8 anos, espaçamentos de 2,5 a 5 metros, e faixas com uma, duas ou três linhas de árvores. O plantio de faixas quebra-vento, primariamente com Eucalyptus camaldulensis, parece muito promissor para fazendeiros e pecuaristas nas planícies da Província do Vale, próximo a Cali.

FENCEROW YIELDS FOR *Eucalyptus* IN THE DEPARTMENT OF VALLE.

Summary

With an increasing interest in fencerow plantations it is necessary to have an estimate of pulpwood yields in rows. Yield tables for volume, green weight and dry weight were developed by means of multiple regressions based on a eucalyptus inventory of more than nine kilometers of fencerows. The tables cover ages four to eight years, spacings of 2.5 to five meters and with one, two or three rows of trees. The planting of fence rows primarily with Eucalyptus camaldulensis appears very promising for farmers and cattlemen in the plain of the Department of Valle, near Cali.

INTRODUCTION

The normal parameters used with yield tables include: 1) stand age, 2) basal area or number of trees per hectare, and 3) site class (based on average height by age or on soil profile analysis). The yield table gives the potential volume per hectare by age, stand density and site quality.

In the case of fencerow plantations of eucalyptus there exists no guide for estimating yields. With increasing interest in promoting the planting of eucalyptus in fencerows in the Valley of the Department of Valle as a source of short-fiber pulp, it is necessary to have some estimate of yield from these plantings to show to the farm owners. The logical thing is to develop yield tables of cubic meters of wood per kilometer of fence. Additionally with the purchase of wood by weight it is important to know how many tons of wood per kilometer can be produced with eucalyptus in fencerows.

PROCEDURE

In a farm in the Department of Valle, eucalyptus were planted in fencerows from 1970 to 1973 along 9 km. of irrigation ditches. The trees were felled for pulpwood in early 1977 when the oldest plantings were seven years old. Before felling the trees, a complete inventory was made. The plots were measured as units of 100 meters in length and the following parameters were recorded for each plot:

DBH per tree in centimeters.
Total height per tree in meters.
Plantation age in years.
Number of rows in the plot.

In the office the following calculations were made for each 100 meters plot:

Average DBH in centimeters.
Average total height in meters
Average spacing between trees in meters
Number of trees per plot
Total volume inside bark in cubic meters.
Commercial volume inside bark (min.top of 10 cmts.)in cubic meters.
Total green weight inside bark in metric tons.
Commercial green weight inside bark in metric tons.
Total basal area in square meters.

The volume and weight formulae used in the calculations were developed for eucalyptus by Forest Research in Research Report No. 30 (Ladrach, 1978). Using the data per plot, average values were calculated for these parameters for the entire farm (Table I).

In order to develop forest yield formulas, multiple regressions were computed using three independent variables: 1) age, 2) number of rows of trees and 3) spacing between trees. The dependent variables tested were: Volume, green weight, dry weight, average height and average diameter.

RESULTS

The height and diameter regressions were significant with the plantation age but not with spacing or the number of rows of trees, and the correlations of these regressions were very high (r^2=89%). The regressions for volume and weight were significant with age, number of rows and spacing and had strong correlations as well (r^2 = 81%) (Table II).

The regression values were compared with the averages from the plots and a good fit was found for all except the plots with wide spacings which were four years old. Yield tables for eucalyptus in fencerows were calculated for ages four to eight years, for one to three rows of trees, and for spacings of 2.5 to five meters between trees (Table III). These were considered the actual limits of the regressions.

DISCUSSION

Tendencies of interrelationships of volume and weight vs. age can be noted in the tables. For the younger trees the green weight in tons is slightly greater than the volume in cubic meters, but in the older trees the volume is greater than the green weight. It can also be observed that the dry weight increases in relation to the green weight with age. To the contrary, the relationship of dry weight to volume stays nearly stable for all ages. These variations are based on three facts: 1) There exists a 20 percent variation in the data not accounted for in the regressions of age, number of rows and spacing, 2) the green weight varies with age in such a way that a cubic meter of wood four years old has more water than a cubic meter of wood from a tree eight years and 3) the dry weight or specific gravity of eucalyptus wood does not appear to vary with age, at least not the way pine specific gravity varies.

It is important to remember that the trees in the study were grown along the irrigation canals, which is an ideal site for eucalyptus growth. If the eucalyptus are planted on a site that does not have as much water available in the soil, it is logical to suppose that the growth will be less.

The spacing between rows in the farm was approximately five meters. For example, the trees were planted on each side of the canal where there were two rows. The spacing indicated in the yield tables refers to the spacing between trees within the row, assuming the five meter spacing between rows.

It must be recognized that the eucalyptus fencerow plantings do occupy space in a farm and the production of any crop under these or very close may be affected by the competition. Nonetheless, in many farms, there is normally an unutilized strip or trail beside the canals and the fences, and in this case the effect of the eucalyptus on the farm crops is nil.

TABLE I. SUMMARY OF EUCALYPTUS INVENTORY, CHAMBERY FARM *

Age, years	4			5			6		7
No. of rows	1	2	3	1	2	3	1	2	1
No. of plots	21	5	4	8	17	2	1	8	27
DBH, average, in centimeters	13.0	16.1	13.7	15.6	17.7	17.7	21.3	26.0	34.7
Average height, meters	10.5	12.4	10.9	13.6	16.7	14.2	12.3	19.6	25.3
Lineal spacing, average, meters	3.7	3.5	3.8	4.0	3.1	3.7	3.4	3.6	3.3
Basal area, M^2/100 meters	.51	1.37	1.38	.61	1.73	2.25	1.08	3.61	3.12
Total volume u.b., M^3/100 meters	2.97	8.06	7.70	3.60	11.07	13.25	4.96	27.04	27.13
Commercial Volume, u.b. M^3/100 meters	2.34	6.92	6.04	3.03	9.85	11.64	4.46	25.05	25,78
Total Green weight, u.b. Ton/100 meters	3.10	8.13	8.16	3.68	10.96	13.16	4.90	25.14	24.76
Commercial green weight, u.b. Ton/100 mts.	2.26	6.64	5.84	2.92	9.45	11.16	4.27	23.75	24.03
Total Dry weight, u.b. Ton/100 meters	1.51	4.25	3.90	1.88	5.92	7.06	2.65	15.09	15.32
Commercial dry weight, u.b. Ton/100 meters	.51	3.95	3.10	1.56	5.11	2.28	2.31	13.18	13.43

*/ All volumes and weights are calculated under bark (u.b).

Table II. Multiple Regression Formulas for Eucalyptus

Title	Formula	R^2	Co	Age, years C1	No. Rows C2	Spacing, mts. C3
Total height, ave. mts.	$Co+C_1$ Age	88.8	-8.290701	4.761516		
DBH, average, cmts.	$Co+C_1$ Age	89.2	-16.59690	7.187172		
Total volume, u.b., M^3/100 mts.	$Co+C_1$ Age$+C_2$Rows.$+C_3$Space	80.7	-29.49291	8.327248	3.419266	-1.647104
Comm. volume, u.b., M^3/100 mts.	$Co+C_1$ Age$+C_2$Rows.$+C_3$Space	81.3	-29.04268	8.069116	2.866255	-1.484449
Total green weight, u.b., Ton/100 mts	$Co+C_1$ Age$+C_2$Rows.$+C_3$Space	80.7	-25.84638	7.443449	3.504167	-1.601592
Comm. green weight, u.b. Ton/100 mts.	$Co+C_1$ Age$+C_2$Rows.$+C_3$Space	81.0	-27.02384	7.515435	2.854061	-1.420714
Total dry weight, u.b. Ton/100 mts.	$Co+C_1$ Age$+C_2$Rows.$+C_3$Space	80.7	-17.07795	4.764409	1.780041	-.8914154
Comm. dry weight, u.b. Ton/100 mts.	$Co+C_1$ Age$+C_2$Rows.$+C_3$Space	80.5	-16.03423	4.257804	1.842010	-.7191333

TABLE III EUCALYPTUS YIELDS IN FENCEROWS*

Age: 4 years; Ave. DBH: 12.2 cmts., Ave. Total Height: 10.8 mts.

No. of Rows Per Fence	1					2					3				
Spacing, Mts.	2.5	3.0	3.5	4.0	5.0	2.5	3.0	3.5	4.0	5.0	2.5	3.0	3.5	4.0	5.0
Total Volume, M^3/Km.	31	23	15	6	-	65	57	49	41	24	100	91	83	75	58
Commercial Vol., M^3/Km.	24	16	9	-	-	53	45	38	30	15	81	74	66	59	44
Tot. Green Wt., Ton/km.	34	26	18	10	-	69	61	53	45	29	104	96	88	80	64
Comm. Green Wt., Ton/Km.	23	16	9	2	-	52	45	38	31	16	80	73	66	59	45
Total Dry Wt., Ton/Km.	15	11	6	2	-	33	29	24	20	11	51	46	42	38	29
Comm. Dry Wt., Ton/Km.	10	7	3	-	-	29	25	22	18	11	47	44	40	36	29

Age: 5 years: Ave. DBH: 19.3 cmts.; Ave. Total Height: 15.5 Mts.

No. of Rows Per Fence	1					2					3				
Spacing, Mts.	2.5	3.0	3.5	4.0	5.0	2.5	3.0	3.5	4.0	5.0	2.5	3.0	3.5	4.0	5.0
Total Volume, M^3/Km.	114	106	98	90	73	149	140	132	124	107	183	175	166	158	142
Commercial Vol., M^3/Km.	105	97	90	82	67	133	126	118	111	96	162	154	147	140	125
Tot. Green Wt., Ton/Km.	109	101	93	85	69	144	136	128	120	104	179	171	163	155	139
Comm. Green Wt., Ton/Km.	99	91	84	77	63	127	120	113	106	92	156	149	141	134	120
Tot. Dry Wt., Ton./Km.	63	58	54	50	41	81	76	72	67	58	99	94	90	85	76
Comm. Dry Wt., Ton/km.	53	49	46	42	35	71	68	64	61	53	90	86	83	79	72

Age: 6 years: Ave. DBH: 26.5 cmts.; Ave. Total Height: 20.3 Mts.

No. of Rows Per Fence	1					2					3				
Spacing, Mts.	2.5	3.0	3.5	4.0	5.0	2.5	3.0	3.5	4.0	5.0	2.5	3.0	3.5	4.0	5.0
Total Volume, M^3/Km.	198	189	181	173	157	232	224	215	207	191	266	258	250	241	225
Commercial Vol., M^3/K.	185	178	170	163	148	214	207	199	192	177	243	235	228	220	205
Tot. Green Wt., Ton/ K.	183	175	167	159	143	218	210	202	194	178	253	245	237	229	213
Comm. Green Wt., Ton/Km.	174	167	160	152	138	202	195	188	181	167	231	224	217	209	195
Tot. Dry Wt., Ton./ Km.	111	106	102	97	88	128	124	119	115	106	146	142	137	133	124
Comm. Dry Wt., Ton/Km.	96	92	88	85	78	114	110	107	103	96	132	129	125	122	114

Age: 7 years; Ave. DBH: 33.7 cmts.; Ave. Total Height: 25.0 Mts.

No. of Rows Per Fence	1					2					3				
Spacing, Mts.	2.5	3.0	3.5	4.0	5.0	2.5	3.0	3.5	4.0	5.0	2.5	3.0	3.5	4.0	5.0
Total Volume, M^3/Km.	281	273	265	256	240	315	307	299	290	274	349	341	333	325	308
Commercial Vol., M^3/Km.	266	259	251	244	229	295	287	280	272	258	323	316	308	301	286
Tot. Green Wt., Ton./Km.	258	250	242	234	218	293	285	277	269	253	328	320	312	304	288
Comm. Green Wt., Ton./Km.	249	242	235	228	213	277	270	263	256	242	306	299	292	285	270
Total Dry Wt., Ton./Km.	158	154	149	145	136	176	172	167	163	154	194	189	185	180	172
Comm. Dry Wt., Ton./Km.	138	135	131	127	120	157	153	149	146	139	175	171	168	164	157

Age: 8 years; Ave. DBH. 40.9 cmts.; Ave. Total Height: 29.8 Mts.

No. of Rows Per Fence	1					2					3				
Spacing, Mts.	2.5	3.0	3.5	4.0	5.0	2.5	3.0	3.5	4.0	5.0	2.5	3.0	3.5	4.0	5.0
Total Volume, M^3/Km.	364	356	348	340	323	398	390	382	374	357	433	424	416	408	391
Commercial Vol., M^3/Km.	347	339	332	324	310	375	368	360	353	338	404	397	389	382	367
Tot. Green Wt., Ton./Km.	332	324	316	308	292	367	359	351	343	327	402	394	386	378	362
Comm. Green Wt., Ton./Km.	324	317	310	303	289	353	345	338	331	317	381	374	367	360	346
Total Dry Wt., Ton./Km.	206	201	197	103	184	224	219	215	210	201	241	237	233	228	219
Comm. Dry Wt., Ton./Km.	181	177	174	170	163	199	196	192	188	181	218	214	210	207	200

*/ All volumes and weights are calculated under bark (u.b.)

On cattle farms the eucalyptus in fencerows have not shown any tendency to reduce the growth of the pasture, but to the contrary have been valuable as shade for the cattle while they are producing an additional income for the farm.

LITERATURE CITED

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ESTIMATIVA DA REMOÇÃO DA BIOMASSA E DOS NUTRIENTES EM PLANTAÇÕES DE *Eucalyptus grandis* EM REGIME DE MINI-ROTAÇÃO.

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Resumo

Vinte e quatro árvores, incluindo todas as classes de diâmetro de um talhão de Eucalyptus grandis (com 2,5 anos - 5333 árvores/ha) foram selecionadas, cortadas e seus componentes (folhas, galhos e tronco) pesados. Amostras dos componentes foram secos em estufa para determinação da umidade e para estabelecer as relações entre as folhas, os galhos e o tronco. Foram, também estimados os nutrientes removidos pelos componentes do estande. Observou-se que 9% da biomassa é contida nas folhas, 7% nos galhos e 83% nos troncos. Todavia, 37% dos nutrientes são contidos nas folhas, 10% nos galhos e 53% nos troncos. Face à baixa fertilidade dos solos de cerrado, principalmente com relação ao P e K, seria oportuno evitar a remoção das folhas, galhos e cascas do "site".

BIOMASS AND NUTRIENT ESTIMATES REMOVAL IN SHORT ROTATION INTENSIVELY CULTURED PLANTATION OF *Eucalyptus grandis.*

Summary

Twenty four trees, including all diameters of an Eucalyptus grandis stand (2.5 years old - 5333 trees/ha) were weighted by component parts (leaves, limbs and stems). Samples were oven-dried to determine moisture content and to establish: leaves, limbs, crown, stem weight-relationships. Also macro and microelements of each tree component were analysed to estimate the nutrient contents removed by bolewood, harvest or complete trees utilization. Biomass distribution among the components of the stand is about 9% leaves, 7% limbs and 83% stems. However nutrients content in the stand biomass are about 37% in the leaves, 10% in the lims and 53% in the stems. Because "cerrado" soil (Savanna) is very low in available form of nutrients, mainly P and K, it is suggested to avoid the remotion of leaves, limbs and bark from the site.

Introduction.

Escalating costs of oil and energy shortage have forced wood users to consider maximizing total tree use. In fact, crown biomass and tree bark may become sources of energy. Therefore, intensive management of forest plantations will increase significantly biomass production.

In this area several papers have been published in Europe and North America (HANSEN & BAKER, 1979), however only a few studies were conducted in Brazil. Preliminar data have been published by POGGIANI, COUTO & SIMÕES (1979) regarding biomass production . nutrient accumulation in forest stand of Eucalyptus grandis planted in the State of São Paulo.

According to HANSEN & BAKER (1979), intensive management of plantations may significantly increase biomass production (3 to 5 times), however it increases also nutrient removal from the site and a strong fertilization must become an integral part of such management.

POGGIANI (1980) reports some data regarding Eucalyptus and Pinus plantations in the states of São Paulo and Minas Gerais and believes to be primordial to evaluate silvicultural and ecological consequences of intensively cultured plantations and short rotations in tropical areas. "Cerrado" soils (Brazilian Savannas) have in general low fertility, mainly in P and K and high concentrations of iron, manganese and aluminium.

This papers discusses the distribution of biomass and nutrients in a stand of Eucalyptus grandis (2.5 years old). Equations predicting the dry biomass of the total tree and its components are presented.
Nutrient removal by conventional bolewood harvest and complete tree utilization are also discussed.

Material and Methods.

Site and stand description.

Seedlings of Eucalyptus grandis (Hill ex-Maiden) were produced from seeds provenient from Coff's Harbour (Australia) and planted in November 1976. The area of this experiment, located in Bom Despacho (Minas Gerais) presents the tipical climate of Brazilian savannas: annual mean temperature around 19.5ºC with occasional frost in the winter; annual rainfall about 1400 mm, with 80% of the total rain-fall concentrated on the hot-wet season (October-March).

Each seedling planted in the initial spacing of 1.0 by 1.5 m was fertilized with 150 g of N-P-K (10:28:6) and B and Zn.

The planting area was previously occupied by a kind of savanna vegetation (Cerrado) and the soil is a clay latosol very deep and with a low content of avaliable nutrients such as: phosphorus 33 Kg/ha, potassium 99 Kg/ha, calcium 312 Kg/ha and magnesium 220 Kg/ha (0-120 cm depth).

The survival rate was around 80% at the end of the experiment.

Field and laboratory methods.

A random sample of 150 trees was selected from the 2.5 years old plantation of Eucalyptus grandis. D.B.H. and the total height data of each tree were determined and the sample was divided in nine diameter classes. Two to four trees from each D.B.H. class from 2.0 to 11.0 cm (total 24 trees) were selected, felled and limbed. Each component of the tree (leaves, limbs and stem) was separated and weighted in the field.

Three samples (about 150 g) of leaves and small sections of the limbs collected from the median part of the crown and a disk collected from the median part of the stem were weighted and sealed in polyethylene bags for laboratory analysis. All the samples were oven-dried at 80ºC until constant weight. After this moisture content of the different components were determined and the dry weight of each tree calculated. Weighted values for moisture content in the samples were used to convert component green weight to oven-dry weight.

Chemical analyses.

After oven-drying, leaves, limbs and stem samples (sections of the disks including wood and bark taken at half of the tree total height) were ground in a Wiley mill and passed throgh a 20 mesh screen. The chemical analyses were performed according to SARRUGE & HAAG (1974). Nitrogen by the micro-Kjeldahl method, phosphorus by the vanadomolybdate method and all other nutrients were determined from the acid solution by atomic absorption spectrophotometry.

Analytical Procedure.

In order to estimate biomass content of the E. grandis stand, regression models were determined and the parameters were estimated using the S.A.S. (Statistical Analysis System) computer package.

For choosing the best model, to estimate dry biomass components of the tree, a step-wise procedure was performed using as independent variables D.B.H. and total height, and their transformed values.

Results and Discussion.

Biomass production.

Leaves, limbs and stems biomass as dependent variables of the D.B.H. are shown in Figure 1. Also tree total height as dependent variable of diameter is shown in Figure 2.

Equations of the figure 1 show: that D.B.H. has good correlation with stem and leaves biomass, but only regular correlation with limbs. However, the best equations found by step-wise procedure include also tree height as an independent variable usefull to improve the correlation. The following models proved to give the best fit.

TABLE-1. BIOMASS DISTRIBUTION (Kg/ha) OF A *Eucalyptus grandis* STAND FOR DIFFERENT DIAMETER CLASSES.
TABELA-1. DISTRIBUIÇÃO DA BIOMASSA (Kg/ha) NO TALHÃO DE *Eucalyptus grandis* NAS DIFERENTES CLASSES DE DIÂMETRO.

CLASSES D.B.H. D.A.P. (cm)	TREES /ha Árvores	LEAVES Kg/ha Folhas	LIMBS Kg/ha Galhos	CROWNS Kg/ha Copa	STEMS Kg/ha Tronco	TOTAL TREES Kg/ha Árvore total
1) 2.1-3.0	267	20.3	106.8	127.8	180.2	307.3
2) 3.1-4.0	213	36.4	76.4	112.8	339.0	451.8
3) 4.1-5.0	480	209.3	208.3	417.6	1,722.7	2,140.3
4) 5.1-6.0	747	564.0	404.1	968.1	5,354.5	6,322.6
5) 6.1-7.0	1,013	1,167.0	772.9	1,939.9	11,108.5	13,048.4
6) 7.1-8.0	1,013	1,661.3	1,170.0	2,831.3	15,833.2	18,664.5
7) 8.1-9.0	907	1,892.0	1,454.0	3,346.0	18,038.4	21,384.4
8) 9.1-10.0	480	1,350.2	1,039.2	2,389.4	[illegible]	15,275.0
9) 10.1-11.0	213	717.4	553.4	1,270.8	6,849.2	8,120.0
TOTAL	5,333	7,617.9	5,785.1	13,403.0	72,311.3	85,714.3
%	(100%)	(8.9%)	(6.7%)	(15.6%)	(84.4%)	(100.0%)

a) Leaves dry biomass (Biomassa seca das folhas)

$Y = -0.0277 + 0.0020\ D^2 \cdot H \qquad R^2 = 0.94^{**}$

b) Limbs dry biomass (Biomassa seca dos galhos)

$Y = 0.9448 - 0.1049\ H + 0.0330\ D^2 \qquad R^2 = 0.80^{**}$

D=D.B.H.
H=Height

c) Stem dry biomass (Biomassa seca do tronco)

$Y = -0.3145 + 0.0197\ D^2 \cdot H \qquad R^2 = 0.99^{**}$

Table 1 shows the dry biomass data for all classes of diameter and the total biomass produced by the stand of *E. grandis*.

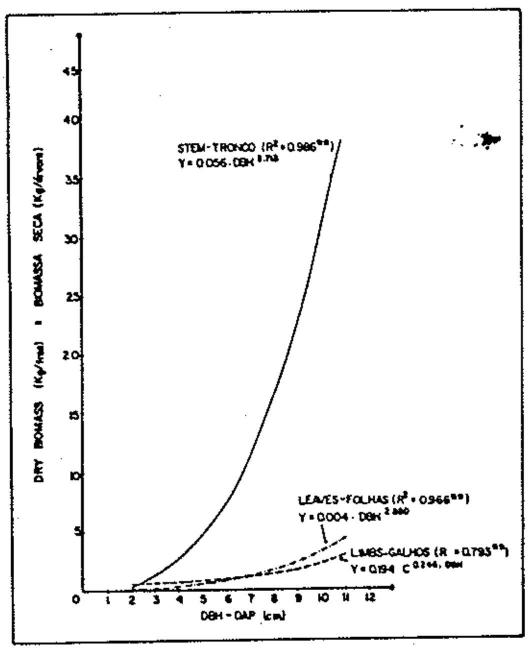

Figure 1.

Changes in dry biomass of *Eucalyptus grandis* components by tree diameters (D.B.H.)

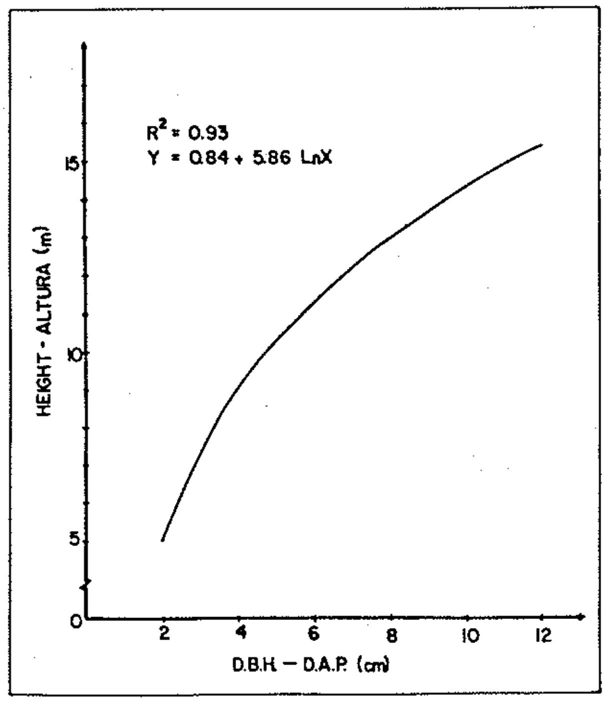

Figure-2.

Tree total height as dependent variable of diameter (D.B.H.)

If the complete tree utilization is considered, the total biomass amounts 85,7 tons per hectare. Conventional bolewood harvest of the stand would provide 72.3 tons of wood biomass (About 29 tons/ha per year).

These data compared with several data presented by HANSEN & BAKER (1979) including biomass production per year of some fast growing trees species in temperate zones show clearly the strong potential of *Eucalyptus* for wood production in the tropics.

Spacing has also a strong influence in biomass produced by short rotations. Very closed spacings, according to BELANGER & PEPPER (1978) increased biomass production in sycamore plantations, however the rate of survival became lower in very closed spacings ($0.4\ m^2$).

Presently several experiments with closed spacings and short rotations are conducted by the Department of Silviculture of São Paulo University (Piracicaba). Preliminar data show the spacing 1.0 by 1.0 as the best for *Eucalyptus saligna* and *Eucalyptus alba* plantations, one year old, with a survival rate of 94%.

Anyway, short rotation increase strongly the biomass production. Comparing the biomass produced in this experiment with an 8 years old stand of *E. grandis* planted in the conventional spacing-3.0 by 2.0 m -(BELLOTE, 1979 and POGGIANI, 1980) it is possible to conclude that short rotations have twice the potential for wood production than usual rotations for *Eucalyptus* trees in Brazil.

In short rotations biomass distribution is also different comparing with conventional plantations. According to BELLOTE(1979) an *Eucalyptus grandis* stand- 2 years old and 3.0 by 2.0 m spacing-presented the following proportion for biomass distribution in the different components of the trees: 68.3% in the stem, 12.2% in the leaves and 19.5% in the limbs. The present experiment found for *E. grandis*(2.5 years old plantation) 83.2% of the biomass in the stem, 8.9% in the leaves and 7.9% in the limbs. It indicates more closed spacings in short rotations increase stem biomass. However more experiment must be carry out in this sense.

In the table 2 are shown the dry biomass data per tree, for each class of diameter. Crown weight of the lower class is 41.3% of the total tree weight, although in the higher class crown weight is only 15.6% of the tree. This remark will be discussed in the item 3.4

TABLE -2. BIOMASS DISTRIBUTION ON THE AVERAGE TREE FOR DIFFERENT DIAMETER CLASSES.

TABELA-2. DISTRIBUIÇÃO DA BIOMASSA NA ÁRVORE MÉDIA DAS DIFERENTES CLASSES DE DIÂMETRO.

CLASSES Classes	D.B.H. D.A.P. cm	LEAVES Folhas Kg	LIMBS Galhos Kg	CROWN Copa Kg	STEM Tronco Kg	TOTAL TREE Árvore total Kg
1	2.1-3.0	0.076 (6.6%)	0.400 (34.7%)	0.476 (41.3%)	0.675 (58.7%)	1.151 (100.0%)
2	3.1-4.0	0.171 (8.0%)	0.357 (16.8%)	0.528 (24.8%)	1.594 (75.2%)	2.122 (100.0%)
3	4.1-5.0	0.436 (9.8%)	0.434 (9.7%)	0.870 (19.5%)	3.589 (80.5%)	4.459 (100.0%)
4	5.1-6.0	0.755 (8.9%)	0.541 (6.4%)	1.296 (15.3%)	7.168 (84.7%)	8.464 (100.0%)
5	6.1-7.0	1.152 (8.9%)	0.763 (5.9%)	1.915 (14.8%)	10.966 (85.2%)	12.881 (100.0%)
6	7.1-8.0	1.640 (8.9%)	1.155 (6.3%)	2.795 (15.2%)	15.630 (84.8%)	18.425 (100.0%)
7	8.1-9.0	2.085 (8.8%)	1.604 (6.8%)	3.689 (15.6%)	19.888 (84.4%)	23.577 (100.0%)
8	9.1-10.0	2.813 (8.8%)	2.165 (6.8%)	4.978 (15.6%)	26.845 (84.4%)	31.823 (100.0%)
9	10.1-11.0	3.368 (8.8%)	2.598 (6.8%)	5.966 (15.6%)	32.156 (84.4%)	38.122 (100.0%)

Nutrient concentration in the tree components.

Means and standard errors of nutrient concentration are included in table-3. For all the components nutrient concentrations in the biomass are as follows: N>K>Ca>Mg≥P>Mn>Fe>Zn>Cu.

Nutrients concentration is for all the elements higher in the leaves than in the stem: 12 times for nitrogen, 4.5 times for phosphorus, 2.8 times for potassium, 6.5 times for calcium and 9.5 times for magnesium.

In general, nutrient concentrations found in this experiment are similar to the concentrations presented by HAAG et alii(1976) and BELLOTE(1979) for *E. grandis* plantations in "Cerrado" soil, however they are lower than concentrations presented by LUBRANO(1967) for *Eucalyptus viminalis* planted in Italy.

TABELA-3.
MÉDIA E ÊRRO PADRÃO DA CONCENTRAÇÃO DE NUTRIENTES NOS COMPONENTES DAS ÁRVORES DE *Eucalyptus grandis*(2,5 ANOS)

TABLE-3.
MEAN AND STANDARD ERROR OF NUTRIENT CONCENTRATIONS IN THE TREES COMPONENTS OF *Eucalyptus grandis*.(2.5 YEARS OLD)

COMPONENTS Componentes	N	P	K	Ca	Mg	Fe	Cu	Mn	Zn
	%					ppm			
LEAVES Folhas S.Er.	1.850 ± 0.020	0.110 ± 0.012	0.650 ± 0.050	0.590 ± 0.060	0.200 ± 0.014	296.0 ± 33.0	4.0 ± 0.2	953.0 ± 102,0	12.5 ± 0.6
LIMBS Galhos S.Er.	0.460 ± 0.017	0.040 ± 0.003	0.370 ± 0.030	0.260 ± 0.023	0.040 ± 0.007	93.0 ± 10.1	3.6 ± 0.1	396.0 ± 26.3	5.7 ± 0.4
STEMS Troncos S.Er.	0.150 ± 0.009	0.024 ± 0.003	0.230 ± 0.007	0.090 ± 0.006	0.021 ± 0.002	38.6 ± 2.4	1.5 ± 0.1	185.0 ± 13.8	5.3 ± 0.3

Certainly N-P-K fertilization in the planting (150 g -10:28:6) makes available a regular supply of N and K, but P is strongly fixed by aluminium in the soil(pH 4.6), that is also very poor in calcium. Also high levels of Mn and Fe were observed in the leaves due to soil acidity, however no symptoms of toxicity were evident in the trees.

Nutrient content in the biomass of the stand.

Recently in Brazil some foresters believe to be suitable whole tree utilization, mainly for energy supplies. In this sense several researches are conducted in Brazil and in other countries. A critical evaluation about this problem was published by SWITZER, NELSON & HINESLEY(1978) but only for temperate zone. It is necessary to point out the problem is more complicated in the fragile ecosystems of the tropics, because the ecological and economical implications.

Table 4 presents the data on biomass and nutrients distribution in the stand.

TABLE-4. BIOMASS AND NUTRIENTS CONTENT(Kg/ha) IN AN *Eucalyptus grandis* STAND, 2.5 YEARS OLD(5,333 TREES/ha).

TABELA-4. BIOMASSA E NUTRIENTES CONTIDOS(Kg/ha) NUM TALHÃO DE *Eucalyptus grandis* AOS 2,5 ANOS DE IDADE.(5.333 ARVORES/ha)

COMPONENTS Componentes	BIOMASS Biomassa	N	P	K	Ca	Mg	Fe	Cu	Mn	Zn	TOTAL NUTR.
TOTAL TREE Arvore tot.	85,714.3	275.9	28.0	237.2	125.0	32.7	5.5	0.16	22.8	0.52	727.7
LEAVES Folhas	7,617.9	140.9	8.4	49.5	44.9	15.2	2.2	0.03	7.2	0.09	268.4
LIMBS Galhos	5,785.1	26.6	2.3	21.4	15.0	2.3	0.5	0.02	2.3	0.03	70.4
CROWN Copa	13,403.0	167.5	10.7	70.9	59.9	17.5	2.7	0.05	9.5	0.12	338.8
STEM Tronco	72,311.3	108.4	17.3	166.3	65.1	15.2	2.8	0.11	13.3	0.40	388.9

TAPLE-5. AVERAGE OF BIOMASS(Kg)AND NUTRIENTS CONTENT(g) PER TREE OF *Eucalyptus grandis*, 2.5 YEARS OLD.

TABELA-5. MÉDIA DA BIOMASSA(Kg) E DO CONTEUDO DE NUTRIENTES(g) POR ÁRVORE DE *Eucalyptus grandis* aos 2,5 anos de idade.

COMPONENTS Componentes	BIOMASS Biomassa	N	P	K	Ca	Mg	Fe	Cu	Mn	Zn	TOTAL NUTRIENTS Total nutrientes
		g/tree									
TOTAL TREE Árvore tot.	16.071 (100%)	51.7	5.2	44.5	23.4	6.0	1.0	0.038	4.3	0.054	136.2 (100%)
LEAVES Folhas	1.428 (8.9%)	26.4	1.6	9.3	8.4	2.8	0.4	0.005	1.4	0.018	50.3 (36.9%)
LIMBS Calhos	1.084 (6.7%)	5.0	0.4	4.0	2.8	0.4	0.1	0.004	0.4	0.006	13.1 (9.6%)
CROWN Copa	2.512 (15.6%)	31.4	2.0	13.3	11.2	3.2	0.5	0.009	1.8	0.024	63.4 (46.5%)
STEM Tronco	13.559 (84.4%)	20.3	3.2	31.2	12.2	2.8	0.5	0.020	2.5	0.070	72.8 (53.5%)

Leaves and limbs constitute 15.6% of the total biomass,but contain 46.6% of the nutrients(338.8 Kg/ha).Stems content is 388.9 Kg/ha.Nitrogen is the nutrient highly accumulated in the crown and potassium in the stem.

According to POGGIANI(1980) total biomass production of a stand of *E.grandis* in short rotation intensively cultured plantation might reach, in an eight years period, twice the production of a conventional rotation stand(3.0 by 2.0 m spacing).However the short rotation removes three times more nutrients than conventional plantations.

With the purpose to reduce the strong nutrient remotion by short rotations other alternatives of management and exploitation must be developed.Moreover new species provenances and clones with a higher "utilization efficiency" for closed spacings and short rotations must be introduced in silviculture practices.

According to HANSEN & BAKER(1979) we use "utilization efficiency" to express the weight of biomass produced per unit weight of nutrients.

Fertilization versus nutrients removed by trees harvest.

As was shown before,the "Cerrado" soil where this experience was laid down is poor in available nutrients(P-33 Kg/ha,K-99Kg/ha,Ca-312 Kg/ha and Mg- 220 Kg/ha.).Comparing nutrient content of above ground biomass of *Eucalyptus* stand,as shown in Table 5,with soil nutrients(0-120 cm depth),it can be seen that this soil does not support for a long time a forest plantation intensively exploited.

In fact,nutrient content in the soil is almost equivalent to nutrient content in the biomass of the *Eucalyptus* stand.Mainly for potassium,phosphorus and calcium,will be necessary to pay a supplementary attention.In such case is necessary to supply the nutrients removed by harvesting with a suitable fertilization to maintain the stand productivity.

In this experiment each tree received as fertilizer 150g of N-P-K(10:28:6) corresponding to 15 g of nitrogen,18.3 g of phosphorus and 7.5 g of potassium.

Probably nitrogen is also fixed from the air by symbiotic and asymbiotic process,however a large rate of P is fixed by aluminum in the soil and potassium is accumulated in the plant tissues.Low content of potassium in the soil can become very critical for the next rotations. Calcium is also a scarce element in the soil and must be supplied by fertilization.This calcium scarcity is evident if we compare its concentration in the trees tissues with some data reported by LUBRANO(1967) for *Eucalyptus viminalis* in Italy.Probably soil liming before planting may result in more available nutrients for root systems and better economy in fertilizers.

Final considerations.

Some considerations are also essential to preserve nutrients in the site.Leaves and crown exploitation seem to be not convenient under an ecological and silvicultural point of view,mainly for dominated trees that present a large proportion of crown biomass with high rate of nutrients.

Therefore,to mitigate the loss of soil fertility in tropical zones,would be suggested to avoid crown exploitation mainly in short rotation regime.

Another suggestion would be to encourage research for species and clones selection with high"utilization efficiency" in order to improve biomass production with a lower nutrient remotion from the site.According to BAKER & COOPER(1978) and BOWERSOX & WARD(1976) considerable variation in nutrient concentration has been noted in eastern cottonwood and in young hybrid poplars growing in closed spacing.

Fertilization studies are also primordial to develop more appropriated know-how for tropical soils of the Brazilian savannas.

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VARIAÇÃO GENÉTICA NA PRODUÇÃO DE BIOMASSA EM *Eucalyptus grandis.*

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Resumo

As pesquisas no sentido da utilização do *E. gran dis* em plantações para produção de biomassa são sumarizadas. As melhores famílias existentes em um programa convencional de melhoramento foram utilizadas. A produção e a plantação das mudas foram bem sucedidas, o crescimento no primeiro ano foi considerado bom. A variação genética na produção para biomassa,aos seis meses de idade, não ficou evidenciada nos três espaçamentos "amplos". Em espaçamentos mais fechados os efeitos da competição apareceram aos seis meses e determinadas tendência continuaram a se manifestar aos nove meses. Observações posteriores estão previstas.

GENETIC VARIATION FOR BIOMASS PRODUCTION IN *Eucalyptus grandis.*

Summary

Research activities relating to utilization of Eucalyptus grandis for biomass plantations are summarized. The best families available from a conventional breeding program were utilized. Propagation and establishment of the seedlings were successful, and growth for the first year has been good. Genetic variation in biomass production was not evident through 6 months, nor was spacing at three "wide" spacings. At denser spacings, competition effects were present at six months, and certain trends continued at nine months. Further observations are planned.

INTRODUCTION

Eucalyptus grandis (Hill) Maiden is known worldwide for its rapid growth capability (Eldridge, 1978). Considerable variation has been observed in the species, and breeding programs have been successful in increasing growth rate (van Wyk, 1977; Campinhos and Ikemori, 1977). In Florida, a 68% gain in individual tree volume has been obtained in four generations of selection (E. C. Franklin, 1979 Eucalyptus Working Group, Bainbridge, GA).

Gains achieved in these programs have been applicable to pulpwood and sawtimber production systems. An alternative product in Florida, due to the rapid growth rate and acceptable coppicing ability of E. grandis, and the relatively long distance of the suitable growing sites from pulpwood and sawtimber markets, is fuelwood. One potential means of producing fuelwood is "biomass farms," high planting density, intensive culture, short rotation silvicultural operations.

Research activities dealing with variation in biomass production in E. grandis, and preliminary results, are presented here.

METHODS

Plant materials were supplied by George Meskimen of the U.S. Forest Service at Lehigh Acres, Florida. Thirty-three of the best trees based on progeny, sibling, and individual performance for six traits, were selected. Seed from these trees were sown in the greenhouse in containers in April, 1979. Seedlings were outplanted in July near LaBelle, Florida.

The seedlings were installed in three studies. A planting to assess genetic variation for biomass production per se was composed of 20 families established in 3 replications using 5 by 5 block plots at a 1 m x 1 m spacing. In addition, a bulk lot of a mixture of improved trees was included. The site was rotovated and then bedded using a vegetable bedder, and ground rock phosphate was applied. Height and survival data were taken in January, 1980.

Trees of the same 20 families, as available, were used to establish a spacing study examining 3 spacings - 1 m x .5 m, 1 m x 1 m, and 1 m x 1.5 m. Four replications of 10 by 10 block plots were installed. The site was prepared and treated as above. Height and survival measurements were made in January, 1980.

Nelder's design (Namkoong, 1965) was utilized to evaluate all 33 families at five spacings ranging from .25 m² to 2.25 m² per tree. Eight replications were used. The site was rotovated and fertilized but was not bedded. Height and survival were measured in January and in March, 1980.

RESULTS AND DISCUSSION

The orchard open-pollinated families included in our plantings were derived from 12 third-generation selections, 19 second-generation selections, and two first-generation selections out of a total of 381 trees that were evaluated. These 33 families, chosen with particular emphasis on coppicing, volume, and specific gravity were generally well-ranked in comparison to the balance of the breeding population (Table 1). Progeny volume averaged 5.96 cu. m/ha, and most of the families utilized were above 6.8 cu. m. Almost all of the selected families were above the average stem wood specific gravity of .409.

Growth in the genetic variation study was generally good through the first six months (Table 2). Survival has been very adequate, despite a long period of dry weather following planting; only one family averaged less than 80% survival. Observations at nine months indicate that considerable growth has occurred since the January measurement and that survival is still high.

No effects of spacing were evident in the 6-month data from the spacing trial (Table 3). All three spacings are considerably denser than what has been studied in Florida (Meskimen and Franklin,1978). Their results indicated that a 1.2 m x 2.4 m spacing produced more total volume than wider spacings, but this increase was not in proportion to the decrease in spacing. The impact of the high densities employed in our studies, and at this point postulated to be necessary for maximum biomass production in a short time period, remains to be determined.

An indication about the ability of E. grandis to tolerate extreme competition was evident in the genotype x spacing trial using Nelder's design (Table 4). A definite trend was established soon after competition was established, with a wave of maximum height starting at the middle of the circles and moving to the outside with time. At 6 months, the trees at the

Table 1. Overall and individual trait rankings for Eucalyptus grandis selections.

Selection	Mean[1/] Rank	Prog. Copp.	Prog. Vol.	Sib. S.G.	Sib. C.S.	Ind. C.S.	Prog. Form
88	74	54	100	48	76	--	96
90	67	54	93	53	54	--	82
847	76	80	98	79	83	15	100
849	53	82	72	53	54	15	40
867	62	96	92	87	13	1	82
869	60	97	75	81	23	15	72
888	49	41	68	63	23	15	82
898	59	62	84	69	32	15	92
910	61	41	82	83	54	15	92
965	63	71	92	56	54	15	92
987	60	59	97	88	7	15	96
988	56	41	87	88	7	15	96
993	62	90	70	66	46	15	82
997	70	92	94	48	76	15	92
998	65	62	96	48	76	15	92
1000	71	45	90	48	76	97	72
1001	76	41	98	48	76	97	97
1002	78	97	97	53	54	97	72
1003	64	88	94	53	54	15	82
1010	58	82	93	44	62	15	52
1011	64	82	84	44	62	15	99
1012	66	80	99	44	62	15	97
1035	45	90	56	56	32	15	22
1038	57	97	53	56	32	15	92
1146	56	65	47	98	69	15	40
1176	66	45	90	94	83	1	62
1499	66	49	97	83	69	15	82
1501	44	59	51	86	32	15	22
1510	70	66	77	53	46	97	82
1516	50	62	70	87	32	15	32
1517	55	75	70	87	32	1	62
1529	56	57	53	78	76	1	72
1535	63	41	81	87	69	15	82

[1/] Average ranking of selection based on individual trait percentiles for: progeny coppicing 3 months after felling at 1.1 year, progeny volume at 1.5 year, sibling wood specific gravity at 2.9 years, sibling cold soore, individual cold score (3, 4, or 5 on a 0 to 5 scale), and progeny form score at 1.5 year. All evaluations were conducted by the U.S. Forest Service, Lehigh Acres, Florida.

inside were taller, and the outside trees were perhaps twice as large in diameter at the ground line. At 9 months, the taller trees were located at the second and third planting positions, and the outside trees were usually 2.5 times larger in diameter. Observations at 11 months indicate that the peak of the wave has moved more to the outside. No appreciable mortality has yet occurred, but the obvious conclusion is that growing spaces of less than .40 m^2 are inappropriate for a one-year period. Also evident was the ability of these trees to grow well at close spacings without bedding.

Genotype differences in tolerance to competition were evident. Close spacings tended to force all families into height growth, but some families were tall even at wide spacings while most were bushy at the wider spacings. A goal from examining the 33 families in the Nelder's plots is the selection of genotypes that can tolerate the high planting densities perhaps necessary in biomass farms.

Table 2. Six-month height and survival of Eucalyptus grandis families.

Family	Height (m)	Survival (%)
90	1.5	93
847	1.6	88
849	1.6	95
867	1.6	93
869	1.8	93
888	1.7	99
898	1.9	97
965	1.5	73
988	1.6	92
993	1.8	84
997	1.8	97
1002	1.6	95
1003	1.6	97
1011	1.5	95
1012	1.6	95
1035	1.5	91
1146	1.8	83
1510	1.5	95
1516	1.6	84
1517	1.5	95
Nursery Check	1.4	89
Mean	1.6	90

Table 3. Six-month height and survival in the Eucalyptus grandis spacing trial.

Spacing	Height (m)	Survival (%)
1 m x .5 m	1.4	91
1 m x 1 m	1.4	96
1 m x 1.5 m	1.4	90
Mean	1.4	92

Conclusions concerning genetic variation, spacing, and their interactions will not be definite for another three or four years. Periodic observations will be made to establish growth trends. Coppicing response following harvest will also be examined.

Table 4. Design of the Eucalyptus grandis genotype x spacing trial, including spacing equivalents.

Distance from Center (m)	Space (m^2)
1.72	Border
2.27	.25
2.99	.40
3.93	.68
5.17	1.19
6.81	2.25
8.96	Border

CONCLUSION

Eucalyptus grandis has considerable potential for many sites in south Florida. Families selected under conventional criteria may be suitable for a biomass farm system. Observations through one year suggest that acceptable growth rates can be achieved. Continuing measurement will identify the relevance of high density systems to maximum biomass production.

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FLORESTAS ENERGÉTICAS - RESULTADOS

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Resumo

No presente trabalho discute-se em termos da produtividade de florestas plantadas em espaçamento de 1,0 x 1,5 m, e manejadas para serem cortadas à idade de 3 anos.

Considerou-se a produção columétrica de madeira para queima, a produção de matéria seca, aspectos relacionados com a ciclagem de nutrientes, as curvas de secagem da madeira e a qualidade do carvão.

Tais aspectos são de fundamental importância na adoção de técnicas de curtas rotações para as florestas.

Summary

The productivity of forests planted with 1.0 x 1.5 meter spacing and managed to undergo a shallow cut at three years is outlined in this work.

We have considered the volumetric production of fire wood, dry matter, aspects of nutrient cycling, drying curves of the wood and quality of the resulting charcoal.

These aspects have a fundamental importance on the adoption of the technique of short cycles for forests.

1 - Introdução.

Além das atuais fontes de consumo da madeira, tanto para a produção de energia ou como matéria prima, devido a crise do petróleo, surgiu a necessidade de buscar outras fontes de energia, baseadas em recursos renováveis.

Nesta nova caracterização a madeira surgiu como solução a curto prazo, para as condições brasileiras.

Alguns trabalhos com o objetivo de verificar apenas a influência do espaçamento sobre o manejo e a produção de florestas fo ram conduzidos por GUIMARÃES (1960); COELHO et alii (1970); FISHWICK (1976) e PINHEIRO (1961).

BRITO e BARRICHELO (1977) trabalhando com Eucalyptus alba, analisaram a influência do espaçamento sobre as qualidades da madeira. Os autores concluiram que apesar da densidade básica e o teor de lignina não variarem significativamente, em função do espaçamento, existe uma ligeira tendência de aumentos nos menores espaçamento.

JUVILLAR (1978) estudando Eucalyptus grandis de várias idades encontrou a densidade a granel variando entre 174 e 210 kg / estéreo de madeira seca quando as idades variaram entre 4 e 8 anos respectivamente.

BRITO e BARRICHELO (1978) estudaram o mesmo material considerado por JUVILLAR, sob os aspectos químicos e físicos da madeira. Os autores concluiram que tais características não variam em função da idade.

MELLO (1979), cita que com as técnicas florestais já desenvolvidas, e nas condições ecológicas brasileiras, índices volumétricos, ao redor, de 100 st/ha/ano, são atingidos. Tal produtividade permitirá aumentar a participação da madeira como fonte de energia, sem prejudicar os outros setores da indústria florestal.

BALLONI (1979), estudando a hipótese de aproveitamento total da árvore, considerou que os conhecimentos sobre o assunto ainda carecem de melhores estudos, principalmente no aspecto de ciclagem de nutrientes.

SWITZER e NELSON (1976) citados por BALLONI (1979) afirmam que o corte raso da floresta durante o período de desenvolvimento não permitem que se estabeleça um ciclo de nutrientes equilibrado e eficiente.

BRITO et alii (1979), avaliaram as possibilidades de utilização de resíduos de exploração florestal de E.saligna, para fins energéticos. Os autores avaliaram que em termos percentuais, aquela espécie aos 8 anos de idade, possuia 5,2 % do peso representado pela casca e, 11,9 % do peso representado pela copa e madeira fina.

SUITER FILHO et alii (1980) estudando produções de floresta de ciclo curto, plantada em espaçamento 1,0 x 1,5 m, concluiu que algumas procedências de E.grandis plantadas neste espaçamento chegam a fornecer um incremento médio anual 100% maior do que aquele obtido em plantios normais, feitos no espaçamento 3,0 x 2,0 m.

2 - Material e Método.

A área estudada, corresponde ao plantio de três procedências de Eucalyptus grandis, plantadas no espaçamento 1,0 x 1,5 m.

As procedências consideradas são:

Procedência 1 - Área de produção da Champion Papel e Celulose.

Procedência 2 - Área de produção da Cia. Agrícola e Florestal Santa Bárbara. (Material originário de Coff's Harbour).

Procedência 3 - Semente de Coff's Harbour, Queenslande, Austrália.

As mudas foram produzidas por semeadura direta, em sacos plásticos e receberam 1,0 g de NPK (4-16-4) antes do semeio, em mistura com a terra.

O plantio foi realizado em novembro de 1976, em Bom Despacho, M.G. em área de Latossolo Vermelho-Amarelo, coberta primariamente por cerrados.

A área foi desmatada, arada e gradeada mecanicamente, e o plantio foi manual, sendo que cada muda recebeu 150 g de NPK + Micronutrientes (10-28-6 + boro e zinco).

As áreas plantadas por procedência foram as seguintes:

Área 1 - E.grandis - Champion - 9.082 m2
Área 2 - E.grandis - CAF - 8.969 m2.
Área 3 - E.grandis - Coff's Harbour - 5.563 m2.
Área total -23.614 m2.

Em cada área foram instaladas 3 parcelas de 288 m2 (12 x 24m), nas quais foram efetuadas medições semestrais, a partir do 19º mês de idade.

3 - Resultados e Discussão.

Nos quadros que se seguem estão contidos os resultados da medição realizada aos 39 meses de idades, alguns dados sobre a ciclagem de nutrientes, as percentagem de umidade da lenha em função do tempo de secagem e os dados relativos à carbonização.

Quadro I - Rendimento em volume e em massa, aos 39 meses de idade, por procedência.

Procedências	Volume* (m3/ha)	Massa** (TMS/HA)	Incremento Média Anual m3/ha/ano	TMS/ha/ano
Champion	188,431	84,794	57,979	26,090
CAF	145,582	68,278	44,794	21,009
Coff's Harbour	164,249	73,912	50,538	22,742
Médias	166,087	75,661	51,104	23,281

* Volume sólido do material com diâmetro igual ou maior que 3,0 cm.

** Toneladas de matéria seca do material com diâmetro igual ou maior que 3,0 cm.

Observamos que cada procedência apresenta resposta diferente, em termos de volume e de massa, ao mini-espaçamento.

Já o incremento médio anual aos 39 meses é muito superior aquele obtido pelo E.grandis (Rodésia) plantado no mesmo local, no espaçamento 3,0 x 2,0 m, que é de aproximadamente 28 m3/ha/ano aos 3 anos de idade.

Quadro II - Nutrientes contidos nos componentes das árvores (considerando-se a sobrevivência atual de 76%). Média das 3 procedências*.

Elementos	Folha (kg/ha)	%	Galhos (kg/ha)	%	Troncos (kg/ha)	%	Árv.Total (kg/ha)
N	124,56	51,6	28,20	11,70	88,59	36,70	241,35
P	6,79	30,0	2,62	11,60	13,19	58,40	22,61
K	41,07	19,9	22,40	10,80	142,62	69,3	206,10
Mg	13,06	46,6	2,39	8,60	12,56	44,8	28,01
Ca	37,03	35,4	15,59	14,90	52,14	49,7	104,76
Fe	2,21	38,8	0,59	10,40	2,89	50,8	5,69
Cu	0,02	23,0	0,02	15,40	0,06	61,6	0,10
Mn	5,91	31,0	2,20	11,60	10,93	57,4	19,04
Zn	0,08	18,2	0,03	7,30	0,31	74,5	0,42
Total	230,73	36,8	74,04	11,80	323,30	51,4	628,07

* Fonte - POGGIANI (1980).

Observa-se que 48,6 % dos nutrientes considerados estão contidos nos galhos e nas folhas. Determinou-se esta porção das árvores equivale a 19,14 % da massa total, sendo que as partes com diâmetro igual ou maior que 3,0 cm, correspondem a 80,86% da massa total.

Sob este aspecto, POGGIANI (1980) considera que a adubação utilizada não supre as perdas dos nutrientes pela exploração, principalmente em relação ao potássio.

O quadro seguinte nos permite observar estes dados.

Quadro III - Quantidade de nutrientes adicionados devido à adubação, retirados devido à exploração, e contidos nas folhas e ramos desprendidos das árvores, considerando-se a sobrevivência atual. Média das 3 procedências.

Elementos	Adubação* g/planta	Retirada na exploração (g/planta) Tronco	Copa	Total
N	15,2	13,20	22,90	36,10
P	47,2	2,00	1,40	3,40
K	9,1	21,40	9,50	30,90
Mg	-	1,80	2,30	4,10
Ca	11,0	7,80	7,90	15,70
Fe	-	0,50	0,40	0,90
Cu	-	0,10	0,005	0,1005
Mm	-	1,60	1,20	2,80
Zn	0,79	0,05	0,016	0,066

* Considerou-se a aplicação de 1000 kg/ha de NPK + micro (10-28-60 + boro e zinco). Cada tonelada da fórmula é constituída de 100 kg de sulfato de amônio, 450 kg de fosfato diamônico, 200 kg de superfosfato triplo, 100 kg de fosfato de Araxá, 100 kg de cloreto de potássio, 26 kg de bórax e 24 kg de sulfato de zinco.

Observamos que, se não for feito o aproveitamento da copa, teremos um bom balanço de nutrientes, exceto para o caso do potássio, onde existe um acentuado desequilíbrio.

Quadro IV - Percentagem de umidade da lenha, nos diversos períodos de secagem média das três procedências.

Tempo de Secagem (dias)	Umidade (% base seca)
0	115,2
45	50,0
75	35,4
90	31,7
105	33,1
120	23,5
140	35,6

Observamos que a queda da umidade nos primeiros 45 dias de secagem é muito rápida, o que não acontece com lenha de maior diâmetro, proveniente de áreas plantadas no espaçamento 3,0 x 2,0 m (gráfico anexo I). Tal fato permite a utilização da madeira, para carbonização, com um curto período de secagem.

Quadro V - Resultados da carbonização em forno comercial. Médias das três procedências e dados comparativos com carvão da mesma espécie com 7 anos de idade.

Variáveis	Flor.Energética (3 anos)	Flor.Normal (7 anos)
Umidade de Carvão (bS %)	3,6	4,0
Peso seco (kg/m3)	145,1	230,0
Fragmento médio (mm)	33,1	44,3
Friabilidade média*(%)	61,2	74,4
Cinzas (%)	2,4	2,5
Materiais voláteis (%)	23,3	24,9
Carbono fixo (%)	75,1	72,6
Carbono fixo (kg/m3)	108,9	167,0

*"Tumbler test".

O carvão da floresta energética é mais leve, menos friável e apresenta uma menor quantidade de carbono fixo, por umidade de volume.

Este último dado é importante, porque o consumo de carvão dos altos-fornos depende da quantidade de carbono fixo por m3 de carvão. São necessários cerca de 450 a 500 kg de carbono fixo, por tonelada de gusa.

4 - Conclusões.

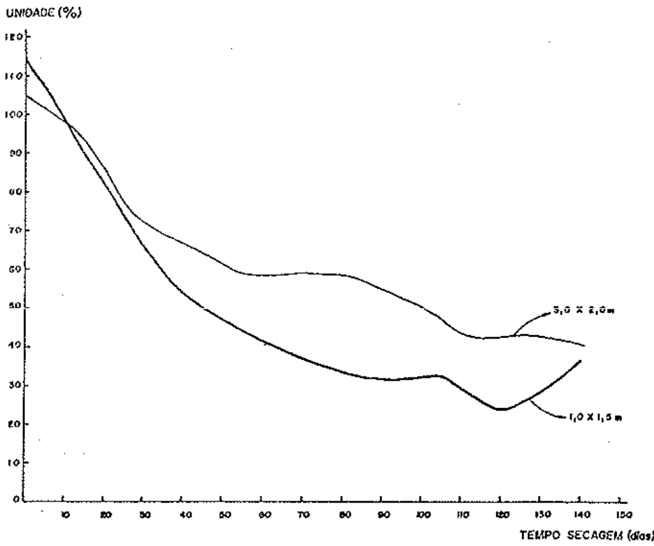
A implantação das florestas energéticas nos permitirão reduzir o ciclo de corte à metade, sem diminuir a produção, ou prejudicar o balanço de nutrientes.

Também se reduzirá o tempo de secagem da lenha, e devido às menores dimensões das árvores, os equipamentos usados na exploração da floresta poderão ser de menor porte.

Para o caso específico da produção de carvão siderúrgico, tem-se um maior consumo volumétrico (35,0 %), que pode ser compensado pela maior produtividade (82 %) da floresta energética, em relação a floresta tradicional (3,0 X 2,0 m).

ANEXO I

CURVAS DE SECAGEM



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DETERMINAÇÃO DE EQUAÇÕES PARA *Eucalyptus citriodora* HOOK E *Eucalyptus saligna* CONDUZIDOS EM REGIME DE ALTO FUSTE.

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Resumo

São feitas comparações entre equações não formais aritméticas e logarítmicas para florestas de *Eucalyptus citriodora* e *Eucalyptus saligna* conduzidas em regime de alto fuste, com o propósito de selecionar as mais precisas para a estimativa do volume total de madeira com casca. Foram também selecionadas equações para a estimativa do volume total sem casca e do volume comercial sem e com casca até o nível de 0,05 m do topo, para a espécie *E. saligna*. O modelo STOATE (Australiano), o qual é dado por $V = b_0 + b_1 D^2 + b_2 H + b_2 D^2 H$ foi selecionado, onde tem-se que: V = volume, D = DAP, H = altura.

Summary

Arithmetic and logarithimic non form equations are compared for high forest Eucalyptus citriodora and Eucalyptus saligna trees, with the objective of selecting the most precise for outside bark total cubic volume estimation. Equations are also selected for E. saligna - inside bark total cubic volume estimation and merchantable

volumes inside and outside bark to 0.05 m top. The STOATE (australian) model, given by $V = b_o + b_1D^2 + b_2H + b_2D^2H$ was selectede, where V = volume, D = d.b.h. outside bark, and H = height.

Introdução

Com o amplo desenvolvimento que vem apresentando o setor florestal brasileiro, reveste-se de importância cada vez maior a condução de estudos sobre crescimento, produtividade e manejo das florestas implantadas.

A metodologia de levantamentos volumétricos com o auxílio de equações ou tabelas de volume é uma das técnicas básicas para uma conclusão criteriosa desses estudos, sem se esquecer, também, das tabelas de rendimento, Veiga(1967).

A literatura brasileira sobre equações de volume para eucaliptus é relativamente escassa. Andrade (1961) publicou tabelas de volume para *E. grandis*, *E. saligna* e *E. tereticornis*, referentes apenas a volume total com casca. Heinsdjik et alii (1965) elaboraram tabela para volume total com casca, envolvendo 24 árvores de *E. robusta*, 51 de E. citriodora e 187 árvores misturadas de *E. alba*, *E. tereticornis*, *E. saligna* e *E. grandis*, Veiga (1973_a, 1973_b, 1973_c 1973_d), construiu equações de volume aritmética não formais para *E. saligna* em ocasião do primeiro corte sob o regime de talhadia simples e regular, testando, também, para a referida espécie equações aritméticas formais, equações formais e não formais. Por outro lado, Veiga e Tanaka (1973), compararam métodos de estimativa de volumes. Veiga e Carvalho (1972) elaboraram tabelas de volume com base nas melhores equações obtidas para volumes totais e sem casca. Couto (1977) relacionou tabelas de volume para brotações de touças de terceiro corte de *E. saligna* com 7 anos de idade.

O presente estudo tem por objetivo a determinação de tabelas de volume das espécies de *E. citriodora* e *E. saligna* conduzidas sob regime de alto fuste.

Materiais e Métodos

Foram amostradas 139 árvores de *E. citriodora* Hook e 79 de *E. saligna* Smith, de plantações manejadas em regime de alto fuste e situadas em diferentes localidades do Estado de São Paulo.

Das árvores de *E. citriodora*, 50 foram selecionadas na E.E. de Luiz Antonio, 28 na E.E. de Moji Guaçu, 20 na E.E. de Itirapina, 20 na E.E. de Moji Mirim, 11 em Rio Claro, no Horto Florestal da FEPASA e 10 na E.E. de Tupí. As alturas totais variaram de 10,0 a 34,9m e os DAP com casca de 15,0 a 38,2cm.

Das árvores de *E. saligna*, 20 eram provenientes da E. E. de Angatuba, 14 da E.E. de Moji Guaçu, e 10 de cada um dos seguintes locais: Rio Claro (Horto FEPASA), E.E. de Tupí e E.E. de São Simão. Os valores de DAP com casca variaram de 14,0 a 38,0cm, e as alturas totais de 11,0 a 36,0m.

Para determinações de volumes, as árvores foram abatidas e realizadas as seguintes medidas: CAP com e sem casca, altura total, e circunferências ao longo do fuste de metro a partir da base. As determinações de altura total foram efetuadas com auxílio de trena e as diametrais com fita métrica.

As estimativas do volume real das árvores foram realizadas através da fórmula de Smalian generalizada, considerando-se cepa e ponta como respectivamente cilindro e cone.

Para o estabelecimento das equações de volume foram testados os seguintes modelos aritméticos e logarítmicos:

$$V = b_o + b_1D^2H \qquad (I)$$

$$V = b_o + b_1D^2 + b_2H + b_3D^2H \qquad (II)$$

$$\log V = b_o + b_1 \log D + b_2 \log H \qquad (III)$$

$$\log V = b_o + b_1 \log (D^2H) \qquad (IV)$$

onde V representa o volume real, D o DAP com casca, e H a altura total. Tais modelos são conhecidos, respectivamente, como variável combinada de SPURR, modelo australiano(de STOATE), modelo de SHUMACHER-HALL, e variável combinada logarítmica de Spurr (LOETSCH et alii, 1973). Para *E. citriodora*, os modelos foram testados para o volume total com casca, enquanto para *E. saligna* foram também testados para o volume total sem casca e para os volumes comerciais com e sem casca até o limite de 5cm.

A resolução das equações procedeu-se através de regressão pelo método clássico dos quadrados mínimos (STELL & TORRIE, 1960).

Foram determinados os valores dos desvios padrões dos coeficientes, o coeficiente de determinação total (R^2) e o valor dado pelo teste F para exprimir a precisão de cada regressão.

Resultados e Discussão

Os resultados obtidos com as equações testadas para *E. citriodora* acham-se sintetizados nas tabelas 1 e 2.

Tabela 1 - Equações de volume obtidas para volume total com casca de E. citriodora (V em m^3, D em m e H em m)

1	$V = 0{,}00617 + 0{,}31775\ D^2H$
2	$V = 0{,}03646 + 0{,}85371\ D^2 - 0{,}00246\ H + 0{,}31109\ D^2H$
3	$\log V = -0{,}11121 + 2{,}08413 \log D + 0{,}77015 \log H$
4	$\log V = -0{,}488898 + 0{,}96548 \log (D^2H)$

Tabela 2 - Valores estatísticos correspondentes às equações inseridas na tabela 1.

Equação	R^2	$t(b_1)$	$t(b_2)$	$t(b_3)$	F
1	0,9888	101,90	-	-	12077,01 **
2	0,9904	2,07	-3,92	24,05	4649,44 **
3	0,9878	45,56	14,21	-	5489,60 **
4	0,9866	100,28	-	-	10056,21 **

Os resultados obtidos para *E. saligna* econtram-se reunidos nas tabelas 3 e 4 para volume total com casca, 5 e 6 para volume total sem casca, e 7 a 10 para volumes comerciais com e sem casca ao limite de desponta de 5 cm.

Tabela 3 - Equações de volume obtidas para volume total com casca de *E. saligna* (V em dm^3; D em cm; H em m).

5	$V = 20{,}95432 + 0{,}032079855\ D^2H$
5	$V = -33{,}61460 + 0{,}0375097\ D^2 + 3{,}05139\ H + 0{,}0296778\ D^2H$
7	$\log_e V = -2{,}8982 + 1{,}968523 \log_e D + 0{,}883803 \log_e H$
8	$\log_e V = -2{,}961811 + 0{,}956879 \log_e (D^2H)$

Tabela 4 - Valores estatísticos correspondentes às equações inseridas na tabela 3.

Equação	R^2	CV (%)	s_{xy}	F
5	0,9802	17,08	56,133	3769,41 **
6	0,9810	16,95	55,727	1275,87 **
7	0,9739	2,94	0,155	1402,09 **
8	0,9736	2,93	0,155	2807,74 **

Tabela 5 - Equações de volume obtidas para volume total sem casca de E. saligna (V em dm^3; D em cm; H em m).

9	$V = 18,35436 + 0,02811 4415\ D^2 H$
10	$V = -32,18106 + 0,838690021\ D^2 + 2,480054\ H + 0,024704\ D^2 H$
11	$\log_e V = -3,0263 + 2,336425 \log_e D + 0,866165 \log H$
12	$\log_e V = -3,188040 + 0,966963 \log_e (D^2 H)$

Tabela 6 - Valores estatísticos correspondentes às equações inseridas na tabela 5

	R^2	CV(%)	s_{xy}	F
9	0,9791	17,56	50,577	3566,12 **
10	0,9798	15,51	50,438	1196,11 **
11	0,9732	3,27	0,178	1366,92 **
12	0,9682	3,35	0,173	2313,05 **

Tabela 7 - Equações de volume obtidas para volume comercial com casca de E. saligna, ao limite de desponta de 5 cm (V em m^3; D em cm; H em m).

13	$V = 2,89680 + 0,032214\ D^2 H$
14	$V = -53,50834 + 0,2454\ D^2 + 3,25423\ H + 0,030075\ D^2 H$
15	$\log_e V = -4,034638 + 2,336425 \log_e D + 0,866165 \log_e H$
16	$\log_e V = -4,225672 + 1,085884 \log_e (D^2 H)$

Tabela 8 - Valores estatísticos correspondentes às equações inseridas na tabela 5.

	R^2	CV(%)	s_{xy}	F
13	0,9804	17,99	56,097	3805,99 **
14	0,9814	17,79	55,477	1298,44 **
15	0,9732	3,47	0,178	1366,92 **
16	0,9712	3,59	0,184	2559,26 **

Tabela 9 - Equações de volume obtidas para volume comercial sem casca de E. saligna ao limite de desponta de 5cm (V em m^3; D em cm; H em m).

17	$V = 3,858465 + 0,028275\ D^2 H$
18	$V = -59,97754 + 0,132446\ D^2 + 2,94626\ H + 0,023323\ D^2 H$
19	$\log_e V = -4,189371 + 2,469068 \log_e D + 0,747777 \log_e H$
20	$\log_e V = -4,497230 + 1,101860 \log_e (D^2 H)$

Tabela 10 - Valores estatísticos correspondentes às equações inseridas na tabela 7.

	R^2	CV(%)	s_{xy}	F
17	0,9801	18,05	49,650	3743,09 **
18	0,9811	17,83	49,044	1280,04 **
19	0,9741	3,57	0,179	1408,68 **
20	0,9686	3,90	0,195	2351,39 **

Cotejando-se os resultados referentes aos modelos aritméticos testados, depreende-se que para ambas as esécies o modelo australiano de STOATE (II) apresentou em todos os casos maior coeficiente de determinação total que o da variável combinada (I).

Comparando-se os modelos logarítimicos, depreende-se que o modelo de SCHUMACHER-HALL (III) levou, em ambas as espécies, a um coeficiente de determinação total ao decorrente da aplicação da variável combinada logarítimica (IV), embora inferior ao obtido através do modelo australiano.

Assim, para a elaboração de tabelas de volume optou-se em todos os casos em estudo pelas equações obtidas através do modelo australiano de STOATE.

Resumo e Conclusões

Em diferentes locais do Estado de São Paulo, árvores de E. citriodora e E. saligna conduzidas sob regime de alto fuste foram amostradas para determinações volumétricas. Foram testados 4 modelos de equações de volume, obtendo-se melhores resultados através do modelo australiano (de STOATE). As equações selecionadas foram:

E. citriodora:

$$V_{tcc} = 36,46 + 0,085371\ D^2 - 2,46\ H + 0,031109\ D^2 H$$

E. saligna:

$$V_{tcc} = -33,6146 + 0,0375097\ D^2 + 3,05139\ H + 0,0296778\ D^2 H$$

$$V_{tsc} = -32,18106 + 0,0838690\ D^2 + 2,480054 H + 0,024704\ D^2 H$$

$$V_{5cc} = -53,50834 + 0,02454\ D^2 + 3,25423\ H + 0,0300755\ D^2 H$$

$$V_{5sc} = -59,97754 + 0,132446\ D^2 + 2,94626\ H + 0,0233228\ D^2 H$$

onde V_{tcc} e V_{tsc} representam o volume total com e sem casca em dm^3; V_{5cc} e V_{5sc} exprimem o volume comercial com e sem casca até o diâmetro de desponte de 5 cm, em m^3; D representa o DAP com casca, em cm; e H exprime a altura total, em metros.

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EQUAÇÕES PARA ESTIMATIVAS DE PESO DE MATÉRIA SECA E DE VOLUME PARA *Eucalyptus propinqua* DEANE EX MAIDEN.

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Resumo

Foram coletados dados de 140 árvores em plantações de 5 anos de idade de *Eucalyptus propinqua* Deane ex-Maiden em dois sites diferentes no Estado de São Paulo, Brasil. Estes dados foram utilizados para o desenvolvimento de um modelo geral, baseado em métodos de regressão, para a estimativa do peso seco do tronco sem casca (P) até o nível de 0,05 m do topo da árvore, do diâmetro a altura do peito (D) e da altura total da árvore (H). A equação proposta, apresentando coeficiente $r^2 = 0{,}9535$, é a seguinte:

$$P = -0{,}62611 + 0{,}01330\ D^2H$$

onde: P é dado em kg, D, em cm, e H, em metros. Equações volumétricas puderam também ser selecionadas.

STEM DRY WEIGHT EQUATIONS AND VOLUME EQUATIONS FOR *Eucalyptus propinqua* DEANE EX MAIDEN.

Summary

Data were collected from 140 trees of 5 years old *Eucalyptus propinqua* Deane ex Maiden plantations in two different sites of São Paulo State, Brazil. These sample trees were used to develop a general model, fitted by least squares regression techniques, for the prediction of stem dry weight (P) without bark to 0.05 m top, from diameter outside bark at breast height (D) and total tree height (H). The proposed equation, with regression coeficient of $r^2 = 0.9535$, is:

$$P = -0.62611 + 0.01330\ D^2H$$

where P is given in kg, D in cm and H in m. Volume equations were also selected.

Introdução

No Brasil as medições volumétricas são atualmente a base para estimativas em inventários florestais e transações comerciais de compra e venda de madeira.

Contudo em alguns países, como os Estados Unidos, é de uso corrente a determinação do peso em vez do volume da madeira (HARDY & WEILAND, 1 ; CURTIS, 2).

A estimativa da madeira através de peso pode ser conduzida em relação ao peso verde ou ao peso de matéria seca.

O peso verde é um parâmetro de avaliação rápida e simples para toras, toros ou madeira desdobrada, sendo determinado pela diferença de peso do veículo de transporte com e sem a carga. Tabelas podem ser elaboradas para conversão dos valores encontrados nos correspondentes em peso de matéria seca.

O peso de matéria seca é um parâmetro de inestimável utilidade por permitir estimar o rendimento final em celulose e chapas de fibras de madeira, contudo não pode ser medido diretamente.

É de se supor que se possa vir a utilizar também no Brasil o peso como unidade de medida da madeira de eucalipto. Devido a isso foi instalado o presente ensaio, que tem por principal objetivo estimar para *Eucalyptus propinqua* Deane ex Maiden o peso de matéria seca correspondente à parte comercial do fuste, em função de parâmetros dendrométricos de fácil medição no campo.

Assim, procura-se identificar um modelo de regressão adequado para prever o peso da matéria seca em termos de altura total e do DAP com casca ("diâmetro à altura do peito", medido a 1,30 m do nível do solo). Paralelamente, procura-se utilizar os dados para determinação de equações de volume, que estimem o volume comercial sem casca em função do DAP com casca e da altura total da árvore, para facilitar levantamentos volumétricos da espécie em estudo.

Material e Métodos

O estudo foi conduzido em árvores de *Eucalyptus propinqua* Deane ex Maiden de 5 anos de idade, de duas regiões de condições ecológicas diferentes, mas provenientes do mesmo lote de sementes.

Foram amostradas 80 árvores em Itupeva, Estado de São Paulo, em área de propriedade da Duratex S/A Indústria e Comércio, situada a 47°03' de longitude oeste de Greenwich e 23°09' de latitude sul, com clima mesotérmico úmido do tipo Cfa segundo o sistema de Koppen e solo podzolizado com cascalhos, moderadamente drenado, pouco profundo, de elevada acidez e baixa fertilidade.

Outras 60 árvores foram amostradas em Mogi Guaçu, Estado de São Paulo, em área de propriedade da Champion Papel e Celulose S/A, localizado a 47°07' de longitude oeste e 22°11' de latitude sul, com clima mesotérmico de inverno seco do tipo Cwa segundo o sistema de Koppen e solo latosol vermelho amarelo fase arenosa, bem drenado, profundo, ácido e de baixa fertilidade.

As árvores foram desdobradas, extraindo-se de 2 em 2 m e ao nível do DAP secções transversais para determinações de densidade básica pelo método da balança hidrostática. Foram medidos diâmetros com e sem casca ao nível do DAP e de 2 em 2 m, e as alturas total e comercial. Considerou-se a altura comercial até o limite de desponta de 5 cm, por ser regra geral o mais utilizado no parque industrial consumidor de madeira de eucalipto como matéria-prima para produção de celulose e papel e de chapas de madeira aglomerada.

Para cada árvore foram determinados a densidade básica ao nível do DAP, a densidade básica média da árvore, o volume comercial sem casca, e o peso de matéria seca.

Com base nos resultados foram realizados estudos de correlação entre as variáveis e comparados diferentes modelos de equação visando à obtenção de equações de regressão que permitam estimar o peso da parte comercial do fuste em função do DAP com casca e altura total da árvore, bem como de equações que possibilitem a estimativa do volume comercial em função dessas duas últimas variáveis citadas.

Resultados e Discussão

As 140 árvores amostradas possuiam DAP com casca de 5,0 a 21,0 cm, com média de 11,2 cm e desvio padrão de 2,9 cm; o DAP sem casca variou de 4,5 a 19,3 cm, com média de 10,2 cm e desvio padrão de 2,7 cm; a altura total era em média de 17,5 m, com desvio padrão de 2,8 m e variação de 9,0 a 25,2 m; a altura comercial variou de 4 a 22 m, com média de 13,6 e desvio padrão de 3,8 m; o volume comercial sem casca foi em média igual a 0,056342 m^3, com amplitude de 0,001610 a 0,236489 m^3; a densidade básica ao DAP foi de 0,578 t/m^3 em média, com variação de 0,435 a 0,685 e desvio padrão de 0,052; a densidade básica média da árvore teve como média 0,585 t/m^3, com desvio padrão de 0,050 e valores mínimo e máximo de 0,444 a 0,698; o peso de matéria seca foi de 32,57 kg em média, variando de 23,36 a 132,63 kg.

Os coeficientes de correlação parcial simples calculados para as variáveis em estudo constam na tabela 1. Cabe destacar o elevado coeficiente de correlação encontrado para peso de matéria seca e a variável combinada D^2H, que foi de r = 0,9765, pouco inferior ao valor r = 0,9784 obtido entre o volume e aquela variável combinada. Outras transformações testadas, envolvendo logarítmos, não chegaram a aumentar esses coeficientes de correlação, caso de correlação entre os logarítmos neperianos do peso e D^2H, que foi de r = 0,9397.

Tabela 1. Coeficientes de correlação parcial simples entre variáveis, para 140 árvores de *E. propinqua* aos 5 anos de idade. (D = DAP com casca; H = altura total; A = altura comercial; V = volume comercial sem casca; P = peso de matéria seca).

	H	A	V	P	D^2	D^2H
D	0,8377	0,8219	0,9265	0,9207	0,9816	0,9484
H		0,9432	0,8594	0,8514	0,8150	0,8479
A			0,8106	0,7872	0,7770	0,7890
V				0,9897	0,9639	0,9784
P					0,9602	0,9765

Foram testadas equações volumétricas logarítmicas e não logarítmicas, cujos resultados encontram-se relacionados na tabela 2. Os coeficientes de variação e de determinação correspondentes e o valor de F estão apresentados na tabela 3, e o teste de significância para os parâmetros das duas melhores equações, 2 e 1, constam na tabela 4.

Tabela 2. Equações de volume para 140 árvores de *E. propinqua* (V = volume comercial sem casca em m^3; D = DAP com casca em cm; H = altura total em m; L = logarítmo neperiano).

Número	Equação de Volume
(1)	$V = -0,00208549 + 0,00002341\ D^2H$
(2)	$V = -0,02059091 - 0,00071937\ D + 0,00167194H + 0,00002231\ D^2\ H$
(3)	$LV = -14,91819557 + 1,4096437\ LD + 2,94544349\ LH$
(4)	$LV = -12,14050145 + 1,17936989\ L\ (D^2\ H)$

Tabela 3. Valores de coeficiente de determinação (r^2), coeficiente de variação (CV) e teste F, correspondentes às equações de volume constantes na tabela 2.

Equação	r^2	CV	F
(1)	0,9575	15,08%	3105,24 **
(2)	0,9608	14,57%	1112,82 **
(3)	0,8896	9,28%	552,05 **
(4)	0,8550	10,59%	814,25 **

Tabela 4. Teste de significância para os parâmetros das duas melhores equações de volume encontradas.

Equação	Variável	$\hat{b}_i$	$s(\hat{b}_i)$	t para H_o : parâmetro=0	prob > |t|
(1)	D^2H	0,00002341	0,00000042	55,72	0,0001
(2)	D	-0,00071937	0,00076124	-0,94	0,3463
	H	0,00167194	0,00048738	3,43	0,0008
	D^2H	0,00002231	0,00000135	16,58	0,0001

Os menores valores de coeficiente de variação constatados nas equações logarítmicas são resultantes da transformação utilizada.

A equação 2 foi a que levou a melhor estimativa do volume em função das variáveis diâmetro e altura. Contudo, o seu coeficiente de determinação, de r^2 = 0,9608, superou em pouco o de r^2 = 0,9575 correspondente à equação 1. Devido a isso a equação 1 pode ser o modelo recomendado pois é de boa precisão e oferece maior facilidade de uso e menos custo de computação quando cotejado com o modelo da equação 2.

A elevada significância correspondente ao valor de r^2 na equação 1 era de se esperar, considerado o valor r^2 = 0,9690 encontrado por VEIGA (3) para o mesmo modelo de regressão aplicado a *E. saligna* em ocasião de primeiro corte.

Procurando atender ao principal objetivo do presente trabalho, foram testadas equações para estimativa do peso da matéria seca. Os resultados constam nas tabelas 5 e 6, enquanto na tabela 7 estão reunidas mais informações referentes às duas melhores equações de peso.

Tabela 5. Equações de peso de matéria seca para 140 árvores de *E. propinqua* (P = peso de matéria seca, em t; D = DAP com casca, em cm; H = altura total em m; DD = densidade básica ao nível do DAP, em t/m^3; L = logarítmo neperiano).

Número	Equação de Peso de Matéria Seca
(5)	$P = -0,04913870 + 0,00731202\ D$
(6)	$P = -0,09418477 + 0,00723415\ H$
(7)	$P = -0,000626\ H + 0,00001330\ D^2\ H$
(8)	$P = 0,00236162 - 0,00041992\ D + 0,00001398\ D^2\ H$
(9)	$LP = -14,71594835 + 1,40999156\ LD + 2,84609072\ LH + 0,80162234\ LDD$
(10)	$LP = -10,17801521 + 2,72757509\ LD$
(11)	$LP = -16,94273677 + 4,64819504\ LH$
(12)	$LP = -12,23460977 + 1,12305197\ L\ (D^2\ H)$

Tabela 6. Valores de coeficiente de determinação (r^2), coeficiente de variação (CV) e teste F, correspondentes às equações de peso de matéria seca constantes na tabela 5.

Equação	r^2	CV	F
(5)	0,8478	28,09%	768,46 **
(6)	0,7249	37,76%	363,60 **
(7)	0,9535	15,51%	2832,45 **
(8)	0,9538	15,52%	1414,95 **
(9)	0,9221	6,29%	537,01 **
(10)	0,8236	9,40%	644,15 **
(11)	0,8478	8,73%	768,57 **
(12)	0,8830	7,66%	1041,69 **

Tabela 7. Teste de significância para os parâmetros das duas melhores equações de peso de matéria seca encontradas.

Equação	Variável	$\hat{b}_i$	$s(\hat{b}_i)$	t para H_0 : parâmetro=0	prob > $\lvert t \rvert$
(7)	D^2H	0,00001330	0,00075602	53,22	0,0001
(8)	D	-0,00041992	0,00045960	-0,91	0,0001
	D^2H	0,00001398	0,00000079	17,74	0,0001

A elevada significância estatística encontrada na estimativa do peso em função de DAP e altura, conforme as equações 7 ou 8, pode ser perfeitamente justificada ante à alta correlação r = 0,9897 encontrada entre o volume da árvore e o seu peso de matéria seca, e a alta correlação r = 0,9784 existente por sua vez entre o volume e a variável combinada D^2H.

Embora a equação 8 tenha sido, dentre as testadas, a que levou a melhor resultado, o seu coeficiente de determinação ($r^2 = 0,9538$) é praticamente igual ao correspondente à equação 7.

Desse modo, para estimativas de peso pode-se recomendar a equação 7, que é de boa precisão e cujo modelo envolve maior facilidade de uso e menor custo de computação quando comparado com a equação 8.

Com base na referida equação 7 foi elaborada a Tabela 8, onde são fornecidas as estimativas do peso da árvore em função do DAP com casca e da altura total. Os valores correspondem ao peso da matéria seca do fuste até o diâmetro limite de desponta de 0,05 m.

Na referida tabela seguiu-se a convenção de delimitar entre linhas cheias a distribuição original dos dados amostrados.

É importante destacar que os resultados do presente trabalho mostram a desnecessidade de inclusão, na estimativa do peso, de valor correspondente à densidade ao nível do DAP (equação 9), pois apenas em função de D^2 H já se alcançou grande precisão na estimativa do peso de matéria seca.

Assim, os resultados obtidos no presente estudo são de elevado interesse prático, pois demonstram a possibilidade de se estimar com boa precisão o peso da árvore em função de duas variáveis de fácil determinação no campo: o diâmetro com casca e a altura total da árvore. A aplicabilidade das equações poderá ser facilitada nos inventários com o estabelecimento de relações hipsométricas diâmetro-altura, o que reduziria a medição de altura a apenas um pequeno número de árvores nas parcelas.

Devido ao interesse em estimativas do peso de matéria seca, os autores estão conduzindo trabalhos similares para outras espécies de eucalipto e de outros gêneros importantes às atividades florestais do País.

Conclusões

Da discussão dos resultados obtidos para as 140 árvores de *E. propinqua* com 5 anos de idade em duas regiões do Estado de São Paulo podem ser retiradas as seguintes conclusões:

a. O peso de matéria seca (P) pode ser estimado com boa precisão em função do DAP com casca (D) e da altura total (H) da árvore.

b. A equação sugerida para estimar o peso da matéria seca é

$$P = -0,62611 + 0,01330\ D^2\ H \quad (r^2 = 0,9535)$$

onde P é expresso em kg, D em cm e H em m.

c. A equação de volume recomendada é

$$V = -2,08549 + 0,02341\ D^2\ H \quad (r^2 = 0,9575)$$

onde V é dado em dm^3, D em cm e H em m.

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TABELA 8. Estimativa do peso de uma árvore em função do DAP com casca e da altura total. Valores expressos em kg de matéria seca, estimados para o fuste de *E. propinqua* com 5 anos de idade até o diâmetro limite de desponta de 0,05 m.

DAP	ALTURA TOTAL (m)																		
(cm)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
5	2,0	2,4	2,7	3,0	3,4	3,7	4,0	4,4	4,7	5,0	5,3	5,7							
6	3,2	3,7	4,2	4,6	5,1	5,6	6,1	6,6	7,0	7,5	8,0	8,5							
7	4,6	5,2	5,9	6,5	7,2	7,8	8,5	9,1	9,8	10,4	11,1	11,8							
8	6,2	7,0	7,9	8,7	9,6	10,4	11,3	12,1	13,0	13,8	14,7	15,5	16,4	17,2					
9				11,2	12,3	13,4	14,5	15,5	16,6	17,7	18,8	19,9	20,9	22,0					
10				14,0	15,3	16,7	18,0	19,3	20,7	22,0	23,3	24,6	26,0	27,3	28,6	30,0	31,3		
11				17,1	18,7	20,3	21,9	23,5	25,1	26,7	28,3	30,0	31,6	33,2	34,8	36,4	38,0		
12				20,4	22,4	24,3	26,2	28,1	30,0	31,9	33,8	35,8	37,7	39,6	41,5	43,4	45,3	47,2	49,2
13						28,6	30,8	33,1	35,3	37,6	39,8	42,1	44,3	46,6	48,8	51,1	53,3	55,6	57,8
14						33,3	35,9	38,5	41,1	43,7	46,3	48,9	51,5	54,1	56,7	59,3	61,9	64,5	67,2
15						38,3	41,3	44,3	47,3	50,2	53,2	56,2	59,2	62,2	65,2	68,2	71,2	74,2	77,2
16						46,4	47,0	50,4	53,9	57,2	60,7	64,1	67,5	70,9	74,3	77,7	81,1	84,5	87,9
17						49,3	53,2	57,0	60,9	64,7	68,6	72,4	76,2	80,1	83,9	87,8	91,6	95,5	99,3
18						55,4	59,7	64,0	68,3	72,6	76,9	81,2	85,6	89,9	94,2	98,5	102,8	107,8	111,4
19											85,8	90,6	95,4	100,2	105,0	109,8	114,6	119,4	124,2
20											95,1	100,4	105,8	111,1	116,4	121,7	127,1	132,4	137,7
21													116,7	122,5	128,4	134,3	140,1	146,1	151,9
22													128,1	134,6	141,0	147,4	153,9	160,3	166,7

CRESCIMENTO DE *Eucalyptus deglupta* À IDADE DE 3 ANOS EM SOLOS DIFERENTES NA JARI.

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Resumo

A altura de E. deglupta à idade de 3 anos plantado em latosolo vermelho-amarelo fase arenosa alcançou, em média, 13,8 m, em comparação com 14,4 m atingidos em solo podzólico vermelho-amarelo cargiloso. A partir destes resultados, procurou-se plantar em solos apresentando grandes diferenças nas propriedades químicas e físicas. A idade de um ano, as alturas variaram de 2,0 a 5,9 m. O pior crescimento foi verificado em solo podzólico vermelho-amarelo, o qual apresentava marchetamento superficial.

As três melhores parcelas apresentaram altura média de 5,7 m ao primeiro ano. Os solos nestas três melhores parcelas apresentavam grande diferença no pH, conteúdo de nutrientes, textura e drenagem. O pH destes três solos variou de 4,6 a 7,5; o conteúdo de fósforo variou de 0 a 78 ppm, e a capacidade de troca de cátions variou de 4,2 a 12,0 m.e./100g. A textura do solo variou desde não-marchetada aos 24 cm de profundidade.

Estes resultados preliminares indicam que o E.deglupta vai bem em solos arenosos ou argilosos que não apresentam problemas sérios de drenagem.

GROWTH OF *Eucalyptus deglupta* BL. AT JARI ON DIFERENT SOILS UP THROUGH AGE THREE.

Summary

Height of Eucalyptus deglupta at age three on a sandy red-yellow latosol averaged 13.8 m as compared to 14.4 m on a clay red-yellow podzolic soil. Encouraged by these results, plantings were made on other soils differing greatly in chemical and physical soil properties. At age one, heights ranged from 2.0 to 5.9 m. The poorest growth was on a red-yellow podzolic soil which was mottled at the surface.

The three best plots averaged 5.7 m in height after one year. The soils of these three best plots differed drastically in pH, nutrient content, soil texture and drainage. The pH among these three plots varied from 4.6 to 7.5, P from 0 to 78 ppm, and cation exchange capacity from 4.2 to 12.0 m.e./100g. Soil textures varied from no mottling to mottling at 24 cm.

These juvenile results indicate that deglupta is well suited to both sandy and clay soils that do not have a serious drainage problem.

INTRODUCTION

Eucalyptus species have been planted very successfully in mid and southern Brazil for many years. Recognizing this, several species of Eucalyptus of a Brazilian seed source were planted at Jari in 1970 on company lands in the northeastern portion of the Amazonian state of Para. Growth was satisfactory on a sandy red-yellow latosol soil up through seven growing seasons. The best species, probably a E. urophylla or E. alba hybrid, averaged 3.3 m a year (Batista and Woessner, 1980). The poorest growth was 2.2 m a year for plots identified as E. robusta. Although growth was satisfactory, commercial planting of Eucalyptus with pure seed sources was not undertaken because all species under trial had some degree of attack by the Eucalyptus canker (Diaporthe cubensis Bruner). A report that deglupta (E. deglupta Bl.) was highly immune to the canker disease (Hodges et al., 1976), coupled with the fact that it is a tropical Eucalyptus, stimulated the planting of several deglupta trials. Studies were established on clay and sandy soils in May of 1977. At 29 months, the trial on the clay soil averaged 12.3 m while two on sandy soils averaged 11.6 m. Encouraged by these results, additional trials were planted in 1979 which sampled a wider range of soil conditions. Growth on the various soils is reported in this paper.

MATERIALS AND METHODS

The Jari lands lie less than one degree south of the equator in the Brazilian Amazonian state of Para at 53° west longitude. The altitude ranges from 5 to 240 m above sea level and total rainfall averages 2200 mm. Eighty-five percent of the rainfall occurs from January to August. The months of September through December average 68 mm per month. The driest month is October as it receives only 45 mm of rain. Daily extremes in temperature range from a high of 34°C to a low of 24°.

The first planting of deglupta in 1977 was plot 19 on a clay Ultisol soil and plots 21 A and B on a sandy Oxisol soil. All three of these are included here (Table 1). In 1979, 27 plots were established on the widest range of soil conditions available for planting that year. Thirteen representative plots of the 27 are used here. All trials were established after clearing and burning of the upland tropical rainforest.

Table 1. Geologic origin and soil classification for each experiment.

Trial Code	Geologic Origin	Soil Classification
	Ultisol	
X	Devonian	red-yellow podzolic
N	"	"
19	"	"
M	"	"
G	"	"
H	Tertiary-Devonian	"
E	Devonian	"
W	"	"
	Oxisol	
A	Devonian	yellow latosol
C	"	"
21B	Tertiary	red-yellow latosol
21A	"	"
S	"	yellow latosol
T	"	red-yellow latosol
O	"	yellow latosol
	Alfisol	
L	Jurassic	reddish-brown laterite

A soil pit was dug at each of the 16 studies and samples were collected from the A and B horizons. The geologic origin of the soil of each plot and the soil classification are given in Table 1. The percentages of sand, silt and clay were determined by the hydrometer method (Black et al., 1965) from the samples collected in the soil pit. Chemical analyses were done for P, K, Ca, Mg and Al on soil samples collected at 0 to 10 and 20 to 40 cm depth on ten randomly distributed samples collected on each of the measurement plots surrounding the soil pit. The extraction for P and K was by the double acid method. Actual determination of P was by the molybenum blue method and a photocolorimeter. A flame photometer was used for K determination. The Ca, Mg, and Al were extracted with potassium chlorate and analysed by EDTA rate and analysed by EDTA titration. Percent organic matter was by the Walkely-Black method (Black et al., 1965). The pH was determined in water with a meter. The ratio of soil to water was 1:2.5 by volume.

The analyses of the percentage of sand, silt and clay were translated into soil textures using the American texture triangle. The P, K, Ca, Mg and Al results were presented as the sum of the bases ($Ca^{++}+Mg^{++}+K^{+}$), the (C.E.C.) cation exchange capacity ($Ca^{++}+Mg^{++}+K^{+}+Al^{+++}$), and percentage of Aluminum saturation (Al^{+++}/C.E.C x100). All lab analyses were replicated twice.

Trial 19 in 1977 was a species trial of four species with 25 trees in each of 12 replications. A soil pit was dug in the deglupta plot in replication six and the other two closest deglupta plots were also measured. A total of 75 deglupta trees were measured. The layout for trials 21 A and B in 1977 was 50-tree row plots of four species running across a site gradient and replicated two times at two locations. A soil pit was dug in both a lower and upper slope position at each location. A 25-tree plot was centered on the pit and 25 trees were measured in the adjacent replication at the same slope position. Thus, 50 trees represent each pit at each slope position at each location. In the 1979 studies, a measurement plot of seven rows with 10 trees to the row was positioned around the soil pit.

Total heights were measured to the nearest 0.1 m and diameter was taken at 1.4 m to the nearest 0.1 cm. The mean, variance, and coefficient of variation were calculated for each location.

At the time of measurement, the 1977 trials were 3 years old. The 1979 trials ranged in age from 1.08 years to 1.34 years. All trial heights and diameters were transformed to a base age of one by a direct proportion based on age.

RESULTS

Height, Diameter and Survival

At age three, average total height was 13.9 m and diameter was 13.9 cm (Table 2). The best height growth was on the upper slope of plot 21 B and the poorest height growth was on the upper slope of plot 21 A. Combining all data from plots 21 A and B indicates there is a very small advantage in height and diameter growth in favor of the lower slope position. The mean height for the Ultisol plot was 14.4 m, slightly more than the mean on the Oxisol plots.

Table 2. Height, diameter, and survival for the 3-year old Jari deglupta.

Trial Code	Height (m)	(CV)	Diameter (cm)	(CV)	Survival (%)
		Ultisol			
19	14.4	11	12.9	21	97
		Oxisol			
21A 1 2/	13.0	28	13.4	32	92
" u 3/	12.4	16	12.6	23	100
21B 1	14.6	16	15.6	23	92
" u	15.1	17	15.2	25	100
mean	13.8	19	14.2	26	96
overall mean	13.9	18	13.9	25	96

2/ l = lower slope
3/ u = upper slope

At age one (Table 3), the poorest and the best height growth took place on an Ultisol. The same was true of diameter. The mean height for all the Ultisol plots was essentially the same as the plots on the Oxisol. The one Alfisol plot was approximately 20 percent taller. Diameter followed the same trend.

Table 3. Mean annual height, diameter and survival of all 16 trials.

	Height (m)	(CV)	Diameter (cm)	(CV)	Survival (%)
		Ultisol			
X	5.9	14	5.9	19	99
N	5.3	26	5.2	30	77
19	4.8	11	4.3	21	97
M	4.6	23	4.2	36	93
G	4.3	30	3.9	43	100
U	4.0	31	3.8	34	87
E	3.9	20	3.2	38	99
W	2.0	44	1.3	66	100
mean	4.4	25	4.0	36	94
		Oxisol			
A	5.8	12	5.9	20	97
C	5.2	18	4.6	28	99
21B	4.9	22	5.1	28	96
21A	4.2	16	4.3	24	96
S	4.6	17	4.5	29	100
T	3.6	27	3.5	40	100
O	3.0	29	2.8	41	99
mean	4.5	20	4.4	30	98
		Alfisol			
L	5.4	29	4.5	36	83

Average survival at age three for the 1977 plots was 96 percent and average survival at age one for the 1979 plots (Table 2) was 95 percent. There is no indication that poor site quality decreased survival since the poorest growing plot had 100 percent survival. Low survivals were more likely caused by attacks of leaf-cutting ants or heavy vine competition.

The poorest growing plot had the highest coefficient of variation for both height and diameter thus indicating a lack of uniformity in growth from tree to tree relative to other plots.

Chemical Analyses

The results of the chemical analyses (Table 4) indicated Oxisol soils were the least fertile and Alfisol soil was the most fertile. The Alfisol, named Terra Roxa in Brazil, is a very fine agricultural soil when not too steep. The P, sum of the bases, and C.E.C. of this soil were much greater than on the Oxisol and Ultisol plots. The pH of the Alfisol was also much higher than for the Ultisol and Oxisol plots. Aluminum saturation was much lower. The organic matter content was not consistent within soil types.

With increasing depth from 0-10 to 20-40 cm, there is almost always a drop in organic matter content, pH, P, C.E.C. and sum of the bases. Likewise, the percent aluminum concentration invariably increased with depth.

The relatively high values for the chemical analyses of plot (X) are an anomaly, occurring only at the surface since a sample taken at 10 to 20 cm indicated a fertility status similar to other Ultisols.

Soil Physical Properties

The texture of the A horizon (Table 5) ranges from loamy sand to heavy clay while that of the B horizon ranges from sandy-loam to heavy clay. The Oxisol plots are the sandiest while the Ultisol plots and the Alfisol have more clay.

The A horizon depth of the Ultisol averages about the same as the Alfisol. The Oxisol plots vary considerably in their depth of the A horizon but the overall mean is 50 percent deeper than the mean for the Ultisol plots.

The Ultisols are the most poorly drained; six of the eight sampled show some degree of mottling in the A horizon and half the Ultisols had gley development as compared to none of the Oxisols or the Alfisol. The poorest growth occurred on

Table 4. Chemical analyses for the Jari deglupta trials.

Trial Code	Organic matter (%)	pH	P (ppm)	Sum of bases (m.e./100g)	C.E.C. (m.e./100g)	AL (%)
			Ultisol (0-10 cm)			
X	4.9	5.7	26.2	3.4	9.2	9
N	2.3	4.3	1.9	1.7	5.3	59
19	4.9	4.9	6.5	3.2	5.6	14
M	3.4	5.2	5.7	1.0	3.0	66
G	9.3	4.7	3.3	1.3	10.4	83
H	3.4	4.9	3.4	1.2	5.0	77
E	3.2	4.9	3.5	1.9	4.1	53
W	6.1	4.6	2.3	1.1	7.6	86
mean	4.3	5.0	6.6	2.5	6.3	62
			Oxisol (0-10 cm)			
A	1.5	4.5	1.2	0.4	4.2	93
C	2.9	4.4	4.3	0.5	3.5	36
21B l 4/	1.3	5.5	5.7	1.3	1.5	17
" u 5/	1.7	4.7	4.4	0.7	1.8	63
21A l	1.2	4.9	3.2	1.0	1.9	49
" u	1.8	4.8	5.0	0.7	1.3	60
S	1.4	5.0	2.3	0.4	1.2	70
T	2.4	4.3	2.4	0.4	2.2	32
O	4.8	5.1	1.3	1.6	2.7	43
mean	2.1	4.9	3.5	0.8	2.3	62
			Alfisol (0-10 cm)			
L	3.9	7.8	79.7	12.8	12.8	0
			Ultisol (20-40 cm)			
X	2.3	4.9	1.5	0.8	6.1	87
N	1.3	4.8	0.2	0.3	4.8	94
19	2.2	4.9	0.5	0.6	4.2	37
M	2.4	4.7	0.7	0.3	1.9	34
G	7.8	4.7	1.7	0.6	6.5	92
H	1.4	4.9	0.7	0.5	4.8	90
E	1.9	4.9	0.9	0.5	3.7	36
W	1.1	4.6	0.2	0.4	5.7	95
mean	2.6	4.8	0.8	0.5	4.7	39
			Oxisol (20-40 cm)			
A	1.0	4.8	0.6	0.3	4.3	94
C	1.9	4.5	1.1	0.2	2.6	95
21B l	1.3	4.9	1.1	0.2	1.7	37
" u	1.1	4.6	1.3	0.2	2.0	90
21A l	1.0	4.7	0.6	0.2	1.5	89
" u	1.1	4.7	0.8	0.2	1.5	92
S	1.7	4.7	0.7	0.1	1.2	92
T	0.9	4.8	0.3	0.2	2.0	93
O	1.9	5.1	0.2	0.2	1.1	31
mean	1.3	4.8	0.7	0.2	2.0	90
			Alfisol (20-40 cm)			
L	1.8	6.7	3.3	5.2	5.2	1

4/ l = lower slope

5/ u = upper slope

the Ultisol soil mottled at the surface. Mottling that occurs deeper in the horizon was not detrimental since the best growing plots (X and A) had mottling at 24 and 28 cm respectively.

Table 5. Soil texture, depth of A horizon, and depth to mottling and gley of the Jari deglupta trials.

Trial Code	Horizon Texture A	Horizon Texture B	Depth of A Horizon (cm)	Depth to mottling d 6/	Depth to mottling s 7/	Depth to Gley
		Ultisol				
X	silty-clay-loam	clay	49	24	49	49
N	clay-loam	clay	42	28	42	81
19	clay	clay	33	-	-	-
M	clay-loam	silty-clay-loam	31	-	-	-
G	clay	heavy-clay	40	40	-	-
H	clay-loam	heavy-clay	33	33	-	-
E	clay	heavy-clay	60	33	60	93
W	heavy-clay	heavy-clay	28	0	-	12
		Mean	40			
		Oxisol				
A	sandy-clay	clay	83	28	-	-
C	sandy-clay	sandy-clay	128	-	-	-
21B l	sandy-loam	sandy-clay-loam	39	-	-	-
" u	sandy-clay-loam	sandy-clay-loam	27	-	-	-
21A l	loamy-sand	sandy-clay-loam	48	23	155	-
" u	sandy-clay	sandy-clay	32	-	-	-
S	sandy-loam	sandy-loam	103	-	-	-
T	sandy-clay	clay	50	-	88	-
O	clay-loam	silty-loam	29	-	-	-
		Mean	60			
		Alfisol				
L	clay-loam	clay-loam	37	-	-	-

6/ Diffuse mottling

7/ Severe mottling

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sessão session grupo group V C

MOBILIZAÇÃO DE ELEMENTOS MINERAIS POR ALGUMAS ESPÉCIES ARBÓREAS DE RÁPIDO CRESCIMENTO.

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Resumo

Os geneticistas fazem uso da análise mineral para a seleção, e devido ainda ao fato de que são poucas as informações disponíveis à respeito do papel diferencial desempenhado pelos elementos, assim como suas variações no que diz respeito a espécies arbóreas de rápido crescimento, parece útil resumir alguns resultados para as seguintes espécies: *pinus kesiya, P. caribaea, Eucalyptus grandis, E. platyphylla, Terminalia arvorensis* e *Aucoumes klainèana*, em relação aos métodos de amostragem que foram utilizados.

MOBILIZATION OF MINERAL ELEMENTS BY SOME FAST GROWING TREE SPECIES.

Summary

Geneticians use mineral analysis for the selection of plants. Because of the few information available on the levels of elements and their variation concerning fast growing tree species, it appears useful to supply some results for the following species : Pinus kesiya and caribaea, Eucalyptus grandis and platyphylla, Terminalia ivorensis and Aucoumea klaineana, with reference to the sampling methods used.

MOBILIZATION EN ELEMENTS MINERAUX PAR QUELQUES ESSENCES FORESTIERES TROPICALES A CROISSANCE RAPIDE.

Resumé

Les analyses des éléments minéraux sont maintenant d'une pratique courante dans les études sur la nutrition des arbres forestiers.

Les généticiens utilisent d'ailleurs ces méthodes pour l'identification des clones, pour la sélection des génotypes adaptés à des conditions de site défavorables telles que déficience en éléments nutritifs, toxicité, pollution, fortes attaques parasitaires, sécheresse... ou encore pour interpréter les différentes réponses à une fertilisation.

On a constaté, en effet, maintes fois, dans des conditions de culture semblables, des différences de métabolisme et donc de croissance entre génotypes (1976, Kleinschmit et Sauer dans "Tree physiology and yield improvement"), les hauteurs des plants étant corrélées avec la teneur d'un ou plusieurs éléments dans tous les organes selon le génotype. D'où l'intérêt de l'utilisation des techniques d'analyse minérale pour une sélection précoce des provenances les mieux adaptées dans un programme d'amélioration (E.H. Evers et W. Bücking dans Modern methods in forest genetics, 1976).

Les études sur la nutrition minérale, notamment des conifères et de certains feuillus, en zone tempérée sont relativement nombreuses. Il n'en est pas de même pour les essences forestières tropicales, nos connaissances sur les teneurs en éléments majeurs et en oligoéléments et sur leurs variations étant ou rares et souvent peu précises, ou parfois inexistantes, notamment chez les espèces à croissance rapide.

Les résultats des recherches effectuées au Centre Technique Forestier Tropical sur les maladies de carence étant susceptibles de fournir aux spécialistes quelques éléments de comparaison intéressants sur la nutrition minérale des essences tropicales à croissance rapide, il nous a semblé utile de donner ici un aperçu rapide de quelques-uns d'entre eux.

L'échantillonnage : 1) diagnostic foliaire simple :

a) prélèvement de la deuxième feuille verte adulte après les feuilles juvéniles dans la partie supérieure du houppier (deuxième à quatrième verticille de branches selon l'âge), à raison de 4 à 6 feuilles par arbre et sur 20 arbres au minimum par station ou placette dans le cas des feuillus.

b) prélèvement des aiguilles de la pousse qui précède celle en cours de croissance dans la partie supérieure du houppier (deuxième à quatrième verticille de branches selon l'âge) sur 20 arbres au minimum, dans le cas des Pins.

2) diagnostic complet : afin de tenir compte des variations souvent importantes observées selon le niveau de prélèvement, on considère les tiers inférieur, moyen et supérieur du fût de l'arbre séparément et de même à chaque niveau pour les feuilles et les tiges.

On distingue donc : a) les feuilles jeunes, adultes et âgées sur l'ensemble des branches de chaque niveau (prélèvement d'une quantité aliquote), soit 9 échantillons au total.

b) les grosses branches, les branches de diamètre moyen et les rameaux à chaque niveau (prélèvement d'une quantité aliquote) soit 9 échantillons au total.

c) le bois, en distinguant écorce, aubier, zone intermédiaire et bois parfait, à chaque niveau soit 12 échantillons au total. Sur les jeunes arbres, on distingue écorce et bois.

On effectue d'autre part parallèlement un certain nombre de prélèvements en vue de déterminer le poids sec de chaque constituant et les mensurations et pesées pour estimation des volumes et poids vert (détermination de l'humidité à 103°C).

Epoque et mode de prélèvement : les prélèvements sont effectués entre 7 h et 9 h du matin un jour sans pluie et s'il n'y a pas eu de pluie pendant les 24 heures précédentes, en général en début de saison sèche, sinon en début de période de forte croissance.

Préparation des échantillons : dès la récolte les échantillons pour analyses sont séchés en étuve à 65°C pendant 2 à 4 jours puis réduits en poudre aussi fine que possible et bien homogénéisés.

Méthodes d'analyses : selon le tableau ci-après :

Elément	N	Fe Mn Cu Zn K	Ca	Mg	Na	P	S	B
Minéralisation	Digestion SO_4H_2 (Kjeldahl)	Calcination à 550° reprise par HCl. reprise par FH et reprise par HCl					Digestion NO_3H calcination à 520° en présence de $(NO_3)_2Mg$ reprise par HCl	Calcination à 430°C reprise par SO_4H_2
Dosage	Déplacement NH_3 Titration volumétrique par neutralisation en retour	Spectrométrie d'absorption atomique	avec addition de chlorure de lanthane		avec addition de chlorure de cesium	Spectrométrie moléculaire à 430 nm du complexe phosphovanadomolybdique	Turbidimétrie sur le sulfate de baryum	Spectrométrie moléculaire à 630 nm du colorant développé dans la dianthrimide

I - <u>Pinus kesiya</u>

1) composition minérale des feuilles : d'après des prélèvements effectués sur des essais mis en place par le Département des Recherches Forestières et Piscicoles à Madagascar.

Station	Caractéristiques de la station	Origine	Age des plants	N	P	K	Ca	Mg	Na	S	B	Fe	Mn	Cu	Zn	Al
Morarano	Carence en Zn,	Andraimbe (Madagascar)	38 mois	0,66	0,044	0,28	0,14	0,05	0,006	0,078	26,9	33	157	0,7	3,9	278
	K et P	Zomba (Malawi)	"	1,19	0,059	0,19	0,25	0,05	0,003	0,081	12,8	42	318	1,5	5,3	227
		Talogbor (Philippines) (1)	"	1,50	0,067	0,36	0,16	0,08	0,006	0,086	33,4	32	240	2,4	8,4	164
		Bodana (Madagascar)	"	1,01	0,051	0,15	0,32	0,10	0,006	0,104	12,8	32	326	1,8	4,2	263
Ampototra	Forte carence en	Ambatofinandrana (Madagascar)	56 mois	1,24	0,078	0,13	0,15	0,09	0,003	0,047	27,1	51	254	1,6	7,6	622
	Zn et K, carence	Andraimbe (Madadascar) (2)	"	1,20	0,075	0,10	0,15	0,08	0,003	0,057	30,2	52	231	1,6	5,6	629
	en P et toxicité	Bontoc (Philippines)	"	1,09	0,088	0,10	0,08	0,07	0,003	0,070	20,9	57	185	1,5	7,4	447
	Al	Fandriana (Madagascar) (3)	"	1,15	0,065	0,15	0,07	0,06	0,003	0,041	13,7	46	174	1,3	6,9	402
Besakay (4)	Carence en Zn, P	Zambie	57 mois	1,97	0,079	0,22	0,70	0,18	0,041	0,106	24,5	128	402	20,7	7,8	689
	et K - forte	Bontoc (Philippines)	"	1,53	0,091	0,22	0,66	0,19	0,041	0,106	23,4	82	391	21,7	9,0	566
	toxicité Al	Fandriana (Madagascar)	"	1,58	0,079	0,18	0,42	0,16	0,042	0,106	26,3	70	400	22,5	11,7	596
Andoharanomaitso	Bonne fertilité	Ambatofinandrana (Madagascar)(5)	42 mois	1,30	0,130	1,11	0,11	0,14	0,010	0,064	10,5	53	58	1,9	18,3	-

macroéléments en % de la matière sèche - oligoéléments en ppm

R e m a r q u e s : (1) = seule provenance de l'essai ne présentant aucun symptome de déficience
(2) = provenance présentant les symptomes les moins importants
(3) = provenance présentant les symptomes les plus graves
(4) = symptomes légers pour les 3 provenances
(5) = bonne croissance.

2) composition minérale de l'arbre entier (feuilles + branches + tronc + racines), d'après des prélèvements effectués sur des arbres de la provenance Ambatofinandrana (Madagascar) dans des essais mis en place à Madagascar

Station	Zone	Aspect du plant	Age	Hauteur totale	Diamètre à la base	Poids sec total	N	P	K	Ca	Mg	S	B	Fe	Mn	Cu	Zn
Besakay	malade	légèrement déficient	24mois	1,35 m	4,77 cm	1.190 gr	0,84	0,05	0,2	0,07	0,11	0,03	0,0008	0,022	0,007	0,0002	0,0006
Analabe	malade	sain	22mois	1,47 m	5,25 cm	1.056 gr	0,72	0,07	0,3	0,18	0,14	0,04	0,0008	0,032	0,004	0,0002	0,0011
Andoharanomaitso	saine	sain	42mois	4,57 m	13,69 cm	7.805 gr	0,62	0,05	0,4	0,23	0,10	0,04	0,0005	0,018	0,004	0,0002	0,0012

en % du poids sec total

II - <u>Pinus caribaea</u>

21) Composition minérale des aiguilles, d'après des prélèvements effectués sur 4 arbres d'une même provenance à l'âge de 7 ans ½ dans la station de Loandjili en République Populaire du Congo

	N	P	K	Ca	Mg	S	B	Cu	Zn
Arbre n° 1	0,82	0,125	0,56	0,11	0,20	0,05	21	1	18
2	0,98	0,120	0,64	0,13	0,19	0,06	24	1	16
3	0,79	0,116	0,52	0,10	0,16	0,05	24	1,2	15
4	0,93	0,116	0,61	0,11	0,18	0,06	20	1,3	21

macroéléments en % de la matière sèche
oligoéléments en ppm

Remarque : on n'observe aucune différence entre ces arbres, les teneurs sont sensiblement identiques pour presque tous les éléments analysés.

22) Composition minérale du fût (écorce et bois)
prélèvements effectués sur les mêmes arbres que ci-dessus

N° arbre	Hauteur totale	Circonférence à 1,50 m	Volume vert	Poids anhydre écorce	Poids anhydre bois	N	P	K	Ca	Mg	S	B	Cu
1	10,40 m	43 cm	95dm3	7,2kg	28 kg	0,054	0,011	0,016	0,06	0,018	0,009	0,0002	0,0001
2	12,10	49	105	8,0	30,9	0,060	0,012	0,012	0,06	0,022	0,008	0,0002	0,0001
3	9,85	42	73	5,6	21,5	0,069	0,012	0,024	0,04	0,032	0,013	0,0003	0,0002
4	10,90	46,5	98	7,6	28,8	0,065	0,014	0,020	0,06	0,020	0,013	0,0002	0,0002

en % du poids anhydre total

Remarque : on note par contre à ce niveau une certaine hétérogénéité des teneurs des éléments analysés entre les arbres.

III – Eucalyptus grandis

Composition minérale du fût (écorce et bois) d'Eucalyptus de 6 ans d'un essai provenance mis en place en 1973 par le Département des recherches forestières et piscicoles à Madagascar dans la station de Mahela

Origine	Hauteur totale	Diamètre à 1,50 m	Volume frais fût	Poids anhydre fût	N	P	K	Ca	Mg	Na	S	B	Fe	Mn	Cu	Zn
Atherton	12,50 m	14 cm	104060cm3	47673 gr	0,14%	0,03%	0,12%	0,18%	0,10%	0,06%	0,01%	0,0009%	0,003%	0,03%	0,0004%	0,0005%
Atherton	10,50 m	10,8cm	56714cm3	27005 gr	0,10%	0,03%	0,10%	0,14%	0,07%	0,06%	0,02%	0,0004%	0,003%	0,015%	0,0002%	0,0005%
Angavokely	11,30 m	14,2cm	97085cm3	42613 gr	0,13%	0,03%	0,13%	0,16%	0,06%	0,09%	0,015%	0,0006%	0,005%	0,02%	0,0003%	0,0006%
Ampamaherana	8,55 m	9,4	36547cm3	12886 gr	0,15%	0,04%	0,10%	0,35%	0,12%	0,08%	0,013%	0,0005%	0,0005%	0,04%	0,0003%	0,0006%

en % du poids anhydre total

IV – Eucalyptus platyphylla

Composition minérale de jeunes plants de 4 mois (feuilles, tiges et racines) d'après des prélèvements effectués dans un essai de plantation avec fertilisation à Loandjili en République Populaire du Congo

Hauteur	Poids sec	N	P	K	Ca	Mg	S	B	Cu	Zn
62 cm	35 gr	0,8	0,14	0,29	0,40	0,24	0,07	0,0011	0,0007	0,018
74 cm	50 gr	1,14	0,12	0,21	0,36	0,20	0,08	0,0012	0,0005	0,0011
87 cm	135 gr	1,48	0,14	0,79	0,42	0,21	0,07	0,0008	0,0006	0,0009
97 cm	180 gr	1,57	0,14	0,91	0,28	0,15	0,08	0,0008	0,0006	0,0007
102 cm	185 gr	1,49	0,13	1,22	0,38	0,11	0,10	0,0008	0,0006	0,0007
110 cm	262 gr	1,35	0,13	1,24	0,33	0,12	0,11	0,0007	0,0008	0,0006

en % du poids total anhydre.

L'influence de la potasse sur la croissance des plants est ici très nette, ainsi que l'antanogisme K – Mg.

V – Terminalia ivorensis

a) Composition minérale des feuilles : prélèvements effectués en Côte d'Ivoire dans une plantation de 1952 à Yapo et dans un peuplement naturel à Goudi.

Station	Age	N	P	K	Ca	Mg	S	B	Fe	Mn	Cu	Zn
Yapo	22ans	1,62	0,114	0,80	0,76	0,171	0,108	21	85	93	13	20
"	"	1,68	0,147	1,15	0,50	0,172	0,123	14	64	64	13	17
"	"	1,26	0,095	0,61	0,60	0,175	0,088	27	100	42	11	14
"	"	1,66	0,148	1,02	0,84	0,182	0,106	20	102	52	10	15
Goudi	17ans	1,46	0,117	0,62	0,84	0,360	0,110	35	125	121	13	23
"	23ans	1,26	0,109	0,68	0,85	0,240	0,110	30	111	95	14	25

macroéléments en % de la matière sèche – oligoéléments en ppm

b) Composition minérale du fût (écorce et bois) d'après des prélèvements effectués en Côte d'Ivoire, à Goudi, sur des arbres d'un peuplement naturel

Age	Hauteur	Poids sec	N	P	K	Ca	Mg	S	B	Fe	Mn	Cu	Zn
17ans	26,5 m	1461 kg	0,19	0,008	0,15	0,17	0,05	0,042	0,00047	0,0034	0,0011	0,00015	0,00107
18ans	34,5 m	2654 kg	0,17	0,007	0,16	0,19	0,05	0,024	0,00045	0,0032	0,0012	0,00024	0,00091
23ans	34,0 m	2473 kg	0,17	0,007	0,14	0,19	0,05	0,034	0,00042	0,0031	0,0012	0,00016	0,00067

en % du poids sec total

VI – Aucoumea klaineana

a) Composition minérale des feuilles : prélèvements effectués dans la station de la M'Voum au Gabon sur des arbres âgés de 3 ans

Origine	Hauteur moyenne	N	P	K	Ca	Mg	S	B
Cap Esterias (Gabon)	4,64 m	2,3	0,128	0,98	0,53	0,244	0,125	32
"	5,14 m	2,2	0,132	0,98	0,49	0,237	0,125	36
"	5,84 m	2,3	0,138	0,82	0,57	0,262	0,197	26
Rép. Pop. du Congo	4,18 m	2,2	0,139	0,96	0,61	0,237	0,128	31
"	4,70 m	2,2	0,138	0,92	0,48	0,219	0,135	25
"	5,56 m	2,2	0,144	0,93	0,66	0,235	0,142	31
Guinée équatoriale	4,50 m	2,3	0,135	0,92	0,52	0,247	0,104	30
"	5,47 m	2,2	0,126	0,87	0,57	0,250	0,168	29
"	5,82 m	2,3	0,150	0,97	0,49	0,268	0,173	33
Pointe-Denis (Gabon)	4,56 m	2,3	0,144	0,92	0,57	0,245	0,122	31
"	5,97 m	2,3	0,135	0,92	0,48	0,240	0,142	26
"	6,70 m	2,2	0,150	0,87	0,57	0,244	0,168	23

La croissance est d'autant plus forte que les teneurs en soufre et phosphore sont élevées pour une même provenance.

macroéléments en % de la matière sèche – oligoéléments en ppm

b) Composition minérale de la partie aérienne (feuilles, branches et tronc) d'après les prélèvements effectués sur des arbres de plantation dans la station de la M'Voum au Gabon

Age	Hauteur	Poids sec	N	P	K	Ca	Mg	S	B	Fe	Mn	Cu	Zn
4½ ans	10,71 m	28650 gr	0,37	0,04	0,40	0,27	0,1	0,06	0,0007	0,005	0,0012	0,0006	0,0009
6½ ans	15,47 m	108343 gr	0,34	0,03	0,36	0,26	0,1	0,05	0,0007	0,005	0,0011	0,0007	0,0009
8½ ans	16,66 m	92384 gr	0,33	0,03	0,35	0,22	0,09	0,05	0,0007	0,006	0,0008	0,0006	0,0012

en % du poids sec total

FAST GROWING TREES

ESTUDOS DE NUTRIÇÃO DE *Eucalyptus camaldulensis* IRRIGADO NO NORTE DA AUSTRÁLIA.

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Resumo

Os conteúdos de nitrogênio, fósforo, enxofre, zinco, ferro e outros nutrientes vegetais (potássio, magnésio, cobre, boro e molibdênio) foram analisados em um experimento fatorial realizado em floresta irrigada de *Eucalyptus camaldulensis* Dehn., em argilas alcalinas de grande expansividade.

O nitrogênio produziu uma resposta altamente significativa ($P < 0{,}001$) no crescimento em diâmetro e em altura, havendo ainda um benefício adicional resultante da aplicação do fósforo ($P < 0{,}05$). A sobrevivência foi considerada excelente, mas o ataque de brocas reduziu o crescimento e afetou a forma. Foram desenvolvidas equações de regressão para peso seco, diâmetro do tronco e altura. Decorridos 42 meses, as parcelas que receberam nitrogênio e fósforo apresentavam produção de 25,6 ton/ha de madeira de tronco, enquanto que parcelas irrigadas e que receberam nitrogênio e fósforo apresentavam produção da ordem de 31,8 ton/ha, dando um incremento anual de 15,4 ton/ha.

Um método bem sucedido de irrigação e fertilização de *E. camaldulensis* para a região do Rio Ord foi desenvolvido, e a produção de matéria seca e de volume de madeira verificadas revelam o *E. camaldulensis* como espécie de apoio para qualquer indústria de fibras.

NUTRITION STUDIES WITH IRRIGATED *Eucalyptus camaldulensis* IN NORTHERN AUSTRALIA.

Summary

Nitrogen, phosphorus, sulphur, zinc and iron, and other plant nutrients (potassium, magnesium, manganese, copper, boron, and molybdenum) were tested in a factorial experiment with irrigated Eucalyptus camaldulensis Dehnh. on an alkaline cracking clay in the Ord River Irrigation area.

Nitrogen significantly increased height and diameter and there was an additional benefit from the application of phosphorus. Survival was excellent but borer attack reduced growth and affected form. Regressions for dry weight have been derived from stem diameter and height. After 42 months the nitrogen and phosphorus treated plots averaged 25.6 t/ha stemwood while some lower slope nitrogen and phosphorous plots averaged 31.8 t/ha stemwood with a current increment of 15.4 t/ha/annum.

A successful method of irrigating and fertilizing E. camaldulensis has been developed for the Ord River Irrigation Area and production of dry matter and volume indicates that this could be a valuable species for pulping.

INTRODUCTION

Approximately 70% of Australia's forest harvest consists of eucalypt timber which is used for a wide range of purposes including fuel, furniture, construction, and paper. While the annual cut has increased slightly over the last 30 years, the cut of plantation conifer timber has increased much faster as plantations established during the same period reach a productive age. Eucalypt forests are expected to have a continuing but declining role and until recently little research effort had been directed towards improving their productivity and this mostly in the south-east and south-west of the continent. In northern Australia, there is a small timber industry centred on the better watered areas of the east coast. There is a need to produce timber for a range of uses in other parts of the north and recent trials indicate that plantation forestry will be limited to the deeper soils in the areas receiving more than 1500 mm on the central north coast (unpubl. data).

A wide range of crops have been tested under irrigation at Kununurra in the Ord River Irrigation Area in northern Western Australia, including the annual fibre crop kenaf (Hibiscus cannabinus L.). Its early performance was promising and it was considered necessary to investigate the possibility of some traditional forest fibre crops for comparison. As little information was available on the response of tropical tree species to irrigation, a broad range of 27 species was tested in a 1974 trial (unpubl. data). Of the ten eucalypts, Murray River red gum (Eucalyptus camaldulensis Dehnh.) was the best in height and diameter growth. After twelve months, health of most species including E. camaldulensis had deteriorated and this was attributed to inadequate soil aeration or nutritional deficiencies.

In this paper we report on an experiment testing a range of nutrients applied to irrigated E. camaldulensis planted on high mounds in a cracking clay at Kununurra.

MATERIALS AND METHODS

The soils of the Ord River Irrigation Area are dark brown to very dark greyish brown (10YR 3/3-3/2) medium to heavy alkaline clays with pronounced swelling and shrinkage properties. Those in the vicinity of the experimental area are described by Gunn (1969) and the site selected would conform with the classification of a Cununurra clay.

Flat-topped mounds 2.5 m wide by 45 cm high were constructed 3.5 m apart down the slope (approximately 10 cm/100 m) with a grader. The whole experimental area was enclosed by a high embankment allowing gravity flooding from an adjacent irrigation channel. Tops of the mounds were to be kept free of irrigation water and the excess water released through the embankment after four to five days, however the lower slope did not drain completely. Irrigation was planned for 6-8 week intervals during the dry season but the trial was only irrigated twice in 1978 and four times in 1979.

The experimental design was a 2^5 factorial confounded into blocks of eight plots, with the long axis of the blocks parallel with the contour (Cochran and Cox 1957). The five treatments were nitrogen, phosphorus, sulphur, zinc and iron combined, and other plant nutrients (potassium, magnesium, manganese, copper, boron, and molybdenum). Details of applications are given in Table 1.

Seed from the Fergusson R., Northern Territory was germinated in sand, pricked out shortly after the cotyledonary stage into 7.5 cm flatlay polythene tubes, 18 cm long, and planted when 30-40 cm in height. Ten mounds were planted with two staggered rows at 3 m spacing within rows and 2.5 m between adjacent plants in adjoining rows (1111 plants/ha). A plot consisted of 2 rows of 6 seedlings. Two isolation mounds were also planted, and trees were removed at 6, 12, 19, and 28 months to provide a range of sizes for biomass determinations. At 42 months trees were removed from plot boundaries. All trees were measured at establishment and after 6, 12, 19, 28, and 42 months. Foliar samples were collected for laboratory analysis at each measurement date and these results will be published elsewhere.

RESULTS

After six months there was a highly significant height response to nitrogen application (N_0 = 143 cm; N_1 = 180 cm; $P < 0.001$) and at twelve months there was a small ($P < 0.05$) additional response to applications of phosphorus. Differences between replicates were pronounced with a marked height increase down the slope of the experiment; this was attributed to uneven water distribution. These responses were observed at the 19, 28, and 42 month measurements. The results for the 42 month measurement are given in Table 2. There were no other significant responses to nutrients and no interactions.

Survival and health were very good throughout the duration of the experiment. Of the 768 plot trees planted, only four had died at 28 months, and there were no further losses. Eleven were extensively damaged by borer attack and its incidence increased with time. After 42 months, 65 trees (8.5%) had suffered stem breakage during storms; 24 at a stem fork, 27 at a borer site, and the others had no obvious cause. Most of the damaged trees produced vigorous epicormic growth below the break, with one leader becoming dominant after a few months. Symptoms of ill-health detected in the 1974 trial were not repeated.

Linear regressions were derived from 23 sample trees and were used to estimate stem dry weight (including bark) and total dry weight (stem + branches + leaves) from heights (ht) and diameters (dbhob). The estimating equations (1) and (2) accounted for 95.5% and 94.0% of the variance respectively.

Stem dry wt. (kg) = 0.05206 volume - 0.03786 ....(1)
Total dry wt. (kg) = 0.06718 volume + 0.79594 ....(2)
where volume = 0.5 basal area. ht.

Linear regressions on $dbhob^2.ht^2/(ht-1.30)$ accounted for 95.3% and 94.1% of the variance respectively. Mean tree dry weights from equations (1) and (2) and volumes are shown in Table 2.

DISCUSSION

The major fertilizer requirement for E. camaldulensis was nitrogen, with a smaller need for phosphorus. The interaction was not significant, but in terms of biomass production the combined treatment was of interest (mean tree stem production at 42 months (kg); N_oP_o = 12.2, N_oP_1 = 14.6; N_1P_o = 22.5; N_1P_1 = 25.6). Droughting in the four NP plots at the bottom of the slope was rare and these plots yielded stem dry weights and total dry weights of 31.8

Table 1.

Times and rates of fertilizer applications (g element/tree).

Treatment	Form	Months since planting 0^A	3^A	6^A	11^A	12^D	19^D	28^D
N;	urea	1.7	7.4	7.4	7.4	46.0	46.0	46.0
P;	$NaH_2PO_4.H_2O$	12.9	-	-	-	-	-	-
	$Ca(H_2PO_4)_2.H_2O$	-	6.2	-	6.2	25.0	25.0	18.7
S;	$CaSO_4.2H_2O$	4.4	2.2	-	2.2	7.2	-	-
	flowers of S	-	-	-	-	-	30.0	30.0
Zn + Fe;	Zn chelate	1.5 g/l[B]	1 g/l[B]	-	-	1.2 g/l[B]	-	-
	$ZnSO_4.H_2O$	-	-	-	-	-	3.6	3.6
	Fe chelate	1.5 g/l[B]	1 g/l[B]	-	-	1.2 g/l[B]	-	-
	$FeSO_4.7H_2O$	-	-	-	-	-	-	2.9
Rest K;	$K HCO_3$	7.8	3.9	-	3.9	19.5	19.5	19.5
Mg;	$MgCO_3$	2.1	1.1[C]	-	1.1	5.4	5.4	5.4
Mn;	$MnCl_2$	0.4	0.2[C]	-	-	-	-	-
Mn;	$MnSO_4.8H_2O$	-	-	-	-	1.4	1.4	2.8
Cu;	$CuCO_3$	0.7	-	-	-	1.4	-	-
Cu;	$CuSO_4.5H_2O$	-	0.1[C]	-	-	-	0.5	1.3
B;	$Na_2B_4O_7.10H_2O$	0.1	0.06[C]	-	-	0.6	0.6	1.1
Mo;	Na_2MoO_4	0.02	0.01[C]	-	-	0.05[C]	-	0.47

[A] Applied in pockets near the base of the tree unless indicated otherwise.
[B] Applied as a foliar spray with wetting agent.
[C] Applied in solution around the base of the tree.
[D] Applied in a semi-circle of about 1 m radius to the top of the mound, ensuring that none of the fertilizer fell into the water in the channel.

Table 2.

Growth responses to nitrogen and phosphorus after 42 months.

Treatment	Mean Plot Height (m) Total	CAI	DBHOB (cm) Total	CAI	Estimated Stem Volume (m^3) Total	CAI	Estimated Dry Wt. (kg) Stem Total	CAI	Stem + Branches Leaves
N_o	8.72	1.99	8.68	2.03	.0267	.0140	13.4	7.0	18.1
N_1	9.92	2.14	10.89	2.45	.0474	.0240	24.0	12.2	31.8
P_o	9.19	2.06	9.48	2.13	.0343	.0173	16.8	8.6	22.6
P_1	9.44	2.09	10.09	2.35	.0399	.0206	19.6	10.2	26.2
LSD P<0.05	0.24	0.11	0.40	0.21	[illegible]	.0021	-	-	-

and 41.9 t/ha (about 60 m^3/ha) at 42 months with current annual increments of 15.4 and 23.2 t/ha respectively. This was achieved with a nitrogen input of 182 kg/ha in total compared with typical inputs of 200-240 kg/ha/annum for kenaf.

Loss of production from insect attack (both borers and leaf eaters) and wind damage has not been a major problem. Damage from birds has not been recorded in this experiments but was in earlier trials. Insects, birds, and wind could be major causes for damage and loss with this species in the Ord River Irrigation Area. As with other eucalypts, R. camaldulensis has demonstrated a strong ability to coppice from wind damaged stems. Such a feature could be advantageous for ratoon cropping.

There are few reports on irrigated trials with this species. Karschon (1970) reported increased mean annual volume increments over a four year period from 7 m^3/ha to 14-16 m^3/ha with 6-8 irrigations per year. In a provenance trial, Hafeez and Sheikh (1972) recorded mean heights of 10-11 m and mean diameters of 9.9-11.5 cm after six growing seasons with their better provenances. The absence of further information on growth, soil type, and irrigation methods in either paper makes more detailed comparisons difficult. Our mean annual and current annual increments in the N_1 treatment after 3½ years of about 13 and 24 m^3/ha respectively (assuming 1000 trees/ha) are close to Karschon's results. However, our height and diameter performance is superior to that reported by Hafeez and Sheikh.

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OS ASPECTOS NUTRICIONAIS DA SILVICULTURA DE ROTAÇÕES CURTAS.

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Resumo

Foram f.itas comparações em termos de biomassa e de conteúdo de nutrientes em *Eucalyptus delegatensis* e *Pinus radiata*, com a finalidade de verificar:

a) se o eucalipto apresenta uma menor exigência nutricional (principalmente de fósforo) do que outros gêneros;

b) em que proporção o período de rotação modifica a hipótese acima.

Foi concluído que o eucalipto pode apresentar uma menor exigência de fósforo, mas apenas quando cresce em rotações médias e longas. Para rotações de 7 anos ou próximas, onde a maior parte da madeira retirada é constituída de algurno, parece haver pouca diferença entre o eucalipto e outros fêneros.

Estas conclusões apresentam importância em silvicultura de espécies de rápido crescimento, onde se procura a manutenção de uma produtividade ótima ao longo de rotações múltiplas.

THE NUTRITIONAL EFFECT OF SHORT ROTATIONAL SILVICULTURE.

Summary

The biomass and nutrient content of *Eucalyptus delegatensis* and *Pinus radiata* stands were compared to see if:

(a) eucalypts have a lower absolute nutritional requirement (particularly phosphorus) than other genera, and

(b) how much the length of rotation modifies the hypothesis (a) above.

We conclude that eucalypts may have a lower absolute requirement for phosphorus, but only if grown on medium to long rotations. For rotations of 7 years or thereabouts, where most of the harvested wood is sapwood, there may be little difference between eucalypts and other genera.

These conclusions have significance in the silviculture of fast-grown trees if optimal and sustained productivity through multiple rotations is to be ensured.

I N T R O D U C T I O N

The nutritional requirements of eucalypts have received relatively little research, despite the increasing use of the species as a forest crop throughout the world. Only a few references on nutrition are listed in the review by Hillis and Brown (1978), most of which concern fertilisation of eucalypts at establishment.

The nutrition of eucalypts may be somewhat unique because of the generally infertile forest soils of Australia with which eucalypt forest ecosystems have evolved. Australian sclerophyll forests are dominated by the genus *Eucalyptus* and the family *Leguminacea*, and have evolved over long periods of geological time, during which soil fertility has declined. The majority of forest soils in Australia are low in nutrients (especially P). Total P concentrations of 100-300 $\mu g.g^{-1}$ are the average in the surface horizons of most Australian forest soils and P is moderately to strongly fixed by aluminium and iron oxides. Phosphorus is almost universally limiting in Australia and most grazing and agricultural cropping requires regular additions of phosphatic fertilisers.

The question thus arises as to whether eucalypts have evolved a special or unique physiology to survive and grow on such relatively infertile soils. The answer to this question may be relevant to the nutrition of fast growing eucalypts in Brazil and elsewhere outside of Australia.

In relation to phosphorus, Attiwill (1980) indicated that although eucalypts do not appear to be any more efficient than other genera at keeping phosphorus within the biomass, there was evidence that eucalypts may in fact have a low absolute requirement for P.

We studied the nutrient requirements of native eucalypt stands (*E. delegatensis*) and the most commonly used fast-growing tree species in Australia - *Pinus radiata*. Measurements of biomass and the P content of stems were made for both stands at several ages. Our conclusions support Attiwill's thesis that eucalypts may have a low absolute requirement for phosphorus.

However in examining the biochemical cycle of phosphorus across the sapwood/heartwood boundary in the stem of the trees as heartwood is formed, we have shown that the absolute requirement for phosphorus per unit of biomass increases markedly if rotations are shortened.

This paper briefly summarises an earlier one on this topic (Crane et al. 1980) of *E. delegatensis* and *P. radiata*. The paper is also a summary of a similar paper presented earlier this year to the ANZIF conference 'Plantation Forestry - What Future?' in Rotorua, N.Z. (Crane *et al.* 1980), and further details can be obtained from this paper.

M E T H O D S

Two almost pure, unthinned stands of *E. delegatensis* aged 25 and 49 years respectively were measured and sampled for estimation of biomass. Cross sectional discs of wood and bark were cut from selected felled trees, and were sub sampled into two categories of bark ('old' = rough/dead, and 'new' = inner/live), and into five-year intervals of growth rings within the visible heartwood, and inner and outer sapwood. The biomass of the stem and bark components were calculated, and phosphorus (P) was determined on Kjeldahl digests. The estimates of biomass and P in stems was extrapolated to an area basis and for two ages (to match the ages of the pine stands) using yield tables for *E. delegatensis* (Lindsay 1939)

Two plantations of *P. radiata* aged 22 and 40 years on similar soil and sites were similarly sampled and measured. The pine data was then fitted into two strategies of plantation management:

(a) a clear felling at age 18, and

(b) four thinnings at ages 16, 22, 28, 34, followed by clear felling at age 40.

R E S U L T S

Some characteristics of the four stands are summarised in Table 1.

Table 1. Stand characteristics

Stand	Height (m)	Mean dbhob (cm)	Merch. vol. ($m^3 ha^{-1}$)	MAI	Biomass ($t\ ha^{-1}$) Wood	Bark	Stem (w+b)
E. delegatensis unthinned and clearfelled at age 18	22	14	220	12	152	18	170
E. delegatensis unthinned and clearfelled at age 57	42	48	740	13	486	25	511
P. radiata unthinned and clearfelled at age 18	26	22	345	19	177	44	221
P. radiata thinned at ages 16,22,28,34 c.f. at age 40	38	53	911	23	466	89	545

Table 2 summarises the concentrations of P in the wood and bark of *E. delegatensis* and *P. radiata*.

The two most significant features are:

(a) the marked reduction in P concentration from outer sapwood to inner sapwood and into the heartwood. This was the most pronounced in *E. delegatensis*, in which the ratio of P concentration in the outer sapwood to that in the heartwood was 33 (or more) : 1. The ratio for *P. radiata* was approximately 9:1, and

(b) the number of sapwood rings (and hence amount of sapwood) was much less in *E. delegatensis* (7 years) than in *P. radiata* (17-25 years).

Table 2. Concentration of P in wood and bark and partitioning of wood

	E. delegatensis		*P. radiata*	
Age	25	49	22	40
P ($\mu g\ g^{-1}$)				
Old bark	102	125	60	
New bark	255	353	502	
Outer sapwood	167	163	156	161
Inner sapwood	34	57	42	32
Heartwood	<15	<5	-	17
Number of annual rings				
Outer sapwood	5	2	5	5
Inner sapwood	2	2	17	25
Heartwood	18	42	0	10

The rates of removal of P from the forest site both per tonne of wood and per unit time (100 yrs) are shown in Table 3.

Table 3. P removal per unit of wood harvested, and removal rate for the two species grown on short and long rotations

	Alpine ash		Radiata pine	
Rotation (yr)	18	57	18	40
P removed ($g\ P\ t^{-1}$ wood) if harvesting				
Wood alone	58	34	94	67
Whole stems (wood + bark)	86	51	192	116
Rate of P removed ($kg\ P\ ha^{-1} 100\ yr^{-1}$) by harvesting				
Wood alone	49	29	92	78
Whole stems	67	44	188	135

The amount of P removed per tonne of *E. delegatensis* wood harvested was less than half that of *P. radiata* at ages 18 and 40/57. The main reason for this is the relatively small amount (7 rings) of sapwood in the eucalypt compared with the pine.

However, had the eucalypt stand been harvested at age 7 when all the harvested wood was sapwood, then the difference between eucalypt and pine in terms of P removed per tonne of wood, would have been small or negligible.

In terms of the drain of P from the soil over time, the differences between the eucalypt and pine at ages 18, and 40/57 were considerable, pine requiring 3-4 times that of eucalypts. Again however, as the MAI's for both species (especially in terms of biomass) were not dissimilar, a comparison at age 7 when all the harvested wood was sapwood would show little difference between species.

The absolute amounts of P removed by harvesting is shown in Table 4.

Table 4. Amount of P removed in stem components from the stands

	Alpine ash		Radiata pine	
Rotation (yr)	18	57	18	40
P removed (kg ha^{-1})				
Wood	8.8	16.5	16.6	31.1
Bark	3.3	8.3	17.3	22.9
Stem (wood + bark)	12.2	24.8	33.9	54.0

CONCLUSIONS

The data are preliminary and have certain limitations which we have discussed previously (Crane *et al.* 1980). Additionally we do not have specific information on rates of nutrient removal when trees are grown on very short (5-10 yr) rotations.

However the data on concentration of P in the wood shown in Table 2 indicate clearly that if rotations of *E. delegatensis* were shortened to the extent where the major proportion of harvested wood is sapwood (5-10 years), then the drain of P will be little different from that of *P. radiata*.

The data as presented in Table 3 show that shortening rotations will increase the rate of P removed from the site in harvesting of both the species examined. For example, two 7 year rotations of *E. delegatensis* will make a considerably greater nutritional drain on the site than one 14 year rotation for a similar MAI and wood yield.

The main difference between *E. delegatensis* and *P. radiata* (and possibly many other genera) may be the age at which the absolute nutritional demand on the site begin to reduce. Eucalypts appear to have an advantage in this respect, with a reduction in demand for nutrients commencing at an earlier age than other genera.

We thus conclude that varying the age of rotation has a strong influence on the absolute nutritional requirements of tree crops in general, and that this factor can possibly negate the hypothesis that eucalypts have a lower absolute nutritional requirement - specifically in relation to phosphorus.

An additional effect of shortening rotations is to increase the proportion of time during which the site is not fully occupied. Nutrient losses due to erosion and leaching, and increased soil respiration leading to loss of soil organic matter may occur during these periods. Shorter rotations also necessitate more frequent disturbance and potential compaction of the soil during harvesting and site preparation, and hence may increase nutrient losses.

We cannot draw any conclusions with respect to possible problems of maintaining productivity through multiple rotations of fast growing eucalypts in Brazil as we have little knowledge of Brazilian soils. Our conclusions (Crane *et al.* 1980) with respect to problems of maintaining productivity in fast growing *P. radiata* plantations in Australia, are specific to the generally infertile soils and variable climatic conditions under which Australian plantations are often grown.

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FAST GROWING TREES

BIOMASSA E ABSORÇÃO DE NUTRIENTES EM FLORESTAS ADUBADAS DE *E. globulus.*

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Australia.

Resumo

O crescimento de *E. glubulus* à idade de 9,5 anos foi relacionado com a quantidade de adubo que as árvores receberam imediatamente após o plantio. O experimento foi desenvolvido nas proximidades de Morwell, em Vitória, na Austrália, e o nível máximo de adubo aplicado forneceu 202 kg de nitrogênio e 90 kg de fósforo por hectare.

A biomassa (parte aérea) total nas parcelas não fertilizadas foi de 31 ton/ha (peso seco), dos quais 62 porcento foi tronco. A biomassa total na parcela que recebeu a maior dose de adubação foi de 83 ton/ha, dos quais 70 porcento foi tronco. O peso de tronco produzido por árvore que receberam a dose máxima dè fertilizante foi 3 vêzes maior do que o peso produzido pelas árvores das parcelas não adubadas.

O conteúdo de nitrogênio do tronco aumentou de 18 porcento da absorção total nas árvores não adubadas, para 28 porcento nas árvores que receberam a dose máxima.

BIOMASS AND NUTRIENT UPTAKE IN FERTILIZED *E. globulus.*

Summary

The growth of *E.globulus* trees aged 9.5 years was related to the quantity of fertilizer they received soon after planting. The experiment was located near Morwell in Victoria, Australia and the highest level of fertilizer supplied 202 kg of nitrogen and 90 kg of phosphorus per ha.

The total (above ground) biomass in unfertilized plots was 31 t per ha (oven dry wt) of which 62 per cent was stemwood. The total biomass in the most heavily fertilized plots was 83 t per ha of which 70 per cent was stemwood. The mass of stemwood produced by trees which received the highest level of fertilizer was 3 times greater than the mass produced by trees in the unfertilized plots.

The nitrogen content of the stemwood increased from 18 per cent of total uptake in the unfertilized trees to 28 per cent in those which had been heavily fertilized. The phosphorus content increased from 18 per cent of total uptake in the unfertilized trees to 38 per cent in the heavily fertilized trees.

Whilst the total uptake of nutrients increased as the quantity of fertilizer increased, there was a drop in the proportion of fertilizer nutrients recovered. A major proportion of the nitrogen and phosphorus in the above ground biomass was located in the leaves, branches and bark of the trees. Whole tree harvesting of short rotation eucalypt plantations would increase the rate of removal of nutrients, particularly phosphorus and increase the need to use fertilizers to maintain productivity.

INTRODUCTION

There has been considerable interest in full tree utilization and short rotation cropping since the concept was proposed (Young 1964). The fertilizer experiment described in this paper provided an opportunity to examine the progressive development of a plantation of *Eucalyptus globulus ssp globulus*. Components of the biomass and the uptake and allocation of nutrients between the components have been examined. Data for the plantation at 9.5 years of age are presented here and earlier results have been published elsewhere by Cromer et.al. 1972 and 1975.

METHODS

Design

The experiment was located at Silver Creek on land owned by A.P.M. Forests Pty. Ltd., south west of Morwell in Victoria, Australia. Seedlings of *E.globulus* were planted in June 1969 at 2.1 m spacing (2196 ha^{-1}). Four levels of fertilizer and two levels of weed control were applied across 4 replications. The fertilizer was a commercial blend of ammonium phosphate and ammonium sulphate. Soil type was described as Silver Creek loam by Poutsma and Turvey (1979) and consisted of a dark brown or red loam surface horizon over a yellow brown or red brown clay.

Sampling

The diameters of all trees were measured in January 1979 and each plot was divided into 3 diameter classes. One tree from each class was selected from the two plots of each fertilizer treatment in each replicate. The 48 sample trees (12 from each treatment) were felled in February 1979 and the following procedure adopted: Total height and diameter at breast height over bark was recorded. All dead branches were cut from the tree, weighed and retained. A random sample of live branches was cut from the tree, weighed and retained. The remaining green branches were cut from the tree, weighed and discarded. The tree stem was cut into 10 billets of equal length and the large end diameter measured over and under bark. Each billet was weighed, a disc cut from the base and placed in a plastic bag in ice for transport to the laboratory. Fresh weight of disc wood, disc bark and the volume of the disc wood were measured accurately in the laboratory. All samples were dried at 70°C and the dry weight of the components in each tree calculated by proportion.

Chemical Analysis

Sub samples of each oven dry sample were ground for chemical analysis in the laboratory. Ground samples were digested in 25 mm pyrex tubes in a heated aluminium block with sulphuric acid and hydrogen peroxide (Clarke and Jayman 1975). Nitrogen was distilled from the diluted digest as ammonia, absorbed into boric acid and the quantity determined by titration. Phosphorus was determined colourimetrically using the molybdate blue method (John 1970).

ANALYSIS AND RESULTS

Estimation of biomass

The sample tree data were used to derive a regression model for each component of the biomass and for stemwood volume. The model linearly related the logarithm of the component biomasses of the sample trees to the logarithm of their basal area; linear terms were also included to identify the replication number and treatment applied to the sample trees. This model proved very satisfactory, giving r^2 values of 0.99 for volume, stemwood and stembark; 0.96 for live branches, 0.93 for leaves but only 0.44 for dead branches. The inclusion of separate regression coefficients for each treatment did not significantly improve the fitted model. Also the inclusion of height in the regression equation only marginally improved the fit and would not have justified the extra effort involved in measuring the heights of all trees in the experiment for the purpose of estimating biomass. The regression coefficients for volume and all components except dead branches were similar and ranged from 1.2 to 1.29.

Component biomass for each tree in the experiment was then estimated using the regression relationship and adjusting for the systematic bias induced by the logarithmic transformation (Meyer 1938); thus component totals for each of the 32 plots were derived.

Analysis of plot biomass

Growth and biomass are presented in Table 1 together with the standard errors for the comparison of two treatment totals derived from a randomized block analysis of the plot data. The treatment effects for each variable are highly significant ($P<.001$). The mean diameter of trees was increased from 6.9 cm in the untreated control to 10.8 cm at the two highest fertilizer levels. The increases in diameter and height produced by the fertilizer treatments resulted in a three fold increase in stemwood volume from 34.9 to 109.6 m^3 ha^{-1}. There was no significant response to weed control so these data have not been presented.

Total biomass increased from 31.2 in the untreated control to 83.3 t ha^{-1} in treatment 4. For the individual components, stemwood showed the greatest percentage increase in biomass. This resulted in a change in the relationship between the components as fertilizer level increased which is shown in Table 2. As the proportion of stemwood increased, the proportion of all other components fell.

The biomass data also presented graphically in Fig. 1 to demonstrate the nature of the response to fertilizer. This shows there was a steady decline in response as fertilizer level increased. These data were redrawn to show the marginal increment resulting from successive application of fertilizer (Fig. 2). The initial application of fertilizer (188 kg ha^{-1}) produced a marginal increment in stemwood biomass of 20 t ha^{-1} compared with 19 t ha^{-1} produced in the untreated control plots. Further additions of 377 and 565 kg of fertilizer ha^{-1} resulted in marginal increments of 11 and 7 t of stemwood ha^{-1} respectively. The effectiveness of successive fertilizer applications was determined by dividing the marginal increment in stemwood biomass by the additional quantity of fertilizer applied to each treatment. Each kg of additional fertilizer increased stemwood biomass by 112 kg, 30 kg and 12 kg ha^{-1} in treatments 2, 3 and 4 respectively.

Analysis of plot nutrient data

The mean concentration of nitrogen and phosphorus in each component, obtained from the sample data, was multiplied by the estimated biomass of that component to determine the uptake of nitrogen and phosphorus in the above ground components for each plot. A randomized block analysis showed that the effect of the treatments on both total nitrogen and total phosphorus uptake was highly significant ($P<.001$), reflecting an increase in nutrient uptake from treatment 1 to treatment 4 (Table 3). Similar results were obtained for the component uptakes. Hence these data were re analyzed as a percentage of the total uptake for both nitrogen and phosphorus. Results are also given in Table 3.

Total quantities of nitrogen in the above ground component increased from 69 kg ha^{-1} in the unfertilized trees to 153 kg ha^{-1} in treatment 4. The quantity of phosphorus increased from 4.9 to 14.1 kg ha^{-1} over the same treatments. The relationship between the nutrients in the components also changed substantially. Nitrogen in the stemwood increased from 17 to 27 percent but fell from 58 to 46 percent in the leaves. The same trend occurred with phosphorus which increased from 17 to 35 percent in the stemwood but fell from 50 to 30 per cent in the leaves. Note that the possible introduction of a between plot correlation due to the method of estimation of biomass could slightly affect the formal significance levels quoted in Table 3. Hence it is preferable not to draw conclusions from the significant ($P<.05$) effects for stembark and dead branches.

DISCUSSION

There have been significant and substantial responses in the growth of *E.globulus* to fertilizer applied at this site. The relative difference in biomass between unfertilized and fertilized plots was much greater when the trees were younger but the threefold difference in stemwood biomass after 9.5 years was still appreciable.

There have been some studies which have attempted to measure the biomass and nutrient content of native eucalypt forests in Australia (Bevege 1978) but few data are available for eucalypt plantations. The application of fertilizer has not only increased the total biomass but it has altered the relationship between the components. The increase in the amount of stemwood from 61.5 percent in the unfertilized plots to 70.1 percent in treatment 4 is a considerable gain. Combined with a decrease in the amount of leaf from 12.8 to 7.9 percent over the range of treatments, this represents a major change in the structure of the forest. Whilst it can be seen that the major response was to the initial application of fertilizer and that subsequent treatments produced a diminishing response, the economic implications of these observations have not been determined.

The total uptake of nitrogen in the biomass of trees which were not fertilized was 70.6 kg ha^{-1}. An estimate of the recovery of fertilizer nutrients by the trees was obtained by subtracting the uptake in the unfertilized plots from the uptake in the fertilized plots and dividing by the quantity applied. The initial application of fertilizer contained 34 kg ha^{-1} of nitrogen and increased uptake by 42.1 kg ha^{-1}. The increased growth must have encouraged better exploration of natural nitrogen reserves so that recovery exceeded 100 percent. Recovery fell to 57.5 and 40.9 percent in treatments 3 and 4 respectively.

The total uptake of phosphorus in the biomass of the trees which were not fertilized was less than 5 kg ha^{-1}. The application of fertilizer containing 15 kg ha^{-1} of phosphorus almost doubled uptake but an application of 90 kg ha^{-1} was required to obtain an uptake of 15 kg ha^{-1}. Compared with the untreated trees, the additional biomass in treatment 2 contained the equivalent of 31 percent of the phosphorus applied in the fertilizer. This recovery fell to 13.5 and 11.5 percent in treatments 3 and 4 respectively.

It is now recognised that the major response in the growth of *E.globulus* at the experimental site was to the phosphorus component of the fertilizer. The soil no doubt has a high capacity to adsorb phosphorus however so that recovery of this element was low (Attiwill 1971b). The site previously carried native forest of *E.obliqua* and *E.sieberi* which was cleared and heaped into windrows prior to planting. An *E.obliqua* forest with a mean age of 51 years had an above ground biomass of 301 t ha^{-1} which contained 12 kg ha^{-1} of phosphorus in the stemwood. A high proportion of the phosphorus in the biomass of *E.obliqua* forests is retained for internal redistribution (Attiwill 1971a).

Conventional harvesting (stemwood only) of *E.obliqua* aged 51 years would remove 12 kg ha^{-1} of phosphorus from the site. The results obtained in this study show that whole tree harvesting of fertilized *E.globulus* aged

9.5 years would remove between 10 and 15 kg ha^{-1} of phosphorus. Over 5 rotations the removal of phosphorus in the biomass would be 5 times that removed in conventional harvesting of an *E.obliqua* forest. The response of planted eucalypts to fertilizer on this site may in part be due to the removal of the existing biomass before planting. The area of native forest available for wood production in Australia is decreasing and the development of intensive, fertilized plantations may be required to maintain supplies. Whilst the comparison made here is fairly crude, it is clear that shorter rotations and whole tree harvesting are likely to increase our dependance on fertilizer to supply nutrients removed.

TABLE 1

Growth and biomass of fertilized *E.globulus* aged 9.5 years

Factor	Fertilizer treat. (a) 1	2	3	4	Standard error	Significance level (b)
Growth						
Mean diam (BHOB cm)	6.9	9.7	10.8	10.8	0.467	***
Stemwood volume (m^3ha^{-1})	34.9	76.5	96.2	109.6	7.58	***
Biomass (t ha^{-1} oven dry)						
Stemwood	19.2	40.2	51.6	58.4	4.00	***
Stembark	4.7	9.0	11.0	11.4	0.81	***
Branches (live)	2.6	3.9	5.0	5.5	0.43	***
Branches (dead)	0.7	0.9	1.0	1.4	0.06	***
Leaves	4.0	5.1	6.7	6.6	0.60	***
TOTAL	31.2	59.1	75.2	83.3	5.74	***

(a) 1 = Untreated control
2 = 188 kg ha^{-1} (18%N, 8%P)
3 = 565 " " "
4 = 1130 " " "

(b) *** P < .001

TABLE 2

Components of the biomass as a percentage of the total

	Fertilizer treatment 1	2	3	4	Standard error	Significance level
Stemwood	60.4	67.5	67.9	69.7	0.22	***
Stembark	15.0	15.1	14.5	13.7	0.11	***
Branches	11.2	8.4	8.3	8.5	0.13	***
Leaves	13.3	8.9	9.4	8.1	0.15	***

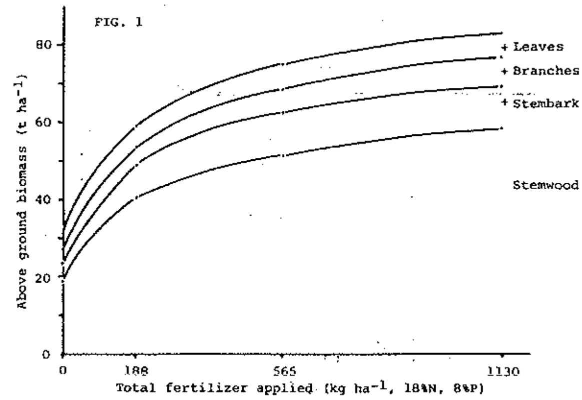
TABLE 3

Total nitrogen and phosphorus uptake
and tree components as a % of the total

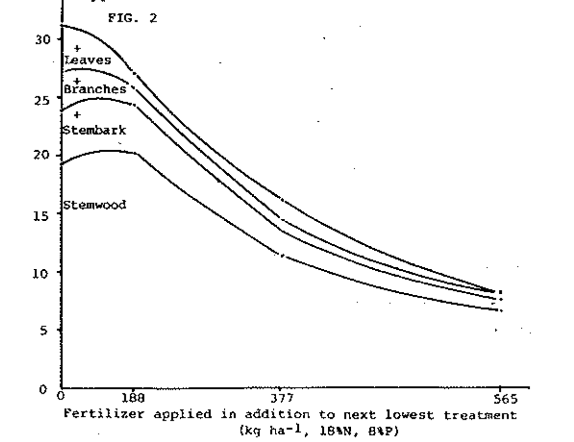
	Fertilizer treatment 1	2	3	4	Standard error	Significance level (a)
Nitrogen uptake (kg ha^{-1})	59	112	126	153	10.1	***
Stemwood %	17	25	20	27	1.9	***
Stembark %	12	14	15	15	0.9	*
Branches (live) %	11	12	11	11	0.8	ns
Leaves %	58	48	54	46	1.7	***
Branches (dead) %	1.7	1.1	1.0	1.4	0.25	*
Phosphorus uptake (kg ha^{-1})	4.9	8.8	10.4	14.1	1.02	***
Stemwood %	17	24	25	35	3.7	***
Stembark %	18	24	24	21	2.0	*
Branches (live) %	15	15	13	14	1.4	ns
Leaves %	50	37	38	30	2.1	***
Branches (dead) %	0.6	0.3	0.3	0.3	0.08	*

(a) *** P < .001
* P < .05
ns Not significant

Components in biomass of fertilized *E.globulus* aged 9.5 years (cumulative).



Marginal increment in biomass components of *E.globulus* aged 9.5 years resulting from successive application of fertilizer.



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CONTEÚDO MINERAL DE *Eucalyptus globulus*, *Pinus pinea* e *Quercus suber* E A BIOCICLAGEM DE ALUMÍNIO DESTAS ESPÉCIES NOS MESMOS TIPOS DE SOLO E CLIMA MEDITERRÂNEO.

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Resumo

Com o objetivo de estimar a extração de nutrientes e os efeitos sobre o solo das plantações de *Eucalyptus globulus* sob condições de clima mediterrâneo, foi feita a análise dos nutrientes concentrados na madeira e na casca dessa espécie e se fez a comparação dos resultados com aqueles apresentados por outros autores; resultou que por unidade de matéria, o conteúdo de nutrientes é maior no eucalipto do que nos pinhos, mas menor em outras espécies de crescimento rápido: *Populus, Sali* e *Platanus*; sendo:1, 4, 5: 5, 5; 15 e 2 kg/ha/ano de N, P, K, Ca e Mg, respectivamente, as quantidades extraídas pelo aproveitamento de 6 m.c. (produtividade média da região mediterrânea) da madeira de *E. Globulus*. Quantidades que se supõe serão respostas com os aportes naturais (precipitações e meteorização, pelo que se refere a K, Ca e Mg, mas que será necessário restituir ao menos em parte, mediante fertilizantes, no que se refere a N. e P.

Por outro lado, e dada a influência que tem os cátions básicos (K, Ca e Mg) e Al na formação do húmus, se determinou a concentração destes elementos em folhas e, além de Al no solo superficial em massas adjacentes, de *E. globulus, Quercus suber* e *Pinus Pinea*, resultando que a concentração de K, Ca e Mg é maior no eucalipto do que no pinho e da mesma ordem no sobreiro, variando a concentração de Al em sentido inverso, tanto em folhas como no solo. Pelo que é de se supor que o processo de humificação sob o *Eucalyptus globulus* em condições de clima mediterrâneo seja análogo ao processo sob *Quercus suber*, originando-se em ambos os casos um húmus de tipo "mull".

Summary

Mineral content of Eucalyptus globulus, Pinus Pinea and Quercus suber and biocycling of aluminium of these species growing on the same type of soil and under mediterranean conditions.

In order to asses the nutrients removal and the effects on the soil by Eucalyptus globulus plantations, nutrient concentrations in wood and bark have been determined and the analytical data compared with the data form other authors Thus, the nutrient content per unit of matter in eucalypt is higher than in pines, but lower than in other fast growing species harvested through short rotations: Populus, Salix and Platanus. For an annual yield of 6 cu.m. of stemwood with bark (estimated average yield in the Mediterranean region) the annual nutrient removals would be 4,5, 1, 5.5, 15 and 2 Kg/ha of N,P,K,Ca, and Mg, respectively. From the soil analysis it is deduced that the nutrients removed would be replaced by natural input(mineral weathering and precipitations) except N and P which should be replaced, at least in part, by fertilization.

On the other hand and because of the opposite influences of bases (K,Ca,and Mg) and Al on forest soil formation, the foliar concentrations of these elements and Al at the surface soil have been investigated in adjacent stands of E.globulus, Quercus suber(open woodland) and Pinus pinea. From the analytical data it is concluded that K,Ca and Mg concentrations are higher in eucalypt than in pine and similar to concentrations in the cork tree. On the contrary, Al in leaves and soil is present in the reverse order. Therefore, this suggests that under mediterranean conditions the effects of Eucalyptus globulus and Quercus suber on litter decomposition and humus formation would be alike, producing both species a humus of "mull" type.

CONTENIDO MINERAL DE *Eucalyptus globulus*, *Pinus pinea* Y *Quercus suber* Y BIOCICLO DEL ALUMINIO DE ESTAS ESPECIES SOBRE EL MISMO TIPO DE SULO Y CLIMA METIRRÂNEO.

Resumen

Con el fin de estimar la extracción de nutrientes y los efectos sobre el suelo de las plantaciones de Eucalyptus globulus bajo condiciones de clima mediterráneo, se han analizado los nutrientes concentrados en la madera y corteza de dicha especie y comparado los resultados con los de otros autores; resultando que por unidad de materia el contenido de nutrientes en el eucalipto es mayor que en los pinos, pero menor que en otras especies de crecimiento rápido: Populus, Salix y Platanus; siendo: 4,5; 1; 5,5; 15 y 2 Kg/ha/año de N,P,K,Ca y Mg, respectivamente, las cantidades extraidas por el aprovechamiento de 6 m.c.(productividad media de la región mediterránea) de la madera de E.globulus. Cantidades que se supone serán repuestas con los aportes naturales(precipitaciones y meteorización), por lo que se refiere a K,Ca y Mg, pero que será necesario restituir, al menos en parte, mediante fertilizantes las correspondientes a N y P.

Por otra parte y dada la influencia que tienen los cationes básicos (K,Ca y Mg) y Al en la formación del humus se ha determinado la concentración de estos elementos en hojas y, además de Al en el suelo superficial en masas adyacentes de E.globulus; Quercus suber y Pinus pinea, resultando que la concentración de K,Ca y Mg es mayor en el eucalipto que en pino y del mismo orden que en el alcornoque, variando la concentración de Al en sentido inverso, tanto en hojas como en el suelo. Por lo que es de suponer que el proceso de humificación bajo el Eucalyptus globulus en condiciones de clima mediterráneo sea análogo al proceso bajo Quercus suber, originandose en ambos casos un humus de tipo "mull".

I N T R O D U C C I O N

Con el fin de satisfacer la creciente demanda de productos forestales, principalmente pastas celulósicas, se han efectuado durante los últimos años extensas plantaciones de eucaliptos, con preponderancia del Eucalyptus globulus, en varias localidades de clima mediterráneo del suroeste español, cubriendo en la actualidad más de 150.000 ha. Pero en vista del rápido crecimiento y relativa gran producción de esta especie, aprovechada a turnos cortos, se ha generalizado en diversos ambientes, tanto científicos como profanos, la preocupación por el posible empobrecimiento del suelo, como consecuencia del cultivo intenso del eucalipto. No obstante, debido a la reciente introducción de los eucaliptos en el área mediterránea, la alteración de la fertilidad del suelo, en uno u otro sentido, es, actualmente, inapreciable, teniendo que recurrir a métodos indirectos para predecir, con algun fundamento, su futura evolución. Así, con el estudio de la composición mineral de los eucaliptos se ha conseguido conocer la cantidad de nutrientes que se extraen del suelo juntamente con los productos (madera y corteza) objeto de aprovechamiento (Speer y Philippis, 1965). No obstante, al comprobar que existen diferencias de composición, no sólo entre distintas especies de eucaliptos sino tambien dentro de la misma especie cultivada en diferentes condiciones climáticas (Lubrano, 1967 y N. Isasa 1962) se ha estimado conveniente insistir en el tema, concretándonos al Eucalyptus globulus en estaciones de clima mediterráneo, con el fin de aportar nuevos datos a los ya existentes.

Por otra parte se ha comprobado que en los efectos de la vegetación sobre el suelo (Jenny, 1941, Pritchett,1979), la composición mineral de aquella es un factor decisivo en la evolución de éste; originándose bajo la vegetación rica en cationes básicos (frondosas) un humus de tipo "mull" merced a la rápida descomposición de los restos vegetales por los organismos del suelo, y, por el contrario, bajo la vegetación pobre en bases (coníferas) la materia orgánica se acumula, descomponiéndose lentamente, y forma un humus bruto de tipo "mor" o "moder" (Kubiëna, 1952). Además, con la baja concentración de bases suele coincidir una alta de aluminio que acentúa los procesos de acidificación (Manil, 1971 y Messenger et all, 1978).

Por todo ello hemos considerado interesante comparar la concentración de nutrientes en las hojas de Eucalyptus globulus cultivado en la región mediterránea con la de dos especies estables de la misma región y cuyos efectos en la formación del suelo son bien conocidos: El alcornoque (Quercus suber L.) especie considerada como climácica sobre suelos no calizos y el pino piñonero (Pinus pinea L.) cuyas masas bien adaptadas al medio ocupan los suelos arenosos que por su menor fertilidad rehuye el alcornoque.

M E T O D O S   E X P E R I M E N T A L E S

A r e a   e x p e r i m e n t a l

El estudio se ha realizado en varias localidades de la provincia de Huelva (España) sitas a una altitud comprendida entre 0 y 300 m. y cuyo clima responde a las características del mediterráneo semiárido: Lluvia anual de 400 a 800 mm. con un máximo en otoño y otro en final de invierno y un periodo seco mayor de cinco meses. La temperatura media mensual oscila de 11º C en Enero a 26º C en Julio.

Gibraleón

Para el estudio comparativo del contenido mineral de las especies se eligió un sitio del término municipal de Gibraleón, definido geográficamente por 3º 21'40'' Long. Oeste y 37º 25'-15'' de Lat. Norte, siendo su altitud de unos 100 m. y de 20 Km. su distancia al mar. En él se encuentran, a muy corta distancia unos de otros, un bosquete de Pinus pinea de unos 30 - años de edad, otro de Eucalyptus globulus plantado hace 32 - años, y en la actualidad formado por brotes de cepa de 8 años de edad, con densidad de unos 600 pies por hectárea, y por último, una dehesa con añosos alcornoques (Quercus suber) muy espaciados. Tanto el sotobosque de pinos como el de eucaliptos está formado por un matorral en el que destacan las Cistaceas: Cistus crispus L. ; Halinium halimifolium L. y Cistus ladanifezus L., siendo tambien muy abundante el cantueso (Lavandula - stoechas L.) y en menor proporción otras especies propias del maquis,como Erica australis L. , Ulex eriocladus C. Vic., etc.

Beas

A esta localidad, cercana a la anterior y de análoga altitud, corresponde una plantación de E. globulus de 10 años de edad, con densidad de 800 pies por hectárea, a la que se aplicaron diversos tratamientos de fertilización durante los cinco últimos años, no existiendo sotobosque por labrarse anualmente.

Niebla

Plantación sita en dicho término a unos 280 m. de altitud, compuesta por pies de E. globulus de 11 años de edad con densidad de unos 600 pies por hectárea. El sotobosque, muy aclarado por las labores periódicas del suelo, está constituido, como en Gibraleón, por especies del maquis.

Suelo

En la zona baja de la provincia de Huelva de terrenos poco accidentados y situados de 10 a 150 m de altitud, predominan los suelos arenosos, siendo frecuente la aparición, a profundidad variable, de un horizonte iluvial de acumulación de arcilla de tonos rojizos.

La casi totalidad de los suelos de la zona de media montaña (150 a 300 m de altitud) son de tipo "braunerde meridional" con textura franca (loam), apareciendo las pizarras a muy poca profundidad, por lo que es necesario efectuar una labor de subsolado antes de la plantación.

El humus de todos estos suelos, en general muy escaso, - corresponde al tipo "mull".

A continuación se indican algunas de las caracteristicas fisico-quimicas de los suelos de las localidades estudiadas:

Características del suelo	Beas	Gibraleón	Niebla (d)
Prof. de la muestra,cm	10-30	10-30	10-30
Arena (Sand), %	81,2	88,0	73,6
Limo (Silt), %	12,0	5,9	18,9
Arcilla(Clay), %	6,8	6,1	7,5
pH en agua, 1:2,5	5,5	5,4	4,9
Cal (lime)	-	-	-
C %	0,35	0,29	0,70
N %	0,035	0,04	0,076
C/N	10	7,2	9,1
P_2O_5 asimilable,ppm	1,5(c)	4,5(c)	5(b)
K_2O de cambio, " (a)	30	70	130
Ca id id " "	100	400	n.d.
Mg id id " "	25	95	n.d.

(Localidades: Beas, Gibraleón, Niebla)

(a) Acetato amónico 1N,pH 7,0 (b) Método de Olsen

(c) ClH y SO_4H_2 diluidos, Nelson et al. (1953)

(d) Segun Giulimondi, 1967

Productividad

La productividad del Eucalyptus globulus en la provincia de Huelva es muy variable. De los inventarios realizados por el Servicio Forestal resulta una productividad comprendida entre 2 y 10 mc./ha./año, siendo la media ponderada de 6 mc. de leño con corteza /ha./año. De los datos de N. Isasa (1962) se deduce que 1 m. c. equivale a 506 kg. de madera y 67 kg. de corteza, ambas secas, correspondiendo, por tanto, a la corteza un 11,6 % del leño más corteza.

Analogamente, la productividad del Pinus pinea oscila entre 0,8 y 9,1 m.c., siendo la media de 3,4 m.c./ha/año, correspondiendo a 1 m.c.: 362 kg. de madera y 106 de corteza.

M é t o d o s

Toma de muestras

Para las muestras de madera y corteza se tomaron discos del tronco a 1,30 m. de altura. En Beas, dos pies por tratamiento (Testigo, 50-80-80 y 100-80-80 Kg de N, P_2O_5 y K_2O por hectaréa, respectivamente). En Niebla, plantación no fertilizada, tres pies elegidos al azar. En Gibraleón y otras localidades, las muestras se tomaron de arboles en pie con barrena de alma hueca, formando una muestra media de diez pies. En enero 1980 se tomaron en Gibraleón hojas basales de ramas de Quercus suber, Pinus pinea y Eucalyptus globulus, procedentes de - la parte inferior de la copa; mezclando los correspondientes a diez diez arboles para obtener una muestra media. También en Gibraleón y bajo la copa de cada una de dichas especies se tomaron muestras de la parte superficial (0-2 cm) del horizonte A_H del suelo correspondiente, y otras muestras a la profundidad de mayor densidad de raices, según se indica en el cuadro correspondiente.

Métodos de análisis

Las muestras vegetales fueron desecadas a 65ºC y molidas para su análisis químico: El nitrógeno se determinó por micro-Kjeldahl; previa calcinación a 480ºC, el fósforo se analizó -- por colorimetría con vanado-molibdato; el potasio por espectrometría de emisión; el Ca y Mg por absorción atómica, y el aluminio por colorimetría con azul de metil-timol (MTB). El aluminio en suelos, previamente extraido con acetato amónico (pH:-- 4,8), se determinó por absorción atómica (N_2O, como oxidante).

R E S U L T A D O S   Y   D I S C U S I O N

E x t r a c c i ó n   d e   n u t r i e n t e s

Como puede verse en la tabla 1, la concentración de N y P aumenta con la fertilización, lo que hace suponer una insuficiencia de estos dos elementos en el suelo, extremo comprobado en los experimentos de fertilización, en los que se consiguió aumentar la producción en un 250% con la aportación - de N y en un 40 % con la suplementaria de P. En cambio, el K no sufre apenas variación, indicando su suficiencia en el suelo, lo que se confirmó al no tener respuesta en los experimentos de fertilización. También es de señalar la baja concentración de Ca y Mg en el leño y, por el contrario, muy alta sobre todo de Ca, en la corteza, existiendo patente correspondencia con la concentración de Ca en el suelo.

En cuanto a las concentraciones, son, prácticamente, coincidentes las por nosotros halladas en Beas y Gibraleón con -- las concentraciones en Niebla y Roma por Giulimondi (1967) y

Lubrano (1967), respectivamente, excepto por lo que respecta al potasio que se registra una ligera diferencia en la concentración correspondiente al leño.

En la tabla 2, se aprecia que las extracciones de los nutrientes por unidad de materia (leño con corteza) son menores en los pinos que en el E.globulus, siendo, en cambio, mayores las correspondientes a otras especies (Populus, Salix y Platanus) de crecimiento rápido, aprovechadas a turnos cortos.

Para una productividad de 6 m.c./ha/año de leño con corteza, que es la media de la provincia de Huelva y probablemente en toda el área mediterránea, las extracciones anuales de nutrientes serían, aproximadamente 4,5; 1; 5,5; 15 y 2 Kg/ha para N,P,K,Ca y Mg, respectivamente. Estas cantidades se compensan en gran parte con los elementos disueltos en el agua de lluvia que según Lossaint y Rapp (1971), para una estación de clima mediterráneo (Montpellier, Francia) son: 15; 1; 2; 10 y 2 Kg/ha/año. Si además, tenemos en cuenta que los suelos estudiados son relativamente ricos en bases (K,Ca y Mg) es de suponer que las extraciones de estos tres nutrientes se compensen durante muchos años con la mereorización de las reservas del suelo y las cantidades aportadas por la lluvia.

TABLA 1.- Concentración de nutrientes como porcentaje de materia seca de Eucalyptus globulus en localidades de clima mediterráneo.

Nutrient concentration as porcentage of dry matter of Eucaplyptus globulus from some localities of mediterranean climate.

Localidad Tratamiento fertilizante.	N	P	K	Ca	Mg
	Leño sin corteza(Stemwood)				
Beas (Huelva) Ninguno	0,07	0,015	0,15	0,07	0,04
id id (50-80-80)	0,11	0,044	0,18	0,08	0,03
id id (100-80-80)	0,21	0,034	0,16	0,08	0,04
Gibraleon(Huelva) Ninguno	0,16	0,033	0,12	0,16	0,04
Niebla (Huelva) Ninguno (a)	0,07	0,028	0,07	0,10	n.d.
MEDIA(AVERAGE)HUELVA-ESPAÑA	0,11	0,030	0,15	0,10	0,04
Roma (Italia) (b)	0,06	0,018	0,07	0,08	0,08
	Corteza (Stembark)				
Beas (Huelva) Ninguno	0,11	0,015	0,16	2,15	0,21
id id (50-80-80)	0,19	0,036	0,16	2,02	0,16
id id (100-80-80)	0,40	0,038	0,20	2,60	0,17
Gibraleón(Huelva) Ninguno	0,25	0,031	0,27	4,12	0,18
Niebla id id (a)	0,22	0,023	0,28	2,73	n.d.
MEDIA(AVERAGE)HUELVA-ESPAÑA	0,25	0,025	0,25	3,00	0,20
Roma (Italia) (b)	0,24	0,029	0,25	4,75	0,52

Notas: (a) Giulimondi, 1967; (b) Lubrano, 1967

En cambio, para el nitrógeno y fósforo sería aventurado afirmar lo mismo; ya que los suelos mediterráneos son, en general, pobres en estos dos nutrientes y en la práctica las plantaciones de eucaliptus han acusado la deficiencia de los mismos. No obstante, la totalidad de las exportaciones podría compensarse mediante la fertilización con solo 45 Kg. de N y 23 Kg de P_2O_5 cada 10 años, período que corresponde al turno de corta.

Efectos sobre el suelo

En la tabla 3, vemos que la concentración de bases, sobre todo Ca, en el eucalipto es superior, no solo a la del pino, sino también a la del alcornoque; lo que se refleja en el pH del suelo, cuya acidez aumenta con la disminución de bases.

Por el contrario, la concentración de aluminio en las hojas de eucalipto es notablemente inferior a la de las otras especies, incluso a la de *Cistus crispus*, especie dominante en el sotobosque. Correlativamente, el aluminio del suelo superficial también es más abundante bajo el pino que bajo el alcornoque y eucalipto, que acusan concentraciones del mismo orden. Asimismo, para Eucalyptus globulus se han encontrado, en localidades de clima y suelo análogos a los correspondientes a las estudiadas en Huelva, valores similares a los señalados en la tabla 3 para la concentración en hojas de dicha especie: Cabral (1963) para plantaciones de 7 años en Portugal: 1,01; 0,052; 0,68; 2,28 y 0,34, y Lubrano (1967) para plantaciones de 10 años en Roma: 1,30; 0,062; 0,56; 0,98 y 0,12 como porcentajes de N,P,K,Ca y Mg, respectivamente.

Por otra parte, es interesante señalar que las concentraciones de nutrientes en las hojas de *Eucalyptus globulus* coinciden sensiblemente con las determinadas por Rapp (1969) en las hojas del segundo año de *Quercus ilex*: (1,17 N; 0,08 P; 0,61 K; 1,30 Ca y 0,12 Mg) en Rouquet-Montpellier (Francia), clima mediterráneo subhumedo (770 mm de lluvia anual) y suelo pardo mediterráneo sobre paleosol rojo sin caliza activa, pero de reacción ligeramente alcalina pH (H_2O): 7,6.

De lo anterior se deduce que el *E.globulus* en estaciones de clima mediterráneo concentra los elementos básicos, principalmente calcio, en hojas y corteza. Ahora bien, sería aventurado suponer que otras especies de eucalipto e incluso el mismo E.globulus en otras condiciones de clima se comportasen análogamente. Así vemos que Attiwell (1972) asigna a las hojas de *E.obliqua* 0,43 y 0,33 % de K y Ca, respectivamente, y Baró (1970) para *E.globulus* de 10 años de edad, en clima submediterráneo templado (1400 mm. de lluvia anual y sobre suelo ranker) halla las siguientes concentraciones en hojas: 0,53; 0,44; 0,20 por cien de K,Ca, y Mg, respectivamente y 94 pmm. de Al.

Por lo tanto no parece arriesgado suponer que el *Eucalyptus globulus*, por su contenido en bases, igual o mayor que los correspondientes a las de *Quercus suber* y *Quercus ilex* (especies consideradas como climácicas) y menor contenido de aluminio, dará lugar en el área mediterránea, a un proceso de humificación semejante al de estas dos especies, tendiendo a la formación de un humus de tipo"mull", a no ser que el eucalipto contenga alguna sustancia inhibidora, hasta ahora no determinada, que alterase la normal actividad biológica del suelo. Suposición que en los estudios, hasta ahora realizados, no ha sido comprobada. (Speer y Philippis, 1965)

TABLA 2. Concnetración de nutrientes del leño con corteza en algunas plantaciones forestales

Nutrient concentration of stemwood with bark in some forest plantations.

Especie, edad localidad, producción años tm/ha/año	% peso seco (% dry weight) N	P	K	Ca	Mg
Pinus elliottii-15-Florida-U.S.-10	0,12 (92)	0,007 (24)	0,05 (31)	0,08 (18)	0,02 (33)(a)
Pinus pinea-30-Huelva-España-1,6	0,11 (85)	0,006 (21)	0,04 (25)	0,21 (48)	0,03 (50)
Eucalyptus globulus-10-Huelva-España-3,5	0,13(100)	0,029(100)	0,16(100)	0,44(100)	0,06(100)
Populus euramericana, cv."I 214"-10 Casale Monferrato-Italia-8,5	0,14(108)	0,059(203)	0,21(131)	0,34 (77)	n.d. (b)
Salix americana-1-Cuenca-España-12	0,43(331)	0,075(259)	0,18(112)	0,54(123)	0,05 (83)
Platanus occidentalis-3-Kentucky-U.S.-3	0,44(338)	0,137(472)	0,24(150)	0,22 (50)	0,09(150)(c)

Notas: (a) Pritchett and Smith 1974; (b) Giulimondi, 1966; (c) Wood et al, 1977

Cifras entre parentesis: % respecto a E. globulus

Figures within parentheses: % With respect to E. globulus

TABLA 3.- Comparación de nutrientes en hojas y aluminio y pH en el suelo de tres masas contiguas desarrolladas sobre el mismo tipo de suelo y bajo las mismas condiciones climáticas (Gibraleón-Huelva-España)

Comparison of nutrients in leaves and aluminium and pH in soil from three adjacent stands grown on the same type of soil and under the same climatic conditions (Gibraleón-Huelva-España)

E S P E C I E	HOJAS (l e a v e s)						SUELO Horizonte A_H	
	N	P	K %	Ca	Mg	Al ppm	pH(a) H_2O	Al(b) ppm
Pinus pinea	1,15	0,066	0,44	0,32	0,21	553	5,8	49
Quercus suber	1,65	0,152	0,45	0,68	0,16	184	6,2	9,5
Eucalyptus globulus	1,15	0,082	0,58	1,52	0,25	59	6,45	10
Cistus crispus (c)	1,56	0,100	0,62	1,05	0,25	290	-	-

(a) Suspensión enagua 1:2,5. (b) Extraido con $1N-NH_4OAc$ (pH:4,8) (c) Sotobosque(underbrush) de P.pinea y E.globulus.

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PRODUTIVIDADE A LONGO PRAZO DE PLANTAÇÕES TROPICAIS — UMA APRECIAÇÃO.

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Resumo

Não foi ainda constatada nenhuma evidência de um declínio da produtividade com as sucessivas rotações das Plantações tropicais. Todavia, poucos dados são disponíveis, desde que muitos dos povoamentos encontram-se ainda em sua primeira rotação. Por outro lado, programas vigorosos de melhoramento florestal e também as diferenças climáticas entre as rotações poderiam mascarar as evidências de deterioração do lugar devido ao plantio em monocultura. É muito importante que sejam estabelecidas parcelas de crescimento, as quais devem ser *mantidas* em rotações sucessivas, de tal forma a permitir a comparação dos dados de crescimento no futuro.

LONG — TERM PRODUCTIVITY OF TROPICAL PLANTATIONS — AN OVERVIEW.

Summary

There is no evidence yet of declining productivity with successive rotations in tropical plantations. However, few data are available since many stands are still first rotation. Also, vigorous tree improvement programmes and climatic differences between rotations may disguise evidence of site degrade due to plantation monoculture. It is extremely important that growth plots are established and maintained in successive rotations so that comparative growth data will be available in the future.

INTRODUCTION

The last 20 years has seen a rapid expansion in plantation forestry in the tropics; for area data see (Lanly and Clement, 1979). Many large planting programmes are planned for the 1980s and it is clear that forest plantations in the tropics are becoming a significant new timber resource.

One of the main reasons for this increase is the rapid growth of plantations in many parts of the tropics. In the moister tropics yields are commonly 3 to 7 times greater than either managed natural forest or most plantations in more temperate regions. On rotations of 10-30 years pines achieve mean annual increments of 15-30 m^3 ha^{-1} yr^{-1}, many broadleaved species 20-35 m^3 ha^{-1} yr^{-1}, and some eucalypts up to 50 m^3 ha^{-1} yr^{-1}.

However, with few exceptions the many data used to obtain the above averages come from first rotation crops. The present expansion of plantations and investment in processing mills are on the assumption that these kinds of productivities will be maintained for several rotations, if not in perpetuity. This question, therefore, of long-term productivity (second rotation decline) is of central importance to all industrial plantation development. This overview paper attempts to draw together information about long-term productivity for the three main genera which account for 85 per cent of all planting in the tropics - pines, eucalypts, and teak.

PINES

Most interest in second rotation decline concerns pines largely because of reports in the 1960s of serious (25-33 per cent) drops in productivity of second rotation *Pinus radiate* in nearly all regenerated stands in the Mt. Gambier area of S. Australia (Keeves, 1966; Bednall, 1968) and on some sites in the Nelson area of New Zealand (Muir, 1970; Whyte,1973). However, this evidence of decline, though Kio (1976) assumed it will apply to tropical plantations, is probably not wholly relevant to the tropics apart from generally warning of the problem. *P. radiata* is a warm temperate species, and many second rotation stands elsewhere are equally or more productive than the first (Squire, 1977a; Evans, 1978a; Muir *op.cit.*) which is even true of some third rotation ones in S.Australia (Boardman, 1978). Moreover, the cause of the decline in S.Australia, though the stands are on infertile sands, is not a simple one (Boardman, 1979) and, in fact, maximum amelioration work has brought about such dramatic growth improvement (see Woods,1976) in stands of both rotations that the factor of rotation has greatly diminished in significance.

Studies of long-term productivity of tropical pines have been limited by the small areas of second rotation stands of measurable size. Nearly all plantations of the most widely planted pine in the lowlands, *P.caribaea*, are first rotation, though in Jamaica there are a few young second rotation ones. No long-term growth studies are known to the writer though a continuous monitoring of soil changes beneath *P.caribaea* stands is being done at Jari (Amazon). Unfavourable soil changes have been observed under *P.caribaea* in Trinidad (Cornforth, 1970) but beneficial accumulations of phosphorus and other nutrients under such stands on the Jos plateau, Nigeria, (Iyambo, 1973).

P.elliottii has been extensively planted for a considerable time in the cooler tropics and sub-tropics and several second rotation stands exist. There are no reports of growth decline and data from an experiment in Queensland comparing two rotations shows the second crop to be marginally superior up to eight years. In this experiment the second rotation of *P. elliottii* was from seed collected off the <u>same</u> parent trees as for the first rotation crop thirty years before. Not only is there no evidence of productivity decline but soil analyses indicate no long-term changes (Queensland, 1979).

Long-term productivity of *P. patula* plantations has received more attention than other pines, both mensurationally (Evans, 1975; 1978a) and from their effects on soil and ecological conditions (Robinson, 1967; Lundgren, 1978). Studies of second rotation performance in the Usutu forest, Swaziland, have revealed no marked falling-off in productivity owing to site degrade after two complete rotations, though second rotation stands showing better and poorer growth were found (Evans, 1978a). In the comparative work in Swaziland seed genetic quality changed little between rotations but climatic differences, especially in rainfall amounts and distribution, differed considerably. This rainfall factor greatly complicated the growth comparison since it is a very significant influence on growth (Evans, 1978b) but, on balance, rainfall has been less favourable during the second rotation than the first.

There are no reports of declining growth in second or third rotation pine crops in the Eastern Transvaal of South Africa.

EUCALYPTS

Comparing rotations of eucalypts differs from pines in that most stands in the tropics have been established for fuelwood or low grade roundwood and are managed for several coppice rotations before replanting. Thus the productivity question has two forms, the relative growth of successive coppice crops and the longer term comparison of yield of successive seedling (replanted) crops including their coppice yields.

Growth of successive coppice crops

It is well established that the yields from each management cycle (seedling crop, first coppice, second coppice etc) of eucalypts grown by coppicing do differ. But there is conflict in published work over whether the first coppice crop is rather more productive than the original seedling crop, with subsequent coppice gradually declining in productivity (Champion and Brasnett, 1958; Goes, 1954; WRI,1972.) or whether yields decline with every successive coppice crop (Myburgh, 1967). However, though successive coppice crops are identical genetically, unavoidable silvicultural differences exist between the crops which makes relating productivity changes to site degrade or soil impoverishment extremely difficult, though Metro (1955) and Keet (1966) have suggested this possibility as one explanation for declining yields.

The most obvious difference between the original seedling crop and the first coppice one is that coppice regrowth grows from an existing stump (stool) and makes use of the parent root system rather than developing a completely new one (Jacobs, 1955). The existence of an established root system produces very vigorous coppice growth in the early years and, according to Barret *et al* (1975), results in superior height growth of *Eucalyptus grandis* coppice compared with seedlings for about the first 10 years. Also, coppice shoots which develop from large old stools produce stems that lose their sapling form and assume a mature shape at an earlier stage of height growth than shoots from smaller younger stools (WRI, 1972).

Because coppice growth depends largely on the pre-existing root system, the yield of each coppice crop is directly related to the extent that root system occupied the site (WRI, 1972). But, with each cutting, a few stumps die, for *E. grandis* 3-5 per cent mortality is typical, thus the stocking of each successive crop declines. Stool death may be caused by many factors, season of felling, method of cutting, damage during extraction, stand density of parent crop, site conditions, root decay etc. Nevertheless,the yield of any one coppice crop is dependent upon the density of the parent stand, and any future improvement of yield will require an increase in or better distribution of the number of stools (Jacobs, 1955); the initial spacing of the seedling crop therefore assumes great importance (Stubbings and Schonau, 1979).

However, though the number of live stools per hectare is a major determinant of subsequent yield some compensation for loss of stools can be effected by leaving more than one shoot to grow from a stool. Indeed, different degrees of 'singling' coppice, e.g. none at all, to 2 or 3 stems, or to one stem, markedly influences total production per hectare. The greatest volume of wood usually results from leaving 2 or 3 shoots per stump (Couto *et al* 1973; Howland, 1969; Stubbings and Schonau, 1979).

The above discussion clearly shows the difficulty of reaching a firm conclusion regarding the relative growth of successive coppice crops, but provided good cutting practices are followed, stump mortality is not excessive, and rotations are kept short,the first coppice crop is probably the most productive with subsequent ones gradually declining owing to increasing loss of stools, and diminishing utilization of the site. Table 1 shows yields of four rotations of *E. globulus*, reported by Champion and Brasnett (1958), which support this view.

Table 1

Mean annual increment of successive rotations of *E. globulus* ($m^3 ha^{-1} yr^{-1}$)

Rotation	Location	
	Tagus Plains, Portugal	Nilgiris Hills, India
Seedling	10.5	27.0
First coppice	13.5	28.0
Second coppice	10.0	25.0
Third coppice	8.0	22.0
	(Goes, 1954)	(Ranganathan, 1941)

This pattern of yields is supported by Sharma (1979) who found that first generation coppice of *E. 'hybrid'* in India at 5 or 6 years of age was markedly superior in production to the parent seedling crop at the same age. Also, much *E. grandis* grown in central Brazil is worked on three rotations, a seedling one of 8 years followed by a coppice one of 7 years and then one of 8 years to ensure approximately equal crop yields. It is usually concluded that two satisfactory coppice crops after the original seedling stands can be obtained if the crops are on short rotations up to 10 or 12 years (FAO, 1976). Declining yields with second and subsequent coppice crops are due to loss of stumps. No firm evidence exists that regular coppicing *per se* leads to a long-term decline in site productivity, and in some countries coppice has been carried out continuously for over 100 years (Champion and Brasnett, 1958; FAO 1976).

Long-term cultivation of eucalypts

The conclusion at the end of the last paragraph really summarises what is known about successive seedling crops of eucalypts and the writer is unaware of any reports of long-term declines in productivity owing to site degrade. However, seedling regeneration as opposed to coppice does allow genetic change of the crop and with eucalypts, as well as improvement from new species, provenances, or using superior seed, under certain circumstances declining yield can occur from genetic degrade.

Where eucalypts are planted as exotics, often in trial collections or arboreta, there is much opportunity for interspecific hybridizing between species among which it would not occur naturally in Australia (Pryor, 1976). The example in Brazil of E. 'alba' is well known and the continuing use of 'Brazilian' seed, collected from stands of hybrids up until the mid-1960s resulted in successively poorer plantations reflecting the effects of deleterious segregation. However, this poor genetic stock allows for great yield improvement in the second rotation. At Aracruz Florestal, in Espirito Santo, the early plantings of E. 'alba' yielding an MAI of about 23 m^3 ha^{-1} yr^{-1} are being replaced with E. urophylla ex Timor or E. grandis of the northerly Atherton provenance in Queensland which are expected to have an average MAI of about 35 m^3 ha^{-1} yr^{-1}.

Long-term productivity of eucalypt plantations in the tropics has not been associated with concerns about second rotation decline though coppice management has greatly confused the picture. However, very large areas of eucalypt monoculture are being planted and it is to be hoped that it will not be long before more firm growth data are available.

TEAK

Reduced growth in the second rotation of pure teak plantations in India and Java led to research into what was termed "the pure teak problem" (Laurie and Griffith, 1942; Griffith and Gupta, 1948). More recent research has not generally confirmed this problem, and no sign of deterioration in site quality has been found with replanted teak at Kerala (India, 1974). However, there is concern that excessive soil erosion under teak will lower yields in second and later rotations (Trinidad, 1974) and on slopes where leaf litter is burned in the dry season serious erosion does occur (Bell, 1973). Fears of declining yield of teak on certain soil in Senegal have been expressed by Maheut and Dommergues (1960).

OTHER SPECIES

For Acacias, Lewis (1967) quotes a report that up to eight rotations of A. mearnsii have been harvested from the same site without apparent growth decline, but rotations are short and, since the crop is leguminous, some benefit may derive from their nitrogen fixing ability. Indeed, Orchard and Darby (1956) found that nitrogen had accumulated under 30-year-old Acacia stands growing on infertile grassland sites in Natal at a rate of 200 kg ha^{-1} yr^{-1} and that the exchangeable base content of the topsoil had not declined appreciably despite regular harvesting for wattle bark and timber.

Few other studies of long-term productivity have been reported though second rotation investigations are beginning in Araucaria cunninghamii stands in Queensland (Anon, 1979).

CAUSAL FACTORS

In the tropics there have been few mensurational studies comparing successive rotations. Most work, as examples quoted have shown, has investigated changes to the site induced by the plantation crop and the way it is managed mainly to detect evidence of site degrade since this is one of the factors that could cause productivity decline. This paper does not attempt an analysis of causal factors, but it is important to distinguish the possible environmental and ecological changes that could alter productivity between rotations.

Climate Always a factor when comparing successive rotations on the same site. Not a problem if stands of different rotations are established at the same time and are (say) on adjacent sites. In the tropics rainfall differences, distribution and total amount, are likely to be the most important aspect of climate - see Evans (1978a and b), but other phenomena e.g. hail damage can also affect growth and may easily go undetected and be not known about when yield comparison is made.

Genetic differences between rotations. Obviously, change of species will influence productivity but so too will change in seed origin and seed quality. When comparing two rotations of the same species seed identity becomes especially important since use of genetically superior seed may disguise evidence of declining site productivity. This is particularly important in view of the vigorous tree improvement programmes with many important plantation species, most notably Pinus caribaea.

Site changes due to carrying out plantation forestry. This subject has received most attention and it concerns the effects of one plantation crop on its successor. Changes may occur to physical, chemical and biological characteristics of the site - see Florence (1967) and are caused by three related influences.

1. Management imposed factors. Ground preparation practices, addition of fertiliser, departmental burning, removals from the ecosystem in thinning and felling, method of disposal of debris after harvesting, etc.

2. Effects of harvesting produce. This is allied to 1. above but is identified separately because the damage extraction equipment causes to a site is a clearly distinct effect. Dragging and skidding logs over site leads to compaction and localised erosion of soil. In the Usutu Forest, Swaziland, the location of skidder tracks used in harvesting the first rotation is clearly identified in several compartments years later by strips of poorer growth in the second rotation stand.

3. Effects of the plantation itself on the site. The growing of a plantation, usually a monoculture, will influence the site and soil and numerous reports of changing soil conditions associated with forest monoculture have been reported; a good example including a comprehensive review is that of Lundgren (1978). This factor of soil/site change is particularly important in the tropics because many plantations are being established on old rainforest sites, of which the history of clearance and conversion to sedentary agriculture is a catalogue of failures, and long weathered, infertile, savanna or grassland soils. Moreover, it is suggested that on many of these sites maintenance of productivity in the long-term requires a multi-layered and multi-specific cropping structure, akin to rainforest physiognomy, rather than the much simpler ecosystem of monoculture (Andrenae, 1974; Brunig et al, 1975).

Biological and silvicultural differences. Clearly differences between rotations in silvicultural practices will affect growth as will the relative incidence of pests and diseases. Less obvious may be changes in soil microflora and microfauna e.g. mycorrhizae (Robinson, 1971, and 1973; Squire, 1977b).

CONCLUSIONS

Long-term productivity is important if the prospects afforded by plantation forestry in the tropics are to be sustained. However, there are few factual data available on yields of successive crops. This is partly due to there being few second rotation stands but partly from a failure to establish and maintain sample plots over long periods and then to publish the results. This, along with ecological studies of site changes caused by plantation forestry, should be accorded top priority in future mensurational investigations in tropical plantations.

Nevertheless, what meagre evidence exists suggests that serious declines in productivity with successive crops is not going to be an immediate problem on most sites as soon as the second rotation is established.

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PESQUISA SOBRE IRRIGAÇÃO E TOLERÂNCIA AO SAL EM *Eucalyptus* EM ISRAEL.

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Resumo

O *E. camaldulensis* é altamente tolerante à salinidade e ao encharcamento com água salina; esta tolerância está relacionada com as condições ambientais que prevalecem na região de origem das sementes na Austrália. A espécie responde à irrigação durante a estação chuvosa (outubro a maio), dobrando a produção, mas a irrigação durante a estação seca do verão mostrou ser ineficiente, por causa da dormência.

O *E. occidentalis* também mostrou-se altamente tolerante às condições salinas e de encharcamento. Os dados disponíveis mostram ainda que esta tolerância está também relacionada com as condições de origem das sementes.

Diferenças significativas na tolerância às condições de

encharcamento relacionadas com a origem das sementes foram também verificadas com o *E. viminalis.*

Este trabalho revê as pesquisas sobre os efeitos da irrigação e sobre a tolerância à salinidade de plantações de *Eucalyptus camaldulensis, E. oocidentalis*, e *E. viminalis* em Israel.

RESEARCH ON IRRIGATION AND SALT TOLERANCE OF *Eucalyptus* IN ISRAEL.

Summary

This paper reviews research on irrigation effects and salinity tolerance of Eucalyptus camaldulensis, E. occidentalis, and E. viminalis in Israel.

E. camaldulensis is highly tolerant to salinity and flooding with saline water; this tolerance is related to the environmental conditions prevailing at the seed origin in Australia. The species responds to irrigation during the rainy season (October - May) by a twofold increase in yield, but irrigation during the dry summer is ineffective because of dormancy.

E. occidentalis is also highly tolerant to saline conditions and flooding. Available data also point to the fact that tolerance is related to the seed origin.

Significant differences in tolerance to flooding as related to seed origin, were also obtained in E. viminalis.

Introduction

The first large refforestation project with eucalypts was carried out here during the last decade of the 19th century. Eucalyptus camaldulensis was planted at Hadera with the express purpose to drain the vast malaria-infested swamps (the plants were set into the soil below the water (11). With time, the cultivation of eucalypts spread to most parts of the country and the tree became the main source of timber for industrial and agricultural uses. Large-scale planting and occasional failures under a very wide range of environmental conditions emphasized the need for research on their site requirements and on tree-soil-water relationships. Although an impressive list of publications on these subjects is available, only little research was carried out on irrigation and salt tolerance. This is due to two .ain causes. Water in Israel constitutes the limiting factor for agricultural development, is expensive and its use for irrigating forest plantations is, so far, commercially unsound. Saline soils in the northern part of the country are used for agriculture, the salt being leached by irrigation; in the south, saline soils are in the desert where drought precludes the growing of eucalypts on a commercial scale.

Results of Research

Although as a rule eucalypt plantations are not irrigated on a commercial scale, investigations were carried out on the effect of irrigation on yield of E. camaldulensis. In a preliminary trial irrigation applied during the summer, the usual season for irrigation application in agriculture and orchards, failed to achieve a significant response in yield because of summer dormancy. However, when sprinkler irrigation was applied during the growing season by replenishing the water content of the root zone to field capacity every two weeks, from September until May, a five-year-old plantation of E. camaldulensis responded by a more than twofold increase of the growing stock - to 72-79m^3/ha as compared to that of the control - 36m^3/ha. Yet, in spite of the considerable increment, irrigation is at present not economic due to the high expenditure for water and labour (5).

The tolerance to flooding was investigated since, in the case of E. viminalis, low-lying locations, where the snow melt accumulates in the spring, are available for refforestation in the high altitudes of Golan. In the case of E. camaldulensis, resistance to flooding with even saline water is required for planting in so-called liman plantations (14) in the Negev desert, where natural or artificial depressions accumulating the run-off from small catchments are used to grow trees mainly for anemity purposes (12). Since the soil of the catchments may be saline, the run-off may be expected to contain various amounts of soluble salts. For a discussion of the soil-water regime of liman plantations see Stibbe (13).

In a nursery experiment including the flooding of eucalypts for 103 days, five seed sources of E. viminalis (four from Australia and a local one from Golan) showed significant variation in tolerance according to their origin. The fact that the experiment was carried out with seedlings does not detract from its practical value, since effects of flooding on mature; vigorous trees are less pronounced than on seedlings (9).

In its natural habitats in Australia E. camaldulensis is known to be flood-tolerant. Use of this property was made in large-scale refforestation to drain m laria-infested swamps, and under conditions of unlimited moisture su pply to the root zone, growth was exceptionally fast, evapotranspiration being equal to, or even exceeding, potential evapotranspiration (2). Similar conditions prevail in eucalypts planted on drained lake Hula peat (16). Coppice regeneration is also tolerant to flooding provided that the coppice shoots are not completely submerged. It is, therefore, recommended to carry out coppice fellings in the spring after the period of flood hazard (7). For the water balance of E. camaldulensis plantation see Karschon and Heth (8) and Karschon (6).

Preliminary investigations on salt tolerance of various eucalypt species were made by Bidner-Bar-Hava and Ramati. Though the value of their experiment is dubious, there are clear indications of differences in tolerance according to species. E. camaldulensis var. subcinerea was found to be highly tolerant, but E. occidentalis, E. leucoxylon, E. gomphocephala, E. rudis and E. tereticornis are only partly tolerant to soil salinity (17 and 22 mmhos/cm) (1). Some of these data are not confirmed by later research.

Growth of E. camaldulensis was investigated on solonchak soils in the Haifa Bay. It was shown that in the presence of $CaCO_3$ the salt tolerance is good and the trees supported without injury up to 0.28% soluble salts and 0.11% chloride; on soils containing organic matter in addition to $CaCO_3$, they tolerated up to 1.25% total soluble salts and 0.51% chloride in the soil (3). For growth of E. camaldulensis in an oasis in the Wadi Arava see Karschon (4).

A nursery experiment was reported with three provenances of E. camaldulensis on the effects of seed source to flooding and irrigation with saline water. It was concluded that the differences in tolerance are related to contrasting ecological conditions at the seed sources. Provenance 6845 from Lake Albacutya, Vict., tolerated tapwater flooding for 12 months and 12 months irrigation with water containing up to 4500 ppm NaCl; provenance 6863 from Katherine, N.T. - 4 months and 4 months, and provenance 8403 from Wyndham, W.A. - 4 months and 2 months, respectively (10).

Zohar (15) found that growth of E. occidentalis is not impaired by prolonged flooding for more than one year. The species also tolerates salinity exceeding 3,000 ppm NaCl in a soil containing more than 30% $CaCO_3$, the tolerance to salinity being improved by high lime contents. Growth of E. occidentalis from four seed sources in Australia and a local source, under the extreme conditions of saline swamps in the Wadi Arava, was found to be related to the seed origin; the progeny from Esperance, W.A.. being the most tolerant. The species under trial were ranked in the following decreasing order of salt tolerance: E. occidentalis from Esperance, E. sargentii, E. spathulata and E. kondininiensis. Under moderate conditions of salinity E. loxophleba was found outstanding(17).

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VARIAÇÃO ESTACIONAL DO CONTEÚDO DE NUTRIENTES NAS FOLHAS DE *E. grandis*.

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Resumo

As variações mensais das concentrações de 6 macro-nutrientes e de 4 micro-nutrientes nas folhas de *Eucalyptus grandis* foram medidas durante 2 anos em três sites diferentes, período durante o qual as árvores estudadas apresentaram de 1 a 3 anos de idade. Pode ser observada relação íntima entre a taxa de crescimento em altura das árvores e as chuvas verificadas durante o período experimental. As variações do conteúdo de N, P, K, Ca, Mg, S e Zn nas folhas também guardaram semelhança com a taxa de crescimento em altura. Para o caso do Fe, esta relação foi inversa. Para o caso do Cu e do Mn, ela foi apenas incipiente, sendo mínima para o caso do Mn. Os conteúdos foliar de N, Ca, S, Cu, Zn, e Fe também foram relacionados com a precipitação, sendo que o Fe mostrou uma relação inversa com as chuvas ocorridas. Foi observado um declínio perceptível no conteúdo foliar de N, P, S e Cu durante os dois anos de observações. Parece recomendável a amostragem rotineira de folhas de plantações de *E. grandis* durante o pico da estação de crescimento do primeiro ano após o plantio, quando as respostas são maiores e as diferenças são mais pronunciadas.

SEASONAL CHANGES IN FOLIAR NUTRIENT CONTENT OF *E. grandis*.

Summary

The monthly variations in the concentrations of six macro- and four micro-nutrients in the foliage of *Eucalyptus grandis* were studied at three different sites during two years, when the trees were between one and three years of age. There was a close relationship between rate of height growth and rainfall during this period. The changes in foliar levels of N, P, K, Ca, Mg, S and Zn conformed very closely to the rate of height growth. For Fe this relationship was inverse. It was only just apparent for Cu and Mn, and the seasonal variation of the last nutrient was minimal. The foliar levels of N, Ca, S, Cu, Zn and Fe were also related to rainfall, the last nutrient showing again an inverse relationship. There was a distinct decline in the foliar levels of N, P, S and Cu during the two years of observation. It seems advisable that routine sampling of *E.grandis* leaves should be carried out during the height of the growing season of the first year after planting when responses are greatest and differences more pronounced.

INTRODUCTION

Very little is known about the foliar nutrient concentrations of eucalypts and even less about their seasonal variations. The effect of fertilizing on the foliar nutrient status of *Eucalyptus grandis*, the main commercial eucalypt species grown in Southern Africa, has been described by the author (Schönau, undated). In order to study the seasonal changes in these concentrations, a small pilot experiment was started early in 1977 as a preliminary investigation. This paper gives the results of the first two years of this study.

EXPERIMENTAL SITES AND METHODS

The investigations were carried out on three properties near Pietermaritzburg in the Natal Midlands and the relevant details of each site and past history are given in Table 1. Unfortunately, no temperature records are available, but Broadmoor has the highest temperatures and best growing conditions irrespective of rainfall and Garlick's the lowest temperatures and poorest growing conditions respectively. No particulars of the soils are available at present, but they should be very similar on each site.

TABLE 1

Details of the three sampling sites

Name of property	Broadmoor	Garlick's	Henley Dam
Owner	Holley Brothers (Pty) Ltd	Philip L Garlick (Timber) (Pty)Ltd	Pietermaritzburg Municipality
Altitude (m)	875	1 125	950
Distance from Pietermaritzburg (km)	27	7	13
Direction from Pietermaritzburg	NE	NNW	WSW
Annual rainfall (mm)	1 146	1 255	1 082
Trees planted	Dec 1975	Jan 1976	Nov 1975
Fertilizer applied per tree at planting	115 g 3:2:1(25)*	100 g LAN** 100 g Supers***	-
Previous crop	*Pinus patula*	*Acacia mearnsii*	Virgin veld

* NPK mixture
** Limestone ammonium nitrate
*** Superphosphate (8,3% P)

At each site 12 well-grown *E.grandis* trees were selected and were sampled approximately monthly for two years since March 1977, when the trees were just over one year old. At each sampling, a composite leaf sample from the upper third of the crown was collected from the same trees separately for each site. The sampling and the methods of analysis are described in detail elsewhere (Schönau, *loc.cit.*)

RESULTS

The monthly rainfall, growth rate and development of mean height at the three sites are illustrated in Figure 1.

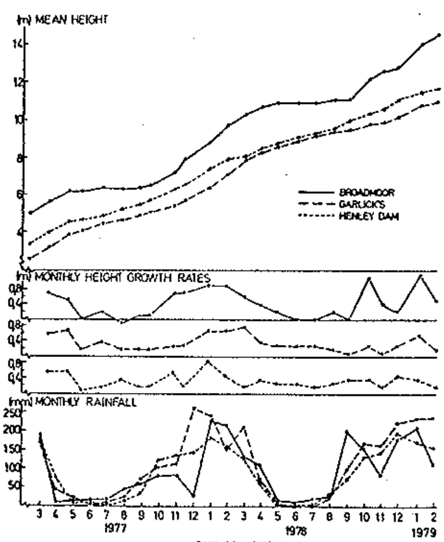


Figure 1. Monthly rainfall, growth rate and development of mean tree height at the three sites during observation period.

Figure 1 shows that the growth rate during the summer was the best at Broadmoor where the temperatures were the highest. However, during winter the growth rate at this site was poorer than at the other two sites and was even negative in one instance. This is due to the situation of the sample plot in a frost pocket where the tips of the trees were frosted during the winters of 1977 and 1978. The poorest growth occurred at Garlick's where the daily temperatures are much lower and the site is very exposed to strong winds. At Henley Dam the trees were severely suppressed during the first year after planting, due to heavy uncontrolled weed growth. It is interesting to note that the patterns of height development at the three sites were very similar and that the mutual differences remained more or less the same during the two years under observation.

It is very clear that the growth rate was closely related to monthly rainfall. This is obvious especially when they both dropped in November 1978 and rose the following month. Other examples are the drop and rise at Garlick's in February 1978 and the drop at Henley Dam after January 1978.

The mean foliar concentrations, standard deviations and range of six macro-nutrients (N, P, K, Ca, Mg and S) and four micro-nutrients (Cu, Zn, Fe and Mn) are given in Table 2 for each site separately.

TABLE 2

Means, standard deviations and overall range of foliar nutrient concentrations for the three sampling sites during the two-year period of observation

Nutrient	Broadmoor		Garlick's		Henley Dam		Overall range	
	Mean	SD	Mean	SD	Mean	SD	Max.	Min.
N (%)	2,81	0,57	2,46	0,44	1,87	0,27	4,42	1,48
P (%)	0,17	0,04	0,14	0,03	0,12	0,01	0,25	0,09
K (%)	0,77	0,11	0,63	0,09	0,76	0,13	1,06	0,40
Ca(%)	0,79	0,13	0,90	0,16	0,69	0,14	1,27	0,46
Mg(%)	0,26	0,06	0,22	0,03	0,22	0,04	0,37	0,15
S (%)	0,20	0,03	0,17	0,02	0,14	0,02	0,26	0,11
Cu(mg/kg)	12	4	14	4	10	3	23	4
Zn(mg/kg)	31	3	22	3	21	2	36	15
Fe(mg/kg)	251	86	162	66	209	101	491	85
Mn(mg/kg)	785	238	2 169	348	848	156	2 701	455

It is evident from Table 2 that the levels of N, P, Mg, S, Fe and Zn were the highest and the level of Mn the lowest at Broadmoor, the site with the best growing conditions. The opposite was the case at Garlick's, the poorest site for *E.grandis*, although the levels for N, P and S were higher than at Henley Dam, probably due to the fertilizing which was carried out at the former site and which was omitted at the latter. On the exposed and windy site at Garlick's the foliar concentrations of K and Fe were appreciably lower. If the data of Table 2 are compared with the annual rainfall in Table 1, it is obvious that the levels of Ca and Cu are directly related to rainfall.

The seasonal variations for the two years after March 1977 in the foliar concentrations of the macro-nutrients are illustrated graphically in Figures 2 and 3, and those of the micro-nutrients in Figure 4.

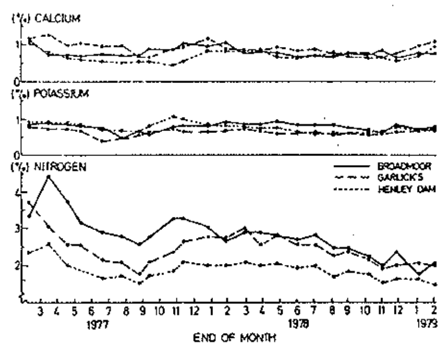


Figure 2. Variation of foliar N, K and Ca at the three sites during observation period.

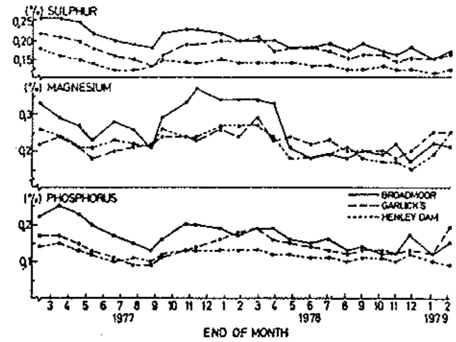


Figure 3. Variation of foliar P, Mg and S at the three sites during observation period.

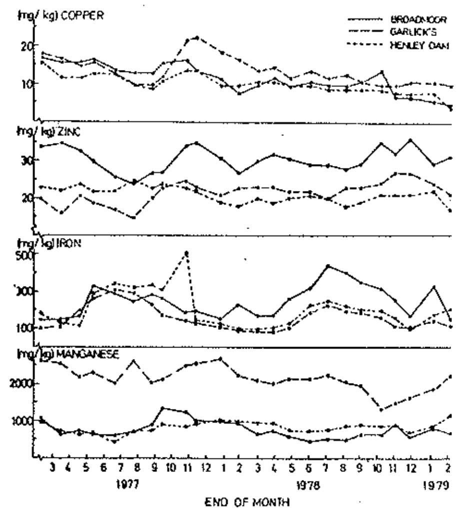


Figure 4. Variation of foliar Cu, Zn, Fe and Mn at the three sites during observation period.

D I S C U S S I O N

The figures show that the foliar nutrient concentrations varied in harmony with rainfall and growth rate and that they were mainly directly related except in the case of Fe where an inverse relationship existed. The variation for each nutrient is discussed briefly below.

N i t r o g e n

The changes in foliar N conformed very closely with those in rainfall and growth rate. In general this direct relationship was more delayed than for the other nutrients. This is especially noticeable for Broadmoor at the end of the observation period and for Garlick's during the summer of 1977/78. The initial level of foliar N at Garlick's was the highest, probably due to the high level of fertilizer with limestone ammonium nitrate (LAN) and the previous crop of *Acacia mearnsii*, a leguminous tree species. An overall decline in foliar concentration was evident during the two-year period. This decline was the least at Garlick's, most probably on account of the previous leguminous tree crop.

P h o s p h o r u s

The changes of foliar P conformed very closely with those of the growth rate. The relationship with rainfall was less obvious than for foliar N. It is thought that the relationship between temperature and foliar P, however, is much closer. The decline in foliar P was much less marked than for foliar N and the overall level was distinctly higher where the trees have been fertilized with phosphates (Broadmoor and Garlick's).

P o t a s s i u m

Foliar K showed the least seasonal variation of all the nutrients, but there was still a direct relationship with growth rate. It was generally the lowest on the exposed site with the highest rainfall (Garlick's). There was no marked decline in foliar K over the two-year period and the influence of the light fertilizing at Broadmoor was noticeable only during the second year of the observations.

C a l c i u m

Although the seasonal variation in foliar Ca was also small, it was more closely related to growth rate than was foliar K. There was also a clear direct relationship with rainfall, and Ca levels were the highest where rainfall was the highest. No marked decline in foliar Ca was noticeable over the two-year period.

M a g n e s i u m

Foliar Mg showed the strongest seasonal variation especially at Broadmoor, the site with the best growing conditions. It was less marked during the summer of 1978/79, but no overall decline during the two-year period was noticeable. The foliar levels were closely and directly related to growth rate.

S u l p h u r

Foliar S changed in close conformity with rainfall and growth rate. There was a slight decline of the levels over the two-year period. At Henley Dam where no fertilizing with either superphosphate or the 3:2:1(25) mixture took place, foliar S levels were lower throughout the period.

C o p p e r

Foliar Cu was related directly to rainfall, and appeared to "anticipate" increases in rainfall during spring, but because of the general rise in temperature at this time, it is considered that this effect is due to foliar Cu being more closely related to temperature. After the winter of 1978 the seasonal variations seem to disappear accompanied by a general decline in levels.

Z i n c

At Broadmoor and Garlick's the variation in foliar Zn conformed with those of rainfall and growth rate. This direct relationship was not apparent at Henley Dam where foliar Zn was more or less stable during the two-year period. There was no decline in foliar levels of Zn during the two-year period.

I r o n

Of all the nutrients analysed, levels of foliar Fe were the only ones which are inversely related to growth rate and rainfall. The increase of foliar Fe during winter, when the daily temperatures are low, might be connected with the dark purple colour of the foliage of *E.grandis*. The levels during the second winter were the highest at Broadmoor when severe frost damage was observed on the tops of the trees which were then already more than 10 m tall. The slightly higher levels at Henley Dam during the first winter might have been due to generally colder conditions at this site. Another peculiarity of foliar Fe is that it was the only nutrient of which the variation increased over the two-year period.

M a n g a n e s e

Foliar Mn was the highest at Garlick's, the site with the poorest growing conditions at the higher altitude. The seasonal variation was not very distinct and no general decline over the two-year period was apparent. On the exposed site at Garlick's there seems to be a decline in foliar Mn during summer, especially during 1978/79. However, under the better growing conditions at Broadmoor this trend seems to be reversed, when foliar Mn increased slightly during summer.

C O N C L U S I O N S

These results indicate clearly that there is a considerable seasonal variation in foliar nutrient levels of *E.grandis* and that the differences between the various sites are greater during the height of the growing season. The more pronounced differences in foliar nutrient concentrations during summer make it preferable that routine sampling for detection of nutrient deficiencies and for fertilizer recommendations are carried out during the growing season. Also, the general decline in nutrient levels after two years of age and the poor response to fertilizer application in older trees, makes it advisable that sampling is carried out at an early age, preferably during the first year after planting.

L I T E R A T U R E C I T E D

Schönau, A. P. G. (undated) : The effect of fertilizing on the foliar nutrient concentration of *E.grandis*. (In preparation).

sessão V
session V
grupo AB
group AB

DANISH/FAO — CENTRO DE SEMENTES FLORESTAIS DINAMARQUÊS 1969/1979.

H. Barner

H. Keiding

DANISH/FAO Forest Tree Seed Centre.

Resumo

O Centro de Sementes Florestais Dinamarques foi criado a partir de 1969, para dar apoio aos paises em desenvolvimento em seus esforços na procura e obtenção de sementes florestais melhoradas das espécies/raças bem adaptadas, destinadas à implantação de florestas em áreas tropicais e sub-tropicais. O centro é patrocinado pela F.A.O. e suas atividades estão diretamente ligadas ao "Grupo de Especialistas em Recursos Genéticos da F.A.O." e na Região do Sudeste da Ásia". O trabalho apresenta uma síntese de todas as atividades do Centro no período de 1969-1979.

WORKING PROGRAMME

General objectives:

To support developing countries in their efforts to procure improved forest tree seed of well adaptable species and races for plantation forestry mainly in the tropical and sub-tropical zones. Next, to support the development of national and regional institutions for seed procurement and tree improvement and further to take part in the preservation of genetically important seed sources.

Function:

The Seed Centre works under the auspices of FAO and in co-operation with other seed centres according to a common, global plan the contents of which is currently discussed and formulated by the FAO Panel of Experts on Forest Gene Resources. As part of this plan for international co-ordination the Danish/FAO Seed Centre is allocated the SE-Asian region as the main area for its operations.

To achieve these objectives the work of the Seed Centre comprises the following activities:

1. Organization and execution of representative seed collections from highly rated tree species for testing in species and provenance trials.
2. Supplementary seed collections with the dual purpose of further testing of promising seed sources on a wider scale and of preserving gene resources outside their original habitat (conservation ex situ).

3. Development of practical methods for seed collection, extraction, storage, germination and sowing.

4. Consultative service at:

a) establishment of local seed and tree improvement centres.

b) delineation of seed collection zones and establishment of classification and certification systems.

c) experimental procedures and evaluation of species and provenance trials.

d) import of seed for large planting programmes.

5. Training and education in the fields of work connected with the Seed Centre. These may be given either in the form of stipends for individuals or in courses for groups.

SUMMARY OF ACTIVITIES

1. Organisation and Execution of Representative Seed Collections

One of the main objectives of the Seed Centre has been to organize seed collection expeditions to original habitats of important forest tree species in order to provide material for testing and bases for improvement. Being allocated the SE-Asian region for operation as part of an internationally coordinated scheme, collections were carried out mainly in India, Thailand, Laos and Indonesia. The species handled were teak (Tectona grandis), Pinus merkusii and Gmelina arborea, while 4 other are still pending.

Teak:

While seed was collected in SE-Asia with some supplementary samples of domesticated populations in Africa, it was distributed from the Seed Centre to all parts of the tropics, where interest for the species in question was expressed.

Collections were carried out in the period from 1971-73. Nearly 75 different sources are represented, the majority of which is from natural stands. A total of 149o kg has been stocked at the Seed Centre of which now only remain 13o kg, the rest being distributed to 29 countries or regions.

From appendix 1 it appears which countries/regions have received samples for international provenance trials. Appendix 2 indicates the test sites on a global scale.

On top of that the following countries have received a smaller number of provenances for trials of more limited scope:

Africa	South and Central America	SE and East Asia
Somalia	Columbia	China
Tcad	Belize	Nepal
Central Africa Rep.	Puerto Rico	Vietnam
Liberia		Sabah,Malaysia
		Maldives
		Philippines

Further, provenance samples have been sent for special seed tests and investigations to various seed laboratories or universities e.g. to U.S.A-, Finland, England and Australia. Often it has been in connections with preparations of doctor thesis (ph.D.) for Thai students studying in Australia or Finland.

Pinus merkusii.

Collections were carried out in 1972 in Thailand and N. Sumatra. Smaller amounts were received before that date, but these could not be included in the int. provenance trials. Conditions for travelling and collecting have been described in some details in reports and papers. See references Appendix 8.

The material collected by the Seed Centre and the Pine Improvement Centre, Thailand, jointly comprises in all 23 provenances of which 16 derive from Thailand and 7 from Sumatra. The latter only in small quantities, due to special circumstances (difficulties) for collections. see appendix 3.

The seed, totalling 24.6 kg, has been distributed to 25 countries or regions. Seven of these participate in the international provenance trials. Of the original stock remains 4.95 kg i.e. nearly 2o kg have been distributed. For information 5o gr. seed of P. merkusii may produce from 6oo-12oo plants which is enough for 3-6 trials, each of 4 replications.

Distribution to countries/regions 1972-198o.

Africa	South & Central America	Oceania	S.E. and East Asia
Nigeria)	Brazil)	New Caledonia	India (2 trials)) INT
Tanzania) INT	Mexico) INT	Australia	Sri Lanka)
Zambia)	Venezuela)	Papua New Guinea	China
Uganda	Ecuador	Solomon Isl.	N. Vietnam
Mocambique	Bolivia		Thailand
Liberia			Bangladesh
			Sabah, Malaysia
			Philippines

INT = Participants in the international prov. trials.

Gmelina arborea:

Gmelina arborea has attracted much attention for use in industrial plantations due to its general useful wood (incl. superior quality for paper), its fast growth and relative ease of establishment.

The species occurs naturally, widely distributed in South and South East Asia. Seed used for trials and plantations have so far, however, been collected in a very limited part only of the natural range of occurrence.

Anticipating a substantial genetical variability, it was in 1968 (in meeting of Panel of Experts on Forest Gene Resources, FAO) proposed to initiate a comprehensive provenance trial scheme aiming at investigation and exploration of the supposed genetical diversity. The scheme was to be the joint responsibility of The Forest Research Institute, Dehra Dun, India and The Danish/FAO Forest Tree Seed Centre.

Due to little existing knowledge on details of occurrence, difficulties in locating trees and problems of seed collection in connection with lack of staff at the two responsible institutes, the scheme could not be implemented until early in the year of 1975.

After exploratory travels in India in 1975-76, seeds were collected by the local forest services in India, Thailand,Brazil Ivory Coast and Malawi (three latter domesticated Gmelina arborea) during the years 1975-77, and seed were distributed to participating countries that had responded to circulated questionnaires prior to the start of the scheme. Requests for participating in the scheme were, however, continuously submitted to the Seed Centre during 1977-78 and it was decided to make another collection this time to include if possible a wider range of the natural occurrence of Gmelina arborea (Burma, Yunnan in China and Vietnam). These collections were initiated in 1978 and will finish by June 198o. Seed distribution is supposed to start by July 198o. For details of collection and distribution, refer to appendices 4,5 and 6.

In all, around 13oo kilogrammes of seeds are collected in the scheme of which some 1ooo kg have been stored at and distributed from Denmark. Around 4o provenances are represented in the collections and the tests are made ot to be made on some 8o sites.

9 countries have contributed seeds to the scheme: 4 in S. and S.E. Asia, 4 in Africa and 1 in S. America.

26 countries are participating in the scheme: 9 in S. and S.E. Asia, 7 in Africa, 1 in East Asia (Taiwan), 4 in Oceania and 5 in Latin and South America.

A circular requesting information on early performance in the first trial series was circulated by May 1979, but very few participants have so far responded. In connection with other work, Seed Centre representatives have visited trial localities in India, Thailand and Mexico. A tour scheduled for November-December 1978 to West Africa was cancelled. Otherwise the limited resources of the Seed Centre has not made it possible to engage in a comprehensive evaluation of the established trials.

Besides of the provenance scheme,small amounts of seeds were used for seed investigation experiments (doctorands), around 6 kilogrammes, and for plantation establishment in Peru, 21 kilogrammes.

2. Supplementary Seed Collections

Pinus caribaea, P. oocarpa and P. cubensis.

Due to very promising results from provenance research, initiated by the Commonwealth Forestry Institute, Oxford there is an increasing interest in seeds of Pinus caribaea for large scale trials and for establishment of stands for future seed production.

Seed representing more than 2o different sources have been purchased through the Seed Centre and shipped to India, Mosambique, Philippines, Sri Lanka and Thailand.

Eucalyptus Species.

The Eucalyptus Research Centre in India has shown great interest in testing of Eucalyptus species and has asked for assistence in procurement of seed samples. The Seed Centre has purchased samples of 8 species from Australia. Further we have supplied seed samples from Argentina, Israel, Portugal, Rhodesia, Spain and South Africa to India. Australia is now in direct contact with India.

North American Species.

Through the IUFRO-Coordinating Centre the following samples have been distributed to developing countries:

Country	Seed samples, No.			
	Douglas fir	Contorta pine	Other	Total
Argentina	56	2o		76
Chile	56	5	6	67
India	39			39
Iran	2o	1o		3o
N.Korea	21	9	9	39
S. -	11	8	4	23
Turkey	157	9o	2	249
Venezuela	6			6
Total samples	366	142	21	529

The purchase has been made through funds made available by F.A.O.

Comments

The bottle-neck in some countries in South-East Asia and India is the complicated import regulations and lack of proper storage facilities. Much seed has got lost in customs or has been damaged by wrong storage or treatment in the nurseries. The seed Centre, therefore, has hesistated to invest too much time and money in procurement of larger quantities of seed. Meanwhile we have been working on the import regulations which is now being discussed by ISTA (International Seed Testing Association).

If results from research shall be implemented into forest practise in the developing countries action must be taken now. Most of the Seed Centres confine themselves to procurement of samples for research of gene conservation. The seed Centre in Humlebæk would like to contribute in supporting the developing countries by procurement of bulk seed for plantation establishment.

3. Development of Methods for Seed Collection and Handling

The subject has been presented in lectures of the FAO/DANIDA Trainings Courses, mentioned under item 5.

The main efforts have been concentrated on Thailand and India. Chile, Cuba, Ecuador, Indonesia, Malawi, Mexico, Nigeria, Turkey and Zambia have shown particular interest in the subjects and have in connection with visits of their specialists thoroughly discussed the various problems. The Centre is currently in contact with the developing countries and has provided details and pamphlets about equipment for seed handling. Comprehensive series of experiments with germination, pretreatment and storage of teak seeds have been carried out in close liaison with the Teak Centre in Thailand. Experiments with other species (Gmelina, Pines) have also been made. The Seed Centre has served as an advisor to Danida as regards the purchase of equipment for the projects in Thailand and India.

The Centre makes an effort to be up to date regarding the development of equipment for collection, handling, testing and storing of seeds and keeps and updated file on equipment available. The Centre has promised FAO to draft a booklet on the subject, but regrettably we never managed to fulfil the obligation.

There is a considerable need for development in this field. Much seed is lost due to wrong treatment. The almost constant shortage of seed from suitable seed sources combined with an unnecessary wastage force consumers to use less suitable sources with a long time detrimental effect on production and quantity of the future forests. In many cases improvements can be achieved by short term training or by application of well established techniques and cheap equipment. Many of the tropical broadleaved species being of importance for forestry as well as for agroforestry loose the germination capacity very quickly. The problems involved can only be solved by research.

4a. Establishment of National Seed Centres.

The main purpose of a Seed Centre is to provide seed from well defined sources for 1) forest plantations, 2) research, 3) tree improvement or 4) gene conservation.

A national Seed Centre should initiate and provide information on:

1. Species priorities.
2. Seed demand by species.
3. Seed collection zones and seed certification
4. Selection, registration and description of seed sources.
5. Seed collection,handling and testing of seed quality.
6. Results from testing of seed sources.

Seed Centres may furthermore initiate or take active part in tree improvement and breeding, particularly in implementation of results, e.g. establishment of seed production areas and seed orchards, aiming at mass production of improved seed.

The activities of a Seed Centre are outlined in Appendix 7. The core activities are seed procurement and a well equipped Seed Bank, working in close collaboration with the research institutes.

A regional or international Seed Centre is responsible for exchange of seeds and information on related problems beyond the local requirements. For seed exchange it is recommended within each forest region to select a number of representative sources from which seed readily can be made available upon request.

Regional or international exchange of seeds can only be accomplished if undue restrictions on export and import are abolished.

The development of local or national procurement of seed is an indispendable part of the increasing plantation programmes in most developing countries. Without some organisation of seed collection and seed handling, as outlined above, the plantation programmes will be difficult to accomplish satisfactory.

In an international connection this became particularly apparent during the provenance collections. Local support is absolutely necessary for the proper execution of the collections as well as for the establishment and the evaluation of the ensueing trials. See Keiding, Kemp, 1977.

The idea of regional centres or cooperation is naturally related to the geographic distribution of important tree species across national borders and in common technical problems.

Local Seed Centres may be able to contribute to international or regional seed supply, whereas the efficiency of a Regional Centre depends very much on the efficiency of the local centres. Therefore the Centre in Humlebæk from the beginning recommended to concentrate the efforts on establishment of local Seed Centres rather than on ambitious regional projects.

India.

A major feature of the activities in this fiels has been the establishment of the Indo/Danish Seed Procurement and Tree Improvement Project in August 1976. Three Centres have been established.

The Danish Seed Centre has devoted much time on the Indian/Danish Project. Progress has been slow. It should be kept in mind, however, that the Project is an integrated part of the Indian Forest Service. The progress made will therefore have much more longterm effect than an independent short term project staffed with foreign experts.

Thailand.

The Danish Seed Centre has taken part in the revision, evaluation and extension of the Teak and Pine Centre in Thailand. The establishment of the Teak Seed Centre in 1975/76 was strongly supported by the Seed Centre in Humelbæk. Close collaboration has been maintained throughout the years.

4b. Seed Certification

Training Courses. The subject has been presented in lectures at the FAO/DANIDA Training Courses held in:

Denmark	1966
Kenya	1973
Thailand	1975
Venezuela	198o

Lecture-notes and documents have been distributed to many institutions and countries.

FAO has repeatedly recommended the establishment of certification schemes. The Seed Centre has contributed with information on the OECD Scheme (Report of the Second Session of the FAO Panel of Experts on Forest Gene Resources, 1971).

India. Mr. M. Gopal, I.F.S. has been working on certification schemes since 1968 and has published a number of documents on the subject. When Mr. A.V.R.G. Murty, I.F.S. was in Denmark in 1971/72 he drafted a proposal for a seed certification scheme for India.

Seed Certification is one of the main objectives of the Indian/Danish Project, based on the recommendation of the National Committee on Agriculture in 1976. The Seed Centre has discussed the problems at length with Mr. Gopal and has recommended the Scheme to be framed in accordance with the principles outlined in the OECD Scheme. A draft proposal was circulated in 1978 and the final rules and directives have been circulated to all concerned in 1979.

Thailand.

Seed Certification was discussed in details at the Training Course held in Chiang Mai in 1975. A Teak Seed Centre was established in 1976. Draft proposals for delimitation of seed zones were published in 1978. The Danish Seed Centre has submitted information on seed certification to the Pine Centre and to the Teak Centre as well. When a Danish mission visited Thailand in February 1977, it was recommend to strengthen the activities on seed certification and seed procurement in Thailand to set a good example in S.E. Asia.

Mexico and Central America.

The countries in Central America are important suppliers of seed to the tropical countries. Efforts have therefore been made to establish seed certification schemes in the region. Whereas there is little response from Mexico, Cuba, Guatemala and Honduras are working on the certification scheme.

Turkey.

The Seed Centre is in contact with Turkey and have submitted a great deal of information on seed certification. Turkey has now expressed her intention to adhere to the OECD Scheme on seed certification.

4c. Experimental Procedure for Provenance Trials.

As the start of each provenance scheme, questionnaires were circulated to each potential participant incl. proposal of experimental design to be used.

Also, to obtain information on existing knowledge of each species regarding seed handling and to what extend participants possessed satisfactory knowledge, a questionnaire was circulated concerning collection, handling etc. of seeds.

Participants who encountered specific problems would be given advice in correspondance. The uneven germination of teak for instance required special considerations in experimental lay-out. Where possible discussions of experimental procedures were made in more details during visits, especially in India and Thailand, but also Nigeria, Ivory Coast and Mexico have been visited.

Unfortunately the Seed Centre has not been able to neither extend the visits and field inspections nor to offer the services in processing the data received as desired and anticipated, due to cirsumstances of staffing and funding.

4d. Seed for larger Planting Programmes.

A few of the seed samples mentioned under item 2, Supplementary Seed Collections, have been large enough to be of significance for larger planting programmes. In some of the introduced fast growing species (Pines and Eucalyptus) achievements from research are now so advanced that bulk seed is in high demand in a great many developing countries. The problems in respect of seed procurement for developing countries may be summarized as follows:

1. Lack of contact to authorities or seed dealers in the seed source areas.
2. Prohibition on use of foreign currency for purchase of seed.
3. Complicated import regulations causing delay in clearing the seed through customs and other controlling agencies with the result that germination capacity of the seed is reduced or erased.
4. Limited seed production in the most desired seed sources results in either seed requests not being met or in the authenticity of the seed offered under the desired designation being doubtful.

The bottle-neck in some countries in Asia is the complicated import regulations and lack of proper storage facilities. Much seed has got lost in customs or has been damaged by wrong storage or treatment in the nurseries. The Seed Centre, therefore, has hesitated to invest too much time and money in procurement of larger quantities of seed. Meanwhile we have been working on the import regulations which is now being discussed by ISTA (International Seed Testing Association).

If results from research shall be implemented into forest practise in the developing countries action must be taken now. Most of the Seed Centres confine themselves to procurement of samples for research or gene conservation. The Seed Centre in Humlebæk would like to contribute in supporting the developing countries by procurement of bulk seed for plantation establishment.

5. Training and Education

Training Courses.

1. FAO/DANIDA Seminar on Forest Seed and Tree Improvement, Denmark 25th July - 13th Aug. 1966.

A total of 26 persons attended either as participants or as observers, representing 24 countries in Africa, Middle-East and Asia. Case studies were an essential part of the training and reports were prepared. All participants submitted country statements in relation to the subjects of the course. All lecturenotes were printed and distributed at the beginning of the course. Copies of the lecture-notes have been widely distributed after the course.

2. FAO/DANIDA Training Course on Forest Tree Improvement, Limuru, Kenya 24th Sept. - 2oth Oct. 1973.

A total of 23 persons attended either as participants or as observers, representing 14 countries in Africa, Latin-America and the Mediterranean region. Participants contributed valuable information, in the form of completed questionnaires on the present status of tree improvement. Case studies of main species were considered in detail. All lecture-notes were printed and distributed at the beginning of the course. Lecture-notes and country statements have been published by FAO and have been widely distributed after the course.

3. FAO/DANIDA Training Course on Forest Seed Collection and Handling. Chiang Mai, Thailand, 17th Febr. - 13th March 1975

A total of 27 persons attended either as participants or as observers, representing 16 countries in Asia, Africa and Latin America. Case studies were an essential part of the training, which was concentrated on species of main interest. All participants submitted country statements in relation to the subjects of the course. Working groups were active throughout the course. All lecture-notes were distributed at the beginning of the course. Lecture-notes, country statements and working group reports have been published by FAO and have been widely distributed after the course. The Pine Centre has used the documents for further training.

4. FAO/DANIDA Training Course on Forest Nursery and Establishment Techniques for African Savannas and Symposium on Savanna Afforestation, Kaduna, Nigeria 16th Febr.- 21st March 1976.

Regrettably, the closing of Nigeria's international borders in response to political disturbances in the country forced the cancellation of the training course. The symposium was held as scheduled but with reduced participation. FAO has published a report, which contains the lecture-notes prepared in advance of the training course, the principal symposium papers and the country statements. The report has been widely distributed.

5. FAO/DANIDA Training Course on Forest Tree Improvement, Merida, Venezuela 14th Jan. - 2. Febr. 198o.

Mr. Bjerne Ditlevsen, Danish Forest Service served as Danida Co-director. A total of 28 persons participated either as participants or as observers, representing 19 countries in Central - and South America.

6. IUFRO/FAO World Consultations on Forest Tree Breeding. Washington, D.C. 1969 and Canberra, Australia 1977.

The staff members of the Seed Centre contributed with documents and participated in the consultations. In connection with the consultation in 1969 a Training Course for developing countries was held in North Carolina.

7. IUFRO Working Party Meetings on Tropical Species Provenances and Breeding, Florida 1971, Kenya 1973 and Brisbane 1977.

The Seed Centre participated in and contributed to the meetings. Three important publications were issued in 1972/73, 1974 and 1979 respectively, being edited and printed in Oxford.

Fellowships

K.P. Muniswami, 1971-1972 .... India
A,K.R.G. Krishan Murthy 1971-72 .... India
B.L. Das, 1979 .... India
Kamulwat Visehtshasiri, 1975 .... Thailand
Sanan Kingmuangkan, 1975 .... Thailand
Trirut Nanasasyanoong, 1969 .... Thailand
Antonia Agmata, 1978-79 .... Philippines

6. Publications

Publications and reports distributed by the Seed Centre are shown in Appendix 8. The following Circular Letters have been distributed:

Danish/FAO Forest Tree Seed Centre 1969 (Establishment)

1. Provenance Testing of Teak, 1971
2. International Provenance Trials of Teak, 1971
3. - - - - - , 1972
4. Progress of the International Trials in Teak, 1972
5. Seed Collections of Pinus merkusii, 1972
6. Progress in International Provenance Trials of Teak
8. International Provenance Trials of Gmelina arborea, 1977
9. Progress Report on Provenance Trials of Gmelina arborea, 1978
1o. Assessment of International Provenance Trials of Gmelina arborea, 1979.

The reports of the activities of the Seed Centre, 1969-1974 and 1975-1977 have been widely distributed.

Teak, Appendix 1

Table 1. Status of international provenance trials in teak as reported by January 1977.

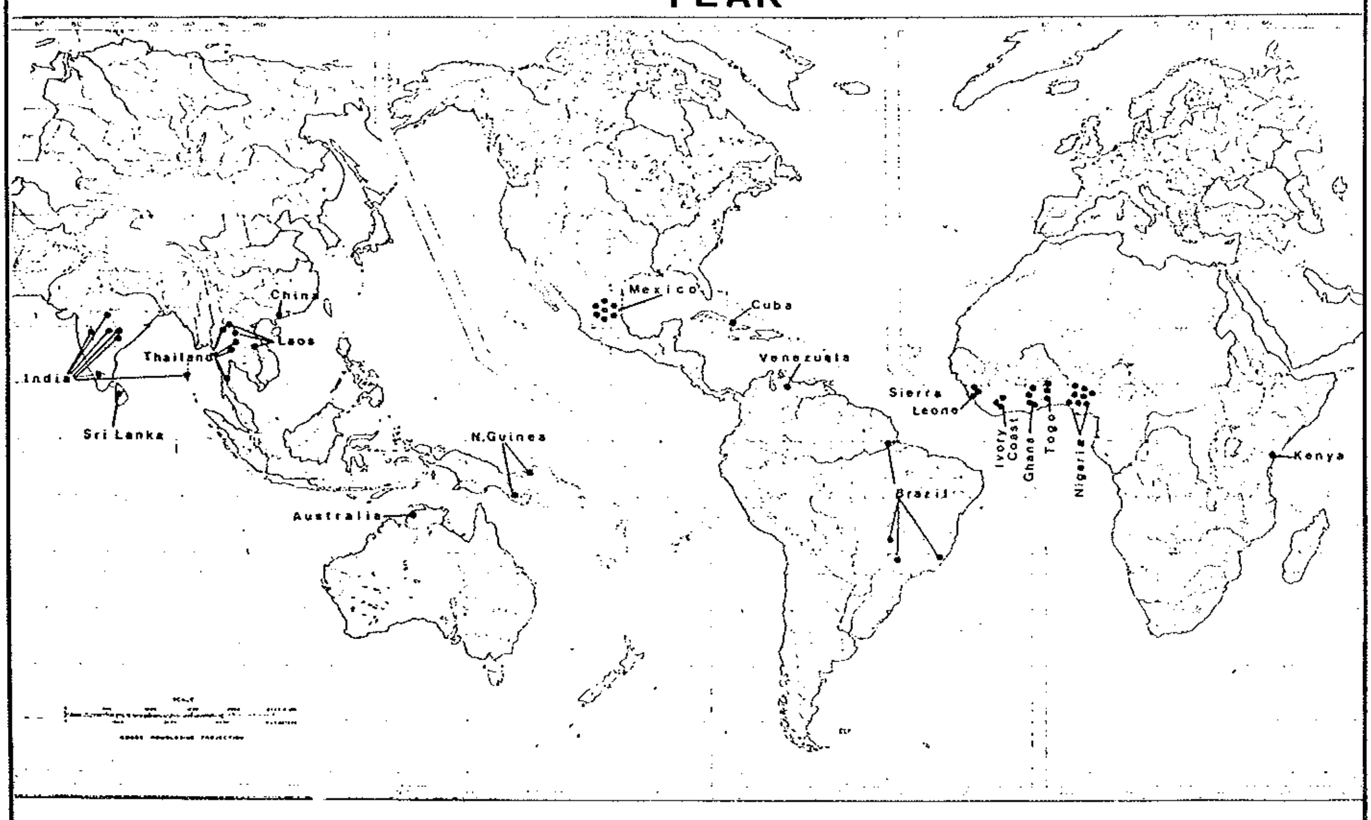
Country/region	Distribution			Results reported		
	No. of prov.	No. of sites x	Year	Germ.% or plant prod.	Field trials xx	No. of prov.
Australien	1o	1	1972	x	1	8
Brazil: Central	48	1-3	1972		1-2	17
– : Jari Co.	9	1-3	1974		1	8
– : FAO proj.	6	2	1975			
Cuba	15	2	1973			
Ghana	13	2-4	1972	x	1-4	1o
	11	4	1973			
Indien: FRI	31	2-4	1972	x	4	?
–	7	1	1974			
Andra Pradesh	34	1-4	1972	x	1	11
–	22	2-3	1974			22
Ivory Coast	16	3	1973	x	1	12
	12	3-4	1974	x		
Kenya	23	1-2	1974			
Laos	12	3	1972	x	2-3	9
Mexico	45	2-7	1974			
Papua/New Guinea	2o	2	1972	x		
Nigeria	39	2-8	1972	x	1-7	2o
	16	4-8	1974			
Sierra Leone	14	1-3	1972			
Sri Lanka	1o	3	1974	x	2-4	1o
Thailand	44	4	1972	x	1-6	29
Togo	1o	3	1972			
Venezuela	14	1-3	1976			

x The varying number of sites (as for instance 1-3 for Brazil 1972) indicates that parts of the samples were intended for trials at 3 sites, others at 2, and some at 1 site only.

xx Reflects the number of sites for which plants of individual provenance were available.

Teak, Appendix 2

TEAK



Approx. distribution of international provenance trials (1974)

Appendix 3

PINUS MERKUSII - COLLECTIONS 1972

Lot No.	Country PROVENANCE	Latitude Longitude	Elevation m.	Annual rainfall mm.	Quantity kg.	Remarks
	<u>Thailand:</u>					
2o1o	MAE SANAM	18°o4' N 98°1o' E	1ooo-11oo	12oo-14oo	1.5	
2o11	KHUN LAO	19°o2' N 99°2o' E	78o	1ooo-12oo	o.3	
2o12	MAE SUAI	19°42' N 99°35' E	68o	16oo-2ooo	o.5	
2o13	PHAYAO (a)	19°o4' N 99°5o' E	84o	1ooo-12oo	1.5	
2o14	PHAYAO (b)	19°o4' N 99°95' E	45o	[illegible]	1.5	
2o15	KHUN TAN	18°21' N 99°2o' E	79o	[illegible]	1.5	
2o16	DOI SAKET	18°59' N 99°12' E	[illegible]	[illegible]	1.o	
2o17	PHRAO	19°o6' N 99°1o' E	8oo	14oo-16oo	1.5	
2o18	FANG	19°54' N 99°17' E	45o	14oo-16oo	1.5	
2o19	PAI	19°22' N 97°24' E	7oo	1ooo-12oo	1.5	
2o2o	MAE HONGSON	19°o7' N 97°59' E	45o	12oo-14oo	2.o	
2o21	KHUN YUAM	18°5o' N 97°56' E	53o	12oo-14oo	1.5	
2o22	MAE SOT	16°43' N 98°49' E	45o	1ooo-12oo	1.5	
2o23	OMKOI	17°52' N 98°2o' E	9oo	12oo-14oo	1.5	
2o24	SURIN	14°43' N 1o3°5o' E	18o	-	1.5	
2o25	UBON	14°46' N 1o5°25' E	24o	-	1.o	
	<u>Java:</u>					
2o26	W.PEKALONGAN	7°1o' S 1o9°1o' E	9oo	-	3,5	

PINUS MERKUSII - COLLECTIONS 1972*

Sumatra - Java

Lot No.	Region PROVENANCE	Latitude Longitude	Elevation m.	Annual** rainfall	Quantity gr.	Remarks
	<u>Sumatra, Atjeh</u>					
2o28	BURNI TELONG	4°43' N 96°5o' E	135o-15oo	approx. 211o	78.o	
2o29	BRAH PANDJANG	4°37' N 96°52' E	145o-16oo	211o	42.5	
2o3o	PENARON	4°33' N 97°o2' E	6oo-1ooo	2416	86,o	
2o31	BLANG RAKAL	4°52' N 96°43' E	5oo-6oo	211o	22,3	
2o32	RADJAMALI	4°43' N 96°45' E	9oo-95o	211o	2o.o	
2o33	BALEQ	4°43' N 96°45' E	9oo	211o	5,1	
	<u>Java:</u>					
2o27	W.PEKALONGAN	7°1o' S 1o9°1o' E	9oo	-	32,8	One plus tree

*) Not available for provenance trials.

**) Rainfall figures are the average for 5 years 1967-1971 for Takengon

Appendix 4

List of seeds collected in the Gmelina provenance scheme 1975-79.

Rainfall mm/year	Forest type *	Altitude m	Latitude	Longitude	Provenance Number	Provenance Name	Provenance Country	Seeds received kg dry stones
830	NI	1100	14°00' S	33°43' E	4004	Chinsapo	Malawi	41.0
1000	DD	1000	18°22' N	73°49' E	4007	Sitabai Valley	India	24.1
1000	MDS	1000	17°14' N	73°57' E	4008	Ghotil-18	-	31.5
1000	MDS	1000	17°14' N	73°57' E	4046	- -	-	8.8
1025	MDS	1000	12°27' N	75°25' E	4025	Herrur	-	16.1
1200	MD	300	14°37' N	101°07' E	4002	Mung Lek	Thailand	41.0
1200	NI	300	7°48' N	5°05' W	4035	Bamoro	Ivory Coast	35.0
1375	MD	850	12°12' N	76°05' E	4024	Thithimathi	India	16.1
1375	MD	850	12°12' N	76°05' E	4042	-	-	24.4
1400	MD	310	18°30' N	99°45' E	4003	Ngao	Thailand	41.0
1400	DDP	600	20°30' N	85°20' E	4016	Kundrukutu	India	51.0
1442	DDP	600	23°30' N	85°30' E	[illegible]	[illegible]	India	7.0
1500	MDSP		22°23' N	82° E	[illegible]	Bilaspur	-	13.3
1500	MDSP		22°15' N	82° E	4012	Kota 143	-	1.0
1500	MDSP		22°15' N	82° E	4013	Kota 168/169	-	4.2
1500	MDSP		22°15' N	82° E	4014	Nagchua	-	4.7
1500	MDSP		22° N	82° E	4015	Nawapara	-	2.0
1500	DD	1400	17°52' N	82°21' E	4036	Chintapalli	-	19.5
1500	MD	500	17°41' N	81°42' E	4037	Maredumilli	-	14.8
1500	MD	1500	17°52' N	82°30' E	4038	Lambasingi	-	16.0
1673	EGS		24° N	92°15' E	4034	Longai R.F.	-	12.0
1700	MD	850	17-18° N	83-84° E	4048	Raghavendra Nagar	-	21.3
1700	MD	625	10°27' N	76°51' E	4033	Mt.Stuart	-	2.1
1824	EGS	100	26° N	93° E	4030	Odah	-	18.9
2000	MD	275	17°28' N	81°49' E	4047	Bhadrachalam S.	-	9.5
2000	MD	500	20°44' N	73°41' E	4020	South Dangs	-	19.1
2000	MD	500	20°44' N	73°41' E	4021	Dangs unsp.1	-	17.1
2000	MD	500	20°44' N	73°41' E	4029	- - 2	-	8.0
2200	MDP	120	23°46' N	91°34' E	4027	Baramura 1965	-	49.6
2200	MD	600	13°37' N	75°57' E	4041	Tanigebyle	-	6.8
2300	MDP	200	24°13' N	92°07' E	4026	Shikaritari	India	49.0
2476	NI	66	0°52' S	52°32' W	4040	Sao Miquel 72-14	Brazil	62.7
2500	MD	700	11°55' N	76°05' E	4032	Begur Range	India	12.5
2500	MD	700	11°55' N	76°05' E	4044	- -	-	4.6
2569	MD	525	25°46' N	91°46' E	4017	Nongpoh	-	47.0
3000	MD	100	15°54' N	73°46' E	4009	Kudal	-	23.5
3000	MD	100	9°00' N	76°50' E	4018	Chitara	-	9.7
3000	MD	100	9°00' N	76°50' E	4039	-	-	28.0
4300	EGS	700	10°19' N	76°41' E	4031	Sholayar	-	2.4
4800	MDP	50	26°40' N	89°20' E	4005	Godamdabri-3	-	10.0
4800	MD	50	26°40' N	89°50' E	4010	Sankos-1	-	2.8
4800	MD	50	26°40' N	89°20' E	4022	Godamdabri-3	-	2.8
4800	MD	50	26°45' N	89°35' E	4023	Dima-4	-	14.5
4800	MD	50	26°40' N	89°50' E	4045	Sankos-1	-	27.0

* DD = Dry deciduous forests
DDP = - - - Plantation of local origin
MDS = Semi-moist deciduous forests
MDSP = - - - - Plant.of local origin
MD = Moist deciduous forests
MDP = - - - , Plant.of local origin
EGS = Semi-evergreen forests
NI = Non-indigenous

Forest types after Champion & Seth, Forest Types of India, 1968.

DANISH/FAO FOREST TREE SEED CENTRE

Seed stock list, February 1980, *Gmelina arborea*.

Provenance No.	Provenance Name	Country	Locality factors: Rainfall mm/year	Locality factors: Forest type ¤	Seeds in stock kg.	Viability test (Tetrazolium) Febr. 1980: Fully stained	Viability test (Tetrazolium) Febr. 1980: Partially stained
4004	Chinsapo	Malawi	830	NI	2.3	16	20
4006	Mahilong	India	1440	DDP	0.3	64	16
4019	Tanigebyle	India	2200	MD	0.1	72	16
4024	Thithimathi	India	1375	MD	0.25	60	12
4036	Chintapally	India	1500	DD	0.1	52	24
4040	Sao Miquel	Brasil	2476	NI	13.6	84	0
4045	Sankosh-1	India	4800	MD	17.6	68	28
4048	Raghavendra Nagar	India	1700	MD	8.9	76	12
4052	Punalur	India	3000	MD	10.0 o)	88	12
4053	Chitari	India	3000	MD	10.0 o)	76	20
4054	Sitabai Valley	India	1000	DD	4.5	24	60
4055	Ghotil-18	India	1000	MDS	9.4	88	8
4056	Kudal	India	3000	MD	9.3	76	8
4057	Anakapalli	India			1.4	64	0
4058	Andhra Pradesh	India			3.1	44	40
4059	Nongpoh	India	2500	MD	10.2	60	16
4060	Chichinagaotha	India	2000	MD	0.9 o)	48	24
4061	Chikhali	India	2000	MD	1.1 o)	40	48
4062	Ahwa	India	2000	MD	0.9 o)	48	16
4063	Shamgahan	India			0.9 o)	76	4
4064		India			5.1	72	20
4065	Lambasingi	India	1500	MD	5.0	80	4
4066	Tripura 1)	India	22-2300	MDP	9.0	100	0
4067	1)	Sri Lanka			15.8	48	16
4068	1)	Sri Lanka			10.1	36	4
4069	Thithimathi	India	1375	MD	9.6	64	16
4070	Magat	Philippines		NI	9.7	8	20

¤ DD: Dry decidous forest (Champion & Seth, 1968) Forest Types of India
MDS: Semi-moist deciduous forest - -
MD: Moist deciduous forest - -
NI: Non-indigenous plantation

o) With dry pulp

1) Details on locality are forthcoming.

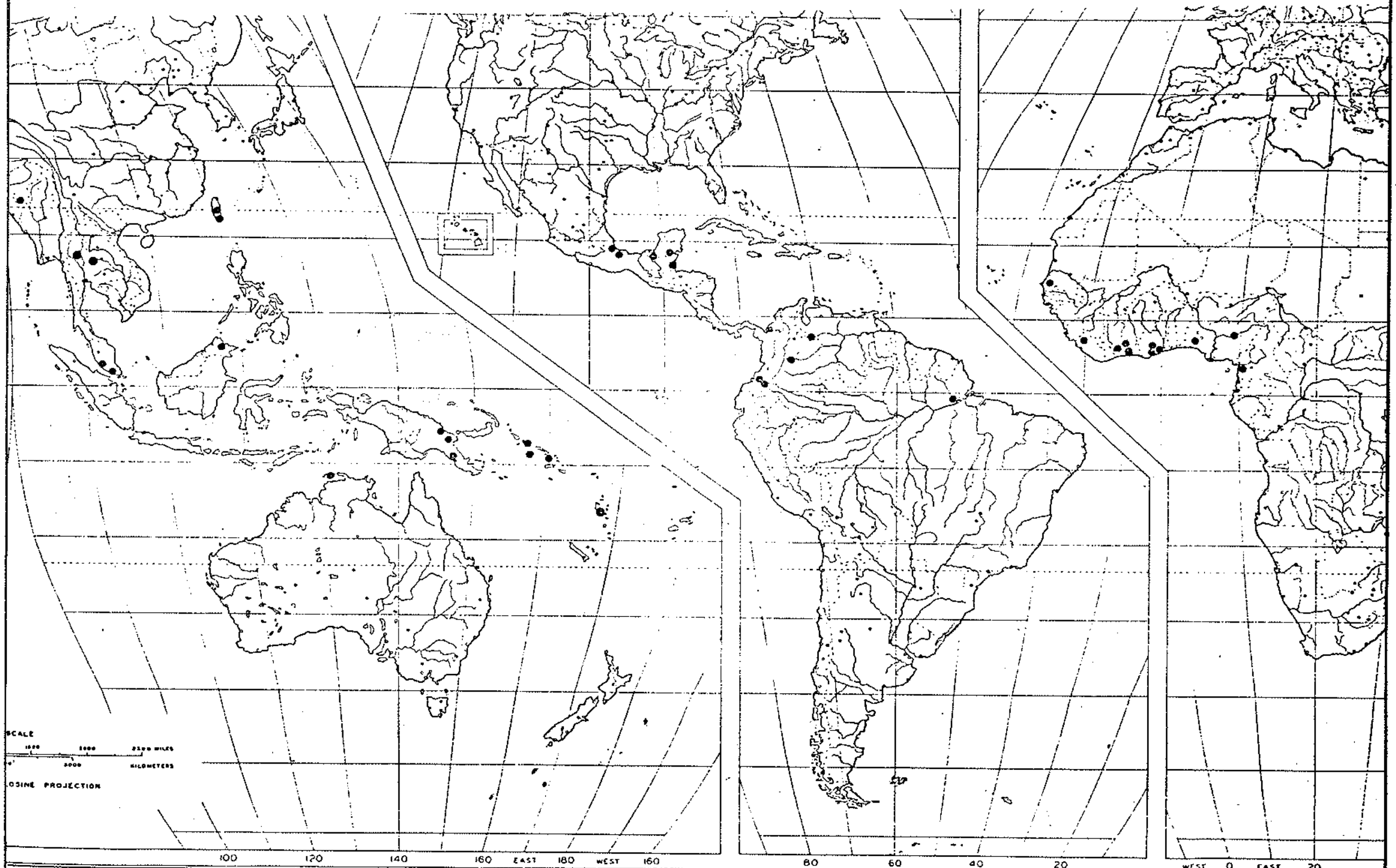
Appendix 5

International provenance trials of Gmelina arborea

List of participants, proposed test sites and provenances distributed, ultimo May 1978.

Country	Rainfall per year mm	Site location: Latitude	Longitude	Altitude m	No. of provenances: exotics	local	** see p.15 Seeds forwarded kg	Date of dispatch	Remarks
Malawi	900	16°28' S	35°00' E	50	6	2	14.8	April 78	Details for 1 of 5 sites only
Mexico	1070	18°36' N	90°44' W	50	15	1	61.0 a)	June 77	
Mexico	1070	18°36' N	90°44' W	50	15	1	a)	- 77	
Nepal	1130	26°41' N	86°45' E	79	17	1	43.3 b)	Oct. 77	
Columbia	1200	4°18' N	74°38' W	500	18	1	87.4 c)	- 77	
Papua N. Guinea	1248	6°22' S	146°41' E	720	13	1	41.5 d)	- 77	
Mexico	1282	18°46' N	88°17' W	10	15	1	a)	June 77	
Mexico	1282	18°46' N	88°17' W	10	15	1	a)	- 77	
Mexico	1282	18°46' N	88°17' W	10	15	1	a)	- 77	
Ghana	1270-1524	7°10' N	1°45' W	150-300	13	2	55.1 e)	Oct. 77	
Thailand	1282	18° N	99° E	300	12	7	24.0 f)	June 77	
Nigeria	1290	7°12' N	3°53' E	600	21	3	121.0 h)	Aug. 77	Details for 3 og 6 sites only.
Ivory Coast	1350	6°20' N	5°30' W	200	13	1	25.0 g)	June 77	
Ivory Coast	1400	4°27' N	5°38' W	300	13	1	g)	- 77	
Thailand	1440	16°45' N	102° E	300	12	7	f)	- 77	
Senegal	1500				15		23.8	Oct. 77	
Ghana	1524	6°15' N	1°15' W	150	13	2	e)	- 77	
Australia	1611	12° 4' S	130° 8' E	30	12	1	12.0	June 77	Irrigated trial
Venezuela	1650	7°26' N	70°45' W	100	17	1	34.0	- 77	
Ivory Coast	1700-1900	4°45' N	6°38' W	100	13	1	g)	- 77	
Nigeria	1750	8°30' N	9°30' E	600	21	3	h)	Aug. 77	

Country	Rainfall per year mm	Site location: Latitude	Longitude	Altitude	No. of provenances: exotics	local	**see p.15 Seeds forwarded kg	Date of dispatch	Remarks
Ghana	2032	5°10' N	1°52' W	150	13	2	e)	Oct. 77	
Malaysia	2060	3°28' N	102°17' E	80	11	1	22.0 i)	June 77	
Nepal	2160	27°27' N	85°01' E	480	17	1	b)	Oct. 77	
Papua N.Guinea	2186	9°12' S	147°18' E	80	13	1	d)	- 77	
Mexico	2452	18°05' N	96°07' W	90	9	1	a)	June 77	
Mexico	2452	18°05' N	96°07' W	90	9	1	a)	- 77	
Brazil	2476	0°50' S	52°32' W	100	15	1	71.8	Oct. 77	4 test sites in all
Belize	2500	17° 0' N	88°15' W	30	16	3	16.0	June 77	
Salomon Islands	2500	9°35' S	160°10' E	100	8	1	24.0 l)	- 77	
Malaysia Plant.	2550	5°30' N	117°40' E	80	12		12.0	- 77	
Taiwan	2500	22°40' N	120°50' E	800	9		8.9 k)	Apr. 78	
Taiwan	2500	21°55' N	120°46' E	40	9		k)	- 78	
Cameroun	2630	4° 0' N	10°15' E	30	12		38.0	Jan. 78	
Mexico	2860	18°31' N	96°45' W	180	15	1	a)	June 77	
Mexico	2860	18°31' N	96°45' W	180	15	1	a)	- 77	
Malaysia	2960	1°55' N	103°53' E	80	11	1	i)	- 77	
New Hebrides	3000	15°24' S	167°10' E	50	12	1	13.7	Nov. 77	
Columbia	3100	1°38' N	78°46' W	16	18	1	c)	Oct. 77	
Papua N. Guinea	3197	5°10' S	145°39' E	280	13	1	d)	- 77	
Salomon Islands	3500	7°50' S	157°20' E	100	8	1	l)	June 77	
Salomon Islands	3500	8°35' S	157°40' E	150	8	1	l)	- 77	
Columbia	3600	7°51' N	77°04' W	10	18	1	c)	Oct. 77	
Columbia	5000	1°25' N	78°30' W	300-500	18	1	c)	- 77	
India	Various sites				4	18	48.0	June 77	c. 12 sites
India					2	18	24.0	Oct. 77	c. 12 sites
India						3	16.0	- 77	Progeny tests
India	Distributed from F.R.I. Dehra Dun					30	250-300		Distr.1976 Oct. & 77



Appendix 6 Distribution of trial sites in the Gmelina provenance scheme: •

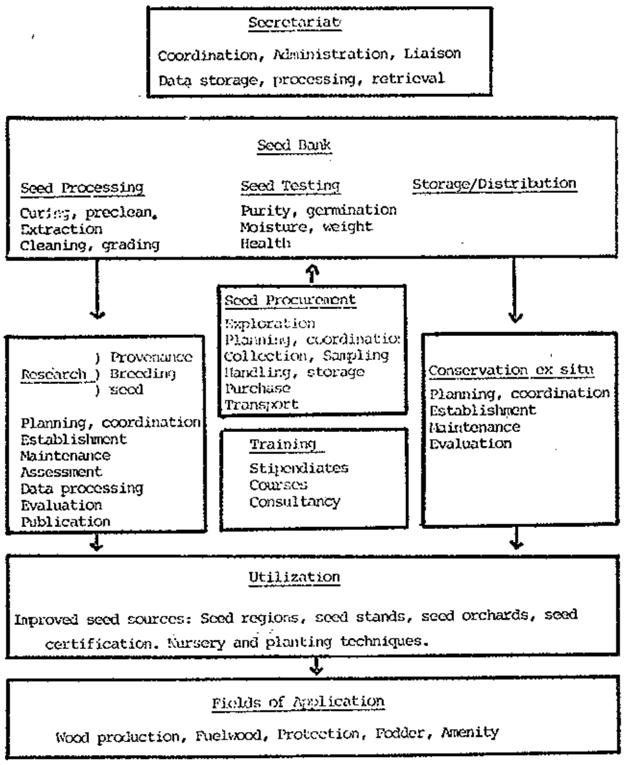
Appendix 7

FOREST TREE SEED CENTRE

SEED PROCUREMENT

for

Research -Conservation- Utilization



Appendix 8

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2. Classification of Seed Sources - FAO Seminar, Denmark, 1966.
3. Certification Schemes - FAO Seminar, Denmark, 1966.
4. Certification and Classification of Seed Orchards - Forest Tree Improvement, Arboretum, Hørsholm, No. 4, 1972
5. A Scheme for the Control of Forest Reproductive Material - Report of the second session of the FAO Panel of Experts on Forest Gene Resources, FAO, Rome 1972.
6. Classification of Sources for Procurement of Forest Reproductive Material - FAO/DANIDA Training Course, Limuru, Kenya, 1973.
7. Certification and Evaluation of Forest Reproductive Material FAO/DANIDA Training Course, Limuru, Kenya, 1973.
8. Procurement of Douglas Fir Seed for Provenance Research - 15th I.U.F.R.O. Congress, Florida, 1971.

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9. Tree Seed Development and Germination, pp 24-41
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11. The Storage of Seed, pp 152-171.
12. Klassificering af frøkilder, DST 59, 1974.
13. Terminology and Definitions to be used in Certification Schemes for Forest Reproductive Materials. IUFRO Working Party S. 2.1o.2, Oslo 1976.

H. Keiding

14. Report on a Journey to Sumatra, Thailand and India for the Danish/FAO Forest Tree Seed Centre, January-March 197o. Report for restricted distribution to Seed Centres, FAO, DANIDA and other interested.
15. Collection of Pine Seed in SE-Asia with Emphasis on Provenance Sampling, 1971. Paper to 15th IUFRO Congress, Gainsville, Florida, USA.
16. International Cooperation in the Exploration, Conservation and Development of Tropical and Sub-Tropical Forest Gene Resources. Co-authors R.H. Kemp, J. Burley and D.G. Nikles. Paper to Seventh World Forestry Congress, Argentina 1972.
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18. Tree Improvement in Relation to National Forest Policy. - FAO/DANIDA Training Course on Forest Tree Improvement, Kenya, 1973.
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2o. Selection of Individual Trees - FAO/DANIDA Training Course on Forest Tree Improvement, Kenya, 1973.
21. Status of the International Provenance Trials of Teak, Tectona grandis L., October 1973. - Paper to IUFRO-meeting for Working Parties on Tropical Species Provenances and Breeding of Tropical Species, Kenya, 1973.

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22. Seed Stands, pp 192-211.
23. Seed Production in Seed Orchards, pp-22o-234
24. Economic Considerations in Improved Seed Sources,pp 235-248.

In report from FAO/DANIDA Training Course on Forest Nursery and Establishment Techniques for African Savannas, Kaduna Nigeria, 1976.

25. Tree Improvement, Seed Stands and Seed Orchards.
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27. Exploration, Collection and Investigation of Gene Resources: Tropical Pines and Teak. Co-author: R. Kemp. 3rd World Consultation on Forest Tree Breeding, Canberra, March 1977.
28. "Progress in international provenance trials of teak".
29. Some Aspects of Gene Resource Conservation in Forest Trees with special reference to SE-Asia.
3o. Constrains and Prospects in International Cooperation on Tree Improvement and Seed Procurement. Thailand 1979.
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32. Et forstligt samarbejde med udviklingslandene om frøforsyning og skovtræforædling, 1977.

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33. Report on Gmelina arborea International Provenance Trials, 1976.
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36. Progress Report on Provenance Trials of Gmelina arborea (Circular Letter no. 9, Seed Centre).

COLETA E DIFUSÃO DE SEMENTE DE *Eucalyptus* PELO C.T.F.T.

C. Cossalter
o Centre Technique Forestier Tropical.
France.

Resumo

Nos últimos anos, nossas atividades no campo de coleta de sementes de Eucalyptus têm sido caracterizadas pela execução de 5 missões de campo nas áreas australianas naturais assim como em Sunda Islands. Da mesma maneira coletar situ estão sendo executadas mais frequentemente nos vários países africanos e territórios franceses de além-mar. O sistema no CTFT de um laboratório de sementes permite-nos a empreender uma ampla difusão das sementes.

COLLECTION AND DIFFUSION OF *Eucalyptus* SEED BY THE CENTRE TECHNIQUE FORESTIER TROPICAL.

Summary

For the past years our activities in the field of Eucalyptus seed collections have been caracterised by the carrying out of five field missions in the natural australian areas as well as in the Sunda Islands. In the same way ex situ collections are being carried out more and more often in various African countries and French overseas territories. The establishment at the CTFT headquarter of a seed laboratory allows us to achieve a broad diffusion of the seeds.

I N T R O D U C T I O N

Sur un financement du Fonds d'Aide et de Coopération français et grâce à des appuis locaux, le CENTRE TECHNIQUE FORESTIER TROPICAL a pu organiser ces dernières années 5 séries de récolte in situ sur diverses espèces d'Eucalyptus d'AUSTRALIE et des ILES de la SONDE.

Dans les Etats et Territoires avec lesquels nous entretenons une collaboration dans la recherche, des récoltes ex situ sont régulièrement entreprises sur les espèces qui se révèlent être les plus intéressantes.

Après avoir décrit brièvement les conditions et les résultats de ces collectes, l'auteur montre la part prise par le Laboratoire de graines de NOGENT-sur-MARNE dans la diffusion internationale des semences d'Eucalyptus.

R E C O L T E S I N S I T U

Il s'agit de diverses missions de collecte qui doivent leur réalisation au bon esprit de coopération du C.S.I.R.O. du L.P.H. et des administration forestières de différents états d'AUSTRALIE, du TIMOR et de l'INDONESIE.

Les Eucalyptus australiens

En 1973, une première mission de prospection des aires tropicales et subtropicales australiennes permit de rassembler 112 espèces totalisant 300 provenances. Nous donnons ci-dessous la répartition de cette collection par grande zone climatique :

- 55 provenances environ représentant une trentaine d'espèces proviennent de régions subtropicales humides,
- 25 provenances environ représentant une vingtaine d'espèces proviennent de régions subtropicales sèches,
- 40 provenances environ représentant une quinzaine d'espèces proviennent de régions tropicales humides,
- 180 provenances environ représentant une cinquantaine d'espèces proviennent de régions tropicales sèches.

Les provenances sont généralement composées de 10 semenciers mais il est arrivé que ce chiffre soit inférieur à 10. On a conservé des lots de graines individualisés au niveau de chaque semencier.

Pour certaines espèces de première priorité, on a pu rassembler plusieurs provenances. Citons par exemple :

Eucalyptus camaldulensis	: 33 provenances du Queensland, 2 provenances du Northern Territory, 19 provenances du Western Australia
Eucalyptus tereticornis	: 1 provenance du New South Wales, 11 provenances du Queensland
Eucalyptus cloeziana	: 7 provenances
Eucalyptus grandis	: 4 provenances du Queensland
Eucalyptus alba	: 3 provenances du Northern Territory
Eucalyptus robusta	: 3 provenances du Queensland
Eucalyptus microtheca	: 1 provenance du Queensland, 1 provenance du Northern Territory, 1 provenance du Western Australia

Ces récoltes permirent au cours des années qui suivirent, de mettre en place d'importants essais de comportement d'espèces et de comparaisons de provenances dans les Etats ou Territoires où nous collaborons aux programmes de recherche (essais dans 35 stations réparties dans 12 Etats et Territoires). Il faut citer à ce propos les travaux des pays d'Afrique tropicale sèche, Haute-Volta, Niger, Sénégal (près de 50 espèces testées dans 13 stations essais comparatifs de provenances d'Eucalyptus camaldulensis dans 5 stations) mais aussi ceux de Madagascar (une cinquantaine d'espèces testées dans 2 stations, plusieurs essais de provenances) et de la R.P. du Congo (une quarantaine d'espèces testées dans 2 stations, plusieurs essais de provenances).

De nombreux lots furent envoyés dans une quinzaine d'autres pays d'Afrique, du Sud-Est asiatique, d'Amérique latine, du Pacifique et de l'Océan Indien.

Le CSIRO, destinataire d'une part des récoltes, assura aussi de son côté une importante diffusion de cette collection.

Les résultats du premier stade d'essais sont ou commencent à être disponibles dans de nombreux Etats. Le besoin de créer des parcelles conservatoires avec les provenances reconnues les meilleures parmi toutes celles rassemblées en 1973, nous ont conduit en Janvier-Février 1980 dans différents sites du Queensland pour y récolter en collaboration avec le CSIRO :

- 3 provenances d'Eucalyptus camaldulensis composées chacune de 25 à 26 semenciers
- 1 provenance d'Eucalyptus tereticornis composée de 25 semenciers

Deux autres espèces de seconde priorité furent récoltées à l'occasion de cette mission.

Ces provenances n'ont pour l'instant été distribuées qu'au Sénégal.

Les Eucalyptus des Iles de la Sonde

Deux missions furent nécessaires (1973 et 1975) pour mener à bien la prospection systématique entreprise sur les 7 Iles qui composent l'aire naturelle de l'Eucalyptus urophylla. Il fut rassemblé pour cette espèce des graines de 435 semenciers répartis dans 86 stations.

Au cours des mêmes missions, on récolta également des graines d'Eucalyptus alba (19 provenances sur 5 Iles).

Outre les distributions faites dans les pays où nous collaborons aux programmes de recherche (16 stations d'essais réparties dans 11 pays), des lots de cette collection ont été envoyés dans 20 autres pays.

Des motivations de même nature que celles citées précédemment nous ont conduit à récolter en Août 1979, les provenances d'Eucalyptus urophylla suivantes :

- Cours supérieur de la rivière Ulanu, région Ouest de l'Ile d'Alor (composée de 30 semenciers)
- Mte Lewotobi, Ile de Florès (composée de 50 semenciers)
- Mte Egon, Ile de Florès (composée de 30 semenciers)

A ce jour, ces 3 provenances ont été distribuées dans 7 pays.

La combinaison d'observations et de données recueillies dans les peuplements naturels et sur plusieurs stations d'essais à divers âges de plantation, nous ont permis d'identifier, à partir du matériel rassemblé pour Eucalyptus urophylla, une trentaine de "provenances" au sens génétique du terme. Nous tenons des graines disponibles pour 17 d'entre elles (voir tableau ci-après) en vue d'une distribution internationale. Nous avons au cours de ces derniers mois, demandé à la FAO de tenir les forestiers tropicaux informés de ce projet.

Année de la collecte	Provenances	Altitude	Nbre de semenciers composant la prov.
1973	Région de Remexio, Ile de Timor Lot n° 80/2793 N	800-1250	15
1973	Région d'Aileu, Ile de Timor Lot n° 80/2794 N	1160-1320	12
1973	Région de Maubisse, Ile de Timor Lot n° 80/2795 N	1200-1540	14
1973	Région de Laclubar, Ile de Timor Lot n° 80/2797 N	1100-1400	18
1973	Mte Moutis, Ile de Timor Lot n° 80/2798 N	1800-2300	11
1973	Région Sud Ouest, Ile de Lembata Lot n° 80/2770 N	500-950	9
1975	Mte Siroeng, Ile de Pantar Lot n° 80/2799 N	500-700	10
1975	Région Nord-Est, Ile de Pantar Lot n° 80/2800 N	350-600	12
1975	Région Sud-Ouest, Ile de Wetar Lot n° 80/2801 N	350	5
1975	Région d'Ilwaki, Ile de Wetar Lot n° 80/2802 N	350-400	6
1975	Région centrale, Ile de Timor Lot n° 80/2803 N	600-1000	12
1975	Région Est, Ile de Timor Lot n° 80/2804 N	600-900	18
1975	Mt Moena, Ile d'Alor Lot n° 80/2806 N	700-800	6
1975 et 1979	Région Ouest, Ile d'Alor Lot n° 80/2808 N	450-700	30
1973 et 1979	Mte Egon, Ile de Florès Lot n° 80/28/7 N	315-700	38
1979	Mte Lewotobi, Ile de Florès Lot n° 80/2809 N	325-500	49
1973	Mte Wuko, Ile de Florès Lot n° 80/2805 N	750-900	7

R E C O L T E S   E X   S I T U

Il existe dans les Etats et Territoires où le Centre Technique Forestier Tropical collabore à la recherche, des possibilités de s'approvisionner en assez grandes quantités de graines à partir de vergers et d'arbres plus (par exemple : verger Koutal-Sénégal pour Eucalyptus camaldulensis - verger Sassandra, Côte d'Ivoire et parcelle 20 M Loudima, R.P. du Congo pour Eucalyptus deglupta - verger A Malolo, R.P. du Congo pour Eucalyptus 12 ABL (tereticornis)

Dans les autres cas, on récolte un produit tout venant dans des parcelles de première introduction ou dans des peuplements locaux de 2ème génération.

La totalité des récoltes concerne une dizaine d'espèces. Nous procédons tous les ans à près de 100 envois en direction d'une dizaine de pays.

Un premier groupe de 3 espèces :

- Eucalyptus camaldulensis (origines Haute-Volta, Niger, Sénégal)
- Eucalyptus deglupta (origines Côte d'Ivoire, République Populaire du Congo, Guyane)
- Eucalyptus 12 ABL (tereticornis) (origine République Populaire du Congo)

totalise 80 % des lots distribués. Vient ensuite pour les 15 % restants un groupe où figurent :

- Eucalyptus torelliana (origines R.P. du Congo, Haute-Volta)
- Eucalyptus citriodora (origines R.P. du Congo, Haute-Volta)
- Eucalyptus cloeziana (origine R.P. du Congo)
- Eucalyptus alba (origine Haute-Volta)
- Eucalyptus paniculata (origine R.P. du Congo)
- Eucalyptus crebra (origine Haute-Volta)

D'autres espèces telles que Eucalyptus urophylla (origines Côte d'Ivoire, R.P. du Congo) ne sont pour le moment disponibles que sous forme d'échantillons.

Il faut signaler la création prochaine en Haute Volta, d'un Centre National de Semences forestières dont les objectifs sont l'amélioration d'espèces à croissance rapide, la production et la multiplication de semences de haute qualité. Ce centre s'intéresse d'abord aux espèces adaptées aux zones sahélo-soudaniennes ou soudaniennes à pluviométrie moyenne annuelle supérieure à 750 mm. Des essais antérieurs ont montré que les espèces qui dans ces conditions donnent le plus de satisfaction sont des Eucalyptus. Il est prévu dans un premier temps d'implanter d'importantes parcelles conservatoires de certaines provenances d'Eucalyptus camaldulensis. Ce n'est que plus tard que le Centre s'intéressera à la production d'espèces destinées aux zones des 400 à 750 mm de pluviométrie annuelle.

Signalons également les travaux de la République Populaire du Congo sur la recherche et la création d'hybrides à fort hétérosis. A l'issue de la campagne de pollinisation contrôlée de 1978, il était mis en place l'an dernier :

- 86 hybrides issus de croisements entre clones
- 27 hybrides issus de croisements entre espèces.

Il n'est pas prévu pour le moment de diffuser ce matériel hors de la République Populaire du Congo.

L E   L A B O R A T O I R E   D E   G R A I N E S   D E   N O G E N T / M A R N E

Le CTFT s'est doté en 1976 d'un laboratoire de graines chargé de planifier et de veiller à la qualité des approvisionnements, de conserver les semences dans de bonnes conditions et de les diffuser. Cette unité mise en place pour répondre aux besoins des structures de recherche et projets de développement auxquels le CTFT collabore, satisfait de nos jours à des demandes extérieures de plus en plus nombreuses.

Nous disposons actuellement d'un choix de 245 espèces (121 espèces d'Eucalyptus, 12 espèces de Pins, 112 espèces d'autres genres) totalisant 1100 provenances dont 730 provenances d'Eucalyptus. Ceci représente un stock d'environ 3 500 lots de graines, compte tenu du fait que certaines provenances comptent des lots de graines individualisés au niveau des semenciers.

Les approvisionnements se font à partir de nos implantations de recherche et à l'occasion de missions de récolte ; nous procédons également à des échanges avec d'autres Instituts. Il faut signaler à ce propos la part importante tenue par le CSIRO dans nos fournitures de graines d'Eucalyptus.

Nos équipements nous permettent de parfaire le nettoyage et le séchage des graines, d'effectuer des contrôles de teneur en eau et de faculté germinative et de conserver tous nos lots à basse température (+ 4°C) et faible hygrométrie (40 %).

En ce qui concerne la diffusion, nous avons assuré ces deux dernières années (1978-1979) la distribution dans 25 pays de 970 lots échantillons de provenances répartis en 94 espèces (41 espèces d'Eucalyptus, 11 espèces de Pins, 42 espèces d'autres genres). Près des 2 tiers des lots distribués étaient des Eucalyptus.

FAST GROWING TREES

CONTRIBUIÇÃO DO C.T.F.T. PARA A COLETA E DIFUSÃO DE SEMENTES E MATERIAL VEGETATIVO DE ESPÉCIES DE RÁPIDO CRESCIMENTO, EXCLUINDO OS *Eucalyptus*

Christian Cossalter
o Centre Technique Forestier Tropical.
France.

Resumo

Nos últimos anos, nossas atividades no campo de coleta de sementes para espécie de rápido crescimento além de Eucalyptus têm sido caracterizadas por:

- a continuação da ação iniciada em espécies de madeira dura da África e nos Arancarios da Nova Caledônia.
- o começo de um programa em madeiras duras da Guiana
- a execução de missões de campo de alcance limitado nos vários gêneros de espécies australianas assim como nos pinheiros tropicais da América Central.

Coletas Ex situ são regularmente organizadas de espécie introduzidas em várias estações experimentais de países africanos e territórios franceses de além-mar.

CONTRIBUTION OF THE CENTRE TECHNIQUE FORESTIER TROPICAL TO THE COLLECTION AND DIFFUSION OF SEED AND VEGETAL MATERIAL OF FAST GROWING SPECIES OTHER THAN *Eucalyptus.*

Summary

For the past years our activities in the field of seed collection for fast growing species other than Eucalyptus have been caracterised by :

- the continuation of the action initiated on African hardwood, and on the New Caledonian Araucariaceae
- the beginning of a program on Guyanese hardwood
- the carrying out of limited scope field missions on various genera of the australian area as well as on tropical Central America pines

Ex situ collections are regularly organized from species introduced into various experiment stations of African countries and French overseas Territories.

INTRODUCTION

Les activités de prospection d'aires naturelles et de récolte de graines in situ que nous menons en collaboration avec divers Etats et Territoires ont été marqué ces dernières années par :

- la poursuite de l'action entreprise sur les feuillus africains et les araucariacées de Nouvelle Calédonie,
- le démarrage d'un programme sur les feuillus guyanais
- la réalisation de missions ponctuelles sur divers genres de l'aire australienne ainsi que sur les pins tropicaux d'Amérique Centrale

Des récoltes ex situ sont régulièrement organisées à partir d'espèces introduites dans diverses stations d'essais.

LES FEUILLUS AFRICAINS

En appui aux programmes de reboisements réalisés avec les espèces autochtones les plus performantes, la recherche s'intéresse à la biologie des floraisons et des fructifications ainsi qu'à l'identification de nouvelles provenances.

Le tableau ci-dessous donne certaines caractéristiques des espèces de premier ordre.

Espèce de forêt dense sempervirente (FDS), de forêt dense semi-décidue (FDSD), de savane (S)	Date de fructification	Localisation des récoltes	Rang occupé dans les reboisements
Terminalia ivorensis (plus fréquente en FDS)	Janv.-Févr.-Mars (Côte d'Ivoire)	Mopri - Yapo - Oumé - San Pédro (Côte d'Ivoire)	4ème rang en Côte d'Ivoire
Terminalia superba (FDSD essentiellement intrusion en FDS)	Déc.-Janv.-Févr.	Gregbeu (Côte d'Ivoire) MBalmayo, Bolalo (Cameroun)	1er rang en Côte d'Ivoire
	Août-Sept.-Oct.	Mayombe (R.P. du Congo)	R.P. du Congo
Triplochiton scleroxylon (FDSD essentiellement, intrusion en FDS)	irrégulière	Toute l'aire ivoirienne Région centrale de la R. du Cameroun	3ème rang en Côte d'Ivoire
Aucoumea klaineana	Janv.-Févr. (Gabon)	Gabon	1er rang au Gabon

Les Khaya spp (K. ivorensis ; K. anthoteca ; K. grandifolia) dont la croissance est comparable à celle d'Aucoumea klaineana sont assez peu utilisés dans les reboisements du fait de leur sensibilité aux attaques de borers à leur jeune stade de croissance.

Citons enfin, en extrême limite du groupe des essences à croissance rapide : Cleistopholis patens et Cleistopholis glauca.

Des semences sont généralement disponibles pour des essais internationaux, cependant des contraintes naturelles telles que :
- l'irrégularité des fructifications (Triplochiton scleroxylon)
- les attaques parasitaires de graines sur l'arbre (apions pour les Terminalia ssp mais surtout pour Triplochiton scleroxylon lépidoptères pour les Khaya ssp)
- la durée limite de conservation au froid des facultés germinatives (de l'ordre de quelques mois pour Terminalia ssp)

réduisent les possibilités d'approvisionnement.

Des programmes de conservation de ressources génétiques sont en cours en Côte d'Ivoire pour Terminalia superba et Triplochiton scleroxylon. En République Populaire du Congo, il est prévu pour Terminalia superba la mise en place d'un essai comparatif de plusieurs provenances des aires boréale et australe, ainsi que la création prochaine d'un centre pilote d'afforestation dans la région de Niari. L'intérêt porté à ces deux espèces devrait, à l'avenir, permettre de diversifier leurs sources d'approvisionnement en graines.

Depuis 1974, le Centre Technique Forestier Tropical reçoit une contribution FAO de $ 3 000 US en moyenne par an pour la récolte et la diffusion à travers le monde de semences de feuillus africains des régions sèches et des régions humides. Les espèces à croissance rapide représentent environ 60 % des demandes. Dans ce cas les pays demandeurs (une dizaine tous les ans) se situent essentiellement en Amérique Latine ou dans le Sud Est asiatique.

LES ARAUCARIACEES DE NOUVELLE CALEDONIE

Sur les 13 espèces d'Araucaria et les 5 espèces d'Agathis que compte la Nouvelle Calédonie, seuls Agathis moorei et Agathis lanceolata peuvent être considérés comme des essences à croissance rapide, avec dans le cas d'Agathis moorei des productions pouvant approcher celles de Pinus caribaea var hondurensis.

Bien que les fructifications soient dans l'ensemble très aléatoires, on obtient tous les ans des graines de plusieurs espèces. Ces récoltes sont principalement destinées à la mise en place d'essais de sylviculture d'essences locales, elles permettent aussi de compléter la collection vivante du jardin d'essais de Païta. De nouvelles provenances sont récoltées dans le but de découvrir des phénotypes à croissance rapide.

Il faut signaler l'effort entrepris pour la conservation du patrimoine génétique des espèces les plus menacées par la protection des peuplements naturels et la création de vergers à graines (Ouenarou).

LES FEUILLUS GUYANAIS

Depuis 1978 une étude intéressant 22 espèces commerciales de l'aire guyanaise est en cours. Les objectifs sont d'étudier la phénologie des espèces et de récolter des semences pour éprouver différents procédés de conservation et mettre au point les techniques appropriées de pépinière.

Des graines ont déjà été obtenues pour plus de la moitié des espèces retenues, parmi elles, Goupia glabra, Didymopanax morototoni, Jacaranda copaia, Simarouba amara sont déjà reconnues comme étant des essences à croissance rapide.

De fortes croissances ont également été observées dans les plantations de l'Office National des Forêts avec des espèces des genres Parkia et Sterculia.

Dès qu'une bonne fructification se présentera, il est prévu de récolter une provenance de Cedrela odorata, afin de l'intégrer à la collection que rassemble en ce moment sur cette espèce le C.F.I. d'Oxford.

DIVERS GENRES AUSTRALIENS

Grâce au bon esprit de coopération du CSIRO et des administrations forestières de différents Etats, une mission a pu parcourir en 1973 les aires tropicales et subtropicales de l'Australie.

Des semences furent récoltées sur 62 espèces de genres divers totalisant 104 provenances.

Parmi les genres les mieux représentés citons :
- les Acacia spp (21 espèces, 38 provenances)
- les Melaleuca spp (5 espèces, 13 provenances)
- les Cassia spp (5 espèces, 12 provenances)
- les Grevillea spp (3 espèces, 4 provenances)
- les Araucaria spp (2 espèces, 5 provenances)
- les Casuarina spp (2 espèces, 3 provenances)
- les Hakea spp (2 espèces, 3 provenances)

Dix semenciers au moins composent la plupart des provenances. La moitié des espèces et provenances furent récoltées en Austalie de l'Ouest dans les régions arides du Pilbara district et de Mont Tom Price situées entre les latitudes 18° et 24° Sud. Un quart de cette collection fut rassemblé dans la frange forestière du Territoire du Nord autour de la latitude 12° Sud (région d'Arnhem Land). La part restante provient d'autres régions tropicales et subtropicales, les Araucaria spp en particulier furent récoltés dans le Sud Queensland.

La plupart des lots de cette collection ont été mis en place dans les Etats de la zone sahélienne dans lesquels nous participons à la recherche : Haute Volta (Gonse, Lanfiera), Niger (Aviation), Sénégal (Bambey, M'Bao). Un nombre plus restreint d'espèces a été distribué dans une dizaine d'autres pays. Les Araucaria spp, seules espèces récoltées dans des régions humides, furent expédiés au Cameroun, en Côte d'Ivoire, au Congo, au Gabon, en Nouvelle Calédonie et à Madagascar.

LES PINS TROPICAUX D'AMERIQUE CENTRALE

L'intérêt suscité par les pins tropicaux d'Amérique Centrale conduisit le C.T.F.T. à s'informer sur place, dès 1969, des possibilités de fourniture de semences aux pays africains. Les contacts noués à l'occasion de cette première mission permirent d'introduire, au cours des années suivantes, de nouvelles provenances dans plusieurs Etats africains.

A partir de 1970-1971, l'Unit of Tropical Sylviculture d'Oxford entreprit, à la demande de la FAO et avec sa contribution financière, plusieurs séries de récoltes de graines sur l'ensemble de l'aire de Pinus caribaea var hondurensis et étendit par la suite son action à Pinus oocarpa et Pinus pseudostrobus.

Des lots de semences récoltés sur les deux premières espèces furent fournis au C.T.F.T. qui les intégra aux dispositifs d'essais mis en place dans divers pays africains, en Nouvelle Calédonie et en Guyane française.

Face à une demande grandissante de graines et conscient de la nécessité de compléter les études de provenances, nous avons organisé en 1978 une nouvelle mission qui reçu l'appui local du C.F.I., de l'INFONAC et de la COHDEFOR.

Des graines de Pinus caribaea var hondurensis furent récoltées sur 5 provenances côtières du Nicaragua et 3 provenances de l'intérieur du Honduras. Nous donnons leurs principales caractéristiques dans le tableau ci-dessous.

Provenance	Latitude	Longitude	Altitude	Nbre de semenciers composant la provenance
Lapan, NICARAGUA	13°57'N	83°41'W	50-100	28
Laguna el Pinar, NICARAGUA	12°13'N	83°42'W	2-3	16
Karawala, NICARAGUA	12°58'N	83°34'W	5-10	30
Limbaika, NICARAGUA	13°34'N	84°11'W	25-30	103
Taguantara, NICARAGUA	13°22'N	83°35'W	5-10	20
Jocon-Yoro, HONDURAS	15°15'N	86°53'W	520-620	55
Misora-Lempira, HONDURAS	14°44'N	88°39'W	520-680	60
El Jilote-Santa Barbara, HONDURAS	14°55'N	88°14'W	250-300	50

Les distributions faites jusqu'à ce jour avec ces semences concernent les sept pays suivants : Australie, République Populaire du Congo, Côte d'Ivoire, Gabon, Honduras, Philippines, Sénégal.

RECOLTES EX SITU

Dans les Etats et Territoires où le C.T.F.T. participe à la recherche, il existe une quinzaine d'espèces à croissance rapide autres que l'Eucalyptus susceptibles de produire des semences en assez grande quantité. Mises à part les parcelles P603 Loandjili (Pinus caribaea var hondurensis) et F55 Bamoro (Gmelina arborea) qu'on peut considérer comme des peuplements grainiers, on récolte dans les autres cas un produit tout venant sur des peuplements ou parcelles de première introduction.

Tous les ans une trentaine de lots de semences sont envoyés dans une dizaine de pays. Les espèces les plus distribuées sont :

- Cordia alliodora, origines : Yapo ; Oumé, Côte d'Ivoire
- Pinus caribaea var hondurensis, origine : P603 Loandjili Rép. Pop. du Congo
- Gmelina arborea, origine : F55, Bamoro, Côte d'Ivoire
- Acacia holosericea, origine : Bambey, Sénégal
- Albizzia falcata, origine : Yapo, Côte d'Ivoire

Signalons qu'il existe également dans le cadre de l'amélioration de Pinus caribaea var hondurensis d'importants échanges de graines sélectionnées (vergers à graines ou arbre +) entre la Rép. Pop. du Congo (Pointe Noire) et la Nouvelle Calédonie (Port Laguerre ; Champ de Bataille) d'une part, entre ces deux Etats, le Département des Forêts du Queensland (Beerburrum ; Byfield) et Fidji d'autre part. Ces échanges se sont étendus ces dernières années aux greffons et au pollen. Citons à ce propos l'exemple de la Nouvelle Calédonie qui comptait fin 1978, 100 clônes étrangers introduits.

Du matériel amélioré commence à être disponible en Côte d'Ivoire. Il est à prévoir qu'au cours de ces prochaines années de tels échanges vont s'intensifier aussi bien pour Pinus caribaea var hondurensis que pour Pinus oocarpa.

PROGRAMA COOPERATIVO DE MEJORAMENTO GENÉTICO DE *Pinus radiata*.

Roberto Delmastro.
Chile.

Resumo

Pinus radiata es la especie forestal comercial más importante de Chile; se ha plantado en una superficie superior a las 700.000 hectáreas, debido a su amplia adaptabilidad y excelente tasa de crecimiento.

Desde 1976, el mejoramiento genético fue incorporado como una actividad más dentro del manejo intensivo de las plantaciones. Esto fué posible a través de un programa cooperativo entre la Universidad Austral de Chile y siete de las mayores empresas forestales del país, quienes en conjunto poseen más de 300.000 hectáreas de plantaciones.

El programa cooperativo opera mediante tres fases diferentes, realizadas simultáneamente, para obtener semillas genéticamente mejoradas: 1. selección de árboles semilleros, 2. establecimiento de areas productoras de semillas y 3. instalación de huertos semilleros en clones.

Actualmente las empresas se autoabastecen de semillas de árboles semilleros, han establecido 120 hectáreas de areas productoras de semillas y seleccionaron 337 árboles "plus" que constituyen ocho huertos semilleros con una superficie total de casi 142 hectáreas. Este año se instalaron los primeros ensayos de progenie de polinización abierta y se iniciaron los cruzamientos controlados para establecer nuevos ensayos.

También se han realizado selecciones de árboles resistentes a enfermedades y de individuos mejor adaptados a deficiencias nutricionales del suelo. En 1978, se inició un completo estudio sobre la variación geográfica de las propiedades tecnológicas de la madera con financiamiento de otra fuente.

COOPERATIVE PROGRAM OF GENETIC TREE IMPROVEMENT OF *Pinus radiata*.

Summary

Pinus radiata is the most important commercial forest species in Chile; has been planted over 700.000 hectares, because its wide adaptability and excelent growth rate.

Since 1976, breeding programs were included as another activity of the intensive management of plantations This has been possible through a cooperative program between the Austral University and seven of the main forestry industries in the country, which all together owns over 300.000 hectares of plantations.

The cooperative operates through three different faces, executed simultaneously, to obtain genetic improved seeds: 1. seed trees selection, 2. establishment of seed production areas, and 3. establishment of clonal seed orchards.

At present time, the industries are self-sufficient of seeds from seed trees, have established 120 hectares of seed production areas, selected 337 plus trees and eight clonal seed orchards, with an overall surface of almost 142 hectares, have been established. This year the first open pollinated pro

geny tests were planted, and control-pollinations to establish new tests have started.

Selections of apparently resistant trees to several diseases have been done and also of individuals better adapted to nutrients deficient sites. In 1978, a comprehensive study on geographic variations of wood properties of this species was iniciated, with financial support from elsewhere.

1.- I n t r o d u c c i ó n

El caso del Pinus radiata que crece en Chile, es quizás uno de los ejemplos más espectaculares de éxito en la introducción de una especie forestal exótica. El éxito observado con esta especie, se debe principalmente a dos factores, que han influído para que en el presente existan más de 700.000 hectáreas plantadas y haya una tasa de forestación de unas 60.000 hectáreas anuales. En primer término P.radiata tiene excelente adaptabilidad a una amplia gama de climas y suelos diversos ya que crece en plantaciones comerciales, desde la zona de Valparaíso (33°Lat.Sur), con una precipitación media anual de 500 mm., hasta la zona de Valdivia (40° lat.Sur),con una pluviometría de 2500 mm.,representando ésto un área de más o menos 800 kilómetros en dirección norte-sur y 80 a 100 kilómetros de este a oeste, desde el nivel del mar hasta los 600 metros de altitud. El segundo elemento que ha influído en el gran auge de esta especie,es su rápido crecimiento, puesto que alcanza incrementos medios anuales de 18 metros cúbicos por hectárea al año, hasta 35 o más m^3/ha/año en sitios mejores.

El P.radiata se introdujo en Chile en el año 1887 y desde 1908 se ha aumentado progresivamente la tasa de plantación, especialmente en la región Centro-Sur del país (Junge, 1953). No obstante que no se conoce con precisión la procedencia de las semillas utilizadas en las primeras plantaciones, de las cuales probablemente más tarde se obtuvo gran parte de las semillas, hay evidencia que las principales procedencias originales, fueron Monterrey y Año Nuevo, principalmente de ésta última (Burdon,1978). Este autor ha sugerido que por esta misma razón, la base genética de las plantaciones en el país no debe ser muy amplia, no obstante que probablemente se ha producido divergencia entre las poblaciones, como respuesta a las presiones de selección en las diferentes localidades donde la especie ha sido plantada (Burdon, 1978).

Desde hace algunos años, el manejo intensivo de las plantaciones de P.radiata,es una práctica normal en la mayoría de las grandes empresas forestales chilenas, existiendo gran preocupación por obtener productos forestales de mejor calidad para ser más competitivos especialmente en el mercado exterior. El negocio del bosque y la madera, es una de las actividades productivas que ha tenido más auge en los últimos años, mostrando un crecimiento extraordinario. Desde 1974 , aumentó la exportación de productos forestales por un valor de 60 millones de dólares anuales, a 500 millones de dólares estimados para el año 1980. (Chile Forestal, 1980).

No obstante la creciente importancia económica de esta especie en el país, hasta el año 1976, en general no hubo preocupación por el origen y calidad genética de la semilla utilizada. Hasta ese año se transfirió semillas de una zona a otra,sin considerar el origen y/o la calidad de los rodales o árboles semilleros de los cuales se obtenían las semillas. En 1976 varias empresas forestales solicitaron a la Facultad de Ingeniería Forestal de la Universidad Austral de Chile, proyectos de programas de mejoramiento genético para sus plantaciones de P. radiata , con el fin de obtener mejores rendimientos y mejor calidad de los productos. La Facultad sugirió aunar los esfuerzos participando conjuntamente en un Programa Cooperativo de Mejoramiento Genético (Convenio), que fue creado en Junio de 1976 en base a un proyecto y plan de trabajo propuesto. (Delmastro, 1976) (1)

La factibilidad económica de programas de mejoramiento genético de esta especie en Chile es atractiva, como fue demostrado mediante un completo análisis realizado en 1977 y que se describe más adelante.

2.- P l a n d e T r a b a j o

Las empresas miembros del convenio, son propietarias de más de 300.000 hectáreas de plantaciones de P. radiata , que se concentran principalmente entre los paralelos 36°30' y 38° lat. sur (Figura 1). Una de las empresas y la Universidad Austral,tienen sus actividades al sur de esta región (40°lat. sur).

Considerando que aún no se conoce con exactitud, cuál es la diferenciación genética que las plantaciones de P. radiata han tenido en las distintas zonas donde operan las empresas,y con el fin de no mezclar posibles diferentes orígenes de semillas , cada empresa mantiene un programa de mejoramiento genético separado, existiendo nueve programas diferentes . Además de esta separación, se dividió en programas distintos las zonas con suelo de origen arenoso y arcilloso.

(1) Bajo la dirección de la Facultad de Ingeniería Forestal de la Universidad Austral de Chile, el Programa Cooperativo lo integran las siguientes instituciones y empresas forestales: Corporación Nacional Forestal (CONAF), Empresa Forestal Arauco Ltda., Forestal Mininco S.A. (ex Compañía Manufacturera de Papeles y Cartones S.A.,C.M.P.C.) ,Forestal Tornagaleones Ltda, Forestal Cholgúan S.A. , Industrias Forestales S.A. (INFORSA) y Sociedad Forestal Crecex Ltda. Actualmente se está integrando la empresa Celulosa Constitución (CELCO) .

La estrategia del plan de trabajo, está planteada en tres fases de operación que fueron iniciadas simultáneamente y cuyos objetivos son obtener semillas genéticamente mejoradas en el corto, mediano y largo plazo respectivamente. Las tres fases son: selección de árboles semilleros, para el abastecimiento de semillas en forma inmediata; establecimiento de áreas productoras de semillas, para obtener semillas en el mediano plazo; y el establecimiento de huertos semilleros de clones para el abastecimiento de semilla en un plazo mayor y que fue estimado en ocho años desde el inicio del programa.

2.1 Semillas de Arboles Semilleros

A partir de 1976, cada empresa inició colecciones masivas de semillas procedentes de árboles semilleros, en aquellos rodales bajo régimen de explotación final. El criterio general de selección empleado, es elegir los árboles con mayor vigor y mejor forma . Los árboles seleccionados tienen un volúmen superior al promedio del rodal, de fuste recto y buena calidad de copa, caracterizada por ramas pequeñas, delgadas y horizontales.

La intensidad de selección de los árboles semilleros es en términos reales de 25 a 50 árboles por hectárea, dependiendo de la calidad del bosque.La mayoría de los casos son rodales que no tuvieron ningún tipo de tratamiento silvícola, excepto poda a mediana altura, con una densidad que fluctúa entre 600 y 1100 árboles por hectárea.

En los últimos tres años se ha cosechado un promedio anual total de 4.500 kilógramos de semillas de árboles semilleros, lo que ha permitido a algunas empresas vender semillas a medianos y pequeños forestadores. Dependiendo de la región y tipo de rodal, el rendimiento medio de semillas por árbol seleccionado varía entre 0.2 y 0.4 kilógramos.

El resultado obtenido con este tipo de semillas ha sido muy satisfactorio, ya que el porcentaje de germinación es mayor al compararlo con las semillas comerciales comunes, que se emplearon tradicionalmente. La semilla comercial generalmente tiene un porcentaje medio de germinación no mayor de 70% , en tanto que la semilla de árboles semilleros fluctúa entre 80 y 90%. Este hecho tuvo como consecuencia que debió disminuirse la densidad de siembra en los viveros. No obstante que el costo de la semilla de árboles semilleros es unas tres veces más alto que la semilla comercial, su efecto en el costo de plantación significa un aumento de sólo US$ 1.0 por hectárea plantada, sin considerar la mayor sobrevivencia y el mayor rendimiento de plantas - plantables por kilógramo de semillas , originado por el mayor porcentaje de germinación (Delmastro, 1979a) .

En la región de Valdivia, de un ensayo comparativo entre plantas originadas de semillas de árboles semilleros (familias de medio hermanos) y de semillas comunes, al segundo año de plantación, se ha medido un 34% de superioridad en altura y 32% de superioridad en sobrevivencia (Delmastro, 1979a). No obstante que este estudio aún no permite obtener conclusiones definitivas en en cuanto al crecimiento, es importante el hecho que todas las familias tuvieron mejor sobrevivencia. En caso de mantenerse la diferencia en crecimiento , las ventajas de la selección de árboles semilleros será evidente en el futuro.

2.2 Establecimiento de Areas Productoras de Semillas

Las áreas productoras de semillas se han establecido en rodales relativamente adultos a un mínimo de cinco años previos de la cosecha final. Esta fase del programa actualmente está suspendida, básicamente porque la calidad de los bosques no permite dejar los 150 a 200 árboles por hectárea deseables con el fin de evitar daños por viento.

Hasta la fecha se han establecido unas 120 hectáreas de áreas productoras de semillas de 3 a 8 hectáreas de superficie con 190 a 230 árboles definitivos, en rodales con un número inicial de 600 hasta 1200 árboles por hectárea. El daño por viento no reviste un problema serio ya que no ha superado el 5% en los casos más extremos.

La expectación de ganancia genética de las áreas productoras de semillas aparentemente no sería tan alta como la de árboles semilleros, a pesar que en este caso ambos padres son fenotípicamente superiores y supuestamente de mejor genotipo, debido principalmente a la menor intensidad de selección (Burdon, comunicación personal). Aún no se ha iniciado la cosecha de semillas de áreas productoras de semillas y por tanto no se han establecido estudios comparativos de estas semillas con las de árboles semilleros y comerciales.

2.3 Establecimiento de Huertos Semilleros de Clones

Simultáneamente a la obtención de semillas mejoradas mediante los sistemas ya descritos, en 1976 se inició la selección de árboles " plus " y ubicación de los sitios para establecer los huertos semilleros, trabajo que prácticamente ha finalizado . A continuación se entrega una breve reseña de la labor desarrollada en esta fase del programa.

2.3.1 Selección de Arboles " plus "

La selección de árboles " plus " se ha basado en una pauta de selección adaptada para P. radiata , teniendo como modelo la usada por la Universidad de Carolina del Norte, Estados Unidos.

La pauta permite comparar el árbol candidato con cinco de los mejores árboles vecinos del rodal, considerando principalmente el vigor y la forma, además de la ausencia absoluta de enfermedades o daños de cualquier tipo . Los caracteres evaluados son : altura, volumen , rectitud , calidad de la copa, diámetro y ángulo de ramas y número de conos en el fuste, asignándole un puntaje determinado a cada carácter , dependiendo de su calidad o superioridad en relación a los árboles de comparación. En general se ha seleccionado en rodales entre 16 y 35 años de edad, siendo más frecuente la edad de 20 - 25 años .

Hasta el presente, se ha seleccionado un total de 337 árboles " plus " de los cuales 82 corresponden a los dos programas desarrollados para suelos de tipo arenoso. Cada programa tiene 42 a 51 árboles seleccionados, que constituyen el número de clones de los huertos semilleros de cada empresa. La intensidad de selección de árboles " plus " ha sido bastante alta, que en cifras reales llegó a un árbol cada 60 a 80 hectáreas; es decir, uno de cada 50 a 80 mil árboles analizados.

2.3.2. Propagación de los árboles " plus "

Los árboles " plus " seleccionados han sido propagados masivamente mediante injertos del tipo lateral, en plantas condicionadas de 2 años de edad; inicialmente, también se pretendió propagarlos mediante arraigamiento de estacas. Este intento se hizo prácticamente en condiciones de campo, por lo que su éxito fue sólo marginal, con sobrevivencias no superiores al 10 por ciento. Por el contrario, el porcentaje medio de sobrevivencia de los injertos normalmente es entre 80 y 90% , dependiendo de la experiencia de los injertadores. A excepción de algunos casos aislados, hasta el presente no hay síntomas de incompatibilidad de los injertos, lo que con *P. radiata* puede llegar a ser un problema grave sino se toman precauciones a tiempo. (Kellison , 1974)

2.3.3. Instalación y Cuidados de los Huertos Semilleros

Los huertos semilleros se han instalado en sitios de excelente calidad, lo que asegura un fácil manejo y buena producción de semillas en el futuro. La distribución de los rametos se hizo en forma dirigida, manteniendo una adecuada distancia entre rametos del mismo clon; la distancia de plantación empleada es de 5.0 x 5.0 m.

Los ocho huertos semilleros instalados a la fecha, suman 141.5 hectáreas en total, de las cuales 104 hectáreas (seis huertos) son de origen costa o suelo arcilloso y 37.5 hectáreas (dos huertos) de origen arenales.

Previo a la instalación de los huertos, se realizó una completa preparación del suelo y en algunos casos se estableció empastadas, principalmente en base a trébol. En la mayoría de los huertos se cuenta con facilidades de riego durante todo el año y se están haciendo inversiones necesarias para tener riego por aspersión.

De acuerdo a análisis preliminares de suelo se ha aplicado fertilizantes, principalmente N, P y K , directamente a los rametos. En el futuro se contempla el control de los nutrientes disponibles en el suelo, mediante análisis cada dos años, con el fin de aumentar la producción de semillas y disminuir las posibilidades de incompatibilidad de los injertos.

Desde el segundo año de instalación de los huertos, comenzó la " floración " de los rametos, especialmente de estróbilos femeninos ; esta temporada ya se observa gran cantidad de estróbilos, tanto femeninos como masculinos, en la mayoría de los huertos.

Además de los huertos semilleros, cada empresa cuenta con un banco o archivo de clones, donde mantiene una colección completa de los clones propios y de los otros programas, además de clones especiales que puedan tener algún uso en el futuro. El objetivo de los bancos es tener material suficiente para aumentar la base genética en el futuro , a través de nuevos ensayos de progenie , intercambio de clones entre las empresas e importación de material genético del extranjero.

2.3.4. Ensayos de Progenie

De los árboles " plus " seleccionados se colectó suficiente cantidad de semillas y este año se inició el establecimiento de ensayos de progenie de polinización abierta para cada huerto semillero; esta actividad concluirá el año 1981 .

El diseño experimental de las plantaciones de los ensayos de progenie, consiste de familias en parcelas en línea de 5 árboles cada una, totalmente al azar en repeticiones. De acuerdo a la disponibilidad de plantas, se han establecido ensayos con 8 a 12 repeticiones en dos sitios diferentes. Todas las empresas utilizaron los mismos controles comerciales, además de una mezcla de semillas de los ensayos de las otras empresas. El próximo año se repetirá el mismo ensayo en otros dos sitios diferentes.

En forma preliminar este año se han iniciado los cruzamientos controlados en los huertos semilleros y bancos de clones, para poder establecer pronto los ensayos de progenie; el personal de las empresas está siendo entrenado para ello. Los ensayos de progenie además de servir para la determinación de heredabilidades, habilidades combinatorias y para depurar los huertos semilleros, serán la fuente de futuras selecciones de cada empresa para establecer los huertos semilleros de segunda generación.

El diseño de cruzamiento que en principio se usará será el de probadores (N. C. State II) ; no obstante es muy posible que se cambie al sistema de dialelo parcial desconectado, propuesto por Griffin (1976), para evitar al máximo la consanguinidad de las futuras selecciones.

3. Programas Complementarios

El *P. radiata* , a pesar de ser una especie de gran vigor y adaptabilidad, es objeto de ataque por diversos patógenos, especialmente hongos y debido que a veces se planta en sitios marginales, sufre las consecuencias de deficiencias de nutrientes en el suelo.

En el ámbito del Programa Cooperativo, se están desarrollando diversos proyectos con el objetivo de obtener individuos resistentes a algunos patógenos y a deficiencias nutricionales del suelo, específicamente de boro.

En relación al hongo *Macrophoma sabinea* (ex *Diplodia pinea*) ,se ha efectuado una selección de 45 árboles aparentemente resistentes, que fueron propagados mediante injertos y de los cuales además se obtuvo semillas para establecer un ensayo de progenie de polinización abierta en condiciones de terreno y otro para inoculación artificial en vivero (Delmastro ,1976).

En la región de Valdivia se han seleccionado cinco árboles, aparentemente resistentes al hongo *Dothistroma septosporum* (ex *D. pini*), con los cuales se realizó un ensayo de resistencia " in vitro " de las acículas y otro mediante inoculación directa en vivero de las plantas de polinización abierta. Los resultados de estos ensayos están siendo evaluados y se espera que al correlacionar ambos procedimientos, se podrá determinar si es posible en el futuro evaluar la resistencia al hongo mediante ensayos " in vitro " (Engdhal, 1980).

La deficiencia de boro en el suelo es un problema común en diversas zonas del país, especialmente en los arenales. El efecto de esta deficiencia en *P. radiata* , es el secamiento reiterado del ápice principal y ramas, produciendo árboles achaparrados con poco o ningún valor del punto de vista industrial. En rodales con alto porcentaje de daño, fue posible seleccionar 80 árboles totalmente sanos, los cuales fueron propagados mediante injertos y por semillas de polinización abierta. Este año se estableció un ensayo de progenie y otro de fertilización con boro con la mayoría de las progenies obtenidas (Delmastro, 1978). Es muy posible que los árboles sanos estén aislados reproductivamente, por cuanto la deficiencia de boro afecta drásticamente la producción de polen y de estróbilos femeninos y por lo tanto puede haber mayor porcentaje de autopolinización; esto se deberá tener presente en la evaluación del ensayo de progenie (Zobel ,1978).

Uno de los aspectos que no se incluyó en la selección de los árboles " plus ", fue la calidad de la madera, principalmente debido a que la forma y magnitud de la variación de las propiedades tecnológicas no era conocida. Con el apoyo de un proyecto entre la Corporación Nacional Forestal, el PNUD y FAO, actualmente se está estudiando la variabilidad de las propiedades tecnológicas hereditarias de la madera de *P. radiata* , a lo largo de toda su distribución geográfica en Chile (Delmastro *et al.*, 1979). Este estudio permitirá incluir en las futuras selecciones las propiedades tecnológicas, especialmente la densidad de la madera.

4. Discusión y Conclusiones

El *P. radiata* es una especie de excelentes cualidades por su adaptabilidad, rápido crecimiento y calidad de la madera , que permite una utilización industrial diversificada. Del punto de vista genético, es una especie que presenta gran variabilidad en general, lo que posibilita una manipulación relativamente fácil y efectiva.

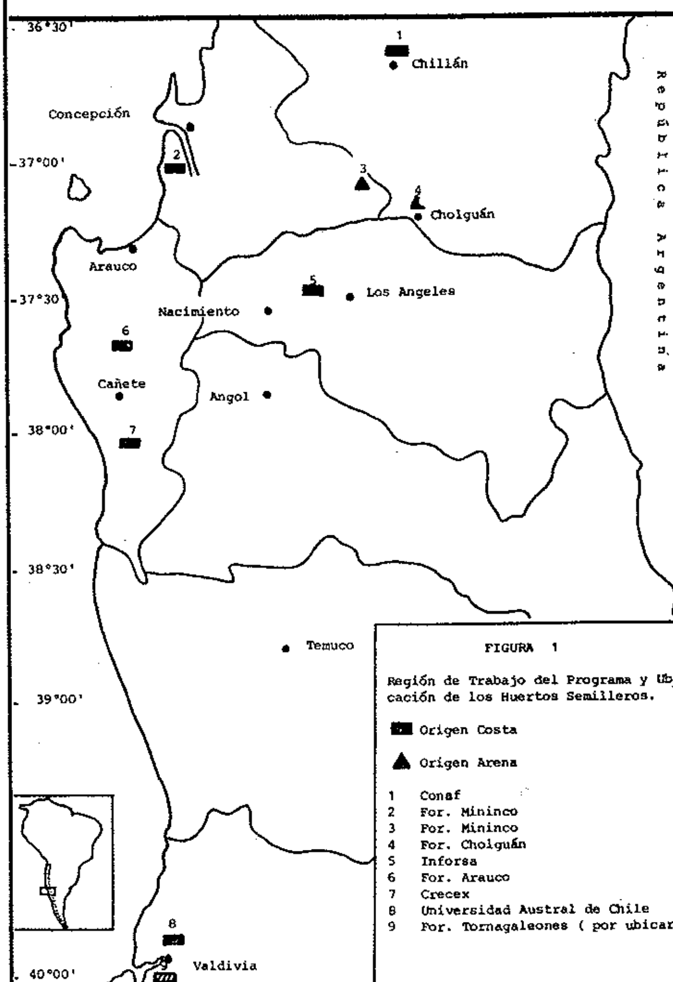

FIGURA 1

Región de Trabajo del Programa y Ubicación de los Huertos Semilleros.

■ Origen Costa

▲ Origen Arena

1 Conaf
2 For. Mininco
3 For. Mininco
4 For. Cholguán
5 Inforsa
6 For. Arauco
7 Crecex
8 Universidad Austral de Chile
9 For. Tornagaleones (por ubicar)

El mejoramiento genético de esta especie en Chile, aparentemente será una actividad rentable del punto de vista económico. En un estudio de factibilidad económica se determinó que con sólo 3% de mejoramiento en volumen los costos de un programa son totalmente cubiertos, incluyendo los costos del ensayo de progenie de polinización controlada. En este caso se asumió un rendimiento medio del huerto de 25 kilógramos de semillas por hectárea al año, una tasa de descuento de 10% , con una vida útil del huerto de 20 años y una rotación de los bosques de 24 años en clase de sitio I. En el peor de los casos, este porcentaje aumentó a 16.5% en clase de sitios III , para una rotación de 30 años, una vida útil del huerto de sólo 10 años y 10 kilógramos de semillas por hectárea al año de producción (Delmastro y Olivares, 1977) . Es necesario destacar que no se consideró el mejoramiento de la forma de los árboles, el que probablemente será aún más significativo que el volumen .

El manejo de las plantaciones de esta especie será aún más intenso en el futuro, debido a la creciente demanda por sus productos, la menor disponibilidad de bosques adultos durante este decenio y por una mayor y mejor disponibilidad de información silvicultural y de mercado para la toma de decisiones (Olivares et al., 1979). Esto obliga a que nuestros programas de mejoramiento genético, se mantengan abiertos y flexibles ante cualquier cambio futuro de las necesidades de la industria y el mercado tanto interno como externo.

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ACERVO GENÉTICO DE *Pinus radiata* PARA CONSERVAÇÃO EX-SITU E SELEÇÃO.

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Resumo

O trabalho descreve vários delineamentos de campo, utilizados para o estabelecimento de plantações de *P. radiata* visando a conservação ex-situ e seleção na Austrália e outros países, discute ainda as razões para a escolha desses delineamentos.

Os delineamentos usados em 1979 e 1980, incluiram testes de procedências visando determinar as melhores fontes de sementes para cada uma das amplas condições ecológicas envolvidas, e determinar as mais significativas interações procedência x localidade. Plantios experimentais, envolvendo vários hectares de cada procedência, visando futuras colheitas de sementes e a implantação de testes de progênies (para seleção entre progênies de 621 árvores derivadas da colheita de sementes efetuada nos U.S.A. e México em 1978).

Pinus radiata GENE POOLS FOR EX SITU CONSERVATION AND SELECTION.

Summary

The paper describes several field designs used to establish plantations of *Pinus radiata* for *ex situ* gene conservation and selection in Australia and other countries, and discusses reasons for the choice of these procedures.

The designs used in 1979 and 1980 included *provenance testing* to determine the best seed sources for each of a wide variety of sites and any major provenance x site interactions; *block plantings* of several hectares of each provenance for future seed collection and *progeny testing* for selection among progenies of the 621 trees from which seed was collected in U.S.A. and Mexico in 1978.

I N T R O D U C T I O N

With more than 2 000 000 ha of fast-growing plantations in several countries, *Pinus radiata* has become a major species of world forestry. Its natural occurrence (Figure 1) totals only about 7000 ha at Año Nuevo, Monterey and Cambria on the coast of California U.S.A. and on Guadalupe Island and Cedros Island Mexico (Forde 1966, Libby *et al.* 1968).

There is no prospect of maintaining *in situ* more than a token amount of the remaining gene resource of *P. radiata* due to rapid urban development at Monterey and Cambria and grazing of seedling regeneration by feral goats on Guadalupe Island.

It seems likely that early Californian collections of seed, from which plantations were developed, were from a small number of coastal trees at Monterey and Año Nuevo (Eldridge 1978a, Shelbourne *et al.* 1979, p299). Thus the large commercial plantations probably contain only a small part of the total genetic variability that comprises the species.

Prof. W.J. Libby of the University of California, Berkeley, has preserved a very diverse sample of the whole species by making cross pollinations between several trees representing each of the five populations. Some of the seeds from these crosses are to be planted out and crosses made again to maintain a small, very variable gene pool for several generations. The remaining seed has been put in long-term storage, together with some of the open-pollinated seed collected in natural stands in 1978 (see below).

The large gene pool plantations in several countries arranged by Dr C.J.A. Shelbourne of the New Zealand Forest Research Institute between 1970 and 1973 are a valuable source of variability. However, they may be only a small part of the total variability because the 300 seed lots were mainly from selected trees in plantations which probably have a limited common origin.

In the few provenance trials old enough to assess in Australia, New Zealand and California (Doran 1974, Shelbourne *et al.* 1979, and Hood and Libby 1980) the Monterey and Año Nuevo provenances have grown most rapidly followed by Cambria, Guadalupe and Cedros. However, these trials are on sites which represent only a few of the many plantation environments and, with the exception of a large New Zealand trial, are inadequate to select for superior growth rate within plantations.

The purpose of this paper is to describe provenance trials and genetic base populations established in 1979 and 1980 from seed collected in 1978 (Eldridge 1978a,b).

SEED COLLECTIONS IN 1978

Forty cones were collected from each of 621 trees throughout the natural range of the species (Table 1, Figure 1). The trees chosen were more than 100 m apart and, where there was a choice, were larger and of better form than their neighbours. Ten cones from each tree were kept separate for open pollinated families for progeny tests and for population genetic studies by Dr G.F. Moran using isoenzymes. The remainder were bulked by sub-populations.

Table 1. Summary of 1978 seed collections

Population	Latitude Altitude Rainfall Area	Sub-population number and description		No. of trees sampled
Año Nuevo	37°N	01/1	coast	70
	10-330 m	01/2	inland central	40
	800 mm	01/3	inland Swanton	40
	1000 ha	01/4	inland N	29
Monterey	36½°N	02/1	coastal dunes N	55
	10-440 m	02/2	town	37
	400 mm	02/3	Huckleberry Hill	35
	5000 ha	02/4	Jacks Peak Park	61
		02/5	coast S	22
		02/6	Carmel Highlands	34
Cambria	35½°N	03/1	Pico Creek	26
	10-200 m	03/2	town	49
	500 mm	03/3	inland	24
	1000 ha			
Guadalupe Is.	29°N	14	ridge top	48
	400-1200 m			
	150 mm			
	368 trees			
Cedros Is.	28°N	15	ridge tops	51
	380-640 m			
	150 mm			
	130 ha			

The collections were initiated by CSIRO and supported with staff, funds and equipment by N.Z.F.R.I., F.A.O., U.C. Berkeley, U.S. Forest Service and several other organizations and invididuals.

Of the 67 kg of seed collected 17 kg has been used in Australia, 13 kg in New Zealand, smaller quantities in 20 other countries, and 34 kg is in cold store in Canberra for future distribution.

PLANTINGS FOR CONSERVATION AND SELECTION

Seedlings were raised for provenance trials, block plantings and progeny tests (Table 2) to meet several objectives in conserving and utilizing gene resources. No single field design was compatible with the priorities given to these objectives or to the allocation of the technical resources available to each organization using the seed.

Table 2. Three kinds of field plantings of *Pinus radiata* for conservation and selection, 1979 and 1980

	Trees/ plot	Replic- ations	Design (4)	No. of sites Australia	N.Z.(5)	Other countries
Provenance						
small plot	5-10	10-12	r.c.b.	16	18	c. 40
large plot	36	10	latt.	-	5	-
Block(1)	500-10 000	1	-	2	1	-
Progeny(2)(3)						
460 families	4	7	latt.	2	-	-
	5	1	r.s.	5		

(1) Smaller block plantings of up to a few hundred seedlings per sub-population have been planted adjacent to most provenance trials.

(2) The progeny trials can also be analysed as provenance trials by grouping family data into sub-populations and populations.

(3) The N.Z.F.R.I. planted a large trial of 250 families between 1964 and 1968 (Shelbourne *et al.* 1979) and several small cooperative trials of 150 familes were planted in California, New Zealand and Australia between 1968 and 1970 (Hood and Libby 1980).

(4) Field designs: r.c.b. randomized complete blocks; latt., lattice square or generalized lattice; r.s., response surface or trend surface.

(5) Source: Burdon (1979).

Provenance testing

The design most commonly used was randomized complete blocks, 10-tree row plots with 10 replications. Fewer trees per plot, more replications and lattice designs were used in some trials. Two or three local 'control seedlots were included. There was only sufficient Guadalupe and Cedros seed to include in a few trials.

Usually the 13 sub-populations were placed at random throughout each block, rather than in groups by population, to maximize the precision of comparison of any pair of sub-populations. The results of Shelbourne *et al.* (1979) and W.J. Libby (pers. comm.) indicate that, except for the Guadalupe and Cedros populations, differences in growth rate would not be enough for one plot to start suppressing another within the expected life of the trials, about 15 to 20 years. Larger plots are necessary for longer term trials.

Provenance trials, though generally unsuitable for future open-pollinated seed collection because of cross pollination between populations and with adjacent commercial plantations, can nevertheless be used for selection of outstanding individuals to include in breeding programs by grafts, cuttings or pollen. However, numbers selected per sub-population must be small (strictly speaking one only) to avoid inbreeding effects because the selected individuals may well be from a single outstanding family, as observed by E.C. Franklin (pers. comm.) in selection of *Eucalyptus grandis*.

Block plantings

Several thousand seedlings from the bulk seedlots of each sub-population were planted in large unreplicated blocks in South Australia, New South Wales and New Zealand in 1980. The objective is future collection of considerable quantities of open-pollinated seed from the better trees in the centre of each block. To increase the area of each block, and thereby improve the chances of the central trees being pollinated by trees of the same sub-population, the trees were planted at wider than usual spacing and, in one case, trees of a local commercial seed source were planted in every third row for removal at first thinning.

Ideally a large block of each sub-population should be planted on a site to which it is well adapted and isolated from unwanted pollen, as is a seed orchard. After about 10 years, when results of provenance trials are available for each major plantation environment, additional and possibly larger block plantings could be made of the best sub-populations either from seed collected in the 1980 block plantings, or from stored seed of the 1978 collections, or from new collections in the natural stands if they still exist.

Inbreeding effects must also limit plus tree selection to the very small numbers per sub-population available from provenance trials, despite the much larger numbers of trees in the block plantings. However, larger numbers of plus trees might be selected in the next generation of block plantings since, as Burdon (1979) observed, they will probably then 'be free of the neighbourhood inbreeding which evidently occurs in natural stands'.

Progeny testing

Two large progeny trials (14 168 plants each) and five smaller trials (2300 to 4600 plants) were established in southeastern Australia in 1980.

The larger trials contain 453 mainland families, 9 Guadalupe, 4 Cedros and 40 'controls'. Because of the expected slower growth of the island populations (Shelbourne *et al.* 1979, W.J. Libby pers. comm.) these two populations were planted on separate adjacent sites, with a few island families common to both trials. The mainland families were located at random throughout the field design, not grouped by sub-populations. The objective was to maximize the precision of pair-wise comparisons between all families, and not only to choose the best families in the best sub-populations. On the advice of Dr E.R. Williams (CSIRO Canberra) we used a generalized lattice design (Williams 1977, Patterson *et al.* 1978) with 22 families per incomplete block, 23 incomplete blocks per replication, 7 replications and 4-tree row plots.

The other progeny tests were laid out in a design known as trend surface or response surface (Jeffers 1975) in which the comparison of families is made in relation to the performance of a standard seedlot planted in about 20% of plots.

The main justification for the much greater expense of progeny testing compared with provenance testing or block plantings is the opportunity for more efficient selection of many unrelated plus trees from each sub-population. Other advantages are a pedigree for future selection and information on inheritance of quantitative characters in the species.

INCLUSION OF NEW MATERIAL IN COMMERCIAL PLANTATIONS

Strategies for efficiently incluiding selected trees from genetic conservation field trials into operational breeding programs and commercial plantations have not yet been worked out in detail for *P. radiata*, nor perhaps for any other forest tree. Of many possible methods two are outlined here.

A simple procedure, which might be followed in an emergency due to new insect pests or fungous diseases, would be to thin heavily to remove unhealthy trees and collect seed later from pollination among retained trees.

A more complex procedure would be to cross newly selected trees with plus trees of the already highly selected breeding population using a mating design such as that described by Morton (1979), and include in seed orchards the best of the progeny of one or two generations of crossing.

The restricted and threatened natural genetic resource of *P. radiata* has made *ex situ* conservation necessary. The choice of efficient selection procedures and the management of these *ex situ* genetic resources depend on continuation of the already excellent cooperation of many people and organizations in many countries. IUFRO Working Party S2.03-09, 'Breeding Pinus radiata', will have a key role in coordinating the results of the field trials established in 1979 and 1980.

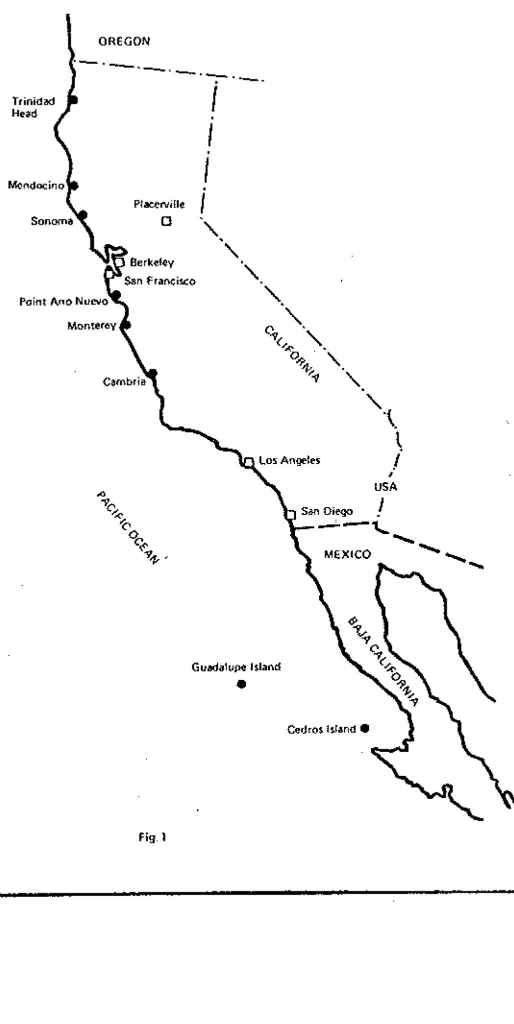

Fig. 1

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USOS ESTRATÉGICOS DO PÓLEN EM PROGRAMAS INTERNACIONAIS DE MELHORAMENTO FLORESTAL.

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Resumo

O intercâmbio internacional de pólen de árvores está tendo ampla aceitação como um meio eficiente de distribuição e utilização de germoplasmas escassos. Ao contrário, das sementes escassas, o pólen muitas vezes é viável em abundância em árvores de procedências superiores ou de qualidade genética excepcional. O acondicionamento e o transporte são facilmente efetuados com riscos mínimos de perdas devido a injúrias. Para os receptores de pólen este intercâmbio oferece opções interessantes para testes e enriquecimento dos recursos genéticos.

REVIEW DRAFT: STRATEGIC USES POLLEN IN INTERNATIONAL FOREST TREE IMPROVEMENT.

Summary

The international exchange of forest tree pollen is gaining wide acceptance as an efficient means of distributing and utilizing scarce germ plasm. Unlike scarce seed, pollen is often available in abundance from trees of superior provenances or of exceptional genetic quality. Preparation and transport are easily accomplished with minimal risks of losses due to spoilage. At the destination, pollen offers interesting options for genetic testing and enrichment of gene pool resources.

INTRODUCTION

The use of pollen in international tree improvement programs has not received much consideration. Probably because of questions, doubts, and some restrictions concerning international exchange and quarantine regulations. There are no custom regulations on the international exchange of pollen because such regulations would require microscopic examination which by international agreement are not routinely required. However, most countries have certain certifications, specifications, and restrictions which must be considered both by the exporting and importing agencies. The general, but limited, experience has been that when the proper agencies are contacted and informed concerning requests for pollen exchange, and when restrictions are adequately met there has been little problem in the international exchange of pollen. Therefore it seemed appropriate to discuss some of the uses of pollen in international forest tree improvement.

For reasons of convenience and tradition, seed has been the primary medium of exchange of plant material for many centuries. Only in recent times has a limited exchange of scion material taken place under very restrictive conditions. While seed has been considered generally free of noxious pest organisms when surface sterilized, recent evidence has suggested that some organisms may be transported inside the seed coat. Scions have been avoided in international exchange generally because of the diffiuclty of adequate surface sterilization. Based on present knowledge it is fair to say that pollen exchange involves no more risk in terms of the exchange of noxious plant or animal pests than either seed or scions and therefore the way should be open for wider exchange and use of pollen.

POLLEN USE IN A COMPREHENSIVE BREEDING STRATEGY

Pollen ersus Seeds or Scions

One of the big advantages of pollen over seed is the genetic purity that can be obtained. It is very difficult or impossible for cooperators to supply large quantities of controlled-pollinated seed because of the high cost of production. It is relatively much less expensive to obtain adequate quantities of pollen of high purity. In fact, pollen is much more readily available in large quantities with limited amounts of labor than open-pollinated seed. Early in tree improvement programs there is use for most of the seed which is produced, whereas much pollen is shed and lost each year which could be made available. Similarly, scion material is often in short supply particularly early in a program because of the small sizes of ramets.

With relatively simply processing and packaging precautions, pollen viability is much easier to assure than is viability of seed or scion material. This is particularly critical when considering international exchange and the limitations and costs of international transportation. So in terms of purity, availability, and viability upon receipt, pollen seems to have several advantages over more conventional sources of germ plasm such as seed or scions.

Genetic Testing

Once a tree improvement program is well established with large numbers of seed-bearing trees in orchards and clone banks for use as female parents, the use of pollen offers numerous and varied advantages. For example, many male parents may be tested on a single female parent, or one male may be crossed with a wide range of female parents in various design configurations such as full or partial diallels, disconnected diallels, and male or female tester systems. This versality means that pollen can be used to facilitate various mating designs according to differing program requirements and selection strategies. Test results can be utilized on a progeny test basis for evaluation of general combining ability of female or male parents, or for evaluation of specific combining ability of particular combinations. If pollen has been carefully source identified by male parent, additional pollen may often be obtained from the original suppliers or additional pollen may be available from inventory. In either case, crosses may be repeated or pollen may be used in mass pollination of selected orchard parents. The offspring which result from the genetic testing process can also be used as advanced generation selections of known pedigree.

POLLEN USE TO BROADEN THE GENETIC BASE

When new germ plasm is to be introduced into an ongoing program of genetic selection, the use of pollen from new seed sources or selected trees in wild stands of a proven source often facilitates the most expedient means of integrating new variation into the selected population. By pollinating selected female parents with the newly obtained pollen, one generation is skipped as opposed to the introduction seed or scion material. This results in the newly introduced variation being immediately under test on the genetic background of the improved variety. This is strategically important because it is unlikely that the newly introduced source would exceed the performance of the improved variety which has already undergone one or more generations of selections.

Another important source of gene pool enrichment is pollen from genetically improved strains in other programs. The advantage in this case, as in the previous situation, is that the improved germ plasm can be immediately introduced into the genetic base population on the background of the locally adapted, improved variety. The principal advantage of pollen from improved strains as opposed to wild stands or untested seed sources is that some genetic gain may have already been achieved. However, this gain may only be considered potential until it is proven on the genetic background of the locally adapted strain, and in the environments that are typical for that strain.

MAXIMUM USE OF SCARCE GENETIC RESOURCES

A genetic resource is principally the germ plasm or genic content of a population of interest, but in a narrower sense the genetic resource is also the material with which the breeder can cross, graft and in other ways propagate the genetically defined population. Such genetic material for propagation is often in short supply. There are often not enough ramets of each clone for scions, or seed is not available in the quantities or of the quality desired. In this regard, pollen may offer some special opportunities because in many cases, quantities are ample once a commitment to collect has been made. For example, very small quantities of pollen have the potential to produce hundreds or even thousands of seed if measures are taken to extend the pollen by adding other materials such as killed pollen or talcum powder. Thus, even the smallest quantity of pollen, can be used in ways to make a major contribution to the next generation of breeding stock.

Related to this is the utility of pollen in the sense that it can be used over an extremely broad genetic background by crossing to female genotypes in a given generation. This also is an extension of a scarce genetic resource which is uniquely possible by using pollen.

Pollen may also be considered to offer an opportunity to utilize a scarce genetic resource in terms of the quality of the resource. When an individual tree is chosen as a pollen source, it is possible with careful collection to obtain only the genes of that particular individual tree. This is the cheapest way to get a pure sample of a genotype which is immediately available for genetic trails through crossing. The individual genotype is obtained, of course, with cuttings but it is often several years before any breeding can begin.

PRESERVATION OF GENIC RESOURCES

For many of the reasons already discussed, pollen offers some unique opportunities in preservation of valuable genic resources. Value in this case could either refer to a high degree of genetic improvement, to a particularly unusual or useful genetic trait, or to population samples which would be collected to preserve a broadly based genetic resource such as a provenance or indemically adapted species. Compared to other types of genetic material which might be used, pollen is exceptionally easy to collect and prepare by cleaning and drying for storage. The space requirements are quite small when techniques such as freeze drying and vacuum sealing are used. Recent results indicate that satisfactory storage of freeze dried, vacuum sealed pollen can be done at room temperature, thus eliminating the necessity and the risk of refrigerated storage.

The use of pollen as a source of material for gene preservation deserves some special considerations. Pollen has no easily recognized morphological characteristics to distinguish individual trees or even species in many cases, so care must be taken to identify each collection accurately from the source tree to final storage environment. The maintenance of purity must also receive special attention. The best method is to physically isolate the pollen bearing structures on the tree prior to collection but care must also be taken not to leave the pollen in such isolation for long periods of time after it has shed. Once the collections have been completed, the maintenance of purity must receive attention at every step in the processing and storage procedure.

Whenever collections are done for gene preservation, the importance of obtaining adequate quantities cannot be overstressed. Several hundred grams of pollen are no less difficult to process than a few grams. Relatively large quantities will compensate for losses of viability in storage yielding larger absolute numbers of viable pollen grains at the end of storage, and will also provide more pollen for wider breeding use when that phase of the cycle is to be accomplished.

Special consideration must also be given to the renewal of the stored inventory. How often should additional collections be made and placed in inventory? Should older stored material be retained or discarded after a certain number of years? Answers to many of these questions must await more research and experience with this method of gene pool preservation and utilization.

The recycling of the genetic base population through the use of stored pollen also deserves special consideration. Only half the pedigree is stored when pollen is used. If for some reason, it is desirable to store and preserve the entire pedigree, then other provisions must be made. If so, how do the other provisions fit in with the utilization of pollen? If the pollen is to be utilized simply by crossing to existing female parents at the time the recycling is done, what are the implications of this in terms of long term gene pool preservation? As with the renewal of inventory, the recycling of stored pollen must await further research and experience to answer these questions concerning preservation through the use of stored pollen.

Prospects for gene preservation with pollen in forestry warrants only a brief summary. There are many agencies considering the use of pollen as a method of gene preservation. A few agencies have actually begun to store pollen on a long term basis. Certainly it is a prospect which will receive increasing amounts of attention in the near future as the preservation of newly derived and naturally occuring gene pools is considered.

INTERNATIONAL EXCHANGE

This discussion might be considered incomplete without some reference to preparation and methods of transport in international exchange. I have already indicated in the opening paragraph that there are no quarantine restrictions per se regarding export or import of pollen other than those which apply traditionally to most plant materials. There are some special requirements which vary from country to country and must be investigated in each particular case. The major consideration in the preparation of pollen for transport is to keep it out of direct sunlight and to keep it from acquiring moisture. It should be dried to about 10 percent moisture on a dry weight basis just as it would be for long-term storage. The freeze drying vacuum, sealing method is excellent in this regard. Containers should be packed to avoid breakage in boxes which conform to international transport regulations. As with any commodity which is fragile, perishable, and of high value, air transportation is usually the best and surest way of assuring a successful exchange. However, if pollen is freeze dried and sealed under vacuum it could easily survive a 4-month surface voyage without adverse effects. So if funds are not available for air transport, surface transportation is a good alternative. In this regard, as in other situations discussed above, pollen may offer some unique advantages in the international exchange of forest reproductive material.

OS ESFORÇOS COMBINADOS INDÚSTRIA-UNIVERSIDADE-GOVERNO PARA FORMAR O "CENTRAL AMERICA AND MEXICO CONIFEROUS RESOURCES COOPER COOPERATIVE" (CAMCORE).

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Resumo

A expansão das populações humanas no mundo está conduzindo a erradicação de recursos genéticos de valor comprovado e potencial para a humanidade. Este fato é agora evidente em regiões da América Central e México, onde o aumento das pastagens para subsistência, adicionando-se, ainda, danos extensivos causados por insetos e outras causas naturais, etc. , vem conduzindo algumas coníferas nativas a limites próximos à extinção. Esta destruição indiscriminada das árvores está em andamento em tal intensidade que as espécies ou raças poderão ser extintas, a menos que um esforço concentrado seja empreendido, visando salvar esse material genético. Por essa razão o CAMCORE foi recentemente estabelecido, envolvendo várias indústrias florestais norte-americanas internacionais, algumas companhias latino americanas, a Universidade do Estado da Carolina do Norte (Escola de Recursos Florestais) e os governos dos países anfitriões.

O objetivo principal do CAMCORE é preservar, testar e utilizar os recursos das coníferas da América Central e México, visando a melhoria da produtividade das áreas florestais nos trópicos e sub-trópicos. O CAMCORE é o único esforço cooperativo patrocinado pela indústria, visando salvar genótipos florestais em perigo, para benefício de toda a humanidade. O programa terá sua sede na Universidade do Estado da Carolina do Norte, sob a coordenação de um diretor, mais a assistência de corpo consultivo selecionado entre os seus membros, e irá iniciar suas atividades na Guatemala. Os conhecimentos derivados das pesquisas do CAMCORE serão distribuidos para o público em geral. A filiação está aberta para todas as organizações interessadas que queiram contribuir com sua cota para o Programa. O CAMCORE colaborará, quando possível, com outras organizações internacionais.

THE COMBINED INDUSTRY-UNIVERSITY-GOVERNMENT EFFORTS TO FORM THE CENTRAL AMERICA AND MEXICO CONIFEROUS RESOURCES COOPERATIVE.

Summary

The expansion of human populations throughout the world is leading to the erradication of genetic resources of proven and potential value to mankind. Nowhere is this more evident than in portions of Central America and Mexico, where the explosive increase of fuelwood cutters, shifting agriculture farmers, subsistance livestock growers, in addition to extensive insect damage and other natural causes, etc. is leading to the near extinction of some coniferous forests native to that part of the world. This widespread destruction of trees is continuing at such a rate that species as well as races will be lost unless a concerted effort is undertaken to save this genetic material. For this reason, the Central America and Mexico Coniferous Resources (CAMCORE) Cooperative was recently established between several North American forest industries with international operations, certain Latin American forest products companies, the North Carolina State University, School of Forest Resources, and host country governments.

The stated goal of the CAMCORE Cooperative is to preserve, test and utilise the coniferous resources of Central America and Mexico for the purpose of improving the productivity of forest lands in the tropics and subtropics. CAMCORE also is unique in that it is the first known cooperative effort instigated by industry to save endangered tree genotypes for the benefit of all mankind. The Cooperative will be headquartered at North Carolina State University, and under the guidance of a Director plus the assistance of an Advisory Board selected from the membership, it will initiate its activities in Guatemala. The knowledge developed through the research efforts of CAMCORE will be made available to the general public. Membership is open to all interested organizations who are willing to contribute their share to the Cooperative. CAMCORE will collaborate with other international organizations wherever possible.

Introduction

The complex biology of trees, their longevity, wide distribution, and environmental requirements for survival make forestry a complex and multi-faceted field. In fact, trees are so complex that no single organization is capable of studying the many aspects of a single, widespread tree species, and this has resulted in a piece-meal approach to investigating individual tree species and developing their commercial potential. However, with the advent of cooperative agreements between industry and universities, between governments and international organizations, and others, it has become possible to not only study the full complexity of certain species but also to develop and utilize species of commerical value. The cooperative approach has served to bring together the scientific, financial and natural resources of universities, industry and government into a single organization capable of coordinating activities to preserve and utilize valuable tree resources. Notable examples of successful cooperatives which have interest in tropical conifers are the North Carolina State University Industry Cooperative Tree Improvement Program, the Instituto de Pesquiscas e Estudios Florestais (IPEF) and the work done by the Commonwealth Forest Institute (CFI) and the Division of Forest Research of the Commonwealth Scientific and Industrial Research Organization (CSIRO).

Owing to the comparatively small amount of work that has been done with plantation forestry in the tropics and subtropics, relatively few of the potentially valuable timber tree species have been adequately tested. In the conifers, comparatively few species are currently being planted under tropical conditions; e.g. *Pinus caribaea, Pinus oocarpa, Pinus patula, Cupressus lusitanica, Pinus keysia,* and *Pinus merkusii.* There are many additional conifers which grow in Central America and Mexico that could be quite valuable for commercial plantation forestry in the tropics and subtropics, but thus far, inadequate efforts have been made to test and utilize these species.

An increasingly important complicating factor affecting the preservation of genotypes is the fact that throughout the world population pressures are expanding at alarming rates, and great pressure is being placed on the forest by subsistance farmers, stockmen, woodcutters, etc. as a result of this. In fact, the increased use of the forest by these people has caused much damage and stress in residual trees, and the old enemies of the forest, such as insects and diseases, have become more virulent and are destroying larger numbers of trees. Nowhere is this more evident than in Central America and Mexico, where the indiscriminate cutting and damaging of the forests by practices such as excessive limb removal is resulting in the loss of many proven and potentially valuable timber species.

For the above reasons, six large forest industry companies, including Aracruz Florestal, S.A. of Brazil, Corporacion Nacional de Reforestacion of Venezuela, Container Corporation of America, Mead Corporation, Weyerhaeuser Company and International Paper Company, plus North Carolina State University, School of Forest Resources, have joined together to form the Central America and Mexico Coniferous Resources Cooperative (CAMCORE). This group, which will include forestry organizations from the host country as affiliate or full members, is patterned after the North Carolina State University Cooperative Tree Improvement Program. The stated objective of CAMCORE is to preserve, test and utilize the coniferous resources of Central America and Mexico for the purpose of increasing the productivity of tropical and subtropical land. CAMCORE is a unique Cooperative in that the primary driving force behind its organization and formation has come from the forest industry community. In this sense, it is exemplary of the industry's genuine concern to preserve and develop a valuable natural resource for the benefit of all mankind.

Organization and Functions of the Cooperative

Within the past several years, forestry and the development of forest industry have become increasingly important in tropical and subtropical countries. Combined with this greater interest have come requests from these countries to forest products manufacturing companies to make investments in their forests and to provide some of the capital and expertise needed to develop this industry. At the same time, plantations of exotic tree species have shown considerable potential in tropical environments, and this has led to the realization that commercial timber producing operations could be established in the tropics to help satisfy the ever-increasing world demand for wood and wood products.

The CAMCORE Cooperative has been founded to collect and preserve pine genotypes, as well as to help improve proven species and to help develop new species for use by forest industry in the tropics. For this reason, a two-staged program is visualized for the Cooperative. The most immediate goal will be to prevent the extinction of endangered genetic resources and to provide for immediate collection and testing of this material. The second stage would involve the initiation of support activities necessary to produce commercial quantities of seed for operational planting of the desired species. These operational activities are to be done separately by the companies, and the Cooperative will supply technical expertise along with suitable genetic stock. By being affiliated with N. C. State University, CAMCORE will be able to directly sponsor the research activities of students at the School of Forest Resources, and this will undoubtedly prove of great value to the Cooperative in accomplishing its two primary goals.

The actual working objectives of CAMCORE will be to:

1. Develop the necessary biological information for the species of interest. This includes geographic and individual tree variation and taxonomic interrelationships.
2. Determine the best seed sources.
3. Conserve valuable genotypes.
4. Obtain seed in sufficient quantity to establish meaningful tests.
5. Improve genetic quality of the seed through breeding.
6. Progeny test different sources and individual trees.
7. Help establish seed orchards for members of the Cooperative.
8. Prepare for the activities of advanced generations.
9. Make assessments of wood quality and utility.
10. Develop methods of regeneration for each species.

The Cooperative will be headquartered at North Carolina State University, and the Director, Mr. W. S. Dvorak, and his staff will direct the Cooperative's activities from this location. Field offices are to be established in the countries of Central America where major collections and investigations are being conducted. There is now an Advisory Board, consisting of one person from each member organization, and an Executive Committee will be elected from members of the Advisory Board to work with the Director. Each cooperator contributes annual dues of $10,000 per year for an initial minimum commitment of three years, with any fee changes due to inflation, etc. being decided by the Advisory Committee.

A set of bylaws was drawn-up for the Cooperative and adopted by the cooperators for the purpose of complying with United States government antitrust regulations, and also to state concisely the goals and regulations of the Cooperative. Most importantly, the bylaws state the urgency for protecting from destruction an extremely valuable genetic resource, and that "the scope, cost and duration of this effort are such that the foregoing purpose can be achieved only through cooperative, rather than individual, action." In addition, it is stated that "membership in the Cooperative is open to any company or organization willing to share in the cost and effort of carrying on the work of the Cooperative." All research results are to be published and made available to the public, and basic collections of information and plant material will also be available at a reasonable cost. These bylaws do "not preclude any cooperator from engaging in individual research or operations which are similar to those carried out by the Cooperative."

Immediate Goals of the Cooperative

The first country in which CAMCORE will initiate its activities is in Guatemala because of the large number of coniferous tree species that are native to the country. Furthermore, population pressures and the resulting rate of cutting are acute in the country, and there is an urgent need to protect valuable coniferous resources from being permanently lost. Investigations have already been initiated in Guatemala by students from the North Carolina State University, School of Forest Resources, and many valuable contacts have already been made in that country which will greatly facilitate the Cooperative's work. Dr. W. L. Mittak and Dr. J. P. Perry, who are doing some excellent taxonomic work with the pines of Guatemala, and the government sponsored Banco Nacional de Semillas Forestales (BANSEFOR) have expressed great interest in CAMCORE and have agreed to help with the activities of the Cooperative. The Parochia de San Lucas Toliman (a foreign sponsored Catholic aid organization) has also tentatively agreed to provide on-the-ground facilities for investigators from the Cooperative who travel to Guatemala to conduct their investigations.

Eventually, CAMCORE's activities will be expanded to include Mexico and other Central American countries. Many valuable timber species grow in these countries and the rate at which these irreplaceable genetic resources are being lost due to excessive population pressures is nearly as bad or worse than in Guatemala. A factor which will undoubtedly complicate these expanded efforts is the political stability of the region. Presently, it is difficult to enter some of the Central American countries to collect material from the forest, but the changing political situation could make it impossible to make future collections of genetic material and conduct investigations in the forests of these countries. This merely adds to the urgency for expanding the work of CAMCORE into these other countries.

Plans are being made to conduct the first field collections early in 1981. In the meantime, the headquarters office is being set up at North Carolina State University, and the necessary contacts, clearances and permits are being obtained to facilitate the initiation of this work. It is intended that plant material be preserved and tested both within the host country and abroad where members of the Cooperative have their operations. At all times, the activities of CAMCORE will be closely coordinated with the host government, because one of the primary purposes of the Cooperative is to benefit forestry within that country.

All members of the Cooperative are expected to make a major contribution by actively participating in the testing and clone bank phases of CAMCORE. However, development of operational seed orchards will be the responsibility of each cooperator. As more organizations join the Cooperative and more funds are obtained, additional moneys will be made available for student research. Also, specialists (like Dr. Mittak and Dr. Perry) will be funded in order to obtain the proper balance of CAMCORE's activities.

Conclusion

The Central America and Mexico Coniferous Resources Cooperative is a new organization which is combining the efforts and resources of the academic, governmental and industrial organizations to preserve, test and utilize the major coniferous resources of Mexico and Central America. The Cooperative is unique in that it was created largely through the efforts of industry, and it evolved directly as the result of the increased importance of industrial forestry in the tropics and subtropics and the need to have adequate material to plant in this environment. However, this effort is not unique because several organizations have been working on this problem for many years, e.g. FAO, IUFRO, UNEP, the Commonwealth Forest Institute, Centre Technique Forestier Tropical, CSIRO, and the Danish International Development Agency (Nikles, 1979). Nonetheless, the alarming rate at which proven and potentially valuable genetic resources are being lost has led to the urgent need for immediate action.

CAMCORE will initiate its activities in Guatemala, but it will strive to expand to other countries in Central America and Mexico. In this respect, it will cooperate with other organizations presently engaged in similar activities, (e.g. the FAO, CFI, and CSIRO), and the Cooperative will strive to increase its membership to include other forestry organizations in both Latin America and North America with interests in the tropics. Two present members of CAMCORE are Latin American forest industries, and many other organizations in both Latin America and North America have indicated a desire to join the Cooperative in 1981. In addition, coniferous species are being emphasized by CAMCORE, but many valuable hardwood genera such as *Liquidambar*, *Liriodendron*, *Quercus*, *Alnus*, *Swietenia*, *Cedrela*, etc. are also native to Central America. If funds and manpower are available, it is possible that future investigations sponsored by the Cooperative could be conducted with hardwoods.

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PROGRESSOS NOS ESTABELECIMENTOS DE UM PROGRAMA COOPERATIVO DE MELHORAMENTO FLORESTAL NA ÁSIA SUDESTE.

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Resumo

Por iniciativa do "Royal Thai Forest Department", uma conferência foi realizada em Chiangmai, Tailândia, em fevereiro de 1979, com o intuito de discutir as necessidades e possibilidades do estabelecimento de um programa de melhoramento florestal na região Sudeste da Ásia. Dez países da Ásia, o Departamento Florestal da FAO e a Dinamarca se fizeram representar nesta conferência, os quais, além de financiarem a reunião, mostraram-se interessados a patrocinar o programa. Os debates revelaram os pontos comuns de interesse, bem como as possíveis restrições e problemas no desenvolvimento de um programa como preposto. Foi concluído também que dada as dificuldades de operação regional, se fazia necessário, antes de tudo, o estabelecimento de uma ou duas unidades de comunicação. A sugestão proposta pela Tailândia, de se estabelecer em Chiangmai uma unidade coordenadora do programa para o Sudeste da Ásia foi aprovada pelos participantes. Foi sugerido que a Tailândia procurasse fundos para estabelecer àquele centro durante os primeiros cinco anos de operação.

REPORT ON PROGRESS IN ESTABLISHING E SOUTHEAST ASIAN COOPERATIVE TREE IMPROVEMENT AND SEED PROCUREMENT PROGRAMME.

Summary

On the initiative of the Royal Thai Forest Department, a conference was held in Chiangmai, Thailand during February 1979 to discuss the need for and possibilities of establishing a Southeast Asian regional cooperation on tree improvement and seed procurement. 10 countries from Asia, the Dep. of Forestry/FAO, Rome as well as Denmark, as financial contributor to the conference and prospective future supporter, were represented at the meeting.

Discussions revealed a number of areas of common constraint to progress in tree improvement and seed procurement, where cooperation and coordination might be started.

It was finally concluded that in view of the severe constraints resulting from inadequate regional cooperation, the establishment of one or more communication units was essential. The programme proposed by Thailand was by and large endorsed with regard to location (Chiangmai) of the coordinating unit (centre) for SE. Asia, the structure and functions. Thailand was recommended to seek external sources to finance the start up and first period of operation (5 years).

For funding purposes it was suggested to plan a project in 2 phases: initially 18 months for 1 professional to survey progress and problems and to prepare a second phase of 3½ years for 2 professionals to include information services and support to development & implementation of national programmes.

During 1980 Thailand has forwarded 2 project proposals for external assistance :

1) "ASEAN Forest Tree improvement Centre Programme"
Limited to participation by ASEAN countries, forwarded to UNDP/FAO.

2) "International Tree improvement and Seed procurement Cooperative Programme".
Open to any country but in particular in Southeast Asia; to develop in line with other international seed centres and according to directions from IUFRO and the Panel of Experts on Forest Gene Resources.
Forwarded to DANIDA (Danish International Development Agency).

INTRODUCTION

The need for organised tree improvement as well as conservation of important tropical species is being recognised with increasing awareness in many developing countries.

Efforts have been accelerated over the last decade by the establishment of national improvement programmes, often in collaboration with various aid agencies. Internationally coordinated provenance trials of teak and Gmelina arborea and the fast growing tropical pines have speeded up and effectively guided the initial steps in population improvement.

Lately, the rapid depletion of genetic resources in tropical species has caused the initiation of gene conservation programmes, mostly as ex-situ plantations but in the case of P.merkusii in NE.Thailand also as in-situ, financed by UNEP and Danida.

The need for coordination of forest plantation and tree improvement research on a regional basis was already recognised by Fielding in 1973, but also the FAO/DANIDA training course on forest seed collection & handling (Thailand 1975) realised the prospects in regional cooperation.

It was in realization of this that the Royal Thai Forest Department (RTFD) proposed a conference to discuss the need for and possibility of establishing a "Southeast Asian Cooperative Tree improvement and Seed procurement Cooperative Programme". With economic support from DANIDA this conference was held in Chiangmai during February 12-18, 1979.

10 countries from Asia and the Far East were represented at the conference : Australia, Bangladesh, India, Indonesia, Japan, Malaysia, Papua New Guinea, Philippines and Sri Lanka as well as the two host countries, Thailand and Denmark. Chairing the meeting was 1 senior representative from FAO/Dep. of Forestry/Rome.

Conference activities covered : lectures, presentation of country statements, group work on constraints on tree improvement & seed procurement as well as field trips.

DETAILS OF A REGIONAL COOPERATIVE FOREST TREE IMPROVEMENT AND SEED PROCUREMENT PROGRAMME

Functions

According to the original proposal forwarded by RTFD the coordinating unit (centre) in such a programme would have 3 functions, the details of which are as follows :

1. Communication
1.1 The centre will collect and distribute written material such as research programmes, working plans, reports and research papers.
1.2 Organise exchange of research workers among participating countries
1.3 Invite experts from outside as well as fromthe region to boost activities in the participating countries.
1.4 Organise scholarships, study tours and seminars, i.e. gather and distribute information on needs and offers.

2. Coordination
The centre will
2.1 support coordination of national research programmes, e.g. provenance and progeny testing.
2.2 support cooperative research, e.g. on flowering, seed, hybridization, vegetative propagation etc.
2.4 work for the establishment of standards in research work, e.g. germination tests, plus tree grading, experimental descriptions, filing and retrieval systems.
2.5 work for the establishment of standards in the certification of seed and other plant material.

3. Actions
The centre will
3.1 organise collections of forest tree seed for research purposes, plantation establishment and gene resources conservation.
3.2 organise exchange and purchase of seed for research as well as in larger quantities for other purposes .
3.3 organise exchange of vegetative materials.
3.4 orgainise exchange of pollen .

Structure

The proposed programme foresees a structure with a central communication & coordination unit and associated centres in cooperating countries .

Since Thailand has taken the initiative to propose the cooperative programme it also offers the facilities and the services of its own tree improvement-and seed centres.

These are at present the following:

1. The 2 centres involved in the improvement and seed procurement of teak, the Teak Improvement Centre (TIC) and the Teak Seed Centre (TSC) .
2. The 2 centres concerned with the improvement and seed procurement of pine and eucalypts, the Pine Improvement Centre (PIC) and the Northern Forest Tree Seed Centre (NFSC).
3. The Central Forest Tree Seed Centre (CFSC) which is at present being established under ASEAN/Canadian auspices.

Management

The proposal envisages an administrative build-up with :

1. A board of directors - consisting of one representative from each of the participating countries .
2. A chairman of the board of directors - a rotating position among the members of the board.

3. A coordinator – one highly qualified expert from a participating country, to serve as a secretary to the board of directors.

4. Associate coordinators – qualified personel from the region, one of whom from Thailand, initially supported by foreign expertise.

DISCUSSION

To clarify the character and extent of constraints on tree improvement and seed procurement in the region, a series of group work sessions were held among participants.
Topics for the group discussions were arranged according to the following themes :

I Communication
II Coordination
III Provision and exchange of seed and experimental material
IV Organisation

Results of discussions were summarized in :

Format 1 : Constraints on tree improvement and seed procurement related to :
1 communication of information
2 coordination, planning & advice

Format 2 : constraints on tree improvement and seed procurement related to species of common interest, with reference to :
1 seed
2 breeding
3 staff and training
4 equipment

List of genera other than the 5 priority, of interest to the region.

The discussions revealed general agreement on the desirability of regional cooperation on tree improvement and seed procurement as well as on the proposed structure, functions and location of a centre.

In addition to this, the weighted registration of constraints listed in formats 1 and 2, identified a number of topics as being of high priority and regional level of concern (marked (.)).

CONCLUSION AND RECOMMENDATIONS

1. The conference concluded that in view of the importance of tree improvement and seed procurement evident from the country statements presented, and the severe constraints resulting from inadequate regional cooperation, the establishment of one or more regional communication and coordination units was essential.
The proposed Southeast Asia region could include the following countries: Burma, Indonesia, Kampuchea, Laos, Malaysia, the Philippines, Singapore, Thailand and Vietnam.

Other countries in neighbouring regions could be eligible as associate members if desired. Associate membership would not preclude such countries from establishing their own regional units later, e.g. for South Asia and Southwest Pacific.

2. The conference unanimously recommended that the coordination unit for Southeast Asia be located at Chiangmai, Thailand, where the excellent facilities of the existing seed centre have been offered by the Royal Thai Forest Department.

3. The conference recommended that each full member country should be represented on a committee to be set up to supervise the coordinating unit.

4. Duration and Manpower
The conference concluded that in order to have a significant impact the activities should be programmed for a period of at least 5 years. However, for funding purposes it would be preferable to plan the project in two phases:

1. An initial phase of 18 months for one professional to survey progress and problems and to prepare the second phase.
2. A second phase of 3½ years for two professionals to include information services and support to development and implementation of national programmes including field activities.

5. Funding
The conference recommended that the host country, Thailand, should seek external sources to finance the Southeast Asia coordination unit. However, a number of delegates recommended that cooperating countries should also contribute to the programme, e.g. towards the travel expenses in connection with visits within each country.

REQUESTED PROJECTS

2 alternative project requests have been prepared by the RFTD for assistance :

1) "ASEAN Forest Tree improvement Centre Programme".
Essentially only open for participation by ASEAN countries.
Forwarded to UNDP/FAO.

2) "International Tree improvement and Seed procurement Cooperative Programme".
Open for participation, but in particular aimed at countries in Southeast Asia; to develop in line with other international seed centres and according to directions from IUFRO and the Panel of experts on Forest Gene Resources .
Forwarded to DANIDA (Danish International Development Agency).

FORMAT 1

Constraints on tree improvement and seed procurement related to:
1) communication of information
2) coordination, planning & advice

Codes : priority P 1–3 : 1 high priority, 3 low priority.
level of concern : L/N – Local/National, R – Regional
I – International.

		P 1-3	L/N	R	I
1.	COMMUNICATION OF INFORMATION				
1.A	Existing information				
1.A.1	National publications				
	(a) Failure of institutes to distribute research publications regularly to other countries in the region. Lack of funds to cover costs of distribution.	2	X		
	(b) Failure of institutes to list names of research workers in their publications.	3	X	X	
	(c) Failure to circulate library accession lists.	2	X		
	(d) Failure of publications to reach interested individuals within the countries.	1	X		
	(e) Lack of specific national publication series on tree improvement and seed procurement.	1	X		
	(f) Inadequate library facilities.	2	X		
1.A.2	International publications				
	(a) Inadequate funds for purchase	2	X		
	(b) Inadequate circulation service from HQ to field stations.	1	X		
1.A.3	Language problems				
	(a) Lack of summaries of articles in a common language (English)	2	X		
	(b) Lack of translation facilities to translate important articles in full, both from and to the national language.	2	X	X	
1.A.4	Meetings, seminars, etc.				
	(a) Inadequate numbers of national/regional meetings, seminars.	2	X	X	

Continued

		P 1-3	L/N	R	I
1.B	Synthesis and distribution of new information				
1.B.1	Surveys and summaries				
	(a) Need for survey and report on national research activities on tree improvement and seed procurement relevant to a regional cooperative programme, with particular reference to : (1) Provenance and progeny testing (11) Seed orchard establishment and management (111) Seed collection and handling	(1)	(X)	(X)	
	(b) Lack of regional survey of national genetic resources and of their relative performance.	(1)	(X)	(X)	
	(c) Lack of listing of species of common regional interest for tree improvement, and eventually, of short monographs on selected species.	3	X	X	
1.B.2	Information service				
	(a) Absence of a regional newsletter on tree improvement and seed procurement, to include personel news, progress reports, seed availability, book reviews, e.g. Flora Malesiana Bulletin.	(1)	(X)	(X)	
	(b) Need for a small regional information/documentation centre to provide information and contacts on ad hoc basis.	2	X	X	

		P 1-3	L/N	R	I
2.	COORDINATION, PLANNING, ADVICE				
2.1	Planning Lack of coordination between countries in planning national programmes in tree improvement, in short medium and long term.	(1)	(X)	(X)	(X)
2.2	Techniques and standards (a) Need for adoption of common techniques and standards in tree improvement research, e.g. design of provenance trials, germination tests, plus tree selection, assessment methods, recording forms.	(1)	(X)	(X)	(X)

Continued

		P 1-3	L/N	R	I
	(b) Lack of common standards in the certification of seed and other plant materials.	2	X	X	X
2.3	Implementation of research results (a) Lack of practical manuals or guidelines incorporating tree improvement research results for the use of divisional forest staff.	2	X	X	X
	(b) Lack of executive action to ensure the maximum use of the best techniques and best genetic material identified by research.	2	X		
2.4	Coordination for individual species Need for special action, from time to time, to coordinate work on individual species of importance in the region.	2	X	X	
2.5	Funds and manpower Lack of funds and skilled manpower to undertake large-scale experimental assessments.	(1)	(X)	(X)	(X)

FORMAT 2

Constraints on tree improvement and seed procurement related to species of common interest, with reference to:

1) Seed 2) Breeding 3) Staff and training 4) Equipment

Codes: Countries - B = Bangladesh, I = India, IO = Indonesia, L = Sri Lanka, M = Malaysia, N = Papua New Guinea, P = Philippines, T = Thailand

Each country indicates for each species the importance of the topics using the priority code 1-3. At the bottom of each topic-section the recordings are summarised species-wise as follows: The number of countries interested in the topic (range 0-8)/the sum of priority scores (i.e. sum of country-priorities listed + 4 scores for each country not listed, resulting in a total range of score from 8 (very important) to 32 (unimportant).

Examples: 8/9 - interest in 8 countries (max) and high level of priority (see item 3.1)
6/18 - interest in 6 countries with a total score of 10 + 2 countries not listed, (2 x 4) = 18 (see 2.4).

SPECIES / CONSTRAINTS	PINUS	TEAK	DIPTEROCARPS	GMELINA	EUCALYPTUS	REMARKS	LEVEL L/N	LEVEL R	LEVEL I
1. SEED 1.1 collection technique	I1 M1 N3		B1 I3 IO1 P2 T1		I2	N: P.caribaea	X		
	3/25	0/32	5/20	0/32	1/30				
1.2 handling, storage, germination	I1 IO1 L2 T2 N1	B3 I3 L1 M3 P2 T3	B1 I3 IO1 L3 M1 P1 T1	I3 L2 P2 T1	I2	Teak: dormancy. Gmelina: collect, pretreatment, storage. Dipterocarps: viability, storage. P.merkusii: collection, treatment	X		
	5/18	6/23	7/15	4/24	3/27				
1.3 supply 1.3.1 in bulk	I1 L1 M1 P1 T1 N1	L1 M2 P1 T1	B1 I2 IO1 L3 M1 P3	I3 L3 P1 T1	I2 L2 M3 P1 T2 N2	spec. ref. to P.merk. in N " " " E.degl. ex P Viab. of Shorea rob. in I Spec. ref. to P.kes./T&P " " " P.car. in I,M,IO,L,T	X	X	X
	6/14	4/21	6/19	4/24	6/20				
1.3 supply 1.3.2 for provenance research	B2 I1 IO3 L3 M3 P2 T3 N1	B2 I2 IO2 L2 M2 P2 T3	B1 I3 IO1 L3 M1 P1	B1 I1 IO1 L1 M2 P1 T2 N2	B2 I1 IO1 L1 P1 T2 N1	spec. ref. to P.merk. in N " " " E.degl. ex P in N.	(X)	(X)	(X)
	8/18	7/19	6/18	8/11	7/13				

Continued

SPECIES / CONSTRAINTS	PINUS	TEAK	DIPTEROCARPS	GMELINA	EUCALYPTUS	REMARKS	LEVEL L/N	LEVEL R	LEVEL I
1.3 Supply 1.3.3 for gene resources' conservation	B2 I1 L1 M2 P3 T2 N1	B3 I2 L1 M3 P2 T2 N3	B1 I3 L3 M1 P2	B1 L3 M3 P2 T1 N2	B2 I1 L2 P3 T2 N1	Indigenous and exotix, in-situ and ex-situ	X	X	X
	7/16	7/20	5/22	6/20	6/19				
1.3 Supply 1.3.4 of bred material e.g. seed orch.	I1 IO1 L1 M1 P1 T1 N1	B1 I2 IO1 L1 M1 P1 T1	I3 L3 M1 P3	B2 I1 IO1 L1 M2 P1 T1	I1 IO1 L1 P1 T1	Spec. ref. to P.kesiya in T & P Spec. ref to P.merkusii in N	X		
	7/11	7/12	4/26	7/13	5/17				
1.4 Testing standards (ref. ISTA)	B1 I1 IO1 L1 M1 P1 T1	--------->					X	X	X
	7/11								

1.5 Regist. certificat. standards	B1 I2 I01 L1 M1 P1 T1	--------	--------	--------	--------→		X	X	X
	7/12								
1.6 Pests& diseases	I2 L1 P2 T2 N1	I2 L1 P3	M1 L3 P3 T3	L3 P2	I1 L3 P2	P.strobus & P.oocarpa for N	X		
	5/20	3/26	4/26	2/29	3/26				
1.7 Regulations on export and import	B1 I2 I01 L3 M1 P1 T1 N1	--------	--------	--------	--------→	Legal and quarantine	X		X
	8/11								
1.8 Organizational constraints on ex-/import	I1 L2 M1 P3 T3	I2 L2 M1 P1 T3	M1 L3 P3	I2 L2 M1 P1 T3	I1 L3 P1 T3	e.g. lack of seed centre(s), lack of funds etc.	X		
	4/23	5/21	3/27	5/21	4/24				
2. BREEDING 2.1 exchange of knowledge & experience	I2 L1 I01 P1 T1 N1	B2 I2 I01L1 T2 P1	B1 I01 M1 L3 P1	B2 N2 I01L2 T1 P1	I2 L2 T1 P1	Ref. to information service, planning & strategies	X		
	6/15	6/17	5/19	6/16	4/22				

Continued

CONSTRAINTS / SPECIES	PINUS	TEAK	DIPTERO-CARPS	GMELINA	EUCA-LYPTUS	REMARKS	LEVEL L/N	R	I
2.2 exchange of breeding materials	I1 I01 L1 M1 P1 T1 N1	B3 I1 I01L1 M3 P1 T1	L3 P2	B1 I1 I01 L1 M3 P1 T1	I3 I03 L3 M3 P1 T1 N1	e.g. pollen, clonal material, seed	X	X	X
	7/11	7/15	2/29	7/13	7/19				
2.3 phenology & breeding systems	I2 I01 M1 L1 P1 T2 N1	B2 I2 I01 L1 P1 T1	B1 I01 M1 L3 P1	B2 L3 P1 T1 N1	I2 L2 P1 T2	Special ref. to teak pollination	X		
	7/13	6/16	5/19	5/20	4/23				
2.4 resistance breeding	L1 M2 P1 T2 N1	B3 I1 I01 L1 P3 T1	L3 M1 P3	B2 L3 P3 T1	I1 L3 P2 T3 N1	Spec.ref.to Teak Beehole-Borer(Xyleutes ceramicus) and Pine Shoot Borer (Petrova Salweenensis) T	X		
	5/19	6/18	3/27	4/25	5/22				
2.5 standardisation of methodology	B2 I2 I01 M2 L1 P2 T2 N2	--------	--------	--------	--------→	e.g. assessment, evaluation, definition of technical terms etc.	X	X	X
	8/14								
3. STAFF AND TRAINING 3.1 lack of career possibilities	I2 B1 I01 L1 M1 P1 T1 N1	--------	--------	--------	--------→	Major constraint; frequent transfers of staff (professional and technical)	X		
	8/9								
3.2 inadequate number of training courses & study tours	B1 I2 I01 L1 P1 T1	--------	--------	--------	--------→		X	X	X
	6/16								
4. EQUIPMENT	B1 I2 I01 M3 L1 P1 T2 N3	--------	--------	--------	--------→		X		
	8/14								

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RESTRIÇÕES AO INTERCÂMBIO E PROCURA INTERNACIONAL DE MATERIAIS PARA MELHORAMENTOS DE ÁRVORES.

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England.

Resumo

Este trabalho dá um breve relato dos caminhos nos quais vários tipos de materiais de melhoramentos de árvores tem sido transferidos internacionalmente e discute os efeitos de algumas restrições aos movimentos de vários materiais de plantas. Particular atenção é dada aos perigos à saúde envolvidos e a medidas pelas quais podem ser reduzidas. O artigo conclui que o melhorista de árvores deve sempre se preocupar para obter o melhor material possível para seus estudos propostos, a disponibilidade de várias formas de material vegetativo e as várias limitações que afetam todas as fases de transferência.

CONSTRAINTS UPON INTERNATIONAL PROCUREMENT AND EXCHANGE OF TREE BREEDING MATERIALS.

Summary

This article gives a brief history of the ways in which various types of tree-breeding materials have been transferred internationally and discusses the effects of various constraints on the movements of various plant materials at the present time. Particular attention is paid to the health hazards involved and the measures by which these can be reduced. The article concludes that the tree-breeder must often compromise between his requirements for the best possible material for his proposed studies, the availability of various forms of plant material, and the various limitations affecting all phases of the transfer.

INTRODUCTION

The transfer of tree breeding materials between countries or continents may be necessary for several reasons. One major reason is to introduce material with a broad genetic base to test its suitability as a crop plant in a new area, and to use it subsequently in selection and breeding programmes. Such introductions were carried out frequently in the past, using seed mainly, and have resulted in the establishment of many species and provenance trials. A second major reason is to introduce material with a narrow genetic base, either to test its suitability as above, or to use it as a source of one or more desirable genetic traits in a breeding programme.

Transfers may be carried out between regions of one county, between countries, or between continents, depending on particular circumstances. Originally most transfers were carried out with seed because of the ease with which they can be collected and transported in a dormant state. However, some tree species are difficult to transport in this way for various reasons and were despatched as whole plants or vegetative parts. More recently pollen or tissue culture transfers have been made because of their small size and purity.

Originally the movement of plant material was unregulated and limited only by the difficulties of collection and transportation. Nowadays legal restraints on the movements of plant materials are commonplace and these often dictate which type of material may be transferred. Whole plants are rarely transferred internationally because of the dangers of transmitting associated diseases and pests, and because of their bulk and special transport requirements. Vegetative materials such as scions or rooted cuttings are less bulky, but still pose a considerable health hazard and usually require rapid transportation. This rapid transfer, and the equable conditions under which it is effected, can increase the health hazard by allowing sensitive pests to be transferred also. Tree seeds are frequently easy to collect and store, and to subsequently transport in a dormant stage. However, they may harbour pests and diseases, particularly when sent in large quantities. Various seed treatments can eliminate some of these hazards especially when small consignments are involved. In some cases tree seed is not easily obtainable, or readily storable for easy transportation. Transfers of pollen require greater technical expertise at all stages and quick, reliable transportation. However, the health hazard is greatly reduced, especially as very small quantities are generally employed. Similarly, transfers of plant-tissue cultures require sophisticated expertise during the phases of collection and utilization of the material, although the actual transfer may be easy to carry out.

This paper briefly reviews the various constraints which can limit the exchange, or procurement, of tree-breeding materials.

CONSTRAINTS

Biological constraints

The availability of plant parts for propagation from wild populations may be limited by their erratic or ephemeral production, as in the case of pollen and seeds, or by the need to collect materials in a particular physiological condition. This may be overcome to some extent by collecting from trees grown under cultivation or by treating individual trees in various ways to favour the production of the required materials.

Dormant plant parts, such as seeds, pollen and buds, can be collected, stored, and transported very readily especially when this dormancy can be extended by simple treatments such as drying or cooling. However, the seed of some tree species and most other propagation materials can only be collected and transported whilst in a non-dormant or actively-growing condition. In these cases the longevity of the materials may be a few days only, even under the most favourable transit conditions. This limits the time period between the collection and utilization of these materials, and requires rapid transportation and the provision of suitable transit conditions. These factors can also have a pronounced impact on the quantities of materials which can be handled.

Injurious organisms can be present in all plant parts collected from natural, semi-natural, or in vitro environments, although their variety and incidence are likely to be much less in particular plant parts such as seeds and pollen (Cooper, 1979), or in plant materials grown under less natural or in vitro environmental conditions. The possibility of the inadvertent transmission of contaminant organisms, which may endager crop plants in the recipient country or region, has given rise to legislation in an attempt to minimize this hazard. The danger can be reduced in several ways, which are often reflected in the plant health regulations which have been introduced. Firstly, propagation materials should be obtained, whenever possible, from healthy parent trees or disease free areas; secondly, those plant parts which are likely to carry least contaminant organisms should be used; thirdly, small quantities should be employed to minimize the risk; and fourthly, various treatments should be applied to the materials to remove or kill some of the contaminant organisms. It should be pointed out in this context that the factors which favour the transfer of sensitive propagation materials may also favour the transmission of sensitive disease organisms which might otherwise perish during transit.

Physical constraints

In many parts of the world the lack of collection equipment, inadequate transport over poor roads and long distances, and poor communications, may prevent or limit the selection of suitable parent trees and the subsequent collection and despatch of breeding materials from them.

This is especially true for materials which require precise timing of collection, rapidity of collection and despatch, or the use of sophisticated techniques and equipment. In addition many countries do not possess sufficient qualified staff with the required training and expertise to carry out the work involved, especially if little similar work has been carried out locally with the tree species concerned.

Poor communications and transport facilities between donor and recipient organiations may severely limit the amount and type of plant materials which can be exchanged. Additional delays during transfer can also be caused by inefficient handling or excessive administration procedures at either the port of despatch or the port of entry. These can often be minimized for consignments sent by a direct route by detailed planning and supervision of the transport arrangements at either end of the journey. Unfortunately such supervision is not possible at intermediate places for consignments sent by an indirect route.

Physical constraints to exchanges of plant material may also operate in the recipient country where the facilities and staff available may dictate the types of materials which can be handled and utilized in a breeding programme. In addition the lack of suitable quarantine facilities may prevent or limit the amounts or nature of imports permitted.

Legal constraints

Since 1881, when the 1st International Convention on measures to be taken against *Phylloxera vastatrix* was signed, there have been many agreements made in attempts to limit the international spread of plant disease organisms. These culminated in the International Plant Protection Convention (IPPC) held by FAO in 1951, which is presently contracted into by at least 79 member countries (Chock, 1979). The articles of this convention state that quarantine measures must be based on sound biological grounds against pests which pose a definite risk and which are unlikely to be distributed naturally. They specifically exclude measures aimed at the furtherance of trade or other objectives.

Eight regional plant protection organizations have been set up under the IPCC, which have drawn up plant health regulations appropriate to their regions (Smith, 1979). Individual countries, or subregions, can then formulate their own regulations within these frameworks (Phillips, 1979; Rohwer, 1979; Morschel, 1979). These usually lay down stringent regulations against specified dangerous organisms, and less stringent measures against other less dangerous organisms.

Regulations controlling the movements of forest tree materials between regions, or between countries in some cases, usually contain a prohibition of plants with soil and require all vegetative material to be introduced through quarantine stations. Tree seeds can usually be imported without difficulty, following inspections and treatments with insecticide and fungicide. Some countries do, however, impose more stringent restrictions against specified organisms or against imports from certain parts of the world. Viruses can often be seed-borne but, as yet, are rarely the subject of stringent regulations. Importations of pollen and tissue cultures are usually unrestricted although they can be vectors of some viruses and other sub-microscopic disease organisms (Cooper, 1979; Henshaw, 1979).

Some countries also impose restrictions on the export of plant material, particularly of commercially valuable species, to protect their local trades. These regulations may, however, allow export of small quantities for research purposes.

Economic constraints

The amount and type of plant material which can be transferred obviously depends to a large extent on the costs of collection, transportation and handling during the transfer. These can be very low for materials which are in routine use but can be very high for special collections.

Actual payment by the recipient country can create many problems when currencies are not convertible and foreign currencies are in short supply. The problems of costing, and making foreign currency payments can, however, be avoided by exchanging materials. This requires both countries to have mutually acceptable needs and good cooperation and goodwill between individual researchers or research organizations.

CONCLUSIONS

The constraints listed above usually do not operate alone but interact in many ways with one or more acting as a major limiting factor in each particular case. In general transfers of materials with a broad genetic base, such as seed from wild populations, do not suffer many constraints except for those species with biological limitations and which encounter legal restrictions for plant health or other reasons. More select materials with a narrower genetic base, such as special seed and pollen, are affected similarly but also are likely to require more careful collection and handling. On the other hand vegetative clonal materials, which have a very narrow genetic base, require much more rapid and careful handling and are usually subject to many plant health restrictions. They may, however, be the only material available from immature non-flowering trees.

The tree-breeder must therefore make a compromise between his requirements for the best material for his particular purposes, the availability of the various types of material, the legal restrictions relating to movements of plant materials, and the practical limitations of carrying out the transfer.

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O INSTITUTO DE PESQUISAS E ESTUDOS FLORESTAIS.

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. Instituto de Pesquisas e Estudos Florestais - IPEF

Brasil.

Resumo

Neste trabalho é apresentado, de maneira sucinta, dados sobre a estrutura e organização do IPEF, bem como a filosofia que vem norteando o desenvolvimento do seu programa de cooperação entre a Universidade de São Paulo, através do Departamento de Silvicultura - ESALQ e empresas florestais brasileiras.

É também apresentada em linhas gerais, a programação técnica que vem sendo desenvolvida, bem como os resultados já alcançados e metas a serem atingidas.

Summary

This paper presents a brief review about structure and organization of the Institute of Forest Research and Studies - IPEF - wich is an integration of São Paulo University through the Superior School of Agriculture "Luiz de Queiroz" and brazilian forest enterprises.

It also presents the general working lines of the Institute, some results obtained and goals to be achieved in the near future.

1. INTRODUÇÃO

A criação do IPEF data, aproximadamente, do grande desenvolvimento do setor florestal brasileiro, a partir dos Incentivos Fiscais concedidos pelo governo, para o reflorestamento, em 1966.

Até esta fase o programa florestal brasileiro era bastante modesto, e as estimativas mostram que havia em 1967 apenas 6.000 ha de florestas implantadas. Hoje estima-se que o Brasil possui cerca de 3.000.000 ha reflorestados.

O desconhecimento, na época, dos princípios básicos de genética e da possibilidade de utilização dos mesmos em florestas, levaram a um resultado insatisfatório, quando não ao fracasso, as plantações que vinham sendo feitas.

Desse modo, a falta de conhecimentos básicos, aliada à necessidade de resultados aplicados, fez com que algumas indústrias florestais firmassem, em 1968, um convênio com a Universidade de São Paulo, através do Departamento de Silvicultura da Escola Superior de Agricultura "Luiz de Queiroz", para o desenvolvimento de um programa de pesquisa florestal.

Hoje o IPEF conta com 29 empresas associadas, cuja área de atuação compreende as seguintes regiões: (Figura 1)

Região Sul - Estados do Rio Grande do Sul; Santa Catarina e Paraná.

Região Centro-Sul - Estados de São Paulo e Rio de Janeiro.

Região Centro-Oeste - Estados de Minas Gerais e Mato Grosso do Sul

Região Leste - Estados do Espírito Santo e Bahia

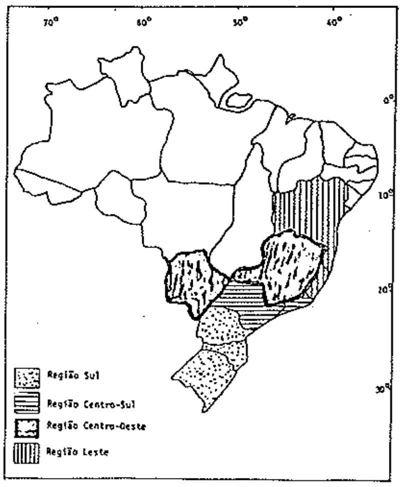

Figura 1. Área de atuação do IPEF

O suporte financeiro para o desenvolvimento dos trabalhos é proporcionado por contribuições mensais das empresas associadas, hoje, cerca de US$ 600 (seiscentos dolares). Além disso o IPEF pode contar com recursos adicionais provenientes de convênios firmados com instituições públicas ou empresas privadas.

O suporte técnico-científico ao desenvolvimento do programa é proporcionado pelo Departamento de Silvicultura da Escola Superior de Agricultura "Luiz de Queiroz", que conta com 20 professores atuando nas diferentes áreas da ciência florestal. Além disso o IPEF possui corpo técnico próprio que hoje conta com 12 engenheiros florestais.

2. ESTRUTURA ORGANIZACIONAL

A estrutura organizacional do IPEF pode ser visualizada no organograma apresentado a seguir (Figura 2).

O órgão máximo do IPEF é o Conselho de Administração, constituído por 9 (nove) representantes de empresas, eleitos em Assembléia Geral, e por 1 (um) membro nato que é o chefe do Departamento de Silvicultura - ESALQ-USP. O presidente do IPEF é eleito, anualmente, entre os membros do Conselho de Administração.

A Diretoria do IPEF é composta por 3 elementos, Diretor Científico (membro nato, Chefe do Departamento de Silvicultura), Diretor Administrativo e Diretor Técnico, estes 2 últimos designados pelo pelo Conselho de Administração.

A integração do Departamento de Silvicultura - ESALQ-USP, à estrutura, é feita através da Diretoria Científica.

Logo a seguir, temos as coordenadorias Técnica e Administrativa, com seus respectivos setores, que têm sob sua responsabilidade a elaboração dos programas anuais, e o estabelecimento de medidas que permitam sua perfeita execução e acompanhamento.

3. FILOSOFIA DE TRABALHO

O trabalho que vem sendo desenvolvido pelo IPEF, está baseado numa filosofia de Integração entre a Universidade, o IPEF e as Empresas, e que é caracterizado por uma ação conjunta.

Para o desenvolvimento desta ação conjunta, tem-se de um lado o potencial técnico representado pela Universidade, pelo corpo técnico próprio do IPEF e pelo corpo técnico das empresas associadas (350 engenheiros); de outro lado há que se ter uma definição clara dos objetivos, por parte da Direção da empresa, possibilitando, desta forma, a definição de prioridades a serem atacadas.

Na Figura 3, pode ser melhor visualizada, através de um fluxograma, a filosofia de integração que vem sendo colocada em prática.

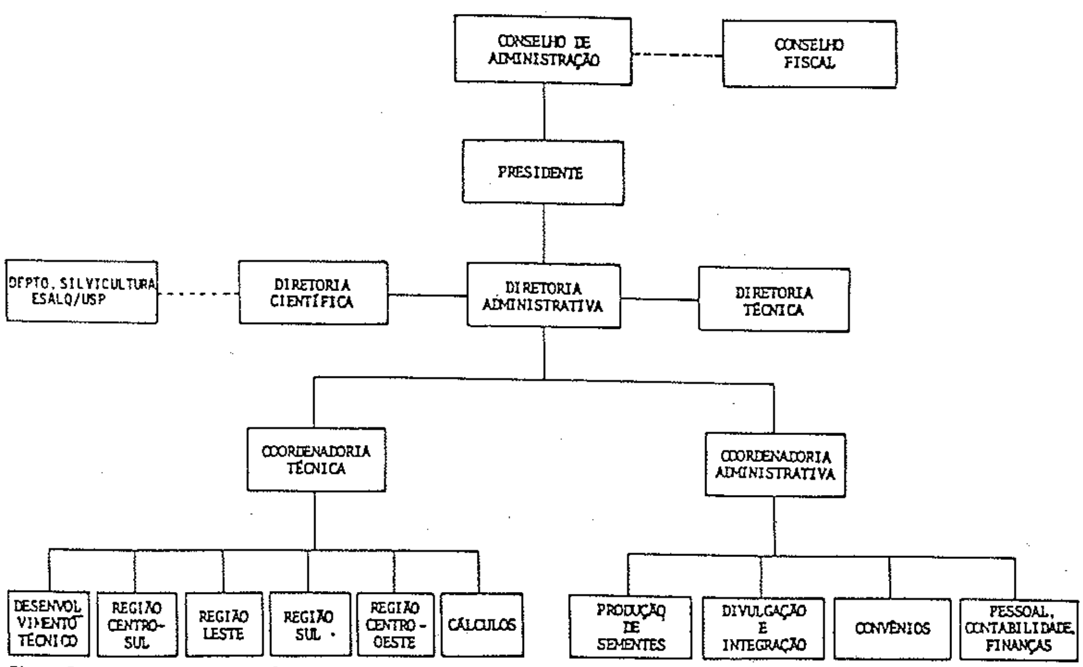

Figura 2. Organograma do IPEF

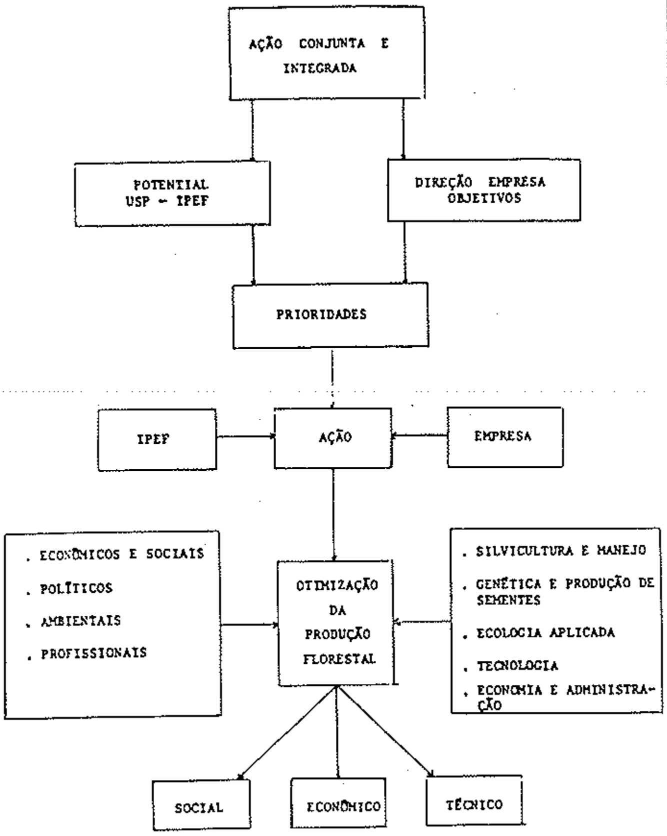

Figura 3. Filosofia da integração Universidade x IPEF x Empresas

4. ESTRATÉGIA DE AÇÃO A NÍVEL DE EMPRESA

Para atendimento das necessidades das empresas e acompanhamento da experimentação o IPEF desenvolve uma série de atividades, quais sejam:

- Realização de visitas às empresas: visitas periódicas marcadas com antecedência, que visam uma avaliação da experimentação no campo e discussão de resultados.

- Reuniões Conjuntas ou Regionais - reuniões técnicas para apresentação de resultados que podem, se conjuntas, enfocar aspectos gerais da programação, ou regionais, se dirigirem-se a uma dada região ecológica.

- Reuniões técnicas específicas: realizadas individualmente com cada empresa, para discussão de problemas específicas.

- Realização de Cursos e Seminários: visam basicamente promover uma reciclagem do corpo técnico das empresas associadas.

- Distribuição de publicações: sem dúvida alguma, as publicações do IPEF, são um dos mais importantes meios de atendimento de que dispomos.

  Visam fornecer, às associadas, da maneira mais rápida possível, as informações obtidas na experimentação florestal. Para isto, o IPEF edita as seguintes publicações:

  - IPEF - Revista de Divulgação Científica: publicação semestral.- circulação ampla.
  - Série Técnica; publicação de periodicidade semestral, destinada a monografias, material para cursos, etc..- circulação ampla.
  - Circular Técnica: publicação semanal, para divulgação de informações gerais - circulação ampla.
  - Boletim Informativo; publicação trimestral, para divulgação de resultados preliminares - circulação restrita às empresas associadas.
  - IPEF - Biblioteca: boletim bibliográfico mensal, onde são relacionados os documentos adquiridos pela Biblioteca do IPEF - circulação ampla.

5. PROGRAMAÇÃO DE PESQUISA

A amplitude do trabalho que o IPEF vem desenvolvendo com suas empresas associadas, com reflexos significativos na evolução da silvicultura nacional, fez com que se fizesse necessário o estabelecimento de Linhas Básicas de Pesquisas, de modo a nortear a continuidade desse trabalho, de maneira objetiva, a curto, médio e longo prazo.

As linhas básicas de pesquisas foram estabelecidas pela equipe técnica do IPEF com o apoio dos docentes do Departamento de Silvicultura. Tendo em vista os interêsses das empresas, em reuniões regionais específicas com as mesmas, foram definidas as prioridades a serem atacadas, a nível regional e por empresa.

O enfoque principal do programa está alicerçado no uso múltiplo da floresta, que hoje se torna imperioso e onde, além da utilização tradicional para celulose, carvão, chapas e serraria, deve-se destacar o uso da biomassa florestal como fonte de energia.

O objetivo básico da programação de pesquisa, está alicerçado na melhoria do rendimento e qualidade das florestas plantadas para usos específicos ou múltiplos.

Na Figura 4 é apresentado, de maneira esquemática, o enfoque da atividade de pesquisa no IPEF.

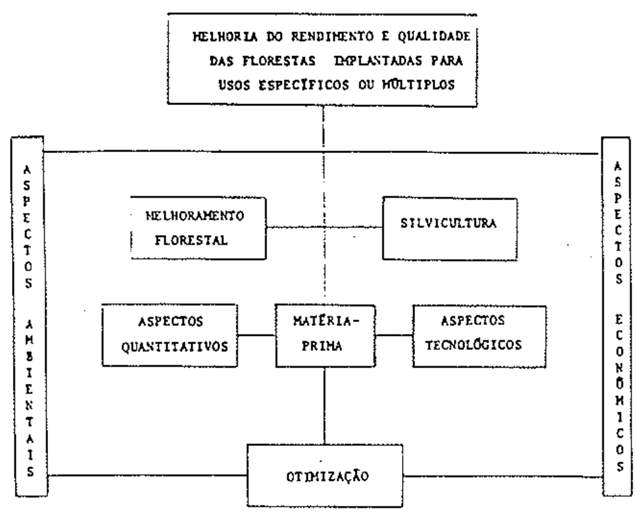

Figura 4. A filosofia da atividade de pesquisas do IPEF

Neste enfoque são as seguintes as áreas básicas de pesquisa do IPEF.

1. MELHORAMENTO FLORESTAL E PRODUÇÃO DE SEMENTES
   - Melhoramento Florestal
   - Produção de Sementes
   - Propagação Vegetativa

2. SILVICULTURA
   - Solos e Nutrição de Plantas
   - Implantação Florestal
   - Manejo Florestal
   - Exploração Florestal

3. PROTEÇÃO FLORESTAL
   - Patologia Florestal
   - Entomologia Florestal
   - Incendios Florestais

4. ECOLOGIA APLICADA
   - Ecologia Florestal
   - Hidrologia
   - Fauna e Áreas Silvestres

5. TECNOLOGIA

- Celulose
- Energia
- Serraria
- Lâminas e Painéis

6. ECONOMIA E ADMINISTRAÇÃO

- Economia Florestal
- Biometria

Para o desenvolvimento do programa de pesquisas, o IPEF- Departamento de Silvicultura, fornece todo o planejamento e orientação técnica, sendo as empresas responsáveis pela instalação e condução d experimentação. Também cabe ao IPEF a análise e divulgação, juntamente com representantes da empresa, dos resultados alcançados.

No quadro a seguir é apresentado, por área de pesquisa e por região, o número de projetos em andamento.

	Melhoramento	Silvicultura	Tecnologia	Ecologia Aplicada	Total
Região Sul	87	24	4	1	116
Região Centro-Sul	105	71	4	8	188
Região Centro-Oeste	50	42	5	5	102
Região Leste	41	40	2	4	87
Total	283	177	15	18	493

6. RESULTADOS ALCANÇADOS

- Aumento da produtividade média das florestas plantadas de suas associadas em aproximadamente 100% em 10 anos.
- Produção e implementação do uso de sementes melhoradas a nível nacional.
- Utilização da fertilização mineral para aproveitamento de solos pobres.
- Estabelecimento e desenvolvimento de técnicas utilizadas para propagação vegetativa (enxertia, estaquia, micropropagação, etc.).
- Formação de consciência técnica construtiva e conjunta dentro do setor.
- Implementação da intregração floresta-indústria a nível científico, profissional e empresarial.
- Formação e disponibilidade às associadas de acervo bibliográfico de nível internacional.
- Estabelecimento de parâmetros técnicos visando a adequação damatéria-prima florestal aos objetivos industriais específicos.
- Determinação, entre as associadas, de padrões de procedimento técnico de eficiência comprovada para as práticas silviculturais básicas.

7. METAS E OBJETIVOS A SEREM ATINGIDOS

- Aumentar em 25% a produtividade média florestal alcançada em 1.979 entre as associadas;

Espécies comerciais básicas	Em 1970 (st/ha/ano)*	Em 1979 (st/ha/ano)*	Em 1985 (st/ha/ano)*
Eucalyptus spp	20	40	50
Pinus spp	18	35	43

* estéreos de madeira com casca/ha/ano

- Aprimoramento e adequação da qualidade da madeira visando o aumento quantitativo e qualitativo do rendimento industrial.
- Utilização de sementes melhoradas de pomares formados com árvores selecionadas e testadas para fins industriais específicos.
- Estabelecimento de programas integrados para proteção biológica das florestas plantadas através do manejo e utilização reacional da flora e fauna nativas.
- Utilização produtiva de áreas marginalizadas das empresas florestais.
- Introdução de técnicas de manejo de florestas naturais e de reflorestamento com essências nativas em condições favoráveis.
- Estabelecimento de modelos econômicos para acompanhar e avaliar a atividade florestal em todas as suas fases.
- Introdução e desenvolvimento de sistemas de produção e exploração florestal com elevação dos índices de mecanização.
- Desenvolvimento de alternativas industriais visando a utilização integrada dos produtos florestais.
- Implementação e elevação do padrão social e econômico do homem fixado ao meio rural e dependente da atividade florestal.

8. EMPRESAS ASSOCIADAS

- Alplan S.A. Ind. e Com de Chapas e de Madeiras Aglomeradas
- Aracruz Florestal S.A.
- Braskraft S.A. - Florestal e Industrial
- Champion Papel e Celulose S.A.
- Cia. Agrícola Florestal Santa Bárbara
- Cia. Agro Florestal Monte Alegre
- Cia. Ferro Brasileiro
- Cia. Suzano de Papel e Celulose
- Duratex S.A. - Indústria e Comércio
- Empreendimentos Florestais S.A. - FLONIBRA
- Eucatex S.A. Indústria e Comércio
- Florestal Acesita S.A.
- Florestas Rio Doce S.A.
- Guatapará Florestal S.A. - Planej. e Reflorestamento
- Indústrias de Papel Simão S.A.
- Indústrias Klabin do Paraná de Celulose S.A.
- Itapeva Florestal Ltda.
- Manasa - Madeireira Nacional S.A.
- Mobasa - Modo-Battistella Reflorestamento S.A.
- Papel e Celulose Catarinense S.A.
- Petróleo Brasileiro S.A. - PETROBRÁS-GEAT
- Plantar - Planejamento, Téc. e Adm. de Reflorestamento
- Rigesa - Celulose, Papel e Embalagens Ltda.
- Reflora - Reflorestadora e Agrícola Ltda.
- Reflorestadora Sacramento "RESA" Ltda.
- Riocell - Rio Grande - Cia. de Celulose do Sul
- Ripasa S.A. Celulose e Papel
- Seiva - Florestas e Indústrias
- Torras Brasil S.A. Ind. e Com. de Celulose

O VALOR DA IMPORTAÇÃO DE RECURSOS GENÉTICOS SELECIONADOS EM MELHORAMENTO GENÉTICO FLORESTAL DE ESPÉCIES EXÓTICAS.

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. Forest Research Centre, Salisbury, Zimbabwe.
N.P. Denison
. Safi LTD, Sabie, Republic Of South Africa.

Resumo

O intercâmbio de recursos genéticos selecionados tem sido prática normal entre vários países, há já alguns anos, e é um desenvolvimento natural do intercâmbio inicial de sementes para testes com espécies e procedências. A experiência obtida com essas transferências, um número de exemplos específicos e o conhecimento de suas bases gerais, seriam benéficos aos países que ainda se encontram nos estágios iniciais do melhoramento. A semente é o meio mais antigo, e provavelmente ainda o melhor, para transferência de recursos genéticos mas outros meios - garfos, estacas enraizadas, pólen e cultura de tecidos, também terão seu papel e poderão ser melhores para objetivos específicos. A importação de material genético selecionado pode ser benéfica ao país receptor desde que:

1. A procedência seja adequada;

2. Os ambientes selecionados no país doador e receptor sejam semelhantes;

3. Os critérios de seleção empregados no doador e receptor sejam os mesmos;

4. O controle fitossanitário e quarentena sejam efetivos e;

5. Registros detalhados de todas as transferências sejam mantidos.

Há um potencial considerável para a cooperação internacional, neste campo de trabalho, que poderia beneficiar a indústria florestal como um todo.

THE VALUE OF IMPORTING SELECT GENETIC RESOURCES IN EXOTIC TREE IMPROVEMENT.

Summary

Exchanges of select genetic resources have been made between various countries over a period of many years and are a natural development from earlier exchanges of seed for species and provenance trials. Experience has been gained from these transfers and a number of specific lessons - and general principles - have been learnt that could be of benefit to countries that are still in the early stages of tree improvement. Seed is the oldest, and probably still the best, medium for transferring genetic resources but the other media - scions, cuttings, pollen, and cultures - also have a role and may be best for particular purposes. The importation of select genetic material can be of great benefit to the recipient country provided that (1) the provenance is right, (2) the selection environments of donor and recipient countries are similar, (3) the selection criteria employed by donor and recipient are the same, (4) phytosanitary and quarantine procedures are effective, and (5) detailed records are maintained of all transfers. There is considerable potential for international cooperation in this field, which would benefit the forest industry as a whole.

Introduction

Many countries, particularly those in the southern hemisphere, are totally, or to a large degree, dependent on exotic forest trees for their timber resources. Over a long period of tree seed introductions, testing, and exchange, large forestry industries have evolved which today form an integral part of the economy of many of these countries. More recently, the emphasis has been on the exchange of select genetic material with the objective of making rapid gains in properties of economic emportance while, at the same time, ensuring a broad genetic base of desirable genotypes for advanced breeding. The importation or exchange of tree breeders' selected material must, therefore, be seen as a natural progression from species screening trials, to provenance trials, and finally to the establishment of breeding programmes with the best material of the best provenances of the best species. Usually only small samples of the total genetic resources of a species are included in introductions of seed for species and provenance trials, let alone a broad sample of the optimal sources that would form a good base for initial breeding, and, while it is a well-known principle that tree breeders should look to their local stands, whether native or exotic, to provide the majority of the selections for their breeding programmes (unless provenance is clearly suboptimal), they may also need to look elsewhere for additional material to supplement what they have, and for genetic combinations that are not available to them from within their own resources. They should consider acquiring new material from both the exotic and the native ranges of their species.

The Republic of South Africa (R.S.A.) and Zimbabwe (formerly Rhodesia) have been active in the importation and exchange of select genetic material, both between themselves and with countries further afield, for some 20 years and this paper sets out to examine this approach to tree improvement in the light of the experience that has been gained by the two countries.

General Considerations

International cooperation

Tree improvement programmes of certain countries could benefit through international cooperation in the exchange of select genetic resources. This would be of particular advantage to countries that have recently embarked on tree improvement programmes. Also, many countries lack professional expertise in the field of tree improvement and could be expected to make more rapid advances through the introduction of select material of desired species and provenances from more advanced and sophisticated programmes. This is particularly relevant today in a world in which the demand for wood-based products will continue to rise as populations increase and the standard of living of developing nations continues to improve. Wood, as a renewable resource, will always be in demand and every effort to improve quality and productivity should receive international support.

So far as is known in forest tree breeding, the questions of breeders' rights and the registration of the products of breeding have not yet received serious international attention. There has been considerable registration of poplar clones in Europe, although this includes many spontaneous hybrids and is not confined to bred cultivars (see FAO 1958), but it is doubtful whether the breeding of any other trees has reached the stage of patented lines.

The general approach to the products of tree breeding among the member countries of SARCCUS (Southern African Regional Commission for the Conservation and Utilization of the Soil) has been to encourage the free interchange of material between breeders and territories and no restrictions are placed on the use of clones or the development of seed sources. Within the SARCCUS region (South Africa, Zimbabwe, Malaŵi, Swaziland, Lesotho, Botswana, and Namibia) tree breeding is conducted almost entirely by State research organizations; the only other involvement is by one private forestry company (South African Forest Investments) and by the Wattle Research Institute (University of Natal), both of which collaborate fully with the State organizations. Breeders' rights are unlikely, therefore, to become an important issue in southern Africa but, if a line of high value were to be produced, the field would undoubtedly be left clear to the originator to develop it for commercial use. The situation is probably not very different in other countries and it is to be hoped that the high level of cooperation that has already been established between tree breeders will be maintained.

Provenance

The initiation of a programme to import or to exchange select breeding material presupposes some knowledge on the part of the recipient of what provenances are best for his conditions. International provenance trials, such as those initiated by the C.F.I.(Commonwealth Forestry Institute, Oxford), and research results compiled by I.U.F.R.O. and other organizations could be of great value in guiding the would-be importer in provenance selection. This is not to suggest that formal provenance testing, desirable though it may be, is an essential prerequisite to the importation of select genetic material, but the recipient must make his acquisitions with discretion. In the R.S.A. and Zimbabwe it is fortuitous that many of the mature, unimproved, exotic plantations of the major tree species originated from provenances well suited to the conditions under which they are now growing; the trees are healthy and well adapted, and have shown good growth and reasonable form. Credit for this good fortune is largely due to a few pioneer foresters who, in the formative years of forestry in the R.S.A., endeavoured to introduce seed from regions in which the climates closely matched those of southern Africa.

If the importer wishes to obtain material directly from the species' natural range, it would be advisable to have a good knowledge of what localities to import from, particularly if he were dealing with a wide-ranging and variable species. If, on the other hand, he wishes to obtain material of a species grown successfully as an exotic in a country with a similar climate to that of his own, he could do so with relative safety. A good example of this is Brazil which, in recent years, has imported many thousands of kilograms of Eucalyptus seed from southern Africa. While testing the full range of provenances from Australia and Tasmania, the Brazilians have been on relatively safe ground in obtaining commercial seed requirements from southern Africa for their large forestry expansion programmes. In the long term they will have laid the foundations for a broad genetic base from the wide-ranging provenance tests now in progress.

The would-be importer must always be prepared to use the knowledge gained from the experiences of other countries through personal contact or through the literature. For example, the first introduction into Zimbabwe of the desirable, southern variant of Pinus oocarpa Schiede was in the form of scion material from select trees in South Africa; this import in 1962 was followed several years later by an import of wind-pollinated seed of the same select trees, later still by non-select seed from central America for a species trial, and, in recent years, by wider-ranging seed collections for provenance testing. Even though southern P.oocarpa was introduced into Zimbabwe in an unconventional way, it was reasonably safe to begin with select genetic material because of the species' already proven worth in a nearby country and because of the climatic similarities between its native range and the parts of Zimbabwe where it was to be grown.

Selection environment

The next consideration is that the selection environments of the donor and recipient countries do not differ too widely, especially if the recipient wishes to import material of first-generation selections that are not yet proven genotypes. An example of the problems that can arise from the transfer of material to a region in which the environment exercises different pressures from those prevailing in the donor country occurred when the wind-pollinated progeny of a number of P.patula Schiede & Deppe selections from high altitudes in Zimbabwe were included in progeny tests at low altitudes in the Eastern Transvaal, R.S.A. The Zimbabwean families fared poorly in these tests compared with the locally selected, Eastern Transvaal families, even though records indicate that all were almost certainly of the same original provenance. It was concluded that as a result of differing selection pressures, the P.patula selections made in the Eastern Transvaal were better adapted to the hotter and harsher conditions of that region (Denison 1973). It was also suggested (Barnes & Mullin, 1976) that P.patula selected in the hail-prone areas of the Eastern Transvaal were more resistant to attack by Diplodia pinea (Desm.) Kickx following hail damage than were those selections made in the eastern border mountains of Zimbabwe, where hail is not a problem. Hail may be regarded as a special feature within the southern African environment that genotypes need to "experience" before they can be effectively selected.

On the other hand, the inherent qualities of a good genotype selected in one environment may still be manifested in its progeny in a completely different environment. As an example, wind-pollinated progeny of a P.taeda L. select tree (7-56 from Williamsburg County at about latitude 33°30'N in coastal South Carolina) have performed well in a mountainous region of Zimbabwe at latitude 18°45'S and an altitude of 1 645 m, and have themselves yielded a select tree for the breeding programme in the latter country. There are indications from early progeny tests that the family 7-56 will also prove a winner in the Eastern Transvaal of the R.S.A. The provenance performance of P.taeda from South Carolina has been below average in trials in Zimbabwe and South Africa but, in the examples cited here, the good adaptability of 7-56 has been demonstrated in spite of the handicaps of inferior provenance and markedly different environment. Such trees are probably rare but the would-be importer should desirably be aware of their existence. Several open-pollinated families of P.elliottii Engelm. and P.taeda selected in South Africa are performing well in the tree breeding programmes of a number of organizations in the United States, which shows that even the country of natural origin may obtain valuable new genetic combinations of its own species after they have gone through a few generations in a foreign country.

Selection criteria

A question that might all too easily be overlooked is whether donor and recipient employ similar selection criteria. Probably every tree breeder demands vigour as a major criterion for selection, but what is the principal measure of vigour? Superiority of height? Superiority of diameter? Superiority of volume? Growth efficiency? And how much weight is attached to each of these criteria? Furthermore, at what age are the selections assessed and accepted into the breeding programme? A small superiority of height or diameter would carry far less weight in a young tree than it would in an old tree. Very young selections may develop serious defects of stem or crown as they grow older, while the large diameters of mature trees may conceal sinuosity that would have been visible in younger trees and may, perhaps, have led to their rejection.

Wood properties could also be important criteria for selection, and are certainly so in the case of P.caribaea Morelet in South Africa, where the tree performs exceptionally well in Zululand but produces wood that falls below the desired standard for density. Since wood density is highly heritable, one would aim to introduce material from high-density genotypes of this species. P.elliottii, on the other hand, produces a very dense wood under similar Zululand coastal conditions, yet at higher altitudes in the Eastern Transvaal the wood is much lighter. Clearly environmental factors exercise a major effect in this case and, unless the selection criteria are suitably qualified, they could mislead the importer.

Phytosanitary procedures and quarantine

Phytosanitary regulations will vary from place to place but most countries have enacted some legislation aimed at preventing the inadvertent importation of economically damaging plant pests and diseases. The tree breeder should comply with local regulations, not simply because the law requires him to do so, but because it is in his interests: indeed, he should be active in helping to frame the regulations.

Select genetic material may be imported in the form of seed or pollen, which may require fumigation but not necessarily quarantine storage, or it may arrive as vegetative material in the form of scions or cuttings, which may require fumigation and will almost certainly have to be raised in quarantine. A further possibility, and one that could become important in the future, is that the imports may be in the form of cultures of organs, tissues, or cells; fumigation will probably not be necessary if the cultures are produced under sterile laboratory conditions but it may be prudent to let them develop in quarantine.

Phytosanitary and quarantine procedures must be effective. The main source of danger to the importer is the native range of the species he wishes to import, because this region is also the natural habitat of the species' principal insect predators and fungal diseases. If vegetative material is obtained from there, the greatest care must be exercised and it may be necessary to extend the quarantine period considerably to ensure that no potentially dangerous organism is allowed to escape. The failure to detect the pine woolly aphid, Pineus pini (L), when it was introduced into Zimbabwe on imported scion material (see Barnes et al.,1976) was undoubtedly due to the very short period of only eight weeks that the material remained in quarantine before being removed for field planting; a longer quarantine period would have permitted the aphid to develop and be identified as a new pest, and to be destroyed before it escaped into the country's pine plantations.

The quarantine regulations governing the importation of Pinus scions into the R.S.A. are strict. This is desirable, since the introduction of a dangerous plant disease or insect pest into the country, with the large, monoculture-type of forestry that is practised, could be catastrophic. The donor must certify that the parent material is free of disease and must provide a phytosanitary certificate stating that the material was inspected and treated with a broad spectrum fungicide and insecticide prior to despatch. The material is again inspected on arrival, then steeped for at least ten minutes in a fungicidal and insecticidal dip before being grafted. Grafting takes place under controlled conditions at a quarantine station, where the grafts are inspected and sprayed at regular intervals. The successful grafts are monitored by qualified personnel at the quarantine station for a minimum of two years before fresh scions from the grown-out material will be released for multiplication.

Records

Detailed records should be kept by donor and recipient of all transfers of select genetic resources. The donor should have a complete record of all material he has exported and when it went to the recipient. The recipient, similarly should maintain records of what has been imported, where it has come from, and the parentage, pedigree, and the test status of the new material; he should also keep the donor informed of the performance of the material. In recent years, large quantities of improved orchard grades of seed have been imported into Brazil from the R.S.A.; unless the grower realizes that this improved seed originates from relatively few, open-pollinated genotypes, where relatedness has occurred through cross pollination in an isolated orchard environment, he runs the risk of retrogression through inbreeding by making his own selections from within the resultant plantations.

Method of Importing Select Genetic Material

As noted in the foregoing section, genetic material may be imported in the form of seed, pollen, scions, cuttings, or cultures of organs, tissues, or cells. Each of these is examined and discussed below.

Seed

Seed is by far the easiest genetic material to import and, once it has been fumigated, it is unlikely to require raising in quarantine except in very unusual circumstances. The transfer of seed is of value to donor and recipient alike: the former has the product of his breeding work tested in a new environment, and the latter is able to increase his selection populations, to assess the performances of the imported families in relation to his own, and to make selections from among those that demonstrate adaptability to the new environment (see Nikles, 1978).

Seed of select genetic material may be open pollinated, from ortets or seed orchard ramets, or it may have been controlled pollinated by pollen mix to produce polycross seed, or by single pollens for two-parent crosses. The most valuable categories of seed for the recipient would be open-pollinated collections from ortets and controlled-pollinated crosses in which both parents are known. Select ortets are usually well separated from each other and there is unlikely to be any paternal relationship between the half-sib families of one tree and those of another, as there would be in the case of half-sib families of seed orchard ramets. Controlled-pollinated, two-parent crosses may come from a wide range of the donor's material (used as females), but it is likely that only a small number of males will have contributed to the crosses and many of the families will be related paternally. Inspite of this limitation, however, the recipient will have his breeding population enriched and he will have the opportunity of making a useful number of unrelated selections from the most adaptable families.

Pollen

No imports or exchanges of pollen have been made within the southern African region but they have taken place elsewhere, e.g. in the Australasian region (D.G.Nikles, personal communication). The barrier to progress in this field in southern Africa has undoubtedly been the belief that there is no method of effective fumigation that will not also destroy the pollen, but, quite clearly, the whole question needs to be re-examined in the light of developments elsewhere.

The principal advantage of pollen is that only small amounts are needed, which makes it possible to import from a large number of parent trees at little cost and without putting undue pressures on available storage facilities. There will, however, be limits to the effectiveness of pollen imports. Some species in southern Africa, e.g., P.patula, are difficult to pollinate artificially, especially when the strobili have to be bagged for controlled pollinations; many strobili die shortly after pollination, others develop into conelets and then abort, and the majority, by far, of the cones that do mature contain very little seed. There is, in addition, the limitation that pollen imports will be used on the recipient's local material and the resultant progeny will be maternally related to what he already has. In the case of seed imports, on the other hand, the recipient's breeding populations will be enriched and enlarged by completely unrelated material.

Scions

Exchanges of scion material between countries in southern and east Africa have been made periodically for the last 20 years, and some of these countries have also imported scions from further afield, e.g. from Australia and the south-eastern United States. Scion imports are appropriate in cases where there is a deficiency of locally selected material of a suitable provenance, and the new material does not appear to require progeny testing first (Nikles, 1978). For example, a considerable number of second-generation selections of P.patula, from a form that appears to have become adapted to the warmer conditions of lower altitudes, have been imported into Zimbabwe from South Africa for the development of a low-altitude form in the former country. The donor may also benefit from the export of his material through the medium of scions: for example, the outbreak of Pineus pini in Zimbabwe (Barnes et al.,1976) has made possible the testing of a large number of imported South African clones of all species for resistance to the aphid, so that tree breeders in the latter country will be in a position to know which families to favour in their breeding programmes well in advance of any possible infestation of South African plantations.

Scion material is bulky and expensive to collect, package, and ship, and its limited life calls for special measures for dispatch by air, and for speedy handling and grafting by the recipient. It provides a good medium for acquiring resources of known genetic identity but, because of the limitations, the importer should always ask himself whether his particular needs might not be met more appropriately through acquisitions of seed.

The R.S.A. (southern hemisphere) has had good experience over the past five years in the introduction of scions of P.elliottii and P.taeda from the south-eastern United States (northern hemisphere). The following are recommended guidelines: the donor must ensure that the scions are dormant, are carefully selected and fresh, and the foliage dry when collected and sealed in plastic bags. The material should be kept cool at all stages and stored by the donor for about two months at about 1-3°C before shipment. Collections in the south-eastern United States could take place from about January through to mid-February so that by the time the material arrives in South Africa, the weather has begun to cool down. Before shipment, quarantine regulations stipulate that the scions be treated with a broad spectrum fungicide and insecticide. Before re-sealing and packing for shipment, free moisture must be removed from the scions, because experience has shown that material transferred in a moist condition will fail. The scions are air-freighted to the R.S.A. in sealed cold-boxes and, on arrival, are grafted as soon as possible. Provided the material has been well selected and handled, good results may be expected. There appears to be considerable clonal variation in percentage survival but there has been no noticeable disruption of seasonal growth rhythm in spite of the transfer of the material from one season to another across the equator.

Cuttings

The seed of many poplars (Populus spp.) is short-lived and the most common method of propagating these trees is by cuttings. The importation of cuttings does not differ from the importation of scions except that cuttings will probably withstand long-distance travel better than scions. Quarantine requirements for cuttings will generally be the same as for scions but, if rooted cuttings are to be imported, there may be additional phytosanitary regulations governing the removal of all traces of soil from the roots before any imports will be permitted.

The importation of poplar cuttings presupposes an intention by the importer to develop new clones that are adaptable to his environmental conditions rather than simply to bulk up material for commercial planting. The recipient should attempt to procure an adequate number of male and female clones for this purpose so that a range of new combinations can be produced to avoid a major danger in poplar growing - that of single-clone monoculture, which carries a high risk of devastating disease. This danger has led to the importation into southern Africa in recent years of cuttings of several new clones of Populus deltoides Bartr. that were developed in Australia from material raised from seed collections made in the southern limits of the species' range in Texas.

Cultures of organs, tissues, or cells

Cultures have probably not yet been developed anywhere to the stage where they can be used as media for transferring genetic resources between countries, but there are prospects that this will happen within the foreseeable future. Imports of cultures would have the same advantages as imports of scions - the acquisition of genotypes - but without the bulkiness of scion material. Cultures would almost certainly be produced under sterile laboratory conditions, so the need for quarantining would largely fall away, but it is likely that the recipient would require sophisticated facilities for handling the cultures. This would restrict exchanges of these media to those countries that have well-advanced breeding programmes.

General Conclusions

The free exchange of select genetic resources between countries, subject only to phytosanitary and quarantine regulations, has been an ongoing exercise in southern Africa for about twenty years, and probably in other regions of the world as well for longer or shorter periods. Transfers may be through the media of seed, pollen, vegetative material (scions, cuttings), or cultures, and the would-be importer should determine which of these would best meet his precise needs. Seed is probably the best general-purpose medium for importing new material, and it is also the one that has been in use the longest, but the other media have their place and any one of them may be the first choice for a specific purpose. The importer should be aware of the advantages and the limitations of each. The whole forestry industry stands to gain through international cooperation in the exchange of select genetic resources.

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ESTRATÉGIAS PARA MELHORAMENTO FLORESTAL E COOPERAÇÃO INTERNACIONAL.

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Resumo

Pequenos investimentos em programas de melhoramento têm amplos efeitos nas economias florestais. A tecnologia genética, todavia, requer prazo longo e desenvolvimento contínuo para obtenção de benefícios plenos. As estratégias para melhoramento devem ser escolhidas com hipóteses implantadas em relação a outras atividades relacionadas, se o melhoramento a longo prazo será o objetivo final. Um primeiro problema na seleção recorrente é aquele relativo aos ganhos máximos a curto prazo; uma seleção muito intensiva e uma paralela severa redução no tamanho da população para reprodução são inevitáveis e este fato limita a oportunidade para avanços futuros, particularmente quando ocorrem mudanças nos critérios ambientais ou sócio-econômicos. Uma expansão posterior da população para reprodução através do material base e a utilização de retrocruzamentos não são praticáveis tendo em vista o ciclo longo no melhoramento. A criação de populações múltiplas é uma solução para esse dilema. Quanto mais amplamente essas populações independentes para reprodução são dispersas, envolvendo uma amplitude de programas, mais diversas elas se tornarão em função da sua resposta a diferentes fatores ambientais e critérios de seleção. Essa diversidade pode ser utilizada para aumentar a variabilidade na população para reprodução e para quando houver necessidade de desenvolver programas para situações não previstas. Para prevenir que a composição da população se torne homogênea, alguma ação de orientação e organização será necessária. Dois tipos de organização seriam considerados: hierárquica e de populações múltiplas. Na forma hierárquica, as populações básicas suporte são centralizadas e a seleção inicial e desenvolvimento de variedades são conduzidas através da ação central. Essa forma de organização é mais adequada às culturas com ciclos reprodutivos curtos. O manejo simultâneo de populações múltiplas, visando um conjunto de objetivos, é mais apropriado para culturas florestais com uma ação coordenadora conduzindo o inventário, coleta e distribuição de materiais e orientações na seleção e condução de testes. Essa atividade pode ser possível a nível nacional, se há muitos programas separados dentro de um país. Quando o programa envolve um amplo gradiente de variações ambientais e o potencial para a manutenção das amplas diferenças existentes no material genético, a ação de coordenação internacional torna-se desejável.

TREE BREEDING STRATEGIES AND INTERNATIONAL COOPERATION.

Summary

Small investments in tree breeding programmes have large effects on forest economics. Genetic technology, however, requires long term and continued development for full benefits to be reaped and breeding strategies must be chosen with implicit assumptions about other agencies' activities if long term improvement is to be sustained. A primary problem in recurrent selection is that, for maximum short term gains, very intensive selection and a concomitant severe reduction of the breeding population size are inevitable and this limits the opportunity for future advance, particularly when shifts in the environmental or socio-economic criteria occur. A later expansion of the breeding population from base material and use of the back cross are not practicable for tree breeding because of the long breeding cycle. The creation of multiple populations is one solution to this dilemma. The more widely these independent breeding populations are spread over a range of programmes, the more diverse they will become as they respond to different environmental factors and selection criteria. This diversity can be used to increase variability in a breeding population and when breeding for new and unexpected situations but, in order to avoid making the constituent populations homogeneous, some monitoring agency is required. Two types of organization could be considered, hierarchical and multiple population. In the hierarchical form, the basic foundation populations are centralized and initial selection and development of varieties are conducted from the central agency. This form of organization is more suitable for crops with short breeding cycles. Management of multiple populations simultaneously for an agreed array of objectives is more appropriate for forest tree crops with a coordinating agency undertaking inventory, collection and distribution of materials and information and advice on selection and testing methods. This may be possible intra-nationally if there are many separate programmes within a country but, internationally, the scale of environmental variation and the potential for maintaining wide material differences make a coordinating agency at this level particularly desirable.

INTRODUCTION

It may appear incongruous to consider breeding strategies and international cooperation in the same context. It seems obvious at first that breeding strategies are chosen independently of international considerations and international cooperation is a political choice taken independently of breeding activities. What is not obvious is that breeding strategies require choices among kinds and sizes of breeding populations that depend to some extent on what the international community is doing to develop the species gene pools. It is also not obvious that breeding for the benefit of future generations requires certain kinds of international cooperation to fulfil national developmental objectives. In this paper we offer the contention that breeding strategies should in fact be chosen with implicit assumptions about other nations' activities and that breeding strategies affect the nature of international cooperation. The concept may be extended to individual, intra-national breeding programmes such as are operated by many research institutes, universities and commercial companies.

ASSUMPTIONS

We assume that genetic improvement will be made through tree breeding programmes in virtually all nations that have a forest generation programme. This assumption is based on the fact that it is technically feasible to breed improvements into trees by various methods and that very simple or highly intensive breeding can be designed with economic feasibility for forestry operations. Therefore, genetic technology exists for improving the economic productivity of land at a very fundamental level and at low cost and, if large land areas are appropriate for forestry uses, small investments in genetics will have large national economic effects.

Genetic technology, however, is not a "quick fix" but requires long term and continued development to reap its benefits. Cumulative improvement in particular requires genetic recombination and regeneration of new genotypes to meet changing environmental and economic demands. Continued attention to gene conservation is also needed to ensure future generation of genetic variations useful for future needs.

We assume that such longer term objectives are parts of the goals of tree breeding programmes and that the techniques of breeding used have short term economic goals as well.

B R E E D I N G · T A C T I C S

The techniques commonly used start with selecting species or populations that have a high average performance and that contain enough genetic variability for advanced selection. When selecting non-native species the risks of misjudging adaptability are considerably higher but, with testing, it can be successful. Similarly, the use of a particular population within species is more risky for non-native sources and again, testing can aid proper selection. This stage is often called provenance selection. Individuals within these better populations are chosen by chance or design and these may be vegetatively propagated for clonal forests or for seed orchards to produce seed-regenerated forests. These genotypes may also be used for seedling seed orchards. In any of these methods, the propagules produced for forest plantings represent the best mix of materials the breeder can generate with this set of genotypes. At this level, testing again may be an important aid in proper selection and is more important for non-native sources of the genotypes. By inter-crossing among selected individuals and allowing the better genes to recombine, new genetic variations are created and selection for cumulative advance is possible for many generations.

Systems of repeated cycles of selection, inter-mating among selected genotypes and renewed selection are called recurrent selection procedures and they may be designed for hybrid breeding, multiple population breeding, synthetic variety breeding, or any form of inbreeding. One of the primary problems in recurrent selection is that maximum progress from breeding requires very intensive selection and therefore implies strong limitations on the size of the breeding population both for production and for long term breeding purposes. This obviously limits the genetic variability of the materials used to plant the current forests as well as the possibility for future advance. All current tree breeding programmes either face this problem now or will face it within one or two generations. We believe that this is a significant problem but for almost all tree breeding programmes we also believe there are ways to obtain both short term gains and long term advance.

M E T A - B R E E D I N G   S T R A T E G I E S

In long term programmes, where the means of achieving immediate objectives may endanger achieving the ultimate objective, a more comprehensive strategy is needed. Various breeding tactics may then be chosen as elements of this comprehensive strategy so that the ultimate objective of continued progress for future generations is assured, while immediate gains are also achieved.

It is never the direct intention of breeders to lose potentially valuable genes, but it is very easy for even large programmes inadvertently to reduce the genetically effective population size (Ne) in the breeding populations. Some programmes screen many thousands of "plus" trees in progeny tests and select the very best for seed orchard production. The problem comes in when they try to select the parents of the next generation from these progenies and, as is likely to occur, the best trees come from a few common ancestors. If no ancestral records are kept, then the selection process will severely reduce the genetic base even if substantial numbers of trees are chosen. If ancestral records are kept and an index selection or tandem selection (on family and individual tree performance) is used, then even fewer ancestors will dominate in future generations; the breeder will be obliged to select only the very best trees to obtain gain and will often thereby reduce the genetically effective population size. Some may wish to avoid inbreeding altogether and require that all crosses for future generation selections be made among unrelated individuals, such as by constructing pairwise mating schemes, and never allowing crosses among individuals with a common ancestor. This limits the selection differential and inevitably leads to a higher rate of inbreeding when avoidance of inbreeding is no longer possible. An alternative suggestion which has been made is to breed intensively with a small effective population size and to keep the initial base population broad by imposing little or no selection. This approach will result in enforced reversion to unimproved populations for future breeding and hence a loss of the possible cumulative gain made in the selectively bred population. Another alternative is simply to expand the breeding population to include lower quality trees to ensure a broader base. These lower quality trees may be kept in separate populations in which case they will eventually find little use, or they may be inter-crossed with the best trees. We doubt that the breeder will want to accept deliberately a lower gain, in whatever generation he happens to be working, to allow future generations to achieve more gain. It may not be economically feasible to dilute present gain for future benefit.

With these problems facing us now or in the near future, we cannot simply apply the easiest breeding tactics as we have in the past and hope that the ultimate objectives of continued progress will be solved. Our tactics have to be designed to accommodate future needs. Plant breeders have ignored these problems for many years because they have been able to backcross and use other breeding systems which involve multiple generations of crossing. In forestry this luxury is not available, and even plant breeders are now faced with problems due to the loss of an adequate germplasm base (Frankel and Bennett, 1970; Frankel and Hawkes, 1975; Hawkes, 1978).

One way to manage breeding programmes to achieve short and long term gains is to construct multiple breeding populations in such a way that the trees used for current seed production come from only one or a few populations while many more are being created for possible future use. These multiple populations may form a hierarchical structure as in many traditional plant breeding programmes where unimproved populations form a germ plasm base; from these, foundation breeding populations are formed through selection and breeding with large effective population sizes in several national or private agencies and, from these, specific varieties are created for release through refined selection and breeding (Allard, 1960). These kinds of programmes require several generations to develop material. Alternatively, multiple populations may be contemporaneously organized as independent sub-populations with selection among the best of them either using the same selection objectives (Baker and Curnow, 1969) or using an array of objectives (Namkoong et al., 1980).

A L L O C A T I O N   O F   R E S O U R C E S

For most tree breeding agencies, the problem of designing a programme to develop an optimum breed is compounded by having several species for which such programmes must be designed. For a given array of species and sites, an optimum allocation of resources among species can be determined if breeders can define the gain to be made in each species for varying levels of investment. Obviously, species with wide distribution, high value, and high genetic variances will yield most gain from investments in intensive breeding. For such species, multiple population breeding, extensive testing and controlled inter-crossing procedures, and refined breeding methods will be used. However, within the usual levels of financial constraints, most nations can afford such investments in a very few species if any. Therefore, all nations will have less intensive breeding programmes for most species. This is likely to mean that single population breeding will be the rule and that the pressure for achieving gain will require that small effective populations be used.

For the currently available sites and for current socio-economic values, simple procedures in small populations may well be adequate. Simple recurrent selection for widely adapted populations will provide some economic gain even if not the maximum possible from refined programmes. However, when shifts in environmental arrays occur, or when silviculture-site subdivisions allow selection for genotype-environment interactions to be more effective, or when socio-economic criteria change, then simple breeding procedures and reduced Ne will not be effective. Current investments in multiple populations or a sacrifice in present gains are necessary to ensure future values of present breeding populations. Since future economic and environmental requirements are highly uncertain, our planning should encompass means to meet several alternate futures. Creating multiple populations is one solution as long as an adequately diverse set of populations is used. The beginnings of such diversity require that we conserve presently available genes and that these be formed into useful populations. Gene conservation, in this framework, has very practical economic objectives.

N A T I O N A L   P R O G R A M M E S

To achieve such breeding objectives, each nation, and agencies within it, can be expected to set priorities for improvement work and to allocate effort among species accordingly. For their high priority species, several populations may be used for their present array of site requirements, and several more may be developed for possible future variations if wider adaptabilities are anticipated. This second set may not be intensively developed if restrictions on resources are severe. For low priority species, some very simple recurrent selection population may be the only one developed. To accommodate future variations, conservation stands may be the only sources of material available even though they would be difficult to use in a tree breeding programme.

The adequacy of such national programmes is dependent upon future sites and needs being quite similar to the present arrays for almost all species and upon each nation generating a diverse but improved set of populations for all species for its future. We believe that neither of these conditions is likely to hold true and that plans based on such requirements are bound to fail. Current environmental shifts due to natural as well as human effects are large enough to require genetic changes in all crop species yet every nation cannot afford continually to improve sufficient populations for all possible futures. Neither trusting to a benign future nor creating independent self-sufficiency are feasible bases for planning tree breeding even for objectives of national self-interest. We therefore believe that the mechanisms and needs of tree breeding require international cooperation. If one nation's populations can help to ensure genetic variability for another nation's future, then each can afford to choose more intensive breeding tactics and each can follow allocation strategies with far greater net efficiency than by independent effort.

INTERNATIONAL PROGRAMMES

International coordination on a regional level may require only bilateral agreements for fairly similar programmes and biological needs. On a more global scale, the needs for cooperation may differ and require broader programme management for the more distant future. At present, many nations rely on others for their current primary seed sources of non-native populations and many are beginning to establish secondary populations or land races adapted to their own environments. These efforts can properly serve as means for diversifying the available gene pool as long as one nation's populations can serve as alternate or replication populations for other nations' future needs.

The establishment of independent breeding populations can give rise to multiple population diversity as local varieties respond to environmental as well as to economically directed selection criteria and as genotype-environment interactions are used to maximize local gain. Since each population is likely to possess some special adaptabilities and some special deficits, some exchange of materials will occasionally be useful. To avoid homogenizing all constituent populations and hence losing the advantages of allelic diversity, whole populations may be substituted or occasional hybridizations made followed by a re-imposition of inter-populational barriers. New population foundations may thus be created and some may be discarded as the collection of populations evolves to meet the array of new demands.

Such activities require that all constituent genotypes be exchangeable and that ancestral records are available. Continuous cooperation at this level is needed as episodes of exchange may occur at various stages of breeding. Clearly, some international agency is required to monitor population and individual genotype identities and to store and update records on identity, history and performance. Such control would be vastly aided by developing efficient finger printing techniques such as isozyme records or, in some species, analysis of other chemical markers such as pine terpenes (see Lever and Burley, 1974). Techniques are presently available for chemical analysis, data handling, and material exchange, though improvements in these fields can help. At this time, however, we lack clear organizational concepts and directions for assisting in our mutual efforts for gene management.

Given our desire to ensure a productive future for forests through breeding management, we can suggest two types of organization for consideration. In a hierarchical form, such as used by many international agencies (e.g. CIMMYT /1), all efforts at developing the basic foundation populations are centralized. Gene conservation is organized from the central agency, initial selection and development of adapted varieties with broad genetic variability are conducted and, from these, individual agencies may draw materials for further breeding for their localized uses. When new problems are faced in member nations, or when the central agencies create a new varietal base, the old varieties are replaced. Since the success of such organizations depends in part on having short breeding cycles so that refined selections can rapidly follow the development of foundation breeds, this form of organization may not work well in forestry.

An alternative is to manage multiple populations simultaneously for an agreed array of objectives. With limited duplication, except for security reasons, all populations essentially are continually improved and evolved with some degree of genetic independence but with availability to all cooperating nations. Continued updating of materials and data is required and this would preferably be done by a designated agency, but there would be less active breeding done by this agency than under the hierarchical form. The agency would have the prime responsibility to ensure that, in the designated species, there exists an overall balance between the inter- and intra-population variance. The greater the degree of genetic variation that is maintained within each population, the less the need exists for multiple populations and the less gain there is in each. The more intense the selection and loss of genetic variation within each, the greater the need for multiple populations, and the greater the short term gain in each.

A reasonable basis for creating a formal starting point for meta-breeding and international cooperation, which allows for short term gain and long term assistance, is contained in programmes like the international provenance trials of *Pinus caribaea* and *P. oocarpa*.

Although we must caution against the narrowing of the genetic base that may arise through selecting individual trees within provenance trials, particularly where parental identities are not maintained within seed sources, the contribution of such individual selections to an international breeding pool could be considerable.

In all the preceding discussion we have, perhaps, implied that breeding is restricted to an individual provenance identified as optimum; however, inter-provenance population crossing may be advantageous provided ancestry control is maintained. Additional sources of material for selection are larger selection plantings and *ex situ* conservation stands of some provenances such as those suggested by FAO for tropical pines and eucalypts (Wood, 1980).

A coordinating agency, such as those proposed by Kemp *et al.* (1972) and Nikles (1979), is required to follow on with the work done in the existing international provenance trial programmes. This agency would be required to undertake the following work for a given species:-

1) inventory of plantations, provenance trials and existing selections;
2) recommendations for selection methods including criteria and their assessment, selection intensity, *etc.*;
3) accumulation of seed and scions;
5) distribution of materials;
6) information collection, storage, retrieval and dissemination;
7) advice and assistance on progeny test design and analysis.

To meet these requirements, the agency would need the staff and facilities for (a) successful propagation, growth and flowering of the selected materials and (b) centralized information processing. These need not be in the same place but would have to be under the coordination of the agency.

/1 CIMMYT, International Maize and Wheat Improvement Centre, Mexico.

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FAST GROWING TREES

ESTUDOS COOPERATIVOS INTERNACIONAIS DE PROGÊNIES DE *PINUS CARIBAEA* MOR. VAR. *HONDURENSIS* BARR. AND: GOLF. INICIADOS PELO DEPARTAMENTO DE SILVICULTURA DE QUEENSLAND.

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Resumo

Estudos cooperativos Internacionais de progênies de *P. caribaea* Mor. var. *hondurensis* Barr and Golf. foram estabelecidos usando lotes de sementes de polinização livre de árvores selecionadas, fornecidos por vários doadores. Os lotes de sementes foram processados e distribuidos pelo Departamento de Silvicultura de Queensland em 1971, 1975-1978 e 1978--1980 para cooperativistas espalhados por 14 países. Um número superior a 60 ensaios de campo foram estabelecidos. Detalhes da sua localização e composição são apresentados.

O objetivo geral do programa é propiciar aos participantes uma ajuda mútua na formação de populações com ampla base genética para seleção, e tendo o maior potencial genético básico para um programa de melhoramento local. Os objetivos específicos também são estabelecidos.

Como Coordenador e participante integral, o Departamento de Silvicultura de Queensland vem dando assessoria nos delineamentos de campo e no setor de coleta e arquivo dos dados de todos os ensaios.

INTERNACIONAL COOPERATIVE PROGENY STUDIES OF *PINUS CARIBAEA* MOR. VAR. *HONDURENSIS* BARR. AND GOLF. INITIATED BY QUEENSLAND DEPARTMENT OF FORESTRY.

Summary

International cooperative progeny studies of Pinus caribaea Mor. var. hondurensis Barr. and Golf. have been established using selected, open-pollinated seedlots supplied by several donors. The seedlots were processed and distributed by the Queensland Department of Forestry in 1971, 1975-1978 and 1978-1980 to Cooperators in a total of 14 countries. More than 60 field trials have been established. Details of their locations and composition are tabulated.

The general aim of the programme is to enable participants to help each other to assemble broadly-based selection populations having the greatest genetic potential as a base for a local breeding programme. The specific objectives are stated.

As Coordinator and full participant, the Queensland Department of Forestry has supplied advice on field design and establishment and maintains records of all the field trials.

Some assessments and analyses have been carried out and reported; a list of these reports is given. These show that the aims are being achieved and practical benefits gained.

Proposals are made for further coordinated assessments to be followed by local and centralised data analyses. It is pointed out that funds will have to be found to finance this work. It seems likely that further studies of the same type will be established, as well as new cooperative projects involving controlled crossing.

INTRODUCTION

A detailed survey carried out by the senior author in 1977 and 1978 (FAO 1979) showed that Pinus caribaea Mor. var. hondurensis Barr. and Golf. was an important plantation species in 30 countries of the tropics and subtropics. The total area planted to this variety by mid-1977 was over 280 000 ha; the annual planting rate was over 50 000 ha and this was estimated to rise to 90 000 ha in the mid-1980s.

There was active interest in genetic improvement of the variety in 30 countries, though not precisely the same countries for various reasons. However only 8 countries had advanced in their breeding work to the stage where appreciable amounts of genetically improved seed were becoming available. Of these, Australia (Queensland) was most advanced, having commenced development of "improved" seed sources during the mid-1950s. These began to yield substantial amounts of seed in the mid-1960s. A few other countries also developed breeding programmes rapidly, notably Congo and Fiji. By the early 1970s, therefore, the Queensland Department of Forestry was able to exchange open-pollinated seeds from phenotypically superior ortets or clones with Fiji and Congo, and later other countries, for establishment of cooperative progeny studies.

Three major international progeny studies have been initiated by the Queensland Department in cooperation with a few other seed donors and several more recipients between 1971 and 1980. These are described in this paper.

AIMS

The general objective of the cooperative programme is for participants to help each other to assemble broadly-based selection populations having the greatest genetic potential as a base for a local breeding programme. This is especially important in the case of exotic species in which early introductions, often the base for initial breeding, usually fail to sample the species range-wide and therefore rarely include optimal sources from the beginning.

The principal specific aims of the cooperative progeny studies are as follows:

1. To increase the number and diversity of families in local progeny trials and thereby, hopefully, to improve the genetic potential of local populations, both as selection bases and seed sources.

2. To investigate genetic parameters, especially family-by-environmental interaction, on a broad basis in an attempt to define breeding zones for more effective cooperation in the future.

3. To identify parents with superior general combining ability and adaptability of which any non-local ones may then be incorporated in local seed orchards through scion importation, or into the local breeding population through pollen importation, or into local selection populations via seed.

The principle involved in the programme is that genetic material skilfully selected elsewhere may well broaden the base and upgrade the genetic quality of locally available breeding material more effectively than any other method in the short term, especially if the populations available locally are narrowly based (as is the case in most of the breeding programmes with var. hondurensis), or of suboptimal provenance.

These progeny studies are of potential value to the recipients primarily. Ideally, participants are both recipients and donors of select material, and each receives material of desirable provenance chosen by means of relevant selection criteria in broadly-based populations growing in environments somewhat similar to those of their own plantations.

TRIALS ESTABLISHED

Tables 1 to 6 inclusive give details of the planting sites and composition of the trials which have resulted from the three major periods of seed distributions. These periods were 1971, 1975-1978 and 1978-1980; resultant field trials have been planted in the following corresponding periods: 1971-1972, 1975-1978 and 1978-1980. In brief outline, the numerous trials may be classified as follows:

Study number	Period of seed distributions	Number of countries	Total number of sites planted
1	1971	2	10
2	1975-1978	7	22
3	1978-1980	11	30/2

The 14 countries participating in one or more trials so far are: Australia, Brazil, Congo, Costa Rica, Fiji, Honduras, Indonesia, Kenya, New Caledonia, Philippines, Republic of S. Africa, Sri Lanka, Tanzania and Thailand.

FURTHER DETAILS

Seeds have been supplied for the programme by Australia (Queensland and N. Territory), Brazil, Congo, Fiji, Honduras, Kenya, New Caledonia, and Rep. S. Africa. The Queensland Department of Forestry has been the principal donor so far. Its policy is to exchange seeds without monetary transactions where possible, but in some cases a charge has had to be levied for Queensland seed. In several cases Queensland seed has been provided through grants from the Australian Development Aid Bureau (ADAB) and FAO of United Nations and these organisations may be approached by individual Cooperators for such assistance.

With one exception, all seeds distributed in the programme between 1971 and 1980 were open-pollinated from superior ortets or clones. The exception was the provision of 14 single-cross seedlots to Congo in 1976/3.

Seedlots received from outside Australia are required to be fumigated with methyl bromide and surface-treated with a sodium hypochlorite solution upon arrival at Brisbane and this is done in Quarantine. Queensland seedlots are not so treated before despatch overseas, but all phytosanitary precautions required for shipment and receipt are carried out. It is recommended that any fumigation treatments required locally be carried out there rather than by the shipper to minimise any damage caused by fumigation.

Seedlots are usually despatched in sets of 60, each seedlot comprising 100 clean and full seeds in a labelled paper packet. The aim is to provide enough seeds to raise at least 60 good plantable stock per lot. It is recommended to recipients that they establish 48 replicates of single-tree plots (as 8 blocks of 6-tree non-contiguous plots). However, some Cooperators prefer to establish 6 to 10 replicates of 6- or 10-tree, line plots in randomised complete block designs. Cooperators are encouraged to include families from local selections and commercial stock for control purposes. This will assist in determining the value of such importation of germ plasm.

The trials planted in Queensland have been established as sets of different families linked by several common entries. This design has been adopted in order to reduce block sizes.

A duplicate set of inventory sheets is usually supplied with each seed shipment so that recipients can record the numbers of germinants by families and advise the Coordinator (retaining a copy locally) who can offer advice on field design.

A description of the proposed field design, of suggested nursery procedure and field establishment, and notes on maintenance and assessment are supplied on request.

/2 Estimated on basis of number of seed shipments, though all field trials not yet established.

/3 Several single-cross (and polycross) seedlots were also supplied to CFI, Oxford in 1980 for the CFI-coordinated second-stage provenance-progeny study.

Cooperators are requested to supply the Coordinator with detailed information on date of planting, location, field design, dates and results of measures and assessments, etc. A file with details of each field trial is maintained at Brisbane.

ASSESSMENTS AND ANALYSES

The three Cooperators in Study 1 (Queensland Department, Division of Forest Research (Darwin) and the Fiji Pine Commission) have carried out measures and assessments independently though after consultations. A 4th-year assessment of all but the Lololo trial was carried out in 1976 and some results were reported by Nikles et al. 1978. Some results of assessments in the 6th year in Fiji (Wilcox, M.D. unpublished report, 1978) and Northern Territory, and in the 7th year in Queensland have been reported as a whole by Eisemann and Nikles 1980. It is considered that the aims of this cooperative study are being largely achieved and that it has been of very considerable practical value. For example, several promising Queensland families have been identified in the Nausori, Fiji planting; the parents of these families have been included in local clonal seed orchards; local selections have been made within the best families, and these trees have been included in the local breeding population.

Assessment and data analyses of the second and third studies will be much more difficult to handle because of the larger number and more widespread locations. But they are potentially of much greater value because of the larger numbers of families and the much greater range of environments. The following proposals are made concerning them.

1. A coordinated measure and assessment, employing uniform procedures, be scheduled for implementation in all viable trials/4 between ages 7 and 8 years, the actual timing within this age class to be for local convenience. Where possible trees should be pruned to 3 m before measurement and assessment.

2. That DBHOB and total height of each living tree be measured and each tree scored for straightness, windfirmness (if appropriate), forking, foxtailing, ramicorn branching and top breakage, all according to a simple schedule to be suggested by the Coordinator, tested in a few places and then implemented by all Cooperators.

3. That standard assessment record sheets be used by all Cooperators to facilitate data handling.

4. That where possible preliminary analyses of the data be carried out locally, and that only checked entry means for each replicate be supplied to the Coordinator for across-sites analyses.

Before such proposed, coordinated assessments and analyses can be carried out, however, it will be necessary to secure funds to finance the coordinating activity.

PUBLICATION OF RESULTS

Few detailed assessments have been carried out yet because the first trials were planted only as recently as 1972. However, reports containing some details of Study no. 1 are as follows: Nikles 1973, 1978; Nikles et al. 1978; Wilcox, M.D., unpublished report, 1978; Eisemann and Nikles 1980; Long and Dykstra 1980 and Brigden and Williams 1980.

FUTURE STUDIES

With the establishment of the Second Stage Provenance-Progeny Trials initiated by CFI, Oxford, in 1981 and subsequently, there will be a total of four international cooperative progeny studies of var. hondurensis in existence. Together with additional, multi-site, national trials, these will probably be sufficient to determine the broad patterns of genotype x environmental interaction at the provenance and family levels. Hopefully it will be possible to delimit

/4 It is suggested that replicates with less than 70 per cent of full stocking be discarded.

"breeding zones" and the most appropriate provenances for each zone. This should enable breeders to form appropriate, smaller groups for more intensive selection, breeding and exchange of germ plasm within zones.

Results of the international provenance trials are already providing leads for the planning of advanced-breeding strategies. In Queensland, for example, proposals have been made for importation of pollen from plus trees of desirable "new" provenances (Nikles 1980). Consequently the thrust of local breeding work in Queensland is expected to change course soon to concentrate attention on controlled crossing between the best products of the first-stage breeding programme as seed parents (Belize, Mountain Pine Ridge provenance), and selections within other desirable provenances as pollen parents. This will require international cooperation in the selection of pollen parents, supply of pollen and exchange of a proportion of the seed of successful crosses. It is anticipated that several Cooperators in the progeny studies described above will join in such a new programme.

Nevertheless, open-pollinated seed from selected ortets or clones is likely to remain in demand, and it is anticipated that exchanges of such material will continue for establishment of further cooperative, open-pollinated progeny studies.

ACKNOWLEDGEMENTS

The authors are especially pleased to thank all donors of seed used in the three studies established so far, and the many cooperators who have so readily supplied details of the local trials established.

Table 1. Some details of the 10 planting sites of International Progeny Study No. 1 of var. hondurensis using seed distributed in 1971

Country	Organisation	Locality and site	Latitude (°S)	Longitude (°E)	Elevation (m)	Rainfall ann. av. (mm)
Australia	Dept. Forestry, Queensland	Cardwell ridge	18°15'	145°55'	30	2030
		Cardwell swamp	18°15'	145°55'	6	2030
		Byfield ridge/1	22°50'	150°40'	30	1697
		Elliott R. "ridge"	25°05'	152°20'	30	1471
		Tuan swamp	25°45'	152°45'	18	1478
	Div. For. Res., N. Territory	Humpty Doo	12°00'	131°00'	10	1523
		Melville Is.	11°45'	131°00'	10	1687
Fiji	Fiji Pine Commission	Nausori	17°48'	177°30'	450	1862
		Lololo - A	17°35'	177°30'	190	1477
		Lololo - B	17°35'	177°30'	190	1477

/1 The planting on a sixth Queensland site, Byfield swamp, was destroyed by cyclone David in January, 1976.

Table 2. Numbers of entries in field trials of Table 1 by seed donor countries field sets and planting dates, and field design

Country	Locality, site and set	Date planted	No. of entries by source country: Qld.	Fiji	Trees/plot (no.)	Reps. (no.)
Australia	Cardwell ridge A	Feb. '72	24	-	6	8
	Cardwell ridge B	Feb. '72	31	3	6	8
	Cardwell swamp A	Feb. '72	24	-	6	8
	Cardwell swamp B	Feb. '72	31	3	6	8
	Byfield ridge A	Jan. '72	30	-	6	8
	Byfield ridge B	Jan. '72	44	10	6	8
	Elliott R. ridge A + B	Apr. '72	45	5	6	8
	Tuan swamp A + B	Mar. '72	20	-	6	8
	Humpty Doo	Mar. '72	41	3	6	5
	Melville Is.	Mar. '72	20	3	6	5
Fiji	Nausori	Feb. '72	25	15	6	12
	Lololo - A	Jan. '72	22	8	6	16
	Lololo - B	Jan. '72	21	9	6	16

Table 3. Some details of the 22 planting sites of International Progeny Study No. 2 of var. hondurensis using seed distributed in 1975 and 1976

Country	Organisation	Locality and site	Latitude (°)	Longitude (°)	Elevation (m)	Rainfall (ann. av. mm)
Australia	Dept. Forestry, Queensland	Kuranda ridge	16°45'S	145°35'E	440	2057
		Cardwell ridge	18°15'S	145°55'E	30	2030
		Cardwell swamp	18°15'S	145°55'E	6	2030
		Byfield ridge	22°50'S	150°40'E	30	1697
		Byfield swamp	22°50'S	150°40'E	30	1697
		Tuan swamp	25°45'S	152°45'E	78	1478
		Toolara ridge	26°00'S	152°50'E	50	1330
		Toolara swamp	26°00'S	152°50'E	30	1330
		Beerburrum ridge	27°00'S	153°00'E	15	1527
	Div. For. Res., N. Territory	Three-ways	11°40'S	130°41'E	100	1343
		Imanawuti	11°42'S	130°49'E	100	1241
Brazil	IPEF	Bahia-Teixeira de Freitas	17°45'S	39°32'W	50	1370
		Sao Paulo - Agudos	22°19'S	49°04'W	550	1215
		Minas Gerais - Romaria	18°30'S	47°20'W	800	1400
		Minas Gerais - Grao Mogol	16°25'S	42°35'W	819	1250
Congo	CTFT	Pointe Noire	4°30'S	11°50'E	80	1200
Indonesia	ITCI	Kenangan, Balikpapan	0°55'S	116°35'E	100	2160
Kenya	AFRO	Kwale	4°11'S	36°26'E	450	1100
Rep. S. Africa	FRI	Wilgeboom	24°56'S	30°57'E	945	1250
		Duku Duku	28°21'S	32°15'E	70	1009
		Kwa-Mbonambi	28°31'S	32°10'E	30	1352
Tanzania	Forest Division, Ministry of Natural Resources	Ruvu, Kibaha	6°35'S	38°55'E	70	921

Table 4. Numbers of entries in field trials of Table 3 by seed donor countries with planting dates and field designs also shown

Country	Locality and site	Date planted	No. of entries by source country				Trees/plot (no.)	Reps. (no.)
			Aust. (Qld.)	Brazil	Fiji	Kenya		
Australia	Kuranda	Jan. '76	27	1	-	-	6	8
	Cardwell ridge	Mar. '76	65	9	23	-	6	8
	Cardwell swamp	Jan. '76	52	7	11	-	6	8
	Byfield ridge	Mar. '76	73	7	12	-	6	8
	Byfield swamp	Jan. '76	65	6	10	-	6	8
	Tuan swamp	Jan. '76	12	-	-	-	6	8
	Toolara ridge	Mar. '76	62	7	-	-	6	8
	Toolara swamp	Jan. '76	53	1	-	-	6	8
	Beerburrum ridge	May '76	23	1	-	-	6	8
	Three-ways	Dec. '75	79	-	18	-	10	6
	Imanawuti	Dec. '75	79	-	18	-	10	6
Brazil	Teixeira de Freitas	Sept. '77	42	5	-	-	-	-
	Agudos	Oct. '77	56	5	-	-	-	-
	Romaria	Dec. '77	36	3	-	-	-	-
	Grao Mogol	Mar. '78	-	-	-	-	-	-
Congo	Pointe Noire	Nov. '76	48 [1]	-	5	-	25	2
Indonesia	Kenangan	Apr. '77	38	-	-	-	1	10-60
Kenya	Kwale	Apr. '77	44	-	-	8	12	10
Rep. of Sth. Africa	Wilgeboom	Jan. '78	43	-	-	-	5	6
	Duku Duku	Jun. '78	33	-	-	-	5	6
	Kwa-Mbonambi	Jul. '78	33	-	-	-	3	3
Tanzania	Ruvu	Mar. '75	40	-	-	-	12	10

[1] Includes 14 control-pollinated Queensland families.

Table 5. Some details of the ± 30 planting sites of International Progeny Study No. 3 of var. *hondurensis* using seed distributed in 1978, 1979 and 1980

Country	Organisation	Locality and site	Latitude (°)	Longitude (°)	Elevation (m)	Rainfall (ann. av. mm)
Australia	Dept. Forestry, Queensland	Cardwell ridge	18°15'S	145°55'E	30	2030
		Cardwell swamp	18°15'S	145°55'E	6	2030
		Byfield ridge	22°50'S	150°40'E	30	1697
		Byfield swamp	22°50'S	150°40'E	30	1697
		Wongi	25°20'S	152°30'E	30	1470
		Tuan swamp	25°45'S	152°45'E	18	1478
		Toolara ridge	26°00'S	152°50'E	50	1330
		Beerburrum ridge	27°00'S	153°00'E	15	1527
	Div. For. Res., N. Territory	Yapilika	11°34'S	130°33'E	100	1199
		Three-ways	11°40'S	130°41'E	100	1343
		Imanawuti	11°42'S	130°49'E	100	1241
	A.P.M. Forests, Queensland	Beerwah swamp	26°50'S	153°00'E	15	1586
Brazil	Jari	Four sites	– S	– W	–	–
	Torras	Juerana	– S	– W	–	–
Congo	CTFT	Pointe Noire	4°31'S	11°50'E	80	1200
Costa Rica	CATIE	Turrialba	– N	– W	–	–
Fiji	Fiji Pine Commission	–	– S	– E	–	–
Honduras	ENCF	–	– N	– W	–	–
Indonesia	ITCI	Kenangan, Balikpapan	0°55'S	116°35'E	100	2160
	Sub-Directorate of Forestry	Bogor	–	–	–	–
New Caledonia	CTFT	Southern N.C.	22°00'S	166°00'E	–	–
Philippines	PICOP	Eastern Mindanao	8°00'S	126°15'E	1500	4220
Sri Lanka						
Thailand	Thai-Danish Pine Project	Two sites	– N	– E	–	–

Table 6. Numbers of entries in field trials of Table 5 by seed donor countries with planting dates and field designs also shown

Country	Locality and site	Date planted	No. of entries by source country								Trees/plot (no.)	Reps. (no.)
			Aust. (Qld.)	Aust. (N.T.)	Congo	Fiji	Hond.	Kenya	New Cal.	R.S.A.		
Australia	Cardwell ridge	Feb. '80	75	2	29	8	35	1	18	2	6	8
	Cardwell swamp	Feb. '80	64	2	29	7	27	1	17	1	6	8
	Byfield ridge	Mar. '80	54	–	22	8	27	–	4	2	6	8
	Byfield swamp	Mar. '80	50	–	22	6	23	–	5	1	6	8
	Wongi	Mar. '80	61	–	22	9	27	–	14	2	6	8
	Tuan swamp	Mar. '80	59	1	24	8	25	–	12	1	6	8
	Toolara ridge	Apr. '80	89	2	31	9	36	3	25	5	6	8
	Beerburrum ridge	May '80	76	2	31	9	36	2	25	4	6	8
	Yapilika	Jan. '80	45	2	13	20	20	–	19	–	–	–
	Three-ways	Jan. '80	45	2	13	20	20	–	19	–	–	–
	Imanawuti	Jan. '80	45	2	13	20	20	–	19	–	–	–
	Beerwah swamp	Jul. '80	–	–	–	–	–	–	–	–	6	8
Brazil	Jari	Apr. '79	60	–	–	–	–	–	–	–	–	–
		Apr. '80	92	–	13	12	20	–	–	–	–	–
	Torras	Apr. '79	49	–	–	–	–	–	–	–	–	–
Congo	Pointe Noire	Nov. '78	58	–	14	–	–	–	29	–	–	–
		Nov. '80	91	–	13	9	20	–	–	–	–	–
Costa Rica	Turrialba	'78	60	–	–	–	–	–	–	–	–	–
Fiji	–	'80	76	–	–	–	–	–	–	–	–	–
Honduras[1]												
Indonesia	Kenangan	Dec. '78	58	–	–	–	–	–	–	–	–	–
		Jan. '80	86	–	13	6	18	–	–	–	–	–
	Bogor		60	–	–	–	–	–	–	–	–	–
New Caledonia	–	'78	37	6	24	14	–	–	23	–	–	–
Philippines	Mindanao	'80	78	–	1	5	18	–	–	–	–	–
Sri Lanka[1]												
Thailand	–	Aug. '80	110	–	1	8	18	–	–	–	–	–

[1] Seed scheduled for shipment soon.

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PROGRESSO NO PROGRAMA COOPERATIVO DE MELHORAMENTO GENÉTICO DAS CONÍFERAS TROPICAIS DE TERRAS BAIXAS.

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Resumo

Informação sobre os resultados de um estudo global feito pela FAO em 1977/79, relacionado com programas de plantação de coníferas tropicais de terras baixas, com os progressos alcançados no melhoramento genético, com as necessidades e possibilidades de estabelecer um programa cooperativo a fim de facilitar o intercâmbio de informação e material genético, e iniciativas recentes tomadas para obter os fundos necessários para uma coordenação de tal programa. Finalmente, a importância da ajuda bilateral, assim como a cooperação informal entre cientistas e florestais é sublinhada: a ação internacional poderia complementar isto, mas nunca substituí-la.

PROGRESS IN THE COOPERATIVE PROGRAME ON GENETIC IMPROVEMENT OF TROPICAL LOWLAND CONIFERS.

Summary

The paper summarizes the findings of a global survey carried out by FAO in 1977/79 on the present status of plantations of tropical lowland conifers, on progress in tree improvement and on the needs and possibilities of establishing a cooperative programme to facilitate the exchange of information and genetic material. Recent action taken to obtain finance for global coordination of such a programme is reported. The importance of bilateral assistance programmes as well as continuing informal cooperation between scientists and foresters is stressed: international action would complement these but could never replace them.

BACKGROUND

The great potential of softwood plantations in the lowland tropics has been fully recognized only during the last 10-15 years. Whereas the total area of plantations of Pinus caribaea var. hondurensis, the most widely planted species in these areas, was only 20 000 ha in 1965, the area in mid 1977 was over 280 000 ha and the annual rate of planting over 50 000 ha; the rate is expected to rise to 90 000 ha a year in the mid 1980s.

Since the early 1970s, international action had largely focused on exploration and collection of provenance seedlots of tropical pines (see e.g. FAO 1974, 1975, 1977; Greaves 1978, 1979). As early results from international provenance trials coordinated by the Commonwealth Forestry Institute, Oxford gradually started becoming available (see e.g. Greaves 1980), great enthusiasm was aroused especially by the promising performance in many countries of Pinus caribaea var. hondurensis. At the same time, collaboration between individual scientists and research institutes, especially in the exchange of select and improved genetic material, was being greatly stimulated and informally coordinated by Dr. D.G. Nikles of the Queensland Forestry Department.

At an inofficial meeting of some 40 tree breeders held in Brisbane in 1977 at the occasion of the previous IUFRO Workshop 1/, it was strongly recommended that the possibilities for more formalized cooperation in the genetic improvement of Pinus caribaea be investigated. As a follow-up to these recommendations, a survey was carried out in 1977-1979 by FAO's Forestry Department on the needs and possibilities of a cooperative breeding programme for this species. The survey was conducted by means of a questionnaire distributed to Government forest services, research institutes and forest industries around the world, and through visits to a large number of countries by an FAO consultant, Dr. D.G. Nikles. The report on the survey, which in the light of the findings of the consultant and the needs expressed by the countries visited was expanded to include other widely planted tropical lowland conifers in addition to P. caribaea, was published in 1979 (FAO 1979).

Exact information on plantation areas is available only for Pinus caribaea var. hondurensis, the species originally included in the survey (180 000 ha in 1977). Estimated plantation areas for other tropical lowland conifers at the end of 1977 were as follows (FAO 1979):

Pinus caribaea var. bahamensis	8 000 ha
P. cariabea var. caribaea	73 000 ha (mainly in Cuba)
P. kesiya	30 000 ha
P. merkusii	200 000 ha (mainly in Indonesia)
P. oocarpa	45 000 ha
Araucaria cunninghamii	44 000 ha
A. hunsteinii	3 000 ha
Agathis spp.	11 000 ha

In 1977, more than 80% of the seed of Pinus caribaea var. hondurensis used in reforestation programmes came from natural stands; 16% came from plantations, and only 5.5% from improved sources (seed stands and seed orchards). The bulk of the seed of the other species was collected from natural stands or, in the case of the other pines, partly also from unimproved plantations.

Thanks to the results from the international provenance trials, there has been an increasing awareness of the large variation found especially within Pinus caribaea var. hondurensis and P. oocarpa and consequently, of the importance of matching sites and provenances. Considerable progress has also been made in some countries in the initial stages of selection and genetic improvement. For example, in P. caribaea var. hondurensis over 1 800 plus trees had been selected and 152 ha of seed orchards had been established by 1977. However, earlier introductions on which some of this work is based often came from a very limited number of trees thus providing

1/ Joint workshop of IUFRO Working Parties S2.02-08 and S2.03-01, held in Brisbane, Australia, 4-7 April 1977.

Table 1.

OPTIONS FOR INTERNATIONAL COOPERATION AND THEIR BENEFITS

Subjective scoring of the effects of options on the various activities in a tree improvement programme 1/

Activity	Option 1 Status quo	Option 2 1 central and 1 regional coordinating unit		Option 3 1 central and 6 regional coordinating units
		Effect in the region in which the regional unit is located	Effect in other regions	
A. Steps in an improvement programme				
1. Determination of best seed sources				
(a) Assessment of existing provenance trials	2	3	3	3
(b) Initiation of new provenance trials	3	3	3	3
2. Conservation of seed sources	1	2	1	2
3. Provision of bulk seed supplies of best sources	0	2	1	2
4. Provision of seed from superior phenotypes				
(a) From seed stands	1	3	2	3
(b) From plus trees with standardized grading	0	3	1	3
5. Provision of genetically improved seed from orchards	0	3	1	3
6. Progeny trials	1	3	2	3
7. Controlled crossing	0	2	1	2
B. General activities				
8. Research	0	2	0	2
9. Information transfer	2	3	2	3
10. Staff and training	1	3	1	3
11. Planning and funds	1	2	2	2
Total	12	34	20	34

1/ 0= very small or nil; 1= small; 2= moderate; 3= large.

an inadequate genetic base for long-term improvement within the local population; in addition, some of the work has been done using less than optimal provenances as a basis for selection. Most of the work has been confined to a few "older", northern provenances whereas selection within the southern, more tropical provenances is only just starting.

N E E D S F O R C O O P E R A T I O N

Nearly 80 organizations in 40 countries, of which 85% developing, expressed an interest in participating in a cooperative programme; they included 22 organizations which already had approved breeding programmes for *Pinus caribaea*.

The present plantation programme of *Pinus caribaea* var. *hondurensis* (some 50 000 ha/an), requires nearly 7 000 kg of seed each year and the amount needed by the mid 1980s is expected to rise to some 12 000 kg/an. The largest constraint in local plantation programmes, particularly prononced in countries using the lowland provenances from Nicaragua and Honduras, was reported to be the procurement of more substantial quantities of source-identified seed of optimal provenances for selection/seed stands, management trials and pilot plantations, as well as procurement of bulk quantities of seed for plantations. Other frequently expressed needs were:

- advice on planning and development of breeding programmes;
- exchange of information and ideas on all aspects of a tree improvement programme;
- procurement of small quantities of select or genetically improved material for testing and breeding.

The report recommends that a global cooperative programme be established to meet the needs identified above. A pooling of efforts and the integration of local breeding programmes into an international framework would lead to improved access to seed and other genetic material; in addition, increased exchange of information, direct assistance in the planning of short and long-term breeding strategies and training by means of scholarships and study tours, would rapidly increase local expertise and ultimately lead to improved and less wasteful use of existing genetic and human resources.

O P T I O N S F O R C O O P E R A T I O N

A number of alternative proposals could be put forward for increasing the effectiveness of international cooperation. For simplicity, the FAO report considers only three options in levels of finance.

The first option is that of a *status quo*. Present arrangements have enabled good progress to be made in the exploration, collection and evaluation of provenances and a start to be made on *ex situ* conservation. As there are no formal arrangements for cooperation in breeding *within* provenances, pooling and exchange of select material for progeny testing and for evaluation of genotype x environment interactions has depended on individual initiative. It is therefore gratifying to note that a promising start has been made in this field and that more than a dozen countries are presently cooperating in a programme exchanging and testing genetic material from other countries for possible inclusion in local breeding populations (see e.g. Nikles 1978).

The second option includes provision of staff and funds for a central coordinating unit (estimated cost US$ 70 000 per year) and one prototype regional unit (estimated cost US$ 90 000 per year). The central unit, operating under the guidance of the FAO Panel of Experts on Forest Gene Resources, would provide global and interregional coordination while the regional unit would provide close cooperation between a more limited number of countries.

The third option, based on a much larger budget, aims at the establishment of a central unit supported by a network of regional coordinating units modelled on the single unit set up under option 2.

In Table 1, an attempt is made to compare by means of relative scoring, the effects of the above options on each of the activities generally identified in a tree improvement programme.

The report recommends that the options be considered as three phases in time. Activities under the *status quo* should be maintained, but should be supplemented as soon as possible by the establishment of a central coordinating unit and one regional unit as proposed under option 2. The regional unit should be the prototype for additional units to be established eventually in all tropical regions, as proposed in option 3.

P O S S I B I L I T I E S F O R F I N A N C E

An important part of the survey was to assess the readiness of potential cooperators to contribute funds towards the costs of running a central coordinating unit. It was found that in spite of the considerable interest in participation, only 11 organizations were willing to make a firm commitment to contribute funds for the programme.

A prerequisite for any formalized cooperation at a global or regional level would thus be the provision of finance from external sources. From the administrative point of view, the basic programme should ideally be financed by one or only a few bilateral or multilateral sources; such a centrally financed core programme with assured funding over several years, could be supplemented through contributions from cooperating organizations or third parties to include satellite projects, special studies, scholarships or advisory services of a more limited duration.

P R O G R E S S

International Initiatives

Since the survey in 1977/79, proposals for projects within the framework of a cooperative programme on tropical lowland conifers have been submitted by FAO to a number of donors. They include proposals both for a central coordinating unit and/or for regional units, as recommended in the report. None of these proposals has yet been accepted for financing.

Initiatives to promote international cooperation and to obtain finance to cover the costs of coordination have also been taken by a number of other organizations and institutes. These include:

(i) Thailand Forest Department. A conference on a South East Asian Tree Improvement and Seed Procurement Cooperative Programme was held in Chiang Mai, Thailand in February 1979 (Anon. 1980). Progress is reported in another paper submitted to this Symposium (Granhof *et al*. 1980).

(ii) FAO/Danish Forest Tree Seed Centre, Humlebaek. A proposal for extension of the Seed Centre has been submitted to DANIDA. The proposal was appraised by an international evaluation mission in June 1980 and a final decision from the Board of DANIDA, which finances the Seed Centre, is expected towards the end of 1980. A strengthened Seed Centre would be able to include in its programme part of the coordination proposed in the FAO report on tropical lowland conifers.

(iii) Queensland Forestry Department. Several approaches have been made by this Department to the Australian Development Assistance Bureau, ADAB for regional coordination in tree improvement programmes (D.G. Nikles, *pers. comm.*).

Bilateral Aid

Over the past two decades bilateral donors have provided aid in plantation forestry and tree improvement to many developing countries in the form of specialist advice, scholarships and equipment. It is essential that assistance of this type should continue and be expanded. An international cooperative programme would complement such aid but could never replace it.

Informal Cooperation

Extension of national breeding programmes through informal cooperation at a personal level or between individual institutes or organizations is of great importance as a first step towards more formalized cooperation and as an essential supplement to it. Work of this type has been continued under the guidance of Dr. D.G. Nikles of the Queensland Forestry Department. Activities resulting from these initiatives have included the exchange of seed, scions and pollen between countries; the establishment of cooperative progeny trials; the conduct of on-the-job training programmes and study tours in Queensland; and professional advice and the development of joint research projects in a number of developed and developing countries.

Both ADAB and FAO have contributed to the Queensland programme by providing occasional financial support to cover the costs of small quantities of seed and scions for developing countries which could not otherwise participate in the programme.

Exchange of information has been greatly facilitated by the series of workshops organized by IUFRO Working Parties S2.02-08 and S2.03-01 (Gainesville 1971; Nairobi 1973; Brisbane 1977; Águas de São Pedro 1980).

C O N C L U D I N G R E M A R K S

Presently large amounts of unselected seed from wild stands, often of poor quality and/or unsuitable provenances, are used in plantation programmes in the tropics. Selection and further breeding is often based on populations of inadequate size and unknown genetic composition.

Assuming an average establishment cost of US$ 500 per ha, the forecast planting area of 90 000 ha by the mid 1980s represents an investment of $ 45 million per year for *Pinus caribaea* var. *hondurensis* alone. Coordinated action is urgently needed to reinforce present efforts and to prevent the establishment of large areas of inferior plantations.

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1/ The letters in parenthesis indicate the languages in which the document is available (E= English; F= French; S= Spanish).

PROGRESSO NO PROGRAMA GLOBAL PARA MELHOR APROVEITAMENTO DE RECURSOS GENÉTICOS FLORESTAIS.

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Resumo

Apesar de ter-se conseguido progresso consideráveis no campo de recursos genéticos florestais desde 1874 quando a FAO endossou o Programa Internacional para Melhor Aproveitamento de Recursos Genéticos Florestais, a tarefa que teremos é grande e urgente. O presente trabalho resume os progressos alcançados neste campo durante a última década e identifica algumas atividades de alta prioridade.

PROGRESS IN THE GLOBAL PROGRAMME FOR IMPROVED USE OF FOREST GENETIC RESOURCES.

Summary

In spite of the considerable progress achieved in the field of forest genetic resources since the endorsement in 1974 by the FAO Panel of Experts on Forest Gene Resources of the Global Programme for Improved Use of Forest Genetic Resources, the task still in front of us is enormous as well as urgent. The paper summarizes progress in this field achieved during the past decade and identifies some areas in which early action is needed.

Resumé

Malgré les progrès considérables réalisés dans le domaine des ressources génétiques forestières depuis l'acceptation en 1974 par le Groupe FAO d'Experts des Ressources Génétiques Forestières du Programme mondial destiné a assurer une meilleure utilisation des ressources génétiques forestières, la tâche qui nous attend est à la fois énorme et urgente. Le document résume les progrès réalisés ces dix dernières années et indique quelques activités où une action rapide est nécessaire.

I N T R O D U C T I O N

Concern over the loss of genetic diversity has grown rapidly since the early 1950s and has led to increasing action on a national as well as an international level. This loss of diversity stems from two main factors: (i) the disappearence of ecosystems in their natural state; and (ii) selection and intensive breeding of economically important species.

The FAO Panel of Experts on Forest Gene Resources was constituted in 1968 to "... help plan and coordinate FAO's efforts to explore, utilize and conserve the gene resources of forest trees". At its Third Session held in Rome in 1974 (FAO 1974a), the Panel examined and endorsed a proposal for a Global Programme for Improved Use of Forest Genetic Resources (see FAO 1975a) presented by the FAO Secretariat for its consideration. The Panel reiterated its support to the Programme at its Fourth Session (FAO 1977b).

T H E G L O B A L P R O G R A M M E

The Global Programme for Improved Use of Forest Genetic Resources is an action programme which identifies species and field operations in which action is needed, assigns relative priorities to these operations, identifies institutes capable of assuming operational responsibility for the various projects, presents a budget for projects likely to be financed by existing and on-going programmes, and suggests possible sources of finance for projects not covered by these. The species included, with priority ratings for each of the different phases in a genetic resources programme, are based on the degree to which the species may be in danger as well as on their socio-economic importance or potential. The programme is flexible and can be periodically up-dated in accordance with the recommendations of the FAO Panel.

Within each project, activities recognized as essential steps to maintenance of genetic diversity and to the fuller use of existing genetic resources are (i) exploration; (ii) collection; (iii) evaluation; (iv) conservation; and (v) utilization. Ancillary activities, essential to a balanced programme comprise (vi) dissemination of information; (vii) data storage and retrieval; (viii) training; (ix) seed certification and (x) overall coordination.

PROGRESS

The Global Programme, or parts thereof, has been submitted by FAO to a number of donor agencies, viz. UNDP (1972; 1979); CGIRAR/IBPGR (1974); UNEP (1975); and DANIDA (1979–80)1/. Specific, short-term programmes have been or are likely to be approved by these agencies, however, no agency has so far undertaken to finance longer-term programmes on a global scale, nor to strengthen the central coordination presently carried out by FAO's Forest Resources Division on a part-time basis.

In this paper, the Global Programme is interpreted in its broadest sense, i.e. progress in all activities contributing towards the general aims of the Programme is considered.

The FAO Panel of Experts on Forest Gene Resources

Although at the time of the establishment of the FAO Panel in 1968 some national institutes had already been involved in systematic collections of forest tree seeds for international use, the Panel has without doubt acted as a catalyst both for international and national activities in the exploration, collection and investigation of forest genetic resources through creating a world-wide awareness of the need for conservation, and through channelling international and national funds to pilot schemes and action in these fields.

The Panel has met four times; reports of these meetings listing progress, past and present trends and recommendations for future action, have been published by FAO (FAO 1969; 1972; 1974a; 1977b).

Expenditure recommended by the Panel for programmes coordinated by FAO's Forestry Department has to date concentrated on the exploration, collection and conservation of genetic resources and on dissemination of information and training (see Appendix I for a summary of direct financial contributions by FAO). In addition to national institutes, FAO cooperates in these activities with other international agencies such as UNEP, UNESCO, IUCN, and collaborates actively with relevant Subject Groups and Working Parties of IUFRO; some funds have also recently been received from IBPGR (see below).

Exploration, Collection, Evaluation and Utilization

Based on the priority lists drawn up by the FAO Panel, exploration and collection followed by the establishment of centrally coordinated international provenance trials have to date been accomplished for 14 tropical and 6 Mediterranean or sub-tropical species, viz. *Araucaria angustifolia*, *A. cunninghamii*, *A. hunsteinii*, *Cedrela odorata*, *Eucalyptus camaldulensis*, *E. microtheca*, *Gmelina arborea*, *Pinus caribaea*, *P. kesiya*, *P. merkusii*, *P. patula*, *P. oocarpa*, *P. pseudostrobus*, *Tectona grandis*; *Pinus halepensis*, *P. brutia*, *P. eldarica*, *Abies cephalonica*; *Pinus radiata*, *P. muricata*.

Progress is being made on the exploration, collection and distribution of a number of other species and genera, e.g. *Aucoumea* spp., *Terminalia* spp., *Acacia aneura*, *A. auriculaeformis*, *A. mangium*, *Cordia alliodora*, *Eucalyptus deglupta*, *E. urophylla*, *E. globulus*, *E. delegatensis* and *Cedrela* spp. (supplementary collections); plans have also been made for the collection/evaluation of some additional species such as *Pinus strobus* var. *chiapensis*, *P. canariensis*, *Prosopis* spp. and *Leucaena leucocephala*. Through the activities of IUFRO, good progress has been made in the collection, distribution and evaluation of temperate species, especially North American conifers and *Populus* spp. 1/. Detailed biological studies are being conducted on a number of potentially important tropical species, e.g. *Agathis* spp. and *Triplochiton* spp.

Although many of the trials established from the range-wide provenance collections are too young to have yielded accurate information, many already indicate the existence of large provenance differences and clear interactions between provenances and sites (see e.g. Burley and Nikles 1972, 1973a; 1973b; Nikles, Burley and Barnes 1978).

The earliest of these trials were started in the mid 1960s using provenance seedlots of *Eucalyptus camaldulensis* collected by a joint Tunisian/Australian team. The trials, established in 21 countries, have shown striking differences of up to 800% in growth in volume between the provenances, and have clearly indicated that the Lake Albacutya provenance from the State of Victoria is the optimum provenance in Mediterranean, winter-rainfall areas, whereas the Kathrine and Petford provenances from the Northern Territory and Queensland are the best performers in summer-rainfall areas (Lacaze (1978).

Although not as clearcut as the *E. camaldulensis* trials, some other international trials established in the 1960s and early 1970s have also given enough indications of the potentially most valuable provenances to allow coordinating institutes to proceed to second stage provenance collections, i.e. to a more intensive sampling of limited parts of the species range. This is the case e.g. with *E. urophylla* and *E. alba*; following early exploration/collection activites by Indonesian and Australian foresters in 1963, 1968 and 1971, provenance collections of these two species were made in 1973 and 1975 by a French/Indonesian team (Martin and Cossalter 1975-76). Second stage collections have recently been made through the joint efforts of the Indonesian Forest Service; CTFT, France; and CSIRO, Canberra (Anon. 1979). Second stage provenance collections of *Pinus caribaea* var. *hondurensis* and *P. oocarpa* have during the last few years been carried out by the Commonwealth Forestry Institute, Oxford. Special seed collections for the establishment of *ex situ* conservation stands have been made for *Pinus caribaea* var. *hondurensis*, *P. oocarpa* (CFI, Oxford); *Eucalyptus camaldulensis* and *E. tereticornis* (CSIRO, Canberra).

Recognizing the importance of standardized methods for accurate evaluation of the overall performance of the provenances being tested, CFI recently drew up detailed measurement/assessment forms for the over 40 countries participating in the international trials of *P. caribaea* and *P. oocarpa* established in the mid 1970s. To ensure strictly uniform criteria and identical assessment standards for a representative sample of the trials, 28 sites (out of the total of 350 experiments established) were singled out for inclusion in an overall, combined analysis; assessment of these trials was carried out in 1978/1979 by the various institutes in charge, in collaboration with an officer from CFI travelling from one experiment to another. The basis for selection of the 28 sites was (i) maximum number of common provenances; (ii) high standards of design, establishment and maintenance; and (iii) desirability to fully cover the climatic and geographic ranges of the trials. In addition to handling the combined analysis CFI will perform, at request, computerized analyses for all individual participating countries. (See also Greaves 1980 for an earlier evaluation of the trials).

A greatly increased, world-wide interest in the establishment of national seed centres as a focal point for activities related to forest genetic resources has recently been evidenced. National centres have during the last few years been established in many key areas, e.g. in Chile, Colombia, Guatemala, Honduras, India, Iraq, Thailand and Costa Rica (regional centre); and have been planned for many others, e.g. Iran, Paraguay, Peru, Senegal and Sabah. Many of these centres have received support from bilateral or international sources. The centres are likely to facilitate seed procurement at the experimental level, and it is hoped that they will also at a later stage be able to meet requests for bulk quantities of source-identified seed of specific provenances.

Efforts towards the establishment of a globally coordinated, cooperative programme on seed procurement and genetic improvement of tropical lowland conifers, including initiatives taken on a regional level in South-East Asia to further this idea, are reported in another paper presented to this Symposium (Palmberg, Willan and Nikles 1980).

Conservation

With the financial support of UNEP, FAO carried out a Pilot Study in 1975 which resulted in the publication "The Methodology of Conservation of Forest Genetic Resources" (FAO 1975b). Based on technical recommendations made in this study and on early results from exploration and the international provenance trials mentioned above, an FAO/UNEP project was started in 1975/76 for the conservation of genetic resources of selected forest tree species and provenances.

The *ex situ* component of the above FAO/UNEP project has met all expectations. During the past 4 years, 38 international *ex situ* conservation/selection stands of some 10 ha each have been established in 5 countries in Africa and 1 country in Asia, using a total of 11 provenances of 4 different species (see FAO 1977b, Appendix 7/4). In addition to the international stands financed by UNEP and FAO, some of the countries participating in the project have established national conservation/selection stands. A follow-up project was started by DANIDA in 1980. Progress in *ex situ* conservation is reported in another paper presented to this Symposium (Wood 1980).

Agreements on *in situ* conservation have proved more difficult to achieve. Funding under the FAO/UNEP project has only been provided for two botanical reserves in Zambia, for the *in situ* conservation of *Baikiaea plurijuga* (Zambesi Redwood, Zambian Teak). This action has been followed up by the allocation to Zambia by SIDA of bilateral funds for botanical investigation of this species.

A survey on the needs and possibilities of international cooperation in the exploration, collection, evaluation and conservation of arid and semi-arid zone species for the improvement of rural living, was carried out by FAO in 1979 with financial assistance from IBPGR. Eight countries in Asia, Africa and Latin America which had expressed an interest in the project were visited, species priorities were drawn up and needs for outside assistance in exploration, collection, evaluation and conservation of these species were identified. The report on this first Phase of the project (FAO 1980a, in press) makes detailed recommendations for a badly-needed second Phase; the proposals have been put forward to IBPGR, who have agreed to finance the field activities of the proposed second Phase in 1981-82, however, without provision for central coordination.

Training and Dissemination of Information

Progress in dissemination of information on forest genetic resources during recent years include the organization of several meetings, such as earlier meetings of IUFRO Working Parties on Species, Provenances and Genetic Resources (Gainesville, Florida 1971; Nairobi, Kenya 1973; Brisbane, Australia 1977); the Linnean Society Symposium on Variation, Breeding and Conservation of Tropical Trees held in Oxford, U.K. in 1975 (Burley and Styles 1976); the FAO/IUFRO Third World Consultation of Forest Tree Breeding held in Australia in 1977 (Anon. 1978a; Anon. 1978b) and the Eighth World Forestry Congress (Indonesia 1978).

1/ For information on many of the collections listed, see issues 1 to 9 of "Forest Genetic Resources Information" (FAO 1973–80). Many excellent reports on specific collections with detailed descriptions of collection sites and stands have also been prepared, see e.g. Anon. 1978d; Greaves 1978; Anon. 1979a, 1979b, 1979c; Greaves 1979; Martin and Cossalter 1975-76.

A series of tree improvement training courses financed by DANIDA has been organized by FAO in English, French and Spanish (Kenya, see FAO 1979b; Thailand, see FAO 1976; Nigeria, see FAO 1977a; Venezuela see FAO 1980b); a training course on tree improvement organized by CSIRO, Canberra and financed by the Australian Government was, in addition, held in Australia in 1977 (ADAA 1977). The International Seed Testing Association, ISTA has organized several Workshops on tree seed testing; the Overseas Development Ministry, ODM, U.K. is planning to organize during 1980 a Workshop on tree seed handling and storage at the newly established seed centre in Honduras.

Periodic news about these and other meetings and workshops, on recent relevant literature, on provenance seed collections, and on exploration, evaluation, utilization and conservation of forest genetic resources are published in "Forest Genetic Resources Information" started by FAO in 1973 and published in three issues per biennium. Several IUFRO Working Parties publish species or subject-specific Newsletters and conduct surveys on progress in fields related to genetic resources of forest trees. CFI, Oxford supplies upon request periodically up-dated bibliographies on published information on international provenance trials coordinated by that institute.

Following the publication in 1970-71 of a first, loose-leaf version of a Red Data Book on threatened plant species, a bound volume covering 250 plant species considered extinct, vulnerable or rare was published by IUCN in 1978 (Anon. 1978). The book includes some 30 data sheets on forest tree species. A supplementary volume which will include forest tree species endangered in parts of their ranges is presently being compiled by FAO in collaboration with IUCN, with financial assistance from UNEP. The purpose of this volume is to draw attention to forest tree species in which action is needed to safeguard valuable, intra-specific variation.

Among other, general publications in fields closely related to forest genetic resources, the book entitled "Genetics of Forest Ecosystems" (Stern and Roche 1974); the CFI publication "A Manual on Species and Provenance Research with Particular Reference to the Tropics" (Burley and Wood 1976); and the revised edition of the USDA manual "Seeds of Woody Plants in the United States" (Schopmeyer 1974) can be mentioned. A manual on handling and storage of eucalypt seeds presently being prepared by CSIRO, Canberra will be published shortly.

A World Conservation Strategy prepared by IUCN, UNEP and WWF with the collaboration of FAO and UNESCO, was officially launched in March 1980 (Anon. 1980). The Strategy, which "... aims at providing both an intellectual framework and practical guidance for conservation of genetic resources", calls for global coordination backed by concerted action at national and international levels to implement the programmes proposed. The Strategy has been endorsed by Governments in a number of developed and developing countries.

A summary of current developments in the fields of crop plant, forest, animal, fish and microbial genetic resources has recently been published by UNEP (UNEP 1980).

Data Storage and Retrieval

A computer-based data storage and retrieval system, **INTERPROV, was** developed in the mid 1970s by CFI, Oxford primarily to meet the needs of storing and processing information related to international provenance trials. The system will also be applicable to other related areas of research such as **selection and progeny testing, ex situ conservation, etc. (see Burley and Nikles 1973b).**

Apart from the above, not much progress has been achieved in attempts to coordinate information and standardize research criteria and results at a global level. Early results of collaboration at a regional level in the development of a computerized tree improvement information system proposed for the Nordic countries have been reported by Ditlevsen (1979).

Seed Certification

The presently most widely used seed certification scheme, the OECD Scheme for Reproductive Material Moving in International Trade (OECD 1974) is in use in about a dozen countries, all of them developed. However, the rules have served as a model for many developing countries planning to adopt certification schemes acceptable to potential buyers of seed and helpful for their own afforestation schemes (e.g. Colombia, Thailand).

LOOKING TO THE FUTURE

The account on progress made during the past decade in the field of forest genetic resources is no doubt encouraging. However, the task still before us is enormous as well as urgent.

Three problem areas in which early action is needed can be singled out: the intensifying of activities in the exploration, collection, evaluation and conservation phases for the species already given high priority by the FAO Panel; the expansion of the range and type of species presently receiving attention; and the provision of larger quantities of source- identified seed.

(i) As reported, a total of 20 tropical, sub-tropical or Mediterranean species have to date been extensively explored and provenance seedlots have been distributed to a range of interested countries for evaluation. Conservation stands ex situ have been established for 4 species, whereas in situ reserves established for genetic conservation cover only part of the range of 1 species.

The FAO Panel of Experts on Forest Gene Resources, in its latest list of genetic resources priorities (FAO 1977b), identifies a total of 160 tropical/sub-tropical/Mediterranean species which merit "priority 1" rating (urgent action needed). However, it should be recognized that this list reflects present-day knowledge: exact information on the status and on the potential value of a species will become available only in the course of exploration and evaluation. Additional species to those now listed are **therefore expected to be added as our knowledge of presently lesser-known species increases; unless the present rate of progress (15-20 species per decade) is accelerated, the list of species in need of early action is likely to expand rather than shrink in the future.**

(ii) When drawing up priorities for action, large emphasis has to date been placed on fast-growing pioneer species suitable for plantation forestry. In addition to at least some prior knowledge on genetic variation in these species, knowledge on the methodology of seed storage and on the establishment and management of plantations has facilitated action. Little attention has, on the other hand, been given to e.g. arid/semi-arid zone species or to hardwood species growing in the complex, moist tropical forest.

Arid/semi-arid zone tree species, often of vital importance for the subsistence of communities living in marginal areas, are receiving increased attention as plantation species for multiple use (shade, shelter, fuel, poles) However, little information is available on intra-specific variation in many of the species used: we are still operating on the species, rather than on the provenance level. Urgent attention is needed in the exploration, collection, evaluation and conservation of these species.

Large areas of mixed tropical hardwood forest are presently in imminent danger of extinction or genetic impoverishment due to changing land-use patterns and increasing population pressure. At the present state of knowledge the individual species in these forests, often found at low densities and often of unknown potential, can only be conserved in situ as neither seed storage nor plantation techniques are known for most of them. On the other hand, our biological knowledge of many of these species (patterns of intra-specific variation, breeding systems, life-cycle, successional status etc.) and our technical knowledge on the management of mixed tropical forests are not sufficient to enable us to competently answer fundamental questions on size and location of in situ reserves, the numbers of individuals which constitute a viable genepool etc., nor to enable us to later monitor the success of our efforts to safeguard especially intra-specific variation. Vigorous research on these species is thus urgently called for.

(iii) Identification of promising seed sources from the international provenance trials established during the past decade will gradually lead to demand for increased quantities of seed of certain provenances for conservation/selection stands, growth and management trials ("provenance proving phase") and pilot plantations plus later, for commercial afforestation. Global areas planted to an individual provenance could be of the order of 10-20 ha for initial provenance trials, 200-500 ha for conservation, management and pilot plantings, and 5 000-10 000 ha a year for a superior provenance of wide adaptability in large-scale afforestation. Seed demands will vary in proportion. International action has provided seed for conservation/selection stands of a few provenances of important species, but much more needs to be done in this respect. The bulk quantities that will be needed for afforestation will be mainly the responsibility of Government Forest Services, Seed Centres or commercial seed merchants but also at this stage, international action can do much by helping in the establishment of efficient national seed centres and through insistence on common standards of genetic and physiological quality of the material.

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1/ The letters in parenthesis indicate the languages in which the document is available.

Appendix I.

FOREST GENETIC RESOURCES & TREE IMPROVEMENT

FINANCIAL CONTRIBUTIONS BY FAO'S REGULAR PROGRAMME
($ US)

	1966/67	1968/69	1970/71	1972/73	1974/75	1976/77	1978/79	1980/81
SEED PROCUREMENT								
FRI & CSIRO, Canberra, Australia (Eucalypts, Araucaria, Acacia, P. radiata)	10 000	13 000	10 000	10 000	15 000	15 000	18 000	
CFI, Oxford, UK (Central Am. Pines)			15 000	15 000		3 000	5 000	
INIF, Mexico (Pinus spp.)			5 000	5 000	10 000	5 000	10 000	
IUFRO (N. Am. Conifers)			1 200	5 000	1 000			
UNDP/FAO/Brazil (Araucaria)				8 000	3 000			
FRI, Nigeria + CTFT, France (tropical hardwoods)				5 000	7 500	6 000	10 000	
Inst. Sper. Selvicoltura, Arezzo, Italy (Mediterranean conifers)			5 000	3 000	1 500			
Seed Centre, Macon, USA (cost of seed for developing countries)				500	1 000	1 000	2 000	
Office of Forests, Papua New Guinea (Eucalyptus, Acacia, Araucaria)						5 000	5 000	
Danish/FAO Forest Tree Seed Centre, Humlebaek (Gmelina)							5 000 1/	
P.D. [illegible]icaragua (P. caribaea)							3 500	
BANSEFOR, Guatemala (P. caribaea, P. oocarpa, P. strobus var. chiapensis)							2 800 1/	
Fiji Pine Commission (P. caribaea)							3 000	
Queensland F.D. (P. caribaea)					1 000			
Miscellaneous		1 500						
SUBTOTAL	10 000	14 500	36 200	51 500	40 000	35 000	64 300	(96 000)
EX SITU CONS. STANDS								
FRI, Nigeria						5 000		
CCF, Congo						5 000	2 000	
SUBTOTAL						10 000	2 000	
DISSEMIN. OF INFORMATION								
'Forest Genetic Resources Info'				16 000	17 500	38 000	42 000	(34 000)
'Methodology of Conservation' (FO:MISC/75/8)						10 000	7 000	
SUBTOTAL				16 000	17 500	48 000	49 000	(34 000)
ME[illegible]S								
FAO Panel of Experts on Forest Gene Resources		10 000	9 000		14 000	19 000		(67 000)
3rd World Consultation on Forest Tree Breeding						58 000	4 000	
SUBTOTAL		10 000	9 000		14 000	77 000	4 000	(67 000)
CONSULTANCIES								
Seed proc. & conservation of Tropical Lowland Conifers (Nikles)						15 000	17 000	
Conservation of Forest Genetic Resources, Africa (Wood)							14 000	
SUBTOTAL						15 000	31 000	
HQ STAFF, DIRECT COSTS 2/ 3/	5 000	10 000	16 000	35 000	25 000	64 000	60 000	(60 000)
TOTAL (approximate)	15 000	34 500	61 200	102 500	96 500	234 000	210 300	257 000

1/ Carried forward (in part or fully) to following biennium

2/ Includes posts financed by Finnish Govt Programme (1971-74) and by UNDP (1976-78)

3/ Includes implementation of (i) FAO/UNEP Project 1108-75-05, Conservation of Forest Genetic Resources (1975-81); (ii) FAO/IBPGR Project, Phase I, on Genetic Resources for the Improvement of Rural Living in Arid and Semi-Arid Areas (1978-79).

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SISTEMA E PROGRESSOS DE PROGRAMAS COOPERATIVOS DE MELHORAMENTO DE ÀRVORES COM *PINUS RADIATA* NO SUL DA AUSTRÀLIA.

L.A. Pedreick.

. Forest Commission Victoria, Melbourne. Australia.

Resumo

Na Austrália, a maior parte das áreas florestais são administradas pelo State Government Forest Service, assim como a maior parte dos programas de reprodução de *Pinus radiata*, embora o CSIRO Division of Forest Research e duas companhias sejam também bastante ativas. O desenvolvimento de programas cooperativos de melhoramento de árvores é o resultado de esforços de um grupo oficial de pesquisadores representando às organizações participantes.

Um grupo de pesquisa em Genética Florestal foi estabelecido em 1967 para aconselhar os administradores do Standing Committee of Forest Service nas necessidades da pesquisa. O grupo de trabalho, formado por pesquisadores de cada programa de melhoramento, reconheceu a necessidade de cooperação para melhorar a eficiência dos programas individuais, e foi dada gradualmente responsabilidades e poderes para agir nesta área. Não há apenas um líder para o programa cooperativo, ou melhor a liderança é repartida e orientada. O Radiata Sub-commitee foi formado em 1977. O trabalho de coordenação fok facilitado por indicação de um membro da CSIRO Division of Forest Research para manter as informações e processar os dados para o grupo de trabalho. Referência é feitá com relação ao progresso atingido pelo programa.

ESTABLISMENT AND PROGRESS OF CO-OPERATIVE TREE IMPROVEMENT PROGRAMS WITH *PINUS RADIATA* IN SOUTHERN AUSTRALIA.

Summary

In Australia most of the forest areas are administered by State Government Forest Services. Likewise, most of the radiata breeding programs are undertaken by State forest departments, although the CSIRO Division of Forest Research and two companies are also active. The development of co-operative tree improvement programs has resulted from the efforts of an officially appointed group of research workers representing the participating organisations.

A Research Working Group on Forest Genetics was established in 1967 to advise a Standing Committee of Forest Service administrators on research needs. The Working Group, comprised of workers from each of the breeding programs, recognised the need for co-operation to improve the efficiency of individual programs, and was gradually given increased responsibility and powers to act in this area. There is no single leader for the co-operative programs, rather, leadership is shared, and advisory only. A Radiata Sub-committee was formed in 1977. The work of co-ordination has been facilitated by the appointment of a worker by CSIRO Division of Forest Research to maintain records and process data at the direction of the Working Group. Reference is made to the progress achieved.

INTRODUCTION

A co-operative approach to breeding radiata pine has been in progress for some years among a number of forest organisations in southern Australia. It probably differs from other tree breeding co-operative schemes and so it may be of interest to relate the details.

The Australian model has no recognised leader who directs or supervises the work of the co-operating organisations. Rather, the leadership is shared among a small elected and voluntary sub-group of the Australian tree breeders, most of whom are members of a formal body known as the Research Working Group on Forest Genetics. This may be seen by some to be a weak system, but it has resulted in significant advancement of tree breeding practice in the country.

Before proceeding to describe the co-operative it is necessary to understand the situation in Australia with regard to forestry and the breeding programs.

The great majority of the forest area of Australia is publicly owned and administered by a separate forest department in each State. The State forest departments established extensive Pinus radiata plantations in the southern part of the country. Although companies and individuals now account for half the new plantings in some States, the number of companies planting a sufficient area to justify participation in a tree breeding program is small.

HISTORICAL BACKGROUND

Tree improvement research in Australia was begun by the Forestry and Timber Bureau, the national forestry research organisation, subsequently known as the Forest Research Institute and, since 1975, as CSIRO Division of Forest Research. The research program reached a notable stage in 1957 when the first P. radiata seed orchard was established at Tallaganda, N.S.W. At about this time interest in the prospects for improving the species by breeding spread throughout the country and by 1960 tree improvement programs for Pinus radiata were initiated by all State departments except Queensland (which virtually had no radiata plantations) and a couple of companies followed in later years. The then Forestry and Timber Bureau was also involved in two regional programs. The programs developed slowly due to the small number of workers (usually only one professional per organisation), and the limited contact between them. Some developed their expertise through postgraduate training in Australia or overseas. By the late 1960's the need for a formal organisation of tree breeders which could meet and discuss technical matters for mutual benefit was most acute.

At this stage the State forest service administrators meeting under the framework of the newly constituted Australian Forestry Council recognised a need for expert staff working in various research disciplines to meet periodically to review the state of knowledge and advise where action could be taken. The Research Working Group on Forest Genetics was the first such group to be formed and there are now 12 Research Working Groups each responsible for a different research discipline. Membership of Groups comprises one or two workers from each of the State forest services, the national forest research organisation, industry, Universities and other CSIRO Divisions. Meetings have been held at two-year intervals and the venue has rotated among member organisations. Research Working Group on Forest Genetics has been one of the more successful of the Groups probably because there is great scope for co-operation between workers in this discipline. 1960 - 80 has been a time of very rapid development of the principles and practice of tree breeding, which are applicable to all species subject to tree improvement, and one species in particular, Pinus radiata, is central to the improvement programs of all but one of the member organisations.

With respect to the P. radiata programs it soon became evident that there was much to be gained from co-ordination of the programs and that such co-operation could lead to increased efficiency.

DEVELOPMENT AND ACTIVITIES OF THE CO-OPERATIVE

Groups of members were assigned to take responsibility for particular fields of the work and to report to meetings on latest developments. Topics reported in this way included selection criteria, seed orchard management, wood quality, importation of selected germ plasm, and statistics on seed orchard establishment and seed requirements throughout the country.

An important project was preparation of a national register of plus trees, which has facilitated the exchange of scions among the breeding programs. This was followed by a register of progeny trials and preparation of standard methods for evaluating progeny trials. Some co-operative progeny trials were established and a computer program, developed for analysis of progeny trials, provided a convenient and uniform presentation of results for user organisations. Some of the above co-operative efforts may have happened without the stimulus of the Working Group but the degree of interchange would have been less and confined to workers who actively sought collaboration and these would probably have been the more experienced workers.

Following concern expressed by the Research Working Group for the need for training courses in tree breeding, a three week course was held in January 1976 by the Department of Forestry, Australian National University.

The development of a breeding strategy, involving the consideration of evolving theories and recommendation of procedures appropriate to local conditions, has been the most important issue undertaken by the Research Working Group. It is the area in which co-ordination of breeding programs is seen to provide the greatest advantages to members.

The Research Working Group considered this task too large to be undertaken effectively within the time and facilities available to its members. On two occasions, in 1970 and 1974, it recommended to the forest service administrators that experienced leadership be obtained to assist the Group, firstly on a consultative basis, and at the second time, on a full-time basis located at Canberra. Neither recommendation was accepted by Standing Committee which replied that the co-ordination of research should be a function of the Working Group itself, rather than of an individual employed by one organisation. It is likely that this attitude was influenced by problems of funding the employment of such a person, and possibly also by not wishing to promote a situation where an employee of one organisation, particularly a Commonwealth organisation, was in a position to direct the work of other organisations.

By 1976 the Group accepted that the co-ordination of programs must be a self-administered objective and moved to establish a Radiata Sub-committee of its own members to advise the Group on proposals for co-operative action. The Sub-Committee was elected in early 1977. By this time the work of maintenance of central records had become too heavy a task for any member to continue voluntarily in addition to his normal duties. A successful approach was made to the national forest research organisation, CSIRO Division of Forest Research, to have a person appointed, part of whose duties would be to maintain records of the co-operating programs. The records have since been used to examine such important problems as genotype x environment interactions and stability of genotypes in different regions, so the appointment has been justified on the basis of achieving research results of national importance. The appointment of this person has relieved the members of the Sub-Committee of routine tasks and enabled them to give attention to the wider questions of planning for advanced generation breeding.

PROGRAMME AND ACHIEVEMENTS OF THE CO-OPERATIVE

To sum up the current situation, a Radiata Sub-Committee, composed of four members, advises the Research Working Group on proposals for co-ordination of programs, and acts between meetings to implement them. The Sub-Committee is supported by a staff member of the Division of Forest Research who maintains records but who is not empowered to direct activities of members.

In addition to the projects mentioned earlier the Research Working Group has advised or undertaken the following on behalf of its members :

(1) The recommendation to members of a breeding strategy involving the use of a disconnected partial diallel system of progeny testing.

(2) Co-ordination of the control-crossing programs for the diallels and the sharing of seeds among co-operating members.

(3) Provision of seeds from standard crosses to be used for control purposes in all progeny trials undertaken by co-operating members.

(4) Advice to members on the most suitable clones to be used in new seed orchards, based on analysis of extensive progeny information obtained from member sources.

(5) Prepared a Co-operator's Manual which documents principles and procedures for breeding P. radiata.

The Research Working Group has also provided the means of communication through which initiatives undertaken by individual members have been made available to co-operating members. These include :

(1) Participation in a radiata gene pool experiment initiated in New Zealand in 1970.

(2) Distribution of scions from clones imported from New Zealand in 1978.

(3) Distribution of seeds collected from natural stands in North America in 1978 for the purpose of provenance trials and widening the genetic base of breeding program, and discussion of procedures for their best use.

Mention should also be made of the exchange of information obtained through contact with radiata breeders in New Zealand. Over the years there has been an interchange of visits on an individual basis. Visits by New Zealand colleagues have usually been timed for them to attend meetings of the Working Group. Information gained by Australians during visits to New Zealand has been disseminated to other members at meetings and by means of the Working Group's Newsletter.

Participation by many Group members in the IUFRO Working Party on Breeding Radiata Pine has resulted in further communication with overseas radiata breeders to the benefit of all concerned.

FINAL COMMENT

The Research Working Group has functioned as a co-operative and produced significant progress toward co-ordination of breeding Pinus radiata in Australia. However, the voluntary basis of the membership and contribution to the co-operative should be recognised. Some members are much more active than others and are making a much greater contribution to the objectives.

In the case of this co-operative, in which most of the members represent state or national departments of the one country, such an arrangement can be acceptable in the national interest in order to encourage the less active organisations to implement improved practices. However, it is recognised that such a voluntary arrangement is unlikely to be acceptable in cases where membership of a co-operative is predominantly from private enterprise.

FAST GROWING TREES

PROGRAMA DE MELHORAMENTO DE *PINUS RADIATA*, NA NOVA ZELÂNDIA - PROGRESSOS, PROBLEMAS E PLANEJAMENTO FUTURO.

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Resumo

O programa de melhoramento de *P. radiata*, na Nova Zelândia, começou em 1953, baseado em uma seleção fenotípica intensiva e em pomares de sementes. Os pomares de sementes, plantados de 1957 a 1964, foram baseados em 14 a 36 desses clones. Os testes de progênies, através da polinização controlada, foram efetuados com muito atraso. A compposição desses pomares somente foi modificada em função da eliminação dos clones inferiores, através dos resultados dos testes de progênie.

Em 1968, uma nova estratégia foi usada, uma seleção fenotípica menos intensa, a utilização de maior número de árvores, combinada com a instalação imediata de teste de progênie de polinização livre, tornou possível o estabelecimento a partir de 1976, dos pomares "de uma e meia geração", nos quais somente 60 das 600 árvores originais permanecem, em função dos resultados dos testes de progênie, aos dez anos de idade.

Pomares de sementes de segunda geração, instalados a partir de clones selecionados, nos testes de progênie de polinização, envolvendo os melhores clones da primeira e segunda geração, estão sendo produzidas e os testes do progênie resultante fornecerão populações, para seleções em gerações avançadas, com mais alta qualidade genética do que de qualquer uma das atualmente existentes.

Pomares de sementes, por mudas, estabelecidos a custos baixos em função de sementes de descendência de polinização controlada ou de sementes misturadas, também estão sendo instalados, como medida de segurança, quanto a perda de pomares clonais ou a ausência de produção de sementes.

Testes de procedência e plantações, para conservação genética, instaladas com sementes colhidas em populações nativas, de *P. radiata*, o desenvolvimento de técnicas para a propagação vegetativa massal de famílias selecionadas, bem como a seleção em gerações avançadas, formarão as áreas de intensa atividade na próxima década.

NEW ZEALAND'S *PINUS RADIATA* BREEDING PROGRAME - PROGRESS, PROBLEMS, AND FUTURE PLANS.

Summary

New Zealand's radiata pine (Pinus radiata D. Don) breeding programme began in 1953 with very intensive phenotypic selection of prospective orchard clones. Clonal orchards planted 1957-64 were based on 14 to 36 of these clones. Progeny testing of these normally utilised control-pollinated progenies and was much delayed. Composition of these orchards has been modified to only a minor extent by roguing on progeny test results.

In 1968 a new strategy was adopted of less-intensive phenotypic selection of larger numbers of trees; this, combined with immediate initiation of wind-pollinated progeny tests, has enabled the establishment since 1976 of "1.5 generation" orchards in which only 60 of the original 600 parents will remain, as determined by 10-year-old progeny test results.

Second-generation orchards of clones selected in these same wind-pollinated tests are now being planted. Seed has also been produced by controlled pollination amongst the best first- and second-generation clones and the resulting progeny experiments will provide a source of advanced-generation selections of higher genetic quality than any presently available.

Low cost "extensive seedling seed orchards" are being established from bulked control-pollinated offspring as disaster insurance for the clonal orchards and for back-up seed production.

Provenance testing and gene conservation plantings with seed collected from the native stands of radiata pine, the development of methods for mass vegetative multiplication of selected families, as well as advanced-generation selection will form areas of increased activity in the next decade.

INTRODUCTION

The radiata pine breeding programme in New Zealand reached a watershed in its development this year with the completion of the tenth-year assessment of nearly 600 wind-pollinated progenies. It is these clones and their selected offspring that will take production of improved radiata pine seed into the twenty-first century. The preceding development of this programme is a convoluted but essentially logical one and is outlined below (see Fig. 1).

THE BREEDING PROGRAME TO DATE

Phase 1 - Intensive plus-tree selection; clonal seed orchards

The first round of tree selection undertaken from 1953 to 1958 was very intensive, with about one tree selected per 100 ha of 27- to 30-year-old stands. These clones (registered as "850" series) were selected mainly in the central North Island, but some were selected in the Nelson region (northern part of the South Island) and also in Canterbury and Southland (South Island). Fourteen clones from the central North Island were used in the earliest orchards at Kaingaroa and Gwavas, and this number was later increased to 25 and then 36, there and at Waimihia. Two orchards were planted at Amberley (near Christchurch), one with 20 Canterbury clones, and another with 20 clones from Southland. This early regionalisation of orchards was done in the absence of any information on the effects of site and of genotype x site interaction. Grafts or scion material of the North Island clones were supplied to two companies, N.Z. Forest Products Ltd and Tasman Pulp & Paper Co. Ltd, who planted orchards on their own lands near Tokoroa and near Te Teko.

Progeny testing of these orchards did not start until 1968, with a test of wind-pollinated seed collected from the oldest 14-clone orchard at Kaingaroa. Further tests were planted with wind-pollinated seed from the Tasman Pulp & Paper Co. orchard at Te Teko in 1971 and an NC II 4-tester factorial (23 clones) at Kaingaroa in 1972. A polycross test of the 70 originally selected "850" clones not used in seed orchards, as well as 40 Amberley orchard clones selected in the South Island, was planted in 1975. The delays in the progeny testing programme were caused partly by insistence upon controlled pollination or orchard open pollination, and partly by the destruction of a completed set of control-pollinated crosses in a 1966 cold-store malfunction.

Results of the orchard wind-pollinated and NC II tests have now provided information on which to select the best clones in these original "850" orchards, but the numbers of clones (14 to 36) planted in these orchards and in the Amberley orchard do not allow intensive reselection to remove genetically poorer clones. All the "850" orchards up to 1975 were established with grafts and these are hit by incompatibility between the ages of 5 and 15 years, causing losses of up to 60% depending on site. Removal of genetically poor clones has been held back because incompatibility losses have been occurring at almost the same rate as normal thinnings should have been applied. Further stocking reduction would cause an unacceptable shortfall in seed production in much of the area.

Phase 2 - Extensive plus-tree selection; wind-pollinated progeny tests; 1.5 generation orchards

In 1968 the previous strategy of intensive but limited phenotypic selection of orchard clones was revised in the light of a newer appreciation of selection theory. This allowed less-intensive phenotypic selection of much larger numbers of clones, which would be immediately tested by means of wind-pollinated seed collected from the parent ortets. A selection programme in 12- to 18-year-old stands in the northern part of Kaingaroa Forest (central North Island) resulted in 588 plus-trees ("268"-series clones) being selected, from which cuttings and wind-pollinated cones were collected. In 1969 progeny tests of all these clones were planted at three North Island sites. Progeny tests of 220 of the same families were planted on a further four sites, including three in the South Island, in 1971. A clonal archive was established at the same time and this has been kept hedged to prevent further ageing, to allow plentiful production of cuttings, and also to provide easily accessible flowers for controlled pollination.

In 1974 when the progeny tests were aged 5 years an assessment for diameter growth, bole straightness, and branch quality enabled a ranking of the clones to be made using a multi-trait selection index. The best 120 clones were further assessed, for height and wood density, a year later allowing a ranking incorporating volume, straightness, branch quality, and wood density, and this ranking has been the basis of the choice of about 80 clones for "1.5-generation" seed orchard planting by the Forest Service and three companies in the period from 1976 to 1979. This large number was planned to be reduced by about half on the basis of the tenth-year assessment of their progenies.

In 1979 the 10-year assessment of the "268" progenies was completed at three sites. Traits assessed were diameter, bole straightness, branch habit, wood density (by Pilodyn penetrometer), and susceptibility to Naemacyclus needle cast. Some 45 000 trees (half the original number, after thinning) were assessed, and a combined selection index based on all traits at the three sites has allowed the selection of a group of progenies (and thus their "268"-series parents) that have performed well at all sites. The best 60 clones are being propagated for future orchard planting by the Forest Service and forest industries and existing orchards will be thinned to these best clones only. A further reduction to about 40 clones will be made on the basis of clonal traits important in the orchard, particularly total cone and seed production.

At present, all breeding work and progeny testing is carried out by the Genetics and Tree Improvement group at the Forest Research Institute, though sites are sometimes provided by co-operating companies with their own orchards. Ring-bark pretreated but unrooted cuttings are normally provided to the companies for setting in their own nurseries, for eventual orchard planting.

Phase 3 - Second-generation selection and seed orchards; third-generation progeny tests

A selection was made of the best 97 individual trees (the "875" series) from the best 59 "268"-series wind-pollinated families in 1975 using a combined multi-trait within- and between-family index. These clones have been and will continue to be propagated by means of grafts and cuttings into orchards. They offer potentially significant gains in wood density but their offspring are still unproven. Their genetic gains are expected to be about the equal of those of the "268"-series orchards. Between 1975 and 1977, 97 of these clones (actually the original ortets) were mated together in a disconnected half-diallel design, involving 10 crosses per group of five parents with a total of 143 crosses. These third-generation controlled crosses were planted in 1980 in tests at two sites.

Results of the 10-year assessment of "268" progeny tests have enabled the family and individual performance of the "875" clones to be checked and caused some to be rejected. An additional 190 clones were also selected from these data from one site using an index drawing family information from three sites and individual-tree values from one. These "880"-series clones are being progeny tested using wind-pollinated seed collected from the parent ortets, and the progenies will be planted at three North Island sites in 1981. GCA information from these tests and the "875" diallels will enable a small group of "875" and "880" clones to be reselected for future clonal orchards.

Seedling seed orchards

In 1977 another improved seed production programme was initiated involving the "268" series of clones and their offspring. It had been shown theoretically that a stand produced from control-pollinated offspring from the "268" series of clones would produce seed genetically as good as that from a clonal orchard of the "268" clones themselves, even when thinning of the seedling orchard was done on phenotype alone, and not on family as well as individual performance. An unpedigreed stand could thus be planted, mixing control-pollinated families, and thinned on individual performance. It could be a dual-purpose stand to produce seed as well as sawlogs, and extra costs of use as an "extensive seedling seed orchard" (ESSO) would be confined to the costs of producing the control-pollinated seed and of more careful marking for thinning.

Controlled crosses were therefore made with this end in view; the best 90 of the "268"-series clones were mated as females in clonal archives each to two different "875"-series clones (as males), taking care not to mate any "268" female with its own offspring. These ESSO's were conceived as a high-quality yet inexpensive back-up and insurance against disaster for the clonal seed orchard programme, capable of making up a shortfall of seed production in the clonal orchards. They will take rather longer to come into seed production and will be planted on high-quality, good seed-producing sites. Enough seed is on hand for planting of about 120 ha in 1981.

Control-pollinated families for advanced generation selection

The 150 ESSO families will also be planted in pedigreed family tests on other sites to allow selection of the best families and of the best individuals within families for use in future clonal orchards. The pair-cross mating design has limitations when used for this purpose; if specific-combining-ability effects (non-additive genetic variance) are appreciable, then these will be inseparable from general-combining-ability effects and will result in errors in selection for GCA. Identification of superior families can be utilised by two-clone orchards and by mass vegetative multiplication of control cross seed.

An earlier disconnected diallel crossing design amongst 25 of the "850" seed orchard clones was planted at 12 sites throughout New Zealand in 1975. The major objectives of this experiment were to investigate genetic parameters and genotype and environment interaction, but second-generation trees will also be selected from these trials to include in the future breeding population and in seed orchards.

Third-generation trees will naturally be selected from the disconnected diallel crosses amongst the "875" clones described earlier.

A further series of crosses amongst the best of the "268" series parents was carried out from 1978 to 1981 in a disconnected 4 x 4 factorial design, resulting in 256 families which will be outplanted in family experiments to allow selection of individuals to propagate in second-generation orchards.

An additional project to produce pedigreed trees for second-generation selection was initiated in 1969. Radiata pine breeders from 13 different programmes, located in New Zealand, Australia, Africa, Europe and the United States contributed a total of 319 seedlots which were then divided into 14 complete sets and redistributed to most of the donors and to some other programmes which were not in a position to supply seed. Three-quarters of those seedlots were from seed orchard parents, and were mostly wind-pollinated families collected in seed orchards. New Zealand's experiment was planted in 1974 and is now being assessed to provide additional select trees from the best families with a wider genetic base than available locally.

THE FUTURE

Clonal orchards; mass vegetative multiplication; provenance testing and gene conservation

This, then, is the structure of the radiata pine breeding programme as it enters its fourth decade. Provision of new and better clones from advanced-generation family plantings is assured. The clonal composition of first-generation reselected orchards of "268" clones is now finally determined. Orchard expansion will go ahead limited only by finance and land availability. Replacement of the "850"-series orchards in which selective thinning has been minimal will proceed as fast as maintaining current seed production will allow - which is, slowly. The amount of genetic improvement for the "268" and "875" orchards is expected to be greatly increased over the "850" series, but the only way to get this extra improvement into the forest is by increasing orchard area.

New Zealand has now more than 430 ha of radiata pine clonal seed orchards planted. Over 2500 kg of seed were collected from the orchards in 1980 and the production will increase by 1985 to about 3000 kg/year which will cover at least 60% of New Zealand requirements for radiata pine seed. For the next 5 years all the seed will come from "850" clonal orchards; thereafter an increasing proportion will come from "268" orchards.

It is theoretically possible to produce improved tree stocks with much greater genetic gains than achieved by the best of current clonal orchards. Firstly, if seed could be produced in quantity from just the very best general combiners in the orchards mated to similarly good clones, this could as much as double genetic gains simply by eliminating pollen contamination and restricting crossing and seed production to a few of the very best clones. Non-additive genetic variance could additionally be exploited once a range of crosses of good clones has been evaluated and the resulting production of the best specific crosses would offer additional benefits. Large-scale artificially controlled pollination is one way to achieve this, but it is doubtful whether commercial quantities of seed could be produced. However, it may be feasible to produce many plants from each seed through vegetative propagation by means of stem cuttings, needle fascicles, or tissue and embryo culture. It is in these areas where work is actively proceeding and where the possibilities for large gains lie in the future.

The use of tested clones (as opposed to families) is another means of exploiting non-additive genetic variance. Much experience has been gained in the past in this area: hedging has been successfully developed to maintain the current physiological age of clones; many clonal tests have been established, and techniques for rooting cuttings in open nursery beds have been perfected. However, the problem of ageing or maturation is the main one that has prevented this approach being successfully adopted for large-scale application. To select young enough for clones to be sufficiently juvenile and vigorous is to be too young for meaningful selection. This in turn means maintaining large numbers of clones in hedges before results of clonal tests become known; and large areas of hedges are then needed to produce commercially significant numbers of cuttings. Research on these aspects will continue, aiming at selecting and multiplying clones for specific end-uses.

A new dimension for New Zealand radiata pine breeding in the 1980s involves provenance selection. Seedlings of 14 native subpopulations have been planted in provenance tests on 23 sites and in seed production blocks in 1980. The seed was collected by a joint CSIRO Australia/FRI New Zealand team for provenance testing (something not done properly before), for selection, and for gene-conservation plantings. It is possible that important provenance variation exists between the native populations and that certain ones may be better adapted than others to particular sites. Introduction of genotypes from some of these populations into the New Zealand breeding programme will be desirable anyway in the long run to offset the effects of increased relatedness or inbreeding. Meanwhile it is intended to ensure that stands of unimproved stock of the New Zealand "land-race" are planted each generation as a further source of genetic variability.

The present New Zealand radiata pine stands are a hybrid mixture of two of the native California populations, Año Nuevo and Monterey. Although good results have been obtained by experimentally crossing this land-race to Guadalupe and Cedros Island radiata pine the future directions of provenance hybridisation are uncertain and more research must be done in this area in future.

Selection criteria

Selection criteria have evolved somewhat since the inception of the programme in the early 1950s. Then, trees were selected for vigour, bole straightness, freedom from malformation, light flat-angled branching, and freedom from stem cones on the lower stem. In the phenotypic selection of the "268" ortets, freedom from stem cones was not included and a specifically multinodal branch habit with evenly developed, regularly spaced clusters was favoured. At the first assessment of the "268" wind-pollinated families and for the selection of the second generation "875"s from these, selection for high wood density was added to these criteria but was done only amongst the best 120 of the families. Finally, in 1979 at the second assessment of these families all 588 were evaluated for density by means of the Pilodyn penetrometer and all were also scored for defoliation by the needle cast fungus Naemacyclus niveus. Narrow sense heritabilities estimated from these large wind-pollinated tests were from 0.25 to 0.40 for diameter, bole straightness, branch habit, needle cast, and Pilodyn penetration. Malformation had a lower heritability of 0.10. Future shifts in selection criteria are likely to occur as technological requirements change, as genetic improvement is obtained, and as new diseases become important.

Base population controls and genetic gain estimation

In most progeny tests established in the past, and those to be established now and in future, genetic gains are and will be monitored by including unselected base population seedlots in the experiments. Problems have occurred in the past with non-representative control seedlots and recently a large, carefully sampled, commercial seedlot was set aside for inclusion in all future trials.

It is also important to establish experiments to measure genetic gains of commercial seed orchard lots, at regular intervals, using this base population seedlot. Such experiments have been planted on 27 sites in 1978-1980 which also included bulked polycross progenies designed to simulate as closely as possible the genetic composition of future clonal orchard seed.

ACKNOWLEDGEMENTS

This paper traces the development of the radiata pine breeding programme since it was initiated by Ib Thulin in 1952. The programme and the staff who run it have grown steadily in the last 30 years but most professional and technical staff have remained with the group. These people and their functions are given below:

Ib Thulin (Research Field Leader): Administration, direction of research and breeding, clonal seed orchard planning.

Rowland Burdon: Breeding strategy and selection methodology, genetic studies in base populations.

Trevor Faulds: Vegetative propagation research, production of cuttings and grafts for seed orchards, archives, clonal tests.

Tony Firth: Progeny test assessment, controlled pollination programmes, development of hedged archives, general field organisation.

Charles Low: Data processing, computer programming, statistical analysis.

John Miller: Seed orchards, progeny test establishment and assessment in South Island.

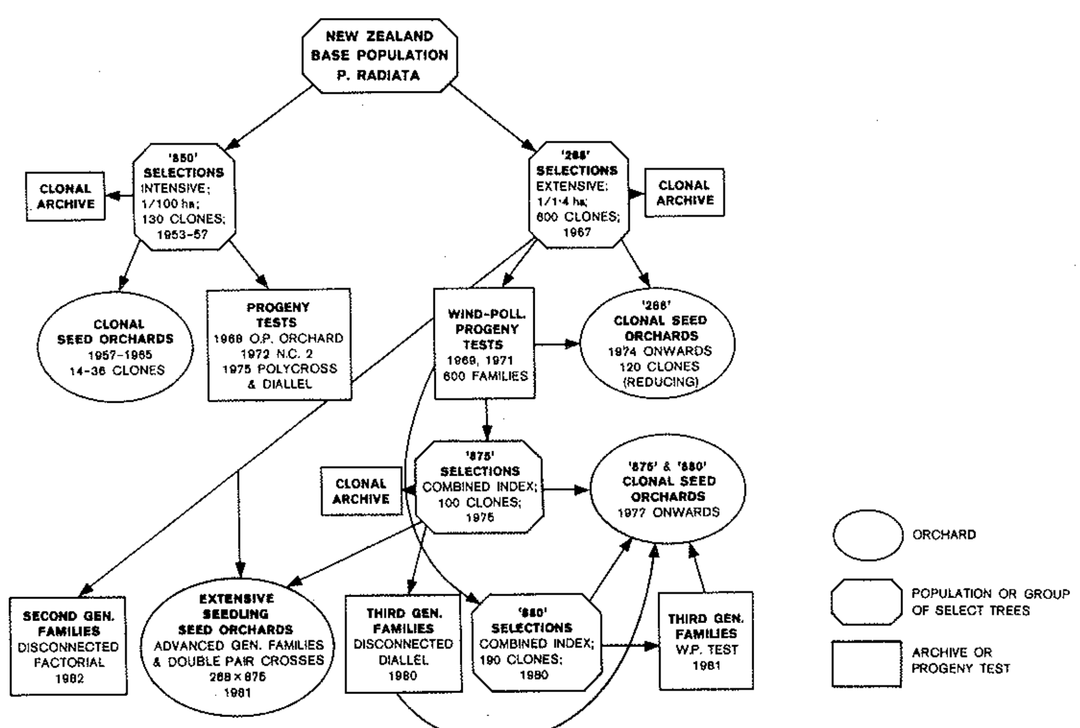
Tony Shelbourne: Breeding planning, progeny testing, advanced-generation selection.

Geoff Sweet (now in research administration): Seed orchard problems, research on flowering and ageing.

Gerry Vincent: Field trial establishment, records, clonal seed orchard establishment and management.

Mike Wilcox: Breeding and selection methods, statistical methods, computing methods.

FIGURE 1 P. RADIATA BREEDING PROGRAMME IN NEW ZEALAND



FAST GROWING TREES

COLETA, DISTRIBUIÇÃO E MELHOR APROVEITAMENTO DE RECURSOS GENÉTICOS FLORESTAIS AUSTRALIANOS - O PROGRAMA DO CENTRO DE SEMENTES, DIVISÃO DE PESQUISA FLORESTAL, CSIRO, CANBERRA.

J.W. Turnbull

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Resumo

O desenvolvimento histórico do Centro Nacional da Austrália para a coleta e distribuição de sementes florestais é revista. A política corrente do centro e os programas e alguns passos tomados para melhorar o uso de recursos genéticos de árvores florestais australianas são delineadas. A necessidade de complementar este trabalho através de arranjos para avaliação de espécie e testes de procedência em outros países é acentuada.

THE COLLECTION, DISTRIBUCTION AND IMPROVED USE OF AUSTRALIAN FOREST GENE RESOURCES - THE PROGRAM OF SEED CENTRE, DIVISION OF FOREST RESEARCH CSIRO, CANBERRA.

Summary

The historical development of Australia's national centre for the collection a . distribution of seed of forest trees is reviewed. The centre's current policies and programs and some steps being taken to improve the use of the gene resources of Australian forest trees are outlined. The need to complement this work through improved arrangements for the evaluation of species and provenance trials in other countries is emphasised.

INTRODUCTION

Australian trees are now being planted on a very large scale throughout the warm temperate and tropical regions of the world. They provide raw materials for both industry and domestic use and often have great social significance in the latter role. In the last two decades extensive exploration and seed collection has been undertaken in Australia by a national seed collection and distribution centre, now part of the Division of Forest Research CSIRO (DFR) Canberra. Since its inception, the aim of the centre has been to provide authentic and representative samples of seed of Australian forest trees for experimental purposes, including trial plantings. Numerous species, including ones of established importance, still await examination.

This paper reviews the historical development of the national seed centre and outlines its current policies and programs. Some of the steps that are being taken by the DFR to improve the use of the gene resources of Australian forest trees through continued exploration and collection of seed to strict scientific standards are described. The need to complement this work in Australia through the systematic evaluation of species and provenance trials in other countries is emphasised.

HISTORICAL REVIEW

An Australian national seed collection and distribution centre was established in 1961 to assist other nations through the provision of forest tree seeds. The origin of the Australian centre can be traced to the 5th Session of the FAO Asia-Pacific Forestry Commission, India 1960, which made a strong recommendation that FAO consult with the Australian Government with a view to organising a supply of certified eucalypt seeds for international use (FAO 1961). In response to a request from FAO the Australian Government agreed in 1961 to set up a centre with three main objectives (Jacobs 1961):

> To assemble and disseminate technical information on *Eucalyptus* species, most suitable for maximum wood production and for sheltering field crops, for use in countries outside Australia.
>
> To assist in the procurement of seeds of *Eucalyptus* species suitable for use in countries outside Australia.
>
> To conduct research in genetics of *Eucalyptus* and in tree breeding for improved varieties.

Jacobs envisaged the newly-formed Forest Research Institute of the Forestry and Timber Bureau to be the logical base for the centre. The desirability of a central seed service to reduce duplication of effort was agreed to by the autonomous State Forest Services in Australia. Appointment of a professional forester enabled the work to commence. Seed orders, which included over 400 kg of eucalypt seed in 1963, were passed on to the most appropriate suppliers, usually State Forest Services or private seed collection companies.

The first seed collections for provenance research began in 1963 with sampling of *E. maculata* and *E. pilularis*. The following year attention turned to *E. camaldulensis*. This is the most widespread of all the eucalypts, occurring naturally in all the Australian States, except Tasmania. Collection expeditions were arranged in cooperation with FAO and Colombo Plan Fellows from India, Pakistan and Tunisia. Six months of field work resulted in seed being obtained from much of the natural range of *E. camaldulensis*. This seed formed the basis of international provenance trials established on 32 sites in 14 Mediterranean and tropical countries under the auspices of the Mediterranean Forestry Research Committee (Lacaze 1978). This successful project demonstrated considerable intraspecific variation and indicated that substantial gains in productivity (300 per cent in Nigeria and Morocco) could be achieved by selection of the best-adapted provenances. These results brought about a resurgence of interest in *E. camaldulensis* as a species for afforestation, especially in arid and semi-arid tropical regions, and demonstrated the value of the seed centre.

A second professional forester was appointed to the seed centre in 1965 to assist with the expanding seed collection and research program. This enabled systematic sampling of more of the important eucalypt species, such as *E. grandis*. By 1966 over 2000 individual seedlots of eucalypts were being despatched annually to 60-70 countries. Much of this seed was for species introduction and provenance research. Advice was provided on species and provenance selection but no formal attempt was made to collate the results of the experimental work in different countries.

Modest financial support by FAO since 1966 has assisted in the expansion of seed collection activities to include species of particular interest to developing nations. The FAO Panel of Experts on Gene Resources (FAO 1969) drew attention to the need to collect seed of species of the genera *Acacia*, *Araucaria*, *Callitris* and *Casuarina* in addition to eucalypts.

The exploration and systematic seed collection of the genetic resources of trees in Australia is an immense task in its demands on the time of skilled staff, as well as financial cost. For this reason overseas foresters have been encouraged to visit Australia to collect their own seed. An outstanding example of resulting cooperation is the year-long seed collection mission of the Cetnre Technique Forestier Tropical (France) to Australia in 1973. CTFT's seed was for use in countries where it has research programs, but half the seed was made available to the Australian seed centre for international use. Other groups within Australia have also carried out major collections, especially of species of commercial importance in this country. This work has been done within CSIRO and in other organisations such as the forest services and, to a lesser extent, universities.

In 1975 the research functions of the Forestry and Timber Bureau were transferred to the Commonwealth Scientific and Industrial Research Organization (CSIRO) and formed the basis for the new Division of Forest Research. The seed centre has continued to operate as previously. CSIRO has actively cooperated in a range of foreign aid programs and this policy appears likely to continue especially where international aid organizations are prepared to contribute financially to the projects. (A recent Government-initiated inquiry into the role of CSIRO (Birch *et al.* 1977) recommended that the Organization should contribute scientific and technical research to foreign aid programs. The existing seed centre and associated research fall within the umbrella of this recommendation)

The support provided by FAO to the seed collection activities in Australia has been most effective in ensuring the development of an exploration and seed collection program of a wide range of Australian species (Kemp 1978). More recently the United Nations Environment Program (UNEP) has supported seed collections for conservation purposes and of a limited number of species suitable for agro-forestry schemes, e.g. *E. microtheca* and *Acacia aneura*. A further encouraging development in 1979 was the decision of the Australian Development Assistance Bureau to contribute funds for the supply of tree seeds to nations of the Indian sub-continent, southeast Asia and the Oceania region. Some of the results of seed collecting expeditions which have been mounted using external funds have been described by Doran (1980).

POLICY

The DFR will continue to provide the National Seed Coordinating Centre (FAO 1975) for forest trees. The role of the centre is to supply detailed information on species and provenances, and give advice to growers on the most appropriate supplier of seed for their conditions. A leaflet listing the major Australian suppliers of tree seed is available on request to DFR and is revised regularly. DFR will acquire, process and distribute tree seed for research purposes. Until 1975 bulk collections of tree seed were purchased from commercial collectors and State Forest Services with the objective of providing a central store for the re-sale of seed to individuals, commercial organisations and governments involved in non-research activities. Subsequently a change in financing arrangements made this policy impractical and the available funds are now directed towards maintaining a supply of high quality, source-identified seed suitable for research programs. The new policy has resulted in the DFR seed collection parties being reduced to two-man teams which aim to collect smaller amounts of seed than previously but to sample more trees. More attention is paid to the spacing of the trees and to the recording of detailed locality and site information.

The new acquisition policy will ensure that limited amounts of high quality seed continue to be available to individuals and institutions for research projects. It does mean, however, that where the research leads to greater quantities of seed being required for pilot plantations or larger projects the seed may have to be secured from other sources. This has proved to be difficult in the past, but the increase in commercial seed collection activities, especially in tropical areas, and greater interest by some of the State Forest Services in the supply of source-identified seed should largely overcome the problem. The DFR seed centre has limited stocks of seed collected under less strictly specified conditions than those which now operate. This seed will remain available until supplies are exhausted; the locality of collection and an estimate of the viability of the seedlot is always supplied to the recipient.

Most commercial seed collectors can specify the origin of the seed they supply. *There is however no tree seed certification scheme operating in Australia,* and it is recommended that the purchaser ascertain details of the seed origins before entering into any purchase agreement. *Purchasers should not assume that the seed of eucalypts or other Australian genera will necessarily be supplied from trees growing in Australia. Seed from exotic plantations is now common in the seed trade.*

Seed distributed by DFR is priced according to a formula based on the cost of collection and processing and is relatively expensive. Prospective purchasers should be aware that excessive economy in obtaining seed may jeopardise the results of costly research programs or the value of plantations. DFR will continue its long-standing policy of exchanging seed whenever an appropriate arrangement can be made.

CURRENT PROGRAMS

Seed collection

The seed collection program of DFR is formulated every two years and is strongly influenced by priorities established by the FAO Panel of Experts in Forest Gene Resources (FAO 1977) and by the needs for research material in Australia.

The program concentrates on the collection of eucalypt seeds but other genera, including *Acacia, Araucaria, Callitris, Casuarina* and *Tristania*, are included. In 1980-81 it is expected that there will be at least two expeditions sent out with the collection of *Casuarina* seeds as the principal objective. *E. grandis, E. saligna, E. botryoides* and *E. pilularis* will be extensively sampled during the biennium. Eleven major collections are planned covering a wide range of eucalypt and other species.

The seed centre is contributing substantially to the UNEP project on the conservation of forest genetic resources (FAO 1977). Special collections of *E. camaldulensis* and *E. tereticornis* have been made in northern Australia in order to provide seed with a suitable genetic base for *ex situ* conservation/selection stands (Doran and Boland 1978; Doran 1980).

The FAO Panel of Experts on Forest Gene Resources selected a number of species which is recommended be given special priority as species for the improvement of agricultural environment and rural living (FAO 1977). With the support of UNEP the DFR responded to this proposal by making extensive seed collections of *E. microtheca* (Doran 1980) and preliminary collections of *Acacia aneura*. It is anticipated that complementary collections of seed of these species will be made as opportunities occur.

A further program was initiated in 1979 with funds from the Australian Development Assistance Bureau (ADAB). In collaboration with the Indonesian government, a joint field party made broadly-based collections of low-altitude sources of *E. urophylla* for use in provenance trials and for conservation purposes (Doran 1980). Most funds provided by ADAB will be used to collect or purchase seeds suitable for distribution in the southern and southeast Asia and Pacific Island regions.

Other activities

The seed centre has been supporting the collection and distribution of seed by appropriate research into the genetic variation of species as the basis for provenance and tree improvement programs and through the compilation of relevant literature.

Currently a study is in progress on *E. microtheca*. Investigations on the geographic variation in *E. cloeziana* (Turnbull 1980) and *E. delegatensis* (Boland personal communication) have been completed. It is anticipated that research of this nature will remain an integral part of the activities of the seed centre.

A new publication, '*Eucalyptus* seed' (Boland *et al.* 1980) is in press, and a major revision of 'Forest Trees of Australia' (Hall *et al.* 1970) is in progress. We are publishing a series of leaflets summarising information on *Acacia* species. The most recent issues cover the tropical acacias, *A. mangium, A. aulacocarpa* and *A. auriculiformis* (Hall *et al.* 1980).

FUTURE PROGRAMS

It is proposed that the seed centre will maintain and consolidate its work in the exploration and collection of the gene resources of Australian forest trees. The main objective will be to provide seeds which can make a positive contribution to effective utilisation and conservation of the available genetic resources.

A clear deficiency in the activities of the seed centre has been its inability to have a major imput into the coordination of international provenance trials. The great potential value of coordinated, overall appraisal of international provenance trials was recognised by the 3rd World Consultation on Forest Tree Breeding (FAO 1978). Recommendations were made for greater uniformity, to be achieved through guidelines for establishment, management and assessment, and periodic visits by experienced international or regional assessment officers. The effectiveness of existing efforts in the exploration and seed collection of eucalypts and other species would undoubtedly be maximised by such procedures. The CSIRO seed centre in Australia is an appropriate body to participate in the coordination of international provenance trials of Australian species. The Australian Government, however, now bears most of the direct and indirect costs of the exploration, seed collection and distribution of Australian species and in the present economic climate it is unrealistic to expect additional funding to cover any extensive evaluation of trials outside Australia.

Thus the Australian seed centre, as now organised and funded, is not able to undertake active and extensive international consultative and advisory roles such as those persued by the Commonwealth Forestry Institute (United Kingdom) and the Centre Technique Forestier Tropical (France), based as they are in countries which have historically supported forestry in developing countries. The seed centre should however be able to contribute to work which can be most efficiently carried out in Australia. Turnbull *et al.* (1980) have listed these as including -

- Further development of the taxonomy and aids to species identification within the eucalypts, acacias and casuarinas.
- Collection and dissemination of data on the ecology of individual species, thus providing a basis for an improved understanding of the performance of species as exotics.
- Promotion of measures to conserve the genetic resources of important species as necessary.
- The development of optimum seed collection strategies, based on knowledge of breeding systems.
- Maintenance of existing seed collections, and their future development as programs to utilise promising species and provenances evolve.
- Assistance to collectors from overseas countries who come to Australia.
- Provision of information on the physical and physiological characteristics of seed, and any diseases which might be seedborne.
- Encouragement of quarantine practices which minimise the chances of Australian insects becoming established in other countries.
- The dissemination of information through the provision of appropriate training, symposia and publications.

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A COOPERAÇÃO NO SETOR DE MELHORAMENTO FLORESTAL NO SUL DA ÁFRICA.

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Resumo

O histórico e a situação atual dos programas de melhoramento nos países do Sul da África são sumarizados. O passado e o presente da cooperação entre as instituições envolvidas, a nível regional e internacional, são descritos e as necessidades e possibilidades para uma cooperação mais íntima são também indicadas. O já formado Grupo de trabalho em Melhoramento Florestal no Sul da África pode desempenhar papel importante para se atingir esses objetivos.

CO-OPERATION IN THE FIEL OF TREE IMPROVEMENT IN SOUTHERN AFRICA.

Summary

The history and present status of the tree improvement programmes of countries in Southern Africa are summarised. The past and present co-operation between the institutions involved, both regional and international, is described and the need for and possibilities of closer co-operation are indicated. The existing Working Group on Tree Improvement in Southern Africa can play an important role in the attainment of these objectives.

I INTRODUCTION

Tree improvement in Southern Africa is undertaken by the following institutions:

Malaŵi

- Department of Forestry and Game

Republic of South Africa

- Department of Water Affairs, Forestry and Environmental Conservation
- Lion Match Company
- S.A. Forest Investments Ltd
- Wattle Research Institute

Zambia

- Division of Forest Research, Ministry of Lands, Natural Resources and Tourism

Zimbabwe

- Forestry Commission

Although no formal co-operative tree improvement programme exists in Southern Africa, collaboration between the parties involved in tree improvement is good and in some cases extensive. Contact exists concerning the exchange of ideas, knowledge and material, the planning of work of mutual interest and the co-ordination of field trials. In order to expand on this co-operation, it is necessary to give a summary of the history and present status of the breeding programmes of each of the institutions.

II THE TREE IMPROVEMENT PROGRAMMES

Malaŵi

The Forestry Research Institute of Malaŵi initiated a tree improvement programme in 1965. Since most Malaŵi forests at that time were too young for selection purposes, early tree breeding work was confined largely to material introduced from neighbouring countries. As the local forests matured, local selections were included in the breeding programme.

The principle timber species in Malaŵi are: Pinus patula, P. kesiya, Eucalyptus grandis, E. camaldulensis and E. tereticornis. Less important species receiving attention are P. caribaea and P. oocarpa.

The programme entails provenance research, selection of plus trees, progeny testing and the establishment of seed orchards.

The total area under seed orchards and progeny trials in December, 1977 was: 27,16 ha of clonal orchards, 16,63 ha of seedling seed orchards and 42,93 ha of progeny trials/seedling seed orchards.

A large number of provenance trials of several pine, eucalypt and cypress species have been established.

Republic of South Africa

Department of Water Affairs, Forestry and Environmental Conservation (The Department)

The Department commenced tree breeding activities in 1957, and developed its programme to include all the major timber species and other species showing promise. There are presently four separate research stations located in different climatic zones working on tree improvement.

The major species are: P. elliottii, P. taeda, P. patula, P. radiata P. pinaster and Eucalyptus grandis. Some of the lesser species are: P. kesiya, P. oocarpa, P. caribaea, P. roxburghii, Eucalyptus cloeziana,

E. maculata and Acacia melanoxylon. Provenance testing covering a wide range of pine and eucalypt species forms an important aspect of the tree improvement programme. In December 1977, the seed orchard area consisted of 319,8 ha of clonal orchards and 43,3 ha of seedling seed orchards of 13 species. Several Eucalyptus grandis progeny trials will be utilised further as seedling seed orchards.

Lion Match Company

The Company is working on the improvement of poplars and concentrates on the testing and evaluation of species, hybrids and clones imported mainly from Europe. Being the only organisation in Southern Africa working on poplars, there is little scope for co-operation with other parties.

S.A. Forest Investments Ltd

S.A.F.I. commenced tree breeding in 1968 to ensure an independent source of improved seed. It was realised at that time that it would be several years before the Department could meet the country's seed requirements. Initially, clones selected by the Department were used for seed orchards. The programme was gradually expanded to include plus tree selections, progeny testing and provenance trials. The tree breeding work concentrates on P. elliottii, P. patula, P. taeda and E. grandis. Several minor species of promise receive attention.

The Company presently manages 35 ha of seed orchards. Second generation seed orchards established to P. elliottii, P. patula and P. taeda are reaching seed production age. Progeny and provenance trials form a major part of the tree improvement programme.

Wattle Research Institute (WRI)

The WRI has run a successful breeding programme for black wattle (Acacia mearnsii) since 1946. In 1969 the WRI became involved in research on short rotation eucalypt crops for species suitable for the cooler areas of Natal and the Southern Transvaal, including some provenance research.

Zambia

The tree improvement programme of the Division of Forest Research started in 1961 with a Pinus kesiya provenance trial, followed in subsequent years with provenance trials for a large number of pine and eucalypt species. The tree improvement programme then developed to include plus trees selection, establishment of seed orchards and progeny trials.

The present programme concentrates on Pinus kesiya, P. oocarpa, P. caribaea, P. merkusii, Eucalyptus grandis, E. cloeziana, E. tereticornis and Gmelina arborea.

Zimbabwe

The Forestry Commission launched a tree improvement programme in 1958, initially for Pinus elliottii, P.patula and P. taeda, but at a later stage also included P. caribaea, P. kesiya, P. oocarpa and some minor pine species. Breeding work on eucalypts started in 1962 with E. grandis, E. paniculata and E. resinifera. Priorities changed, however, and at present the attention is focused on E. grandis, E. camaldulensis, E. tereticornis, E. cloeziana and E. nitens.

The programme entails the full range of tree improvement activities.

The present seed orchard area is 125,8 ha, comprising nine species.

III CO-OPERATION

The tree improvement work of the Department in South Africa is largely lead by the staff of the D.R. de Wet Forestry Research Station near Sabie in the Eastern Transvaal. Since the headquarters of SAFI are situated in the same village, co-operation between these two parties developed through personal contacts from the early stages of the latter's breeding programme with the exchange of plus tree material. As the improvement programmes progressed, the scope for co-operation increased. To prevent unnecessary duplication, further work and priorities are discussed. Benefits are especially evident in the case of progeny and provenance testing where co-ordination and co-operation are exercised to cover as many different sites as possible.

Since the interest of the Department and SAFI are largely congruent and compatible, there is scope for more extensive co-operation between the two parties, e.g. by using the same experimental design and lay-out for joint trials and synchronising and standardising measurement assessment techniques to obtain the full benefit from an overall analysis of the combined trials. Consideration could even be given to allowing one team to assess all trials of a kind to eliminate possible operator bias.

The co-operation between the Department and the WRI, possible only in the case of eucalypt improvement, is rather limited. It comprises exchange of ideas and information, making suitable sites on State forests available for field trials by the WRI and establishing provenance trials with overlapping representation of seed lots by the two parties.

Liaison and co-operation between South Africa and Zimbabwe started in the early stages of the breeding programmes of the two countries, when seed of selected plus trees was exchanged. Grafting material from the South African breeding population was also made available and 131 South African clones, comprising seven pine species (P. kesiya, P. patula, P. elliottii, P. caribaea - two varieties and P. oocarpa) are at present included in the breeding programme of the Forestry Commission of Zimbabwe. The exchange of breeding material was hampered by an embargo on the import of vegetative material of coniferous species into South Africa. This embargo has recently been relaxed, and in exceptional cases, coniferous material may now be introduced provided strict phytosanitary and quarantine regulations are adhered to. This relaxation led to the importation in 1979 of 295 clones, comprising five species (P. patula, P. elliottii, P. taeda, P. kesiya and P. caribaea) from Zimbabwe. More introductions are planned. This material is particularly valuable to South Africa because it consists of clones which are completely immune or highly resistant to attack by Pineus laevis (P. pini), the pine woolly aphid. This pest has been present in Zimbabwe for many years and has only recently been found in South Africa in the Pretoria-Johannesburg area, where it is harmful to a number of pine species. The woolly aphid could threaten the extensive plantation areas in the Transvaal and could spread to the rest of the country. The Zimbabwe material will form the nucleus of a breeding programme aimed at resistance to attack by Pinus laevis.

The co-operation between South Africa, MalaŵI and Zambia consisted mainly of the exchange of seed, both for progeny and provenance testing.

The same is true for MalaŵI, Zambia and Zimbabwe, although some clonal material has been exchanged between these countries.

Table I gives some detail of the movement of clonal material between countries in Southern Africa, but it must be pointed out that in some cases full details are not available.

The exchange of breeding material between the countries in Southern Africa is of utmost importance. Working with exotic species, the base population available for selection purposes in each country is generally of restricted origin and represents only part of the total population of the species concerned. Initially much of the seed used for the establishment of pine plantations in MalaŵI, Zimbabwe and other countries in Southern Africa was imported from the Republic of South Africa. Several countries, however, have independently imported new material from the countries of origin or even arranged for the collection of seed themselves. e.g. seed collection tours by Hodgson from Zimbabwe in 1960, by Mortenson from East Africa in 1968, by Olesen from MalaŵI in 1968, and by Coetzee and Fisk from the Republic of South Africa in 1969, all in Mexico and/or Central America. The exchange of plus tree material from these later introductions would ensure a broad genetic base for each breeding programme.

Contact is maintained with several breeding programmes in the South Eastern United States, and valuable seed lots from improved genetic sources have been exchanged.

In the field of provenance research and progeny testing much could be achieved by close liaison and co-operation and by establishing a series of trials on widely differing sites throughout Southern Africa, to obtain a clear picture of the species' possibilities and of possible genotype x environment interactions.

IV WORKING GROUP ON TREE IMPROVEMENT

In 1978 a working group on tree improvement was formed to co-ordinate and improve co-operation and contact in tree improvement. This working group presently comprises representatives from the Department of Water Affairs, Forestry and Environmental Conservation, S.A. Forest Investments Limited, the Wattle Research Institute, the Lion Match Company and the Forestry Commission of Zimbabwe.

The authors believe that the scope of the working group could be expanded to include all tree breeding organisations in Southern Africa with the common objective of improving the quality and value of our future plantation forests. Since many of the same species are dealt with, greater co-operation between countries would ensure a broader genetic base for advanced generation selections. The working group could be the body to co-ordinate and control this co-operation.

At present there is a general shortage of trained scientists working on tree improvement. Closer contact and co-operation between organisations with a common goal could ensure greater efficacy in tree improvement and eliminate unnecessary duplication, effort and cost in the improvement of the forestry endeavour in Southern Africa.

The working group meets on a formal basis every year, and maintains contact through the publication of a newsletter once a year.

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TABLE I

CLONAL MATERIAL IMPORTED

ZIMBABWE

	Australia	Kenya	MalaŴi	S.A.
Cupressus spp.	-	32	-	-
P. car. v bah.	-	-	-	7
P. car. v. hond.	3	-	5	10
P. ell. v. ell.	3	-	10	35
P. kesiya	-	-	-	6
P. leophylla	-	-	5	-
P. oocarpa	-	-	-	12
P. patula	-	3	24	37
P. radiata	22	1	-	-
P. taeda	10	-	3	24

MALAŴI

	Kenya	MalaŴi	Zambia	Zimbabwe	S.A.
P. patula	16	-	-	18	18
P. ell. v. ell.	-	-	-	13	8
P. kesiya	-	-	35	5	-
P. radiata	25	-	-	-	-
P. taeda	-	-	-	5	-
Cup. spp.	30	-	-	-	-

SOUTH AFRICA

	Australia	Zimbabwe
P. car. var. bah.	-	8
P. car. var. hond.	-	24
P. elliottii	-	61
P. kesiya	-	5
P. oocarpa	-	-
P. patula	-	162
P. pinaster	40	-
P. taeda	-	35

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PROCURA INTERNACIONAL E TROCA DE MATERIAL PARA MELHORAMENTO FLORESTAL.

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Resumo

Os programas de melhoramento de espécies plantadas internacionalmente podem beneficiar-se por material genético introduzido como sementes, pólen, epibioto e "plantlets" de cultura de tecido. Material importado pode ser usado para aumentar programas existentes ou mesmo iniciar outros novos.

Programas de melhoramento de choupos, *Pinus radiata*, Eucalyptus e *Pinus caribaea* tem usado a troca e intercâmbio internacional de material selecionado. Estes exemplos mostram que aquisições de material genético de outros países poderão ser benéficos e valem o esforço envolvido se resultarem na introdução de procedências de qualidade superior às ocorridas no local; se capitalizarem a experiência de outros países sendo bem sucedidas em selecionar e reproduzir genótipos superiores; se derem melhor crescimento como resultado da evolução de espécies exóticos superiores; ou se pouparem tempo de trabalho.

Troca internacional de material melhorado de árvores não tem um mérito como método de melhoramento da árvore. Com material altamente selecionado, seu valor depende no grau de seleção fenótica e acurecidade de testes de progênies ou clonais, e na relevância dos critérios de seleção dos programas de intercâmbio.

INTERNATIONAL PROCUREMENT AND EXCHANGE OF TREE BREEDING MATERIAL.

Summary

Tree breeding programmes in species widely planted internationally may benefit from new genetic material introduced as seed, scions, pollen, and tissue culture plantlets. Imported material can be used to augment existing programmes or to initiate completely new ones.

Breeding programmes in poplars, Pinus radiata, eucalypts, and Pinus caribaea have made use of international procurement and exchange of selected tree breeding material. These examples show that acquisitions from other countries can be very beneficial and worth the effort involved. Importations can: introduce otherwise unobtainable provenances superior to those available locally; capitalise on someone else's skill and success in selecting and breeding superior genotypes; give faster growth as a result of evolution of superior exotic land races; and save time and work.

Importation of tree breeding material has no intrinsic merit itself as a method of tree improvement. With highly selected material, its value depends on the degree of phenotypic selection and accuracy of progeny or clonal testing, and on the relevance of selection criteria to recipient programmes.

INTRODUCTION

The theme of this paper is that exchanges of selected tree breeding material, as opposed to acquisition of "raw" seedlots for provenance trials, among countries growing the same forestry species can be beneficial, but are not necessarily so. The value of exchanges depends on the quality of the material, which in turn rests on the skill of the donor tree breeder; and, most importantly, on its provenance and breadth of genetic base represented by the founding seedlots of early exotic introductions. History plays an important part in the genetic make-up of cultivated stocks of many important species grown as exotics.

Species such as Pinus caribaea Morelet, Pinus radiata D. Don, Pinus patula Schiede & Deppe, Cupressus lusitanica Mill., and Eucalyptus grandis Hill ex Maid. have assumed great international importance, predominantly in exotic afforestation, and offer excellent scope for useful genetic exchanges because of the many countries actively cultivating and breeding them. Likewise, Pinus taeda L., Pinus elliottii Engelm., and Pseudotsuga menziesii (Mirb.) Franco, which are premier forestry trees within their native ranges in North America and the subjects there of large planting programmes and widespread tree breeding activity, present many opportunities for gene exchanges as they are also very important as exotics in several countries.

OBJECTIVES

No special genetic theories need be invoked to predict the value of international gene exchanges. As shown by four case-studies later in the paper, genetic gain in tree breeding programmes utilising imported material is realised from the same principles of forest tree improvement as in independent breeding programmes:- provenance selection, intensive selection within the best populations, maintenance of a broad genetic base, progeny test selection for traits of low heritability, recognition of genotype x environment interaction effects, and avoidance of inbreeding in seed orchards. The only special precautions required in international exchanges of selected material are suitable quarantine measures and the realisation that selection criteria may differ markedly from one country to another, thereby possibly negating the attainment of genetic gains of economic significance.

Procurement and exchange of breeding material may fulfil four general purposes.

Immediate seed supply for planting programmes

Importation of seed orchard seed or superior clonal stock from other countries is potentially the fastest way of achieving genetic improvement in current planting programmes not able to be serviced by local seed supplies. There is already international trafficking in seed orchard seed of some species. The procuring country should preferably carry out prior performance tests of several alternative seed sources to identify the best overseas suppliers of improved seed.

Importations of seed orchard seed may be very useful in initiating afforestation projects. However, the genetic base of the resultant plantations could be far too narrow from which to develop a local breeding programme, should such be necessary. A more immediate disadvantage is that imported orchard seed may not perform as expected because of inappropriate selection criteria, and genotype x environment interactions.

New species introduction

It is common to find that major exotic tree species in many countries were originally introduced haphazardly, with only vague records of provenance or size of the genetic base.

International provenance trials are excellent for formally introducing a species for the first time, or for systematically re-introducing a species of proven commercial importance. Another good way of introducing a species is to use a wide range of selected open-pollinated seedlots from other countries, including selected samples from native stands. As long as the sample is large, there are obvious advantages in early obtaining material selected for universally desired characteristics such as better stem straightness and freedom from malformation. Having selected material can greatly help in assessing the merits and potential of a new exotic species, and in laying solid foundations for future breeding.

It is useful also to import larger unimproved seedlots from numerous parents of the most likely provenances, including exotic land races. Resulting stands could be suitable for local selection programmes, and seed stands.

Strengthening existing breeding programmes

Breeding programmes are usually founded on plus trees selected in local native stands or plantations and will therefore be comparatively narrowly based with respect to the genetic resources of the species as a whole. As the second and third generations of breeding are reached, worrisome coancestry builds up in the breeding population, giving fear that related clones in seed orchards could cause trouble from inbreeding depression. Furthermore, intensive selection for several characteristics may have reduced the scope for breeding for "new" characteristics in the future; in such a situation there will be considerable benefits in introducing new, improved material.

Another possibility is that better provenances than those used to initiate the breeding programme may be identified at a later stage; somehow, this better material has to be incorporated into, if not completely supersede, the current breeding population.

Acquisition of genetic material from overseas programmes, including those where the species is native, can obviously be very helpful in augmenting an otherwise isolated programme with an injection of unrelated or better material.

Rapid initiation of new programmes

Every year delayed in using genetically improved stock for afforestation represents lost opportunity for genetic and thus economic gain from improved strains once they are finally available. It is therefore important, if the species is really a certainty, to find or develop improved seed sources of it quickly. One way is to import the material "ready-made" from another organisation already well advanced in tree breeding and having far greater resources of trees for selection than presently available in the recipient country.

METHODS

Seed

Seed is the most flexible way of introducing genetic material, and has the formidable advantage of allowing opportunity for progeny to be tested before a big commitment is made to them. Family tests can lead quickly and directly to seed production (through seedling seed orchards), provide a source of new selections for the next generation, and an evaluation of the donor's populations for future introductions.

What sort of select seed should be obtained? Open-pollinated (ex ortets), open-pollinated (ex clone bank or seed orchard ramets), controlled-pollinated polycross, or controlled-pollinated full-sib families are the main possibilities. Probably the most generally useful material would be seed of a set of unrelated full-sib families from random single-pair crossing amongst the best available parents in the best provenances. These could be excellent for development into seedling seed orchards, and for new selection programmes. The expectation of genetic gain would naturally be less with open-pollinated families from ortets, and the restricted pollen base of families derived from seed orchard ramets definitely limits this sort of material for long-term breeding.

Importation of seedlots in a complete mating design capable of giving information on general and specific combining ability (e.g. diallel, factorial) would hardly be justified except in the special case of a donor organisation seeking wider testing on sites likely to be of interest in the future.

Pollen

Pollen - the microspores of conifers and flowering plants - is haploid (n) genetic material comprising the male gametophyte, and ultimately producing the male gametes. Especially in conifers it can be an excellent means of effecting gene transfers among programmes as it can be collected in quantity, is easily packaged and posted, presents no problems with quarantine, and can be stored until required. Nevertheless, adequate storage facilities are essential, and there must be a proper mating design (e.g., polycross, nested, factorial) drawn up in advance, with a selection of good local trees on hand to serve as female parents in the design. Pollen of insect-pollinated species such as eucalypts is obviously more difficult to transfer.

A robust mating design such as the polycross is probably the most efficient in which to accommodate numerous pollen samples procured from outside the programme. For example, a mix of pollen from the 50 best trees in each of several overseas programmes could be brought in and used to add to a local pollen mix. Such broadly based resulting polycross families would be excellent for progeny testing local clones, suitable (with little risk of relatedness) for second-generation selection and seedling seed orchards, and allow direct incorporation of new and better genetic material into a programme (e.g., using inter-provenance hybridisation).

Scions

Scions can be exchanged in the form of grafting material or as unrooted cuttings. They afford a direct way of introducing genotypes intact. The commonest transfers of scions have been with grafting material of plus trees, allowing recipients to establish their own clonal banks or seed orchards.

Quarantine problems and delays, transport, and assorted hassles in propagation greatly restrict the international exchange of scions and their successful utilisation in breeding programmes.

Too often the imported material remains little more than a curiosity, serving no useful purpose other than as testimony of a successful, but complicated manoeuvre to promote international goodwill.

Scion introductions for seed orchards should be accompanied by a full set of seedlots suitable for progeny testing the clones alongside locally selected candidates. There is a tendency for imported clones not to be properly tested either because no seed was available or because of a mistaken belief that imported material must be good and need not be tested.

Tissue culture plantlets

There have already been some successful transfers of tree genetic material *in vitro* from one research laboratory to another. Because cultures are strictly maintained under sterile conditions to prevent microbial contamination of the rooting media, healthy tissue cultures can safely be introduced with little risk, without the need for quarantine, thus saving time. Tissue cultures are also obviously more compact and efficient to handle than traditional scion material, allowing much more material to be moved in a single operation.

Needless to say, recipient organisations must have the proper facilities and expertise to make full use of tissue culture introductions.

There is nothing yet inherent in present tissue culture technique for trees to give it any particular advantage over the other methods of gene exchange in terms of genetic gain. It is purely a vehicle of exchange - not a method of breeding. The best scope for it could be as a means of transferring propagules of outstanding genotypes, and rapidly multiplying them.

EXAMPLES OF INTERNATIONAL GENE EXCHANGES IN TREE BREEDING PROGRAMMES

Poplar breeding in New Zealand

The importation of selected clones of natural hybrid black poplars, *Populus* x *euramericana* (Dode) Guinier (= *P.* x *canadensis* aggr.), the collective name for the hybrids between *Populus deltoides* Bartr. ex Marsh and *Populus nigra* L., from tree breeding centres in Italy and other European countries to many temperate countries of the world is a spectacular example of international transfer of tree breeding material at the clonal level.

Cultivation and genetic improvement of poplars in several countries was initially based on local programmes of introduction, testing, and certification of promising clones from overseas. In New Zealand for example (van Kraayenoord, 1968), most poplar planting for erosion control and farm woodlots from 1958 to 1974 was with large unrooted cuttings of nine hybrid black poplar clones from Europe: *P.* x *euramericana* cv. 'Robusta PH', *P.* cv. 'Robusta Zeeland', *P.* cv. 'Eugenei', *P.* cv. 'Laevigiata', *P.* cv. 'I-30', *P.* cv. 'I-78', *P.* cv. 'I-214', *P.* cv. 'I-455' and *P.* cv. 'I-488'. Clonal tests in New Zealand had shown these to be the most suitable clones out of more than a hundred tested. In Australia, however, most of these hybrid clones proved not to be well adapted to more northerly sites (e.g., lat. 30°S), where *P. deltoides* clones of Texas origin were superior (Palmberg, 1977; Pryor and Willing, 1965).

The spread of the poplar rusts *Melampsora medusae* Thum. (American poplar rust) and *Melampsora larici-populina* Kleb. (European poplar rust) from Australia to New Zealand in 1973 (N.Z. Forest Service, 1973; van Kraayenoord, Laundon and Spiers, 1974; Wilkinson and Spiers, 1976) effectively eliminated the "standard" nine hybrid black poplar clones from planting programmes - all were too susceptible to the rusts. Two replacement clones, *P.* x *euramericana* cv. 'Flevo' and *P.* cv. 'I-154', resistant to both rusts, were promptly selected from clonal archives and released for multiplication and planting in 1974 (Wilkinson and van Kraayenoord, 1979).

Through international co-operation fostered by the International Poplar Commission of FAO, and good personal contacts between poplar breeders in New Zealand and overseas, New Zealand was quickly able to import several new rust-resistant clones from Korea, Japan, Argentina, Australia, Italy, Turkey, Yugoslavia, Holland, and the United States. Past experience with imported selected poplar clones is that clone x environment interactions are often large internationally, necessitating stringent testing and re-selection under local conditions. There are nevertheless some clones such as 'I-214' that have grown very well in all countries with a suitable climate.

In contrast to New Zealand where poplar improvement had traditionally been based on clonal introduction and testing (because of the need to use large cuttings as planting stock for erosion control in the presence of grazing sheep and cattle), Australia already had a broad genetic base of *P. deltoides* in the form of numerous American seedlots by the time the poplar rusts arrived there in 1972. Selection of rust-resistant clones from open-pollinated seedling families was therefore possible, and indeed proved effective (Palmberg, 1978).

The need for a broad gene pool for poplar breeding in New Zealand (*see* van Krayenoord and Wilkinson, 1976) has further been vividly demonstrated with the recent arrival of the poplar leaf spot disease, *Marssonina brunnea* (Ell. & Ev.) P. Magn., apparently on imported seed (Anon., 1978b, 1979).

As well as importing rust-resistant clones, New Zealand poplar breeders have now acquired numerous seedlots of species of the sections LEUCE (aspens and white poplars), TACAMAHACA (balsam poplars) and AIGEIROS (cottonwoods and black poplars). These seedlots are now serving as a broad base for a programme of species testing, provenance selection, and interspecific hybridisation, leading to the breeding and selection of new clones combining disease resistance with other desirable characteristics essential in varieties for erosion control in New Zealand (Wilkinson and van Kraayenoord, 1975).

Foreshadowing what might be achieved through these local efforts to breed better rust-resistant poplars, two clones of artificial hybrids between *Populus alba* L. (European white poplar) and *Populus glandulosa* (Uyeki) Uyeki (Korean aspen) imported into New Zealand from Korea in 1976 have proved completely resistant to the aforementioned poplar diseases. The clones proved sufficiently good in other respects to permit their release for soil conservation planting in 1979 (A.G. Wilkinson [1] pers. comm.). Rapid multiplication and release of these clones was accomplished using tissue culture (Wilkinson and van Kraayenoord, 1979).

Poplar breeders in New Zealand have imported or exchanged tree breeding material in the form of woody cuttings, seed, and tissue cultured plantlets. New Zealand regulations require that imported cuttings be quarantined for 2 years before multiplication and clonal testing can begin. Cultured plantlets in test tubes or plates have proved to be an easy and effective means of exchanging material. No quarantine period is required after arrival of stock *in vitro* because healthy, sterile cultures are already guaranteed free of microbial infection (except viruses). Rapid multiplication of material in the recipient country is therefore possible (C.W.S. van Kraayenoord[2], pers. comm.).

Pinus radiata

Pinus radiata D.Don., a native of California in the United States, is the major tree planted for forestry in Chile, New Zealand, and Australia, and is also commercially important in Spain, South Africa, and Kenya. It shows promise in Italy, Tunisia, Morocco, France, Portugal, and Ireland, but is not planted much in its native country.

International exchanges of seed, pollen, and scions have featured in several tree improvement programmes established in the species (Fielding, 1966; Pederick and Griffin, 1978).

Grafting scions from 23 of New Zealand's original group of 40 plus trees selected in the 1950s from local stands were sent to various organisations in Australia (I.J. Thulin[1], pers. comm.). New Zealand clones are still important in several Australian orchards today. The immediate value to Australia of these importations in the 1950s was in obtaining material of very intensively selected plus trees to augment individual local selection programmes. Apart from saving time and work, the real benefits of sending the New Zealand clones to Australia need to be judged in terms of breeding value (as determined from progeny tests) and orchard performance (graft compatability and seed production) in Australia of the New Zealand clones in comparison with Australian clones. The 23 New Zealand clones constitute only 4.5% of the 506 first-generation clones now in the Australian Plus Tree Register (Pederick and Griffin, 1978), and one widely-tested clone, NZ 850-55, has consistently ranked with the best local clones in Australian progeny tests (Eldridge, 1974). The value to Australia of these early scion transfers of untested clones appears promising, but has not really been properly assessed; the question of whether phenotypic selection in New Zealand stands was effective also for Australian sites is unanswered. Nor is there any evidence that distinctive land races that might have evolved in two or three generations of cultivation in New Zealand are better or worse in Australia than local land races.

A further shipment of New Zealand clones to Australia was made in 1977, comprising 24 second-generation ("875"-series) and 6 further first-generation ("268"-series) clones. The latter are a superior group selected on progeny test results in New Zealand from 588 candidates, while the former are special high wood-density selections made in open-pollinated families of the best 50 or so of the 588 first-generation clones. The intention is to use these New Zealand clones as parents in Australian seed orchards and in controlled mating programmes in combination with superior Australian clones. As a follow-up, pollen of 32 second-generation New Zealand plus trees was sent to Australia in 1979 for use in controlled mating programmes.

A selection programme aimed at improving the resistance of *P. radiata* to a serious needle blight disease, *Dothistroma pini* Hulbary, currently controlled by aerial spraying (Kershaw *et al.*, 1979), was initiated in New Zealand in 1966. Several apparently-resistant trees were selected and stored in clonal archives. Seventy-four "field-resistant" trees were selected in Kenya and scion material sent to New Zealand in 1967 (and again in 1968 because much of the first batch was destroyed at the quarantine station) to supplement the local programme (Thulin and Wilcox, 1968). Neither the New Zealand or Kenyan resistant clones have subsequently been used in breeding *P. radiata* in New Zealand since most of the clones were selected only for disease resistance and are thus expected to be inferior to current seed orchard clones in yield and stem quality, and because aerial spraying was very effective.

Potentially the most useful and mutually beneficial international exchange of selected genetic material in *P. radiata* is the co-operative family experiment organised by Shelbourne (1973). In this project, 319 seedlots from plus trees (open-pollinated families from ortets and/or orchard ramets), controlled full- and half-sib pollinated families, and some open-pollinated families from native stands, were assembled from New Zealand, Australia, Kenya, South Africa, France, and California. In addition to the donor countries, Chile, Tunisia, and Morocco planted out test plantations of the families. The general belief is that the international gene pool is "a good thing", but how much direct use can be made of the material in local breeding programmes will depend on performance of the families and the needs of individual programmes. In New Zealand, the best imported families are seen as a potential source of new plus trees. For countries not yet heavily involved in their own breeding programmes, the gene pool could be a very good foundation for local selection programmes leading to seedling and/or clonal seed orchards.

Guidelines for further international gene exchanges in *P. radiata* have been proposed under the auspices of IUFRO Working Party S2-03-09 (Breeding *Pinus radiata*) (A.R. Griffin[1] and R.D. Burdon[2], co-chairmen).

A comprehensive provenance seed collection was made in 1978 in native *P. radiata* stands. Seedlots have been distributed to several countries by the CSIRO Division of Forest Research, Canberra, Australia (Anon., 1978a), in much the same manner and with the same general objectives as for various international provenance trials in tropical pines.

Finally, a pioneering shipment of *P. radiata* plantlets was successfully air-mailed from France to New Zealand in 1979. The plantlets were non-rooted shoots cultured in test tubes, and arrived in good condition with no quarantine delays. There could therefore be scope in future for more exchanges of genetic material in this way.

Eucalypts

Countless transfers of eucalypt seed have been made from Australia to nearly all parts of the world. These importations have resulted in arboretum or roadside plantings, species trials, provenance trials, as well as full-scale industrial plantations and the base for local breeding programmes. Many introductions have been haphazard and of unknown quality in terms of provenance, number of seed trees represented in seedlots, and degree of selection (other than for a heavy seed crop) exercised by seed collectors. For most eucalypts the native Australian forests nevertheless remain by far the most important source of genetic material (Turnbull, Nikles, and Brown, 1980).

As a future base for breeding in recipient countries, it is suggested that the most valuable types of eucalypt seed importations from Australia are:

- commercial seedlots from numerous trees in a specified region (e.g., samples from large seedlots collected from logging areas for air-seeding or planting programmes);
- special collections from numerous individual trees of a range of provenances (e.g., CSIRO provenance study collections, or open-pollinated family seedlots from Australian breeding programmes).

Every importation made should be regarded as a potential future seed source or as a component of the local gene pool for breeding. Poorly documented seed, or large seedlots from very few trees are therefore to be avoided. There is clearly "safety in numbers", and importers should specify their requirements to seed merchants, not only in quantity, but also provenance (using any prior information), and, within reason, minimum number of seed trees and degree of selection.

Imported open-pollinated families from breeding programmes or provenance collections in Australia can be very good supplements or alternatives to any local families selected, provided the provenances are suitable. In both Eucalyptus fastigata Deane & Maid. (Wilcox, Rook and Holden, 1980) and Eucalyptus regnans F. Muell. (Wilcox, Faulds, Vincent and Poole, 1980), many of the Australian families imported have proved to be far superior to local families in frost resistance in New Zealand, mainly because the best provenances are not fully represented in local plantations.

There can also be benefits in a eucalypt breeding programme in obtaining exotic seedlots from other countries growing and/or breeding the same species. These benefits are unpredictable, but could include capitalising on effective natural and artificial selection in even-aged plantations or provenance tests, fortuitous choice of an excellent founding provenance, or avoidance of troublesome hybridisation in local stands. Examples are the introduction of very frost-hardy families of E. fastigata from Natal in South Africa to New Zealand (Wilcox, Rook and Holden, 1980), and the good results obtained in Brazil with seed of Eucalyptus grandis Hill ex Maid. imported from South Africa and Rhodesia (Zimbabwe) (Campinhos and Ikemori, 1978). Exchanges are not all necessarily beneficial, as evidenced from the comparatively poor growth of a South African seed orchard lot of Eucalyptus saligna Sm. in New Zealand tests (Wilcox, Faulds and Vincent, 1980). It is therefore desirable to anticipate possible future exchanges of seedlots of good families by including bulk seedlots of exotic provenances in provenance trials along with the native seedlots. For example, organisations involved in planting out the IUFRO provenance collections of Eucalyptus tereticornis Sm. may obtain good leads as to the value of future exchanges if a range of exotic seedlots (including selected material) is included in their trials.

Pinus caribaea

One of the justifications claimed for the much-discussed international co-operative breeding programme with Pinus caribaea Morelet var. hondurensis Barrett & Golfari was that advantageous exchanges of genetic material could be arranged among co-operators (Nikles, 1978; 1979; Nikles and Burley, 1978). The good performance in Fiji of certain families from Queensland has been taken as evidence that international gene exchanges in this species have good potential. Subsequently, plans have been advanced to institute international progeny testing and seed orchard programmes.

Foremost in any plans for breeding P. caribaea should be results obtained in the international provenance trials sponsored by the Commonwealth Forestry Institute, Oxford (Greaves, 1978). These seedlots represent a precious source of information and a genetic base of immense potential for future selection in all countries growing this species. Thus, the value of future exchanges of selected tree breeding material rests heavily on the provenance being optimal for the recipient programme.

Areas such as Queensland and Fiji (Bell, 1979) with substantial plantations old enough for selection have been able to achieve considerable improvement in stem straightness in P. caribaea var. hondurensis from phenotypic selection in first-generation stands derived from seed importations from Mountain Pine Ridge, Belize. However, there is now evidence in Queensland (D.G. Nikles[1], pers. comm.) that certain coastal lowland provenances from Honduras, Belize, and Nicaragua are better there than the Mountain Pine Ridge strain in several important features, namely wind resistance, stem straightness, and height growth.

Consequently, incorporation of these good characteristics into the current breeding programme is under investigation. One possibility is the importation of pollen from plus trees selected in exotic stands (e.g., in Brazil) derived from coastal lowland provenances, followed by artificial hybridisation with the local base of Mountain Pine Ridge strain clones (D.G. Nikles, pers. comm.).

CONCLUSIONS

1. Importations of tree breeding material from other countries are likely to be beneficial and worth the effort involved if they give -
   - better provenances than those presently available in local plantations or readily obtainable from native stands;
   - better quality individual genotypes (i.e., clones), F_1-hybrids, gametes (pollen), or families than those which could be selected locally; "better" in terms of desired or relevant selection criteria, selection intensities, and proven performance in tests;
   - greater numbers of "new" or "different" genotypes unrelated to existing local stocks, thereby minimising inbreeding problems in seed orchards, and broadening the base of genetic variability for future selection;
   - better growth from seedlots collected in large exotic plantations than from seedlots collected in native stands or stands of limited genetic base as a result of natural selection and adaptation to "new" environments, from silvicultural selection, and from higher rates of outcrossing;
   - a large saving in time and/or work.
2. Seed, scions, and pollen each have their place in gene exchange activities -
   - seed transfer, in many species, is the easiest, the most versatile, and generally the most useful method of gene exhange;
   - pollen is potentially the fastest, most direct, method of incorporating new material into well-advanced breeding programmes having the necessary resources of recipient female parent clones;
   - scion transfers can involve delays or losses in quarantine and are justified mainly for the procurement of the very best, thoroughly pre-tested, or uniquely superior genotypes;
   - tissue culture offers a compact method of transferring clonal material, without the problems of quarantine.
3. Good planning is required to make the best possible use of international gene exchanges -
   - when requesting material from another organisation, give adequate details of how it is proposed to use the material and why it is needed;
   - benefits of gene exchanges will be enhanced if there is also preparatory groundwork in the form of sustained personal contacts, letters, exchanges of reports and publications - all helpful in fostering mutual understanding of the programmes involved.

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APLICAÇÃO DE CITOCININA E FUNGICIDAS NA ENXERTIA DE *EUCALYPTUS UROPHYLLA* S.T. BLAKE E *E. DUNNII* MAIDEN, EXECUTADOS POR BORBULHIA EM JANELA ABERTA E GARFAGEM EM FENDA CHEIA.

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Resumo

Este trabalho preliminar teve como objetivo a avaliação dos efeitos da imersão de propágulos usados em enxertias de Eucalyptus urophylla S.T. Blake e E. dunnii Maiden por borbulhia em janela aberta e garfagem em fenda cheia, em soluções dos fungicidas "Captan" e "Benlate", ambos na concentração de 0,6 g/l por um período de 10 minutos e em uma solução de 10 mg de "6-BAP"/l por períodos de 3 e 5 minutos.

Os resultados obtidos durante um período de observação de 120 dias após a enxertia mostram que a imersão dos propágulos na solução de 6-BAP influiu negativamente na porcentagem de enxertos em desenvolvimento, quando comparados com a testemunha. No entanto, a ação dos fungicidas proporcionaram, em geral, resultados superiores à testemunha, mostrando que a presença de patógenos é um dos fatores limitantes ao emprego da enxertia e que a forma testada para aumentar a concentração de substâncias reguladoras de crescimento não é adequada.

Comparando os resultados das testemunhas, observou-se que o E. dunni apresenta maiores dificuldades de propagação por esses dois tipos de enxertia e que a garfagem em fenda cheia proporciona resultados superiores a borbulhia para as duas espécies.

THE USE OF CITOKININ AND FUNGICIDES IN *EUCALYPTUS UROPHYLLA* S.T. BLAKE AND *E. DUNNII* MAIDEN PATCH BUDDING AND SPLICE GRAFTING.

Summary

This work had the objective of evaluating the effects of fungicide (Benlate and Captan 0,6g/l during 10 minutes) and citokinin (6-BAP 100 mg/l for 3 and 5 minutes) treatments on patch budding and splice grafting E. urophylla S.T. Blake and E. dunnii Maiden .

The conclusions from the analyse of the results obtained during a 120 day period are: a) the 6-BAP treatments had a negative effect on graft survival; and b) the fungicide treatments gave higher graft survival.

Introdução

A cicatrização da união do enxerto se processa através de diversas fases como: produção de calos (células de parênquima), pelos componentes do enxerto na região do câmbio; formação de uma ponte devido ao entrelaçamento das células dos calos; diferenciação de certas células do calo em células cambiais e ; produção de novos tecidos vasculares pelo novo câmbio, permitindo a passagem de nutrientes e água entre o porta-enxerto e o propágulo enxertado. Essa seqüência de desenvolvimento durante a cicatrização da união do enxerto é, em grande parte, influenciada pelas concentrações de substâncias reguladoras de crescimento na região da enxertia e ausência de patógenos.

Além dessas funções fundamentais, as substâncias reguladoras de crescimento são essenciais para o estímulo ao desenvolvimento das gemas, problema observado no emprego da borbulhia, onde grande parte das gemas enxertadas permance em dormência por um longo período após a enxertia.

Procurando fornecer subsídios para o conhecimento dos problemas verificados no uso da enxertia, foi delineado este ensaio preliminar que tem por objetivo avaliar os efeitos da aplicação de hormônios e fungicidas na enxertia do Eucalyptus urophylla St. Blake e E. dunni Maiden, executada por garfagem em fenda cheia e borbulhia em janela aberta.

Materiais e Métodos

Os propágulos foram coletados de 5 clones por espécie, dos bancos clonais localizados em Anhembi-SP e em Piracicaba-SP, de E. urophylla e E. dunni, respectivamente.

A enxertia foi realizada em 11 de julho 1979 no viveiro do Departamento de Silvicultura da ESALQ-USP, em Piracicaba-SP, em porta-enxertos da mesma espécie, com altura média de 90 cm e diâmetro médio na região do colo de 0,9 cm.

Foram executados 04 enxertos por tratamento, permanecendo os mesmos sob cobertura de tela de "nylon" com 50% de sombreamento por um período de 60 dias.

Os tratamentos utilizados foram:

- Imersão dos propágulos por 3' em solução hormonal na concentração de 100 mg de "6-BAP"/l.
- Imersão dos propágulos por 5' em solução hormonal na concentração de 100 mg de "6-BAP"/l.
- Imersão dos propágulos por 10' em solução de 0,6 g do fungicida "Benlate"/l.
- Imersão dos propágulos por 10' em solução de 0,6 g do fungicida "Captan"/l.
- Testemunha

Todos os tratamentos foram empregados associados aos métodos garfagem em fenda cheia e borbulhia em janela aberta, para o Eucalyptus urophylla St. Blake e E. dunnii Maiden.

Resultados e Discussões

As porcentagens de enxertos em desenvolvimento (com brotação) em função da espécie, tipo de enxertia, tratamento e época de avaliação estão apresentadas na Tabela 1.

Analisando somente o comportamento das testemunhas (Figura 1) constatou-se que o E. dunnii apresenta maiores dificuldades de propagação pelos dois tipos de enxertia empregados do que o E. urophylla. Além desse fator, os resultados obtidos através da garfagem em fenda cheia foram sempre superiores aos da borbulhia em janela aberta quando se analisa a espécie separadamente.

Em função desse comportamento os efeitos dos tratamentos aplicados foram analisados separadamente por espécie e por tipo de enxertia (Figuras 2, 3, 4 e 5).

A. Efeito dos tratamentos na enxertia de E. urophylla por garfagem em fenda cheia, apresentado na Figura 2.

Analisando o comportamento do enxertos submetidos aos diferentes tratamentos, observou-se que a imersão dos propágulos no fungicida "Captan" por um período de 10' proporciona maiores porcentagens de enxertos em desenvolvimento, em relação aos demais tratamentos, a partir do 60º dia após a enxertia. Apesar dos resultados da avaliação, realizada aos 30 dias, mostrar diferentes comportamentos em função dos tratamentos, os dados das últimas avaliações, que apresenta na realidade maior importância prática, mostram que todos os tratamentos testados, com excessão do uso do "Captan", proporcionaram resultados semelhantes ao da testemunha.

B. Efeito dos tratamentos na enxertia de E. dunni por garfagem em fenda cheia apresentado na Figura 3.

Como foi observado na enxertia de E. urophylla por esse método o uso do "Captan" proporcionou também melhores resultados em relação à porcentagem de enxertos em desenvolvimento. No entanto, a comparação dos resultados obtidos durante as avaliações finais em função da testemunha mostraram que os efeitos dos tratamentos podem ser agrupados em duas classes: os fungicidas com resultados superiores e o hormônio nas duas concentrações, com resultados inferiores ou semelhantes à testemunha.

C. Efeito dos tratamentos na enxertia de E. urophylla por borbulhia em janela aberta, apresentado na Figura 4.

Nesse caso, a avaliação final realizada no 120º dia mostrou que todos os tratamentos empregados proporcionaram resultados inferiores à testemunha, com excessão do uso do "Captan" que apresentou resultado semelhante.

D. Efeito dos tratamentos na enxertia de E. dunnii por borbulhia em janela aberta, apresentado na Figura 5.

Os resultados da propagação do E. dunnii por borbulhia em janela aberta foram decepcionantes. Apesar dos dados da avaliação realizada no 90º dia mostrar 5% de enxertos em desenvolvimento para a testemunha e para a imersão dos propágulos por 3' no "6-BAP", na avaliação final realizada no 120º dia, todos os tratamentos apresentaram resultados nulos.

E. Efeitos dos tratamentos nos dois tipos de enxertia para as duas espécies testadas.

A imersão dos propágulos na solução hormonal (100 mg de 6-BAP/l) por 3' e 5' influiu negativamente nas porcentagens de enxertos em desenvolvimento (brotados) com relação à testemunha, mostrando que a aplicação de substâncias reguladoras de crescimento na região da união do enxerto nessas concentrações não é adequada para os tipos de enxertias das espécies testadas.

Por outro lado, a imersão dos propágulos em soluções de fungicidas, em especial "Captan", proporcionou, em geral, resultados superiores à testemunha, talvez pela ação de eliminação de patógenos que, devido às características dos calos (células de paredes finas) e alta umidade proporcionada pelo uso do fitilho, encontram condições ideais para se desenvolverem.

Conclusões

a) O E. dunnii apresentou maiores dificuldades de propagação que o E. urophylla nos dois métodos utilizados;

b) a garfagem em fenda cheia proporcionou melhores resultados que a borbulhia em janela aberta, para as duas espécies;

c) com excessão da enxertia de E. dunnii por borbulhia em janela aberta, onde todos os tratamentos, inclusive a testemunha, apresentaram resultados nulos no 120º dia (avaliação final), os efeitos dos tratamentos em relação à testemunha, na variável analisada podem ser classificados em:

c.1) resultados superiores ou semelhantes à testemunha: imersão em solução de fungicidas "Captan" e "Benlate" (100 mg/l) por 10'

c.2) resultados inferiores ou semelhantes à testemunha: imersão em solução de 100 mg de "6-BAP"/l por 3' e 5'.

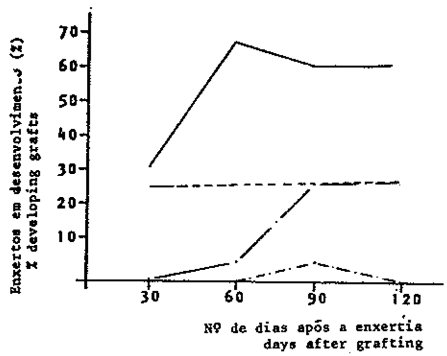

Figure 1. Percentage of grafts in development of the tests according to the time of evaluation.

Figura 1. Porcentagens de enxertos em desenvolvimento das testemunhas em função da época de avaliação.

Legenda: / Key:
- ———— *E. urophylla* (garfagem) (grafting)
- —·—·— *E. urophylla* (borbulhia) (patch budding)
- – – – – *E. dunnii* (garfagem) (grafting)
- ·–·–·– *E. dunnii* (borbulhia) (patch budding)

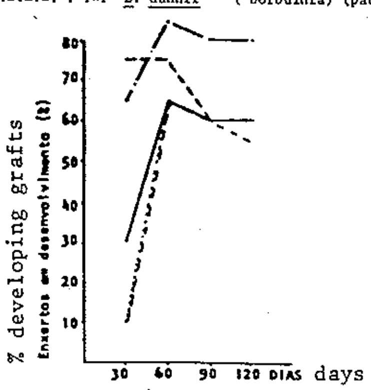

Figura 2. Porcentagem de enxertos, de *E.urophylla* executados por garfagem em fenda cheia, em desenvolvimento, em função dos tratamentos e avaliações

Fig.2-% developing *E. urophylla* splice grafts according to treatments and analyses

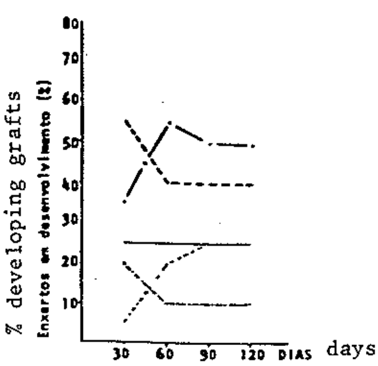

Figura 3. Porcentagem de enxertos, de *E.dunnii* executados por garfagem em fenda cheia, em desenvolvimento, em função dos tratamentos e avaliações

Fig.3- % *E.dinnii* splice grafts under development according to treatments and analyses.

tipos de enxertia. type of graft	TRATAMENTOS treatment	epocas de avaliaçao (dias) evaluation dates (days)							
		E. urophylla				*E. dunnii*			
		30	60	90	120	30	60	90	120
GARFAGEM EM FENDA CHEIA splice grafting	6-BAF 3 min	10	65	60	60	5	20	25	25
	6-BAP 5 min	10	65	60	55	20	10	10	10
	Benlate 10 min	75	75	60	60	55	40	40	40
	Captan10 min	65	85	80	80	35	55	50	50
	Testemunha control	30	65	60	60	25	25	25	25
BORBULHIA EM JANELA ABERTA patch budding	6-BAP 3 min	0	0	25	10	0	0	5	0
	6-BAP 5 min	0	5	15	10	0	0	0	0
	Benlate 10 min	0	0	35	15	0	0	0	0
	Captan10 min	0	10	20	25	0	0	0	0
	Testemunha control	0	5	25	25	0	0	5	0

Table 1- Percentages of developing grafts according to the grafting method, treatment, species and time of analyses.

Tabela 1- Porcentagens de enxertos em desenvolvimento em função do tipo de enxertia, tratamentos, espécies e época de avaliação.

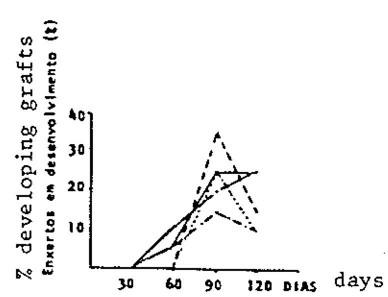

Figura 4. Porcentagem de enxertos, de *E.urophylla* executados por borbulhia em janela aberta, em desenvolvimento, em função dos tratamentos e avaliações

Fig 4.-% developing *E.urophylla* patch budding grafts according to treatments and analyses.

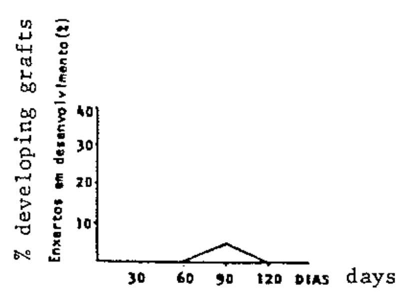

Figura 5. Porcentagem de enxertos, de *E.dunnii* executados por borbulhia em janela aberta, em desenvolvimento, em função dos tratamentos e avaliações

Fig.5- % developing patch budding grafts of *E. dunnii*, according to treatments and analyses.

key: Legenda
- ———— Testemunha Control
- ———— 10' Captan
- – – – – 10' Benlate
- —·—·— 5" 6-BAP
- ········· 3" 6-BAP

FAST GROWING TREES

EFEITO DO ARMAZENAMENTO DE MATERIAL VEGETATIVO NA ENXERTIA DE *Eucalyptus Grandis* HIL EX MAIDEN.

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Resumo

Enxertando propágulos, de clones de Eucalyptus grandis Hill ex Maiden, armazenados por 1, 2, 3, 5 e 7 dias em sacos plásticos e em câmara fria à temperatura de + 3ºC, observou-se 90 dias após a enxertia por borbulhia em janela aberta e encostia em mamadeira que os enxertos dos propágulos armazenados 7 dias não sobreviveram, que a porcentagem de enxertos em desenvolvimento executado por encostia em mamadeira decresceu em função do tempo de armazenamento, que os enxertos executados por borbulhia em janela aberta não se desenvolveram mesmo considerando todos os períodos de armazenamento e, que a encostia em mamadeira apresentou resultados superiores a borbulhia durante o ensaio.

EFFECTS OF SCION STORAGE ON THE GRAFTING OF *Eucalyptus grandis* HILL EX MAIDEN.

Summary

Eucalyptus grandis Hill ex Maiden scions stored in plastic bags in a cold room (3ºC) for 1, 2, 3, 5 and 7 days were used for patch budding and bottle grafting. From observations made one a 90 day period after grafting,the following conclusions were drawn: a) the bottle grafted scions stored for 7 days did not survive; b) the survival of the bottle grafts decreased with the lenght of the scion storage period, and c) the patch bud of the stored scions did not survive.

Introdução

Normalmente, a formação de banco e pomares clonais, implica na coleta de propágulos de árvores selecionados em diversos locais e concentração das atividades de enxertia em viveiro centralizado ou no local definitivo do banco ou pomar.

O armazenamento dos propágulos, tem sido estudado por diversos autores para o gênero Pinus (SUITER, 1971), pois apresenta correlação direta com a diminuição dos custos das atividades pela eliminação de transportes intermediários do material vegetativo e possibilitam a coincidência dos estados vegetativos adequados do enxerto e porta-enxerto.

Este ensaio preliminar teve como objetivo verificar os efeitos do armazenamento de propágulos (acondicionados em sacos plásticos e em Câmara fria à temperatura de ± 3ºC) de Eucalyptus grandis Hill ex Maiden na sobrevivência e porcentagem de enxertos em desenvolvimento executados por borbulhia em janela aberta e encostia em madeira.

Material e Métodos

Os propágulos de clones, coletados do banco clonal de Eucalyptus grandis Hill ex Maiden, com 4 anos de idade, localizado em Piracicaba-SP, foram acondicionados em sacos plásticos armazenados em câmara fria a temperatura de + 3ºC.

A enxertia foi realizada em 01 de agosto de 1978, no viveiro do Departamento de Silvicultura da ESALQ-USP, sob cobertura de tela de "nylon" com sombreamento de 50%. Os porta-enxertos, da mesma espécie, apresentavam altura média de 80 cm e diâmetro médio na região do colo de 0,9 cm.

Foram executados em média, 20 enxertos para cada tipo de enxertia (encostia em mamadeira e borbulhia em janela aberta). A avaliação da sobrevivência e porcentagem de enxertos em desenvolvimento foi realizada 90 dia após a enxertia.

Resultados e Discussão

As porcentagens de enxertos sobreviventes e enxertos em desenvolvimento, 90 dias após a enxertia, por borbulhia em janela aberta e encostia em mamadeira, em função do período de armazenamento, estão apresentadas na Tabela 1.

Tabela 1. Porcentagens de enxertos sobreviventes (VIVOS) e enxertos em desenvolvimento (BROTOS) em função do tipo de enxertia e períodos de armazenamento

Table 1 - Graft performance (survival and development) in function of grafting method and of the storage period.

Período de armazenamento / Storage Period	Performance dos enxertos graft performance %	Tipo de enxertia grafting method: BORBULHIA patch budding	ENCOSTIA bottle grafting
1 dia / 1 day	VIVO - survival	92,8	60,0
	BROTO- developing	0,0	60,0
2 dias / 2 days	VIVO - survival	95,0	90,0
	BROTO- developing	0,0	40,0
3 dias / 3 days	VIVO - survival	100,0	87,5
	BROTO - developing	0,0	25,0
5 dias / 5 days	VIVO - survival	95,0	50,0
	BROTO - developing	0,0	14,3
7 dias / 7 days	VIVO - survival	0,0	0,0
	BROTO - developing	0,0	0,0

Analisando os dados da tabela 1 e Figura 1, observou-se que para a sobrevivência, o armazenamento dos propágulos durante um período inferior a 5 dias não afetou os enxertos executados por borbulhia em janela aberta, no entanto, para enxertos executados por encostia em mamadeira, a maior sobrevivência foi constatada na enxertia com propágulos armazenados por 2 dias, decrescendo gradativamente com o aumento do período de armazenamento. Para os dois métodos empregados, a sobrevivência dos enxertos de propágulos armazenados por 7 dias foi nula.

Quanto à porcentagem de enxertos em desenvolvimento, apresentados na Tabela 1 e Figura 2, verifica-se que para os enxertos executados por encostia em mamadeira, houve um decréscimo gradativo com o aumento do período de armazenamento dos propágulos, sendo que a enxertia do material vegetativo armazenado por 7 dias apresentou, em semelhança à sobrevivência, resultados nulos. Com relação aos enxertos executados por borbulhia em janela aberta, os resultados em função dos armazenamentos nos períodos testados foram semelhantes, não apresentando nenhuma gema em desenvolvimento. Esses resultados sugerem que a indução para o desenvolvimento das gemas enxertadas, através do choque térmico, não se mostrou eficiente para a enxertia do Eucalyptus grandis Hill ex Maiden por borbulhia em janela aberta.

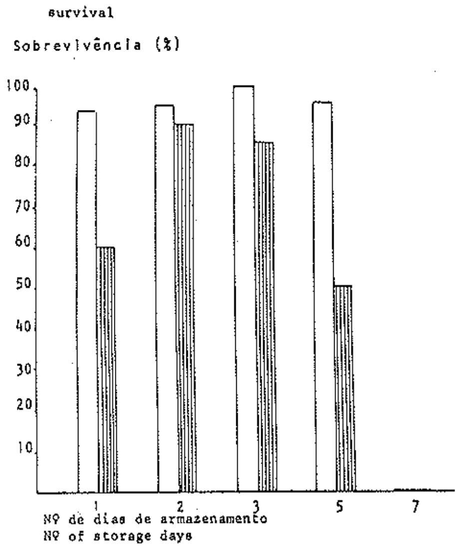

Figura 1. Porcentagem de sobrevivência, 90 dias após a enxertia, em função do período de armazenamento e tipo de enxertia.

Figure 1. percentage survival, 90 days after grafting, according to the storing period and type of graft.

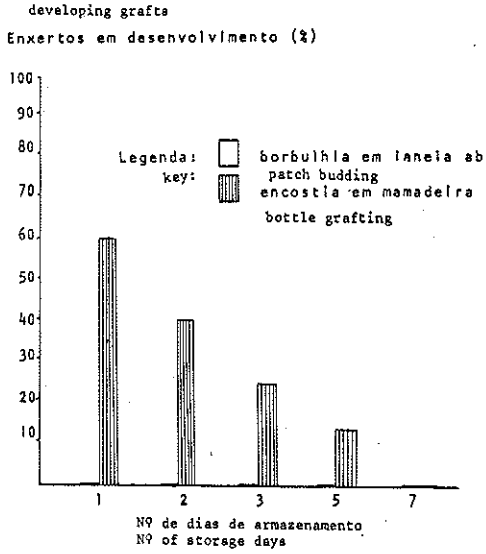

Figura 2. Porcentagem de enxertos em desenvolvimento, 90 dias após a enxertia, em função do período de armazenamento e tipo de enxertia.

Figure 2. Percentage of developing grafts 90 days after grafting, according to storage period and type of graft.

Em função dos resultados obtidos, recomenda-se que o período de armazenamento de propágulos de Eucalyptus grandis Hill ex Maiden, utilizados na enxertia, seja o mínimo possível e que o tempo entre a coleta e a enxertia não seja superior a 3 dias. Observou-se também que a borbulhia em janela aberta é um método com potencial para a propagação vegetativa de Eucalyptus grandis Hill ex Maiden desde que as gemas enxertadas se desenvolvam por processos naturais ou indução externa. Nas condições desse ensaio, no período observado, a encostia em mamadeira apresentou resultados superiores à borbulhia em janela aberta, com relação à porcentagem de enxertos em desenvolvimento, o que representa informações práticas mais importantes.

Conclusões

a) A sobrevivência dos enxertos não foi afetada pelo armazenamento dos propágulos por períodos inferiores a 5 dias à temperatura de 3ºC;

b) a porcentagem de enxertos em desenvolvimento, executados por encostia em mamadeira, decresceu acentuadamente com o aumento do período de armazenamento e, para os enxertos executados por borbulhia em janela aberta foi nula para todos os períodos de armazenamento testados;

c) a enxertia de propágulos armazenados por 7 dias apresentou resultados nulos, para os dois tipos de enxertia com relação a sobrevivência.

d) a borbulhia em janela aberta é um método de propagação vegetativa com grande potencial para a espécia, desde que as gemas enxertadas sejam induzidas a se desenvolverem.

e) nesse ensaio, a encostia em mamadeira apresentou resultados superiores à borbulhia em janela aberta.

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ENXERTIA HOMOPLÁSTICA E HETEROPLÁSTICA ENTRE *Eucalyptus grandis* HILL EX MAIDEN E *E. urophylla* S.T.BLAKE PELO MÉTODO INGLÊS COMPLICADO.

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Resumo

Analisando os efeitos da enxertia homoplástica e heteroplástica entre o Eucalyptus grandis Hill ex Maiden e o E. urophylla S.T. Blake, durante um período de 90 dias após a enxertia pelo método inglês complicado, observou-se que os resultados obtidos com a enxertia heteroplástica foi muito inferior aos obtidos com a enxertia homoplástica, para ambas espécies. Na comparação dos comportamentos das enxertias homoplásticas verificou-se também que o E. grandis apresentou resultados excelentes (90,5% de enxertos em desenvolvimento) em comparação ao E. urophylla (37,5% de enxertos em desenvolvimento), mostrando o potencial do emprego do método para a espécie.

Eucalyptus grandis HIL EX MAIDEN AND *E. urophylla* S.T. BLAKE HOMO AND HETEROPLASTIC SPLICE GRAFTING.

Summary

From the analyses of Eucalyptus grandis Hill ex Maiden and E. urophylla S.T. Blake homo and heteroplastic splice grafting during a 90 day period, the following conclusions were drawn: a) the heteroplastic splice grafting results were much lower than those obtained for the homoplastic grafting; b) the homoplastic splice grafting results were higher for E. grandis (90,5%) than for E. urophylla (37,5%) and c) the splice grafting showed a high potential use for the propagation of E. grandis.

Introdução

A incompatibilidade na enxertia é o principal fator limitante ao emprego dessa técnica de propagação vegetativa na formação de bancos e pomares clonais de Eucalyptus spp.

Uma das hipóteses da causa da incompatibilidade atualmente aceita, relaciona a ocorrência do problema à existência de inibidores na formação da união.

Visando fornecer subsídios para o conhecimento dos fatores que afetam a enxertia, foi delineado esse ensaio preliminar com o objetivo de avaliar os resultados de enxertias homoplásticas e heteroplásticas envolvendo o Eucalyptus grandis Hill ex Maiden e o Eucalyptus urophylla S.T. Blake.

Material e Métodos

A enxertia foi realizada em 01 de agosto de 1978 no viveiro do Departamento de Silvicultura da ESALQ-USP, em Piracicaba-SP, sob cobertura de tela de nylon com 50% de sombreamento.

Os porta- enxertos, formados a partir de sementes coletadas em áreas de produção de Eucalyptus urophylla S.T. Blake e Eucalyptus grandis Hill ex Maiden, apresentavam altura média de 100 cm e diâmetro médio, a 15 cm do solo, de 0,9 cm.

Os propágulos vegetativos foram coletados de clones do banco clonal localizado em Piracicaba-SP.

Foram realizados 12 enxertos por tratamento pelo método inglês complicado.

Os tratamentos empregados foram:

A - enxerto E. grandis / porta-enxerto E. grandis
B - enxerto E. urophylla/porta-enxerto E. urophylla
C - enxerto E. grandis /porta-enxerto E. urophylla
D - enxerto E. urophylla/porta-enxerto E. grandis

Resultados e Discussão

A porcentagem de enxertos em desenvolvimento, realizado através do método inglês complicado, em função da combinação entre enxerto e porta-enxerto e época de avaliação, estão apresentados na Tabela 1 e Figura 1.

Os dados da Tabela 1 e Figura 1 mostram que aos 90 dias após a enxertia, os resultados obtidos com enxertos de E. grandis foram superiores aos obtidos com o E. urophylla, com porcentagens de enxertos em desenvolvimento de 69,4% e 24,1% respectivamente.

Com relação ao comportamento em função dos porta-enxertos, observa-se também, melhor resultado na enxertia sobre o E. grandis. No entanto, esse comportamento pode ser atribuído pelos dados obtidos com a enxertia homoplástica com a espécie, e o que elimina, a princípio, a possibilidade de generalizar a conclusão de que mudas de E. grandis apresentam tendências para porta-enxertos, na enxertia das espécies estudadas.

Em função desses comportamentos, e da comparação dos resultados das enxertias homoplástica e heteroplástica, que apresentaram 64,0% e 29,5% de enxertos em desenvolvimento, respectivamente, conclui-se que a enxertia dessas duas espécies estudadas, por esse método, deve ser executada em porta-enxertos da mesma espécie.

Tabela 1. Porcentagem de Enxertos em desenvolvimento, realizados através do método inglês complicado, em função da época de avaliação e combinação entre enxerto e porta-enxerto.

Table 1. Percentage of developing grafts (splice grafts) in function of evaluation date and of the scion/rootstock combinations of E. grandis and E. urophylla.

Porta-Enxerto (rootstock) \ Enxerto (scion)	E. grandis	E. urophylla	Média (mean)
E. grandis	90.5	10.7	50.6
E. urophylla	48.3	37.5	42.9
Média (mean)	69.4	24.1	46.8

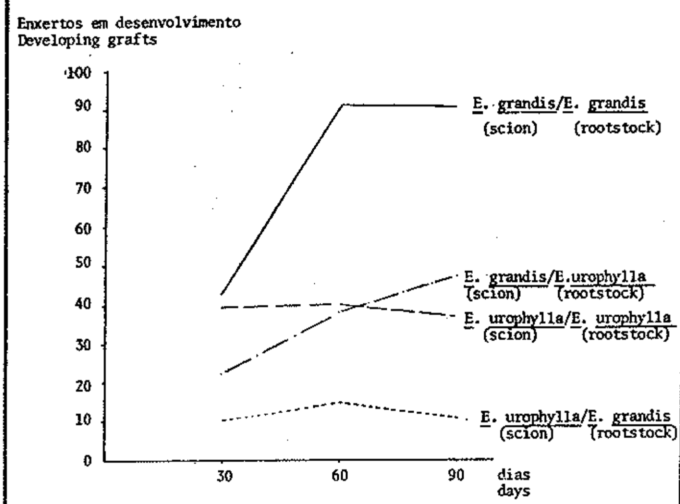

Figura 1. Porcentagem de enxertos, executados pelo método inglês complicado, em desenvolvimento, em função da época de avaliação e combinação entre enxerto e porta-enxerto.

Figure 1. Percentage of developing grafts (splice grafts) in function of evaluation date and of the scion/rootstock combinations of E. grandis and of E. urophylla.

Conclusões

a) A enxertia homoplástica do E. grandis apresentou melhor resultado que a enxertia homoplástica do E. urophylla aos 90 dias após a execução pelo método inglês complicado;

b) A enxertia do E. grandis, nos dois tipos de porta-enxertos empregados apresentou resultados superiores ao E. urophylla, na ordem de 69,4% e 24,1% de enxertos em desenvolvimento, respectivamente;

c) Os resultados preliminares indicaram que a enxertia heteroplástica envolvendo o E. grandis e o E. urophylla não deve ser recomendada para uso em larga escala, no entanto, deve-se estudar a existência de possíveis inibidores principalmente no propágulo adulto do E. urophylla.

ENXERTIA DE *Eucalyptus urophylla* S.T.BLAKE PELOS MÉTODOS GARFAGEM EM FENDA CHEIA E BORBULHIA EM JANELA ABERTA.

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Resumo

O trabalho compara os resultados das enxertias de Eucalyptus urophylla S.T. Blake através da garfagem em fenda cheia e da borbulhia em janela aberta, realizadas no viveiro da Cia. Agro-Florestal Santa Bárbara, em Sabará-MG.

Os dados obtidos até o 120º dia de observação no viveiro, após enxertia, mostram que: a) a sobrevivência dos enxertos realizados pelos dois métodos testados não diferiram estatisticamente; b) a garfagem em fenda cheia apresentou melhor resultado em relação ao número de enxertos com gemas em desenvolvimento e c) há a necessidade de serem intensificados os estudos visando a escolha de gemas mais apropriadas ao método de borbulhia e métodos de ativação das gemas enxertadas.

Eucalyptus urophylla S.T.BLAKE SPLICE GRAFTING AND PATCH BUDDING.

Summary

The objective of this work was to compare the vegetative propagation of Eucalyptus urophylla S.T. Blake using splice grafting and patch budding methods.

Analyses carried out 120 days after grafting revealed that: a) the clone survival between the two grafting methods did not statistically differ; b) when splice grafting was used, there was a superior development of grafted buds; and c) there is a need for more intensive studies on bud selection for patch budding and induction of bud development methods.

Introdução

A escolha do método de enxertia adequado deve ser baseado na característica da espécie, na variação individual, no tipo de material vegetativo, na variação individual dos genótipos, no tipo de porta-enxerto e nas condições ambientais do local de execução da operação.

Em função da análise das vantagens e desvantagens da grande variedade dos métodos de enxertia, foram selecionados a garfagem em fenda cheia e a borbulhia em janela aberta para o desenvolvimento desse trabalho que teve, como objetivo, avaliar o comportamento dos enxertos, na sobrevivência e no desenvolvimento das gemas enxertadas, visando fornecer subsídios para a execução da enxertia em larga escala.

Materiais e Métodos

O material vegetativo dos 4 clones estudados foi coletado

Tabela 1 - Número de enxertos sobreviventes (vivos) e em desenvolvimento (BROTOS), em função do método de enxertia (garfagem em fenda cheia e borbulhia em janela aberta), da época da avaliação (75 e 120 dias) e do clone. Confronto entre os resultados aos 120 dias pelo teste X^2.

Table 1 - Number of surviving grafts (LIVE) and in development (BUDS), according to the grafting method, time of analysis (75 and 120 days) and clone. Comparison of results of analyses taken at 120 using the X^2 test.

Clone	Garfagem em Fenda Cheia - Splice Grafting						Borbulhia em Janela Aberta - Patch Budding					
	Avaliação: 75 dias Evaluation: 75 days			Avaliação: 120 dias Evaluation: 120 days			Avaliação: 75 dias Evaluation: 75 days			Avaliação 120 dias Evaluation 120 days		
	TOTAL	VIVOS Surviving	BROTOS BUDS D.	TOTAL	VIVOS Surviving	BROTOS BUDS D.	TOTAL	VIVOS Surviving	BROTOS BUDS D.	TOTAL	VIVOS Surviving	BROTOS BUDS D.
01	20	8	4	20	8	4	24	15	0	24	15	0
09	20	6	5	20	6	5	24	9	0	24	9	2
26	20	7	4	20	7	4	24	12	0	24	12	0
40	20	6	5	20	6	5	24	10	2	24	10	2
TOTAL	80	27	18	80	27	18	96	46	2	96	46	4
TOTAL %	100,00%	33,75%	22,50%	100,00%	33,75%	22,50%	100,00%	47,92%	2,08%	100,00%	47,92%	4,16%

Teste X^2 (comparação entre totais de enxertos sobreviventes em função do método, aos 120 dias) = 3,61 n.s.

Teste X^2 (comparação entre totais de enxertos em desenvolvimento em função do método, aos 120 dias) = 13,41 **

X^2 test (comparison among total surviving grafts in function of the grafting method at 120 days) = 3,61 n.s.

X^2 test (comparison among total bud developing grafts in function of the grafting method at 120 days) = 13,41**

n.s. = não apresentam diferenças significativas pelo Teste X^2.
** = diferem estatisticamente ao nível de 1% de probabilidade.

n.s. = non significant differencens using the X^2 test
** = statistically different at the 1% level of probability.

no Banco Clonal de Eucalyptus urophylla na Estação Experimental de Recursos Naturais Renováveis de Anhembi, pertencente ao Departamento de Silvicultura da Escola Superior de Agricultura "Luiz de Queiroz". Após a coleta, os propágulos foram acondicionados em sacos plásticos e transportados, via aérea, em caixas de "isopor" com gelo.

A enxertia foi realizada em 14 de dezembro de 1977 no viveiro da Cia. Agro-Florestal Santa Bárbara, no município de Sabará-MG; sob cobertura de esteira de bambu com sombreamento de aproximadamente 80%. Os enxertos permaneceram sob essas condições por um período de 75 dias, recebendo os cuidados necessários.

Para cada um dos 4 clones, foram realizados 20 enxertos pelo método garfagem em fenda cheia e 24 enxertos pelo método borbulhia em janela aberta. Para a análise dos dados de sobrevivência e brotação, após 120 dias de enxertia, foi aplicado o teste X^2.

Resultados e Discussões

O número total dos enxertos sobreviventes e daqueles com gemas em desenvolvimento acham-se relacionados na Tabela 1.

Os dados apresentados na Tabela 1 mostram que nos dois métodos de enxertia usados, garfagem em fenda cheia e borbulhia em janela aberta, não houve modificações nas porcentagens de sobrevivência e enxertos brotados 75 e 120 dias após a enxertia. No entanto, na borbulhia em janela aberta, a porcentagem de gemas brotadas foi duplicado na segunda avaliação feita aos 120 dias. Apesar desse aumento significativo, o número de enxertos aproveitáveis para o plantio no campo, isto é, com gemas bem desenvolvidas, foi de apenas 4,15%, taxa considerada muito baixa.

A sobrevivência de 47,93% constatada para o método borbulhia sugere a necessidade de se concentrar esforços no sentido de estudar uma possível indução da brotação das gemas, que poderá ser realizada através da escolha de tipos de gemas mais apropriadas ou por estímulos externos.

Os resultados dos testes X^2, aplicados aos dados obtidos no 120º dia mostram que não houve diferenças significativas na sobrevivência, apesar da superioridade observada para a borbulhia de 14,17%. Porém, quando comparados os números de enxertos com gemas em desenvolvimento, a garfagem em fenda cheia mostrou uma superioridade altamente significativa.

Conclusões

Em função dos resultados obtidos após 120 dias da enxertia, concluiu-se:

a) A garfagem em fenda cheia apresentou maior sobrevivência e maior número de gemas em desenvolvimento.

b) A borbulhia em janela aberta, apesar da baixa porcentagem de gemas em desenvolvimento (4,16%), é um método com grande potencial para a enxertia da espécie pois apresentou uma sobrevivência de 47,92%.

c) Há necessidade de se intensificar os estudos visando a escolha de gemas mais apropriadas e de métodos de indução da brotação das gemas enxertadas.

MORFOLOGIA E ANATOMIA DAS SEMENTES E PLÂNTULAS DE *Eucalyptus camaldulensis* DEHN.

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Resumo

Os caracteres morfológicos e anatômicos das sementes e plântulas de Eucalyptus camaldulensis Dehn. foram estudados pormenorizadamente visando fornecer bases seguras para a identificação da espécie, ainda nestas fases. Verificou-se ser a morfologia externa das sementes e a anatomia de seus envoltórios, principalmente o tegumento externo, muito úteis na determinação da espécie. Por outro lado, as características do embrião e da plântula parecem ser de menos utilidade.

MOFOLOGICAL AND ANATOMICAL STUDIES OF THE SEEDS AND SEDLINGS OF *Eucalyptus camaldulensis*. DEHN.

Summary

Morphological and anatomical aspects of seeds and young seedlings of Eucalyptus camaldulensis Dehn. were studied in detail. The main purpose of this work was to find morphological and anatomical features in the seeds and seedlings which permit us to differentiate them with certainty among other species of the genus. The external characteristics of the seeds and the seed coat anatomy unlike the features of the embryo and seedling, appeared to be very useful in the identification of this species.

Introdução

A identificação das espécies de Eucalyptus, na fase de sementes é bastante difícil, devido às suas dimensões, geralmente reduzidas.

Assim, pareceu-nos oportuno um estudo morfológico e anatômico pormenorizado das sementes e plântulas de Eucalyptus camaldulensis Dehn., espécie esta de considerável valor econômico. Visamos fornecer bases para a determinação segura da espécie, nesta fase e para possíveis estudos taxonômicos e ecológicos.

Material e Métodos

As sementes de Eucalyptus camaldulensis Dehn. procedem do Horto Florestal "Navarro de Andrade" de Rio Claro (SP), Brasil, colhidas de matrizes selecionadas.

Os caracteres externos e internos das sementes e plântulas foram observados sob esteriomicroscópio. Determinou-se o peso de 100 sementes férteis e as porcentagens de sementes férteis (em peso), em balança analítica e as dimensões das sementes com uma ocular de medição.

A anatomia foi estudada em secções transversais (s.t.), longitudinais (s.l.) e paradérmicas (s.p.), feitas a mão livre (Corner, 1976), determinando-se a natureza microquímica das estruturas celulares pelos testes usuais (Johansen, 1940; Jensen, 1962, Sass, 1951). As ilustrações foram feitas em câmara clara.

A germinação das sementes foi realizada em placas de Petri, sobre papel de filtro úmido, mantidas em condições de temperatura (média de 26°C) e luminosidade ambientais.

Resultados

Em uma amostra de sementes de *Eucalyptus camaldulensis* encontram-se sementes aparentemente férteis, providas de embrião e dois tipos de sementes estéreis (A e B).

Nas amostras estudadas havia, em média 12 ± 5% (em peso) de sementes férteis, representando 25,8 ± 42 sementes férteis por grama. O peso médio de 100 sementes férteis foi de 47,7 ± 4,5 mg.

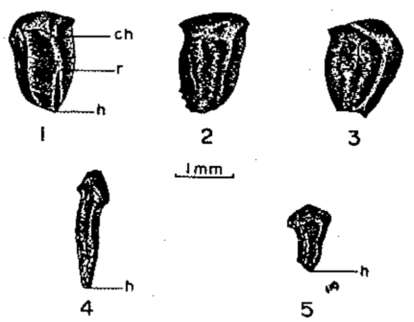
Características das Sementes Férteis (Figs. 1 a 3).

São de formas poliédricas ou trapezoidais; rafe longa; anti-rafe convexa; coloração marrom-claro, amarelado; superfície brilhante, lisa, com finas estrias transversais na anti-rafe; bordos salientes; hilo basal, circular, de coloração clara; micrópila pouco visível, abaixo do hilo. Medem, em média, 1,26 ± 0,16 mm de comprimento por 1,14 ± 0,13 mm de largura.

Características das Sementes Estéreis.

Tipo A (Fig. 4): alongadas - prismáticas ou cilíndricas; coloração marrom-médio, avermelhado; superfície algo brilhante, reticulada; hilo basal. Medem, em média 1,76 ± 0,41 mm de comprimento por 0,54 ± 0,10 mm de largura.

Tipo B: curtas - cúbicas ou trapezoidais; coloração idêntica às de tipo A ou mais amareladas; superfície idêntica ao tipo A; hilo basal; medindo em média 1,01 ± 0,15 mm de comprimento por 0,55 ± 0,13 mm de largura.



Figs. 1 a 5 - *E. camaldulensis*- Aspecto externo das sementes férteis e estéreis. Figs. 1, 2 e 3 - semente fértil; Fig. 4 - sementes estéril tipo A. Fig. 5 - sementes estéril tipo B. (ch = chalaza; h = hilo; r = rafe).

Morfologia Interna da Semente Fértil.

As sementes férteis maduras consistem de envoltórios (testa, tégmem, remanescentes da nucela e do endosperma) e embrião (eixo-hipocótilo radicular e dois cotilédones dobrados - Figs. 13 a 16). O eixo apresenta, em polos opostos, o meristema caulinar e, o meristema radicular, juntamente com o caliptrógeno, parcialmente envolvidos pelo órgão cupuliforme (saliencia do córtex na base do hipocótilo - Fig. 14).

Anatomia dos Envoltórios da Semente Fértil.

A testa consta de duas epidermes, entre as quais, na região da rafe, existe um tecido parenquimático, não suberificado. A epiderme externa, em s.t. (Fig. 6); consta de células baixas, retangulares que, em s.p. (Fig. 7) mostram-se retangulares ou poligonais, alongadas em sentido transversal. Suas paredes periclinais externas e anticlinais, não lignificadas, têm espessamento lamelar.

A epiderme interna (endotesta) apresenta células retangulares, em s.t. (Fig. 6) e pentagonais ou hexagonais em s.p. (Fig. 7). Cada célula tem forte espessamento lamelar em sua parede periclinal interna e contém um ou mais cristais de oxalato de cálcio.

As células de ambas as epidermes contêm substâncias tânicas dissolvidas e impregnando suas paredes o que lhes confere coloração marrom.

O tegumento interno (tégmem), limitado internamente por uma cutícula, não é suberificado encontrando-se totalmente amassado e indistinto (Fig. 6).

Os restos da nucela constam de várias camadas de células obliteradas e o endosperma, de uma só camada de células pouco distintas, com conteúdo lipoproteico (Fig. 7 e 11).

O suprimento vascular da semente consiste de dois ou três feixes colaterais que partem do bordo superior do hilo estendendo-se até a chalaza (Figs. 9 e 10).

A superfície do hilo é constituída por células de paredes finas, rompidas e não suberificadas.

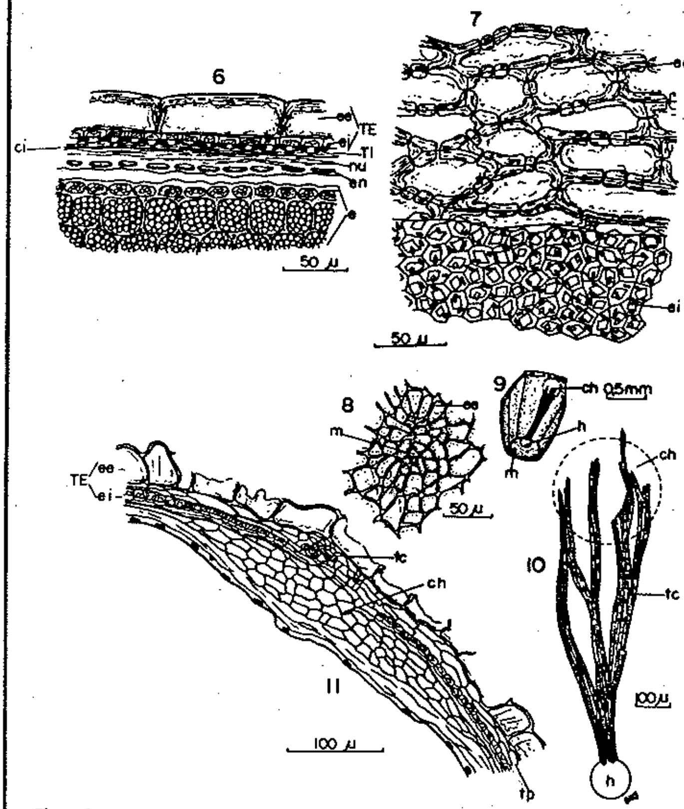
A micrópila é uma pequena abertura, delimitada por células epidérmicas de paredes finas (Fig. 8).

Anatomia do Embrião.

O eixo hipocótilo-radicular apresenta células protodérmicas cúbicas havendo, em formação, pequenas glândulas de óleo, que também ocorrem na face abaxial dos cotilédones. Sob a protoderme há 5 ou 6 camadas de meristema fundamental, precursor do córtex, e internamente o precursor da medula. Entre eles há um cilindro procambial, com 4 a 6 camadas de células longas e estreitas.

Os cotilédones (Fig. 17) têm protoderme em ambas as faces e o mesofilo consta de uma paliçada e 4 ou 5 camadas de células arredondadas.

Os tecidos do hipocótilo e dos cotilédones, exceto o procâmbio e as glândulas (ricas em óleo), contêm grãos de aleurona e gotículas de óleo.



Figs. 6 a 11 - *E. camaldulensis* - Anatomia dos envoltórios da semente fértil. Figs. 6 e 7 - respectivamente s.t. e s.p. dos envoltórios da semente fértil (anti-rafe); Fig. 8 - s.p. na região da micrópila; Fig. 9 - Diagrama da semente mostrando a posição do hilo, chalaza e micrópila; Fig. 10 - percurso dos feixes vasculares; Fig. 11 - s.t. da semente, na região da chalaza. (TE = testa; ee = epid. ext.; ei = epid. int.; TI = tégmem; ci = cutícula int.; nu = nucela; en = endosperma; e = embrião; tc = tec. condutor; tp = tec. parenquimático; ch = chalaza; h = hilo; m = micrópila.

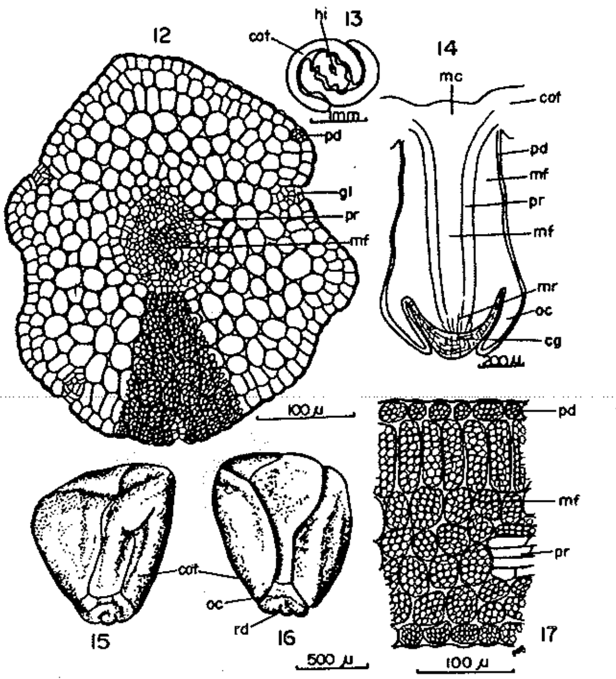
Germinação.

Em dois dias, os tegumentos se rompem, na região da micrópila e o hipocótilo cresce fazendo emergir o primórdio radicular, parcialmente envolvido pelo órgão cupuliforme (Fig. 18). Este é estreito (0,05 mm de largura), pouco saliente, já no terceiro dia revestindo-se de longos pelos absorventes (Fig. 19) e se mantendo funcional por cerca de 30 dias.

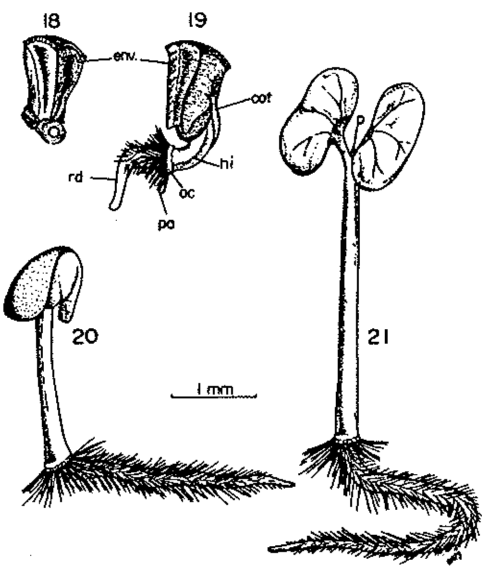
Radícula e hipocótilo crescem rapidamente e, em 5 dias (Fig. 20), a plântula fixa-se ao substrato e os envoltórios se desprendem. O hipocótilo tem coloração púrpura devido à presença de antocianinas em suas células epidérmicas.

Em 10 a 12 dias os cotilédones desdobram-se, sendo bilobados e verdes em ambas as faces. Entre eles, a plúmula é ainda incipiente (Fig. 21).

O crescimento do epicótilo inicia-se em cerca de 20 dias.



Figs. 12 a 17 - E. camaldulensis - Anatomia do embrião. Fig. 12 - s.t. mediana do eixo hipocótilo-radicular; Fig. 13 - Diagrama da s.t. do embrião; Fig. 14 - Diagrama da s.l. do eixo hipocótilo-radicular. Fig. 15 - Vista do embrião (face dorsal); 16 Vista do embrião (face ventral). Fig. 17 - s.t. do cotilédone. (hi = hipocótilo; pd = protoderme; mf = meristema fundamental; pr = procâmbio; gl = glândula; cot = cotilédone; mc = meristema caulinar; mr = meristema radicular; cg = caliptrógeno; oc = orgão cupuliforme; rd = primórdio radicular.).



Figs. 18 a 21 - E. camaldulensis - estágios sucessivos de desenvolvimento da plântula. Fig. 18 - 2º dia; Fig. 19 - 3º dia; Fig. 20 - 5º dia; Fig. 21 - 15º dia.
(cot = cotilédones; hi = hipocótilo; oc = órgão cupuliforme; pa = pelos absorventes; rd = primórdio radicular; env = envoltórios).

Conclusões

Pryor & Johnson (1971) atribuem grande valor às características anatômicas, principalmente da testa, na identificação das sementes de Eucalyptus. Ao compararmos estudos anteriores (Beltrati, 1973, 1977a, 1977b, 1978a, 1978b e 1979) com os resultados obtidos para E. camaldulensis, verificamos serem as características morfológicas externas da testa e a anatomia, principalmente da sua epiderme externa, de muita utilidade na identificação das sementes pois, variam com a espécie considerada. Por outro lado, os caracteres do embrião e da plântula mostraram-se mais uniformes e portanto menos úteis.

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ENRAIZAMENTO DE ESTACAS DE *Eucalyptus* UM MITO DESFEITO.

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Resumo

Com o uso de casas de vegetação aquecidas e de alta umidade, e usando-se como substrato moinha de carvão, o enraizamento de estacas de diversas espécies de Eucalyptus pode ser feito em outros locais que não a costa marítima quente e úmida. O uso de substâncias de crescimento é relativamente secundário, porém a escolha de matrizes aptas ao enraizamento é primordial. Material rejuvenescido apresenta maior facilidade de enraizamento.

Summary

Using greenhouses with controlled heat and high humidity, and ground charcoal as substrate, coppice shoots of several Eucalyptus species root easily. The use of controlled environment is important in situations where natural conditions are not favorable to rooting; different from those prevailing at the Atlantic Coast of Espírito Santo State. Growth substances are relatively secondary, but the choice of aptitude to rooting of different mother trees is of paramount importance. Rejuvenation of shoots increases rooting percentages substantially.

Introdução

Como o enraizamento de estacas é um método que propaga vegetativamente a árvore matriz, proporciona uma vantagem muito grande para se obter ganhos genéticos altos. A herdabilidade passa a ser a de sentido amplo, incluindo para seu cálculo no denominador a variância genética total, e não apenas a variância genética aditiva como em propagação sexuada. Desta feita, mesmo havendo variância ambiental, o ganho passa a aumentar devido à herdabilidade maior. Também o diferencial de seleção pode ser muito maior, pois a seleção pode se restringir a muito poucos indivíduos, o que não é aconselhável em propagação sexuada. Pode haver problemas futuros de endogamia na reprodução sexuada de estacas enraizadas e um risco maior devido a uniformidade genética; porém a curto prazo proporciona o máximo ganho possível.

Desta feita, os trabalhos de Martin e Quillet (7, 8, 9, 10) no Congo proporcionaram um avanço grande em relação aos trabalhos já feitos por Davidson(4) na Papua Nova Guiné e os da Austrália resumidos por Pryor e Willing (13), por proporcionar uso comercial a estudos restritos anteriormente. A descoberta de inibidores de crescimento por Paton et al (11) em material adulto também ajudou a esclarecer a situação e a vantagem de se usar brotação. O método de Martin e Quillet foi adaptado no Espírito Santo com muito sucesso por Ikemori (5, 6), provocando muita notoriedade entre outras firmas de reflorestamento no país. Longe da costa, onde as flutuações térmicas são altas e a umidade relativa oscila muito, o método não funciona tão bem repetitivamente, como atestam diversos outros trabalhos em que se testaram níveis de auxinas, substratos, aquecimento basal e outros artifícios (1, 2, 3, 12, 14). Porisso na CIMETAL FLORESTAS, em Lassance, MG., partiu-se de outra premissa: reproduzir o clima da costa artificialmente e depois testar substratos, auxinas, rejuvenescimento e outros métodos que pudessem aumentar o êxito de enraizamento de estacas de Eucalyptus spp.

Material e Métodos

Inúmeros ensaios e experimentos foram realizados entre outubro de 1979 até a presente data. Destes apenas dois serão apresentados, devido ao seu caráter elucidativo.

a. Comparação entre enraizamento de estacas originadas de brotação de árvores adultas e de estacas de brotação de material já enraizado, com ou sem ácido indol-butírico a 0,2% em talco.

As estacas foram retiradas de brotação de 80 dias após o abate de árvores adultas e de ramos de mudas de três meses de idade. As estacas foram preparadas, deixando-se dois pares de folhas, cortadas pela metade; as bases das estacas imersas por 15 min em 0,2% benlate e depois postas em casa de vegetação com temperatura oscilando entre 24 – 37°C e umidade relativa entre 80 – 100%. Foram instaladas em saquinhos plásticos individuais, com a parte inferior repleta de argila, e a parte superior com moinha de carvão, classificada como "média". Houve 10 blocos casualizados com dez estacas por parcela e ficaram por 30 dias na casa de vegetação. Após este prazo as estacas foram retiradas do saquinho, lavadas e procedeu-se a contagem da proporção enraizada, com calos, morta e sem reação. Os lados foram transformados em arc sen $\sqrt{\%}$ e submetidos ao teste de F e depois ao de Tukey. Os tratamentos foram:

1. Estacas provenientes da brotação de mudas enraizadas;
2. Como em 1. mas imersas em 0,2% de AIB em talco;
3. Estacas provenientes da brotação de cepas de árvores adultas;
4. Como em 3. mas com 0,2% de AIB em talco.

b. Efeito da concentração de substância de crescimento e reação de estacas de diversas matrizes.

Novamente usaram-se estacas tratadas como anteriormente, exceto na diferença quanto a concentração de substâncias de crescimento. Foram usadas estacas de cepas de sete árvores adultas, e as estacas preparadas como anteriormente. Havia 4 blocos casualizados, brotações de cinco matrizes e cinco concentrações de AIB, a saber: 0,0%; 0,05%; 0,10%; 0,15% e 0,20%. Foram usadas 10 estacas por parcela e analizadas como fatorial, depois de 30 dias no leito de enraizamento, como no experimento anterior, usando-se a transformação para arc sen $\sqrt{\%}$.

Resultados

Do experimento a. o teste de F deu significativo a 1% de probabilidade e o teste de Tukey revelou as diferenças entre os tratamentos, conforme o quadro 1.

QUADRO 1. Teste de Tukey para porcentagem de enraizamento

Tratamentos	% de enraizamento	arc sen $\sqrt{\%}$
Brotações já enraizadas + 0,2% AIB	81,0	65,83 a
Brotações árvores adultas + 0,2% AIB	62,0	52,35 a b
Brotações já enraizadas	46,0	42,43 b
Brotações de árvores adultas	18,0	24,23 c

As médias seguidas pela mesma letra, não diferiram significativamente entre si, ao nível de 5% de probabilidade pelo teste de Tukey.

Para o experimento b., a análise de variância mostrou diferenças a 1% de probabilidade para matrizes, não houve diferença significativa para dosagens de auxina e nem de interação.

O teste de Tukey para diferença entre matrizes também mostrou diferença significativa a 5% de probabilidade entre as estacas provenientes de diversas matrizes. A porcentagem de enraizamento das mesmas variou de 9,5% até 67%.

De interesse em outros experimentos é a diferença que dá a moinha de carvão como substrato: dependendo da matriz pode passar de 40% em areia para 92% de enraizamento em moinha. Há muita variação na capacidade de diferentes espécies em enraizar: E. robusta, E. pilularia, E. grandis e E. urophylla enraizam bem; já E. citriodora só enraiza em poucos casos.

Resultados e Conclusões

Apesar de os trabalhos serem iniciais, houve grande progresso no enraizamento de estacas fora da região com vocação natural para tanto. O uso de moinha de carvão como substrato, de casas de vegetação com umidade e calor controlado, uso de estacas de material já enraizado e seleção de matrizes aptas para enraizamento resolveram grande parte dos problemas para a região em estudo. Há fortes indicações de efeitos favoráveis de fertilizantes sobre estacas, não há ainda estudos de efeitos de fungicidas, de diferentes regimes térmicos, da idade de estacas, etc. De toda a forma, há subsídios suficientemente fortes para um programa industrial incipiente baseado em propagação vegetativa. O efeito de auxinas ainda continua controvertido, necessitando de estudos mais detalhados.

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CONTROLE AMBIENTAL PARA ENRAIZAMENTO DE ESTACAS EM CLIMA SUBTROPICAL.

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Resumo

Descreve-se os sistemas utilizados no controle de temperatura e umidade. Mostra-se suscitamente o consumo de energia necessária para o aquecimento da estufa.

Resultados práticos deste sistema foram comprovados atravez de enraizamento de estacas de eucaliptos, obtendo-se até 94% de enraizamento.

Summary

A greenhouse is described, where humidity and high temperatures are maintained. Through the use of this greenhouse, rooting of up to 94% of cuttings was obtained in eucalypt species.

1 - Introdução

O programa de reflorestamento em Minas Gerais, visa em quase sua totalidade suprir a curto prazo as necessidades do carvão vegetal para Siderurgia.

Em muitas regiões do Estado, o programa de melhoramento genético das árvores está incipiente, e resultados só deverão acontecer a médio prazo. A única possibilidade de melhoramento a curto prazo destes plantios é a propagação assexuada dos melhores indivíduos adaptados as condições locais, através do enraizamento de estacas.

A técnica de propagação assexuada com utilização do enraizamento de estacas das cepas brotadas é bastante conhecida, tendo seus primórdios na Austrália, Papua-Nova Guiné, África e mais recentemente na costa do Espírito Santo e Sul da Bahia. A técnica é comercialmente viável onde as temperaturas mínimas noturnas raramente são inferiores a 18ºC. Ikemore (1975) e (1976). Marttin e Quillet (1974), citado por Valle, recomendam o aquecimento na base das estacas em regiões onde as temperaturas mínimas noturnas atinjam valores inferiores a 18ºC. Valle (1978), trabalhando com Eucaluptus urophylla concluiu que nas condições experimentais o aquecimento da base da estaca não afeta a sobrevivência das estacas, mas é fundamental quanto a precocidade e porcentagem de formação de raízes.

2 - Metodologia

2.1 - Características das Instalações

O controle ambiental é feito dentro de uma casa de vegetação construída de madeira e lençol plástico transparente de 0,10 mm de espessura, junto a uma tela plástica preta (sombrite) que reduz a luz em 50% de sua intensidade. Na cobertura, o sombrite fica por cima do lençol plástico, protegendo-o de acidentes mecânicos e evitando também o excessivo aquecimento do plástico pelo efeito estufa.

A casa de vegetação tem 34,0 metros de comprimento por 17,0 metros de largura (578,00 m^2) onde os canteiros ocupam 384 metros quadrados, com capacidade para 153.600 recipientes plásticos (9X15 cm). O piso recebe uma camada de cascalho grosso de 10 cm (tipo seixo rolado), recoberto por outra camada de moinha grosso de carvão vegetal de mesma espessura; a camada de carvão tem a finalidade de promover a drenagem e formar o efeito estufa pelo aproveitamento da energia luminosa que é absorvida pela cor preta do carvão, irradiando energia calorífica que é retida dentro da casa pelo plástico transparente. Este efeito permite elevar a temperatura interna da casa acima de 24ºC, mesmo durante os dias em que se registrem temperaturas externas de 18ºC. Janelas são convenientemente colocadas nas laterais da casa, para reduzir a temperatura interna superiores a 30ºC. Elas permitem manter o ambiente interno na temperatura exterior.

2.2 - Sistema de Nebulização

Um sistema de nebulização comandado por folha eletrônica mantem as folhas sempre úmidas, acompanhando a evapotranspiração da folhas das estacas, mantendo sempre a umidade relativa do ar superior a 80 por cento.

A folha eletrônica comanda um relé de nível conectado em um contactor que liga ou desliga uma moto-bomba. A moto-bomba alimenta uma rede de canos de 2 polegadas ramificada em duas redes de 1 e 1/2 polegada respectivamente. No final da rede de 1/2 polegada é conectado um aspersor de baixa pressão que nebuliza a água dentro da casa de vegetação. Os aspersores em nº de 28, distribuidos convenientemente no interior da casa de vegetação, promovem uma nebulização muito fina capaz de fornecer uma fina lamina d'água sobre as estacas. Estando a folha eletrônica sem este fino filme d'água, há o acionamento da moto-bomba promovendo a nebulização até a formação do fino filme, momento em que desliga o sistema. Assim funciona este sistema, acompanhando exatamente, a evapotranspiração das estacas.

2.3 - Sistema de Aquecimento

Dimensionou-se um sistema de aquecimento para manter a temperatura da casa em 22ºC, para temperatura externa de 8ºC. Para esta diferença máxima, há necessidade de fornecer 83.300 kcal/ hora, utilizando-se de um apropriado trocador de calor e um sistema de circulação de ar forçando o ar da casa passar pela fonte de calor. Este sistema de circulação de ar trabalha com um ventilador de 5 CV, à uma pressão de 40 milimetros de coluna de água e uma vazão de 290 m^3 por minuto.

A energia calorífica, é fornecida por um maçarico a gas, que injeta fogo dentro de um tubo de aço de 0,20 m de diâmetro. Este tubo é aquecido dentro de uma galeria por onde passa todo ar da casa de vegetação na intensidade de 12 vezes por hora. O gas é produzido por um gaseificador de carvão vegetal, montado próximo ao trocador de calor. O sistema funciona automaticamente sempre que a temperatura interna da casa baixe de 22ºC, e desliga automaticamente quando a temperatura ultrapassa os 22ºC (sistema intermitente).

3 - Resultados e Conclusões

O controle ambiental mostrou-se adequado ao enraizamento de estacas de eucalipto, mesmo na época mais fria do ano (junho e julho) alcançando índices de enraizamento de 10 a 94% entre diferentes árvores. Trabalhando-se com um nº grandes de árvores, registrou-se um enraizamento médio de 60%.

Os controles planejados funcionaram perfeitamente, não apresentando desgastes até o momento (3 meses de funcionamento). O consumo de carvão é pequeno, estando na ordem de 90 kilogramas por noite. A metodologia provou ser eficiente onde enraizamento de estacas de eucalipto ocorre repetitivamente em qualquer época do ano, mesmo em climas de mínimas absolutas de 8ºC.

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ESTUDO COMPARATIVO DO COMPORTAMENTO DE ALGUNS HÍBRIDOS DE *Eucalyptus spp*

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Resumo

Os autores comparando híbridos sintéticos com o material genético comercialmente utilizado pela Champion Papel e Celulose S.A., constataram que o híbrido de E.saligna x E.grandis(06) foi superior em altura, incremento médio e volume empilhado estimados para o 7º ano. Quanto à densidade básica da madeira, sobressaiu-se o híbrido de E.urophylla x E.grandis (07). Para os demais parâmetros avaliados - (quantidade de matéria seca estimada para o 7º ano, DAP e volume cilíndrico) - salientaram-se, respectivamente, o E.urophylla biparental (06), E.grandis de Mogi Guaçu (09) e E.grandis da África do Sul (09).

COMPARATIVE STUDY OF SOME *Eucalyptus* HYBRIDS BEHAVIOUR.

Summary

The authors, comparing artificially obtained hybrids with commercial genetic material at Champion Papel e Celulose S.A., showed that E.saligna x E.grandis hybrids were better in height, estimated mean increment and estimated piled volume to the 7th year.

Regarding basic wood density, the E.urophylla x E.grandis hybrid performed better.

Of the other studied parameters the dry wood estimated to the 7th year, DBH and cylindric volume the biparental of E.urophylla, Mogi Guaçu E.grandis and south Africa E.grandis performed better respectivety.

1. Introdução

A hibridação como meio de se obter melhoramento genético de Eucalyptus, é uma prerrogativa que vem sendo há muito sugerida (ANDRADE 1961). VANKATESH e VAKSHASYA (1977) observaram que a superioridade de híbridos de E.camaldulensis não era apenas sustentada, mas até aumentada com a idade, quando comparados com indivíduos originários de auto fecundação e intercruzamentos. CHAPERON (1977) na Republica Popular do Congo, selecionou para reprodução vegetativa híbridos naturais e artificiais que apresentavam produtividade, adaptação, forma e densidade básica da madeira superiores às apresentadas pelas espécies paternais. No Brasil os trabalhos conduzidos pela ex-Cia. Paulista de Estradas de Ferro (ANDRADE 1961) e pela Aracruz Florestal S.A. (CAMPINHOS) - visando obter híbridos de rápido crescimento, resistentes ao cancro (Diaporthe cubensis Brau - ner) e com madeira de boas qualidades - são exemplos da importância que os híbridos vem adquirindo.

Considerando-se as exigências da nova silvicultura, além do custo elevado das terras e adubos, a grande porcentagem de solos marginalizados, e, o que é de fundamental importância, o desenvolvimento atingido pela propagação vegetativa, os híbridos aparecem como uma alternativa para se conseguir melhorias de produtividade e qualidade dos povoamentos florestais, e, de fundamental importância para o melhoramento florestal.

2. Materiais e Métodos

Os híbridos e cruzamentos biparentais utilizados no experimento foram obtidos em trabalhos de polinização controlada nos pomares e bancos clonais de E.urophylla e E.grandis instalados com árvores selecionadas em plantações de Rio Claro (SP) e de E.saligna com matrizes selecionadas em plantações de Mairinque (SP).

O experimento está localizado no município de Brotas - São Paulo, numa longitude de 48°03'W e latitude 22°15'S, com clima mesotérmico de inverno seco, estação seca de abril a setembro, sendo julho o mês mais seco. A precipitação média anual é de 1010mm.

O ensaio foi instalado sob delineamento de blocos ao acaso, com três repetições. As parcelas eram quadradas (5 x 5 plantas) e o espaçamento de 3,0 x 2,0m.

3. Resultados e Conclusões

Os dados de Altura, DAP e densidade básica da madeira, das árvores aos 32 meses, estão relacionados na Tabela 2 e as análises estatísticas destes dados na Tabela 3. Na tabela 4 são apresentados os dados de volume de madeira empilhada, incremento médio anual e toneladas de matéria seca por ha, todos estimados para o 7º ano.

3.1. Altura

Para o caráter altura das árvores deve-se ressaltar que o híbrido E.saligna x E.grandis (06)* foi superior e mais homogêneo que as espécies parentais E.saligna (02) e E.grandis(04).

O híbrido E.saligna x E.grandis (01) mostrou-se inferior ao 06. Atribuiu-se tal fato aos diferentes progenitores utilizados na síntese do híbrido.

TABELA 1. Relação dos híbridos, espécies que compõem o experimento.

TABLE 1. Hybrids and species involved in the trial.

Nº	Tratamentos	Progenitores Nº		Nº
01	E.saligna x E.grandis (Mairinque) (Rio Claro)	1	x	1
02	E.saligna - biparental Matrizes Mairinque	2	x	7
03	E.urophylla - biparental (Rio Claro)	3		8
04	E.grandis - biparental (Rio Claro)	4		10
05	E.grandis x E.robusta (Rio Claro)	5		13
06	E.saligna x E.grandis (Mairinque) (Rio Claro)	6		27
07	E.grandis x E.urophylla (Rio Claro) (Rio Claro)	7		41
08	E.grandis (África do Sul)	Sementes comerciais		
09	E.grandis - (Mogi Guaçu)	Sementes comerciais		
10	E.saligna - (Mairinque)	Sementes comerciais		

3.2. DAP e Volume cilíndrico

Para o DAP não houve diferenças significativas entre os tratamentos; sobressairam-se porém as espécies comercialmente utilizadas: E.grandis de Mogi Guaçu (09), E.grandis da África do Sul (08) e o híbrido de E.saligna x E.grandis (06), sendo que este último apresentou o menor coeficiente de variação (13,4%). Quanto ao volume cilíndrico sobressairam-se o E.grandis da África do Sul (08) e os híbridos de E.saligna x E.grandis (06), E.grandis x E.urophylla (07), sendo bastante inferior o E.grandis biparental de Rio Claro (04).

3.3. Densidade básica da madeira

Constatou-se que a densidade básica da madeira do híbrido de E.grandis x E.urophylla (07) foi caracteristicamente superior, sobressaindo-se também o E.grandis biparental (02) e a testemunha comercial E.grandis de Mogi Guaçu (09). Deve-se ressaltar que os coeficientes de variação foram baixos, mas o tratamento 02 apresentou exemplares com densidade de 0,527 g/cm³ e no tratamento 09 encontrou-se árvores com 0,523 g/cm³. Vide Tabela 3.

(* - nº do tratamento)

Com estes resultados realça-se a importância da escolha das espécies e dos progenitores a serem utilizados nos trabalhos de hibridação, quando se deseja obter vigor heterótico para determinadas características.

3.4. Volume empilhado e incremento médio anual estimados para o 7º ano.

Pode-se constatar pela Tabela 4, que nestes parâmetros sobressairam-se o híbrido de E.saligna x E.grandis (06), o E.urophylla biparental (03) e a testemunha comercial E.grandis de Mogi Guaçu (09). Estes resultados vêm de certa forma confirmar a superioridade do híbrido E.saligna x E.grandis (06). Chama-nos a atenção no entanto os bons resultados apresentados pelo material genético comercialmente utilizado (09 e 08).

TABELA 2 - Médias de Altura - Diâmetro - Volume cilindrico e Densidade básica da madeira com seus respectivos Coeficientes de Variação (CV) e porcentagem de falhas de cada tratamento.

TABLE 2 - Total height, Diameter at breast height, Cilindric volume, Wood basic density and Mortality percents averages of trees by treatments and their respectives coefficients of variation (CV) at 32 months old.

		Altura média		DAP		Densidade básica da madeira		Volume cilin - drico		%Falhas
		Total Height (mean)		DBH		Wood basic densidy		Cilindric volume *		
	Tratamentos (Tratments)	H(m)	CV%	DAP(cm)	CV%	d(g/cm³)	CV%	V(dcm³)	CV%	%Falhas
1	E.saligna x E.grandis	13,30	21,63	10,07	24,31	0,456	7,41	120,44	51,26	6,25
2	E.saligna biparental	12,60	17,54	10,00	33,20	0,485	6,75	117,65	68,92	37,50
3	E.urophylla (Biparental)	13,34	18,29	10,09	24,58	0,479	9,21	119,89	53,48	0,00
4	E.grandis (Biparental)	13,07	15.56	9,03	25,80	0,455	3,34	100,87	61,94	6,25
5	E.grandis x E.robusta	14,04	11,75	9,64	19,50	0,429	4,24	109,79	44,99	12,50
6	E.saligna x E.grandis	15,50	5,85	10,43	13,42	0,418	4,04	135,86	31,35	6,25
7	E.grandis x E.urophylla	13,54	14,21	10,29	26,43	0,502	7,57	127,77	56,92	25,00
8	E.grandis (África do Sul)	14,54	13,82	10,46	23,04	0,438	5,16	137,27	48,01	12,50
9	E.grandis (Mogi Guaçu)	14,00	9,78	10,47	17,26	0,483	3,76	127,10	41,32	6,25
10	E.saligna (Mairinque)	13,82	11,50	9,71	23,17	0,431	3,34	111,19	44,10	12,50
	Médias (Means)	13,77		10,02		0,457		120,78		11,87

$$\text{* Cilindric volume} = \frac{\pi}{4} \sum_{i=1}^{n} (DBHi)^2 \cdot Hi$$

TABELA 3. Análise de variância e Teste Tukey para altura - diâmetro (DAP) - volume cilíndrico e densidade básica da madeira dos tratamentos.

TABLE 3. Analysis of variance and Tukey test for total height, diameter at breast height, cilindric volume and basic density for the treatments.

Altura média (m) Total height mean		Diâmetro médio (DAP - cm) Diameter at breast hight (DBH-cm)		Densidade básica da madeira (g/cm³) Wood basic density (g/cm³)		Volume cilindrico (dcm³) Cilindric volume (dcm³)	
Nº Trat.	*	Nº Trat.	ns	Nº Trat.	**	Nº Trat.	ns
6	15,50	9	10,47	7	0,502	8	137,27
8	14,54	8	10,46	2	0,485	6	135,86
5	14,04	6	10,43	9	0,484	7	127,77
9	14,00	7	10,29	3	0,479	9	127,10
10	13,82	3	10,09	1	0,456	1	120,44
7	13,54	1	10,07	4	0,455	3	119,89
3	13,34	2	10,00	8	0,438	2	117,65
1	13,30	10	9,71	10	0,431	10	111,19
4	13,07	5	9,64	5	0,429	5	109,79
2	12,60	4	9,03	6	0,418	4	100,87
F = 2,36 *		F = 0,57 ns		F = 6,89 **		F = 0,54 ns	
s = 0,82		s = 0,46		s = 0,03		s = 11,58	
CV% = 5,94		CV% = 4,54		CV% = 6,25		CV% = 9,59	

* - significativo ao nível de 5% (significant at 5% level)
** - significativo ao nível de 1% (significant at 1% level)
ns - não significativo (non significant)

TABELA 4. Valores estimados para o 7º ano de: volume empilhado/ha, incremento médio anual/ha e quantidade de matéria seca/ha; comparações, entre tratamento nº 2 e demais quanto ao incremento e quantidade de matéria seca.

TABLE 4. Estimated values per hectare to the 7th years old: piled wood volume, mean annual increment and dry wood weight; relative rank of the treatments in percentages in relation to treatment nº 2 (based on dry wood weight per hectare).

Volume empilhado estimado p/o 7º ano Wood piled volume to the 7th years old (st/ha)		Incremento médio estimado p/o 7º ano Mean annual increment 7th years old (st/ha/ano)		Comparação entre incremento médio dos tratamentos Relative rank percent of mean annual increment (%)		Quantidade de matéria seca estimada p/o 7º ano Dry wood weight to the 7th years old (ton/ha)		Comparação entre a quantidade de matéria seca dos tratamentos Relative rank percent of dry wood weight (%)	
trat.		trat.		trat.		trat.		trat.	
6	233,73	6	33,39	6	156,5	3	69,01	3	147,0
3	222,10	3	31,73	3	148,7	9	68,47	9	145,9
9	218,68	9	31,24	9	146,4	6	64,69	6	137,8
8	213,04	8	30,43	8	142,6	1	61,84	1	131,7
1	207,40	1	29,63	1	138,8	8	61,38	8	130,8
5	188,01	5	26,86	5	125,9	7	58,94	7	125,6
7	182,93	7	26,00	7	121,8	4	53,21	4	113,4
4	178,77	4	25,54	4	119,7	5	53,16	5	113,2
10	174,32	10	24,10	10	116,7	10	49,49	10	105,4
2	149,36	2	21,34	2	100,0	2	46,94	2	100,0
m = 194,67		m = 28,12				m = 58,71			
s = 23,8		s = 3,76				s = 7,77			
CV = 12,2%		CV = 13,38%				CV = 13,18%			

3.5. Tonelada de matéria seca (ton/ha) estimada para o 7º ano.

Para este parâmetro salientaram-se o E.urophylla biparental (03) e a testemunha comercial E.grandis de Mogi Guaçu (09). Nesta estimativa da quantidade de matéria seca/ha, que reflete diretamente a biomassa fixada, os híbridos de E.saligna x E.grandis (06 e 01), que haviam se apresentado bastante diferentes em quase todos os parâmetros avaliados, mostraram valores médios próximos.

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INDUÇÃO DE BROTAÇÃO EM *Eucalyptus saligna* S.M.

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Resumo

Testaram-se diversos métodos de injúria em troncos e a aplicação de diferentes concentrações de ethrel para estimular a brotação de árvores não abatidas. O melhor tratamento foi o de anelamento incompleto da casca e aplicação de 8% de ethrel em solução aquosa. Nesta concentração não se observaram efeitos adversos na árvore.

INDUCTION OF COPPICING *Eucalyptus saligna* S.M.

Summary

Several methods of injury combined with and without application of different concentrations of ethrel on the trunk resulted in the stimulation of coppicing in live trees. The best treatment in stimulating coppicing consisted of incomplete ringing of the bark and application of 8% ethrel in water solution. At this concentration no adverse effects on the trees were observed 68 days later.

Introduction

Trees transmit their whole genotype when vegetatively propagated. With the use of Eucalyptus spp. becoming more common, questions arise as to how to best produce coppice shoots. On the one hand when cutting the tree, there is the risk of losing the whole genotype at once, since some trees do not coppice. On the other hand when cut trees do coppice, this results in very efficient sprouting. Therefore, this work aimed at inducing the production of coppice shoots on standing trees.

Previous work (5) had shown that mechanical and fire injury on the trunk stimulated coppice shoots, but were not as efficient as cutting of the tree. Tension provoked by wind on trees also provoked a thickening of the tree through the production of endogenous ethylene (4). Ethylene applied exogenously on apple trees (6) and Pinus strobus (1) induced thickening of the stem and halted height growth. Working with Eucalyptus grandis seedlings, Brune et al. showed that ethrel, applied with lanolin paste on the stem, induced a thickening on the spot through divisions of cambium and phellogen cells, and at the same time halted height growth (2). They also found that, in high concentration (8%), ethrel induced coppicing of the seedlings, both above and especially below the treated area.

Intending to produce coppicing of adult trees of Eucalyptus saligna, 10% ethrel was pasted on stems, both wounded by ringing and intact ones (7). Coppicing occurred vigorously only on ringed and treated stems. When testing several concentrations of ethrel in water solution up to 20% on ringed Eucalyptus saligna trees, all ethrel treated trees coppiced, but ethrel above 8% caused a dying of leaves and twigs 55 days later (3). In this work an attempt was made at inducing coppice shoot formation on standing trees without affecting their survival.

Materials and Methods

Eight years old Eucalyptus saligna trees were used, in complete randomized design, with ten trees per treatment. There were thirteen treatments:

1. Axe blow injuries;
2. Axe blow injuries and 2% ethrel;
3. Axe blow injuries and 4% ethrel;
4. Axe blow injuries and 8% ethrel;
5. Incomplete spiral ringing;
6. Incomplete spiral ringing and 2% ethrel;
7. Incomplete spiral ringing and 4% ethrel;
8. Incomplete spiral ringing and 8% ethrel;
9. Complete ringing;
10. Complete ringing and 2% ethrel;
11. Complete ringing and 4% ethrel;
12. Complete ringing and 8% ethrel;
13. Felling of tree

Trees of treatments 1,5, 9 and 13 were water sprayed; all others received 5 ml of solution on the injury.

Observations were made weekly on sprouting, numbers of shoots and tip dying, until 60 days after the treatments. Data were classified into three classes depending on the number of sprouts produced, and statistically evaluated.

Results

The analysis of variance from data taken 60 days after the treatments showed significant diference at 5% probability. The results of a Tukey test at 5% probability are shown below.

Treatment		
8	a	
12	a	
13	a	b
11	a	b
6	a	b
7	a	b
10	a	b
5		b
1		b
2		b
3		b
4		b
9		b

Treatments followed by the same letter did not differ among themselves

Sprouting started twenty days after the treatments and, until day 68 no tip or leave dying had been seen.

Conclusions

Ethrel applied to ringed trees induces coppice shoot formation. There are two better treatments than cutting of the tree. The treatment "incomplete ringing and 8% ethrel" is especially promising, since with incomplete ringing there is a higher chance for recovery of the tree. Since ethrel acts on phellogen and cambium, there is a chance to improve rooting ability of coppice shoots.

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MANEJO DE POMARES DE SEMENTES DE *Eucalyptus regnans* - SELEÇÃO, ESTRATÉGIA E ESTUDOS

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Resumo

Um programa de melhoramento de *E. regnans* foi iniciado em 1969. As árvores "phis" foram selecionadas principalmente em talhões naturais com 30 anos de idade, originados a partir de incendios florestais espontaneos e também a partir de talhões de procedências locais. Mais tarde, algumas árvores adicionais foram selecionados a partir de talhões mais velhos de procedências não locais. As árvores plus foram selecionadas com base em vigor, retidão do fuste, tamanho dos galhos, forma da copa e presença de sementes. Re-seleção da segunda geração de árvores plus combinando as características mencionados foi iniciada recentemente. Os pomares de sementes da primeira geração foram estabelecidos em áreas planas, transitáveis e abertas, e manejadas intensivamente para a produção de sementes. Várias árvores de cada família foram plantados a pequenos espaçamentos em "familu-plots", permitindo seleção familiar aos 2 anos assim como intensa seleção entre famílias aos 9 anos.

As mesmas famílias foram também estabelecidas em testes de comparação familiar nos locais de plantações típicas, em espaçamentos normais e com manejo não intensivo. Esta familidade adicional permite seleção familiar de multiplos caracteres através de dois locais contrastantes e regime silvicultural. A adição de fertilizantes nos pomares produziu respostas positivas na floração.

MANAGEMENT OF SEEDLING SEED ORCHARDS OF *Eucalyptus regnans* - SELECTION, STRATEGY AND FLOWERING STUDY.

Summary

A breeding programme to support an E.regnans plantation programme commenced with the selection of plus trees in 1969. Trees were mainly selected from even aged 30 year old natural stands resulting from wild fires, and from within local provenances. Later some additional trees were selected from older stands in non-local provenances.

Plus trees were selected on the basis of vigour, stem straightness, branch size and ease of shedding, crown shape, and presence of seed. Re-selection of some second generation plus trees on an index combining these traits has just commenced.

Strategy adopted for the first generation of breeding employed seedling seed orchards situated on a flat trafficable site, established at wide spacing and managed intensively for seed production. Several trees of each family were planted at close spacing in "family-plots" permitting within family selection at about 2 years as well as intense selection between families at 9 years.

The same families were also established in family comparison trials on typical steep plantation sites at normal spacing and managed relatively unintensively. This additional facility permits multiple trait family selection across two contrasting sites and silvicultural regimes.

Addition of fertilizers in the orchards have produced positive flowering responses.

INTRODUCTION

Eucalyptus regnans F Muell is a most important commercial hardwood in south eastern Australia and now New Zealand, and is a particularly desirable pulping species for Kraft, N.S.S.C. or groundwood processes. Work on natural stands (Hall et al 1973) has shown that E.regnans has relatively low basic density but high pulp yield, low extractives content and hence low chemical requirement and a high burst factor. Similar results have been obtained in other unpublished studies including plantation grown wood. Pulping of E.regnans wood by either Kraft or N.S.S.C. process also results in relatively low quantities of black liquor solids, and these spent liquors swell well and burn easily in a recovery furnace. E.regnans is a straight, well branched and vigorous species which is also suitable for quality sawn timber.

In 1960 A.P.M. Forests began planting E.regnans on abandoned farmland in the eastern Strzelecki ranges, Gippsland, Victoria and all within 50 km. of its Maryvale pulpmill (Mann 1967).

A breeding programme to support this plantation establishment commenced with selection of plus trees in 1969 (Richmond 1971). From 1970 to 1973 11.5 ha. of first generation seedling seed orchard were established (Cameron 1974) followed in 1976 by a further 4 ha. of 1.5 generation seedling seed orchard. (Cameron 1976).

In this paper selection of plus trees, breeding strategy and studies on the influence of fertilizers on flowering are described. Studies on harvesting of capsules and some economic considerations are described by Cameron and Ginn (1980).

PLUS TREE SELECTION

The selection programme commenced prior to a recent range wide provenance study (Griffin 1980). Pioneering work on natural variation of E.regnans by Eldridge (1966,1971) had demonstrated variation with altitude of seed source for a transect on Mt.Erica, Gippsland, Victoria and significant variation between families for diameter and derived basal area. The lower altitudinal provenances (305 to 808 m) were the most vigorous on three sites near Jeeralang, Victoria ranging from 427 to 610 m and typical of A.P.M. Forests planting sites.

Thus without more conclusive data it was decided to concentrate selection of plus trees from within the area known as A.P.M. Forests' Jeeralang Tree Farm, all being below 800 m altitude and in the general vicinity of the Traralgon Creek and Mirboo East provenances sampled later in Griffins' rangewide study. Some plus trees were also selected from southern Tasmania and the central highlands of Victoria to provide a broarder genetic base in case the local provenance proved to be sub-optimal. Fortunately early data from the recent range wide provenance trials indicates the Mirboo East and Traralgon Creek provenances to be among the most vigorous across a range of sites in Victoria and Tasmania, including Jeeralang (Griffin pers. comm.).

Eldridge (1971) concluded that sufficient variation existed for a selection and breeding programme based on intense family selection, thus necessitating commencement of the programme with a relatively large number of plus trees.

First generation plus trees currently in the programme, with location of selection described according to Griffins' range wide provenance study, are shown in Table 1. Plus trees selected in Victoria were from regrowth forests resulting from wild fires in 1939 and 1945 while the Tasmanian plus trees were selected from old growth forests estimated to be 150 to 300 years old. In general seed was collected by shooting down branches with a high powered .222 rifle.

TABLE 1

First generation plus trees in the E.regnans breedin programme of A.P.M. Forests.

Provenance Location*		Latitude	Longitude	Elevation (m ASL)	Number of Plus Trees
Traralgon Ck/Mirboo East.	Vic.	38° 30'	146° 30'	300 to 600	120
Tarago	Vic.	37° 56'	145° 55'	360 to 600	4
Narracan	Vic.	38° 15'	146° 13'	300	1
Florentine Valley	Tas.	42° 29'	146° 27'	360 to 380	10
Styx	Tas.	42° 49'	146° 36'	250 to 550	10
Strathblane	Tas.	43° 22'	146° 58'	200 to 280	20

* According to names used in A.R.Griffins' range-wide collection.

Plus trees were selected on the basis of vigour, stem straightness, branch size and ease of shedding, crown shape and presence of seed. Some very good plus trees were not included because of lack of seed. Richmond (1971) noted during the search that trees of similar phenotypic characteristics occurred in definable groups covering 0.4 to 2 ha. Trees within such groups were thought to be closely related and thus only one tree from such groups was selected. Those family groups containing a high incidence of malformations were ignored for selection purposes.

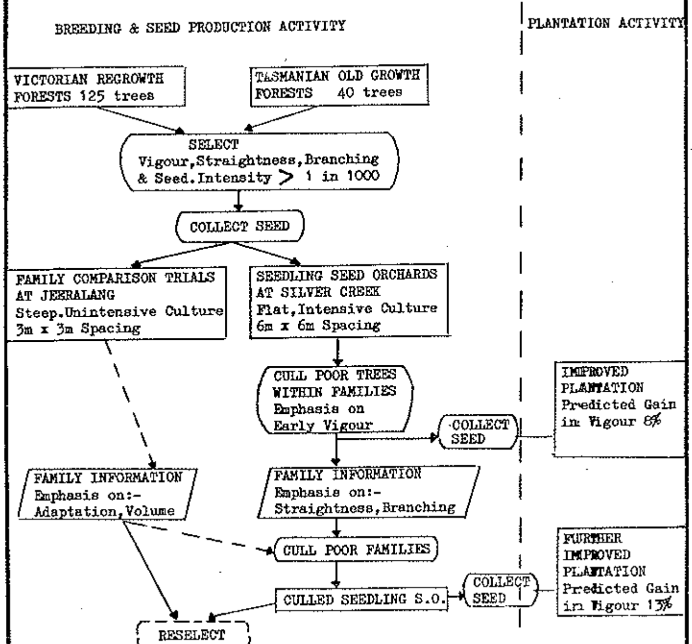
Re-selection of second generation plus trees on a combined index has just commenced. The index combines volume, stem straightness, branch size and height to the first branch (shedding), incidence of forks and crown width.

BREEDING AND SEED PRODUCTION STRATEGY

The strategy adopted for the first generation of breeding is presented in Figure 1. The seedling seed orchards and family comparison trials were established in stages to even the workload. The progressive establishment of seedling seed orchards is depicted in Table 2. Each orchard has an associated family comparison trial containing the same plus tree progenies (families) and several "carry through" or control lots.

FIGURE 1

Breeding Strategy for the first generation adopted by A.P.M.Forests for E.regnans in Gippsland,Victoria.



Open pollinated seedling seed orchards were chosen inst ad of grafted clonal seed orchards, because grafting was considered difficult to achieve on a large scale with the technical resources available at that time.

TABLE 2

Schedule of seedling seed orchards located at Silver Creek,Gippsland.

Trial No.	Description	Planted (yr)	Source of Plus Trees (Provenance)	Families (No)	Area (ha)
VRD 1	1st gen.S.S.O.	1970	Traralgon Ck/Mirboo East	40	2.4
3	"	1971	Traralgon Ck/Mirboo East	40	2.4
8	Experimental 1st gen.S.S.O. (Nutrition & Pollarding Exp.)	1971	Traralgon Ck/Mirboo East	40	1.2
5	"	1972	Traralgon Ck/Mirboo East	38	2.4
			Tarago	2	
7	"	1973	Traralgon Ck/Mirboo East	36	1.9
			Tarago	3	
			Narracan	1	
9	"	1973	Florentine Valley	10	2.4
			Styx River	10	
			Strathblane	40	
15	1.5 gen.S.S.O.	1976	Traralgon Ck/Mirboo East	21	2.8
			Florentine Valley	6	
			Styx River	8	
15A	Experimental 1.5 gen.S.S.O. (Nutrition Exp.)	1976	Traralgon Ck/Mirboo East	2	1.2
			Florentine Valley	6	
			Styx River	7	

The seedling seed orchards described in Table 2 were established progressively with about 40 families in each, on adjacent sites at a latitude of 38° 20' S and a longitude of 146° 10' E and an altitude of 300m. The soils are derived from older volcanic basalt and described by Poutsma and Turvey (1979) as Narracan clay loam (VRD1,15 and 15A) and Silver Creek loam (VRD3,8,5,7 and 9). Rainfall is 1055 mm per year with a relatively dry summer (Dec. to Mar.). To obtain a suitably flat and trafficable site for mechanical seed harvesting it was necessary to locate the orchards at an extremity of the natural habitat for E.regnans. Families were established in randomized complete blocks (16 replications in most cases) generally with five offspring of each plus tree planted in a closely spaced line with 0.6 m between trees. These five tree "family-plots" (Giertych,1975) were subsequently culled over the first three years leaving the most vigourous tree. Family plots were generally spaced at 6m x 6m centres. The design was based on one previously used in Brazil (Castro et al 1967). The orchards have been managed intensively for seed production.

The family comparison trials were progressively established at Jeeralang on "typical" E.regnans plantation sites in the vicinity of latitude 38° 25'S, longitude 146° 30'E, and altitude of 300 to 600 m. The sites are steep with soils derived from Jurrasic mudstones and described by Poutsma and Turvey (1979) as Balook clay loam. An exception is VRD2 which is on Narracan clay loam derived from older volcanic basalt. Rainfall is strongly influenced by altitude and varies from 1097 to 1397 mm. Families were planted in 6 tree row plots in a randomized complete block design with 9 replications. An exception was in 1976 where 5 tree row plots and only 6 replications were used in the more efficient balanced lattice designs,to retest 94 families under improved weed control and nutrition. Spacing of 3m x 3m was used in all family comparison trials. Apart from the 1976 trials no weed control was employed and only a low rate of nitrogen applied. The option exists to heavily cull these family comparison trials for seed production but because of the steep terrain trees would need to be felled to collect seed.

The existence of in effect two separate field facilities, each containing the same families is a notable feature of the strategy adopted. The families are screened over two different sites and also under two contrasting silvicultural regimes, the orchards being weeded and fertilized regularly while the family comparison trials have been managed far less intensively. The option exists of selecting families specific to either situation or robust general purpose families for a range of site or silvicultural regimes.

Analysis of early growth data from the orchards and family comparison trials revealed pronounced changes in family ranking indicating but not substantiating genotype by environment interactions (A more rigorous analysis will be carried out on older data). However analysis on 4 families used as "carry throughs" and thus common to four family comparison trials in Jeeralang Tree Farm, revealed no significant family by site interaction. Genotype by environment interactions do not appear to be important within our plantation region but may be when considering extension to other contrasting sites.

Although the orchards were specifically established to produce seed for Jeeralang plantations the possibility now exists for some future planting at Silver Creek. Because of this and the ever present uncertainty with respect to future utilization of orchard seed, a decision has been made to select families on the basis of performance both in the orchards and family comparison trials.

Work has already commenced on the construction of a multiple trait selection index and this is being extended across sites. As indicated in Figure 1 we expect this work will suggest placing emphasis on adaptation and volume in the family comparison trials grown at typical plantation spacing; and emphasis on straightness, branch quality and shedding, forking and crown form in the orchards where the trees are grown at very wide spacing.

For characters or traits of relatively low heritability most gain is achieved through intense selection between families. Culling in the oldest orchard has commenced and when complete we anticipate about 75% of the poorer families will be removed on the basis of the combined index.

The planting of individuals of each family at close spacing in "family-plots" permitted some within family selection (culling) for early growth. The additional gain derived from such selection will depend on juvenile-mature correlations which for E.regnans are thought to be reasonably (r^2 about 0.7) high (Eldridge 1972).

Establishment of the orchard as a single tree plot design and maintaining family identity would have permitted combined 'among' and 'within' family selection, both on relatively mature characters.

This approach is now favoured, but because this combined culling will be later in the orchard rotation, careful consideration needs to be given to initial spacing to ensure intense tree to tree competition does not result in a substantial decline in seed production.

In addition to the traits previously discussed, studies on family variation in basic density and susceptibility to frost have been conducted but a decision has not been made to include them as selection traits at this stage. In VRD3 family mean basic density of 2.5 year old trees ranged from 0.39 to 0.46 gm cm^{-3}. In VRD5 subjected to a heavy frost at age one, mean family damage ranged from almost nil to desiccation of over half of the foliage. The severity of damage was not correlated with height of the trees or elevation of seed source, (range in elevation was limited to only 300m).

ORCHARD FLOWERING STUDIES

Early trial on rate of fertilizer application (VRD8)

The early orchards established from 1970 to 1973 were fertilized with a commercially available mix called Pivot 18 (N 18%, P 8%) at 227 gm per family-plot. In 1971 seedlings surplus to requirements were planted at Silver Creek in the same general manner as the orchards. Design was a randomized blocks design with four replications. All treatments received 61 kg ha^{-1} (227 gm per tree) of Pivot 18 at planting with the balance split and applied annually for up to three years for the heaviest applications.

Table 3 shows that the heaviest application resulted in a significant increase in basal area and proportion of trees flowering at four years. Commencement of flowering appeared to be a function of tree size, or more specifically, the size of the flower-bearing crown. Strong positive correlations have been reported between crown characters and basal area for E.globulus (Cromer et al, 1975).

TABLE 3

Effect of fertilizer on basal area and flowering of E.regnans

Rate of Pivot 18 (kg/ha)	Basal Area per Tree (cm^2)	Proportion of Trees Flowering (%)
61	38	16.6
183	47	8.4
305	50	10.0
427	59	15.0
793	77	30.0
LSD between treatment means at 5%	20	9.0

It was decided in 1975 to refertilize all orchards with 290 kg ha^{-1} of Pivot 12 (N 12%, P 20%), as a means of bringing forward the onset of flowering and seeding. This quantity raised the level of P applied to 63 kg ha^{-1} elemental, thus being equivalent to the highest rate employed in the trial. Pivot 12 was chosen because its N:P ratio was considered more appropriate for the soil which is known to absorb phosphorous readily.

Rate of fertilizer by family interaction study (VRD 1)

The entire area of the orchard VRD1 was used with fertilizer treatments applied at age five and each block or replicate containing one tree of 40 families adopted as each fertilizer main-plots with single tree family sub-plots within main plots. The replicates of the orchard permitted a lattin square arrangement of main plots for the following rates of Pivot 12; 1300, 650, and 293 kg ha^{-1} plus an unfertilized control.

A significant fertilizer response and fertilizer by family interaction was recorded for volume 18 months after application. Some families appeared to be ill adapted to the low nutrient status of the control plots but responded dramatically, particularly to the heavy application.

A subjective assessment of flower bud crops was also carried out 18 months after application, on two replicates each of the control and heaviest fertilizer rate. The subjective scores for five trees were checked by actual counts and found to be reliable. There was significant family variation for most stages of the flowering cycle. (Table 4). Data in table 5 suggests a positive response in flowering to fertilizer N and P however there were too low degrees of freedom to determine significance. The gain in green capsules and mature flower buds was surprising and indicates the potential for fertilizer treatments in reducing abortion as well as increasing the number of flower buds initiated

Part of this response is believed to be attributed to an observable slowing of the rate of natural branch dieback and shedding in the species. Application of fertilizer appears to have reduced pronounced periodicity in flowering and seeding, characteristic of the species (Ashton 1975, Cunningham 1957).

TABLE 4

Family variation in abundance of each stage of flower development.

Stage of Flowering Cycle	Flowering Year	Range in Family Means (subjective assessment on a scale 0 to 10)	Level of Significance (ANOVA)
Green Capsules	1976	0 to 3.0	NS
Flower Buds	1977	0 to 4.3	.05
Immature Flower Buds	1978	0 to 4.5	.10
Inflorescence Buds	1979	1.3 to 4.8	.05
Overall Fecundity	-	0.6 to 4.0	.05
Periodicity of Flowering	1976-1979	13% to 143% *	Not tested.

* Expressed as coefficient of variation on flowering 1976 to 1979.

TABLE 5

Effect of fertilizer on abundance of E.regnans flowering at 6 to 9 years (subjective score 0 to 10)

Fertilizer Treatment	Flowering Year 1976	1977	1978	1979
Control	0.81	2.36	1.92	3.33
1300 kg/ha	1.92	2.97	3.14	6.67

Nitrogen by potassium by Family interaction study (VRD 15A)

Fifteen families common to VRD15 were established over 16 replicates in exactly the same way as for this orchard. These 16 replicates permitted a latin square arrangement of fertilizer main plots with family sub-plots within main plots. Commencing at age one, nutrients were applied, each at the rate of 50 kg ha^{-1} elemental. In line with the phosphorous adsorption characteristics of the soil, phosphorous was regarded as an essential nutrient for satisfactory growth and has been included in the trial as a base treatment.

Significant family variation and both an N and K response but no interaction was recorded for abundance of flower buds and inflorencence buds (1981 and 1982 flowering respectively) at age four (Table 6). Only N produced a significant growth response two years earlier. At that time significant family variation in growth was also recorded.

TABLE 6

Growth and flowering response to applied nitrogen and potassium.

Fertilizer Treatment *	Stem Volume at 2 yrs dm^3 per tree	Abundance of Flower Buds at 4 yrs (0 to 5 score) flower 1981	Abundance of Infloresence 4 yrs(0 to 5 flower 1982
Control	2.78	1.12	1.57
Nitrogen	4.24	1.50	1.92
Potassium	4.05	1.55	1.98
Nitrogen & Potassium	3.98	1.82	2.33

* All treatments received phosphorous considered essential for satisfactory growth. All nutrients applied annually from age 1 at 50 kg ha^{-1}.

Data in Table 6 indicates that abundance of flowers in these very young trees appears to be a function of tree size. This is not in agreement with Griffin (1980), but he worked with much older trees and not in relation to fertilizer responses. Griffin noted that larger trees tended to flower over a longer period. It will be interesting to see if fertilizer treatments in our trials produce similar results and thus have the potential to improve panmixis in young seedling seed orchards through increasing the degree of overlap in flowering times and the proportion of trees and families flowering at an early age.

ACKNOWLEDGEMENTS

The late Mr. K.P. Richmond warrants special acknowledgement. He was instrumental in selecting the plus trees and commencing the orchard programme. Advice given by Dr. K.G. Eldridge is gratefully acknowledged.

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FAST GROWING TREES

MANEJO DE POMARES DE SEMENTES POR MUDAS DE *Eucalyptus regnans*. II. DENSIDADE; COLHEITA E ASPECTOS ECONÔMICOS.

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Resumo

Informações em situações que não envolvam pomares clonais indicam que os maiores rendimentos de sementes por hectare para um pomar de sementes por mudas, entre 10 e 11 anos, seria para uma densidade de 300 árvores por ha, por outro lado o maior rendimento por árvore seria na metade daquela densidade. A densidade inicial adotada nos nossos pomares é de 277 árvores/ha e após seleção atinge o nível de 70 árvores/ha, para a idade de 9 anos essas densidades foram consideradas compatíveis com razoáveis rendimentos de sementes por ha e por árvore.

Após considerações sobre a não capacidade de brotação do *E. regnans* e a longa duração do desenvolvimento das flores, a derrubada das árvores ou de ramos portadores de sementes, visando a colheita de sementes, foi considerada inapropriada, a não ser através da derrubada ao final do ciclo de rotação do pomar. O fato das cápsulas maduras permanecerem intactas durante um ano na árvore, a existência da periodicidade na floração e produção de sementes, e o potencial para a redução de custos, fazem com que a colheita a cada dois anos seja seriamente considerada.

Cápsulas contendo sementes foram colhidas nos pomares mais velhos nas idades de 8,5 e 9,5 anos, rendendo respectivamente 1 a 10 kg de sementes por ha. Um cabo elevado foi utilizado para se ter acesso às copas das árvores e cortar as cápsulas nos ramos. Estudos mostram que esse método é mais eficiente quando os rendimentos de sementes por árvore são altos, são sugeridos os caminhos para atingí-los e reduzir os custos na colheita.

Todavia os custos atuais da colheita são mais altos do que os encontrados para *P. radiata*, quando analisados com base em kg de sementes produzidas; quando a análise é feita com base em rendimento por ha a situação é inversa. Os custos maiores encontrados para a semente do pomar, em relação a sementes comerciável, são economicamente justificáveis.

MANAGEMENT OF SEEDLING SEED ORCHARDS OF *Eucalyptus Regnans* - STOCKING, HARVESTING AND ECONOMIC ASPECTS.

Summary

Information for situations other than orchards indicated that seed yield per hectare of a ten to eleven year old seedling seed orchard would be highest at about 300 trees ha^{-1} but yield per tree would be higher at about half this stocking. Initial stocking adopted in our orchards of 277 trees ha^{-1} and culling to 70 trees ha^{-1} at about nine years was considered compatible with reasonable seed yields on a per hectare and a per tree basis.

After considering the non-coppicing nature of E.regnans and the protracted development of flowers, felling trees or severing seed bearing branches to collect seed were considered inappropriate apart from felling at the end of the orchard rotation. As ripe capsules will remain in-tact on the tree for one year and because of periodicity in flowering and seeding, and the potential to reduce costs, harvesting every second year is being seriously considered.

Seed bearing capsules have been harvested in the oldest orchard at 8.5 and 9.5 years yielding 1 and 10 kg ha^{-1} respectively. An elevating hoist was used to gain access to the tree crowns and strip capsules from the branches. Studies show this method is most efficient when seed yields per tree are high, and ways of achieving this and reducing costs are suggested.

Although present harvesting costs are higher than for P.radiata on a per kilo basis the reverse is true on a per hectare of resultant plantation basis. The higher orchard seed cost relative to routine seed is economically justifiable.

INTRODUCTION

Details of selection, breeding strategy and flowering studies associated with A.P.M. Forests Eucalyptus regnans F.Muell. breeding programme have already been described in an accompanying paper (Cameron and Kube 1980).

At commencement of the programme information on appropriate orchard stocking and seed harvesting methods was largely unavailable. Development of cost-effective seed harvesting systems was, and still is, seen as a major challenge in the management of Eucalypt seed orchards.

This paper describes stocking, harvesting and some economic aspects associated with the management of A.P.M. Forests E.regnans seedling seed orchards.

STOCKING AND SEED YIELD

At commencement of the programme reported studies on seed production in E.regnans were only available for situations other than in seed orchards. But these reports provided indications on appropriate management and have been summarized in Table 1. Seed production appears to be influenced by location, year of flowering (periodicity), stand type and stocking. The data from plantation spacing trials is most relevent and indicates that a stocking of about 300 trees ha^{-1} is appropriate leading up to commencement of commercial seed production at about 10 years.

However in the Narbethong study although seed yield per hectare at 160 trees ha^{-1} was lower than for 297 trees ha^{-1} the seed crop per tree was higher. It will be shown later that the amount of seed on each tree has a substantial influence on harvesting costs by mechanical means. Taking both seed yield per hectare and harvesting costs into account, the initial stocking of 277 trees ha^{-1} (after within family culling) used in our orchard, was satisfactory considering this is reduced to about 70 trees ha^{-1} by family culling at about nine years. This is about the time production of seed in commercial quantities commences.

Our oldest seedling seed orchard VRD1 produced only 1 kg ha^{-1} approaching 9 years but this rose to an estimated yield of about 10 kg ha^{-1} the following year.(final cleaning still in progress).

FLOWER AND SEED DEVELOPMENT

In considering harvesting systems for E.regnans it is important that the process of flower and seed development are understood. From Ashton (1975), Carr and Carr (1959) and our own observations the following cycle applies:-

TABLE 1

Summary of reported seed production for E.regnans.

Location of Study Area (Altitude)	Stand Type	Age at Seed Collection (Years)	Stocking Trees per ha.	Yield of Seed(& Chaff) (gm/tree)	(kg/ha)
Ada River, Vic. (760m)[1*]	Full Canopy	165	62		1.5to3.6
" " " "	40% Canopy	"	25		2.9
Pioneer Ck. " "		65	148		1.9
Warrentinna, Tas.		35	-		0.3
Wallaby Ck. Vic.(700m)[2]	Mature	200			33.2
(1954 flowering) "	Spar	50			20.4
" " " "	Pole	25			9.5
(1955 flowering) "	Mature	200			0.7
" " " "	Spar	50			-
" " " "	Pole	25			0.3
Narbethong Vic. (800m)[3]	Plantation Spacing Trials	10	160	175	28.0
			297	136	40.4
			741	31	22.7
Jeeralang Vic. (600m)[4]	Plantation Spacing Trials	11	420	88	37.0
			837	34	28.5

* Source of information:

1. Cunningham (1957) - Yields based on free seed and capsule fall over 7 months. Cunningham counted viable seed, and yields shown were thus estimated using 100,000 viables per kg of seed and chaff. Flowering year 1954.

2. Ashton (1975) - Fruit set estimated from operculum, flower and immature fruit shed. Seed yield estimated using .004664 kg seed and chaff/1000 fruit capsules. (Griffin pers comm). Flowering years 1954 and 1955.

3. Pederick (1972) - Flowering year 1971.

4. Doran & Young (1973) - Flowering year 1972.

November (1st month) - The first macroscopic buds appear in the axils of young leaves. These "inflorescence buds" occur either singly or in pairs, are protected by a mitreform involucral operculum and contain about 30 minute flower buds.

March (4th month) - The involucral operculum of four bracts splits on one side and falls off exposing the "immature flower buds". Development is later at higher altitudes.

March (16th month) - The immature flower buds are about half grown.

November to January (24th to 26th month) - The flower buds swell markedly and can be distinguished from the one year younger "immature flower buds" by their much larger size.

March (28th month) - The operculum becomes orange and transluscent, and abscinds exposing the rip anthers for pollination.

April to November (28th to 36th month) - The disc of fertilized capsules expand in winter and by spring the ovary swells to the hemispherical form of the mature capsule.

December to March (37th to 40th month) - Seed bearing capsules are mature enough to harvest and can be distinguished from the capsules resulting from the previous years flowering by their greener colour and position on the branch.

December to March (49th to 57th month) - Mature capsules become greyish brown. Depending on the season large numbers of these capsules will fall or the valves may open and shed the seed. They therefore should be harvested prior to the onset of hot weather over this summer period.

We now believe if our orchards are harvested after November but no later than January, it is possible to collect capsules resulting from two years flowering without experiencing poor seed viability in the current crop or losing too much seed from the previous seasons crop. Because of large potential savings in harvesting costs this will be tried. Periodicity of seed yield is already indicated in flowering studies and an attempt will be made to ensure harvests coincide with peak production of the current crop of capsules.

Seed collection by removing seed bearing branches was considered in the early stages of the orchard programme. From the above pattern of development it is clear that such a practise would remove substantial quantities of mature flower buds, immature flower buds and inflorescence buds (which give rise to ripe capsules one, two and three years hence). The technique is no longer in favour.

As E.regnans is a non-coppicing species collection of seed from felled trees does not appear to have much application other than at the end of the orchard rotation.

HARVESTING STUDIES

Following discussions with Dr. E.C. Franklin it was decided to try a harvesting method similar to that used to collect capsules from E.grandis in Florida. There an elevating platform or "bucket" had been used for sometime, the capsules being stripped from the branches by hand directly into the bucket.

In February 1979 an "Abbey Skyworker SW 500/40" mounted on a two wheel drive truck and with an operating height of 12.5 m. was hired to harvest our oldest (then 8.5 years) E.regnans seedling seed orchard VRD 1. Because seed was required for research as well as routine purposes seed was harvested on an individual tree basis, and it was stripped into small containers rather than directly into the bucket. The orchard was harvested the following year in the same manner accept that a four wheel drive truck and hoist with 15.5 m. reach was used, and capsules were stripped into bags similar to those used for picking apples and pears, but smaller. On both occasions no difficulty was experienced harvesting from the tallest trees and it has been decided to only pollard trees when absolutely necessary and coinciding with a peak yield of the current capsule crop. The first harvest was described by Ginn (1979).

For the harvest in 1979 at 8.5 years productivity was 37 gm of seed per machine hour and 10 gm of seed per man hour. These are low because of the need to harvest on an individual tree basis and all trees irrespective of seed yield, to assemble seed for future research projects. The productivity figures are also low because the average yield of seed was only 14 gm per tree (range 0.2 gm to 490 gm).

A detailed time study was carried out on five trees with relatively heavy but varying seed crops. The purpose was to examine the effect of seed yield per tree on harvesting efficiency; also to provide data to estimate costs for a normal commercial harvest; and identify areas worthy of closer attention in an effort to reduce costs.

TABLE 2

Time study of components of harvesting an E.regnans seed orchard with an Abbey Hoist.

Tree No.	Component of Time				Productivity
	a) Moving Bucket (mins.)	b) Stripping Capsules (mins.)	Total (mins.)	Seed Yield (gm.)	Seed/ Machine hr. (gm.)
entire orchard	-	-	-	14	37
1	1.2	19.5	20.7	37	107
2	6.0	31.5	37.5	46	74
3	2.6	34.5	37.1	54	87
4	1.3	47.6	48.9	125	153
5	5.9	72.1	78.0	180	138
	average excluding entire orchard				112
Av. proportion of total time %	7.8	92.2	100		

Data in Table 2 indicates that harvesting productivity and thus cost are most sensitive to seed yields per tree particularly below 125 gm tree $^{-1}$. Also most time is used in stripping capsules rather than moving the "bucket" around the tree crown or moving the truck. Time involved in moving the truck is not shown but was less than moving the "bucket" and was helped by the ability to harvest entirely, four adjacent trees from one position of the truck.

For crops averaging 150 gm of seed per tree, harvesting costs as low as Aust. \$162 kg $^{-1}$ are thought to be possible (based on Aust. \$10 per machine hr. and Aust. \$5.40 per man hr. for a two man operation). Achieving higher seed yields per tree and lower cost can be assisted by avoiding harvesting trees with very light crops particularly early in the orchard rotation; by only harvesting every second year preferably coinciding with a peak in yield of the current capsule crop; and by using ameliorative treatments such as fertilizer application (Cameron and Kube 1980) and irrigation.

ECONOMIC CONSIDERATIONS

Although harvesting costs for E.regnans seedling seed orchards are about six times higher than for Pinus radiata seed orchards at the current time, 1 kg of E.regnans seed used wisely is sufficient to establish about 100 ha while 1 kg of P.radiata seed would only establish about 10 ha or less. Harvesting costs for E.regnans should be cheaper on a per hectare of plantation basis.

Harvesting costs for E.regnans indicated above to be Aust. \$162 kg $^{-1}$ are not considered sufficiently high to warrant only harvesting from felled trees in an "advancing front" orchard, with its consequential higher land, establishment, and maintenance costs.

The figure above for harvesting exceeds the price charged by contractors for routine seed. When other orchard and breeding costs are taken into account, cost of the orchard seed, as expected is substantially higher. But given that the orchard seed is used efficiently, our economic studies show that a gain in volume alone of about 2% would be sufficient to recover the higher seed cost and at least "break even". A gain in volume of about 13% and improvement in stem, branch and crown quality are expected.

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PRODUÇÃO MASSAL DE *Eucalyptus spp* ATRAVÉS DE ESTAQUIA.

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Resumo

A propagação de Eucalyptus spp. por estaquía é um método que pode trazer ganhos substanciais nas florestas industriais, porque permite a utilização de plantas selecionadas por catacterísticas particulares logo na primeira geração.

O mesmo método permite a formação de bancos genéticos, pomares de sementes e pomares vegetativos. O presente documento mostra o método desenvolvido para servir às condições na região onde o trabalho tem sido feito e os objetivos da aplicação da madeira.

Os autores indicam os resultados obtidos pela aplicação do método ao estabelecer um banco clonal e adotando-o nas operações de plantio industrial.

MASS PRODUCTION OF *Eucalyptus spp* BY ROOTIN CUTTINGS.

Summary

Mass propagation of *Eucalyptus* spp. by rooting cuttings is a method that can provide substantial gains in industrial forests, because it permits the utilization of plants selected for particular characteristics in the first generation.

The same method permits the formation of genetic banks, seed orchards and vegetative orchards. A description is given of the method developed to suit the conditions in the region where the work is being done and for the objectives for wich the wood in intended.

The authors indicate the results obtained by applying the method in setting up an initial clone bank, and adopting it in industrial planting operations.

Introduction

The first contact the authors had with the rooting method was at Coff's Harbour, Australia (Burgess, I.P.) in 1973, when they were shown the results of work done on an experimental level.

In 1965, A. Franclet published his first conclusions and the experimental design for multiplication of homogeneous material from rooting of cuttings from *E. camaldulensis*. Experimental work done previously had permitted the identification of key factors in the method such as the physiological state of the parent plant, the selection of the cutting, the optimum hormonal treatment, the selection of high rooting capacity clones, the growing medium and, especially, the action to be adopted against the causes of rooting of cuttings, besides the best time of year for rooting.

In 1973, J. Davidson described a technique for rooting a large number of cuttings of *E. deglupta*, for research purposes and discussed aspects of preparation of the cuttings, hormonal treatment, containers, rooting media and spraying equipment. He reported on the growth of the cuttings and their performance after they had been planted in the field, and did not foresee problems in propagation on an industrial scale.

In 1969, B. Martin and G. Quillet started experiments at Pointe Noire, Congo, with a view to determining the proper conditions for rooting of cuttings from a number of forest species, including eucalypts. The success of the method developed permitted it to be applied by the U.A.I.C. (Unité d'Afforestation Industrielle du Congo) in industrial scale plantings.

In 1975, Y.K. Ikemori started work on rooting of cuttings from *Eucalyptus* spp. at Aracruz, in the State of Espirito Santo, Brazil, with a view to propagation of better quality plants for the formation of seed orchards and development of a method adapted to the climatic conditions prevailing in the region, to obtain rooted cuttings on a large scale by the use of plants meeting the requirements of production of high quality pulp. A study was made of conditions in the greenhouse, such as humidity, ventilation and spraying frequency. During the environment control tests use was made of fungicides, hormones, various types of cuttings, fertilization and a number of rooting media.

Work evolved up to 1978, by which time the results attained permitted application of the method in the production of rooted cuttings for planting on an industrial scale.

The interest in development and adaptation of methods of vegetative propagation by rooting of cuttings from eucalypts, in the Aracruz region, was due to the absence of seed improved with a view to the needs of that particular region, as well as the time that is normally expended in developing the classic method of improvement.

Notwithstanding the satisfactory results obtained in planting with seed produced in Brazil, South Africa and Zimbabwe (Rhodesia), three negative factors were observed in the various populations, in different degrees of intensity:

1. canker caused by the *Diaporthe cubensis* fungus;
2. phenotype variation;
3. variations in coppicing ability.

By rooting of cuttings, the aforesaid negative factors are eliminated and the whole of the desirable characteristics can be grouped together in the first selection, using individuals from original populations planted in the region and adapted thereto.

This method of propagation ensures the formation of forests of high economic value from a number of different aspects: survival, productivity, quality of lumber and high rate of regeneration of the forest after successive felling.

Sexual reproduction, currently in course of development, will yield pure or controlled hybrid individuals which may in turn be reproduced by rooting of cuttings.

Materials and methods

Various ecological characteristics of the region

Latitude	19°48'S
Longitude	40°17'W
Altitude	5 to 50 m
Average annual rainfall	1,364 mm
Average annual temperature	23.6°C
Average maximum temperature	29.3°C
Average minimum temperature	19.1°C
Relative humidity	80%

Origin of plus trees

E. grandis, *E. saligna* and *E. "alba"* (*E. urophylla*) are the species that were planted in Aracruz between 1967 and 1972, using seeds produced in São Paulo.

Amongst these populations, certain extremely vigorous hybrids have been identified and are being selected and propagated by rooting of cuttings.

Apart from the natural hybrids, controlled inter-specific hybrids of *E. grandis* x *E. urophylla* and *E. grandis* x *E. pellita* are being developed and propagated.

Criteria for selection of plus trees

Tree selection is aimed at production of bleached wood pulp as the primary purpose.

a) Volume
- DBH exceeding 28.0 cm and height exceeding 30.0 m, at ages of between 6 and 8 years;
- DBH exceeding 30.0 cm and height of more than 30.0 m, at ages of between 8 and 10 years;
- DBH greater than 32.0 cm and height above 30.0 m, at ages from 10 to 12 years.

b) Disease resistance
Particular attention is paid to natural resistance to *Diaporthe cubensis* (canker), which affects the bark, generally at the base of the tree. Plants must be completely resistant.

c) Straightness
Good shape is a "must", because this facilitates and renders less expensive both logging operations and chipping at the pulp plant. Moreover, a part of the forest may be used to supply sawmill operations.

d) Pruning ability
Selected trees must have complete natural pruning ability. Trees with thin branches usually have this feature, which facilitates felling operations and reduces the quantity of waste in industrial production because the lumber will contain less knots.

e) Form of crown
Trees with well-formed crowns and a large number of leaves foster shading of the soil and thus avoid burgeoning of weeds. Weeding is expensive, besides harming the soil and the roots. Moreover, the eucalypts is very sensitive to competition.

f) Bark
As the bark is also used to make pulp, the selected hybrids must have smooth bark so as to facilitate the process and improve industrial quality.

From the above-mentioned phase onwards, the tree must be felled so as to obtain information on the following characteristics:

g) Coppicing ability
One of the limiting factors in use of the method is the coppicing ability. Good coppicing ability is basic for the following reasons (Plate I):
- in case of formation of the eucalypts forest, it is hopped that successive rotations will be obtained from the same stump;
- in case a clone bank is formed, it is hoped that sound production of sprouts will occur, from which to obtain cuttings, a procedure that should be repeated in successive cuttings (Plate II).

h) Rooting capacity
Variation in root forming ability amongst the selected trees reaches extremes of 0 and 100 per cent. Those plants with a level of ability of 70% or better are utilized, inasmuch as production in mass of rooted cuttings from parents with low root-forming ability increases costs.

i) Basic density and pulp yield
Wood sample (disc) is collected at the DBH:

1) The basic density is determined with bark and without bark, as well as the percentage of bark. The basic density without bark has varied from 400 to 700 kg/m³. Currently trees are selecting with densities of around 600 kg/m³.

BASIC DENSITY	NUMBER OF TREES
400 to 450	100
451 to 500	617
501 to 550	979
551 to 600	616
601 to 650	164
651 to 700	43
701 to 750	13

2) The yield in unbleached pulp is determined by digesting the sample (15 grams) in micro-digesters and estimating the yield of bleached pulp. The latter has varied from 44.9 to 54.9%.

These yields at the DBH are being used as mere (approximate) indicators of the yield from the respective trees. It is realized that there is no correlatation between the yields obtained in the DBH region and the mean yield of pulp from the tree as a whole (Barrichelo, L.E.G., 1979).

j) Confirmation of the forest characteristics
After the trees have been subjected to the above-mentioned tests and approved, they are planted in vegetative orchards for confirmation of their phenotype. Two years are enough for the obtaining this information and to decide on the selection of the better, parent, trees

The clones are felled for the mass production of cutting. Use is made of those that afford bes characteristics for a particular purpose: pulp, sawmill operations, production of energy.

Present method of rooting cuttings

An endeavor has been made to develop efficient, low-cost

Plate I - Sprouts from a stump of a selected tree, two months after felling. Material used to produce cuttings.

Plate II - Three coppice shoots correctly spaced on the stool.

Plate III - Shade house.

Plate IV - Hormone treatment and cuttings planting.

facilities for large-scale production of rooted cuttings.

1) Shade house
The best environmental conditions for rooting of eucalypts cuttings in this region were developed from use of shade houses covered with plastic net (50% shade). This protects the cuttings from direct sunlight, strong winds, heavy rainfall and also makes for a milder temperature.
The floor of the shade houses slopes at a 2% angle, and an automatic intermittent mist irrigation system keeps the leaves and the medium damp (Plate III).

2) Containers and medium
The container used is a plastic bag 5 cm in diameter and 10 cm high. The medium is sub-soil earth, free from organic matter and weed seeds. Absence of organic matter greatly reduces the risk of appearance of diseases.
The containers are organized in the form of plots 120 cm wide on the ground, spaced 45 cm apart (Plate III). Each container receives a 1 cm deep layer of sand, to foster better aeration around the base of the cutting.
The center of each container pack is perforated down to a depth of 4 cm, so as to prepare the location in which the cutting will be planted (Plate IV).

3) Harvesting of sprouts
Two months after cutting of the clones, sprouts with a height of about 60 cm, are harvested in the vegetative orchard, with two well-located sprouts maintained for formation of new trees.
Harvested sprouts are taken to the nurseries in buckets of water to avoid fading. Normally, five sprout -harvesting operations are effected on each stump, so that approximately 500 cuttings are produced from two-year -old stumps (Plate I)

4) Preparation of cuttings
The best results have been obtained with use of cuttings containing two pairs of leaves. If the cutting loses one or two leaves, the remaining ones ensure root formation. Cuttings with no leaves will not take roots.
When the internode distance is considerable (over 8 cm) the cutting is prepared with one pair of leaves. The apex and the base of the sprout are not suitable for cutting production, because they do not form good roots. The apex is too herbaceous and the base, too highly lignified.
If the cutting already has buds appearing, these are cut off at the leaf angle, because if they are too leafy they will die. New sprouts will emerge later. There is considerable variation in leaf area from matrix to matrix. Large leaves should be reduced:
a) to avoid falling as a result of their own weight plus the water accumulating on them;
b) to avoid overlapping of leaves after planting in containers, in the interests of better lighting and irrigation.
The base of the cutting is soaked in a solution of systemic fungicide (Benlate 200 p.p.m.) for 15 minutes (Plate V).

5) Planting of cuttings in containers
The base of the cutting (2 cm) is treated with rooting hormone. Use is made of indolbutyric acid diluted in talc, at a concentration of 8,000 p.p.m. or a mixture of 6,000 p.p.m. of indolbutyric acid plus 2,000 p.p.m. of indoleacetic acid diluted in talc (Plate IV).
In both situations the results are the same. The former product is to be found in the market. The latter can be prepared on the spot and is therefore less expensive.
From this point onwards, the cuttings are subjected to intermittent spraying, which keeps them alive. On the

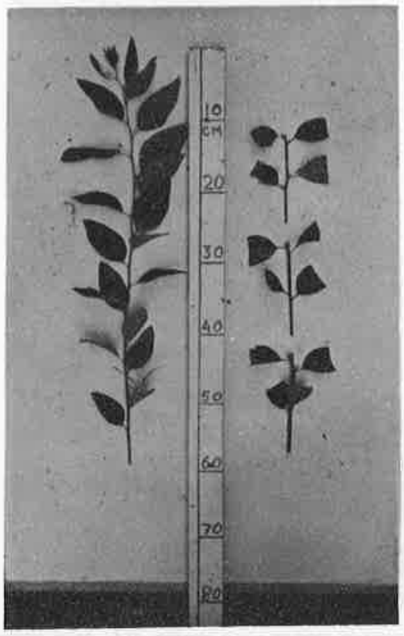

Plate V - Sprout and prepared cuttings.

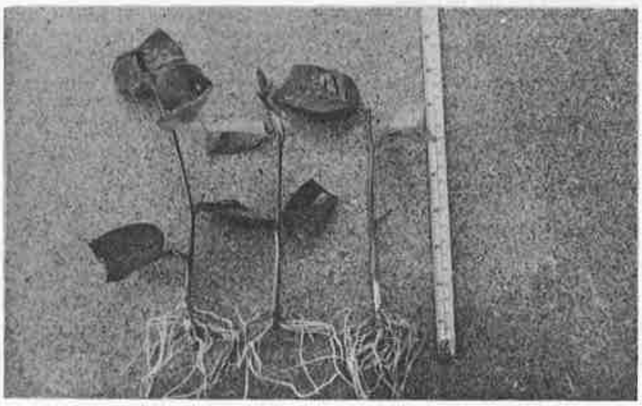

Plate VI - Root system of the cuttings after 40 days.

25th day, the cutting receive their first dose of fertilizer, namely: 3 kg, of N-P-K (5-17-3) diluted in 100 liters of water for 10,000 containers.
The total period under spray treatment is 40 days, sufficient to form a sound root system and commence the sprouting process (Plate VI).

6) First selection
After the period referred to, the rooted cuttings are selected for transfer to an uncovered area. In that area the irrigation system is designed to keep the medium damp.
In this phase the second fertilization is effected, being identical with the first one (Plate VII).

7) Second selection
Between 60 to 70 days the second selection is effected.
   a) If the cutting contain more than one sprout, the more developed one is selected and the remainder removed.
   b) The rooted cuttings are separated into groups of approximatel equal sizes (three groups).
After 70-90 days, the rooted cuttings area ready for planting in the field.

Plate VII - Rooted cuttings after 40 days transferred to an uncovered area

Plate VIII - Rooted cuttings ready for planting

R e s u l t s

The first clone bank was set up three years and ten months ago, using material from the first trees selected in line with the criteria mentioned. It has been noted all, the trees in this bank strictly reproduce the characteristics for which they had been selected (Plates IX and X).
Vigorous hybrids, propagated by rooted cutting display the following rates of growth:

CLONE	$\bar{D}$ (cm)	$\bar{H}$ (m)	$\overline{AB}$ (m^2/ha)	M.A.I. (m^3/ha/yr.)
G 04	15.8	21.7	22.2	58.0
G 15	15.8	21.9	22.1	58.3
G 17	15.9	21.4	22.1	56.7
G 18	16.0	21.2	22.6	57.6
G 20	16.4	18.6	23.8	51.8
G 21	16.3	22.1	23.1	61.1
G 22	16.5	20.0	22.9	55.2
G 25	15.5	21.8	21.6	56.5
G 29	16.2	22.3	23.0	61.6
G 31	15.6	20.9	21.7	54.7
G 32	14.4	20.4	18.4	45.2
G 34	17.3	21.4	25.1	64.7
G 36	18.8	20.6	31.1	76.9
G 40	18.1	20.0	28.9	69.2
U 01	15.9	21.4	22.5	57.9
U 04	15.2	21.5	20.6	53.3
U 06	15.8	21.5	20.8	53.8
U 08	15.0	21.3	19.9	50.9

Table 1 - Hybrid eucalypts trees propagated by rooting of cuttings, after 3 years and 6 months of age. Spacing: 3 x 3 meters.

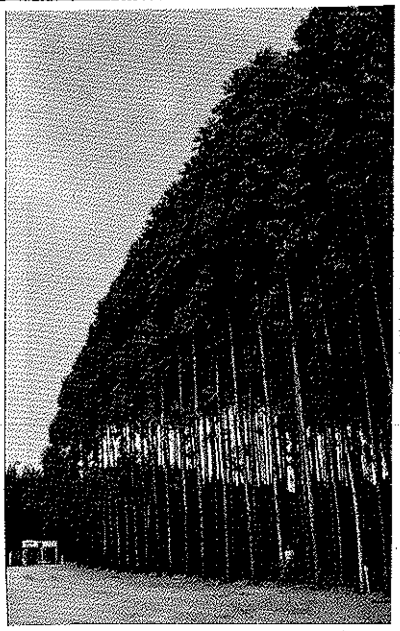

Plate IX - Clone banks, three years and ten months old (rooted cuttings)

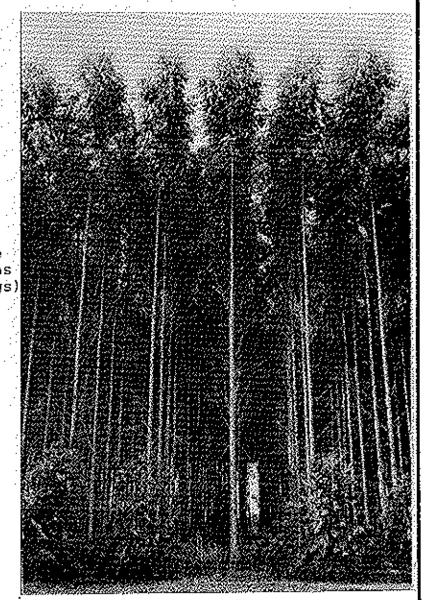

Plate X - Clone bank, three years and ten months old (rooted cuttings)

For each plot of clones derived from a single parent tree, a high degree of uniformity is observed.

Plantings were effected with rooted clones derived from clone banks, for the formation of new clone banks or experimental plantings. Those plantings were cut in three short rotation (18 months after planting, 18 months after first cutting and nine months after second cutting) and showed 100% sprouting after each cut (Plate XI).

In routine planting operations, about one and a half million rooted cuttings have so far been planted, and the oldest individuals are a year and a half old. Survival rate of these trees is about one hundred per cent, and the same uniformity as occurs in the clone banks and experimental plantings has been observed.

The forest previously planted with seedlings has shown a mean annual increment of about 36 m^3/hectare/year, as of the seventh year. Although there are no plantings of rooted cuttings of the same age, the experimental plantings and clone banks with four years of age have shown a mean annual increment (see Table 1) which leads to expectation of minimum gains amounting to 28% per hectare per year as of the seventh year.

The use of parent plants that are in the phase of greatest increment (see Table 1), plus the results of spacing studies, may result in even higher gains. A study is being made of various spacings, (up to 5 x 5 m) and expectations are that the best result will be obtained at between 9 and 12 m^2 per tree.

As may be notes from Table 1, the variation in gain between parent trees as well as in certain other characteristics, is quite considerable, thus favoring the selection of plus trees. About five thousand parent trees are currently in course of testing.

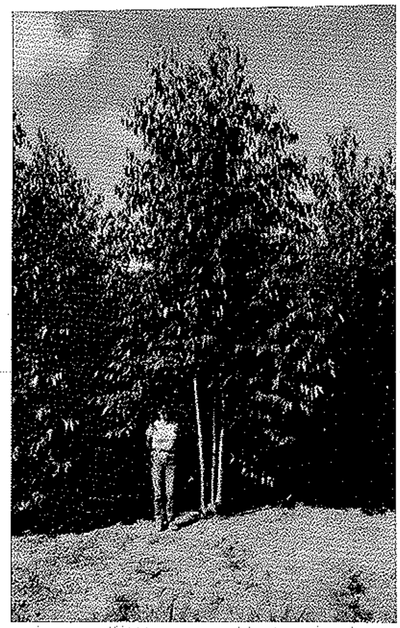

Plate XI - Coppice shoots, ten months old, from rooted cuttings

Cost of production of rooted cuttings is equal to that of producing seedlings. As this is a method still in course of development, certain nursery techniques will have to be improved with a view to their rationalization and consequent reduction in cost. Amongst the factors still in course of development are the following:

. type of container: mechanization of filling and best way of forming root system;
. type of medium : reduction in weight of medium and mechanization of planting.
. fertilization of rooted cuttings: type of fertilizer, form of application (leaf-spraying or otherwise), and period of application;
. control of luminosity: at the various periods of the year.

Conclusion

Mass propagation of *Eucalyptus* spp. via rooted cuttings is feasible and is a means of obtaining high gains in the first generation.

Five thousand hybrids (controlled and not controlled) of *Eucalyptus* spp. trees have been selected. Each selected tree has, at the same time, a number of different characteristics, such as resistance to *Diaporthe cubensis*, coppicing ability, straightness, self-pruning ability and suitable density and cellulose content for pulpwood production.

Vegetative orchards for production of cuttings have already been planted.

One million rooted cuttings were planted in 1979, and five million will be planted in 1980.

The system permits use of vigorous hybrids, of well known behavior and quality, for planting fast-growing forests.

The tropical climate of Aracruz, Brazil, facilitates this strategy, whereby the mass production of rooted cuttings is practiced through simplified methods of environmental control.

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CRIAÇÃO E MULTIPLICAÇÃO VEGETATIVA ATRAVÉS DE ESTAQUIA DE HÍBRIDOS DE *Eucalyptus* NO CONGO

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Resumo

O aparecimento de híbridos de Eucalyptus naturais no Congo explica as primeiras investigações da Pesquisa Florestal na propagação vegetativa destes híbridos.

A técnica de estaquia de Eucalyptus está agora bem desenvolvida e é aplicada em larga escala.

A criação de novos híbridos (alguns podem ser mais produtivos que os híbridos naturais) traz um novo e grande interesse à Pesquisa Florestal e ao programa de reflorestamento nas savanas africanas.

CREATION ET MULTIPLICATION VEGETATIVE PAR BOUTURAGE d'*Eucalyptus* HYBRIDES EM REPUBLIQUE POPULAIRE DU CONGO.

Summary

Forest research has canned out the first investigations on vegetative propgation of natural Eucalyptus hybrids in the Congo.
The cutting technique for Eucalyptus is now well mastered and applied on a large scale
The creation of new hybrids, some of which will be more productive than the natural hybrids, gives Forest Research and the afforestation programm in African savannas new and very great interest.

2 - INTRODUCTION

La région de Pointe-Noire au Congo (4°45' de latitude Sud) est caractérisée par des plateaux d'altitude faible (60 m environ), au relief peu marqué, couverts de savanes faiblement arbustives. Les sols sableux, profonds (sols psammitiques) sont peu fertiles et ne font guère l'objet d'utilisation agricole ou pastorale.

Le climat est caractérisé par deux saisons bien tranchées, une saison chaude, pluvieuse (1254 mm de moyenne) de Novembre à Mai ; une saison plus fraîche, sèche, avec ciel généralement couvert de Mai-Octobre. L'hygrométrie de l'air demeure forte toute l'année.

Les surfaces relativement considérables de savanes (plus de 100 000 hectares) ont amené la recherche forestière à introduire des espèces susceptibles d'être adaptées à ces conditions dans l'objectif, initialement, de fournir du bois de feu pour la ville de Pointe-Noire et des traverses pour le chemin de fer Congo-Océan (CFCO), puis plus tard, dans le but d'approvisionner une usine de pâte.

Dans un premier temps, les recherches ont porté, d'une manière très classique, sur des essais d'introduction d'espèces notamment d'Eucalyptus puis sur des essais provenances.

C'est alors que, dans les premiers boisements effectués par le service forestier à partir des résultats des premières introductions, sont apparus quelques Eucalyptus hybrides phénotypiquement très supérieurs au reste des plantations.

Cette apparition d'hybrides a conduit les chercheurs du CTFT à orienter leurs programmes vers la création de ces hybrides par l'intermédiaire de vergers à graines (voie générative) et vers la multiplication végétative des phénotypes les plus intéressants par la voie du bouturage.

Cette seconde voie a été couronnée de succès et la méthode techniquement bien maîtrisée est actuellement sortie du stade recherche pour passer dans le domaine de l'application industrielle.

Cependant depuis 1978, la voie générative, par la mise au point de l'hybridation artificielle, a permis de créer de nombreux hybrides nouveaux dont certains semblent devoir être plus productifs que ceux actuellement multipliés. C'est donc là le sujet qui, plus que le bouturage, est à la pointe des recherches sur l'Eucalyptus actuellement menées au Congo.

3 - LES INTRODUCTIONS D'ESPECES ET DE PROVENANCES

31 - Les introductions d'espèces

Depuis 1953, soixante trois Eucalyptus ont été introduits au Congo. Nombre d'entr'eux ont été éliminés plus ou moins rapidement mais certains se sont révélés satisfaisants :

Bonne adaptation, croissance intéressante	: E. tereticornis, E. urophylla, E. cloeziana
Bonne adaptation, croissance médiocre	: E. torelliana, E. alba.

3.2. - Les essais de provenances

L'aire naturelle des espèces les plus intéressantes étant particulièrement vaste, nous nous sommes attachés à multiplier les introductions de provenances notamment pour E. tereticornis, E. urophylla, E. cloeziana* et E. alba.

Il faut souligner qu'il existe une grande variabilité intraspécifique chez les espèces introduites. Par exemple, pour Eucalyptus urophylla, dont nous avons introduit 102 provenances (452 descendances). A l'intérieur d'un même essai, nous enregistrons, entre descendances, à l'âge de 4 ans 4 mois, des variations allant de 6,6m à 16,8m pour les hauteurs moyennes et de 21 à 34 cm pour les circonférences moyennes prises à 1,50m.

Pour cette espèce, les provenances les plus intéressantes, tant du point de vue forme que croissance, sont les suivantes :

Ile de FLORES : Mont LEWOTOBI

Ile de FLORES : Mont EGON.

La production de plantations effectuées avec de telles provenances devrait être de l'ordre de 25 m^3/ha/an et des plantations de comportement, réalisées sur des surfaces relativement importantes, seront mises en place en 1980.

4 - L'APPARITION D'EUCALYPTUS HYBRIDES

Les premiers résultats des introductions ont permis au service forestier congolais de mettre en place des plantations d'extension à partir de 1957. Ces premières plantations furent effectuées avec Eucalyptus 12 ABL (en fait Eucalyptus tereticornis origine Ambila Lemaitso, Madagascar) et avec Eucalyptus saligna qui avait été déclaré trop rapidement adapté en raison de son bon comportement au cours des deux premières années.

* Voir J.C. DELWAULLE et P. MONCHAUX - Essais de provenances d'Eucalyptus cloeziana en République Populaire du Congo.

Les plantations ultérieures furent réalisées avec le seul Eucalyptus 12 ABL, à partir de graines récoltées sur place. Leur productivité est de l'ordre de 12 m^3/ha/an à six ans (la croissance à partir de six ans est fortement ralentie).

C'est dans ces peuplements, issus de graines locales, qu'apparurent les premiers hybrides.

41 - Eucalyptus 12 ABL x saligna* (= E. tereticornis x saligna)

Dans les plantations d'Eucalyptus 12 ABL réalisées avec des graines locales apparurent, en faible nombre, des hybrides phénotypiquement très supérieurs à E. 12 ABL. Il s'agissait du croisement d'E. 12 ABL avec E. saligna subsistant dans les vieilles plantations abandonnées.

Cet hybride présente la particularité d'être aisément identifiable dans les planches à semis notamment en raison de sa vigueur. Ceci permettait de réaliser, dès 1964, une petite plantation d'E. 12 ABL x saligna mais une telle méthode ne pouvait être vulgarisée du fait du très faible taux d'apparition d'hybrides et de la disparition progressive des E. saligna.

42 - Eucalyptus PF1 (Eucalyptus alba x urophylla)

En 1957 avait été introduit de Djakarta (Indonésie) Eucalyptus platyphylla qui se révela bien adapté aux conditions locales mais dont la forme est très mauvaise.

En 1964, des graines furent récoltées sur trois de ces E. platyphylla et elles donnèrent naissance à un peuplement ou le nombre d'hybrides, de bonne conformation et de forte croissance, est particulièrement important. En raison de l'incertitude sur la nature du père, cet Eucalyptus hybride fut nommé E. PF1 (E. platyphylla 1ère génération) les pieds mères étant alors nommés E. PO (E. platyphylla origine).

Des plantations de cet hybride furent alors effectuées chaque année sur des surfaces relativement restreintes, et la production de ces parcelles est de l'ordre de 20 m^3/ha/an.

La nature du père d'E. PF1 fut longtemps inconnue et de nombreuses hypothèses furent avancées, contrôlées, puis écartées. Il ne fait actuellement plus de doute, E. platyphylla n'étant qu'une variété d'E. alba, qu'E.PF1 n'est autre que l'hybride E. alba x urophylla.

43 - Conséquences de l'apparition des hybrides naturels

Devant l'apparition de ces hybrides, les chercheurs forestiers eurent la tentation de réaliser des plantations constituées uniquement de ces hybrides dont les potentialités apparaissaient comme étant beaucoup plus fortes que celles des plantations d'espèces pures.

Deux voies de recherche s'ouvraient alors devant eux :
- La voie générative par la création de vergers à graines
- La voie végétative par le bouturage.

5 - LA VOIE GENERATIVE : LES VERGERS A GRAINES

Il était normal de penser favoriser l'apparition d'hybrides en créant des vergers à graines comprenant les deux parents supposés et c'est ainsi, qu'à partir de 1970, furent implantés un certain nombre de vergers à graines destinés à produire ces hybrides.

51 - Eucalyptus 12 ABL x saligna

Ceci ne posa pas de problème majeur pour E. 12 ABL x saligna dont les parents sont connus et un petit verger, situé à Malolo, produit, lorsque les floraisons des parents sont concomittantes, suffisamment de graines pour réaliser environ 100 ha de plantation d'hybrides par an.

* Pour la dénomination des hybrides nous avons adopté l'ordre E. ♀ x ♂

Dans le cas particulier de cet hybride, rappelons que le tri en germoir permet d'éliminer les individus non hybrides et de réaliser ainsi des plantations relativement homogènes dont la production devrait être de l'ordre de 30 m^3/ha/an (les premières plantations importantes datent de 1976).

52 - Eucalyptus PF1

Par contre, pour E.PF1, beaucoup de problèmes se posèrent car la nature du père fut longtemps inconnue. Plusieurs vergers de nature différente, dont l'un permit la création d'un nouvel hybride intéressant en 1972 : E.PO x 12 ABL, ainsi que de nombreux tests de descendances furent nécessaires pour déterminer la nature de l'hybride.

A l'heure actuelle, les vergers E.PO x urophylla (récolte sur E.PO greffes) donnent effectivement naissance à des E.PF1 mais en proportion insuffisante pour envisager leur utilisation pratique.

53 - Commentaires sur les vergers à graines

En raison, essentiellement, du décalage de floraison entre les espèces et même entre les individus, les produits obtenus grâce aux vergers à graines sont très variables d'une année à l'autre et les résultats très irréguliers des tests de descendances montrent bien les limites de l'amélioration génétique et de la production massive de graines d'E. hybride par cette méthode.

6 - LA MULTIPLICATION VEGETATIVE

61 - Technique de Bouturage

A partir de 1970 une seconde voie de recherche fut explorée, celle de la multiplication végétative des Eucalyptus hybrides.

Après plusieurs années de tâtonnements, une technique satisfaisante fut mise au point et devint opérationnelle en 1975. Depuis cette date, la technique s'affina et se simplifia et put ainsi passer, en 1978, au stade industriel.

Plusieurs publications (MARTIN, CHAPERON et QUILLET) ont décrit les différentes phases de cette recherche et nous rendons compte par ailleurs de son application industrielle*. Aussi nous bornerons nous à décrire le processus utilisé :

- Récepage des pieds d'un parc multiplicatif
- Récolte des rejets, essentiellement proventifs, à un stade bien déterminé où le coup d'oeil du récolteur est primordial ;
- Transport rapide et façonnage de ces rejets sous mist pour la production de boutures 4 feuilles.
- Traitement antifongique (Bénomyl)
- Stimulation hormonale par trempage de la base de la bouture dans une poudre contenant de l'acide β indol butyrique ;
- Mise en place de la bouture dans des sacs plastique contenant un sol léger et filtrant .
- Brumisation permanente, de jour, durant 20 à 25 jours . Au bout de cette période, les racines sont apparentes, bord de pot.
- Sevrage durant trente jours, présence de l'ombrière, brumisation progressivement réduite ; apparition rapide d'une ou plusieurs pousses aériennes.

Le plant peut alors être conduit comme un plant issu de semis.

La technique est maintenant parfaitement au point et, en plantations industrielles, où seuls les clones présentant une bonne aptitude au bouturage sont utilisés, le pourcentage de réussite est de l'ordre de 70%.

Si la technique de bouturage de nos deux Eucalyptus hybrides ne pose pratiquement plus de problèmes à la recherche, celle-ci n'en a pas moins un important programme de recherche d'accompagnement dont les grandes lignes sont les suivantes :

Choix des meilleurs phénotypes : Chaque année la recherche passe en sélection dans les plantations de six ans et y choisit les meilleurs phénotypes.

Au 1er Janvier 1980, 174 E.PF1 et 256 E.12 ABL x saligna avaient ainsi été sélectionnés sur les stations de Pointe-Noire et Loudima.

Multiplication végétative de ces phénotypes. Après une description précise de l'arbre sélectionné (l'ortet), celui-ci est abattu et les rejets sont bouturés.
7 clones d'E.PF1 et 2 clones d'E.12 ABL x saligna se sont révélés réfractaires au bouturage et ont été perdus. Les boutures obtenues à partir des rejets de souche sont mises en place dans des tests clonaux, des parcs multiplicatifs ou des parcs à clones.

Les tests clonaux

Ce sont des parcelles expérimentales où sont comparées les performances des différents clones. Celles-ci font l'objet de mensurations ou de notations par clone : hauteur moyenne, surface terrière à l'hectare, production/ha/an, forme, aptitude au bouturage(obtenue en pépinière), valeur papetière.

Les résultats des tests clonaux orientent le reboiseur dans le choix des clones à multiplier, que la plantation soit à objectif papetier, poteaux de ligne ou bois de feu.

Cinq tests clonaux sont actuellement en place dans la région de Pointe-Noire : ils totalisent 397 clones différents.

Les parcs multiplicatifs

Ce sont des parcelles de clones destinés à être multipliés par bouturage pour les plantations d'extension. Le rôle de la recherche s'arrête à la mise en place de ces parcs, leur utilisation ultérieure étant le fait des reboiseurs. Onze parcs multiplicatifs ont ainsi été mis en place depuis 1976 dont un, en 1979, ne contient que des clones susceptibles de fournir des poteaux de ligne.

L'exploitation de ces parcs commençant à l'âge de deux ans et leur pouvoir multiplicatif étant de l'ordre de 100, le nombre de boutures actuellement susceptible d'être produit par ces parcs est de plusieurs millions.

Les parcs à clones

Ce sont des parcelles contenant les clones qui n'ont pû être multipliés en nombre suffisant pour figurer dans les tests clonaux et les parcs multiplicatifs. Ce sont donc uniquement des parcelles relais qui ne sont utilisées que par la recherche.

63 - Conclusion

La technique du bouturage des Eucalyptus hybrides apparus naturellement au Congo a permis de réaliser des plantations multiclonales (par juxtaposition de clones) dont les rendements sont de l'ordre de 35 m^3/ha/an et dépasseront même probablement 40 m^3/ha/an pour les meilleurs clones sélectionnés. Le stade expérimental est maintenant largement dépassé et les plantations industrielles à base uniquement de boutures sont maintenant chose courante au Congo, les réalisations étant, par année, les suivantes :

1975	5 hectares
1976	150 hectares
1977	150 hectares
1978	650 hectares
1979	3100 hectares.

Ces résultats ne concernent que les deux Eucalyptus hybrides apparus naturellement au Congo, le bouturage d'espèces pures comme E.cloeziana et E.urophylla n'ayant pas, à ce jour, trouvé de solution satisfaisante. Ces deux Eucalyptus hybrides seront cependant peut être supplantés par de nouveaux hybrides obtenus artificiellement : les performances de certains d'entr'eux semblant devoir être supérieures à celles d'E.PF1 et E.12 ABL x saligna à âge égal.

7 - CREATION DE NOUVEAUX HYBRIDES - POLLINISATION CONTROLEE

La tentation d'avoir recours à la pollinisation contrôlée est relativement ancienne (1975) mais les premiers résultats tangibles, encore partiels, ne furent obtenus qu'en 1977.

* J.C. DELWAULLE, Y. LAPLACE et G. QUILLET : Production de masse d'Eucalyptus au Congo.

C'est en 1978 que MAILLARD, bénéficiant d'ailleurs d'une année spécialement sèche, put mettre à peu près au point la technique et réaliser 93 croisements différents dont 86 furent mis en place sur le terrain, correspondant à 27 hybrides différents.

La campagne de pollinisation 1979 fut par contre un échec presque total en raison des difficultés liées à la conservation du pollen.

Ce problème est maintenant maîtrisé et tout permet de penser que nous obtiendrons, en 1980, quoique l'année soit particulièrement humide, des résultats au moins aussi bons que ceux de 1978.

71 - Technique de réalisation de l'hybridation contrôlée

La technique de l'hybridation contrôlée passe par les phases suivantes :

Collecte de rameaux florifères, choix des boutons en début de déhiscence, recueil des étamines, dessication de ces étamines et récolte du pollen.

Ce pollen, pour se conserver, doit être bien sec (3 à 6% d'humidité) et être stocké en chambre froide (aux environs de - 16°C).

Les fleurs femelles destinées à être pollinisées sont castrées (élimination des étamines) et ensachées, sur l'arbre, dans un manchon de gaze monté autour d'une armature métallique.

La pollinisation intervient 48 à 72 heures après la castration lorsque le stigmate devient légèrement gluant à son extrémité. Elle est réalisée à l'aide d'une spatule de bois.

72 - La campagne de pollinisation 1973

La période de pollinisation s'est étendue sur deux mois, du 4 Février au 3 Avril 1978 ; Les croisements effectués ont porté sur les espèces pures ou les hybrides suivants : E.PO (=E.alba v.platyphylla), E.alba, E.urophylla, E.12ABL (=E.tereticornis) E.saligna, E.grandis, E.torelliana, E.deglupta, E.kirtoniana (=E.robusta x tereticornis) E.alba du Brésil*, E.robusta du Brésil*,

E.PF1 (=E.alba x urophylla), E. 12 ABL x saligna (=E.tereticornis x saligna).

La plupart des croisements réalisés ont été effectués entre une espèce écologiquement adaptée et une espèce peu adaptée, à croissance rapide. 27 hybrides différents ont pu être mis en place sur le terrain où ils occupent plus de 18 hectares de terrain. A un peu plus d'un an (14,5 mois), on peut faire les constatations suivantes :

- Un certain nombre de nouveaux hybrides ont une croissance supérieure aux croisements contrôlés donnant naissance à E.PF1 et E.12 ABL x saligna.

Il s'agit en particulier des croisements suivants :

. E.urophylla x grandis dont une parcelle de 100 pieds a une hauteur moyenne de 7,70m
. E.PO x grandis (=E.albaxgrandis) : une parcelle de 50 pieds à une Hm = 7,20m et une autre(croisement différent) de 20 pieds atteint 8,70m.
. E.urophylla x kirtoniana, E.urophylla x saligna, E.12 ABL x grandis, E.PO x saligna, E.alba x saligna, E.alba x kirtoniana ont de nombreux placeaux dépassant 6m de haut en moyenne.

- Les croisements contrôlés ayant donné naissance à E.12 ABL x saligna ont une hauteur moyenne légèrement inférieure à 5m.

- Les croisements contrôlés ayant donné naissance à E.PF1 : croisements d'E.urophylla avec E.PO ou E.alba donnent naissance à des populations très hétérogènes ; la plus belle des parcelles de cet hybride a une hauteur moyenne de 6,50m Il y a confirmation de l'hypothèse E.PF1 = E.alba x urophylla.

- Certains croisements contrôlés donnent naissance à des populations très homogènes, il en va ainsi du croisement E.urophylla x grandis et à un moindre degré des croisements E.PO x grandis et E.urophylla x saligna.

- D'autres croisements, par contre, donnent naissance à des populations hétérogènes dans lesquelles la sélection phénotypique permettra de sélectionner des individus très performants à multiplier par bouturage. Il en va en particulier ainsi du croisement E.urophylla x kirtoniana.

- Le croisement E.PF1 x E.12 ABL x saligna, hybride double, est très hétérogène mais certains sujets montrent une excellente croissance.

- La multiplication végétative de ces hybrides, ou tout au moins leur diffusion, devra attendre la confirmation de leur adaptation à nos conditions écologiques. Cependant, à titre expérimental, nous venons de bouturer avec succès E.urophylla x grandis.

73 - La campagne actuelle

La campagne actuelle de pollinisation contrôlée n'est pas terminée puisqu'en Mai 1980 nous commençons à peine la récolte de premières graines.

Parmi les croisements réalisés pour la première fois figurent : E.cloeziana x PO - E.cloeziana x PF1 - E.urophylla x cloeziana - E.urophylla x deglupta - E.urophylla x pellita - E; urophylla x torelliana. Remarquons que des croisements ont été effectués entre espèces botaniquement très éloignées. Il en va ainsi de ceux réalisés avec E.cloeziana, seul représentant du sous genre Idiogenes : il reste à voir si les produits obtenus seront féconds.

74 - Conclusion

Les deux hybrides apparus naturellement au Congo et sur lesquels nous avons travaillé jusqu'à présent ne nous permettaient pas de disposer d'un large éventail génétique, les E.PF1 provenant seulement de trois arbres mères E.PO et les E. 12 ABL, mère de nos hybrides E.12 ABL x saligna, provenant tous d'une petite plantation malgache d'E. tereticornis.

La maîtrise de la pollinisation contrôlée nous permettant en particulier de travailler sur les très nombreuses provenances d'E.urophylla, E.tereticornis, E.alba et E.cloeziana dont nous disposons vont nous permettre de sélectionner nos hybrides à multiplier par bouturage dans un domaine génétique très étendu.

Cette pollinisation contrôlée nous permet de réaliser des hybrides qui ne peuvent apparaitre naturellement (zones géographiques différentes, floraisons non concomittantes etc..) ; l'échange de pollen entre instituts est tout à fait envisageable : on réaliserait ainsi des croisements entre phénotypes remarquables situés dans des pays différents.

Par ailleurs, il n'est pas impensable d'obtenir suffisamment de graines d'un croisement intéressant par pollinisation contrôlée pour réaliser des reboisements industriels à partir de graines. Ce pourrait être le cas de l'hybride E.urophylla x grandis, s'il se révèle adapté, du fait de la grande homogénéité des produits : la mise en place de champs de pollinisation où les parents des hybrides intéressants seraient réunis (par greffes ou marcottes) est envisagé.

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* il s'agit là d'hybrides de nature mal déterminée.

PRODUÇÃO MASSAL DE ESTACAS ENRAIZADAS DE *Eucalyptus* NA REPÚBLICA POPULAR DO CONGO.

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Resumo

Em 1979, a República Popular do Congo havia estabelecido 3.000 ha de plantações clonais de *Eucalyptus*. Pretende-se plantar 30.000 ha no futuro. O programa de plantações, em 1979, envolveu a produção de 1,2 milhão de estacas enraizadas, em dois viveiros comerciais.

O "Centre Technique Forestier" desenvolveu um método de enraizamento de estacas herbâceas de *Eucalyptus* no Congo e agora vem aplicando esta têcnica em escala comercial.

PRODUCTION MASSIVE DE BOUTURES *d'Eucalyptus* EM REPUBLIQUE POPULAIRE DU CONGO.

Summary

In 1979, the people's Republic of Congo had established 3000 ha of clonal plantations of Eucalyptus. It is intended to plant 30000 ha in the future. The 1979 plantation programme requires the production of 1,2 million Eucalyptus cuttings in two industrial nurseries.
The "Centre Technique Forestier Tropical" has invented a herbaceous cutting method for Eucalyptus in the Congo and now applies this technology on an industrial scale.

2 - INTRODUCTION

Dans le but, d'une part, de tester sur une échelle industrielle la technique de bouturage de l'Eucalyptus mise au point par le CTFT ; afin, d'autre part, de réaliser une première tranche de plantations destinées à la fourniture de matière première pour une usine de pâte, le CONGO a créé l'UNITE D'AFFORESTATION INDUSTRIELLE DU CONGO dont il a confiée la gérance au C.T.F.T.

30 000 hectares de plantations devraient permettre d'assurer le ravitaillement d'une usine ayant une capacité annuelle de 250 000 tonnes de pâte cellulosique. La première tranche de plantations, confiée à l'UAIC, est relative à la réalisation de 7000 hectares sur trois ans.

En 1979, 1,2 Million de boutures d'Eucalyptus PF1 et d'Eucalyptus 12 ABL x saligna, les deux meilleurs hybrides naturels actuellement disponibles au Congo(*), ont été produites permettant la réalisation de 3000 hectares de plantations clonales à une densité de 400 plants à l'hectare.

La technique de production végétative de masse de l'Eucalyptus utilisée par l'UAIC depuis 1978, s'inspire directement de la méthode expérimentale mise au point par le CTFT Congo. Toutefois le passage à un stade industriel a permis, en 2 ans, de rationaliser les techniques, de systématiser certaines opérations et de définir des normes.

Dans les paragraphes suivants on se propose d'examiner :
- le calendrier des travaux relatif au cycle annuel de production de boutures d'Eucalyptus ;
- le cadre et l'organisation de ces opérations à échelle industrielle.

3 - LE CALENDRIER DES TRAVAUX

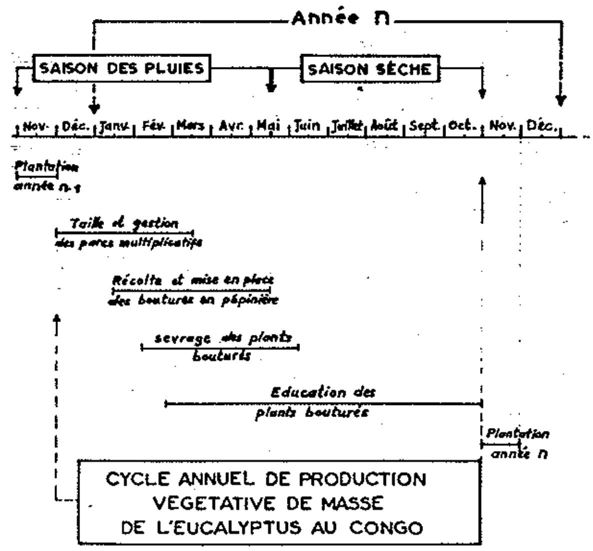
Il est fortement influencé par le régime climatique local - caractérisé par l'alternance d'une saison des pluies et d'une saison sèche de durée sensiblement égale - qui impose :

- la réalisation des opérations de récolte et de mise en place des boutures en pépinière du mois de Janvier au mois de Mai, au coeur de la saison des pluies, seule période favorable à la production massive de rejets de souche aptes au bouturage.

- la concentration des travaux de plantation sur une période très brève, généralement inférieure à 1 mois, en début de saison des pluies, afin que les jeunes plants puissent profiter au maximum des mois chauds et humides qui suivent la plantation.

Ces contraintes climatiques qui excluent l'étalement du programme de production et de plantation sur toute l'année affectent tout particulièrement le mode de conception et de gestion des unités de bouturage industriel.

Le schéma ci-dessous résume la séquence des opérations relatives à un cycle annuel de production industrielle de boutures d'Eucalyptus au Congo.



4 - ORGANISATION DES OPERATIONS A ECHELLE INDUSTRIELLE

En 1979, l'U.A.I.C. comprenait 2 unités de bouturage industriel, chacune ayant une capacité de production de 600 000 boutures d'Eucalyptus par an, correspondant à un programme annuel de 1500 ha de plantations

* cf. Création et Multiplication végétative par bouturage d'Eucalyptus hybrides en République Populaire du Congo par J.C. DELWAULLE.

clonales. Les chiffres cités ci-dessous se rapportent à une unité de cette dimension.

Nous examinerons successivement :

- La gestion des parcs multiplicatifs
- L'organisation de la pépinière
- La réalisation du bouturage
- L'éducation des plants.

41 - La gestion des parcs multiplicatifs

Les parcs multiplicatifs sont des parcelles de clones destinés à être multipliés pour les plantations d'extension. Leur composition et leur mise en place sont effectués avec le concours de la Recherche.

Les parcs multiplicatifs sont généralement inclus dans le périmètre de reboisement ; ils sont d'ailleurs plantés à la même période, selon les mêmes techniques et à la même densité (400 plants/ha) que les parcelles d'extension. Toutefois ils font l'objet dès leur installation d'une gestion particulièrement attentive en ce qui concerne les entretiens, la fertilisation et la surveillance phytosanitaire.

La première taille de production intervient au cours de la 2ème saison des pluies suivant la plantation, sur des sujets âgés de 25 à 29 mois. Les rejets très abondants et vigoureux en cette saison deviennent aptes au bouturage au bout de 6 semaines environ et pour une très courte période.

Les pieds-mères subissent en général deux tailles au cours d'une saison permettant deux récoltes de rejets à 1 mois et demi d'intervalle. La production moyenne d'une souche est de 100 boutures par saison.

Pour une unité de production de 600 000 boutures par an, le parc multiplicatif couvre une surface de 20 hectares et le rythme de coupe est d'environ 95 pieds par jour entre le mois de Décembre et le mois de Mars.

Après cette première récolte, les souches seront laissées au repos pendant près de deux ans pour être à nouveau exploitées au cours de la 2ème saison des pluies suivant la première intervention. A condition de prévoir des entretiens et une fertilisation soutenus, ce rythme d'exploitation des parcs multiplicatifs semble pouvoir être poursuivi sur une longue période sans épuisement apparent des souches.

Les rejets de générations successives fournissent des boutures de très bonne qualité présentant un excellent taux d'enracinement.

42 - L'organisation de la pépinière

Il s'agit d'une pépinière permanente conçue pour une production annuelle de 600 000 boutures. Compte tenu des taux actuels d'enracinement (75% en moyenne pour l'UAIC en 1979) elle doit donc pouvoir contenir 800 000 boutures.

Couvrant une surface de 2 hectares, l'aire de bouturage est composée de bandes de bouturage de 18m de largeur permettant la production de 1160 boutures par mètre linéaire. Les bandes de bouturage sont séparées entre elles par des routes d'accès de 8m de largeur.

L'irrigation s'effectue entièrement par brouillard artificiel, système donnant les meilleurs résultats pour le bouturage herbacé utilisé pour l'Eucalyptus. Le système d'irrigation comprend, pour chaque bande de bouturage, un réseau de conduites d'eau parallèles, espacées de 2m et situées à 2m de hauteur.

Les brumiseurs fixés aux conduites permettent de diffuser à volonté une nappe de brouillard de largeur légèrement supérieure à la bande.

Une ligne de distribution de l'eau comporte une série de vannes actionnées manuellement déterminant des secteurs autonomes de 4 planches de 1160 boutures.

L'alimentation du réseau aérien s'effectue par des conduites enterrées de gros diamètre amenant l'eau à partir d'une réserve artificielle située sur une butte, au-dessus de la pépinière à une hauteur suffisante pour avoir une pression de 2 bars capable d'alimenter le mist. La réserve d'eau est elle-même alimentée par des motopompes branchées sur un lac naturel proche de la pépinière.

43 - La réalisation du bouturage

Les rejets ayant été récoltés très tôt le matin et transportés humides à la pépinière sont conditionnés sous brouillard artificiel en boutures d'environ 20cm (4 feuilles).

Après trempage dans une solution antifongique, la base des boutures est poudrée par une hormone de synthèse (AIB) favorisant la rhizogénèse. Les boutures sont alors plantées individuellement dans des sacs de polyéthylène contenant 1,8 litres de terre sableuse de savane prélevée à proximité immédiate de la pépinière.

12 000 boutures sont en moyenne mises en place chaque jour en pépinière par 2 équipes de 6 " boutureurs". Les planches réalisées vont alors suivre simultanément un cycle de bouturage qui va durer 40 jours. Le schéma en est le suivant :

Mise en place

RHIZOGENESE	SEVRAGE	Education
0	25	40
- Brouillard diurne permanent - Plein découvert	- Diminution progressive des phases de brouillard - Ombrage	

Rhizogénèse : Dans les meilleures conditions les premières racines apparaissent au bout de 8 à 10 jours. En phase industrielle, il est cependant nécessaire de maintenir le brouillard permanent pendant 25 jours afin d'obtenir un taux homogène d'enracinement d'environ 80%*.

Sevrage : La pousse aérienne apparait durant cette période à partir d'un bourgeon axillaire et se développe rapidement en même temps qu'un enracinement puissant.

44 - L'éducation des plants

Après la phase originale du bouturage, la technique d'éducation des plants bouturés s'apparente à celle utilisée dans une pépinière classique de plants issus de semis : entretiens, traitements fertilisants et phytosanitaires etc..

Les boutures étant produites entre Janvier et Mai et la plantation n'ayant lieu qu'en Novembre, les plants passent entre 5 et 9 mois en pépinière. Il est donc nécessaire de limiter leur croissance par des tailles appropriées de l'appareil aérien et des racines, accompagnées du déplacement des pots.

Chaque plant est ainsi manipulé 2 fois en moyenne ce qui ne représente cependant qu'une incidence minime dans le prix de revient.

5 - CONCLUSION

La technique du bouturage des Eucalyptus hybrides mise au point par le C.T.F.T. avant 1978 s'est révélée être parfaitement utilisable au niveau industriel.

* du fait de variations clonales, ce taux varie actuellement de 60 à 98%.

Cette technique permet de ne multiplier que les phénotypes les plus intéressants et donc de mettre en place des plantations de haut rendement.

Le choix des clones de plus en plus important chaque année, mis à la disposition du reboiseur par la recherche, permettra, progressivement, de ne mettre en place que les plus productifs d'entr'eux.

Le nombre de clones ne devra cependant pas être trop faible, en raison en particulier des risques phytosanitaires, et nous nous sommes fixé le nombre de 40 avec mise en place de parcelles monoclonales juxtaposées.

SELEÇÃO E MULTIPLICAÇÃO VEGETATIVA DE HÍBRIDOS DE *Eucalyptus* RESISTENTES A GEADA

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Resumo

No estágio de Viveiro pode-se selecionar certas características tais como resistência à geada, tolerância a solos e vigor. Algumas vezes é interessante usar a variabilidade genética (espécie, procedência, família) para separar o material vegetal: por exemplo, o *E. globulus* não é tão resistente à geada quanto o *E. dunnii, E. veninalis, E. dalrympleana, E. marcatthurii*, e algumas procedências de grandes altitudes de *E. delegatensis*, as quais tem suportado temperaturas de até menos de 12ºC sem apresentar sérios problemas. A sobrevivência e crescimento inicial de plantações de *E. delegatensis*. Alguns híbridos ou mesmo espécies puras podem dar excelentes indivíduos, os quais podem sobreviver a temperaturas de menos de 12ºC, com resultados bastante superiores às espécies acima mencionadas. Estes materiais podem ser propagados através da técnica "in vitro" e produzir elementos bastante resistentes e também em grandes quantidades. Testes clonais em câmaras frias têm indicado que a resistência à temperaturas inferiores a menos de 20ºC é bastante rara de acontecer.

SELECTION ET MULTIPLICATION VEGETATIVE D'*Eucalyptus* RESISTENTE AU FROID.

Summary

Frost resistance, calcareous soil tolerance and juvenile vigor can be selected very early at the nursery stage. It can be quite profitable to use the genetic variability (species, provenances, families) to screen the vegetal material : for instance Eucalyptus globulus is not frost resistant whereas Eucalyptus gunnii, Eucalyptus dalrympleana, Eucalyptus viminalis, Eucalyptus macarthurii and some high elevation provenances of Eucalyptus delegatensis have supported - 12° C without too serious damages.

With Eucalyptus delegatensis, the survival and the juvenile growth of the seedlings are strongly influenced by altitude.

Some hybrids seedlots or pure species can give very remarkable individuals which survive at - 12° C and are much more higher than the resistant ones meanheight. These ortets are vegetatively propagated by "in vitro" technics which can make the rootstock quite reactive again and permit obtaining a great deal of copies in one year.

The clonal test in an artificial radiative frost chamber has indicated that frost resistant individual until - 20° C are extremely rare.

Résumé

Certains caractères se prêtent bien à une sélection précoce dès le stade 6-10 mois en pépinière. On met en évidence la très grande variabilité interspécifique, intraspécifique et familiale à l'égard de la résistance au froid.

Si Eucalyptus globulus est totalement éliminé à - 12° C,par contre Eucalyptus gunnii, Eucalyptus dalrympleana, Eucalyptus viminalis, Eucalyptus macarthurii et quelques provenances de haute altitude d'Eucalyptus delegatensis supportent sans gros dommages de tels froids.

Pour Eucalyptus delegatensis, l'influence de l'altitude du lieu de récolte conditionne la survie ; la croissance moyenne des provenances d'altitude est inférieure à celle de plaine.

Néanmoins, on rencontre dans certains lots de graines d'espèces pures ou d'hybrides naturels, quelques individus très remarquables qui peuvent être sélectionnés à la fois pour leur résistance au froid et leur vigueur juvénile. Ces ortets sont propagés végétativement en utilisant la technique "in vitro" à la fois pour rendre les pieds-mères très réactifs et pour accélérer la constitution des clones.

Le contrôle clonal en chambre à froid artificiel a montré que les individus susceptibles de résister à un froid radiatif de - 20° C sont extrêmement rares.

Dès 1960, LACAZE fixait les objectifs de sélection pour réussir à implanter des Eucalyptus en France sur une échelle importante. Il s'agissait alors de retenir des espèces et des provenances tolérantes au froid et adaptées à des teneurs élevées de calcaire actif dans le sol.

En 1980, ces objectifs n'ont pas changé mais les moyens d'y parvenir permettent de penser que nous ne sommes pas éloignés d'un résultat positif. En effet, on peut citer parmi les progrès réalisés en 20 ans :

- une connaissance plus précise des conditions écologiques des espèces de l'aire naturelle,
- des résultats récents ou anciens de plus en plus nombreux sur les introductions d'Eucalyptus dans les climats tempérés froids,
- une exploitation très fructueuse des données climatologiques permettant de délimiter avec précision les régions françaises où la probabilité de l'occurence de froids destructeurs est inférieure à 0,05,
- la mise au point d'outils de sélection particulièrement fiables comme la chambre à froid de PATON ou les cultures hors sol sur substrats contrôlés,
- le développement original de la physiologie forestière en relation avec les nécessités du rajeunissement des méristèmes,
- la récente possibilité d'une multiplication massale intensive de clones par bouturage classique ou "in vitro"
- un intérêt accru pour les phénomènes liés à l'hétérozygotie.

Pour profiter de ces changements importants, nous avons décidé de ne plus prendre en compte que les aptitudes individuelles à résister au froid ou au calcaire en les triant soit dans des populations de races pures, soit dans des essaims d'hybrides interspécifiques naturels ou artificiels.

Nous décrivons ci-après la méthodologie employée.

- Matériels et méthodes :

On pratique une sélection juvénile à partir de plants issus soit de graines d'hybrides interspécifiques, soit de graines d'espèces pures. Cette sélection est suivie d'une multiplication végétative des individus résistants et d'une comparaison en tests clonaux.

Ces graines sont semées en caisses au printemps à la pépinière de Marvejols (Lozère) et les semis forcés pendant l'été de manière à avoir un développement maximum. Des dépressages par le bas sont faits régulièrement pour enlever les sujets les moins vigoureux, maintenir une densité normale et éviter l'étiolement des plants de manière à arriver à la fin de la période de végétation à une densité variant entre 100 et 500 plants par mètre carré, selon la croissance des lots testés. Le substrat est un mélange d'écorces de Pin broyées, de tourbe et de cendres de lignite. Il est enrichi avec un engrais retard (osmocote). La quantité de semences utilisées varie entre 3 à 6 grammes au mètre carré en fonction de l'espèce.

Après chaque coup de froid, on procède à des notations puis on élimine les semis présentant des traces de gel après les avoir répartis en classes de hauteur et en classes de sensibilité au froid, selon l'échelle suivante :

1 : aucune trace de gelée,
2 : plants peu atteints, seul le bourgeon a souffert. Parfois de petites traces sur quelques feuilles (rare),
3 : plants moyennement atteints, moins de 50 % des feuilles présentent de graves brûlures,
4 : plants très atteints, plus de 50 % des feuilles présentent de graves brûlures,
5 : plants apparemment morts, feuilles sèches, tiges gelées.

Seuls les plants codés 1 sont conservés et font l'objet en fin de 2ème hiver d'une sélection sur la vigueur.

La liste complète des lots testés en 1978 et 1979 est la suivante :

1978	Espèces	Descendances d'arbres hybridogènes en peuplements français
	E. dalrympleana	Sare n° 2,
	"	Tordères 13.3,
	"	Coussergues 1.5042.18,
	E. gunnii	Sare n° 2,
	"	Fêlines 16,
	"	Clairac 5039.4,
	"	Clairac 4034.11,
	E. pauciflora	Tordères 23.3,
	"	Cessenon 1,
	"	Cessenon 2,
	"	Cessenon 3

1979	Espèces	Descendances d'arbres hybridogènes en peuplements français
	E. gunnii	Fêlines 18,
	"	Tordères 16.1.,
	"	Tordères 16.2.,
	"	Tordères 21.2.,
	"	Coussergues 1,
	"	Saint Honoré,
	"	l'Hermitage 2,
	"	l'Hermitage 3,
	E. dalrympleana	Sare 5,
	"	l'Hermitage 1,
	E. macarthurii	l'Herm 2,
	E. viminalis	l'Herm 3,
	Vimdal (viminalis X dalrympleana)	Devinas 3,
	E. globulus	l'Amandier.
		provenances de l'aire naturelle
	E. globulus	Geeveston (Tasmanie),
	"	Uxbridge ("),
	"	Jericho ("),
	"	Pepper Hill ("),
	"	Rheban ("),
	"	Scamander ("),
	"	The Barnback ("),
	E. unialata	Tasmanie,
	E. delegatensis	Ann Repulse (Tasmanie),
	"	Dolerite Road Russel ("),
	"	Esperance Valley ("),
	"	Franklin ("),
	"	Interlaken ("),
	"	Moogara ("),
	"	Sandbanks Tier ("),
	"	Warra 15 ("),
	"	Wihareja ("),
	"	Wood bury ("),
	E. regnans	The Barnback (").

- Résultats :

Pendant l'hiver 1978/1979, on a observé les minima suivants :

- 9,5° C le 2 Décembre 1978,
- 8,5° C le 3 Janvier 1979,
- 10,0° C le 26 Février 1979.

Pendant l'hiver 1979/1980, on a pû observer les minima suivants :

- 6,0 ° C le 18 Novembre 1979,
- 9,0° C le 24 Novembre 1979,
- 12,0° C le 27 Décembre 1979,
- 11,0° C le 3 Janvier 1980.

Ces températures ont été suffisamment basses pour provoquer l'élimination d'un grand nombre de semis.

1°) Sensibilité spécifique :

Les espèces peu sensibles au froid sont :

	% d'individus résistants à - 10° C	à - 12° C
E. dalrympleana	93,5 %	75,7 %
E. gunnii	94,5 %	85,7 %
E. macarthurii,	98,0 %	96,2 %
E. vimdal,	97,6 %	79,4 %
E. viminalis	99,0 %	97,1 %

Les espèces à sensibilité moyenne sont :

E. delegatensis	54,7 %	52,5 %
E. unialata	20,8 %	14,5 %

Les espèces à forte sensibilité sont :

E. globulus	0,1 %	0 %
E. regnans	0,5 %	0 %

2°) Sensibilité intra-spécifique :

Nous disposions de nombreuses provenances de l'aire naturelle d'*Eucalyptus delegatensis* et *Eucalyptus globulus*.

Nous avons reporté ci-dessous les résultats obtenus avec les 7 provenances appartenant toutes à la sous-espèce *Eucalyptus globulus* :

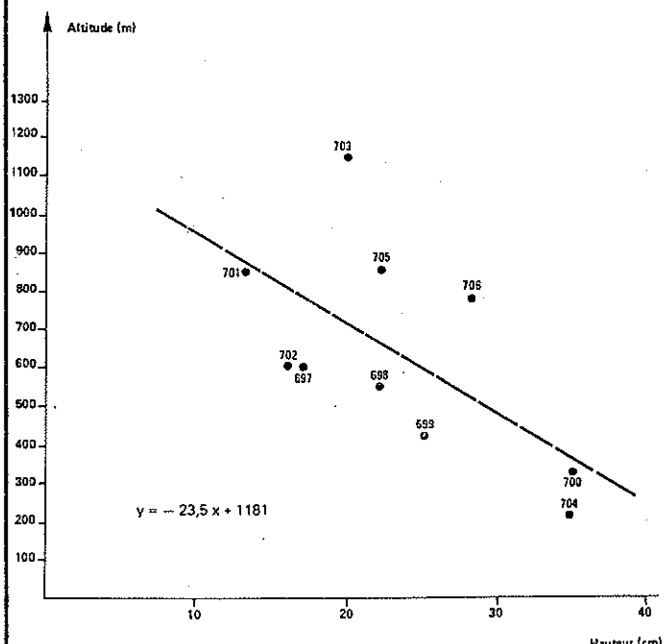
n° lot	provenance	% de mortalité à - 9° C	% de mortalité à - 12° C
78438	Geeveston (Tas.)	100	100
78439	Uxbridge (")	100	100
78440	Jericho (")	84	100
78441	Pepper Hill (")	100	100
78442	Rheban (")	100	100
78443	Scamander (")	87	100
79373	The Barnback (")	100	100

Eucalyptus globulus ssp globulus est donc trop sensible au froid pour pouvoir faire l'objet d'un second tri au niveau individuel.

Pour les 18 provenances d'*Eucalyptus delegatensis* mises en expérimentation, nous avons essayé de trouver une relation entre la résistance au froid et la croissance.Les 18 lots ont été récoltés en Tasmanie aux altitudes suivantes :

78697	Ann Repulse	600 mètres
78698	Dolerite Road-Russel Valley	545 mètres
78699	Esperance Valley	420 mètres
78700	Franklin	330 mètres
78701	Interlaken	850 mètres
78702	Moogara	600 mètres
78703	Sandbanks Tier	1150 mètres
78704	Warra 15	210 mètres
78705	Wihareja	850 mètres
78706	Woodbury	780 mètres
78490	Black Hills	460 mètres
78491	South Brandum	1070 mètres
78492	Maydena	920 mètres
78493	Maggs Mountain	880 mètres
78494	Patersonia	490 mètres
78495	Ben Nevis	970 mètres
78496	Fingal	700 mètres
78497	Fingal	520 mètres

Influence de l'altitude sur la croissance juvénile de 10 provenances de E. delegatensis



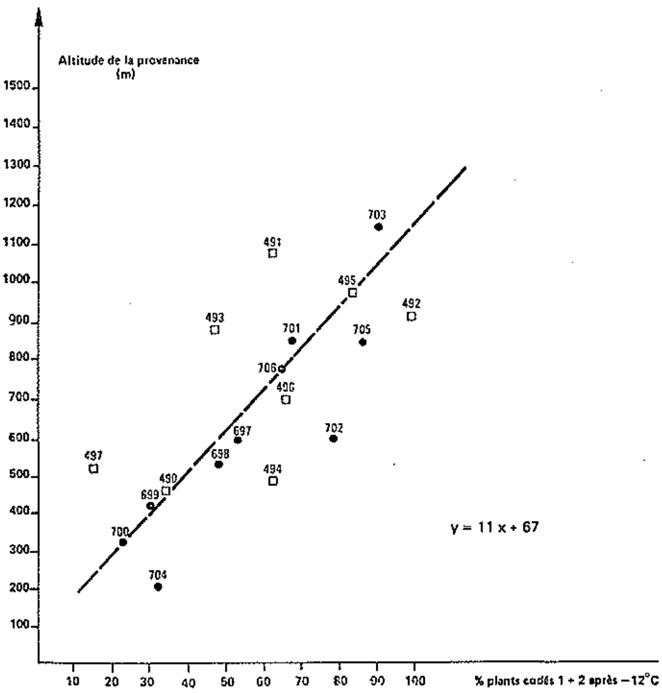
Cette relation inverse entre vigueur et altitude de récolte a été trouvée par ASHTON pour l'*Eucalyptus regnans*, par PRYOR pour l'*Eucalyptus pauciflora*, par BARBER pour l'*Eucalyptus urnigera* ; on peut donc la considérer comme assez générale.

Or le facteur principal conditionnant la résistance au froid semble être l'altitude de récolte comme le montre le graphique ci-dessous.

On se trouve donc devant un dilemne : la sélection pour la résistance semble entraîner une contre-sélection pour la vigueur lorsque l'on ne tient compte que des moyennes de population. D'où en a résulté la nécessité de s'intéresser aux individus aberrants qui dans certaines combinaisons génétiques cumulent à la fois des caractères de vigueur et de résistance au froid.

INFLUENCE DE L'ALTITUDE SUR LA RÉSISTANCE AU FROID

CHEZ 18 PROVENANCES DE E. DELEGATENSIS



3°) SENSIBILITÉ INDIVIDUELLE :

On a profité de la présence dans les anciennes collections d'arbres adultes d'espèces variées plantées côte à côte pour essayer de mettre en évidence des hybridations naturelles favorables. Nous citons les deux exemples les plus probants :

-Le lot 79040 a été récolté sur un *Eucalyptus gunnii* en bordure d'une parcelle d'*Eucalyptus globulus*. Sa descendance était composée presque exclusivement d'hybrides gunnii X globulus. Nous avons reporté ci-dessous les résultats à - 12° C :

	Mensurations \ Classes de sensibilité au froid	1	2	3	4	5
gunnii pur	n	2	0	0	0	0
	H	30,0	-	-	-	-
	H max	55,0	-	-	-	-
	%	6,9	0	0	0	0
hybride putatif gunnii X globulus	n	0	14	5	3	5
	H	-	57,1	51,0	51,7	35,0
	H max	-	75	65	75	65
	%	0	48,3	17,2	10,3	17,2

Les deux *Eucalyptus gunnii* purs sont plus résistants que les hybrides. Parmi les 27 hybrides, 5 avaient résisté sans dommage à - 9° C et leur taille moyenne était de 53 cm. Les trois plus grands mesuraient entre 60 et 70 cm. A - 12° C, ils ont tous montré quelques traces de gel mais 48 % ne sont encore atteints que très légèrement (bourgeon terminal grillé).
Parmi ces hybrides peu atteints, 2 plants font plus de 70 cm. Ils seront retenus pour être propagés végétativement s'ils résistent à un second hiver.
Il faut noter que la hauteur moyenne des semis les moins sensibles est supérieure à celle des hybrides sensibles et à celle des semis d'*Eucalyptus gunnii* purs.

-Dans le lot 78116, descendance d'*Eucalyptus gunnii*, on a pû observer au milieu de plants de l'espèce pure, les hybrides naturels suivants :

. *Eucalyptus gunnii X Eucalyptus cinerea*,
. *Eucalyptus gunnii X Eucalyptus viminalis*,
. *Eucalyptus gunnii X Eucalyptus dalrympleana*.

Les résultats sur la sensibilité des semis ont été notés après le froid de - 12° C :

	Mensurations \ Classes de sensibilité au froid	1	2	3	4	5
Eucalyptus gunnii	n	20	35	3	0	0
	H	27,0	44,6	48,0	-	-
	H max	45	75	65	-	-
	% total	16,1	28,2	2,4	0	0
	% gunnii	34	60	6		
Eucalyptus gunnii X cinerea putatif	n	0	7	2	0	0
	H	-	57,0	45,0	-	-
	H max	-	65	55	-	-
	% total	0	5,6	1,6	0	0
Eucalyptus gunnii X viminalis putatif	n	10	29	2	1	0
	H	44,0	45,0	65,0	45	-
	H max	75	75	75	45	-
	% total	8,0	23,3	1,6	0,8	0
	% hybride	23	69	5	2	
Eucalyptus gunnii X dalrympleana putatif	n	2	12	0	0	0
	H	45	55,0	-	-	-
	H max	45	75	-	-	-
	%	1,6	9,6	0	0	0

On notera que les semis d'*Eucalyptus gunnii* purs ont une vigueur moyenne moindre pour les plants résistants, avec cependant quelques individus à la fois résistants et vigoureux alors que pour l'hybride gunnii X viminalis, on peut sélectionner des clones très vigoureux parmi les moins sensibles au froid.

Si on compare les plants de l'espèce pure et les hybrides, on constate chez ces derniers une vigueur moyenne supérieure à celle d'*Eucalyptus gunnii*. De plus, la répartition par classe de sensibilité au froid de l'hybride *Eucalyptus gunnii X Eucalyptus viminalis* est presque identique à celle d'*Eucalyptus gunnii* pur (cf. graphique 1). On a donc réuni dans cet hybride naturel les caractères recherchés chez les deux parents.

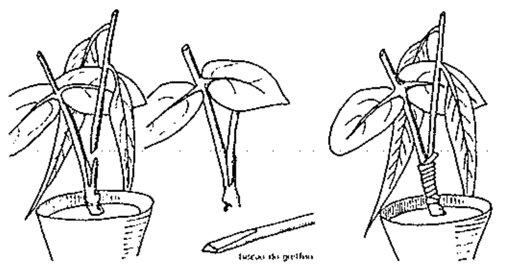
- Discussion :

1°) GAINS DUS À LA SÉLECTION INDIVIDUELLE :

Dans l'essai de 1978, avant les premières gelées, on comptait 11 lots de semis représentés par 2673 individus. Le premier hiver (-10° C) en a éliminé 84,4 %. Le deuxième (-12° C) en a encore fait disparaître quelques uns portant le nombre de plants résistants à 376 pour 9 lots, 2 ayant totalement succombé. La hauteur moyenne des plants résistants est, en fin d'année, de 106 cm.
Sur ces 376 plants, nous en avons retenu 13 présentant à la fois une résistance parfaite aux gelées de Marvejols en 1978 et 1979 et une vigueur importante. Ces 13 individus représentent 3,4 % du nombre des plants résistants et 0,5 % du nombre total des plants testés. Leur hauteur moyenne est de 218 cm ; on a donc un gain de 206 % sur la hauteur à la sortie du tri massal pour le froid après deux saisons de végétation par rapport à la moyenne des plants résistants.

2°) Multiplication végétative des ortets sélectionnés :

Ces 13 ortets furent greffés sur des jeunes semis de 3 mois afin d'être placés en conservatoire de clones, puis multipliés par bouturage horticole classique selon la méthode décrite par CAUVIN.



Greffe en placage avec lanière ("angevine")

• • • • • • • • • • • • •

Mais le coefficient de multiplication de ces procédés étant assez lent, nous avons eu recours à la technique de bouturage "in vitro" pour passer à une propagation à l'échelle commerciale dans l'année qui suit la sélection de l'ortet.
Pour cela, directement sur l'ortet en place en pleine terre, on a prélevé des rameaux axillaires à différents niveaux. Après désinfection pendant une à deux minutes à l'Ethanol concentré à 70 % et en présence d'un mouillant, puis à l'Hypochlorite de calcium à 10 % pendant 7 à 15 minutes selon l'état de lignification du matériel végétal, et enfin rinçage 2 ou 3 fois à l'eau stérile, les explants furent introduits en culture primaire dans les deux milieux décrits ci-dessous :

Eléments	Milieu 1	Milieu 2
KH_2PO_4	170	170
$MgSO_4$ $7H_2O$	370	370
NH_4NO_3	1650	1650
$CaCl_2$ $2H_2O$	146,6	146,6
KNO_3	1900	1900
$FeSO_4$-$7H_2O$	27,85	27,85
Na_2EDTA	37,25	37,25
$NuSO_4$ $4H_2O$	22,3	22,3
$2nSO_4$ $7H_2O$	8,6	8,6
$CuSO_4$ $5H_2O$	0,025	0,025
$AlCl_3$	0,025	0,025
KI	0,83	0,83
H_3 BO_3	6,2	6,2
Na_2MoO_4 $2H_2O$	0,025	0,025
Adenine Salfate		
NaH_2PO_4		
Glutamine		
Thiamine Hcl	10	10
Mesoinositol	100	100
Kinetine		
BAP		1
AIA		
ANA		0,001
Saccharose	30000	30000
Charbon actif	0,1 à 2 %	

-La composition de ces milieux est en mg/l.

Les taux d'infection ont varié entre 20 et 50 % selon les clones.
Le développement des bourgeons axillaires présents sur le noeud et l'allongement des tiges herbacées a nécessité plusieurs subcultures.

Une bonne "réactivité" fut obtenue par passage alterné de quatre semaines environ sur la séquence de milieu 2 ⟶ 1 et ainsi de suite. Le milieu 2 permet une stimulation des bourgeons axillaires qui sont allongés par passage sur 1. Les tiges herbacées obtenues ne sont fractionnées et donc utilisées dans la phase de multiplication qu'à partir du moment où cette réactivité devient excellente.

Lorsque les tiges allongées "in vitro" atteignent de 30 à 50 mm, elles sont découpées en microboutures d'un noeud. Celles-ci sont alors utilisées pour la micropropagation.

Une multiplication par 3 à 5 est ainsi obtenue tous les mois.

3°) Confirmation de la résistance au froid :

Une fois ces hybrides clonés et avant de comparer leurs performances sur le terrain par des tests clonaux, on a tenté de confirmer leurs performances sur leur résistance au froid dans une installation de froid artificiel.

Cette installation comporte 2 chambres froides de même capacité. La première, munie d'un toit en verre, est soumise à la photopériode naturelle. Les clones à tester sont placés par lot de 5 copies enracinées âgées de 6 mois pendant 3 jours à 0° C dans cette chambre dite de durcissement puis ils sont transférés dans la seconde du type PATON dont le toit de cuivre supporte un serpentin raccordé à une arrivée sous pression d'air liquide. Le groupe frigorifique a été réglé pour faire chuter la température de cette chambre de - 3° C par heure. On peut même accélérer le processus en manipulant la vanne d'arrivée de l'air liquide. A partir du moment où la température désirée est atteinte, on stoppe l'arrivée d'air liquide et on laisse remonter la température jusqu'à 0° C suivant le même gradient qu'à la descente.

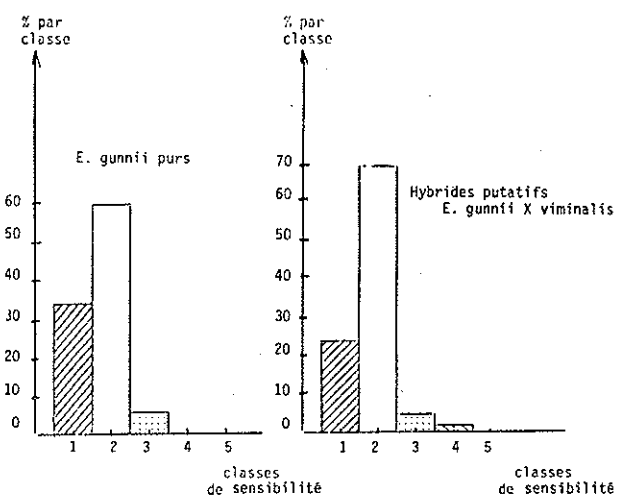
Ce choc thermique est très éprouvant pour les jeunes plants et les essais faits à - 20° C ont provoqué la destruction totale de tous les plants introduits. Il semble donc nécessaire de progresser encore dans le choix des parents pour l'hybridation en choisissant comme mères certains individus d'*Eucalyptus niphophylla*, *Eucalyptus coccifera* ou *Eucalyptus vernicosa*, dont la résistance au froid est supérieure à *Eucalyptus gunnii* et *Eucalyptus pauciflora*.

- Conclusion :

On a conclu de ces premières expériences que l'on pouvait envisager, sans prendre de risques, une extension des plantations d'Eucalyptus en France sous forme de forêt polyclonale cultivée à la condition de commencer par la zone 1 de la carte ci-dessous puis de passer à la zone 2 et ainsi de suite, au fur et à mesure des progrès réalisés dans la sélection de clones pour leur résistance au froid.

On prépare actuellement un programme de développement des plantations pour la zone 2 et on espère parvenir avant 1985 à avoir sélectionné des clones pour la zone 3.

Graphique 1 : Comparaison de la répartition par classes de dégâts au froid pour Eucalyptus gunnii et l'hybride naturel Eucalyptus gunnii X viminalis.



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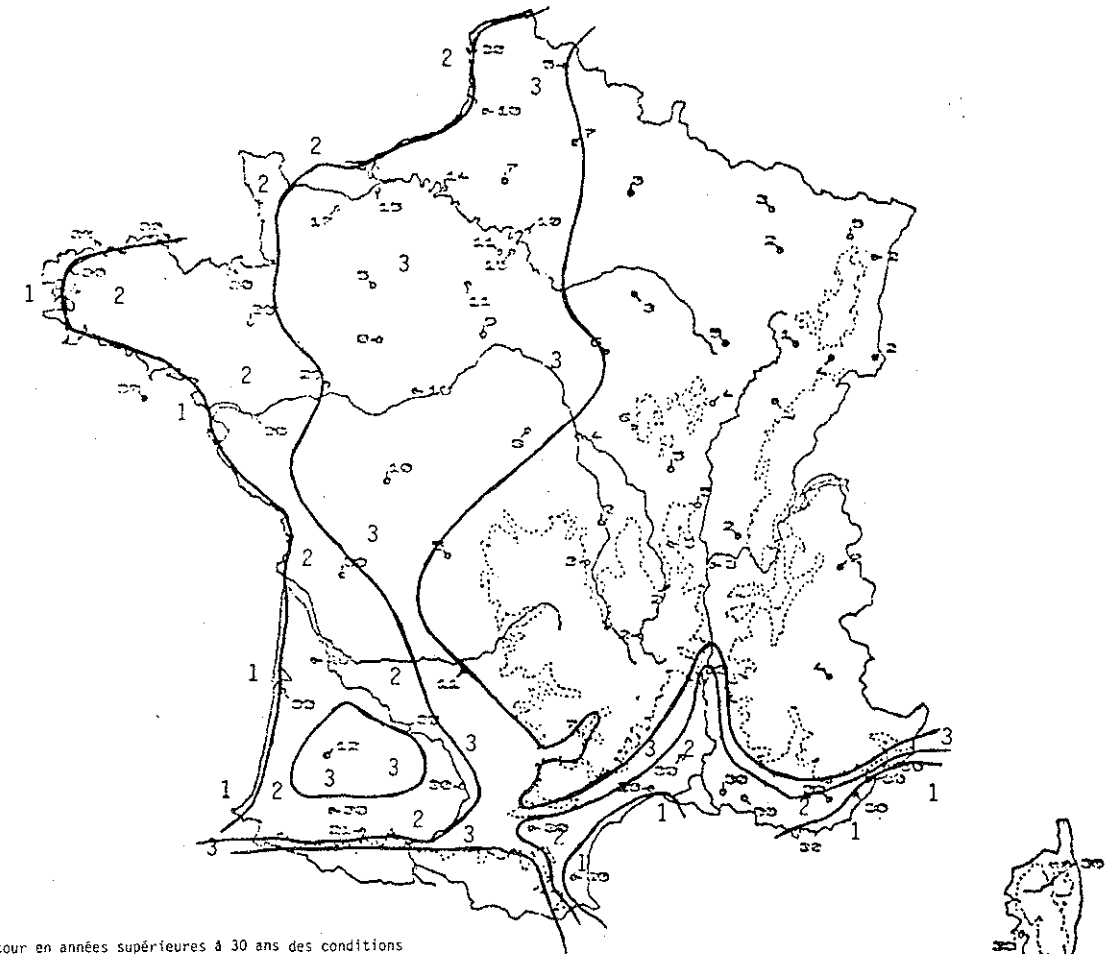

Durées de retour en années supérieures à 30 ans des conditions

1- Températures minimales <- 10° C,
2- Températures minimales <- 15° C,
3- Températures minimales <- 20° C.

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REVERSÃO À JUVENILIDADE E CLONAGEM DE *Eucalyptus urophylla* S. T. BLAKE EM SISTEMAS DE CULTURA DE CÉLULA E DE TECIDO.

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Resumo

Este trabalho sumariza os resultados do trabalho de reversão à juvenilidade e clonagem de árvores selecionadas de Eucalyptus urophylla S.T. Blake em sistemas de cultura de célula e de tecido no Programa de Melhoramento Florestal do Departamento de Silvicultura, ESALQ-USP.

REVERSION TO JUVENILITY AND CLONING OF *Eucalyptus urophylla* S.T. BLAKE IN CELL AND TISSUE CULTURE SYSTEMS.

Summary

This paper summarizes the results of the reversion to juvenility and cloning of selected trees of Eucalyptus urophylla S.T. Blake by the use of cell and tissue culture systems. This work is under development by the Tree Improvement Program of the Departamento de Silvicultura ESALQ-USP.

INTRODUCTION

The vegetative propagation project of the Tree Improvement Program of the Departamento de Silvicultura ESALQ-USP is concerned with cloning physiology, cloning alternatives as well as the efficiency of selected tree cloning.

The cell and tissue culture techniques have been an alternative cloning system due to graft incompatibility, rooting ability and damage of selected trees. The reversion to juvenility, recovery of the morphogenetic capacity, for cloning of selected trees of Eucalyptus urophylla S.T. Blake has been one of the objectives of the use of cell and tissue culture techniques in this project. In order to keep genotypic stability, nodal culture is used for the induction of accessory bud development from the meristematic pads.

MATERIAL AND METHODS

A. Explants

Twigs of the year growth from Eucalyptus urophylla progenies/provenances 13 (6+7) year old grafts are normally sectioned and sterilized by a Benlate 250 g/1 one-hour bath and a NaOCl 1% 30-minutes bath before inoculation.

B. Culture medium

The following culture medium is used:

	mg/1
KNO_3	1000,00
$KH_2PO_4.H_2O$	170,000
$Ca(NO_3)_2.4H_2O$	236,000
$FeSO_4.7H_2O$	27,800
Na_2EDTA	37,300
H_3BO_3	6,200
$CoCl_2.6H_2O$	0,250
$CuSO_4.5H_2O$	0,025
$MnSO_4.H_2O$	1,700
MoO_3	0,144
$ZnSO_4.7H_2O$	3,000
KI	0,750
$MgSO_4.7H_2O$	250,000
menso-inositol	100,000
thiamin HCl	5,000
pyridoxine HCl	0,500
nicotinic acid	0,500
Ca pantothenate	1,000
6-BAP	2,000
sucrose	30 000,000
agar	8 000,000

pH = 5,5 adjusted with KOH or HCl

C. Culture

After inoculation, the explants are grown under a 16/8h 300 lux photoperiod at room temperature.

D. Transfers

Every four weeks, the shoots are isolated and transfered to the same culture medium for shoot mass production. After the 4th transfer, some shoots are transfered to a medium devoid of 6-BAP for rooting test.

RESULTS

A - Problems.

First inoculation usually suffered great losses due to contamination by fungus, mainly Aspergillus and Penicillium. The longer hypochlorite treatments had inhibited development or killed the explants.

Besides the fungal contamination, another major problem had been the browning, phenolic oxidation, of the explant and of the medium. The pre-treatment or the inclusion in the medium of anti-oxidants had disturbed shoot development. A long running water bath pre-treatment had been more efficient than anti-oxidant treatments. A short transfer period also has avoided the browning of the cultures.

B - Multiplication rates and recovery of morphogenetic capacity.

The multiplication rate during the second transfer had been of 9-11 isolated shoots/inoculated shoot. There has been a trend for increasing rates for later and progressive transfers.

During the second transfer, the leaves already present opposite, sessile and rounded juvenile features. The rooting test has shown that the use of auxins induces callus development. The shoots transfered to the rooting medium devoid of auxins, firstly elongate, without lateral bud development, and then start rooting in a period of 8-10 weeks. Rooting of the shoots has shown an incresead through progressive transfers.

In preliminary tests for transfering of in vitro to greenhouse conditions, Eucalyptus maculata plantlets were easily transplanted into a 1:1 sand:vermiculite medium under an intermittent mist system.

CONCLUSIONS

The results of the reversion to juvenility and cloning of Eucalyptus urophylla selected trees through the use of cell and tissue culture techniques is close to success. Further work on biochemical characterization of the juvenile and adult phases and of the reversion process through the peroxidase activity is under development.

The main problem concerning the use of the cell and tissue culture techniques for selected tree cloning is the lack of information on citology, biochemistry and developmental physiology of trees.

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FAST GROWING TREES

TESTES PRELIMINARES PARA PREDIÇÃO DA INCOMPATIBILIDADE NA ENXERTIA DE *Eucalyptus SPP*

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Summary

This work is part of a research program to develop prediction tests - for graft incompatibility in Eucalyptus spp. Preliminary results from this work revealed a tend for higher graft survival in those grafts made with - scions from trees with basic density in the range of 0,40 to 0,50 g/cm^3.

INTRODUÇÃO

Este trabalho é parte de um programa de pesquisa para desenvolver - testes de predição de incompatibilidade na enxertia de Eucalyptus spp. O - estudo apresentatos resultados preliminares de um levantamento da sobrevivência de clones e os relaciona com a densidade básica das árvores matri-/zes. Ainda não é possível especificar qual o grau de similaridade genética necessário entre o epibioto e hipobioto, porém processos metabólicos semelhantes parecem serem mais requeridos do que o grau de parentesco entre os tecidos (TUBBS,1973).GUR (1968), trabalhando com pera/marmelo, obteve provas experimentais que apoiam a teoria da incompatibilidade causada por diferenças fisiológicas e bioquímicas.

MATERIAL E MÉTODO

O enxerto do tipo inglês complicado foi realizado no material vegetativo de Eucalyptus grandis Hill ex Maiden , material este obtido de árvo-/res selecionadas de um povoamento localizado em Mogi Guaçu,SP. Após cinco - meses da instalação do pomar foram feitas observações quanto a sobrevivência dos enxertos e medições de DAP,altura e densidade básica.

RESULTADOS

Os resultados serão resumidamente apresentados na Tabela 1, onde pode-se observar a variação na sobrevivência do enxerto de várias matrizes, com a variabilidade na densidade básica.

TABELA I

Nº da matriz	Densidade básica (g/cm^3)	% de sobrevivência do enxerto
38	0,333	06
36	0,386	18
24	0,390	25
10	0,394	25
16	0,396	18
14	0,397	00
26	0,402	12
34	0,402	18
08	0,402	50
54	0,405	00
33	0,405	18
50	0,406	43
04	0,409	68
22	0,411	37
11	0,412	37
30	0,420	37
43	0,423	00
09	0,427	56
39	0,428	68
23	0,428	25
27	0,429	25
32	0,429	00
19	0,436	18
17	0,437	50
51	0,439	06
40	0,440	12
42	0,441	18
41	0,442	18
25	0,442	31
47	0,445	75
01	0,446	56
52	0,446	18
03	0,448	31
31	0,449	25
12	0,453	37
06	0,453	43
44	0,462	06
37	0,465	37
28	0,467	25
46	0,472	00
29	0,481	56
48	0,502	06
21	0,509	25

Os resultados de sobrevivência foram agrupados em classes em função de um intervalo regular de 0,05 na densidade básica das matrizes.(vide Tabela II).

TABELA II

Intervalo de classe na densidade básica (g/cm^3) *	Média da porcentagem de sobrevivência dos enxertos nos intervalos.
0,30 - 0,35	06,0 %
0,35 - 0,40	17,2 %
0,40 - 0,45	28,1 %
0,45 - 0,50	34,0 %
0,50 - 0,55	15,5 %

*Espécie: Eucalyptus grandis Hill ex Maiden

DISCUSSÃO DOS RESULTADOS E CONCLUSÃO

Os resultados mostram uma tendência de maior sobrevivência dos enxertos feitos com árvores matrizes com densidade que varia de 0,40 à 0,50 g/cm^3.

A densidade sendo um parâmetro facilmente medido, pode-se evitar uniões entre material vegetativo de densidade muito alta ou muito baixa .

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EUCALYPTUS SEED PRODUCTION by FEPASA, State of São Paulo, Brazil.

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Resumo

No presente trabalho os autores tratam da produção de sementes de eucaliptos. Vários aspectos são mostrados: a. a seleção de árvores. São citados os critérios - utilizados na seleção fenotípica de árvores matrizes ou porta-sementes para a produção de sementes; b. modalidade pelas quais a produção de sementes é produzida: 1. por árvores matrizes isoladas, dentro de bons povoamentos e com mais de 50 - anos de idade e originárias de sementes introduzidas da Austrália, em 1913. 2.Há outro tipo de matrizes isoladas, com 30 anos de idade ; também situadas dentro de bons povoamentos. Neste caso, a semente da qual elas provieram foi produzida aqui no Brasil. 3. áreas produtoras de sementes de 1 ha., originárias de plantações - comerciais, após pesados desbastes. 4. areas de produção de sementes especialmente estabelecidas para a produção de sementes, com árvores espaçadas de 10x10m, tais áreas tem de 4 a 8 ha. c. comércio de sementes. Desde 1916, a Fepasa já vendeu cerca de 87 tm de sementes, contudo, nos últimos anos a venda de sementes vem diminuindo. De 1966 até 1975, entre 1,5 a 3,0 tom. de sementes foram vendidas cada ano. d. baseado no total de sementes vendidas as 10 mais importantes espécies de Eucalyptus no Estado de São Paulo são: E.grandis, E.saligna, E.urophylla, E.citriodora, E.tereticornis, E.paniculata, E.robusta, E.maculata, E.camaldulensis e E. microcorys. Atualmente há maior tendência em se plantar as quatro primeiras espécies citadas. e)Atualmente, a Fepasa dispõe de 14 áreas de produção de sementes com 10 diferentes espécies, localizadas em 05 Hortos Florestais de suas propriedades no Estado de São Paulo.

Summary

In the present paper the authors deal with seed production of Eucalyptus. Several aspects are shown: a.Tree selection. The criteria used in phenotypic selection of the nother trees for seed production are pointed out. b. Ways in which seed is produced by isolated mothers trees, inside good stands more than 50 years old from original seed introduced from Australia in 1913. Another way is from isolated mother trees, 30 years old, also inside good stands. In the latter case, the original seeds were produced in Brazil. There are seed production areas of 1 ha originated from comercial plantations after heavy thinnings and seed production areas specially grown for seed production, with trees spaced 10x10 m. Such areas are 4 to 8 ha. Since 1916, the Rail Road Comapny Fepasa has sol near 87 tones seed; however, in later years, the production and selling of seeds os deminishing. From 1966 untill 1975, between 1.5 to 3.0 tones of seed were sol every year; d. Based on seeds sold, the ten important species of Eucalyptus in State of São Paulo are: E.grandis, E.saligna, E.urophylla, E.citriodora, E.tereticornis, E.paniculata, E.robusta, E.camaldulensis and E.micorcorys. Nowadays, special emphasis is put on the first four species cited above. Fepasa has 14 areas for seed production of 10 different species. These are located in 5 Forest Stations in the State of São Paulo

Introduction

Eucalyptus was introduced in Brazil by the Railroad Paulista Co. on a large scale, specially in the State of São Paulo, in the beggning of this century. Soon it become evident that adequate species for almost all purposed could be found within this genus. The prodigious rapid growth, the large use of this genus for fuel, posts, lumber, etc., make Eucalyptus the most important economic hardwood for forestation and afforestation in Brazil.

The Paulista Railroad Co., today integrated in a big consortium with all railroads of the State of São Paulo, identified by the abbreviation of FEPASA (Ferrovia - Paulista S.A.), has taken from the beginning the hard task of producing of the Eucalyptus seeds needs in Brazil. A large amount of knowledege and experience in this field accumulated (Navarro de Andrade, 1961).

In this paper the authors discuss how seed production of Eucalyptus is done at present time and the problems that have to be faced, specially regarding: a) criteria of tree selection, b)handling mother tree plants and c) seed marketing.

Criteria for selection

At first the best stands are selected and all trees are measured at DBH height. In order to facilitate the calculations, the data are arranged in classes of 03 cm and we calculate the arithmetic, the standard error and other statistics.

As a basis for selection we take the arithmetic mean plus one or two times the standard error, depending on the goal of selection. All trees that have a diameter gœater than the set value were selected as potential mother trees.

Second, we go back to the stands and look at the ones which have been selected in the lab, in order to certify that they have a high degree of desirable caracteristics and no visible defects (bifurcation, twisting, large branches,etc) also health .

All tree selection will depend on further analysis of the botanical characteristics of the species and the properties of the wood such as specific gravity and dimensions of the fibers.

Finally, if the trees were approved according to these four tests, they were considered as selected mother trees.

Since Eucalyptus have not been submitted to selection and according to its system of reproduction by cross-polination the results of the selection by progeny test were striking.

A comparision carried out in our Experimental Station at Rio Claro, State of São Paulo, between two types of seeds of E.saligna Sm, one from open pollinated trees and others from plus trees showed the fire wood production after 07 years was respectivally of 19417m^3/ha and 24675m^3, giving and amount of 27% more in favour of the second type of seed (Navarro de Andrade, pag.420, 1961).

Seed Production

The Forest Department of FEPASA has the following possibilities for seed collection:

1. Selected trees 50 or more years old. These trees were planted with original seed from Australia, distributed in eighteen Forest Stations belonging to FEPASA located in the State of São Paulo. Most of such trees are sufficiently isolated (more than 500 meters from trees of other species)to prevent undesirable crosses. These mother trees are maintained as potential gene reserve.
2. Selected trees, 30 or more years old.: These trees were planted with selected seeds produced by the selected trees in item 1. Later on, the Department of Genetics selected new mother trees. Here, the same characteristics of item 1 were folowed. After the selection, all undersirable trees were removed. Also, these stands are isolated from others more 500 meters, in order to prevent spurious crosses.
3. Seed production areas originating from commercial plantations: in very good stands, planted with selected seed, areas of around 1 ha were chosen reduced to 100 best trees. Here, the spacing is around 10x10 meters. Around these seed production areas a large strip of trees of the same genetic origin, for protection against foreign pollen.
4. Seed production areas planted for seed production. Here, the trees were planted at a spacing of 10x10 meters. In each spot four individuals were planted and later the best one was left and the others eliminated. Generally these seed production areas have area between 4 and 8 ha and are protected by strips with the same seed from the original mother trees.

Since the Genetic Department was created in 1942, a total od 9421 trees have been selected as mother trees. From this total, 5739 mother trees have been located in the 14 seed production areas and 3862 in others areas on as isolated mother trees.

Table 1 presents the characteristics of the 14 seed production areas, covering the more important commercial species for the State of São Paulo. The estimated seed production is calculated as 4180 kg. The column with heading "No. of mother trees" indicates the trees that were taken to establish the population of a given seed production area. The four last columns present the dendrological data of the plantation.

Marketing of Seeds

In table 2 is given seed production of FEPASA during the period 1961 until 1979

for the more important economic species in the States of São Paulo.
From this table we see, the most important species is E.grandis followed by E. saligna (corresponding to 60% of the total seed sold). Next comes E.urophylla (ex-alba) and E.citriodora (with 24% of the total) followed by E.tereticornis, E.paniculata, E.robusta, E.camaldulensis, E.maculata and E.microcorys (corresponding to 14%). The other 2% is made up of 28 species that are not planted on a large scale.
In the second part of the table is given the year that a certain species has its maximum seed production. Again, E.grandis has the greast value in 1973, when about 3,5 t were sold. During the period 1961 to 1979 around 38 t were sold. However since the initial sale of seeds in 1916, until the present FEPASA (former Paulista Railroad) sold near 87 t of eucalypt seed.
We sell types od seeds: a)Mixture of fertile and infertile seeds; b) fertile seeds.
Owing to their small size, it is a current practice to sow a mixture of fertile and infertile seeds and for this reason the bulk of our production is sold in this way. The seeds are packed in cloth bags of 0,5; 1; 2; 3; 5; 10 and 60 kg. Some nurseries prefer to sow only the fertile seeds and for this class of consummers we sell packages with 10000 seeds, sufficient to sow one square meter. We use sieves that can separate the seeds. Also, an electrical seed blowing machine is used, since it can perform the same work.

Harvesting of seeds

Seeds are collected by men that the tree with the help of tree climbing spurs and protected by safety belts. Swedish ladders are seldom used. The small branches are cut with tree trimmers. When they fall tothe ground, the fruits are picked up, put in bags and transported to the dryers. Each bag receives card for identification.
In table 3 we give the period of fruiting for most commercial species at Rio - Claro, State of São Paulo.
Generally, for the majority of the species, the seeds are shed from the trees when the fruits are completely ripe. So it is necessary to harvest the fruit before shedding. Only for two species, E.citriodora and E.maculata are the seeds not shed from the ripe fruits, and, if necessary, the harvest of fruits can be postponed until the second year.
The general policy of collecting seed from a selected tree is to pick up fruits from two thirds of the crown every 3 years. On the average a good tree produces 1 kg. seed per year. In certain species, and depending on the season and local conditions, much more seed can be harvested.

Processing of seeds

Drying of fruits - Since the fruits are harvested near maturation, it is necessary to dry them, in order to open the valves of the fruits and allow the seed to be shed.
A few years ago, especially when enough labour was not available, fruits were dried in sunshine, on flat, cemented areas, or in special cement bins. Generally it takes three days of sun exposure to dry the fruits and cause seed shedding. This process is very expensive.
Another process that we still use consists of placing the fruits in special wagons, provided with 6 shelves measuring 0,95x0,15 meters for exposing them to sunshine. During the night or on rainy days the wagons are placed a roof. The capacity of the wagons is near 50 kg. of fruits. It takes 03 days of exposure to sun.
At the present time we are utilizing electrical dryers, that can perform the task very and quickly. The capacity of the dryers is 80 kg. of fruits and the time is 24 to 36 hours, with a temperature of 45°C. The process of drying the fruits by this method is cheaper than the others.
Cleaning the seeds - After the fruits have shed the seeds, it is necessary to set it apart from the fruits. Some years ago this was done by hand, using special sieves. Owing to the high cost of the operation we now have vibratory machines. Capacity is 100 kg. of fruits and seed per hour, producing near 10 kg. of clean seed.

Types of seeds

Generally the seeds of Eucalyptus vary greatly in size, and apart from a few species with quite large seeds, they can be considered as being small in comparision with the seed of other forest trees.
In any single capsule, only a few seeds are fertile. The seeds are always mixed with unfertilized ovules and abnormal ovules known as "chaff". In table 4 are given in mm the dimensions of seeds of several species of Eucalyptus growing in the State of São Paulo.
Generally only few seeds ripen in each loculus and in some cases they are located at the top of the capsules and in other cases in the bottom of the capsule. This last possibility is found in E.citriodora.
The shape and colour of eucalypts seeds vary between very wide limits. Also, the colour varies according to the state of ripeness and according to whether they are fertile or sterile. However, in certain species, the colour of fertile seed is characteristics: in E.camaldulensis the colour is yelow, in E.microcorys brown and in E.citriodora and E.maculata black.

TABLE 1 - Characteristics of seed production areas of FEPASA

Commercial Plantations	Eucalyptus	Location SP	Planted in	Spacing m	Area Ha	Nº of trees for seed production	Estimated seed production - kg	Nº of mother trees *	Age years	D.B.H cm	Height (Mean) m	Basal area m^2
Commercial plantations thinned												
1	grandis	Loreto	1949	2 x 2	37.60	300	300	-	34	35.0	46.5	138.68
2	grandis	Rio Claro	1949	2 x 2	4,25	100	100	-	34	35.0	46.5	138.68
3	microcorys	Rio Claro	1919	3 x 4	1.00	66	60	-	34	33.0	31.5	59.05
4	paniculata	Rio Claro	1919	3 x 4	10.18	119	100	-	34	30.0	28.6	54.40
5	saligna	Loreto	1947	2 x 2	44.08	400	400	-	34	31.3	38.5	96.60
6	saligna	Rio Claro	1945	2 x 2	7.42	100	100	-	34	31.3	38.5	96.60
Planted for seed production												
1	citriodora	Aimorês	1944	10 x10	10.40	1040	390	10	34	27.0	30.6	49.96
2	grandis	Rio Claro	1968	10 x 2	3.60	740	200	2	34	31.3	38.5	138.68
3	punctata	Bebedouro	1947	10 x10	4.00	366	400	4	34	28.5	34.8	67.23
4	resinifera	Guarani	1946	10 x10	4.80	100	100	8	34	29.5	58.8	60.21
5	robusta	Rio Claro	1960	10 x10	4.34	434	250	7	34	27.3	24.8	66.91
6	saligna	Aimorês	1944	10 x10	8.00	800	600	10	34	31.3	38.5	96.60
7	tereticornis	[illegible]	1944	10 x10	4.00	400	400	10	34	32.6	33.3	47.76
8	urophylla	Camaquã	1944	10 x10	8.00	800	780	10	34	27.9	32.0	78.47
Total 14	10	5	-	-	- -	5.739	4.180	-	-	-	-	-

(*) Most of the mother trees have been choosen by progeny test (one-parental test): *E.tereticornis*=10 mother trees; *E.urophylla*=9 mother trees; *E.citriodora*=8 mothers trees. For others species, the number of tested mother trees is smaller that the three above mentioned.

TABLE 2 - Eucalyptus seed production by Ferrovia Paulista S/A - 1961 to 1979.

Classification	Species	Seed prodtuction 1961 to 1979		Maximum seed produtction		
		kg	%	year	kg	%
1	grandis	12,030.365	31.60	1973	3,564.600	72.83
2	saligna	11,010.771	28.92	1972	1,168.700	34.11
3	urophylla	4,616.340	12.12	1969	706.181	26.05
4	citriodora	4,209.943	11.06	1961	801.000	21.24
5	tereticornis	1,694.653	4.45	1964	437.800	22.89
6	paniculata	1,317.071	3.46	1961	461.100	12.23
7	robusta	1,083.833	2,85	1967	232.900	13.58
8	camaldulensis	708,419	1.86	1975	477.150	21.85
9	maculata	405,708	1.18	1965	170.400	14.48
10	microcorys	183.190	0.48	1967	71.600	4.18
11	botryoides	168.485	0.44	1964	40.500	2.12
12	propinqua	116.217	0.31	1964	42.100	2.20
13	punctata	105.133	0.28	1961	44.900	1.19
14	resinifera	93.965	0.25	1963	44.200	1.99
15	longifolia	62.014	0.16	1961	42.900	1.14
16	triantha	55.205	0.14	1963	31.000	1.39
17	pilularis	19.764	0.05	1961	9.600	0.25
-	Total	33,926.076	99.61	-	-	-
Twenty	one no commercial species	147.136	0.39	-	-	-
	Total	38,073.212	100.00	-	-	-

TABLE 3 - Period of frutification at Rio Claro for the most important species of eucalypts in the State of São Paulo. Years of observation 1953-54-55-68.

SPECIES	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
E.camaldulensis	x - - -	x x - -	x x - -	x x x -	- x - -	- - - -
E.citriodora	x x x x	x x - -	x x - -	x - - -	- - - -	x x - -
E.grandis	- - x x	x - x -	x x x -	x - x x	- x x x	- x x x
E.maculata	- - - -	- - - -	x - - -	x - - -	- - - -	x x - -
E.microcorys	- - x x	- - - x	- - x -	- - - -	x - - -	- - - -
E.saligna	x x x -	x x x x	x x x x	x x x x	x x x x	x x x x
E.tereticornis	x x x x	x - - -	- - x -	x - x -	- x x -	x x x -
E.urophylla	x x x x	x - - -	- - x -	x - x -	- x x -	x x x -

SPECIES	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
E.camaldulensis	x x - x	x x x -	- x - -	- x - -	- - x -	- x - -
E.citriodora	- x x x	- x x -	- x x -	- - x -	x x x -	x - x -
E.grandis	- - x x	x x x x	x x - x	x x x x	x - x x	- x x x
E.maculata	- x - -	x - x -	x x - -	- - x -	x x - -	- x - -
E.microcorys	- - x -	- - - -	x x - -	- - - -	- - x -	- - - -
E.saligna	x x x x	x x x x	x - x x	- x x x	- x - x	- x x x
E.tereticornis	- x x -	- - x -	- x x -	- x x -	x - x x	x - x -
E.urophylla	x x x x	x x x x	x x x x	x x x x	x x x x	x - x x

TABLE 4 - Dimentions of the seeds of the main species of eucalypts.

F = Fertile - S = Sterile - O = Aborted ovules

SPECIES		LENGTH mm	WIDTH mm
E.botryoides	- F	1,12 - 1,26	0,94 - 0,96
	- S	1,08 - 1,16	0,50
	- O	0,53 - 0,57	0,45 - 0,57
E.camaldulensis	- F	0,98 - 1,12	0,94 - 1,06
	- S	1,63 - 0,67	0,48 - 0,50
	- O	0,61 - 0,67	0,51 - 0,53
E.citriodora	- F	3,97 - 4,21	2,14 - 2,24
	- S	0,98 - 2,08	0,55 - 0,59
	- O	2,39 - 2,40	1,59 - 1,61
E.maculata	- F	4,88 - 5,08	2,14 - 2,24
	- S	2,33 - 2,43	0,56 - 0,62
	- O	2,49 - 2,51	1,48 - 1,52
E.microcorys	- F	1,88 - 2,04	1,08 - 1,12
	- S	0,69 - 0,75	0,5
	- O	0,52 - 0,54	0,5
E.propinqua	- F	1,03 - 1,07	0,77 - 0,83
	- S	1,23 - 1,31	0,46 - 0,48
	- O	0,71 - 0,77	0,54 - 0,56
E.punctata	- F	1,45 - 1,55	1,09 - 1,15
	- S	1,83 - 1,93	0,50 - 0,51
	- O	0,62 - 0,68	0,93 - 0,94
E.resinifera	- F	0,97 - 1,01	0,79 - 0,85
	- S	1,78 - 1,90	0,50
	- O	0,72 - 0,78	0,55 - 0,57
E.robusta	- F	1,04 - 1,10	0,67 - 0,73
	- S	1,84 - 1,96	0,56 - 0,62
	- O	1,01 - 1,07	0,83 - 0,91
E.saligna	- F	1,15 - 1,23	0,90 - 0,98
	- S	0,18 - 1,26	0,50
	- O	0,59 - 0,63	0,55 - 0,57
E.tereticornis	- F	1,06 - 1,12	0,86 - 0,90
	- S	1,74 - 1,84	0,48 - 0,49
	- O	0,92 - 0,96	0,59 - 0,63
E.urophylla	- F	0,93 - 0,99	0,78 - 0,84
	- S	1,62 - 1,70	0,44 - 0,46
	- O	0,90 - 0,94	0,90 - 0,94

Some eucalypt seeds have prominent wings. In some seeds, the testa is very thin and in some cases it is hard and quite brittle. However, in the majority of species it is usually fairly soft. The surface of the testa sometimes shows sculpturing (Penfold and Willis, 1961).

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PROPAGAÇÃO VEGETATIVA DE *Eucalyptus* ATRAVÉS DE CULTURA DE TECIDOS.

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Resumo

O trabalho apresenta um método de propagação vegetativa através da cultura de tecidos de várias espécies de eucalyptus. Discute-se também as vantagens e desvantagens da cultura de tecidos em relação ao método de estaquia. Também discute-se as aplicações futuras da cultura de tecidos para propagação de espécies de eucalipto.

VEGETATIVE PROPAGATION OF *Eucalyptus* BY TISSUE CULTURE.

Summary

A method for the vegetative propagation of several eucalypt species by means of tissue culture is presented. The advantages of vegetative propagation by tissue culture over propagation by cuttings, and possible future applications of tissue culture are discussed.

INTRODUCTION

Eucalypts like most other tree species have long generation times, are grown in rotations lasting from several years to decades, and are difficult to cross-pollinate in large numbers. All of these factors make tree breeding much more difficult than the breeding of annual crop plants. Controlled-crosses between and within species are standard methods of incorporating desirable genes into our annual crop plants. Controlled-crosses between eucalypt species are also known to result in very large gains in growth rate (Chaperon 1977; Campinhos Jr and Ikemori 1977) but the difficulty and cost of producing large quantities of hybrid seed prevents the growing of hybrid seedlings in plantations.

The vegetative propagation of selected clones (including selected hybrids) enables the cost of breeding and selection to be spread over many individuals. Conventionally, the vegetative propagation of eucalypts for plantations has been by cuttings derived from seedlings, or from basal epicormic shoots of mature trees (Hartney 1980). Tissue culture offers an alternative method of vegetatively propagating eucalypts and has several advantages over cuttings : the multiplication rate is usually greater, pests and diseases are not a problem during culture, and the techniques are more reliable as greater control of physical and chemical factors can be achieved.

In this article the vegetative propagation of several eucalypt species by tissue culture is reported and the potential applications of tissue culture to tree breeding are discussed.

METHODS

Seeds were surface sterilised by washing them several times in tap water, immersing in 70% ethanol for 1 minute followed by 15 minutes in 10% Miltons solution (1% NaOCl, 16.5% NaCl). The seeds were rinsed once in sterile distilled water and placed onto a sterile medium (0.8% agar in distilled water).

Shoots of uncontaminated seedlings were placed onto medium I (Table 2, Hartney and Barker, in press) to induce shoot multiplication. The shoots produced on medium I were divided and subcultured to fresh medium every 3 weeks (4 or 5 shoots per culture tube).

Cultures were kept in a growth cabinet with a constant air temperature of 25°C, a photoperiod of 8 hours (0800 to 1600) and illuminated by florescent tubes (Sylvania, Gro-Lux, WS, VHO) giving an intensity of 100 $\mu E\ m^{-2} s^{-1}$ at the level of the culture tubes.

The shoots were induced to form roots by subculturing them onto medium II (Table 2, Hartney and Barker, in press). After 2 to 3 weeks on medium II the plants were hardened by removing them from the culture tubes and placing them into small pots containing an equal mixture of Perlite and Vermiculite. The plants were kept under high humidity conditions (a plastic cover) in a shaded glasshouse for 3 weeks. The plants were then gradually exposed to full sunlight and the plastic cover removed.

RESULTS

The shoots of several eucalypt species (Table 1) growing on medium I formed a large number of axillary shoots. A 3-fold multiplication rate (at least) of shoots was achieved within 3 weeks which represents a theoretical production rate from a single shoot of about 1.3×10^8 shoots per year.

*Eucalyptus camaldulensis**, *E. curtisii*, *E. ficifolia*, *E. grandis* and *E. obtusiflora* had a high rooting frequency (over 70%) on medium II (Table 1) but *E. globulus* subsp. *bicostata* and *E. regnans* did not have a high rooting frequency indicating that modifications to the medium and physical environment may be necessary for these, and possibly other, eucalypt species.

Table 1. Response of eucalypt species on media

Species	Shoot multiplication rate on Medium I	Rooting response on Medium II*
E. camaldulensis	at least 3-fold	+
E. curtisii	"	+
E. ficifolia	"	+
E. globulus subsp. *bicostata*	"	-
E. grandis	"	+
E. nitens	"	?
E. obtusiflora	"	+
E. oreades	"	?
E. pauciflora	"	?
E. regnans	"	-

* + Rooting frequency of shoots over 70%
 - Rooting frequency of shoots less than 30%
 ? Not tested on medium II.

For most species, over 70% of the plants survived transfer from the culture tubes to pots in a glasshouse. The plants are very sensitive to water stress during the first 2-3 weeks after transfer to pots and care is required to ensure that high humidity conditions are maintained (mist and/or plastic cover). No abnormalities have been noted in any of the plants derived from tissue culture. Some of the trees are now over 2 years old.

DISCUSSION

The vegetative propagation of eucalypts by the culture of shoots can provide an alternative to the rooting of cuttings.

Chaperon (1977) found that the cost per hectare of plantations derived from cuttings was less than the cost per hectare of plantations derived from seedlings. The greater uniformity and vigour of the cuttings allowed planting at wider spacings than the seedlings. The cost of propagation by tissue culture is not necessarily greater than the cost of propagation by cuttings for the following reasons:

1. The cost of the media is small (less than Aust.$0.05 per plant).
2. Once the cultures are established virtually no maintenance is required between subculturing. Cuttings, on the other hand, require regular applications of water, nutrients and chemicals to control pests and diseases.
3. A large number of cultures can be maintained in a small area (960 culture tubes per m^2 in our case).
4. The cultures can be grown in simple controlled environment facilities (such as a shaded glasshouse or a low light intensity room).

The media presented in Table 2 are not the only media suitable for the vegetative propagation of eucalypts as other authors (Lakshmi Sita 1979; Lakshmi Sita and Vaidyanathan 1979; Durand and Boudet 1979) have successfully propagated some eucalypts on different media.

Several adult eucalypts have been propagated by tissue culture of shoots : *E. grandis* (Cresswell and Nitsch 1975; Durand-Cresswell and Nitsch 1977); *E. ficifolia* (Barker *et al.* 1977; deFossard 1978) and *E. dalrympleana* (Durand-Cresswell and Nitsch 1977). This means that there is a potential for the vegetative propagation of adult trees. However, the vegetative propagation of seedlings (such as controlled-crosses or hybrids between species) can be applied immediately to commercial forestry. Ramets of selected clones could be established in field trials and the results of these field trials could form the basis of culling the original ortets. Clones can be maintained as hedged seedlings or in culture over several years and still serve as a source of material for vegetative propagation (Hartney 1980). Such a method of tree improvement would take far less time than the conventional seed-orchard strategy. The experimental verification of genotype x environment interaction, by planting the same clones in different environments, is another important application.

E. citriodora has also been propagated from callus cultures (Aneja and Atal 1969; Lakshmi Sita 1979). The ability to vegetatively propagate from cell cultures offers a new dimension to tree breeding as in several other crop plants it has been possible to select *in-vitro* for disease resistance, and tolerance to salinity and various chemicals. Cell cultures also offer an additional source of genetic variation (see reviews by Reinert and Bajaj 1977). The production of haploid plants and somatic hybrids are other future possibilities.

Table 2. Media for the multiplication of shoots and the rooting of shoots

Constituent	Concentration	
	Medium I	Medium II
NH_4NO_3	10mM	5mM
KNO_3	10mM	5mM
NaH_2PO_4	1mM	0.5mM
$CaCl_2$	2mM	1mM
$MgSO_4$	1.5mM	0.75mM
H_3BO_3	50μM	25μM
$MnSO_4$	50μM	25μM
$ZnSO_4$	20μM	10μM
$CuSO_4$	0.1μM	0.05μM
Na_2MoO_4	0.1μM	0.05μM
$CoCl_2$	0.5μM	0.25μM
KI	2.5μM	1.25μM
$FeSO_4$	100μM	50μM
Na_2EDTA	100μM	50μM
Na_2SO_4	650μM	325μM
IBA*	5μM	5μM
BAP*	1.5μM	0
Kinetin	1.5μM	0
Inositol	600μM	0
Nicotinic Acid	40μM	0
Pyridoxine. HCl	6μM	0
Thiamine. HCl	40μM	0
Biotin	1μM	0
D-Ca-Pantothenate	5μM	0
Riboflavin	10μM	0
Ascorbic Acid	10μM	0
Choline Chloride	10μM	0
L-Cysteine. HCl	120μM	0
Glycine	50μM	0
Sucrose	120mM	60mM
Agar	$8g.l^{-1}$	$8g.l^{-1}$

The pH of the media was adjusted to 5.5 prior to dispensing 10 ml to each screw cap polycarbonate tube (80 mm x 25 mm). The media was autoclaved at 103 kPa for 15 minutes.
* Abbreviations: IBA = Indole-3-butyric acid; BAP = 6-benzylaminopurine

*Nomenclature of the species is as per Chippendale 1976

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EFEITO DA PROCEDÊNCIA EM ENXERTIA DE *Eucalyptus dunii* MAIDEN POR GARFAGEM EM FENDA CHEIA.

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Resumo

Enxertando 22 árvores selecionadas em talhões experimentais com 7 anos de idade, de três procedências de Eucalyptus dunnii Maiden, por garfagem em fenda cheia, observou-se a existência de variabilidade na porcentagem de enxertos em desenvolvimento nas avaliações realizadas aos 35, 60 e 96 dias após a enxertia, em função da procedência. Observou-se, também, que a variação individual entre clones de uma mesma procedência foi superior à variação entre médias de procedências.

Em função dessas observações recomenda-se atenção especial aos estudos da interação entre enxerto e porta-enxerto.

PROVENANCE EFFECTS ON *Eucalyptus dunnii* MAIDEN SPLICE GRAFTING.

Summary

A total of 22 seven-year old trees of Eucalyptus dunni Maiden were selected from three provenances and splice grafted. Results from analyses carried out 35 60 and 96 days after grafting revealed a variability in the percentage of developing grafts between the three provenances. However, variations among clones of the same provenance were higher than variations between provenances. These results reveal the need for more intensive rootstock/scion interaction studies.

Introdução

Dentre as espécies de Eucalyptus potenciais para o reflorestamento no Brasil, o Eucalyptus dunnii Maiden vem se destacando na região tropical e de forma surpreendente na região subtropical com ocorrência de geadas.

O principal fator limitante para o emprego dessa espécie em larga escala é a falta de sementes, tanto na origem como nas parcelas introduzidas em várias localidades. Esse problema poderá ser solucionado através de implantação de pomares clonais em regiões apropriadas, tal como Lages-SC, onde se observou frutificação já a partir do 5º ano de idade.

Para a constituição desses pomares é necessário que as árvores selecionadas nos talhões e parcelas experimentais, espalhadas pelo País, sejam concentradas por propagação vegetativa.

Esse ensaio preliminar teve como objetivo fornecer subsídios para o conhecimento da propagação vegetativa por enxertia através da avaliação do comportamento, na fase de viveiro, de enxertos de árvores selecionadas de procedências conhecidas, executadas por garfagem em fenda cheia.

Materiais e Métodos

A enxertia pelo método garfagem em fenda cheia foi realizada em 20 de outubro de 1977, no viveiro do Departamento de Silvicultura da ESALQ-USP, em porta-enxertos da mesma espécie com altura média de 80 cm e diâmetro médio na região do colo de 0,7 cm.

Os propágulos foram coletados de árvores selecionadas em talhões experimentais com 7 anos de idade, da Duraflora S/A, em Lençóis Paulista-SP.

As procedências das sementes que deram origem aos talhões estão apresentadas na Tabela 1.

Resultados e Discussões

A porcentagem de enxertos em desenvolvimento em função da procedência da semente, das árvores selecionadas e do período de avaliação, estão apresentadas na Tabela 2.

Tabela 1. Procedências das sementes das árvores selecionadas de E. dunnii propagadas por garfagem em fenda cheia.

Table 1. Selected E. dunnii tree provenances propagated by splice grafting.

Procedência Provenance		Latitude	Longitude	Altitude
5663	Urbenville-NSW	28º27'	152º29'	600 m
9245	Moleton- NSW	30º10'	153º00'	304 m
9370	Acacia Creek-NSW	28º23'	152º19'	780 m

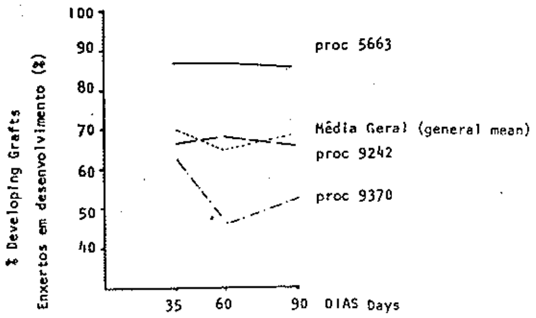

Figura 1. Porcentagens de enxertos em desenvolvimento em função da procedência das sementes dos propágulos e das épocas de avaliação.
Figure 1. Percentage of developing grafts in function of the scion provenance and of the evaluation date

Tabela 2. Porcentagens de enxertos em desenvolvimento em função da procedência da semente, da árvore selecionada e da data de avaliação.
Table 2. Percentage of developing grafts in function of the scion provenance, of the selected tree and of the evaluation date.

Procedência Provenance	Nº da Árvore Tree Nº	Nº de enxertos Nº of grafts	AVALIAÇÃO - EVALUATION 35 dias days	60 dias days	96 dias days
5663	1	30	76,6	80,0	80,0
	2	30	100,0	93,3	93,3
	3	30	90,0	83,3	83,3
	4	30	70,0	80,0	80,0
	5	30	100,0	100,0	93,3
	Média mean	30	87,32a	87,32a	85,98a
9242	6	30	56,6	60,0	56,6
	7	30	83,3	86,6	70,0
	8	30	26,6	26,6	23,3
	9	30	96,6	96,6	86,7
	11	30	60,0	70,0	60,0
	12	30	70,0	70,0	73,3
	13	30	86,6	90,0	86,7
	17	20	30,0	23,3	40,0
	19	20	85,0	100,0	95,0
	21	20	85,0	53,3	65,0
	Média mean	27	67,97b	67,64b	65,66b
9370	10	30	56,6	56,6	46,7
	14	30	70,0	70,0	70,0
	15	30	20,0	13,3	10,0
	16	20	80,0	53,3	65,0
	18	20	70,0	60,0	60,0
	20	20	75,0	50,0	80,0
	22	8	62,5	16,6	37,5
	Média mean	18	62,01b	45,69c	52,74b
Média Geral General Mean	—	26	70,47	65,13	69,17

Obs: As médias das procedências seguidas pela mesma letra, em cada coluna não diferem estatisticamente pelo Teste X^2 ao nível de 5%.

Note : The mean for provenances followed by the same letter in each column, did not statistically differ by the X^2 test at the 5% level.

Analisando os dados da Tabela 2 e Figura 1, observou-se que o número médio de enxertos em desenvolvimento varia em função das procedências, sendo que os clones da procedência Urbenville-NSW apresentou o melhor resultado e os clones da procedência Acacia Creek-NSW, o pior resultado, nas três avaliações.

Esses resultados, apesar de serem baseados em médias, representam informações práticas importantes no dimensionamento dos trabalhos de enxertia. No entanto, deve ser salientado que as variações individuais entre clones de uma mesma procedência são superiores às variações entre médias das procedências.

Essas informações indicam que a interação entre o propágulo e o parta-enxerto é um fator importante e que merece atenção especial em trabalhos dessa natureza.

Conclusões

a) As porcentagens médias de enxertos em desenvolvimento variaram em função das procedências, no entanto, as variações individuais entre clones de uma mesma procedência foram superiores as variações entre médias de procedências.

b) A média geral obtida de 69,17% de enxertos em desenvolvimento para o Eucalyptus dunni propagados por garfagem em fenda cheia aos 96 dias, mostram a potencialidade do emprego do método, sendo necessário, no entanto, o acompanhamento do comportamento dos mesmos durante alguns anos no campo, para o emprego em larga escala.

PROPAGAÇÃO VEGETATIVA DE PROGÊNIES DE *Eucalyptus urophylla* S. T. BLAKE POR BORBULHIA EM JANELA ABERTA.

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Resumo

Neste trabalho preliminar foram propagadas 17 árvores de Eucalyptus urophylla S.T. Blake, selecionadas em 7 famílias de meio-irmãos, pelo método borbulhia em janela aberta, visando estudar a variação em função do enxertador, da família e do indivíduo.

Os resultados obtidos aos 90 dias após a enxertia mostram que não houve influência do enxertador e que existem variações entre e dentro de famílias. Como a variação dentro de famílias foi superior, recomenda-se que os porta-enxertos sejam controlados geneticamente, em trabalhos semelhantes.

PATCH BUDDING OF *Eucalyptus urophylla* S. T. PROGENIES.

Summary

The objective of this preliminary work was to study the variation in the patch budding of Eucalyptus urophylla S.T. Blake progenies in function of the grafter, family and tree. Seventeen trees of 7 selected half-sib families were used in this work.

Analyses taken 90 days after budding revealed that graft survival was not affected by the grafter, and that there was wide variations among and within families. As variations within families were greater, genetic control of rootstocks is recommended for future tests of this nature.

Introdução

O sucesso da propagação vegetativa por enxertia depende de uma série de fatores tais como: as condições ambientais, o método, a habilidade do enxertador, a espécie, o indivíduo e a manifestação da incompatibilidade.

De acordo com LIBBY (1974) existe evidência de que, em muitas espécies florestais, a incompatibilidade está sob forte controle genético ou pelo menos pela expressão de uma interação entre enxerto e porta-enxerto. Já DAVIDSON (1974), estudando vários tipos de enxertia em Eucalyptus deglupta Blume, observou que o porta-enxerto foi afetado por um inibidor produzido pelo material enxertado.

Este trabalho preliminar tem como objetivo estudar a influência do enxertador, da família de meio-irmãos e do indivíduo na porcentagem de enxertos em desenvolvimento, aos 90 dias após a enxertia, visando fornecer subsídios para o conhecimento das causas da incompatibilidade.

Materiais e Métodos

Foram utilizados como porta-enxertos mudas de Eucalyptus urophylla S.T. Blake, formadas com sementes comerciais, com altura média de 1,0 m e diâmetro na região do colo de 1,5 cm.

Os propágulos foram coletados de árvores selecionadas em um teste de progênies, com 6 anos de idade, instalado pelo Instituto Florestal do Estado de São Paulo, em São Paulo, capital.

O método de enxertia adotado foi a borbulhia em janela aberta (HIGA, 1979). Foram propagadas 17 árvores, pertencentes a 7 famílias. Cada um dos 2 enxertadores executou 9 enxertos por árvore selecionada.

A enxertia foi realizada, em 17 de fevereiro de 1977, no viveiro da Cia. Suzano de Papel e Celulose, no município de Biritiba Mirim (SP) sob cobertura de esteiras de bambu, com sombreamento de aproximadamente 80%. Os enxertos permaneceram sob essas condições durante os primeiros 60 dias, recebendo irrigações diárias e adubações periódicas. Após esse período, a cobertura e a irrigação foram retiradas gradativamente, de forma a preparar os enxertos para o plantio no campo.

Resultados e Discussões

Os resultados da porcentagem de enxertos com brotação, 90 dias após a enxertia, estão apresentados na Tabela 1.

O confronto entre as porcentagens médias dos enxertos em desenvolvimento, pelo teste X^2 (Tabela 1), mostra que não houve diferenças estatísticas entre os resultados obtidos pelos 2 enxertadores, apesar de diferirem em 11,76%. Analisando, porém, os resultados isoladamente, verifica-se que em algumas árvores, houve uma influência marcante do enxertador, apesar de terem recebido o mesmo tipo e período de treinamento.

O treinamento de pessoas para a execução da enxertia é um dos fatores essenciais para o sucesso do trabalho, uma vez que a atividade exige uma habilidade manual adequada e o conhecimento dos processos básicos da união das partes enxertadas.

As porcentagens médias de enxertos em desenvolvimento apresentadas pelas famílias diferiram significativamente aos 90 dias após a enxertia. Os resultados do teste X^2 (Tabela 1) mostram a existência de dois grupos distintos. O primeiro, constituído pelas famílias G,B,F e E com 17,00% a 30,56%.

Esses resultados podem levar a conclusão que existe uma influência do parentesco entre o material enxertado e seu comportamento na propagação vegetativa por borbulhia em janela aberta. Deve ser salientado, no entanto, que a comparação entre famílias foi baseada em médias e que existe uma alta variação dentro de cada família. Essa alta variação, pode ser conseqüência da interação entre os propágulos e os porta-enxertos formados a partir de sementes comerciais.

Em função desses resultados, recomenda-se que em trabalhos dessa natureza, sejam utilizados porta-enxertos geneticamente controlados.

O resultado médio de enxertos em desenvolvimento de 30,72%, obtido nesse trabalho aos 90 dias após a enxertia, mostram o potencial do emprego da borbulhia em janela aberta para propagação vegetativa do Eucalyptus urophylla S.T. Blake. O real potencial do uso desse método deverá ser determinado com estudos do comportamento dos enxertos após o plantio no campo, principalmente com relação às manifestações da incompatibilidade da enxertia.

Conclusões

As porcentagens médias de enxertos em desenvolvimento não foram influenciadas pelos trabalhos dos enxertadores, que receberam o mesmo tipo e intensidade de treinamento.

Existe variação dos resultados em função da família, no entanto, apesar de serem propagadas poucas árvores por família, a variação individual foi superior a variação em função da família.

Table 1 - Percentage of developing grafts 90 days after grafting using the patch budding method, considering the grafter, tree and family.

Tabela 1 - Porcentagem de enxertos em desenvolvimento 90 dias após a enxertia pelo método borbulhia em janela aberta, em função do enxertador, a árvore e da família.

Family FAMÍLIA	Tree ÁRVORE	Grafter ENXERTADOR I	II	Mean per tree MÉDIA DE ÁRVORE	Mean per family MÉDIA DE FAMÍLIA
A	12	66,67	55,56	61,62	61,12 a
B	39	33,33	22,22	27,78 a	25,00 cd
	16	22,22	22,22	22,22 a	
C	09	55,56	55,56	55,56 m	44,45 b
	07	33,33	33,33	33,33 n	
D	42	66,67	55,56	61,12 x	50,01 ab
	43	44,44	33,33	38,89 y	
E	28	55,56	11,11	34,34 r	17,00 d
	26	22,22	0,	11,11 s	
	30	11,11	0,	5,56 s	
F	50	44,44	55,56	50,00 t	22,22 cd
	47	33,33	11,11	22,22 u	
	31	44,44	0,	22,22 u	
	33	11,11	22,22	16,67 u	
	35	0,	0,	0, v	
G	03	66,67	44,44	55,56 f	30,56 c
	04	11,11	0,	5,56 g	
Total mean Média Geral		36,60	24,84	30,72	

TESTE X^2 (ENTRE MÉDIAS-GERAIS POR ENXERTADOR) = 3,25 n.s.

X^2 test (between means-total per operator) = 3,25 n.s.

n.s. = não significativo n.s. = non significant

Obs: As médias seguidas pelas mesmas letras, em cada coluna, não diferem estatisticamente pelo Teste X^2 ao nível de 5% de probabilidade.

Note: The means followed by the same letter in each column, did not statistically differ by the X^2 tests at 5% level of probability.

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FAST GROWING TREES

SOBREVIVÊNCIA DE CLONES DE *Eucalyptus urophylla* S.T. BLAKE EM BANCOS CLONAIS INSTALADOS EM PIRACICABA (SP) E CASA BRANCA (SP).

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Resumo

O trabalho objetiva analisar a sobrevivência de 15 clones de Eucalyptus urophylla S.T. Blake, enxertados pelo método garfagem em fenda cheia, 4 anos após o plantio em bancos clonais, instalados em Piracicaba-SP e Casa Branca-SP.

Os resultados mostram que a sobrevivência dos enxertos não foi afetada, significativamente, pelo local de instalação, que a morte dos enxertos, devido à incompatibilidade, é função principalmente do clone e que a correlação entre as sobrevivências dos clones nos dois locais é altamente significativa.

Em função dos resultados, recomenda-se que o método garfagem em fenda cheia não seja utilizado, de forma generalizada, para a propagação vegetativa da espécie.

CLONE SURVIVAL OF *Eucalyptus urophylla* S.T. BLAKE IN GLONAL BANKS ESTABLISHED IN PIRACICABA (SP) AND IN CASA BRANCA (SP).

Summary

The objective of this work was to analyse the survival of 15, four-year old Eucalyptus urophylla S.T. Blake splice grafted clones planted in clonal banks situated in Piracicaba (SP) and in Casa Branca(SP).

The results revealed that: a) planting sites did not significantly affect graft survival; b) plant mortality due to graft incompatibility is a principal clonal function; c) correlations between the clone survival of both sites is highly significant; and d) splice grafting is not recommendable for the vegetative propagation of species.

Introdução

Considerando que os clones conservam os mesmos genótipos das árvores propagadas, a instalação de bancos clonais em diferentes locais possibilita a avaliação do efeito ambiental no comportamento dos enxertos, que pode ser observada na análise de sobrevivência, do crescimento vegetativo e reprodutivo do ensaio, do período de floração e das manifestações da incompatibilidade na enxertia.

Essas informações são de grande utilidade para o melhorista orientar-se na seleção do material a ser colocado no pomar de sementes e estimar o número de enxertos por árvore selecionada a ser executado.

Esse trabalho teve por objetivo estudar a sobrevivência de 15 diferentes clones em bancos clonais, 4 anos após a instalação no campo.

Materiais e Métodos

Os clones de Eucalyptus urophylla S.T. Blake usados foram provenientes de material vegetativo coletado em parcelas da introdução original, feita a partir de 1919 no Horto Florestal da FEPASA - Ferrovia Paulista S.A. (ex: Cia. Paulista de Estradas de Ferro) por Navarro de Andrade.

A enxertia foi realizada em porta-enxertos da mesma espécie, empregando-se o método garfagem em fenda cheia.

Os bancos clonais foram instalados em maio de 1974, na Escola Superior de Agricultura Luiz de Queiroz, em Piracicaba - SP e na Champion Papel e Celulose S.A., em Casa Branca-SP. O espaçamento adotado foi de 4,0 m X 5,0 m.

Visando propiciar melhores condições para a floração e consequentemente maior produção de sementes, foram efetuadas adubações periódicas com NPK na proporção 10:10:10, no banco clonal instalado em Casa Branca-SP.

Resultados e Discussões

Os resultados das avaliações das sobrevivências dos clones estão apresentados na Tabela 1 e Figura 1.

Pela analise dos resultados apresentados na Tabela 1 e Figura 1, pode-se verificar que a sobrevivência diferiu significativamente, 4 anos após o plantio dos enxertos, em função dos clones.

A porcentagem média de enxertos sobreviventes, 4 anos após terem sido instalados nos dois bancos clonais, considerando o total de enxertos plantados e sobreviventes, foi de 26,61%, variando de 23,49% para o banco clonal de Casa Branca e 31,40% para o banco clonal de Piracicaba. Esse baixo índice de aproveitamento mostra que a enxertia pelo método garfagem em fenda cheia não pode ser recomendada, de forma generalizada, para a espécie estudada, em programas de melhoramento que visam a conservação do material genético em forma de clones. Devem ser testados outros métodos de enxertia e também outros tipos de propagação visando oferecer alternativas para a multiplicação dos genótipos que não sobreviveram.

O banco clonal de Casa Branca, apesar de ser manejado adequadamente, através da eliminação da concorrência das ervas daninhas e aplicações periódicas de fertilizantes minerais apresentou menor taxa de sobrevivência média, apesar de não diferirem estatisticamente pelo teste X^2. Deve ser salientado que a qualidade do sítio do banco clonal de Piracicaba é bem superior.

Procurando correlacionar a sobrevivência dos clones em função do local, foi calculado o Coeficiente de Correlação de Spearman (rs). Os resultados mostraram um rs = 0,6089**, indicando que a sobrevivência dos clones não foi afetada pelo local de instalação do banco clonal, e que a incompatibilidade na enxertia é função do material genético a ser propagado, possibilitando ao melhorista selecionar os clones à serem propagados por esse método de enxertia para instalação de futuros pomares de sementes.

Deve ser salientado, no entanto, que esse trabalho inicial deve ser complementado com observações de sintomas exteriores que poderão ser relacionados com indicações de manifestação da incompatibilidade, com o acompanhamento do desenvolvimento da copa e aspectos relacionados com a fenologia, procurando estudar principalmente o efeito na floração e polinização, resultante da interação entre e dentro dos clones com o tipo de porta-enxerto utilizado e o ambiente onde foram instalados os bancos.

Conclusões

A análise dos resultados propiciou as seguintes conclusões:

a) A enxertia por garfagem em fenda cheia, 4 anos após a execução, apresentou uma sobrevivência média de 26,61% para os locais estudados. Para a localidade Casa Branca-SP, a sobrevivência média foi de 23,49% variando de 0 a 100%. Apesar dessa variação, a sobrevivência não foi afetada significativamente pela localidade.

b) A morte dos enxertos, devido à manifestação da incompatibilidade, é função principalmente do clone, sendo altamente significativa a correlação da sobrevivência dos clones nos dois locais estudados.

c) O método garfagem em fenda cheia não pode ser recomendado, de forma generalizada, para a propagação vegetativa da espécie.

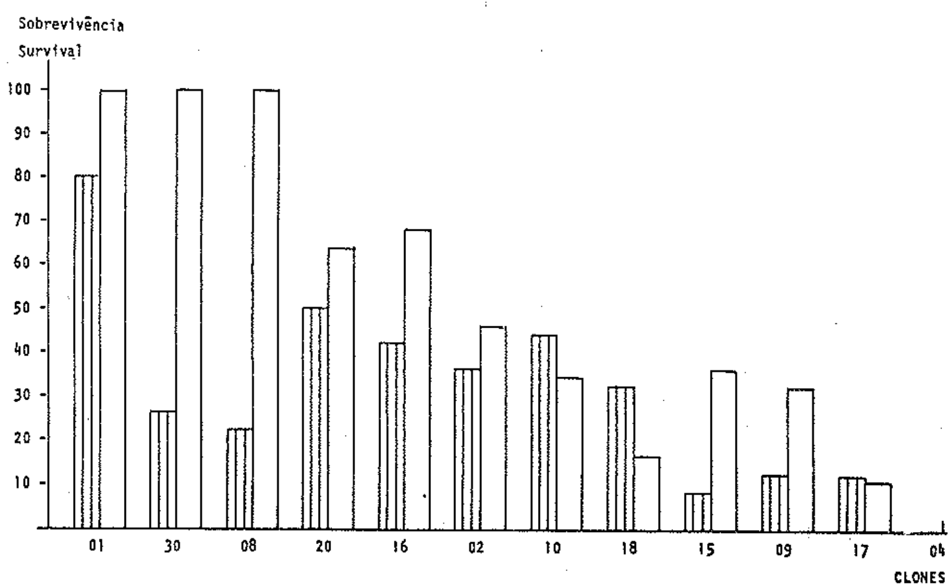

Figura 1 - Sobrevivência (%) dos enxertos nos bancos clonais instalados em Piracicaba-SP (▥) e Casa Branca - SP (□), 4 anos após o plantio.

Figure 1 - Survival (%) of grafts in clonal banks established in Piracicaba(SP) (▥) and in Casa Branca (□), 4 years after planting.

Tabela 1 - Porcentagens de sobrevivência dos enxertos de *E. urophylla* S.T. Blake, 4 anos após o plantio, em função do clone e do local de instalação do Banco Clonal.

Table 1 - *Eucalyptus urophylla* S.T. Blake graft survival in function of clone and site, 4 years after planting.

CLONE	CASA BRANCA - SP			PIRACICABA - SP			MÉDIA Mean
	Nº Enxertos / Nº grafts		Survival %	Nº Enxertos / Nº grafts		Survival %	
	Plantados originally	Atual Present		Plantados originally	Atual Present		
01	10	8	80,00	2	2	100,00	90,00
20	8	4	50,00	10	7	70,00	60,00
10	7	3	42,85	10	3	30,00	36,43
16	5	2	40,00	3	2	66,66	53,33
02	12	4	33,33	9	4	44,44	38,89
18	7	2	28,57	7	1	14,28	21,43
30	8	2	25,00	2	2	100,00	62,50
09	9	1	11,11	10	3	30,00	20,56
08	5	1	20,00	1	1	100,00	60,00
21	11	2	18,18	2	0	0,00	9,9
17	9	1	11,11	10	1	10,00	10,56
15	12	1	8,33	3	1	33,33	20,83
04	9	0	0,00	4	0	0,00	0,00
24	10	0	0,00	4	0	0,00	0,00
26	10	0	0,00	9	0	0,00	0,00
TOTAL	132	31	23,49	86	27	31,40	26,61

Coeficiente de correlação de Spearman (locais) = 0,61**
Spearman's correlation coefficient (site) = 0,61**

Teste X^2 (entre totais dos locais) = 1,67 n.s.
X^2 test (between total and sites

DESENVOLVIMENTO DE POMARES DAS ESPÉCIES *Eucalyptus tereticornis* SM, *E. robusta* SM, *E. maculata* HOOK, *E. citriodora* HOOK, *E. paniculata* SM e *E. umbra* R.T. BAKER.

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Resumo

Instalou-se em 1966, testes de progênie das espécies *Eucalyptus tereticornis* Sm, *E. robusta* Sm, *E. maculata* Hook, *E. citriodora* Hook, *E. paniculata* Sm e *E. umbra* R. T. Baker, em Estações Experimentais do Instituto Florestal de São Paulo. São fornecidos valores médios dos dados de altura total e diâmetro à altura do peito, em várias idades de desenvolvimento. Aborda-se o aspecto de qualidade e utilização das sementes disponíveis.

Summary

Field trials of open-pollinated families from the eucalypt species E. tereticornis Sm, E. robusta Sm, E. maculata Hook, E. citriodora Hook, E. paniculata Sm and E. umbra R. T. Baker were established in 1966.

Height and diameter growth attained at various ages are given. Possibilities of the use of these seeds for large plantations are discussed.

Introdução

São consideráveis as necessidades de sementes florestais melhoradas, e em especial, as do gênero Eucalyptus, tanto para atendimento das metas governamentais para produção de celulose e papel de fibras curtas, como para a produção de ferro gusa à carvão vegetal, e, atualmente, como alternativa energética industrial. Assim deverão ser implantados 320.000 ha do gênero Eucalyptus no biênio 80/81, apenas com recursos oriundos de incentivos fiscais.

O Instituto Florestal do Estado de São Paulo, visando o suprimento da demanda de sementes melhoradas do gênero Eucalyptus, iniciou trabalhos específicos em 1966, elegendo algumas espécies com características silviculturais desejáveis e madeira de qualidade capaz de substituir as nativas tradicionais, que se escasseavam rapidamente.

Com a finalidade de produção de sementes foram estabelecidos pomares de diversas espécies usando-se o material disponível, que na ocasião era o introduzido por Navarro de Andrade, e distribuído pelos diversos hortos da Companhia Paulista de Estradas de Ferro (atualmente FEPASA).

É indiscutível as limitações oferecidas pelo uso do referido material, quando o objetivo for trabalhos de melhoramento, tanto pela estreita base genética, como por problemas de hibridação. O desenvolvimento de um programa de melhoramento à partir de plantações oriundas de poucas árvores não seria desejável, pois de acordo com ELDRIDGE (1978), muitos alelos desejáveis integrantes da população natural, podem não estar aí incluídos. Entretanto, como afirma JACOBS (1973), "o Brasil deve produzir a maioria de seus suprimentos de sementes nas melhores fontes disponíveis, à despeito do problema de hibridação".

Sementes de E. saligna produzidas em Manduri, de um pomar instalado em 1961, tem sido bastante utilizadas. Este pomar foi formado por progênies de árvores "plus", introduzidas por Navarro de Andrade. Está em andamento um teste para avaliação destas sementes em confronto com sementes de pomares clonais introduzidas da África do Sul. Os resultados de 18 meses são descritos por Pásztor et alii, 1980.

Material e Métodos

Progênies de árvores selecionadas nos hortos da antiga Companhia Paulista de Estradas de Ferro, das espécies Eucalyptus tereticornis, E. robusta, E. maculata, E. citriodora, E. umbra e E. paniculata foram plantadas em diferentes localidades, devidamente isoladas para evitar a contaminação por polem estranho. As progênies das diversas matrizes foram plantadas no campo, distribuídas, por sorteio, em linhas, evitando-se o plantio de progênies de uma mesma matriz, em linhas contíguas. Concomitantemente foram instalados testes de progênie em linhas, em uma área menor e mais uniforme escolhida dentro das áreas das diversas espécies, com a finalidade de obtenção de dados mais acurados para avaliação do desenvolvimento das progênies.

Os testes de progênie das diversas espécies seguiram o esquema estatístico de blocos ao acaso, com parcelas constituídas de linhas distanciadas de 5 metros, com exceção do E. citriodora para o qual a distância foi de 10 metros. A distância entre plantas, dentro das linhas foi sempre de 2,5 m. O número de famílias e o número de repetições para as diversas espécies está especificado no Quadro 1. A localização das plantações e os dados climáticos destes locais estão definidas no Quadro 2.

A escolha das matrizes foi feita com base nos dados de crescimento de suas progênies, em altura e diâmetro, em testes que na época estavam em andamento na Companhia Paulista, e com a idade de 5 anos, com exceção do E. umbra para qual as plantas selecionadas foram as de melhor desenvolvimento.

Após 7 anos de plantio foram feitos desbastes seletivos nos pomares das diversas espécies. Todas as plantas com altura e diâmetro inferiores à média menos um erro padrão, bem como as tortas, bifurcadas, doentes, e as atípicas foram eliminadas. As árvores de melhor forma, com altura e diâmetro superiores à média mais um erro padrão foram marcadas para produção de sementes.

Após 12 anos de plantio foram feitos novos desbastes seletivos, eliminando-se as plantas indesejáveis que sobraram do primeiro desbaste e proporcionando um maior espaçamento para as melhores árvores.

O método usado e os resultados obtidos para a espécie E. paniculata, até a idade de 7 anos, são descritos mais detalhadamente por Pásztor e Nogueira (1976).

Resultados

Os valores das alturas totais médias, expressos em metros, e dos diâmetros médios à altura do peito, expressos em centímetros, bem como os erros padrões para as diversas espécies, aos 7 anos foram:

Espécie	Altura média (m)	Erro padrão	Diâmetro médio (m)	Erro padrão
E. robusta	20,70	0,71	20,2	0,61
E. tereticornis	19,23	0,85	19,1	0,84
E. citriodora	16,23	1,28	16,8	1,51
E. maculata	19,33	0,58	19,9	0,61
E. umbra	13,11	1,27	16,9	1,31
E. paniculata	16,26	0,78	15,9	0,68

Quadro 1 Dados dos testes de progênies das espécies trabalhadas.

Espécie	Local de instalação	Nº de matrizes	Espaçamento inicial	Nº de repetições	Nº inicial plantas/ parcela
E. maculata	Stª Barbara Rio Pardo	8	5 x 2,5	5	50
E. citriodora	Manduri	9	10 x 2,5	4	20
E. robusta	Itapetininga	11	5 x 2,5	5	50
E. umbra	Angatuba	8	10 x 2,5	5	50
E. paniculata	Pederneiras	9	5 x 2,5	4	50
E. tereticornis	Itapetininga	12	5 x 2,5	5	50

Quadro 2 Características dos locais de implantação dos pomares de sementes por mudas.

Espécie	Localidade	Latitude	Longitude	Altitude (m)	Temperatura média anual (ºC)	Precipitação anual (mm)	Tipo Climático (Köppen)
E. maculata	Stª Barbara Rio Pardo	22º 53' S	49º 14' W	600	19,9	1260	Cwa
E. citriodora	Manduri	23º 00' S	49º 19' W	700	19,4	1161	Cwa
E. robusta	Itapetininga	23º 42' S	47º 57' W	645	19,3	1128	Cwa
E. umbra	Angatuba	23º 29' S	48º 25' W	950	17,9	1190	Cfb
E. paniculata	Pederneiras	22º 22' S	48º 44' W	500	20,9	1226	Cwa
E. tereticornis	Itapetininga	23º 42' S	47º 57' W	645	19,3	1128	Cwa

Quadro 3 Valores médios do DAP (cm) e altura total (m) das progênies das espécies em diferentes idades de desenvolvimento.

Espécie	1 ano		3 anos		6 anos		8 anos		10 anos		13 anos	
	DAP	$\bar{H}$	DAP	$\bar{H}$	DAP	$\bar{H}$	DAP	$\bar{H}$	DAP	$\bar{H}$	DAP	$\bar{H}$
E. maculata	-	4,14	11,9	11,27	19,9	19,70	21,9	20,86	24,5	22,41	26,4	25,19
E. citriodora	-	-	11,1	10,25	15,3	15,25	21,3	19,21	24,7	23,83	28,1	27,64
E. robusta	-	3,78	-	12,96	19,7	20,15	-	-	-	-	30,2	26,62
E. umbra	-	1,58	10,7	7,48	16,4	12,65	22,7	19,61	26,5	22,31	29,4	23,17
E. paniculata	-	4,30	10,1	10,41	15,0	15,22	-	-	22,8	19,52	27,7	23,99
E. tereticornis	-	3,21	12,1	13,89	18,1	19,23	21,6	21,30	27,6	24,18	31,3	25,88

O Quadro 3 apresenta os valores médios do diâmetro, à altura do peito, e da altura total das progênies, das espécies em estudo, nas idades de 1, 3, 6, 8, 10 e 13 anos.

D I S C U S S Ã O

Os esforços governamentais para ampliar áreas de plantios com espécies de rápido crescimento, como fonte alternativa energética ou para usos específicos da madeira como matéria prima básica, gera necessidades consideráveis de sementes.

O uso de sementes melhoradas, é indiscutivelmente uma necessidade, como forma de incrementar o desfrute da atividade. O abastecimento interno de sementes florestais de valor produtivo elevado é polêmico, pois que, os estudos disponíveis sobre espécies e procedências desejáveis não são suficientes para atendimento das diferentes condições edafo-climáticas de todo o país. Assim, tendo havido insucessos com o uso de sementes de *Eucalyptus grandis* oriundos das primeiras introduções de Navarro de Andrade, em condições climáticas favoráveis ao ataque do *Diaporthe cubensis*. Por outro lado o *Eucalyptus urophylla*, híbrido oriundo das introduções de Navarro de Andrade tem-se mostrado como uma das melhores alternativas em vastas regiões do território nacional; o *Eucalyptus saligna* oriundo de testes de progênie de matrizes de Rio Claro, quando em competição com a mesma espécie procedente de pomares clonais da África do Sul, aos 18 meses, apresenta um comportamento similar no aspecto de sobrevivência e forma, bem como no desenvolvimento em altura.

Os dados de crescimento das espécies *E. maculata*, *E. citriodora*, *E. robusta*, *E. umbra*, *E. paniculata* e *E. tereticornis*, avaliados através de testes de progênies de plantas "plus", sugerem a possibilidade da utilização das sementes produzidas pelos pomares destas espécies, como a melhor opção, no momento, para plantios em larga escala.

As áreas, por espécie, apresentam um potencial estimado de produção de sementes, conforme o quadro abaixo:

Espécie	Área	Produção estimada Kg/ano
E. maculata	24,2	500
E. citriodora	15,0	300
E. robusta	19,3	500
E. umbra	18,7	300
E. paniculata	24,0	400
E. tereticornis	21,0	600

Para as espécies enfocadas no presente trabalho, bem como para o *E. grandis* de outras entidades de pesquisa, as sementes produzidas são suficientes para cobrir quase toda a demanda nacional, sem necessidade de importações maciças. Persiste, entretanto, a conveniência de novas introduções para os trabalhos de melhoramento genético.

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sessão session VII
grupo group ABC

QUALIDADE DA MADEIRA DE *Eucalyptus saligna* SM PARA SERRARIA COMO UM GUIA PARA SELEÇÃO DE ÁRVORES PARA MELHORAMENTO E COLHEITA DE SEMENTES.

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Resumo

A experiência acumulada em vários anos no desdobramento de toras de *E. saligna* Sm., oriundas de algumas localidades da Nova Zelândia, indica que a tendência aos rachamentos nas bases das toras na derrubada das árvores e a tendência da madeira recém-serrada rachar são provavelmente herdáveis. Há geralmente maior variação entre povoamentos do que dentro de povoamentos no grau de rachamento basal e, por sua vez, esse rachamento é correlacionado com o grau de distorção da madeira e com a sua estabilidade após a secagem. Árvores com grã ondulada decorativa aparentemente dão origem a progênies com a mesma característica, e a madeira é normalmente muito estável.

A colheita de sementes de *E. saligna* para plantações, visando produção de toras para serraria, deveria ser feita em árvores com propriedades de desdôbro comprovadas.

SAWING QUALITIES OF *Eucalyptus saligna* S.M. AS A GUIDE TO SELECTION OF TREES FOR BREEDING AND SEED COLLECTION.

Summary

Experience over several years in milling Eucalyptus saligna Sm. logs from some localities in New Zealand indicates that the propensity of logs to end-split on felling and of freshly-sawn timber to spring off the saw is probably heritable to a degree. There is generally more variation between stands than within stands in severity of end-splitting, and this is evidently correlated with the severity of distortion found in the timber, and its stability after drying. Trees with a decorative wavy grain seem to produce progeny with the same feature, and the timber is usually very stable.

Seed collection in E. saligna to be planted for sawlogs should be from trees of proven good milling quality.

INTRODUCTION

When we establish eucalypts in plantations it goes without saying that we must have an end use in view. In New Zealand there is only one large plantation grown to supply pulp logs. Both the state (New Zealand Forest Service) and smaller private growers have planted for an end use of timber especially as a replacement for diminishing indigenous timbers in the decorative and finishing classes. To this end, the New Zealand Forest Service is promoting the growing of five main species:

(a) Eucalyptus saligna Sm. and E. botryoides Sm. with reddish, rather heavy, decorative timbers, and

(b) Eucalyptus regnans F. Muell., E. fastigata Deane & Maid. and E. delegatensis, R.T. Bak. of the ash group, with pale, rather light-weight, timbers.

These two groups of species, selected for their timber qualities (Kininmonth et al., 1974) and promising silvicultural characteristics (Bunn, 1971), have rather different reactions in timber seasoning. Eucalyptus saligna and E. botryoides retain their sawn dimension well and can be sawn generally "on the back" without overdue cupping and little checking. They do sometimes give problems with severe spring and bowing off the saw, resulting in serious degrade and reduced recovery.

The ash species, fast growing and resistant to various worrisome attacks by insects and possums and climatically suited to the predominantly cold areas of the country, have in addition to the off-saw problems, a propensity toward fairly severe drying collapse, shrinkage and checking.

It is these general characteristics of tension in the first group and the additional seasoning problems of the ash group that are the most serious cause of degrade in timber production in our New Zealand plantation-grown eucalypts and in fact in any other country where this genus is to be grown for timber.

SILVICULTURE FOR EUCALYPT SAWLOG PRODUCTION

My experience, as well as that of others in our New Zealand farm forestry group, indicates that stresses can be considerably lessened by silvicultural management designed to grow trees at maximum diameter increment commensurate with a reasonable 10-12 metre log. Our silviculture method involves some pruning of branches and either initial wide spacing over pasture (10 metres x 3 metres) or early thinning of regeneration at height 7-9 metres to stockings of 250 stems per hectare. Jacobs in his book "Growth Habits of the Eucalypts" (Jacobs, 1955) which is something of a bible to New Zealand eucalypt silviculturists, works on a crown-stem ratio of around 15:1. The aim of growers with good stability of sawing in view is a fast-grown 25-30 yr log of diameter around 75 cm or greater dbh (Bunn, 1971; Revell, 1980), so further thinning will be needed, down to final stockings of 100 stems per hectare. In agro-forestry regimes combining grazing of sheep and cattle with timber production, this ultimate wide spacing which to the conifer grower would seem wasteful of space, works in well because wide-spaced eucalypts grow good grazable grass to their trunks due to their compatibility to grass (in New Zealand) and the easy penetration of light from the side.

Trials established in New Zealand by the Forest Research Institute will no doubt sort out the important factors of growth, stem form, branch shedding etc. But the proof of the exercise of growing a tree, especially a hardwood, is in the quality and straightness of the final seasoned product - the timber.

VARIATION IN SAWING PROPERTIES

Growth Stresses and End Splitting

Having spent my life in the warmer end of the North Island, New Zealand, my experience of growing and sawing my own eucalypts over 35 years has been confined in the main to E. saligna and E. botryoides, two closely allied species with very similar timbers, and another bracket of two closely allied species, E. pilularis Sm. and E. muellerana Howitt. With other members of our 2 000-member farm forestry association and with scientists of the Forest Research Institute I have observed very keenly the timber quality sawn from many other species but more particularly of late the variability of timber from a number of stands of the same species. I shall try to make the point in this paper, non-scientific but I hope practical, that even with radical silviculture there are very observable differences in the way various species spring off the saw and that there are also very great differences in sawing quality of logs within a species grown in similar spacings on similar soil types. I shall confine my remarks to the one species, E. saligna, a species which shows most promise in northern New Zealand, and which is represented by a number of stands regenerated from 100-year-old trees of imported seed. I shall hope to develop from a fairly narrow base the thought that spring in logs (Page, 1978; Skolmen, 1974) can be a heritable thing and that some strains of E. saligna are stable (i.e. do not end-split or quarter) given similar silviculture or the lack of it.

Growers in South Africa have long associated lack of end-splitting with good sawing quality in E. grandis Hill ex Maid., i.e., minimum of bowing and cupping (Andrews, 1961; Van Wyk, 1978). End-splitting is unquestionably caused by release of stresses as the log is cross-cut. Jacobs (1955) speaks of the "pull of the sap and the push of the heart", the two warring and explosive forces of tension and compression. This "popping" can occur on felling sometimes with explosive force and more commonly some days or weeks after cutting into logs. But there are logs that don't end-check to any degree and these always saw well. This can always be confirmed by the first outer cut on the saw bench which does not spring. There are E. saligna logs which have a discernible "wavy grain", - usually a sign also of good stability during sawing. This trait can be picked in the standing tree, which is very handy.

Now what I am trying to develop in this fairly long preamble is the theory, based on a good deal of sawing experience of E. saligna from a number of different seed sources and known provenances, that sawing stability (or end-checking) could be heritable and that trials for growth and volume will not sort out the all important factor of stability; nor will grade studies of sawn timber out-turn on traditional conifer lines based mainly on knots, defects, etc., do much to help (Bamber, 1978). Grade studies should be on final and dried timber, for such troublesome degrading features (in E. saligna) as bowing and edge warp.

The "Bartlett's" strain of E. saligna

There are in New Zealand a number of stands, even individual trees, of E. saligna that have been used as seed sources. A.B. Goudie, a prominent nurseryman, in the 1930s, put out E. saligna from a Waikato source it is thought, that has become known as the "Goudie strain", botanically different from the other and very important "strain" from the Bartlett stand at Silverdale just north of Auckland city.

This latter stand which has regenerated from at least three original remaining trees has been notable for the good quality of its timber and for the excellent apical dominance and fine branching of its out-planted progeny. Its growth rate is somewhat slower than some others (Wilcox et al., 1980) but let's forget the scientist's height-diameter growth syndrome in favour of out-turn of straight wide boards per log cut.

I have known this Bartlett's stand for over 40 years now. It is a most unique woodlot possessing some of the best E. pilularis and Acacia melanoxylon R. Br. stands in New Zealand, in addition of course to a very splendid strain of E. saligna of unknown Australian origin. Our family has been cutting furniture timber lots from these E. saligna trees for some 32 years now and planting for our own use and for sale, and distributing seedlings of particular trees which have been notable for milling entirely stable timber of testing dimensions e.g. 20 cm x 3 cm and 10 cm x 7.5 cm in 8 m lengths.

Trees surrounding two old trees in the Bartlett stand have thrown an unusual preponderance of wavy-grained progeny. There appears to be a heritable factor here and the parents themselves have noticeably wavy bark. The notion that wavy grain is heritable will be tested out on a fairly wide scale by out-planting of seedlings from a highly figured tree cut in 1974.

A further experience with trees cut from progeny from a single Bartlett tree of straight-grained character is encouraging. In 1952 a splendid tree 1 m in diameter was cut from this group into 10 cm x 7.5 cm timber some 7 m long. To cut this dimension into such long lengths and to obtain straight pieces was remarkable. Seed was saved and seedlings planted out on my property in 1954.

Forest Research Institute tree breeders looking for good seed trees of Bartlett's strain grown in different forests selected a good dominant tree (unthinned stand but fairly open) and seedlings were grown for progeny tests (Wilcox et al., 1980). This lot was labelled family 119 and trees of the 1952 seedlot are now known in our forest as "119". This seedlot is very striking in form, tall, thin-barked over a low sometimes furrowed stocking of grey sub-fibrous bark. Branch shedding is good, with little need for pruning.

Further Milling Experiences

In 1979 we cut and milled some twenty or so trees of E. saligna (Goudie's strain) and E. botryoides. I followed the operation through from felling to seasoning and final marketing for use in boat-building, furniture and sun deck material. There were notable differences among logs in end-checking, and, being on the breakdown saw, I was able to observe that the more the end-check the more the spring. There was a marked differences in Goudie 1946 and 1948 Goudie stock. Was this a different seedlot? The unanswered question. My guess is Yes.

In the course of our logging we unearthed (almost literally) several small butt-logs of thinnings of "119" strain cut from logs sold as piles. These after a year had barely checked at all so we milled them. They milled into 15 cm x 3 cm, 20 cm x 10 cm sizes and have remained straight and with a minimum of shrinkage after drying.

Encouraged by this we cut three further trees, 25-years-old. From one tree 47 cm in diameter at stump, we cut three 3.65 m logs which were milled and timber kept in separate heaps. Dimensions were from 7.5 cm x 3 cm, 10 cm x 3 cm, 20 cm x 3 cm and about five 30 cm x 3 cm pieces. An open-grown, 25-year tree of larger diameter and crown was also cut. All these logs of 25 year "119 strain" behaved almost as well as conifer logs and after one year's air drying have remained just as they came off the saw, even the 30 cm x 30 cm. D.H. Revell of the Forest Research Institute graded the timber and compared it with a shipment cut from 28 E. saligna logs from 40-year-old trees in Athenree State Forest. Our "119 strain" logs gave a higher recovery of clear grades and showed less spring during sawing than those from Athenree.

Selection of Seed Trees

Sizeable areas of this "119 strain" are being planted on our property and seedlings given to discerning planters. As well, the wavy grained seed is being widely planted and recorded. Farmers have located several other trees of this character and our group proposes to plant out areas of each seedlot and record these. Key planters are now planting seed only of proven good sawing logs believing that trees from a proven mother tree will stand a good chance of producing stable timber.

If we are to produce stable boards with any sort of predictability should not breeders of eucalypts concentrate their attention on growth stresses - or rather the lack of them - rather than on height and diameter only? Should we not segregate seedlots of known good milling strains for planting, and later test the trees for end-checking (and thus milling quality) at an early age, say 12 years, and from then to maturity? Wavy-grained lots could be checked for heritability by bark inspection.

If there is any hope of this valuable trait of log stability in preferred eucalypt species being consistantly inherited over a number of generations, it would be one of the most practical benefits that tree breeders could present practical growers of fast grown plantation logs.

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DENSIDADE BÁSICA, TEOR DE HOLOCELULOSE E RENDIMENTO EM CELULOSE DE MADEIRA DE *Eucalyptus grandis*.

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Resumo

O objetivo do presente trabalho foi estudar a variação da densidade básica, teor de holocelulose e rendimento em celulose sulfato entre e dentro de árvores, de populações de Eucalyptus grandis para as idades de 5, 6, 7, 8, 9 e 10 anos. Da mesma forma procurou-se verificar a existência de correlações entre estes parâmetros e a possibilidade de se expressar o rendimento da floresta, diretamente em termos de toneladas de celulose sulfato branqueada por hectare a partir dos dados dendrométricos normalmente obtidos.

Summary

The objective of this paper was to study wood basic density, holocellulose content and kraft pulp yield variations between and within Eucalyptus grandis trees, with 5, 6, 7, 8, 9 and 10 years old. Likely it was determined correlations among the underline variables and equations for pulp yield estimation for Eucalyptus grandis stands through the data usually recorded in forest surveys.

The following conclusions could be drawn:
1. Wood basic density of the increment core taken at DBH level was lower than that of wood disc of the same level.
2. Tree wood basic density is highly correlated to basic density of the increment core and the disc taken at DBH.
3. Tree wood basic density increases as the age of the stands increases.
4. Within tree wood basic density is higher at bottom and between 50 to 75% high of the commercial stem of the trees.
5. For all ages, tree bottom and top are the regions of the trees that show lower pulp yield.
6. Holocellulose content increases from bottom up to about 75% high of the commercial stem of the trees.
7. There is no correlation between pulp or holocellulose yield with tree wood basic density, even with wood basic density taken at a specific level, DBH for instance.
8. Holocellulose yield is highly correlated to holocellulose content.
9. There is no correlation between pulp yield of the wood taken at DBH level and the yield of the whole tree. Likely there is no correlation of the same yields for holocellulose.
10. Knowing, DBH, total height and wood basic density of the increment core taken at DBH level it is possible to estimate kraft pulp yield per tree, for each age. These results can be used for estimating pulp yield per hectare, through usual forest survey data.

1. INTRODUÇÃO

Dentro do conceito moderno de "silvicultura industrial", novos enfoques estão sendo procurados para a produção de madeira.

A par da preocupação com os incrementos volumétricos dos povoamentos florestais, outros parâmetros estão sendo introduzidos visando-se expressar os rendimentos das florestas em termos de quantidades das matérias-primas. Associados a informações tecnológicas da madeira e industriais de processos visa-se expressá-los em termos de produto final.

O presente trabalho procurou trazer algumas contribuições para se alcançar estes objetivos, tendo sido realizado com as seguintes finalidades:

a) Estudar a variação da densidade básica da madeira, entre árvores e dentro das árvores, de populações de Eucalyptus grandis, para seis idades, a saber: 5, 6, 7, 8, 9 e 10 anos;

b) Estudar as variações do teor de holocelulose e rendimento em celulose sulfato;

c) Verificar a existência de correlações entre densidades básicas, teor de holocelulose e rendimento em celulose sulfato, com o objetivo de nortear os estudos de melhoramento florestal; e

d) Verificar a possibilidade de se expressar o rendimento da floresta, diretamente, em termos de toneladas de celulose sulfato branqueada por hectare.

2. MATERIAL E MÉTODOS

2.1. Material

O material do presente estudo se constituiu de madeira de Eucalyptus grandis colhida de árvores de povoamentos implantados em propriedade da Aracruz Florestal S.A., na região de Aracruz-ES, nas idades de 5, 6, 7, 8, 9 e 10 anos.

2.2. Métodos

2.2.1. Coleta das amostras

Para cada uma das idades foram amostradas 25 árvores em quantidades proporcionais à distribuição normal de diâmetros à altura do peito (DAP) dentro das classes, segundo o método de Draudt (SPURR, 1952).

Estabelecido o número de árvores dentro de cada classe diamétrica, a escolha das mesmas foi feita ao acaso, evitando-se árvores atípicas ou defeituosas (bifurcadas, retorcidas ou espiraladas).

Após a escolha das árvores foram determinados: diâmetro à altura do peito (DAP), altura total (HT) e altura comercial (HC).

A seguir foram retiradas amostras (baguetas) com sonda de Pressler ao nível do DAP, na direção norte-sul, de casca-a-casca, e discos a diferentes alturas conforme mostrado na tabela 1.

Tabela 1. Alturas de retiradas dos discos

DISCO	ALTURA DE RETIRADA
0	Base: altura normal do corte
1	DAP : a 1,30 m do solo
2	25% da altura comercial
3	50% da altura comercial
4	75% da altura comercial
5	Topo: altura do limite mínimo de diâmetro

Os discos obtidos apresentavam espessuras em torno de 2,5 cm, faces paralelas e livres de nós ou qualquer outra anormalidade.

De cada disco foram anotados os diâmetros com e sem casca através de medições perpendiculares entre si.

2.2.2. Determinação da densidade básica

Dos discos foram retiradas cunhas e mantidas em água, sob vácuo intermitente, até atingirem a completa saturação. A seguir foi empregado o método da balança hidrostática (Norma ABCP M14/70) que consiste em se determinar o peso imerso, peso úmido e peso absolutamente seco da amostra.

O cálculo da densidade básica é feito através da seguinte expressão:

$$d_b = \frac{PS}{PU-PI} \quad \text{onde}$$

d_b = densidade básica, em g/cm^3
PS = peso absolutamente seco da amostra, em g
PU = peso úmido da amostra, em g
PI = peso imerso da amostra, em g

Para as baguetas, o método empregado foi o do máximo teor de umidade (FOELKEL et alii, 1971) que consiste em se determinar o peso úmido da amostra e respectivo peso absolutamente seco.

O cálculo da densidade básica é feito através da seguinte expressão:

$$d_b = \frac{1}{\frac{PU}{PS} - 0,346} \quad \text{onde}$$

d_b = densidade básica, em g/cm^3
PU = peso úmido da amostra, em g
PS = peso seco da amostra, em g

2.2.3. Teor de holocelulose

Para a realização dos ensaios, visando a determinação do teor de holocelulose, de cada disco foi retirada uma cunha.

O preparo final da serragem para os ensaios consistiu na moagem do material em moinho Wiley e classificação através de peneira de 40 mesh.

A determinação foi feita segundo método preconizado pelo Forest Products Laboratory (MOORE & JOHNSON, 1967).

2.2.4. Produção de celulose

Para a produção de celulose foi empregado o processo sulfato.

Os cozimentos foram realizados utilizando-se digestor rotatório, de aço inoxidável, capacidade para 20 litros e aquecido através de resistência elétrica.

Dentro de cada idade, os cozimentos foram conjuntos para as 150 amostras utilizando-se recipientes de tela de aço inoxidável, numa técnica semelhante à descrita por BARRICHELO & BRITO (1977).

As condições empregadas para os cozimentos são mostradas na tabela 2.

Tabela 2. Condições empregadas nos cozimentos

VARIÁVEL	
Álcali ativo como Na_2O	13-15 %
Sulfidez	25%
Atividade	100%
RElação licor-madeira	4 litros/1 kg
Temperatura máxima	170ºC
Tempo até 170ºC	180-210 min
Tempo a 170ºC	30 min

Estas condições foram suficientes para produzir celuloses, cujos graus de deslignificação, expresso pelo número de permanganato, se situaram entre 14 e 16.

Após cada cozimento, as celuloses eram removidas dos recipientes lavadas, e determinados os rendimentos em celulose de cada amostra.

A transformação para celulose branqueada foi feita admitindo-se um rendimento de branqueamento da ordem de 90%.

Desta forma:
rendimento em celulose branqueada = rendimento do cozimento x 0,9.

2.2.5. Cálculos estatísticos

Para os parâmetros analisados, a saber: densidade básica, teor de holocelulose e rendimento do cozimento, os resultados obtidos, para cada idade, foram utilizados para análises de variância e teste de Tukey, visando-se observar as variações entre posições. Neste caso, cada árvore foi considerada como sendo uma repetição.

A análise conjunta de todos os valores obtidos foi feita através de regressões lineares, utilizando-se computador eletrônico IBM 370/158.

3. RESULTADOS

3.1. Valores médios e parâmetros estatísticos

Tabela 3. Valores médios e demais parâmetros estatísticos para alturas, diâmetros à altura do peito (DAP) e densidades básicas, por idade

VARIÁVEL	$\bar{m}$	m	M	s	$s_{\bar{m}}$	C.V.
			Idade = 5 anos			
DAPF	15,2	8,0	22,6	3,41	0,68	22,50
ATOT	21,6	14,7	25,2	2,31	0,46	10,69
ACOM	17,3	8,0	21,4	3,20	0,64	18,50
GDAP	0,423	0,350	0,515	0,0351	0,007	8,30
GBAG	0,402	0,238	0,476	0,0472	0,009	11,73
			Idade = 6 anos			
DAPF	17,4	8,9	26,7	4,50	0,90	25,85
ATOT	23,8	16,2	29,0	3,87	0,77	16,29
ACOM	20,7	9,8	25,9	4,79	0,96	23,10
GDAP	0,482	0,408	0,605	0,0491	0,009	10,20
GBAG	0,452	0,365	0,547	0,0426	0,008	9,42

(continua)

Tabela 3. Continuação

VARIÁVEL	$\bar{m}$	m	M	s	$s_{\bar{m}}$	C.V.
			Idade = 7 anos			
DAPF	17,9	8,6	26,7	4,35	0,87	24,23
ATOT	25,1	13,2	32,0	4,13	0,83	16,46
ACOM	21,2	8,8	27,0	4,07	0,81	19,15
GDAP	0,468	0,396	0,590	0,0472	0,009	10,10
GBAG	0,441	0,370	0,510	0,0397	0,008	8,98
			Idade = 8 anos			
DAPF	20,0	9,2	31,8	5,54	1,11	27,76
ATOT	25,9	15,5	31,5	4,32	0,86	16,69
ACOM	22,2	10,2	23,2	4,82	0,94	21,71
GDAP	0,487	0,420	0,559	0,0376	0,008	7,72
GBAG	0,457	0,395	0,515	0,0376	0,008	8,23
			Idade = 9 anos			
DAPF	24,4	11,8	33,1	5,32	1,06	24,84
ATOT	27,4	19,0	33,5	4,02	0,80	14,71
ACOM	23,7	14,3	29,5	4,22	0,84	17,79
GDAP	0,500	0,410	0,608	0,0556	0,011	11,10
GBAG	0,473	0,413	0,572	0,0472	0,009	10,00
			Idade = 10 anos			
DAPF	20,3	11,8	32,8	5,21	1,04	25,69
ATOT	28,1	20,2	34,0	3,71	0,74	13,21
ACOM	24,1	15,1	29,4	4,15	0,83	17,20
GDAP	0,515	0,397	0,649	0,0589	0,012	11,42
GBAG	0,480	0,400	0,591	0,0487	0,010	10,13

DAPF = diâmetro à altura do peito, determinado no campo (cm)
ATOT = altura total (m)
ACOM = altura comercial (m)
GDAP = densidade básica do disco amostrado no DAP (g/cm^3)
GBAG = densidade básica da bagueta amostrada no DAP (g/cm^3)
$\bar{m}$ = valor médio
m = valor mínimo
M = valor máximo
s = desvio padrão da média
$s_{\bar{m}}$ = erro padrão da média
C.V. = coeficiente de variação

3.2. Densidades básicas médias das árvores, em função das densidades básicas dos discos tomados no DAP

Tabela 4. Para o fuste total

IDADE	F	C.V.	r	a	b
5	84,23**	3,81	0,8863**	0,061	0,8840
6	78,84**	4,41	0,8798**	0,108	0,8136
7	75,63**	4,26	0,8758**	0,123	0,7832
8	97,00**	3,26	0,8991**	0,077	0,8774
9	213,94**	3,26	0,9502**	0,063	0,9104
10	155,48**	3,54	0,9333**	0,112	0,8115
GERAL	1.016,70**	3,85	0,9343**	0,066	0,8972

F = valor do teste F da análise de variância da regressão
C.V. = coeficiente de variação (%)
r = coeficiente de correlação
a e b = parâmetros da equação de regressão linear onde a variável dependente é a densidade média da árvore e a variável independente a densidade básica do disco tomado no DAP
** = significativo ao nível de 1% de probabilidade

Tabela 5. Para o fuste comercial

IDADE	F	C.V.	r	a	b
5	85,60**	3,83	0,8878**	0,056	0,8964
6	79,51**	4,40	0,8807**	0,108	0,8147
7	75,63**	4,28	0,8756**	0,122	0,7862
8	97,85**	3,25	0,8998**	0,076	0,8794
9	216,05**	3,25	0,9507**	0,063	0,9118
10	155,67**	3,54	0,9334**	0,111	0,8129
GERAL	1.022,93**	3,84	0,9347**	0,066	0,8985

3.4. Densidades médias das árvores em função das densidades básicas das baguetas tomadas no DAP

Tabela 6. Para o fuste total

IDADE	F	C.V.	r	a	b
5	11,29**	6,73	0,5738**	0,264	0,4249
6	88,70**	4,21	0,8911**	0,070	0,9495
7	29,15**	5,86	0,7477**	0,138	0,7974
8	72,27**	3,66	0,8710**	0,116	0,8509
9	157,07**	3,74	0,9340**	0,022	1,0528
10	115,22*	4,02	0,9130**	0,069	0,9602
GERAL	482,29**	5,23	0,8747**	0,075	0,9327

F = valôr do teste F da análise de variância da regressão
C.V. = coeficiente de variação (%)
r = coeficiente de correlação
a e b = parâmetros da equação de regressão linear onde a variável dependente é a densidade média da árvore e a variável independente é a densidade básica da bagueta tomada no DAP
** = significativo ao nível de 1% de probabilidade

Tabela 7. Para o fuste comercial

IDADE	F	C.V.	r	a	b
5	11,24**	6,82	0,5730**	0,262	0,4296
6	89,44**	4,20	0,8918**	0,070	0,9506
7	29,24**	5,88	0,7481**	0,136	0,8000
8	71,81**	3,67	0,8703**	0,115	0,8515
9	157,92**	3,74	0,9343**	0,021	1,0542
10	114,52**	4,04	0,9125**	0,068	0,9613
GERAL	482,13**	5,24	0,8747**	0,075	0,9337

3.5. Valores médios e demais parâmetros estatísticos para densidades básicas, rendimento em celulose não-branqueada e teor de holocelulose, por idade e posição dentro da árvore

Tabela 8. Para a idade de 5 anos

VARIÁVEL	POSIÇÃO	$\bar{m}$	s	$s_{\bar{m}}$	C.V.
d_b	0	0,462	0,0461	0,0092	9,98
	1	0,423	0,0351	0,0070	8,30
	2	0,423	0,0440	0,0088	10,40
	3	0,430	0,0353	0,0071	8,21
	4	0,437	0,0298	0,0060	6,82
	5	0,427	0,0230	0,0046	5,39
R	0	48,5	1,74	0,35	3,59
	1	51,2	1,90	0,38	3,71
	2	52,3	1,64	0,33	3,14
	3	52,6	1,34	0,27	2,55
	4	51,7	1,22	0,24	2,36
	5	49,5	1,49	0,30	3,01
H	0	75,8	1,61	0,32	2,12
	1	77,2	1,16	0,23	1,50
	2	78,2	1,40	0,28	1,79
	3	79,2	1,23	0,25	1,55
	4	79,6	1,48	0,30	1,86
	5	79,3	1,40	0,28	1,76

d_b = densidade básica do disco (g/cm^3)
R = rendimento em celulose não-branqueada (%)
H = teor de holocelulose (%)
$\bar{m}$ = valor médio
s = desvio padrão
$s_{\bar{m}}$ = erro padrão da média
C.V. = coeficiente de variação (%)

Tabela 9. Para a idade de 6 anos

VARIÁVEL	POSIÇÃO	$\bar{m}$	s	$s_{\bar{m}}$	C.V.
d_b	0	0,488	0,0433	0,0087	8,87
	1	0,482	0,0491	0,0098	10,20
	2	0,496	0,0516	0,0103	10,41
	3	0,516	0,0549	0,0112	10,66
	4	0,509	0,0465	0,0093	9,14
	5	0,494	0,0459	0,0092	9,29

(continua)

Tabela 9. Continuação

VARIÁVEL	POSIÇÃO	$\bar{m}$	s	$s_{\bar{m}}$	C.V.
R	0	51,0	2,59	0,52	5,08
	1	53,8	2,84	0,58	5,28
	2	54,2	2,43	0,48	4,48
	3	54,0	2,79	0,55	5,11
	4	51,9	2,25	0,45	4,34
	5	49,7	1,56	0,31	3,14
H	0	77,7	2,08	0,42	2,68
	1	79,3	1,83	0,36	2,30
	2	80,4	1,53	0,30	1,90
	3	80,6	1,27	0,25	1,58
	4	80,7	1,49	0,30	1,84
	5	79,9	1,77	0,35	2,21

d_b = densidade básica do disco (g/cm^3)
R = rendimento em celulose não branqueada (%)
H = teor de holocelulose (%)
$\bar{m}$ = valor médio
s = desvio padrão
$s_{\bar{m}}$ = erro padrão da média
C.V. = coeficiente de variação (%)

Tabela 10. Para a idade de 7 anos

VARIÁVEL	POSIÇÃO	$\bar{m}$	s	$s_{\bar{m}}$	C.V.
d_b	0	0,512	0,0449	0,0090	8,76
	1	0,468	0,0473	0,0095	10,10
	2	0,468	0,0572	0,0114	12,22
	3	0,499	0,0528	0,0106	10,58
	4	0,496	0,0436	0,0087	8,80
	5	0,488	0,0362	0,0072	7,42
R	0	49,4	3,13	0,63	6,34
	1	52,5	1,93	0,38	3,68
	2	53,3	2,14	0,43	4,02
	3	52,9	1,51	0,30	2,85
	4	51,4	1,25	0,25	2,43
	5	48,9	1,48	0,30	3,03

(continua)

Tabela 10. Continuação

VARIÁVEL	POSIÇÃO	$\bar{m}$	s	$s_{\bar{m}}$	C.V.
H	0	75,8	1,72	0,34	2,28
	1	78,8	1,44	0,29	1,82
	2	79,8	1,05	0,21	1,32
	3	79,9	1,49	0,30	1,86
	4	80,1	1,47	0,30	1,84
	5	79,4	3,67	0,73	4,62

d_b = densidade básica do disco (g/cm^3)
R = rendimento em celulose não-branqueada (%)
H = teor de holocelulose (%)
$\bar{m}$ = valor médio
s = desvio padrão
$s_{\bar{m}}$ = erro padrão da média
C.V. = coeficiente de variação (%)

Tabela 11. Para a idade de 8 anos

VARIÁVEL	POSIÇÃO	$\bar{m}$	s	$s_{\bar{m}}$	C.V.
d_b	0	0,513	0,0348	0,0070	6,77
	1	0,487	0,0376	0,0075	7,72
	2	0,492	0,0417	0,0083	8,47
	3	0,512	0,0416	0,0083	8,11
	4	0,512	0,0450	0,0090	8,80
	5	0,496	0,0377	0,0075	7,59
R	0	48,9	1,94	0,39	3,97
	1	50,9	2,46	0,49	4,84
	2	53,3	2,46	0,49	4,62
	3	52,7	1,83	0,37	3,47
	4	52,0	1,62	0,32	3,12
	5	48,7	1,74	0,35	3,57
H	0	72,8	2,97	0,59	4,08
	1	74,7	4,50	0,90	6,02
	2	75,6	4,66	0,93	6,16
	3	76,5	5,06	1,01	6,61
	4	77,6	3,93	0,79	5,06
	5	77,0	5,02	1,00	6,52

d_b = densidade básica do disco (g/cm^3)
R = rendimento em celulose não-branqueada (%)
H = teor de holocelulose (%)
$\bar{m}$ = valor médio
s = desvio padrão
$s_{\bar{m}}$ = erro padrão da média
C.V. = coeficiente de variação (%)

Tabela 12. Para a idade de 9 anos

VARIÁVEL	POSIÇÃO	$\bar{m}$	s	$s_{\bar{m}}$	C.V.
	0	0,520	0,0503	0,0101	9,67
	1	0,501	0,0556	0,0111	11,10
d_b	2	0,514	0,0583	0,0117	11,35
	3	0,524	0,0627	0,0125	11,97
	4	0,529	0,0570	0,0114	10,77
	5	0,517	0,0463	0,0093	8,97
	0	48,5	1,65	0,33	3,41
	1	51,8	2,46	0,49	4,75
R	2	54,3	3,83	0,77	7,06
	3	54,5	3,24	0,65	5,95
	4	52,0	1,86	0,37	3,58
	5	49,7	1,78	0,36	3,59
	0	73,7	2,93	0,59	3,98
	1	76,1	2,07	0,41	2,72
H	2	77,8	2,13	0,44	2,74
	3	78,3	1,80	0,36	2,30
	4	78,5	1,73	0,34	2,20
	5	78,5	1,76	0,35	2,24

d_b = densidade básica do disco (g/cm^3)
R = rendimento em celulose não-branqueada (%)
H = teor de holocelulose (%)
$\bar{m}$ = valor médio
s = desvio padrão
$s_{\bar{m}}$ = erro padrão da média
C.V. = coeficiente de variação (%)

Tabela 13. Para a idade de 10 anos

VARIÁVEL	POSIÇÃO	$\bar{m}$	s	$s_{\bar{m}}$	C.V.
	0	0,533	0,0517	0,0103	9,70
	1	0,516	0,0589	0,0118	11,42
d_b	2	0,525	0,0556	0,0111	10,60
	3	0,535	0,0549	0,0110	10,25
	4	0,540	0,0544	0,0109	10,08
	5	0,509	0,0465	0,0093	9,14

(continua)

Tabela 13. Continuação

VARIÁVEL	POSIÇÃO	$\bar{m}$	s	$s_{\bar{m}}$	C.V.
	0	45,6	2,10	0,42	4,60
	1	49,1	2,29	0,46	4,66
R	2	50,7	2,53	0,51	4,99
	3	50,8	1,78	0,36	3,50
	4	50,2	1,61	0,32	3,21
	5	48,4	1,37	0,27	2,83
	0	72,1	2,26	0,45	3,13
	1	75,7	2,52	0,50	3,33
H	2	76,6	2,41	0,48	3,15
	3	77,7	1,68	0,34	2,16
	4	78,1	1,87	0,37	2,39
	5	79,1	1,83	0,36	2,31

d_b = densidade básica do disco (g/cm^3)
R = rendimento em celulose não-branqueada (%)
H = teor de holocelulose (%)
$\bar{m}$ = valor médio
s = desvio padrão
$s_{\bar{m}}$ = erro padrão da média
C.V. = coeficiente de variação (%)

3.6. Análises de variância

Tabela 14. Análises de variância entre posições dos discos amostrados para densidades básicas, teor de holocelulose e rendimento em celulose não-branqueada

VARIÁVEL	F	C.V.	d.m. s (5%)	d.m. s (1%)
		Idade = 5 anos		
d_b	4,11**	8,40	0,030	0,035
H	28,65**	17,70	1,1	1,3
R	26,88**	3,08	1,3	1,5
		Idade = 6 anos		
d_b	1,74$^{n.s.}$	9,75	0,040	0,046
H	11,30**	2,10	1,4	1,6
R	1,93$^{n.s.}$	12,70	5,5	6,3

(continua)

Tabela 14. Continuação

VARIÁVEL	F	C.V.	d.m. s (5%)	d.m. s (1%)
		Idade = 7 anos		
d_b	3,47**	9,72	0,039	0,045
H	16,22**	2,53	1,6	1,9
R	37,94**	3,40	1,4	1,7
		Idade = 8 anos		
d_b	2,15$^{n.s.}$	7,94	0,033	0,038
H	3,94**	5,79	3,6	4,2
R	22,59**	3,99	1,7	1,9
		Idade = 9 anos		
d_b	0,78$^{n.s.}$	10,68	0,045	0,052
H	20,71**	2,72	1,7	2,0
R	21,35**	5,02	2,1	2,5
		Idade = 10 anos		
d_b	1,20$^{n.s.}$	10,22	0,044	0,051
H	29,99**	2,96	1,9	2,2
R	24,05**	4,05	1,6	1,9

d_b = densidade básica do disco (g/cm^3)
F = valor do teste F da análise de variância
C.V. = coeficiente de variação (%)
d.m. s (5%) = diferença mínima significativa ao nível de 5% de probabilidade (teste de Tukey)
d.m. s (1%) = diferença mínima significativa ao nível de 1% de probabilidade (teste de Tukey)
n.s. = não-significativo
** = significativo ao nível de 1% de probabilidade

3.7. Correlações testadas entre densidades básicas, rendimento em celulose e teor de holocelulose

Tabela 15. Rendimento em celulose não-branqueada e densidade básica média da árvore (fuste comercial)

IDADE	F	C.V.	r
5	0,12$^{n.s.}$	48,72	0,0708$^{n.s.}$
6	2,57$^{n.s.}$	55,49	0,3171$^{n.s.}$
7	3,40$^{n.s.}$	52,58	0,3590$^{n.s.}$
8	1,59$^{n.s.}$	62,18	0,2538$^{n.s.}$
9	0,34$^{n.s.}$	56,72	0,1208$^{n.s.}$
10	7,55*	50,58	0,4971**
GERAL	38,70**	59,84	0,4553**

F = valor do teste F da análise de variância da regressão
C.V. = coeficiente de variação (%)
r = coeficiente de correlação
n.s. = não-significativo
* = significativo ao nível de 5% de probabilidade
** = significativo ao nível de 1% de probabilidade

Tabela 16. Teor de holocelulose e densidade básica média da árvore (fuste comercial)

IDADE	F	C.V.	r
5	0,11$^{n.s.}$	48,05	0,0693$^{n.s.}$
6	2,37$^{n.s.}$	57,00	0,3059$^{n.s.}$
7	3,30$^{n.s.}$	52,18	0,3539$^{n.s.}$
8	1,57$^{n.s.}$	63,15	0,2530$^{n.s.}$
9	0,36$^{n.s.}$	57,79	0,1247$^{n.s.}$
10	7,47**	50,43	0,4952**
GERAL	38,58**	60,07	0,4548**

F = valor do teste F da análise de variância da regressão
C.V. = coeficiente de variação (%)
r = coeficiente de correlação
n.s. = não-significativo
** = significativo ao nível de 1% de probabilidade

Tabela 17. Rendimento em celulose não-branqueada e teor de holocelulose

IDADE	F	C.V.	r	a	b
5	26943,30**	1,43	0,9996**	-0,48	0,6675
6	6920,25**	3,37	0,9983**	1,70	0,6454
7	19218,41**	1,95	0,9994**	-0,64	0,6666
8	12195,72**	2,79	0,9990**	1,44	0,6713
9	4012,41**	4,32	0,9971**	2,37	0,6613
10	5527,96**	3,75	0,9979**	-0,22	0,6523
GERAL	39281,03**	4,12	0,9982**	0,42	0,6623

F = valor do teste F da análise de variância da regressão
C.V. = coeficiente de variação (%)
r = coeficiente de correlação
a e b = parâmetros da equação de regressão linear onde a variável dependente é o rendimento em celulose e variável independente é o teor de holocelulose
** = significativo ao nível de 1% de probabilidade

Tabela 18. Rendimento em celulose não-branqueada no DAP e densidade básica no DAP

IDADE	F	C.V.	r
5	0,05$^{n.s.}$	3,79	0,0456$^{n.s.}$
6	5,06*	4,78	0,4248*
7	1,62$^{n.s.}$	3,62	0,2563$^{n.s.}$
8	0,79$^{n.s.}$	4,87	0,1821$^{n.s.}$
9	0,41$^{n.s.}$	4,81	0,1317$^{n.s.}$
10	1,92$^{n.s.}$	4,58	0,2777$^{n.s.}$
GERAL	0,33$^{n.s.}$	5,26	0,0473$^{n.s.}$

F = valor do teste F da análise de variância da regressão
C.V. = coeficiente de variação (%)
r = coeficiente de correlação
n.s. = não-significativo
* = significativo ao nível de 5% de probabilidade

Tabela 19. Teor de holocelulose no DAP e densidade básica no DAP

IDADE	F	C.V.	r
5	0,04$^{n.s.}$	1,54	0,0399$^{n.s.}$
6	0,45$^{n.s.}$	2,33	0,1379$^{n.s.}$
7	2,17$^{n.s.}$	1,78	0,2934$^{n.s.}$
8	2,11$^{n.s.}$	5,89	0,2896$^{n.s.}$
9	1,42$^{n.s.}$	2,70	0,2410$^{n.s.}$
10	0,45$^{n.s.}$	3,36	0,1385$^{n.s.}$
GERAL	2,05$^{n.s.}$	3,83	0,1170$^{n.s.}$

F = valor do teste F da análise de variância da regressão
C.V. = coeficiente de variação (%)
r = coeficiente de correlação
n.s. = não-significativo

Tabela 20. Rendimento em celulose não-branqueada na árvore e rendimento em celulose no DAP

IDADE	F	C.V.	r
5	0,57$^{n.s.}$	48,24	0,1561$^{n.s.}$
6	1,54$^{n.s.}$	56,65	0,2502$^{n.s.}$
7	0,21$^{n.s.}$	56,08	0,0960$^{n.s.}$
8	0,27$^{n.s.}$	63,91	0,1084$^{n.s.}$
9	0,20$^{n.s.}$	56,89	0,0934$^{n.s.}$
10	9,19**	49,28	0,5343**
GERAL	0,01$^{n.s.}$	67,21	0,0071$^{n.s.}$

F = valor do teste F da análise de variância da regressão
C.V. = coeficiente de variação (%)
r = coeficiente de correlação
n.s. = não-significativo
** = significativo ao nível de 1% de probabilidade

Tabela 21. Teor de holocelulose na árvore e teor de holocelulose no DAP

IDADE	F	C.V.	r
5	1,05$^{n.s.}$	47,10	0,2093$^{n.s.}$
6	0,89$^{n.s.}$	58,74	0,1926$^{n.s.}$
7	6,69*	49,10	0,4748*
8	0,14$^{n.s.}$	65,07	0,0785$^{n.s.}$
9	9,99**	48,63	0,5503**
10	0,42$^{n.s.}$	57,53	0,1334$^{n.s.}$
GERAL	0,17$^{n.s.}$	67,41	0,0343$^{n.s.}$

F = valor do teste F da análise de variância da regressão
C.V. = coeficiente de variação (%)
r = coeficiente de correlação
n.s. = não-significativo
* = significativo ao nível de 5% de probabilidade
** = significativo ao nível de 1% de probabilidade

Tabela 22. Quantidade (kg) de celulose branqueada por árvore em função do DAP (cm), altura total (m) e densidade básica da bagueta (g/cm^3) amostrada no DAP

IDADE	F	C.V.	r	a	b
5	102,48**	20,91	0,9037**	-14,27	0,3448
6	232,61**	17,55	0,9539**	-25,14	0,4528
7	282,43**	15,46	0,9616**	-22,24	0,4113
8	268,58**	18,06	0,9597**	-40,06	0,4934
9	201,82**	18,28	0,9474**	-45,92	0,5040
10	457,65**	12,75	0,9758**	-34,19	0,4455
GERAL	1886,34**	18,13	0,9629**	-29,23	0,4478

F = valor do teste F da análise de variância da regressão
C.V. = coeficiente de variação (%)
r = coeficiente de correlação
a e b = parâmetros da equação de regressão, sendo a variável independente DAP x altura x densidade básica da bagueta e a variável dependente a quantidade de celulose branqueada por árvore
** = significativo ao nível de 1% de probabilidade

4. DISCUSSÃO DOS RESULTADOS

A tabela 3 apresenta os valores médios, máximos e mínimos, desvios padrões, erros padrões da média e coeficiente de variação dos DAP, alturas, densidades básicas dos discos e baguetas, por idade.

Como era de se esperar, há uma tendência de aumento de todos estes parâmetros com a idade. Como a amostragem esteve limitada a 25 árvores ocorreram alguns desvios, devido, provavelmente à influência genética ou ambiental do material manipulado. Os coeficientes de variação podem ser considerados satisfatórios, com exceção, dos encontrados para DAP. Isto se justifica pelo método de amostragem empregado, que procurou abarcar, ao máximo, a amplitude de variação diamétrica.

Outro fato que reforça observações anteriormente obtidas, é de que, a densidade básica da bagueta é menor que a densidade básica do disco pelo fato da primeira não representar a amostra de maneira proporcional.

A densidade básica média da árvore (peso a.s. total da árvore/volume total) está altamente correlacionada com as densidades básicas determinadas na região do DAP, tanto através do disco como da bagueta, conforme mostrado nas tabelas 4 a 7.

No caso de se considerar os fustes comerciais, as equações de regressão que permitem se estimar as densidades das árvores, são:

a) Para a idade de 5 anos:

GA = 0,056 + 0,8964 GDAP (r = 0,8878**)
GA = 0,262 + 0,4296 GBAG (r = 0,5730**)

b) Para a idade de 6 anos:

GA = 0,108 + 0,8147 GDAP (r = 8807**)
GA = 0,070 + 0,9506 GBAG (r = 8918**)

c) Para a idade de 7 anos:

GA = 0,122 + 0,7862 GDAP (r = 8756**)
GA = 0,136 + 0,8000 GBAG (r = 0,7481**)

d) Para a idade de 8 anos:

GA = 0,076 + 0,8794 GDAP (r = 0,8794**)
GA = 0,115 + 0,8515 GBAG (r = 0,8703**)

e) Para a idade de 9 anos:

GA = 0,063 + 0,9118 GDAP (r = 9507**)
GA = 0,021 + 1,0542 GBAG (r = 0,9343**)

f) Para a idade de 10 anos:

GA = 0,111 + 0,8129 GDAP (r = 0,9334**)
GA = 0,068 + 0,9613 GBAG (r = 0,9126**)

g) Para a espécie, independente da idade:

GA = 0,066 + 0,8985 GDAP (r = 0,9347**)
GA = 0,075 + 0,9337 GBAG (r = 0,8747**)

onde

GA = densidade básica média da árvore (g/cm^3)
GDAP = densidade básica do disco amostrado no DAP (g/cm^3)
GBAG = densidade básica da bagueta amostrada no DAP (g/cm^3)

A evolução da densidade básica média, tanto da bagueta como da árvore, pode ser visualizada no gráfico 1. Sem justificativa aparente, a idade 6, provavelmente devido à influência genética ou ambiental, se apresenta totalmente deslocada na tendência mostrada pela espécie, através das idades restantes.

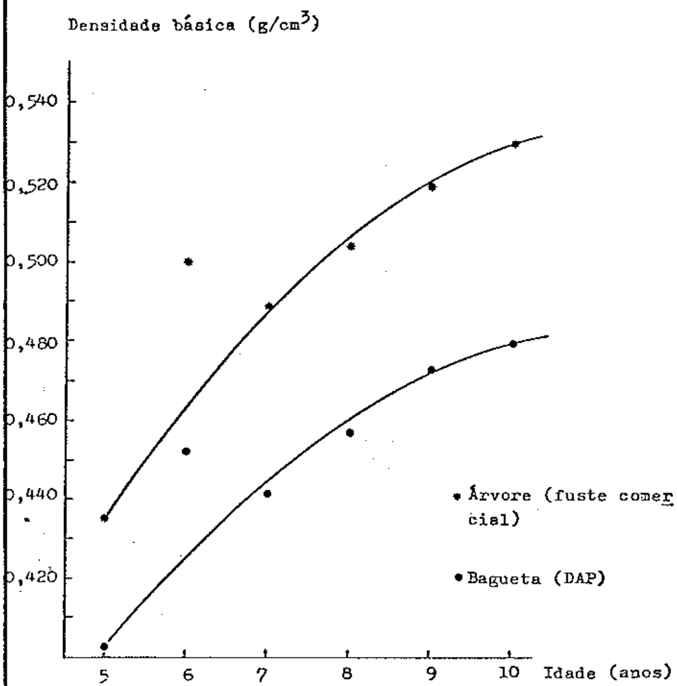

Gráfico 1. Densidades básicas médias das árvores e baguetas em função da idade

As tabelas 8 a 13 apresentam os valores médios, desvios padrões, erros padrões da média, e coeficientes de variação das densidades básicas, rendimentos em celulose não-branqueada e teores de holocelulose, por idade, para os discos amostrados.

De uma maneira geral, os coeficientes de variação, entre árvores e dentro das mesmas posições, se mostraram bastante baixos.

Os gráficos 2 a 4 mostram as variações longitudinais dos valores médios dos parâmetros para as idades ensaiadas.

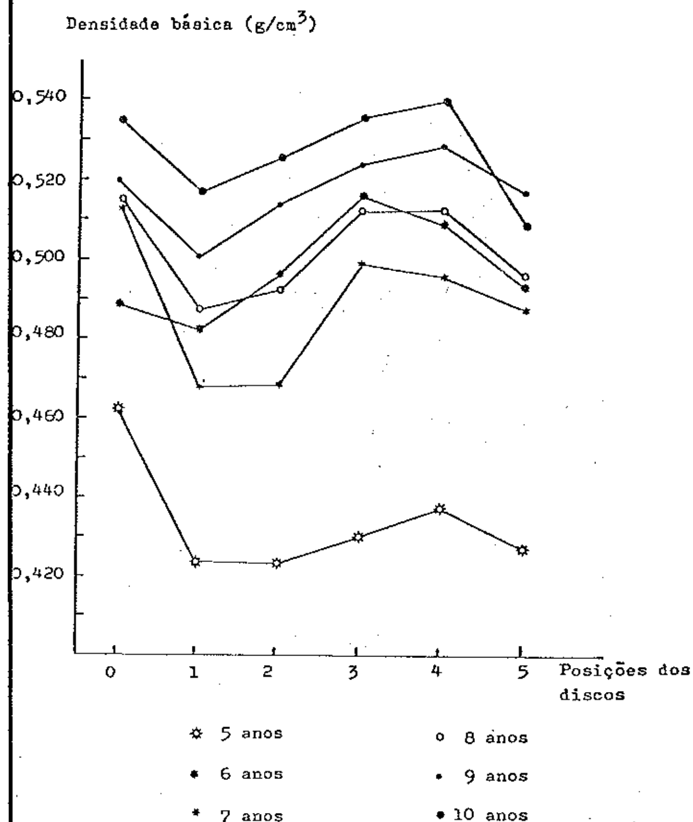

Gráfico 2. Variações longitudinais das médias das densidades básicas dos discos

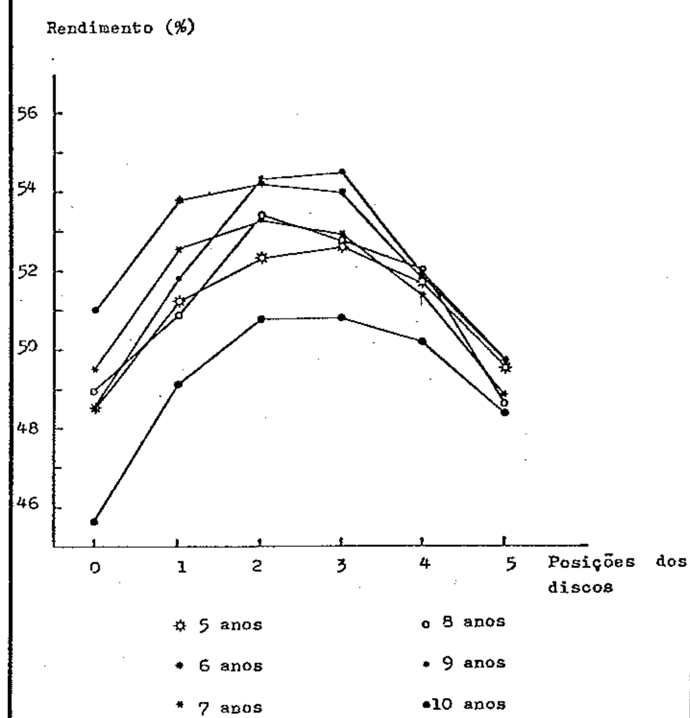

Gráfico 3. Variações longitudinais das médias dos rendimentos em celulose não-branqueada dos discos

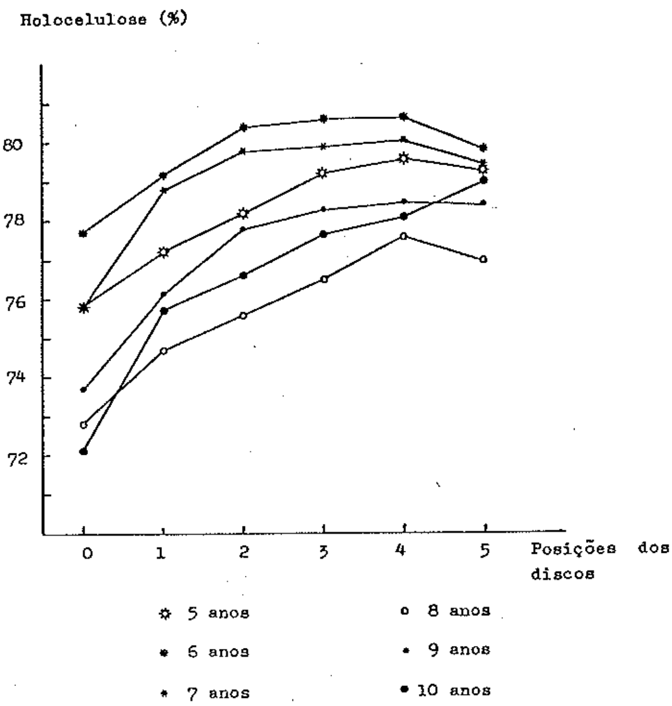

Gráfico 4. Variações longitudinais das médias dos teores de holocelulose dos discos

Pelo gráfico 2 observa-se que a tendência geral é da densidade básica ser elevada na base da árvore, caindo a seguir até a altura do DAP ou 25% da altura comercial, se elevar até 50 a 75% da mesma, e finalmente, decrescer em direção ao topo.

Do ponto de vista estatístico, todavia, as variações apresentadas só se mostraram significativas, através do teste F, para as idades de 5 e 7 anos, como é mostrado na tabela 14.

Com exceção da idade 6, a exemplo do apresentado no gráfico 1, as densidades básicas médias nos pontos amostrados confirmam a tendência da densidade aumentar com a idade do povoamento.

Quanto ao rendimento em celulose não-branqueada, o modelo de variação se aproxima de um polinômio do 2º grau, indistintamente para todas as idades, como pode ser observado no gráfico 2.

Dentro de cada idade, tanto a base como o topo, são as regiões da árvore que conduzem a um menor rendimento em celulose. De um modo geral, a maximização do rendimento é conseguida quando se utiliza a madeira compreendida entre o DAP e 50% da altura comercial para as idades mais jovens e, entre 25% e 75% da altura comercial para as árvores mais velhas, (8 a 10 anos).

Pela análise de variância, mostrada na tabela 14, observa-se que houve diferença significativa para rendimentos em celulose não-branqueada, com exceção da idade 6.

Finalmente, o gráfico 4 mostra que, a exemplo do que ocorreu para rendimento, o teor de holocelulose na base da árvore é sensivelmente menor. O modelo de variação longitudinal se mostra crescente até cerca de 75% da altura comercial, a partir do qual há um pequeno decréscimo. A análise de variância, da tabela 14, ressalta o fato de haver diferenças estatisticamente significativas entre as diferentes posições, quanto ao teor de holocelulose.

A tabela 15 e 16 mostram que, para as idades de 5 a 9 anos, não há correlação entre rendimento em celulose não-branqueada ou teor de holocelulose com a densidade básica média da árvore. Em outras palavras, a árvore de maior densidade, não conduz, necessariamente, a maiores quantidades de celulose ou holocelulose. Como destacado anteriormente, as bases das árvores apresentam altas densidades e relativamente baixo rendimento em celulose e teor de holocelulose (gráficos 2, 3 e 4).

Mesmo quando se considera um ponto definido como referência, por exemplo, a região do DAP, não é encontrada nenhuma correlação entre estes parâmetros, como é mostrado na tabela 18 e 19.

Por outro lado, há uma correlação elevada entre rendimento em celulose não-branqueada e teor de holocelulose para todas as idades estudadas (tabela 17).

Ao contrário do que ocorre para densidade, em que há correlação entre a densidade determinada no DAP e densidade média da árvore, não foi encontrado tal fato para rendimento e teor de holocelulose (tabela 20 e 21). Isto posto, não é possível se estimar o rendimento ou teor de holocelulose, a ser obtido de uma árvore, a partir de dados colhidos, exclusivamente, no DAP.

Devido este fato, foram testados diversos modelos que permitissem calcular a quantidade de celulose a ser obtida em função das observações que normalmente são obtidas em inventários e estudos tecnológicos.

O melhor modelo encontrado foi:

$$Q = a + b \cdot (DAP) \cdot (H) \cdot (GBAG)$$

onde

Q = quantidade de celulose branqueada por árvore (kg)
DAP = diâmetro à altura do peito (cm)
H = altura total da árvore (m)
GBAG = densidade básica da bagueta amostrada no DAP (g/cm^3)
a e b = parâmetros estimados pelo método dos quadrados mínimos

Os valores de F e coeficientes de variação das análises de variância das regressões, para as idades de 5 a 10 anos, bem como, coeficientes de correlação e parâmetros das equações são mostrados na tabela 22.

Estas equações, associadas a dados de inventário e determinação da densidade básica da bagueta amostrada no DAP, permitem, em última análise, se estimar a quantidade de celulose sulfato branqueada a ser obtida por hectare, a uma dada idade.

Para tanto, dever-se-á, para cada árvore da parcela experimental, anotar seu DAP, sua altura total (H) e densidade da bagueta amostrada no DAP (GDAP). Daí:

$$Q_1 = a + b \cdot DAP_1 \cdot H_1 \cdot GBAG_1$$

$$Q_n = a + b \cdot DAP_n \cdot H_n \cdot GBAG_n$$

$$\Sigma Q = n\,a + b \cdot [(DAP_1 \cdot H_1 \cdot GBAG_1) + \ldots + (DAP_n \cdot H_n \cdot GBAG_n)]$$

E finalmente,

$$\text{Quantidade de celulose/ha} = \Sigma Q \cdot \frac{10.000}{\text{Área da parcela}}$$

5. CONCLUSÕES

Da discussão dos resultados podem ser tiradas as seguintes conclusões:

5.1. As densidades básicas das baguetas se mostraram menores que as densidades básicas dos discos.

5.2. As densidades básicas médias das árvores se mostraram altamente correlacionadas com as densidades básicas determinadas na região do DAP, tanto através dos discos como das baguetas.

5.3. As densidades básicas médias das árvores se mostram crescentes com a idade do povoamento.

5.4. Dentro da árvore, a densidade básica se mostra mais elevada na base e entre 50 a 75% do fuste comercial.

5.5. Para todas as idades, as bases e os topos são as regiões das árvores que apresentam um menor rendimento em celulose.

5.6. O teor de holocelulose na base é sensivelmente menor, crescendo até cerca de 75% da altura comercial.

5.7. Não foi encontrada correlação entre rendimento em celulose ou teor de holocelulose com a densidade média da árvore. Tal fato não ocorre, inclusive, quando se trabalha com um ponto definido, por exemplo, o DAP.

5.8. O rendimento em celulose se apresenta altamente correlacionado com o teor de holocelulose.

5.9. Não foi observada correlação entre rendimento em celulose obtida da região do DAP e rendimento em celulose médio da árvore. Da mesma forma, não foi encontrada esta correlação para teor de holocelulose.

5.10. A partir do conhecimento do diâmetro à altura do peito, altura total e densidade básica da bagueta amostrada no DAP é possível, para cada idade, se calcular a quantidade de celulose sulfato branqueada a ser obtida por árvore. Estes dados, associados ao tamanho das parcelas utilizadas no inventário, permitem se estimar a quantidade de celulose a ser obtida por hectare.

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DENSIDADE BÁSICA DA MADEIRA DE *Pinnus eliottii* Var. *elliottii* EM TRÊS REGIÕES DO ESTADO DE SÃO PAULO.

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Brasil.

Resumo

A densidade básica da madeira de *Pinus elliottii* Engelm. var. *elliottii* foi determinada em árvores crescendo nas regiões de Itapeva (Latitude 24°02' S, longitude 49°06' W), Itapetininga (23°42' S, 45°57' W); e Mogi Guaçu (22°18' S, 47°13' W), no Estado de São Paulo, Brasil. A idade dos povoamentos era de 10, 11, 12 e 13 anos, em Itapeva, 13, 17 e 19 anos, em Itapetininga, e 18 e 19 anos para a região de Mogi Guaçu. Todos os povoamentos já haviam sido desbastados, em diferentes idades e em diferentes intensidades.

A densidade básica da madeira aumentou com a idade do povoamento em todas as regiões estudadas. Os maiores valores foram obtidos em Mogi Guaçu, onde as árvores apresentam também menor taxa de crescimento. Em média, a densidade básica da madeira (d_A) pode ser estimada pela seguinte equação:

$$d_A = 0,0455 + 0,8062\ d_D$$

onde: d_D é a densidade básica ao nível do DAP.

Foram feitas ainda comparações entre os pesos de matéria seca dos diferentes locais estudados.

WOOD SPECIFIC GRAVITY OF SLASH PINE TREES IN DIFFERENT SITES OF SÃO PAULO, BRASIL.

Summary

The wood specific gravity of Slash Pine (*Pinus elliottii* Engelm. var. *elliottii*) trees growing in Itapeva (latitude 24°02' S, longitude 49°06' W), Itapetininga (23°42' S, 45°57' W) and Mogi Guaçu (22°18' S, 47°13' W), São Paulo State, Brazil, was determined. The stands were 10, 11, 12 and 13 years old in Itapeva, 13, 17 and 19 in Itapetininga, and 18 and 19 years old in Mogi Guaçu. All stands have been thinned, at different ages with different intensities.

The wood specific gravity has increased with age in each region. The higher values were obtained in Mogi Guaçu where lower growth rate has been observed. As an average the tree wood specific gravity (d_A) can be estimated by the equation:

$$d_A = 0.0455 + 0.8062\ d_D$$

where d_d is the specific gravity at dbh level.

Comparisons were made among sites in terms of dry weight matter.

Introdução

O Instituto Florestal do Estado de São Paulo estabeleceu plantações de *Pinus elliottii* var. *elliottii* em várias de suas Estações Experimentais, tanto em áreas favoráveis ao seu desenvolvimento como também em algumas outras consideradas inaptas segundo zoneamento ecológico realizado por GOLFARI et alii (1978).

O rendimento volumétrico da citada espécie tem-se mostrado variável, encontrando-se produtividades que no Estado de São Paulo variam desde 6,92 até 40,00 m^3/ha/ano (VAN GOOR et alii , 1975). A qualidade da madeira formada em talhões comerciais de diferentes rítmos de crescimento, no entanto, tem sido pouco pesquisada, apesar da importância do seu conhecimento para a utilização tecnológica dessa matéria-prima.

Dentre os parâmetros de qualidade sobressai-se a densidade básica que pode ser utilizada como um índice seguro para avaliar o tipo de madeira produzida face às suas correlações com diferentes propriedades físico-mecânicas.

No presente trabalho estuda-se a variação da densidade básica, do *Pinus elliottii* var. *elliottii* em 3 regiões e diversas idades, objetivando caracterizar o tipo de madeira de fibra longa que o Estado de São Paulo pode produzir com a referida espécie.

Material e Métodos

A espécie estudada foi o *Pinus elliottii* Engelm. var. *elliottii* nas regiões de Itapeva, Itapetininga e Mogi Guaçu, Estado de São Paulo.

Os povoamentos estudados na região de Itapeva encontram-se localizados a 24°02' lat. S. e 49°06' long. W.Gr. O clima é Cfa segundo a classificação de Köppen, com média anual de 1000 a 1400 mm de precipitação. O solo é latosol vermelho-amarelo orto e a altitude média é de 730 m. Foram utilizados maciços com 10; 11; 12 e 13 anos de idade, plantados ao espaçamento inicial de 2,8 x 1,5 m. O povoamento de 10 anos foi desbastado aos 8 anos de idade com retirada de 45% das árvores, e os de 11; 12 e 13 anos foram submetidos a 2 desbastes, com retirada de 38% das árvores no primeiro e 40% no segundo.

As plantações de Itapetininga localizam-se a 23°42' lat. S. e 45°57' long. W. Gr. O clima é classificado como Cfa, com precipitação anual média de 1217 mm. O solo é podzólico vermelho-amarelo variação Laras e a altitude média é de 645 m. Os povoamentos utilizados tinham 13; 17 e 19 anos de idade, tendo sido estabelecidos ao espaçamento inicial de respectivamente 2 x 2 m, 1,5 x 1,5 m e 1,5 x 1,5 m, e foram submetidos a 3 desbastes. O número de árvores remanescentes era de respectivamente 1192; 1078 e 1083 árvores/ha.

Os maciços de Mogi Guaçu estão localizados a 22°18' lat. S. e 47°13' long. W. Gr. O clima é Cwa, com precipitação média anual de 1307 mm. A altitude é de cerca de 600 m e o solo é latosol vermelho-amarelo fase arenosa. As plantações estudadas tinham 18 e 19 anos de idade, e o espaçamento inicial adotado foi de 1,5 x 1,5 m. Os povoamentos foram desbastados aos 13 anos de idade com retirada de 50% das árvores.

Foram amostradas por sorteio ao acaso 10 árvores por idade em cada um dos três locais. As árvores sorteadas foram abatidas, retirando-se secções à altura do DAP e de 2,0 em 2,0 m a partir da base para a determinação da densidade básica. Esta foi estimada pela relação entre peso de matéria seca e volume saturado obtido pelo método da balança hidrostática. A densidade básica média da árvore foi determinada pela metodologia descrita por FERREIRA (1970).

Para melhor caracterizar os povoamentos em estudo realizou-se inventário por ocasião da retirada das árvores abatidas. Foram estabelecidas 8 parcelas de amostragem em Mogi Guaçu, 12 em Itapetininga e 16 em Itapeva, abrangendo todas as idades de cada local. Foram calculados os números de árvores remanscentes, área basal, altura dominante e volume comercial sem casca por hectare.

Resultados e Discussão

As características gerais dos povoamentos estudados encontram-se sintetizadas na tabela 1.

Tabela 1. Características gerais dos talhões comerciais amostrados de *Pinus elliottii* var. *elliottii* nas 3 regiões e diferentes idades estudadas.

Localidade	Idade (anos)	Ano de plantio	Nº de desbastes	Nº de árvores remanescentes/ha	Volume (m^3sc/ha)	Área basal (m^2/ha)	Altura dominante (m)
Itapeva	10	1969	1	1300	215,606	36,40	15,8
	11	1968	2	880	205,153	30,59	18,2
	12	1967	2	880	213,948	31,97	17,8
	13	1966	2	930	232,852	35,30	17,0
Itapetininga	13	1966	3	1192	249,259	35,39	16,4
	17	1963	3	1078	239,230	35,49	16,9
	19	1960	3	1083	247,000	31,30	20,4
Mogi Guaçu	18	1962	1	1690	229,294	34,85	17,0
	19	1961	1	1300	234,030	36,34	17,4

Na tabela 2 estão relacionadas características dendrométricas das árvores amostradas e os respectivos valores de densidade básica média da árvore e ao nível do DAP.

Tabela 2. Valores médios de altura total, DAP com casca e densidade básicas da árvore e ao nível do DAP das árvores amostradas nos 3 locais em diferentes idades.

Local	Idade (anos)	Altura total (m)	DAP com casca (cm)	Densidade da árvore (g/cm^3)	Densidade ao DAP (g/cm^3)
Itapeva	10	14,5	19,1	0,362	0,389
	11	16,5	20,6	0,373	0,400
	12	16,5	21,9	0,400	0,426
	13	15,9	20,0	0,397	0,455
Itapetininga	13	15,4	19,7	0,402	0,444
	17	16,3	19,1	0,453	0,508
	19	19,1	18,9	0,455	0,529
Mogi Guaçu	18	17,0	19,4	0,505	0,562
	19	16,9	19,5	0,517	0,564

Depreende-se da tabela 2 que os valores de densidade básica aumentaram com a idade dentro de cada local, sendo a densidade básica ao nível do DAP sempre superior à da árvore. Não houve diferença entre as densidades obtidas em Itapeva (0,397 g/cm^3) e a de Itapetininga (0,402 g/cm^3) nas idades de 13 anos. Entretanto para a região de Mogi Guaçu, considerada inapta para o plantio da espécie segundo GOLFARI et alii (1978), a densidade de 0,517 g/cm^3 aos 19 anos foi superior à encontrada para Itapetininga na mesma idade (0,455 g/cm^3).

Os valores de densidade básica ao nível do DAP em Mogi Guaçu são semelhantes aos encontrados para a mesma espécie e mesmo local por BRASIL et alii (1978), que obtiveram valores médios de 0,541; 0,550 e 0,531 g/cm^3 respectivamente para as idades de 15, 16 e 17 anos.

Na tabela 3 acham-se relacionados os valores médios de altura, DAP e densidade para as árvores amostradas, por região estudada.

Tabela 3. Valores médios de densidade básica da árvore e do nível do DAP, altura total e DAP com casca nas 3 regiões estudadas.

	Itapeva		Itapetininga		Mogi Guaçu	
	Média	Desvio padrão	Média	Desvio padrão	Média	Desvio padrão
Densidade da árvore (g/cm^3)	0,383	0,031	0,436	0,046	0,511	0,041
Densidade ao DAP (g/cm^3)	0,417	0,038	0,494	0,056	0,563	0,033
Altura total (m)	15,8	1,4	16,8	2,2	16,9	1,8
DAP com casca (cm)	20,4	3,6	19,4	3,3	19,4	3,5

Verifica-se na tabela 3 que os valores médios de DAP e altura das árvores amostradas não são diferentes, embora os povoamentos em Itapeva sejam mais novos que os de Mogi Guaçu e Itapetininga.

Procedeu-se a comparação entre o peso de matéria seca obtido em função de DAP com casca e altura total, segundo as equações desenvolvidas por BRASIL et alii (1980). Considerando-se os valores médios de DAP e altura dos três locais, foram estimados os seguintes pesos de matéria seca, como médias dos três locais: 79,81 kg, para Itapeva; 89,31 kg para Itapetininga ; e 100,98 kg para Mogi Guaçu. Desse modo, nota-se que apesar de serem iguais as médias de DAP e altura encontrados em Mogi Guaçu e Itapetininga os valores de peso de matéria seca são superiores em 11,6% em Mogi Guaçu. Comparando-se com Itapeva, o peso de matéria seca foi 21,0% superior em Mogi Guaçu. Cabe ressaltar que os povoamentos haviam sido instalados a diferentes espaçamentos e manejados de maneira diversa, com realização de desbastes cujo número, época e intensidade diferiram nos três locais estudados.

Na tabela 4 foram reunidos os valores do coeficiente de correlação linear simples entre as variáveis estudadas, por local.

Tabela 4. Coeficientes da correlação parcial simples entre densidade da árvore (d_A), densidade ao nível do DAP (d_D), altura total (H) e DAP com casca (D) do *Pinus elliottii* var. *elliottii* nas 3 regiões estudadas.

Coeficientes de correlação	Itapeva	Itapetininga	Mogi Guaçu	Geral
$r(d_A, D)$	0,1788	-0,4507	0,4395	-0,1052
$r(d_A, H)$	0,3029	0,0839	0,3173	0,3035
$r(d_A, d_D)$	0,7271	0,9077	0,7678	0,9261
$r(d_D, D)$	0,0293	-0,4219	0,2013	-0,1815
$r(d_D, H)$	0,2671	0,1695	0,3437	0,3360

Não foram encontradas correlações significativas entre o DAP e as densidades básicas da árvore e ao nível do DAP, o mesmo ocorrendo entre a altura e ambas as últimas variáveis citadas, indicando que a densidade não pode ser estimada em função apenas desses parâmetros dendrométricos. A não constatação das referidas correlações pode ser explicada pela grande variação da densidade entre árvores verificada nesses povoamentos: para a região de Itapeva os valores variaram de 0,325 a 0,469 g/cm^3, para Itapetininga de 0,352 a 0,555 g/cm^3 e em Mogi Guaçu de 0,414 a 0,594 g/cm^3.

Por outro lado, foram constatadas melhores correlações entre a densidade básica média da árvore (d_A) e a densidade obtida ao nível do DAP (d_D). As equações que permitem estimar d_A em função de d_D são as seguintes:

Itapeva:	$d_A = 0,1330 + 0,5985\ d_D$	$(r = 0,7271)$
Itapetininga:	$d_A = 0,0658 + 0,7493\ d_D$	$(r = 0,9077)$
Mogi Guaçu:	$d_A = -0,0258 + 0,9538\ d_D$	$(r = 0,7678)$

A equação geral obtida foi:

$$d_A = 0,0455 + 0,8062\ d_D \qquad (r = 0,9261)$$

para o conjunto de locais e idades variando de 10 a 20 anos.

Conclusões

Com base nos resultados obtidos para o *Pinus elliottii* var. *elliottii* em três diferentes regiões do Estado de São Paulo pode-se concluir que:

a) Houve um aumento das densidades básicas da árvore e ao nível do DAP com as idades dentro de cada local.

b) Os valores médios de densidade básica foram superiores em Mogi Guaçu, região considerada inapta ao desenvolvimento.

c) A densidade básica da árvore (d_A) pode ser estimada em função da densidade ao nível do DAP (d_D) pela equação:

$$d_A = 0,0455 + 0,8062\ d_D$$

como média para idades de 10 a 19 anos nos três locais estudados.

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VARIAÇÃO DAS QUALIDADES TECNOLÓGICAS DA MADEIRA DE FRAMIRÉ DE PLANTAÇÕES NA COSTA DO MARFIM.

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Resumo

Os métodos experimentais relatados neste trabalho, consistindo na medição de amostras não destrutivas de madeira de *Terminalia ivorensis* de diferentes condições de crescimento, permitiram investigar as variações de algumas propriedades tecnológicas da madeira de plantações desta espécie na Costa do Marfim, sob diversos ângulos:

- Valor médio dentro de parcelas e sua variabilidade;
- Comparação entre as médias das parcelas;
- Correlação entre as características silviculturais e tecnológicas dentro das parcelas.

Os principais resultados podem ser resumidos em quatro pontos:

1 Não houve diferença significativa na densidade básica entre as parcelas.

2. Foram observados gradientes radiais para retração linear e densidade básica, dentro da árvore.

3. Não houve diferença significativa entre a densidade básica e a largura dos anéis.

4. Foi mostrado que existe correlação significativa entre a madeira juvenil e a madeira adulta no que diz respeito à densidade básica.

Summary

The research procedure reported in this paper, consisting in measurements on increment cores of several growth and physical factors led to an investigation of the variation of some technological properties of plantation-grown FRAMIRE (Terminalia ivorensis) in Ivory coast, from several angles :

- Within-plot mean values and their variability
- Between-plot comparison of means
- Within-plot correlation analysis between silvicultural and technological characteristics.

The main results can be summarized in four points :

1 - There is no significant variation of basic density from one plot to the other.

2 - High radial gradients were found within tree for linear shrinkage and basic density.

3 - In this study, no statistical significance between basic density and ring width was found

4 - It was shown that there is a significant correlation between juvénile wood and mature wood as far as basic density is concerned.

VARIATIONS DE QUALITÉS TECHNOLOGIQUES DU BOIS DE FRAMIRÉ DE PLANTATION EN COTE D'IVOIRE.

Resumé

La méthode d'investigation décrite ici, qui consiste en des mesures sur carottes prélevées à la tarière de Pressler, de plusieurs caractéristiques de croissance et technologiques a permi d'étudier la variation de la qualité technologique du FRAMIRE (Terminalia ivorensis) de deux parcelles de Côte d'Ivoire, sous plusieurs aspects :

- Valeur moyenne intra-parcelle de ces caractéristiques et leur variabilité.
- Comparaison de ces moyennes entre parcelles
- Liaison, à l'intérieur de chaque parcelle, des caractéristiques d'ordre sylvicoles et technologiques entre elles.

Les principaux résultats sont les suivants :

1 - La densité basale ne varie pas d'une parcelle à l'autre

2 - A l'intérieur d'un arbre, il existe de forts gradients dans le sens radial de la densité et des retraits linéaires.

3 - Dans les cas étudiés, il n'y a pas de liaison significative entre densité du bois et largeur de cernes.

4 - Une relation bois juvénile - bois adulte a été mis en évidence pour la densité basale.

INTRODUCTION

Lorsque l'on étudie des essences de reboisement artificiel, plusieurs questions se posent :

1°/ Dans des conditions bien définies de sylviculture, quelles sont les propriétés technologiques que l'on peut obtenir avec les bois de plantations, et avec quelle variabilité ?

2°/ Quelles sont les relations qui peuvent exister entre les facteurs de croissance de l'arbre et les qualités technologiques du bois qu'il produit ?

Pour répondre à ces questions, le C.T.F.T. a entrepris récemment une première étude sur le FRAMIRE (Terminalia ivorensis) provenant de deux plantations de Côte d'Ivoire.

Ce document expose en résumé la méthode d'investigation utilisée et les principaux résultats obtenus.

METHODE D'ETUDE.

. Prélèvement

Deux parcelles ont été étudiées : KOUIN et YAPO. Leurs principales caractéristiques sont résumées en annexe 1.
Dans chacune de ces parcelles, des prélèvements SUD-NORD ont été effectués à la tarière de Pressler (diamètre = 5 mm) sur les arbres sur pied à 1,30 m du sol.
16 arbres ont été sondés au hasard, à l'intérieur du peuplement, mais en éliminant les pieds de très mauvaise conformation ou dépérissants. Dans la parcelle de KOUIN (8 ha) qui a une superficie 10 fois supérieure à celle de YAPO (0,8 ha) on a effectué un prélèvement au hasard de 2 carottes par placeau de 0,25 ha, la parcelle étant divisée en 2 blocs de 4 placeaux chacun.

. Traitement en laboratoire.

Aussitôt après le prélèvement sur les arbres sur pied, les carottes, devant être mesurées à l'état vert, sont maintenues dans des étuis étanches indivuels jusqu'au laboratoire où elles sont mises dans une enceinte close à atmosphère saturée.

Pour évaluer les différentes intra-arbres entre le bois juvénile et le bois adulte, chaque carotte a été divisée en 3 sous-carottes (2)
Sous-carotte A = zone de bois juvénile, proche du coeur
Sous-carotte C = zone périphérique correspondant dans le cas de cette étude à la zone d'aubier (visible à l'état frais sur le FRAMIRE par une nette différenciation de couleur.
Sous-carotte B = zone intermédiaire.

. Mesure du retrait linéaire.

Les mesures sont effectuées dans le sens tangentiel et radial, à l'état saturé et à l'état sec à l'air (stabilisation à 22°c, 65 %). La méthode de mesure utilisée est celle mise au point par POLGE (6). Les retraits linéaires sont définis par les formules suivantes :

$$TG\ \% = \frac{T_{SAT} - T_{STAB}}{T_{SAT}} \times 100$$

$$RD\ \% = \frac{R_{SAT} - R_{STAB}}{R_{SAT}} \times 100.$$

où T_{SAT}, T_{STAB}, R_{SAT}, R_{STAB} sont les dimensions dans les sens tangentiel (diamètre de la carotte) et radial (longueur de la carotte) aux états saturé et stabilisé respectivement.

Pour les dimensions dans le sens tangentiel, un grand nombre de points de mesure est nécessaire si l'on veut obtenir des valeurs moyennes statistiquement valables, sans qu'il soit nécessaire de faire en sorte que les mesures soient effectués aux mêmes emplacements à l'état saturé et à l'état sec à l'air (6). Le C.T.F.T. a utilisé un dispositif qui assure une mesure du diamètre tous les 5 mm le long de la carotte, à l'aide d'un palmer avec une précision du 1/100 mm.

Pour les dimensions dans le sens radial, les mesures ont été effectuée au pied à coulisse au 1/100 mm près.

. Mesure de la densité basale.

La densité basale (ou infra-densité) est le rapport de la masse anhydre au volume saturé. La méthode utilisé est celle dite de "saturation intégrale" préconisée par KEYLWERTH et modifiée par POLGE (1), (5).

Cette méthode consiste uniquement en des mesures pondérales (rapides et précises) ($d = 10^{-2}$ g) des carottes à l'état saturé et à l'état anhydre, en évitant ainsi toutes les mesures de volumes plus délicates et plus imprécises.

La densité basale DB est donnée par la formule :

$$DB = \frac{1}{\frac{Ms}{Mo} - 0.347}$$

où Ms = masse de la carotte saturée
Mo = masse de la carotte anhydre.

Mesure de la largeur des cernes d'accroissement.

Les mesures de densité terminées, les carottes ont été mises en enceinte climatisée (22°, 65 %) pour stabilisation. Puis collées sur des supports rainurés de telle sorte que le fil du bois soit perpendiculaire au support. Un ponçage progressif jusqu'au grain 400 a été effectué de façon à rendre visibles les cernes d'accroissement.

D'une manière générale, les premiers cernes formés autour de la moelle ne présentent pas de limites bien nettes; ils ont souvent des caractères anormaux de bois juvénile, et en particulier leurs largeurs sont extrêmement variables. Cette zone correspond à la sous-carotte A, et il a été convenu que pour cette étude, la largeur des cernes ne serait pas examinée dans cette partie du prélèvement.

RESULTATS.

Grâce à ces mesures, on dispose d'un certain nombre de variables caractérisant la carotte et permettant d'évaluer la qualité du bois.

. Comparaison intra-parcelle des moyennes des sous-carottes, variation et étendue.

Le tableau 1 consigne les principaux résultats pour les deux parcelles étudiées.

TABLEAU 1 - Moyennes intra-parcelles, variation et étendue des principales caractéristiques mesurées sur les carottes.

Variables.		KOUIN - $\frac{g}{S}$ 51 Moyenne	CV %	IC o95	YAPO - 44 Moyenne	CV %	IC o95
RETRAIT	RDA	1.95	26.2	1.63-2.27	2.72	20.6	2.38-3.06
RADIAL	RDB	2.16	14.4	1.96-2.36	2.91	24.2	2.49-3.33
(%)	RDC	2.66	26.3	2.22-3.10	3.35	7.1	3.21-3.49
RETRAIT	TGA	2.22	30.6	1.79-2.65	3.66	23.3	3.15-4.17
TANGENTIEL	TGB	3.30	14.6	3.00-3.60	4.50	18.9	3.99-5.01
(%)	TGC	4.11	15.0	3.72-4.50	4.97	14.0	4.55-5.38
LARGEUR DE	LCB	1.06	18.6	0.94-1.18	1.00	26.1	0.84-1.16
CERNES (CM)	LCC	0.81	16.7	0.70-0.92	0.73	21.7	0.63-0.82
DENSITE	DBA	326.57	11.4	303-350	313.78	14.4	286-340
BASALE	DBB	378.71	7.2	361-395	376.11	12.2	348-403
(g/dm3)	DBC	442.95	7.6	421-464	462.81	8.7	438-486
(1) DENSITE PONDEREE	DMP (*)	411.92	7.3	393-430	404.27	9.8	380-427

(1) Densité moyenne pondérée (DMP) = C'est la densité basale moyenne (en g/dm3) à hauteur d'homme pondérée par l'importance relative occupée par chaque sous carotte.

ANNEXE 1 - Principales caractéristiques des parcelles étudiées.

Parcelles	K O U I N	Y A P O
Phytogéographie	Forêt semi décidue	Forêt sempervirente
Age de la parcelle	28 ans (1951)	35 ans (1944)
Superficie	8 ha	0,8 ha
Pluviométrie	1700 mm/an	1700 mm/an
Durée moyenne de saison sèche	5 mois	4 mois
Surface terrière	18,28 m2/ha	17,3 m2/ha
Densité moyenne de plants à l'hectare	131/ha en mélange avec TECK	110/ha en mélange avec essences diverses.
Circonférence moyenne	130.7 cm CV = 18,6 %	132.4 cm CV = 39,7 %.
Hauteur dominante	29,3 m	33,6 m. (les 50 plus grands)
Accroissement moyen en diamètre	1,5 cm/an	1,2 cm/an.

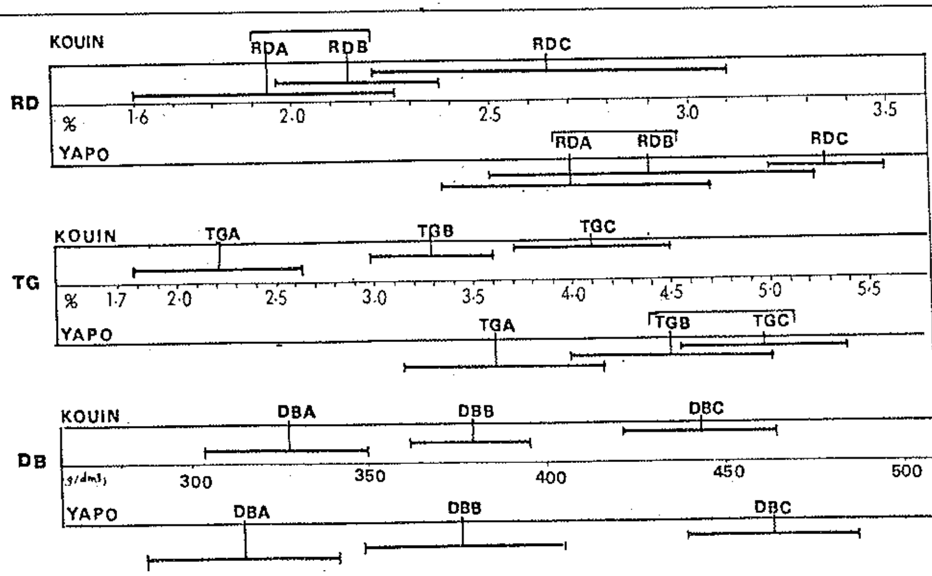

FIG 1 COMPARAISON ENTRE SOUS-CAROTTES PAR PARCELLE — intervalles de confiance et différences significatives au niveau 0.95 - Le trait au dessus des variables indique l'homogénéité - (TUKEY-HARTLEY)

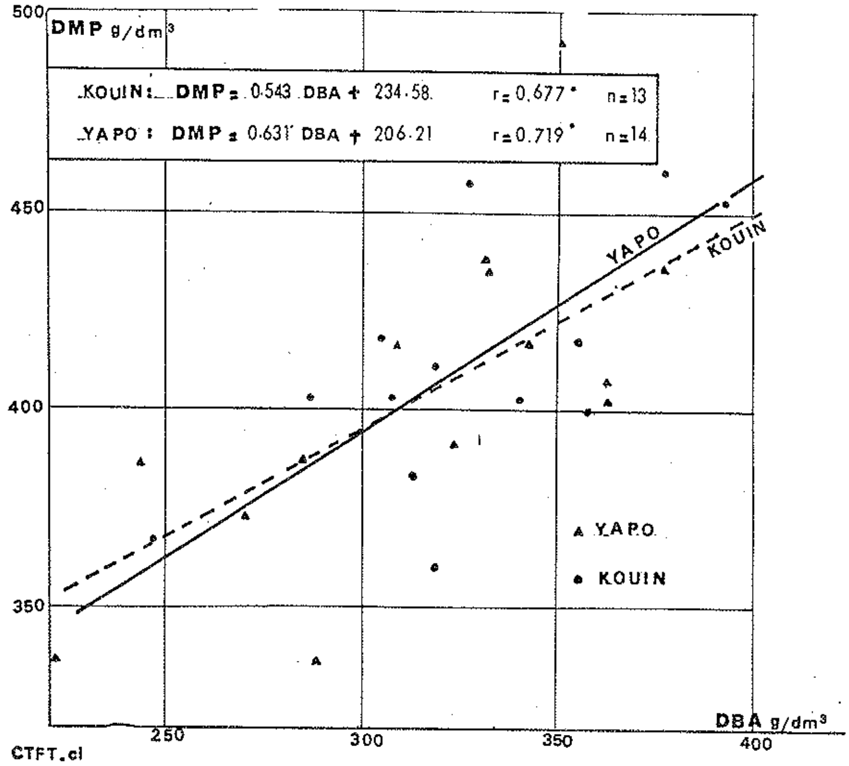

FIG 2 : Corrélation entre la densité basale du bois juvénile et la densité moyonne pondérée

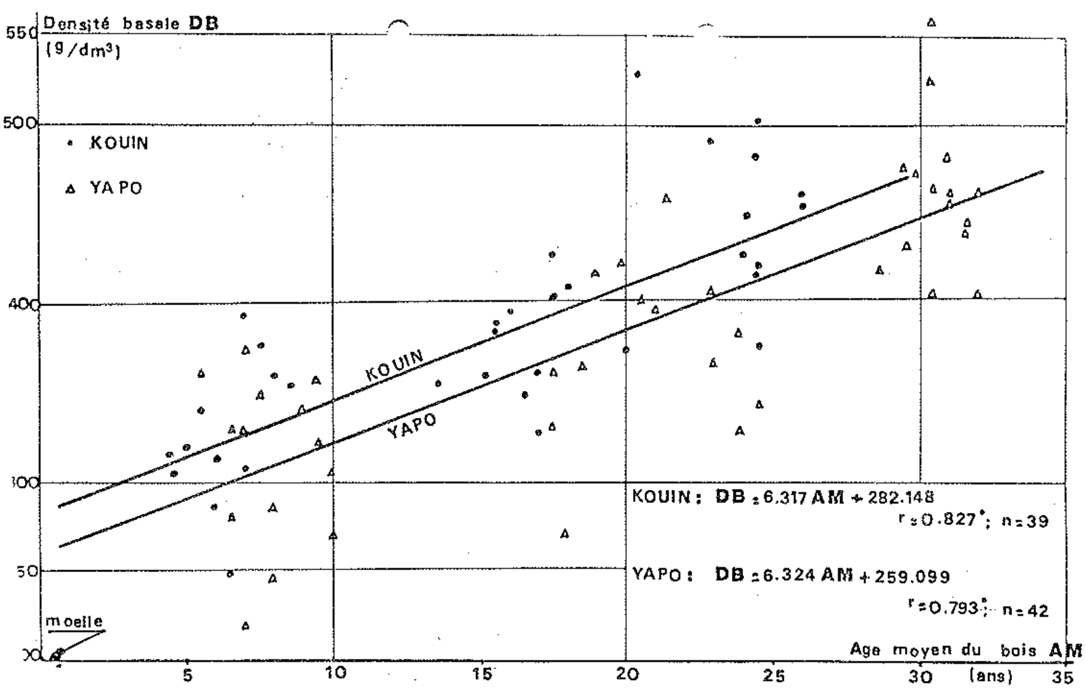

FIG 3 Corrélation Densité basale – Age moyen du bois **CTFT.cl**

Pour chacune des deux parcelles, une analyse de variance effectuée sur les variables de retrait, la densité basale et la largeur des cernes démontre qu'il existe des différences significatives entre les sous-carottes A, B et C pour toutes ces variables. De tests de comparaison de moyennes (TUKEY-HARTLEY) en précisent ces différences qui sont schématisées dans la figure 1.

. Comparaison inter-parcelle des moyennes.

Les parcelles de FRAMIRE étudiées étant bien connues sur le plan phytogéographique aussi bien que du point de vue de la sylviculture, il est intéressant de comparer entre parcelles les diverses variables mesurées sur les sous-carottes.

Des tests-t de STUDENT portant sur les moyennes de sous-carottes permet une comparaison entre les parcelles de KOUIN et de YAPO. On démontre, d'après cette analyse, que les deux parcelles étudiés, diffèrent sur le plan de la rétractibilité linéaire (YAPO > KOUIN), mais sont identiques en ce qui concerne la densité et la largeur des cernes.

. Liaisons entre variables.

* Liaisons largeur de cernes (LC)/Densité basale (DB).

Ces liaisons sont très importantes pour le sylviculteur : la largeur des cernes est en effet fortement liée à l'accroissement de l'arbre, donc à la production, tandisque la densité basale est la caractéristique principale du point de vue de la technologie du bois.

Dans le cas du FRAMIRE, le coefficient de corrélation intra-parcelle correspondant aux deux variables LC et DB est faible :

Parcelles / Liaisons	KOUIN (n = 13)	YAPO (n° = 14)
LCB/DBB	r = – 0.096(NS)	r = – 0.443(NS)
LCC/DBC	r = – 0.149(NS)	r = 0.223 (NS)

(NS = non significatif au niveau 0.95).

Le faible échantillonnage ne permet certes pas d'émettre une conclusion définitive, mais ces faibles correlations soulignent bien le fait que la liaison largeur de cernes – densité basale généralement admise est loin d'être vérifiée dans tous les cas et pour toutes les essences.

Le bois juvénile formé dans la région proche de la moelle présente souvent des caractéristiques physiques très différentes de celles du bois adulte (4). La question qu'il convient de se poser est la suivante : Les caractéristiques physiques d'un bois à proximité de la moelle préfigurent-elles bien celles que l'on retrouvera 30 ou 35 ans plus tard, à l'âge d'exploitabilité ? Cette question est d'un intérêt évident pour la sylviculture et l'amélioration génétique.

D'une manière générale, les seules corrélations fortes sont celles qui concernent la densité basale et la densité moyenne pondérée DMP, comme le montre le tableau ci-après :

Parcelles / Liaisons	KOUIN (n = 13)	YAPO (n = 14)
RDA / RDC	r = 0.317 (NS)	r = 0.419 (NS)
TGA / TGC	r = 0.164 (NS)	r = 0.565 (*)
DBA / DBC	r = 0.580 (*)	r = 0.384 (NS)
DBA / DMP	r = 0.677 (*)	r = 0.720 (*)

(*) = Significatif à 0.95 ; (NS) = non significatif) 0.95.

La figure 2 illustre les relations existant entre ces deux dernières caractéristiques.

Cette liaison bois juvénile/bois adulte a également été étudiée sous la forme âge moyen de la sous-carotte (AM)/densité basale correspondant (DB). On trouve des corrélations significatives.

KOUIN : r = 0.827 (*) n = 39
YAPO : r = 0.793 (*) n = 42.

La figure 3 donne les régressions correspondantes.

* Liaison densité basale/retrait linéaire.

Nous avons vérifié enfin la rélation linéaire générale souvent signalée (3), (4) qui lie la densité basale aux retraits linéaires.

CONCLUSION

La méthode d'investigation décrite précédemment a permi d'obtenir quelques résultats sur la variation de la qualité technologique des FRAMIRE de plantation en Côte d'Ivoire :

1 – La densité basale ne varie pratiquement pas d'une parcelle à l'autre.
Il n'en est pas de même du retrait.

2 – A l'intérieur de l'arbre, il existe de forts gradients dans le sens radial, non seulement pour les retraits linéaires mais aussi pour la densité basale. Les valeurs de ces caractéristiques vont croissant de la zone centrale vers l'écorce.

3 – Dans le cas du FRAMIRE, pour les deux parcelles étudiées, nous n'avons pas trouvé de liaison significative entre largeur des cernes et densité basale.

4 – La liaison bois juvénile / bois adulte n'est vraiment nette que pour la densité basale. Une relation linéaire hautement significative a en outre été mise en évidence pour les 2 parcelles entre la densité du bois et son âge moyen correspondant, le long de la carotte.

5 – Enfin, la relation générale entre la densité basale et les retraits linéaires a été vérifiée.

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VARIAÇÕES NAS PROPRIEDADES DA MADEIRA E NAS CARACTERÍSTICAS DA CELULOSE EM ALGUMAS PLANTAÇÕES DE PINHEIROS TROPICAIS.

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Resumo

O presente trabalho apresenta um resumo dos resultados de diversos estudos desenvolvidos pelo Centro Técnico de Floresta Tropical (CTFT) com *Pinus caribaea* e *Pinus oocarpa*, na Costa do Marfim, e com *Pinus patula*, em Madagascar, há alguns anos atrás, relacionados com a influência de fatores do meio, tais como fertilidade do solo, e da interação destes fatores com outras variáveis tais como a procedência, sobre a qualidade da madeira e características da celulose.

Os principais resultados aqui discutidos se relacionam:

– com as variações das propriedades da madeira dentro e entre diversas procedências de *Pinus caribaea* e *Pinus oocarpa*

– com as variações numa mesma árvore e entre diferentes "sites" das características da madeira e da celulose em *Pinus patula* crescendo em diferentes "sites".

VARIATIONS IN WOOD PROPERTIES AND PULPING CHARACTERISTICS OF SOME TROPICAL PINES GROWN IN PLANTATION.

Summary

The present paper summarizes some results from several studies carried out by C.T.F.T. on Pinus caribaea and Pinus oocarpa in Ivory Coast, and on Pinus patula in Madagascar some years ago, concerning the influence of environmental factors such as soil fertility and of an interaction of these with factors such as provenance on wood quality and pulping characteristics.

The main results hereafter presented concern :

- the variations in wood properties within and between several provenances of Pinus caribaea and Pinus oocarpa
- the within-tree and between-site variations of wood and pulping characteristics of Pinus patula grown in different sites.

VARIATION DES PROPRIETES TECHNOLOGIQUES ET PAPETIERES DE QUELQUES PINS TROPICAUX DE PLANTATION.

Resumé

Le présent document expose en résumé quelques résultats obtenus d'études menées par le Centre Technique Forestier Tropical sur Pinus caribaea et Pinus oocarpa en Côte d'Ivoire et, il y a quelques années, à Madagascar sur Pinus patula, concernant l'influence de facteurs d'environnement tels que la fertilité du sol ou d'une interaction de ceux-ci avec d'autres tels que les provenances, sur la qualité technologique et les caractéristiques papetières des bois de plantation.

Les principaux résultats présentés ci-après concernent :

- les variations intra et inter-provenances dans la qualité du bois de Pinus caribaea et de Pinus oocarpa,
- les variations intra-arbres et inter-stations de la qualité du bois et des propriétés papetières de Pinus patula plantés sur différentes stations.

INTRODUCTION

Il a été noté par de nombreux auteurs que les facteurs d'environnement et/ou une intéractions de ceux-ci avec la constitution génétique de l'arbre pouvait être à l'origine de fortes variations dans la qualite du bois produit par le nombreux pins tropicaux de plantation (2) (8).

La présente note consigne en résumé quelques résultats obtenus à partir de plusieurs études réalisées en Côte d'Ivoire et à Madagascar. Les principaux objectifs étaient de connaître l'ampleur de :

a/ La variation intra-et inter-provenance de quelques espèces des propriétés technologiques du bois à l'intérieur d'une même station.

b/ La variation des qualités technologiques et papetières qu'offre une même espèce dans des stations différentes.

La première question a été abordée avec les Pinus caribaea et les Pinus oocarpa de Côte d'Ivoire.

La seconde concerne les Pinus patula de Madagascar

VARIATIONS DE LA QUALITE DU BOIS INTRA ET INTER-PROVENANCES

Matériels et méthodes.

Les détails des Essais Internationaux de Provenances de Pinus oocarpa et Pinus caribaea de San Pedro (Côte d'Ivoire) sont résumés en annexes 1 et 2 (3) (4).

Seuls, les 8 x 4 = 32 arbres centraux de chaque parcelle unitaire ont été pris en considération. Dans chaque parcelle unitaire des meilleures provenances (6 pour P. oocarpa et 8 pour P. caribaea), les 3 plus gros arbres en diamètre, ne présentant pas de signes évidents de maladie ou de malformation, ont été sélectionnés pour évaluer la densité basale. Une carotte a été prélevée selon une orientation déterminée, dans chaque arbre échantillon de P. oocarpa et P. caribaea. La carotte, de la moelle jusqu'à l'écorce a été mesurée, et chaque carotte a ensuite été subdivisée en 3 parties égales (5): A = sous-carotte près de la moelle ; B = partie centrale ; C = sous-carotte proche de l'écorce. La densité basale de chaque sous-carotte a été déterminée en mesurant les masses saturée et anhydre selon une méthode mise au point par KEYLWERTH (6) et améliorée par POLGE (1).

La densité moyenne pondérée (DMP) a ensuite été calculée en pondérant la densité basale de chaque sous-carotte par la surface transversale occupée par chacune d'elle :

$$DMP = 0.111\ DBA + 0.333\ DBB + 0.556\ DBC.$$

Les autres données concernant les retraits linéaires et la largeur des cernes n'étaient pas disponibles au moment de la rédaction de ce document.

Résultats.

* Valeurs moyennes et dispersion.

Les résultats sont donnés en annexes 3 et 4. Il est à remarquer que la variation intra-provenance de la Densité moyenne Pondérée présente la même étendue pour les espèces P. oocarpa et P. caribaea, et du même ordre de grandeur que P. patula (voir annexe 5) (C V $\simeq$ 10 %).

* Variation inter-provenances de la densité basale.

Une analyse de variance menée sur les deux espèces de Pin a démontré qu'il n'y avait pas de différence significative pour les provenances étudiées, de Pinus oocarpa et P. caribaea.

* Gradients de densité basale.

La densité basale des trois sous-carottes a été calculée. Les valeurs moyennes sont consignées pour chaque provenance dans le tableau 1.

Par analyse de variance, on démontre qu'il existe des différences significatives intra-carottes.

* Corrélation.

La corrélation liant la densité basale près de la moelle (DBA) et la densité moyenne pondérée (DMP) a été calculée pour chaque espèce, et pour toutes provenances (Tableau 2).

Tableau 1 - Valeurs moyennes de la densité basale (en g/dm3) de plusieurs provenances de Pinus oocarpa et P. caribaea déterminées sur les sous-carottes : A - proche de la moelle ; B - partie centrale ; C - proche de l'écorce.

PINUS OOCARPA

Provenances	Sous-carotte A	Sous-carotte B	Sous-carotte C
261	336.78	365.31	413.41
274	346.00	387.18	443.05
277	366.67	402.49	445.10
267	355.89	386.18	445.67
263	357.09	388.35	419.72
266	361.24	391.46	456.62

PINUS CARIBAEA

301	310.59	341.32	433.99
313	326.28	356.55	453.73
304	335.85	361.75	463.57
312	312.94	349.90	447:67
306	334.28	355.07	420.33
315	325.19	370.76	474.64
305	355.57	385.65	476.45
316	326.21	354.98	491.87

Tableau 2 - Coefficient de corrélation de la densité basale près de la moelle (DBA) et de la densité moyenne pondérée (DMP) pour P. oocarpa et P. caribaea.

	Pinus caribaea	Pinus oocarpa
Coefficient de corrélation	r = 0.332 * * n = 122	r = 0.637 * * n = 120
Régression simple	(DMP) = 0.679 (DBA) + 183.983	(DMP) = 0.698 (DBA) + 167.403

* Variations inter-station des qualités technologiques et papetière.

Des analyses de variances ont été effectuées pour chacune des variables mesurées concernant la croissance (largeur des cernes) la qualité du bois (densité basale) et les propriétés papetières (longueur de fibre). Il en résulte que des différences significatives ont été calculées entre stations pour la largeur des cernes, et la densité basale, mais pas pour la longueur de fibres.

- Largeur de cernes : La largeur augmente avec la fertilité de la station.
- Densité basale : A SAMBAINA, station très fertile, le Pinus patula produit un bois moins dense que celui produit sur une station peu fertile.
- Longueur de fibres : Il a été démontré que la longueur des fibres décroit avec la fertilité du sol, bien qu'une différence significative n'ait été trouvée qu'entre les stations extrêmes 1 et 3.

* Gradients de densité basale.

Des analyses de variance ont été effectuées à l'intérieur de chaque station pour les densités basales proche de la moelle et dans la zone périphérique. A l'exception de la station n° 1 de faible fertilité, des différences significatives ont été notées entre les densités proche de la moelle et proche de l'écorce.

* Corrélations.

Les corrélations entre les diverses caractéristiques de qualité du bois ont été analysées. Les coefficients de corrélation pour les variables étudiées sont consignés dans le tableau 2, pour chaque station et pour toutes stations.

D'une façon générale, et pour toutes stations, la densité basale est corrélée significativement à la largeur des cernes, et la densité du bois juvénile à celle du bois adulte. (fig 4)

Cependant, ces corrélations ne sont pas très fortes et toute déduction basée sur de telles corrélation/ne saurait être précise.

VARIATIONS DES QUALITES TECHNOLOGIQUES ET PAPETIERES EN FONCTION DES CONDITIONS DE CROISSANCE.

Matériels et méthodes.

3 stations de Pinus patula à Madagascar ont été étudiées, dont les caractéristiques sont consignées dans le tableau 3.

Station N°	1	2	3
Lieu	TODIANA	SANGASANGA	SAMBAINA
Age (ans)	20	15	15
Classe de fertilité (*)	5	1 - 2	0
Croissance annuelle (*) (m3/ha/an)	4,6 à 9,5	20	40

Tableau 3 : Caractéristiques des 3 stations considérées dans cette étude (BEDEL, RAKOTOVAO, 1973) (1). (*) Les classes de fertilité et la croissance annuelle sont tirées du document (7) (MALVOS, BAILLY, BENOIT, LEFEVRE, 1972).

Dans chaque parcelle, un arbre sur huit a été choisi et cette sélection a été effectuée toutes les 5 lignes. Au total 50 arbres environ ont été échantillonnés par station. Deux carottes ont été prélevées sur chacun de ces arbres.

La première carotte a servi pour la détermination de la densité basale, à partir de mesures à l'état saturé, après extraction de résine, et à l'état anhydre selon une méthode de mise au point par POLGE (5). Toujours à l'état saturé, cette même carotte a été divisée en sous-carottes correspondant chacunes à 2 cernes d'accroissement à partir de l'écorce, et la largeur des cernes a alors été mesurée. La densité basale de chaque sous-carotte a également été calculée.

La seconde carotte a été prélevée à 10 cm au-dessus de la première, et a servi pour les mesures de longueur de fibre après avoir subi une cuisson selon un cycle bien déterminé.

Résultats.

* Valeurs moyennes et dispersion.

Les résultats sont donnés en annexe 5. A partir de ces chiffres, on note que d'après les coefficients de variations concernant les diamètres, la station n° 3 la plus fertile (SAMBAINA) donne des plantations plus homogènes (CV = 19,3 %) que la station la moins fertile (n° 1). (CV= 23,7%)

Variables analysées	Densité basale et largeur de cernes	Bois juvénile/bois adulte (densité basale)
Station 1	r = - 0.0312 (NS) n = 251	r = 0.271 (*) n = 52
Station 2	r = - 0.224 (* *) n = 256	r = 0.422 (* *) n = 52
Station 3	r = - 0.283 (* *) n = 259	r = 0.534 (* *) n = 49
Toutes Stations	r = - 0.205 (* *) n = 766	r = 0.340 (*) n = 153

Tableau 4.- Corrélations entre caractéristiques de qualité du bois
(*) et(* *) = Significatif au niveau 0.05 et 0.01
(NS) = non significatif.

C O N C L U S I O N

Un des résultats les plus importants de cette étude est que la variation intra-provenance de la densité basale est relativement faible (C.V = 10 %) pour les deux espèces de Pinus, au moins pour les provenances analysées.

Il est également intéressant de signaler que pour des arbres âgés de 8 ans, il n'y a pas de différences significatives entre les quelques provenances étudiées ici.

Cependant, il aurait été souhaitable d'analyser les 21 provenances pour éviter d'avancer des conclusions hâtives sur les différences significatives inter-provenances de la densité basale, c'est-à-dire sur la qualité même di bois.

En revanche, il existe un fort gradient intra-arbre dans le sens radial de la densité basale. Une corrélation forte a été mise en évidence pour Pinus caribaea, et surtout pour P. oocarpa, entre la densité basale près de la moelle (bois juvénile) et la densité moyenne pondérée.

Par les expérimentations menées à Madagascar sur Pinus patula, il est démontré qu'il existe des différences significatives entre stations de fertilités de sol différentes, pour la densité basale et la largeur des cernes.

On peut ainsi conclure que, pour P. patula, la fertilité du sol d'une station a un effet favorable sur la croissance mais au détriment de la densité.

En outre, les faibles corrélations entre densité du bois à l'état juvénile et celle du bois plus âgé ne permettent pas d'émettre des conclusions définitives concernant la qualité du bois en se basant uniquement sur la densité du bois dans ses premières années de plantation, du moins jusqu'à ce que d'autres résultats soient acquis dans ce domaine.

Appendix 1 = INTERNATIONAL PROVENANCE TRIAL ON P. OOCARPA.

- Date of plantation = 1972
- Site = SAN PEDRO – Ivory Coast – Lat = 4°45'N ; Long 6°38'w
- Experimental arrangement : un-complete balanced blocks.
  - Number of provenances = 19 + 2 P. caribaea
  - number of blocks = 21
  - Provenances per block = 5
  - Replications = 5
  - Number of plants per plot = 60
  - Planting distance = 4 m x 2 m.
- Results from 1975 inventory (10 best provenances).

Provenance N°	Sites / Country	Significance
267	Yucul – Nicaragua	
261	Camelias – "	
272	Rafael – "	
274	M P R – Belize	
277	Camelias – Nicaragua	
265	Bucaral – Guatemala	
270	Chuacus – "	
262	Zapotillo – Honduras	
279	Conacaste – Guatemala	
278	San Marcos – Honduras	

- Results from 1979 inventory (6 first provenances).

Provenance N°	Site / Country	Mean DBH (cm)
261	Camelias – Nicaragua	17.0
274	M P R – Belize	16.5
277	Camelias – Nicaragua	16.4
267	Yucul – Nicaragua	16.3
263	Lima – Guatemala	15.8
266	Zamorano – Honduras	15.7

Appendix 2 – INTERNATIONAL PROVENANCE TRIAL ON P. CARIBAEA.

- Date of plantation = 1972
- Site : SAN PEDRO (Ivory Coast)–Lat : 4°45'N ; Long : 6°38'w
- Experimental arrangement : Complete randomized blocks.
  - Number of blocks = 5
  - Replications per provenance = 5
  - Number of plants per plot = 60
  - Planting distance = 4 m x 2 m.
- Results from 1975 inventory (10 first provenances)

Provenance N°	Site / Country	Significance
301	Alamicamba – Nicaragua	
312	Santa clara – "	
306	Karawala – "	
299	Poptun – Guatemala	
313	Karawala – Nicaragua	
305	Limones – Honduras	
300	Briones – "	
304	Guanaja – "	
310	Brus – "	
316	By field – Queensland-(Australia)	

- Results from 1979 inventory (8 first provenances)

Proveance N°	Site / Country	DBH (cm) (mean)
304	Guanaja – Honduras	16.8
301	Alamicamba – Nicaragua	16.6
313	Karawala – "	16.6
312	Santa clara – "	16.4
306	Karawala – "	16.4
315	Pinalcho – Honduras	16.3
305	Limones – "	16.3
316	Byfield – Queensland (Australia)	16.3.

Annexe 3 - Moyenne et dispersion de la Densité moyenne Pondérée (DMP) (en g/dm3) de *Pinus oocarpa* (Côte d'Ivoire)

Provenances	261	274	277	267	263	266
DMP (moyenne)	388.89	413.67	422.06	416.56	402.32	424.34
C V %	11.6	11.8	9.1	12.9	6.8	7.9
Intervalle de confiance	362.94	385.74	399.93	380.89	386.66	405.09
	414.84	441.60	444.18	452.23	417.97	443.59

Annexe 4 - Moyenne et dispersion de la Densité moyenne Pondérée (DMP) (en g/dm3) de *Pinus caribaea* (Côte d'Ivoire).

Provenances	301	313	304	312	306	315	305	316
DMP (moyenne)	389.44	406.40	415.49	397.68	389.05	423.46	430.70	427.90
C V %	9.0	11.6	12.6	9.9	10.8	13.0	9.6	10.7
Intervalle de confiance	369.42	379.28	385.58	375.01	365.00	391.86	407.05	401.72
	409.46	433.52	445.40	420.35	413.10	455.06	454.35	454.08

Appendix 5 - Means and confidence interval-*Pinus patula* - Madagascar.

Variables	Site N°	Means	Coefficient of variation (%)	Confidence interval
D B H (cm)	1	15.048	23,7	14.078 - 16.018
	2	18.370	22,6	17.218 - 19.522
	3	21.827	19,3	20.671 - 22.983
Basic density	1	0.415	8,7	0.407 - 0.423
	2	0.383	10,7	0.373 - 0.393
	3	0.330	8,4	0.324 - 0.336
Growth ring (mm)	1	4.903	16,4	4.689 - 5.115
	2	7.424	14,4	7.132 - 7.726
	3	8.191	20,2	7.725 - 8.657
Fiber length (x 100) (*)	1	288.38	4,2	285.08 - 291.68
	2	292.30	4,9	288.08 - 295.91
	3	295.36	5,1	291.19 - 299.52

Sites : 1 = TODIANA 2 = SANGASANGA 3 = TODIANA.

(*) Units = Visual field of the microscope. X 100

example : for 295 : 2 means 2 x visual field
95 = estimate of the part which does not cover the field diameter.

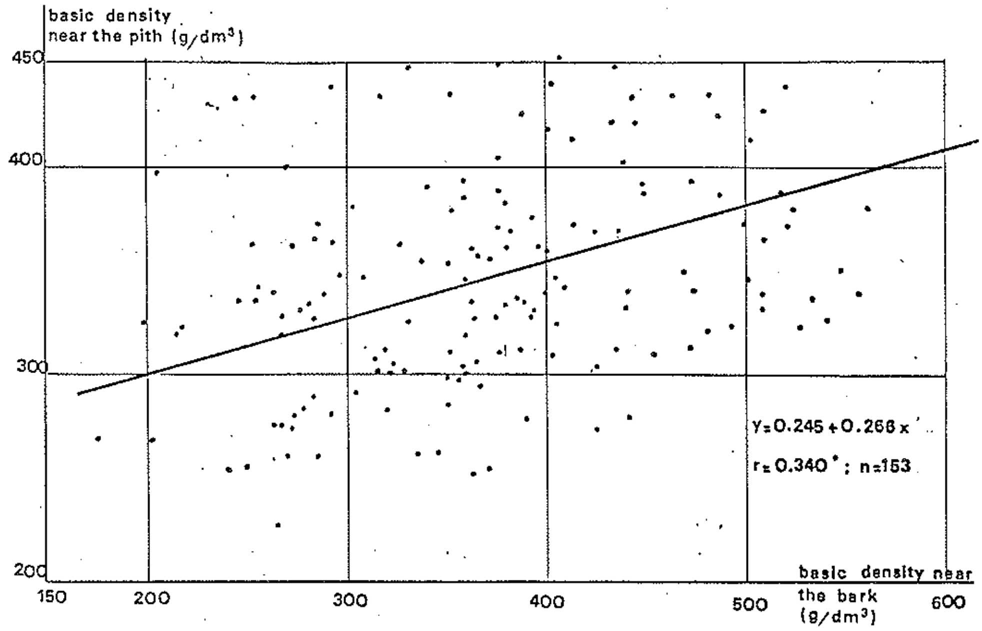

FIG 1 - Juvenile - mature correlation of basic density in plantation-grown Pinus patula in Madagascar (all sites combined) from BEDEL - RAKOTOVAO:1973

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ANÉIS DE CRESCIMENTO E CLIMA EM *Eucalyptus.*

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Center for Nuclear Energy in Agriculture.

Resumo

Discos de madeira de *Eucalyptos saligna, E. propinqua, E. grandis,* e *E. alba* foram analisados através da técnica de atenuação de raios gama, o que permitiu a confecção dos perfis da variabilidade radial da densidade básica. Todas as amostras foram provenientes de árvores com 9 anos de idade, crescendo no mesmo *"site"*, sob condições idênticas. O balanço hídrico foi calculado utilizando-se dados meteorológicos coletados no local. A análise comparativa entre os dados de picos de densidade máxima anual e os deficits hídricos verificados durante o período indicou existir alta correlação entre as amostras, com exceção do *E. saligna*, o que evidencia que a susceptibilidade desta espécie às condições climáticas é baixa.

GROWTH RINGS AND CLIMATE IN *Eucalyptus*

Summary

Using the gamma-ray attenuation technique, disc samples of *Eucalyptus saligna, E. propinqua, E. grandis* and *E. alba* were analysed and the profiles of radial variability in density were plotted. All the trees were 9 years old and were grown in the same site, under the same conditions. The water balance was calculated from meteorological data collected at the site. A comparative analysis between the data for the annual maximum density peaks and water deficit during the period indicated a close correlation between the samples, with the exception of *E. saligna*, thus evidencing that its susceptibility to climatic conditions is very light.

Introduction

The alternate sequence of concentrical rings of different colors which is observed in a cross-section of a tree trunk reveals, sometimes quite accurately, the environmental and agricultural conditions under which that tree has been during its life. This information is sort of recorded on the growth rings and can be evidenced by studying the dimensions and structure of the cells, radioactivity, isotope abundance, chemical composition and density variability in the rings.

The density variability in the growth rings is a good parameter for correlating climatic alterations. The traditional methods for measurement of density, such as the gravimetric methods, are not suited for this kind of study, the non-destructive nuclear technique being the best. The x-ray technique (POLGE, 1963) is the most commonly used, however the gamma-ray attenuation technique, developed by FERRAZ (1979) from an idea of LOOS (1961), can also be used in certain cases as successfully.

Profiles of radial variability in density were plotted for five samples and the annual maximum density peaks were correlated with the water deficit calculated.

Density Measurement

The samples utilized were from trees from a uniformly planted experimental lot in the region of Itupeva, State of São Paulo, of *Eucalyptus saligna, E. propinqua, E. grandis* and *E. alba.* The site, planting season, soil and climate characteristics, as well as agricultural practices, were the same for all the trees.

Some 9-year old trees were cut down and a disc was cut out each of them at 1.5 m above ground level. After drying, these discs were analysed through gamma-ray equipment, the density having been determined at every milimeter, from heartwood center to bark. The experimental error in the density measurement is smaller than 2%.

The graph in Fig. 1 shows the radial density profile for five samples analysed: *E. propinqua, E. saligna, E. grandis* and *E. alba* (2).

Using the data on step by step density, parabolic equations were calculated for the five samples by the method of minimum squares. This curve represents the mean trend in radial density variation. The data obtained are indicated in Table I.

With the aid of the graphs in Fig. 1, maximum density peaks were selected, which should correspond to the dry seasons in the period studied. With these experimentally obtained maximum density data and those expected mean data estimated through parabolic regression, a difference was obtained which, multiplied by 1,000, was called delta (Δ).

$$\Delta = \text{(density at point - expected density) } 1{,}000$$

A Δ (delta) thus represents the increase in wood density in the period considered in relation to the expected average. These results are shown in Table II.

Correlation with Climatic Parameters

Using the climatic data obtained at the local meteorological station the water balance was calculated for the region in the study period, by Thornthwaite and Mater's method (1955), considering 100 mm the storage capacity of the soil. The graph in Fig. 2 shows the variation in P-EP (precipitation minus potential evapotranspiration) as a function of time, calculated monthly. The monthly water deficit was calculated as well as the accumulated water deficit in the period (area indicated below the zero line).

Between years 1965 and 1971 nine deficit points were selected: one for each year, two dry seasons being considered for both 1968 and 1971. The monthly water deficit data for each of these dry seasons are shown in the last column of Table II.

Once the months of the year in which the maximum water deficit occurred were identified, the next step was to try to correlate these data with the wood variation at the corresponding point, i.e., the monthly water deficit (column 8 of Table II) was correlated with the Δ's obtained for all the samples in the corresponding periods (columns 3 to 7 of Table II).

Results and Conclusions

The graph in Fig. 1 and the results of parabolic regression analyses made with all the data obtained show that:

1. *E. alba* I and *E. alba* II samples maintain a practically constant mean density along the radius;
2. *E. propinqua* and *E. grandis* samples show a slight increase in mean density along the heartwood center-to-bark direction;
3. The *E. saligna* sample shows a marked increase in mean density along the heartwood center-to-bark direction;
4. *E. alba* I and *E. alba* II samples show greater variability in mean density, while *E. saligna* shows the smallest variability of all the species;
5. The influence of climatic conditions can be clearly observed by analysing the results in Fig. 1 as, for instance, the long period of water deficit in 1968 and 1969; the water excess in the rain seasons in 1967/68 and 1969/70; and the two drought periods which occurred in 1968 and 1971.

The results of the regression analyses between the maximum density data and the monthly water deficit are in Table III. An overall analysis shows that there is a linear correlation between Δ and monthly water deficit for all the samples with the exception of *E. saligna*. *E. alba* I and *E. alba* II samples showed the highest correlation coefficients.

From the results obtained, the following conclusions can be drawn:

There is a close correlation between density increase in the autumn growth ring and soil water defficiency in *Eucalyptus*.

E. alba I and *E. alba* II samples showed to be more sensitive to climatic variations and particularly to water defficiency, while *E. saligna* showed to be the least sensitive of all samples studied.

Table I. Results of parabolic equations obtained by using density data on *Eucalyptus* samples.
($\rho = a_o + a_1 x + a_2 x^2$)

	SAMPLES	*alba*	*alba*	*propinqua*	*grandis*	*saligna*
a_o	zero coefficient	0.59750	0.56224	0.67723	0.43980	0.44834
a_1	first order coef.	-0.00030	0.00506	-0.00190	-0.00466	-0.00179
a_2	second order coef.	0.00001	-0.00004	0.00004	0.00008	0.00008
ρ	mean density	0.608	0.682	0.673	0.411	0.518
N	number of variables	73	68	68	68	70
r^2	quadratic regression determination coef.	0.061	0.472	0.183	0.566	0.837

Table II. Δ results (maximum density in period - expected density)1,000 observed for the 9 time periods listed and respective water deficits during those months.

Point	Mo./year	*saligna*	*alba* I	*alba* II	*prop.*	*grandis*	Def.
1	June 65	71	71	69	25	59	25
2	July 66	38	29	60	7	33	26
3	Aug. 67	61	53	78	15	39	43
4	Sep. 68	65	1	40	104	49	14
5	Nov. 68	39	113	94	117	78	79
6	Sep. 69	53	105	78	85	73	29
7	Apr. 70	7	50	104	30	1	31
8	Jan. 71	2	63	12	6	42	11
9	Sep. 71	52	72	41	68	42	12

Table III. Results of linear regression analyses (DEF. = a + b Δ) for five samples

SAMPLE	Angular coef.(b)	Coefficient (a)	Correlation coef. (r)
E. alba I	0.332	9.51	0.547
E. alba II	0.406	6.70	0.654
E. propinqua	0.181	20.78	0.372
E. grandis	0.355	13.60	0.386
E. saligna	0.029	28.77	0.033
TOTAL	0.284	14.67	0.472

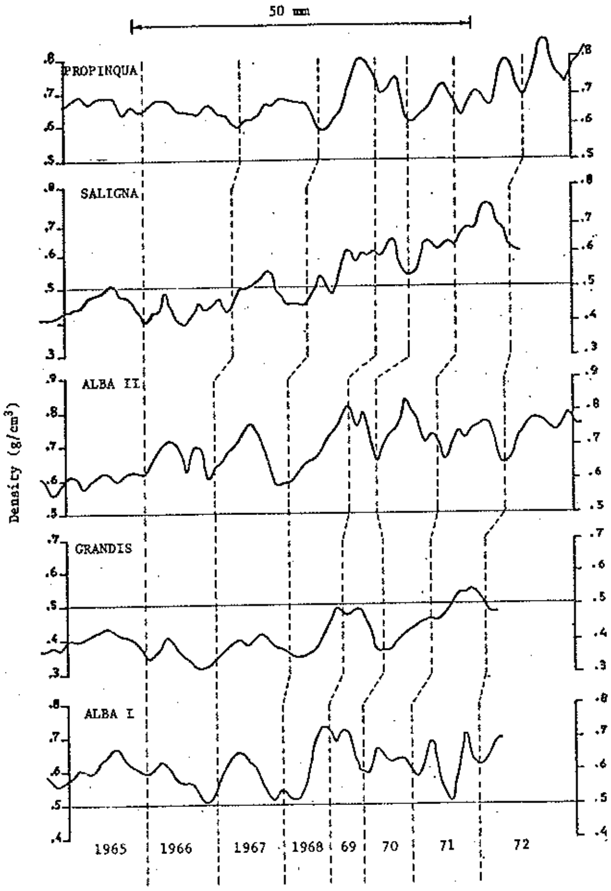

Fig.1 - Radial density profiles for 5 samples.

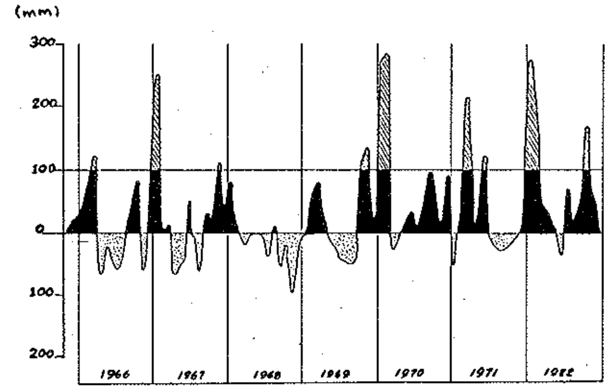

Fig.2 - P-EP (precipitation minus potential evapotranspiration as a function of time) calculated monthly. Area below zero line indicates monthly water deficit.

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EM BUSCA DA QUALIDADE IDEAL DA MADEIRA DE EUCALIPTO PARA PRODUÇÃO DE CELULOSE-*Eucalyptus* TROPICAIS.

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Resumo

O propósito do trabalho é o de definir quais características da madeira do eucalipto podem ser alteradas no sentido de torná-la ideal para produção de celulose. É recomendado o aumento concomitante da densidade básica da madeira, da espessura da parede celular, do comprimento da fibra, da proporção de fibras longas e de paredes espessas, do índice de enfeltramento, da relação comprimento de fibra/espessura da parede e a diminuição do teor de lignina da madeira.

SEARCHING THE IDEAL *Eucalyptus* PULP-WOOD-TROPICAL *Eucalyptus*.

Summary

First, the paper describes the main correlations between wood characteristics and kraft pulp properties for thirteen species of eucalyptus. The objective was to define, as a first approach, the ideal pulpwood quality for all eucalyptus. As conclusions, it is recommended a simultaneous increasing of wood density, cell wall thickness, fiber length, percentage of long and thick-walled fibers, felting index, fiber length/cell wall thickness ratio and decreasing of wood lignin content.

Introdução

O estudo das inter-relações entre as características das madeiras, que definem a sua qualidade, e as propriedades da celulose e papel tornou-se bastante popular nos últimos vinte anos. Inúmeros trabalhos, tanto de revisão bibliográfica, como de pesquisas aplicadas, surgiram para mostrar como determinadas propriedades da celulose podiam ser alteradas pela modificação da qualidade da madeira. Vários parâmetros de qualidade da madeira foram definidos, principalmente aqueles relativos à morfologia da fibra, e relacionados com as características da celulose e papel resultantes. Extensos e bem completos apanhados teóricos e práticos do assunto foram publicados por DINWOODIE (1966), WARDROP (1962, 1969), BAREFOOT et alii (1971) e FOELKEL & BARRICHELO (1975), dentre outros. A literatura é muito rica em trabalhos sobre esse particular, e executados principalmente sobre coníferas, mas também são comuns aqueles aplicados a folhosas (PETROFF & NORMAND, 1961; BAWAGAN, 1962; JOEDODIBROTO, 1961) e mais especificamente aos eucaliptos (HILLIS, 1972; TAYLOR, 1973; BARRICHELO & BRITO, 1977). O importante nesse tipo de estudos não é apenas a simples verificação de quais variáveis de qualidade afetam quais outras, e sim de se buscar definições acerca de quais propriedades da madeira são mais interessantes para se trabalhar em programas florestais. O objetivo final é a produção de madeira de qualidade a mais ideal possível para a produção de celulose de qualidade superior. É importante se lembrar, que a qualidade de uma madeira para um dado fim pode ser definida como a somatória de suas características que a tornam viável para esse uso específico. Assim sendo, muitas propriedades da madeira que são, por exemplo, importantes para a mesma ser usada em construções civis, não se revestem da mínima importância para seu uso como matéria-prima para a fabricação de celulose.

O presente estudo foi realizado com o propósito de iniciar a busca de definições quanto às características da madeira do eucalipto que podem servir de base para programas florestais de melhoramento e aperfeiçoamento dessa madeira à conversão em celulose. Nesse primeiro trabalho de uma série extensa, buscaram-se as inter-relações entre as características das madeiras e das celuloses resultantes para treze espécies de eucaliptos, a maioria dos quais ditos tropicais. O propósito foi bem claro: era o de verificar como as diferenças entre as características das madeiras dessas espécies afetavam as celuloses kraft resultantes. A partir daí, em novos estudos, procurar-se-á chegar a quais seriam as condições de ótimo no que concerne à qualidade da madeira do eucalipto para produção de celulose, independentemente assim da espécie. O objetivo a médio prazo é se definir quais as propriedades que deve apresentar a madeira de um eucalipto para ser classificada como de qualidade para produção de celulose.

Material e métodos

Material

As madeiras ensaiadas provinham de plantações experimentais com 51 a 61 meses de idade e localizadas na região de Linhares, E.S. As espécies analisadas foram as seguintes: *Eucalyptus urophylla*, *E. grandis*, *E. cloeziana*, *E. deglupta*, *E. tereticornis*, *E. camaldulensis*, *E. robusta*, *E. phaeotricha*, *E. torelliana*, *E. citriodora*, *E. paniculata*, *E. dunnii* e *E. pilularis*.

Métodos

As madeiras foram perfeitamente caracterizadas no que diz respeito às seguintes propriedades:

- Propriedades físicas: teores de cerne e alburno na árvore integral e em discos amostrados à base, DAP, 25%, 50%, 75% e 100% da altura comercial (H); relação cerne/alburno nas diversas localizações de amostragem; densidade básica da madeira integral para a árvore; densidade básica da madeira integral, do cerne e do alburno na base, DAP, 25%, 50%, 75% e 100% da altura comercial.
- Propriedades anatômicas: comprimento médio da fibra; largura média da fibra em seu meio e em sua ponta; diâmetro médio do lúmen no meio e na ponta da fibra; espessura média da parede celular no meio e ponta da fibra; comprimento e largura do elemento de vaso.
- Relações entre as dimensões anatômicas fundamentais da fibra: fator de afilamento $|(\text{largura da fibra ao meio})^2 + (\text{largura da fibra na ponta})^2 / 2 \times (\text{largura da fibra ao meio})^2|$, índice de Runkel; fração parede; coeficiente de flexibilidade; número de Boiler; relação de Mulsteph; relação comprimento/espessura da parede no meio da fibra; relação entre as espessuras da parede na ponta e no meio da fibra.
- Distribuição de frequência (% de fibras em determinadas faixas de dimensões):

a) Faixas de comprimento de fibra = 0,125 a 0,250 mm; 0,250 a 0,375 mm; 0,375 a 0,500 mm; 0,500 a 0,625 mm; 0,625 a 0,750 mm; 0,750 a 0,875 mm; 0,875 a 1,000 mm; 1,000 a 1,125 mm; 1,125 a 1,250 mm; 1,250 a 1,375 mm; 1,375 a 1,500 mm; 1,500 a 1,625 mm; 1,625 a 1,750 mm; 1,750 a 1,875 mm; 1,875 a 2,000 mm; 2,000 a 2,125 mm; 2,125 a 2,250 mm; 2,250 a 2,375 mm; % fibras menores que 0,75 mm; % fibras entre 0,75 a 1,25 mm; % fibras maiores que 1,25 mm.

b) Faixas de largura de fibra = 8 a 12 μ, 12 a 16 μ, 16 a 20 μ, 20 a 24 μ, 24 a 28 μ, 28 a 32 μ, 32 a 36 μ, % fibras mais estreitas que 12 μ, % fibras entre 12 a 20 μ, % fibras mais largas que 20 μ.

c) Faixas de espessura da parede da fibra = 0,0 a 1,5 μ; 1,5 a 3,0 μ; 3,0 a 4,5 μ; 4,5 a 6,0 μ; 6,0 a 7,5 μ; 7,5 a 9,0 μ; 9,0 a 10,5 μ; % de fibras com paredes mais finas que 3 μ; % de fibras com paredes entre 3 a 6 μ; de fibras com paredes mais espessas que 6 μ.

d) Meio da classe de frequência máxima: para comprimento, para largura e para espessura da parede.

- Composição química: teores de lignina, pentosanas, cinzas, extrativos em água quente, NaOH 1%, álcool/benzeno e diclorometano.

A seguir as madeiras isentas de casca foram transformadas em cavacos, os quais foram convertidos a celuloses kraft com número kappa pré-fixado na faixa de 17,0 a 23,0. Foram realizadas duas repetições por espécie e apenas o resultado médio foi utilizado para os propósitos do trabalho. As seguintes determinações foram realizadas sobre as celuloses:

- Rendimentos: rendimento bruto, rendimento depurado, teor de rejeitos e consumo específico de madeira para produção de uma tonelada absolutamente seca de celulose não-branqueada.

- Celulose não-branqueada: número kappa, viscosidade.

- Branqueabilidade: % cloro total aplicado e consumido base polpa a.s.; % NaOH total aplicada e consumida base polpa, viscosidade final, alvura final, alvura após reversão e número de cor posterior.

- Propriedades físico-mecânicas: adotou-se o conceito de número índice descrito por FOELKEL *et alii* (1978), onde o *Eucalyptus grandis* tinha sua área de refino para cada propriedade considerada igual a 100 e as demais espécies eram referidas à mesma. Considerou-se o número índice médio entre as propriedades físico-mecânicas das celuloses não-branqueadas e branqueadas. As seguintes propriedades físico-mecânicas foram objeto de determinação e expressas como número índice relativo a *E. grandis*: tempo de refino, resistência à tração, resistência ao rasgo, resistência ao estouro, resistência ao dobramento, elongação, densidade aparente e coeficiente de dispersão da luz, esse último apenas para a celulose branqueada.

Obtidas as avaliações detalhadas das qualidades das madeiras e das celuloses, buscaram-se analisar as inter-dependências entre ambas por análise de regressão e correlação. Foram utilizados os valores médios de cada propriedade por espécie e o modelo testado entre os pares de variáveis foi o linear. O nível de significância adotado foi de 1%.

Discussão dos resultados

Frente às dimensões da parte experimental desse estudo, os resultados serão apenas discutidos, mostrando as principais descobertas baseadas nos mesmos. Procurar-se-ão discutir então, quais as principais inter-relações, e se definir, em uma primeira aproximação, as principais características da madeira que podem servir de base para a avaliação da qualidade da madeira do eucalipto para produção de celulose.

Rendimentos bruto e depurado

Rendimentos em produção de celulose mostraram ser principalmente dependentes da espessura da parede da fibra, principalmente no que diz respeito à quantidade porcentual de fibras de paredes finas e espessas. O índice de enfeltramento também associou-se a rendimentos, da mesma forma que o teor de pentosanas.

Teor de rejeitos

O teor de rejeitos caracterizou-se pela alta dependência com a densidade básica da madeira na região da árvore mais próxima ao solo (base até 25%H), o que é explicável, pois essa região da árvore é a que mostra maiores densidades e que representa a maior proporção em volume de madeira.

Consumo específico de madeira

Definitivamente, trata-se de uma das propriedades do mais alto significado econômico e que, para satisfação do técnico, é altamente influenciada pelas características da madeira. Sua correlação negativa com a densidade da madeira em suas diversas formas (madeira integral, cerne, alburno) e alturas é da mais alta significância. Além da densidade básica, outras características com notáveis influências sobre o consumo específico foram a espessura da parede, as relações entre as dimensões das fibras que se associam à espessura (relação de Mulsteph, número de Boiler, fração parede, coeficiente de flexibilidade, índice de Runkel, relação comprimento da fibra/espessura da parede); e as distribuições porcentuais de fibras de paredes espessas e finas. O diâmetro do lúmen, talvez numa indicação da quantidade de fibras de lenho inicial na madeira do eucalipto, associou-se positivamente ao consumo específico.

Número kappa

Embora pré-fixado, o número kappa mostrou ser influenciado pelo teor de cinzas da madeira, pois essas, representando minerais, podem permanecer parcialmente na polpa e demandarem um maior consumo químico de $KMnO_4$ na análise de número kappa.

Viscosidade das celuloses não-branqueada e branqueada

A ausência de inter-dependência da viscosidade da celulose com as características da madeira permite a suposição de ser essa propriedade muito mais dependente das condições do processo do que do tipo de madeira de eucalipto empregado, desde que essa madeira se apresente em boas condições, livre de deterioração.

Dosagem e consumo de agentes para branqueamento

Tratando-se de parâmetros que se associam ao número kappa das celuloses, pois dependem dele para serem calculados e aplicados, as cargas químicas de agentes para branqueamento se associaram também ao teor de cinzas, numa relação indireta. Entretanto, o total de soda consumida no branqueamento mostrou correlação positiva ao teor de lignina da madeira.

Alvura e reversão da alvura das polpas branqueadas

Não foram detectadas influências significativas da qualidade da madeira sobre a alvura e sua reversão, expressa essa última também pelo número de cor posterior. É de se supor então, que essas propriedades da celulose, no caso das espécies de eucalipto em questão, dependem muito mais, do processo de branqueamento do que do tipo de madeira empregado.

Resistência à tração

Curiosamente, essa propriedade não foi influenciada significativamente, ao nível de significância adotado, por nenhuma das características da madeira.

Resistência ao rasgo

Índice de enfeltramento, comprimento médio de fibra e quantidade de fibras mais longas foram as principais características da madeira a afetar essa resistência. Não se pode fugir à realidade que o aumento da resistência ao rasgo da celulose do eucalipto poderá ser conseguido às custas do esforço do melhorista florestal para aumentar tanto o índice de enfeltramento como o comprimento da fibra.

Resistência ao estouro

A principal característica da madeira a afetá-la positivamente foi a relação entre o comprimento e a espessura da parede da fibra. Entretanto, influências bastante acentuadas foram dete ctadas para a densidade básica da madeira integral às diferentes alturas ensaiadas e para a espessura da parede, principalmente no que concerne à frequência relativa de fibras de paredes finas e espessas. Tanto a densidade básica como a espessura da parede mostraram correlação negativa com a resistência ao estouro.

Resistência ao dobramento

Essa resistência da celulose mostrava comportamento muito similar à resistência ao estouro, frente às suas inter- relações com as características da madeira. As principais propriedades da madeira a influenciá-la eram a densidade básica (madeira integral, cerne, alburno) a diversas alturas e para a árvore e a espessura da parede da fibra, bem como a quantidade de fibras de paredes finas e espessas. Tanto densidade básica como espessura da parede relacionavam-se negativamente com a resistência ao dobramento. Algumas das relações entre as dimensões fundamentais da fibra, a saber, número de Boiler, relação de Mulsteph e fração parede também mantinham relação negativa com a resistência ao dobramento. Positivamente, a resistência ao dobramento era influenciada pela relação entre comprimento da fibra/espessura da parede e pelo coeficiente de flexibilidade

Elongação

Mostrava-se também influenciada negativamente pela espessura da parede da fibra e pela quantidade de fibras de paredes espessas na madeira.

Tempo de refino

Não se mostrou influenciado significativamente pela qualidade da madeira.

Coeficiente de dispersão da luz

Apresentou-se ligeiramente influenciado de maneira positiva pela proporção de fibras curtas na madeira, indicando que indiretamente é afetado pelo número de fibras por peso de polpa.

Densidade aparente das folhas

Os modelos de inter-relação entre essa propriedade e as características da madeira lembram bastante os encontrados para as resistências ao estouro e ao dobramento. As principais características da madeira a mostrar correlação com a densidade aparente das folhas foram: densidade básica da madeira (integral, cerne e alburno) a diversas alturas e para a árvore, espessura média da parede celular e proporção de fibras de paredes espessas. Essas três características mostram correlação negativa com a densidade aparente das folhas. Também influenciando de forma inversa a densidade aparente das folhas, destacaram-se as seguintes relações entre as dimensões fundamentais das fibras: relação de Mulsteph, número de Boiler, fração parede e índice de Runkel. Positivamente, a densidade das folhas era afetada pela frequência de fibras de paredes delgadas, pelo coeficiente de flexibilidade e pela relação comprimento da fibra/espessura da parede. Também o diâmetro do lúmen mostrava correlação positiva com a densidade aparente das folhas, talvez numa indicação indireta do teor de fibras de lenho inicial das madeiras.

Conclusões

Como se sabe, a madeira ideal seria aquela com a qual se produzisse celulose com o menor consumo específico e que essa celulose obtida apresentasse fácil branqueabilidade e mostrasse altas resistências físico-mecânicas. Para o caso da celulose do eucalipto, é importante também que ela apresente alto coeficiente de dispersão de luz e que suas folhas mostrem baixa densidade aparente. No ítem anterior, observou-se que algumas propriedades da madeira mostram significativas influências sobre essas propriedades desejáveis. Infelizmente, os modelos de influência não ocorrem sempre no sentido de melhorar todas as propriedades da celulose. Na maioria dos casos, o aumento dos valores de uma dada característica da madeira correspondem a uma melhoria de algumas das propriedades da celulose e a perda de outras. Um programa de melhoramento de qualidade da madeira, para ser completo, deve procurar evitar ao máximo as perdas que possam ocorrer, quando o melhoramento se faz em um sentido. O ideal é que não existam perdas e sim ganhos de qualidade.

Baseados na exposição anterior é possível se visualizar o seguinte:

a) Economias de madeira para produção de celulose podem ser conseguidas pelo aumento do rendimento e diminuição do consumo específico. Isso pode ser obtido pelo aumento da espessura média das paredes das fibras, pelo aumento da densidade básica da madeira e pelo aumento da proporção de fibras de paredes espessas relativamente àquelas de paredes delgadas. Pode-se também trabalhar no sentido de diminuir o consumo específico aumentando as seguintes relações entre as dimensões fundamentais das fibras: relação de Mulsteph, número de Boiler, fração parede e índice de Runkel.

b) O aumento dos valores das características mencionadas no ítem a, embora reduzam o consumo de madeira por tonelada de celulose, prejudicam as seguintes propriedades: resistência ao estouro, resistência ao dobramento, e elongação. Por outro lado, colaboram também para uma diminuição da densidade aparente das folhas do papel o que é desejável para o eucalipto.

c) Para compensar a perda de qualidade da celulose pelo aumento dos valores das características mencionadas no ítem a recomenda-se aumentar concomitantemente as seguintes propriedades da madeira: comprimento da fibra, proporção relativa de fibras longas e índice de enfeltramento. O aumento do comprimento da fibra do eucalipto faz-se necessário, pois além de corresponder a um aumento na resistência ao rasgo da celulose, provocará um aumento desejável no índice de enfeltramento e colaborará para que a relação comprimento/espessura da parede não caia, ou mesmo se eleve, quando o sentido do melhoramento é o de se aumentar a espessura da parede e a densidade básica da madeira. Embora se reconheçam as dificuldades para se aumentar o comprimento médio da fibra do eucalipto, é importante vencer esse desafio para se atingir a qualidade ideal na madeira do eucalipto.

d) Quimicamente, é interessante a redução no teor de lignina da madeira pois isso acarretará mais fácil cozimento e menor consumo de soda cáustica no branqueamento.

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RELAÇÕES ENTRE DENSIDADE BÁSICA, CONTEÚDO DE EXTRATIVOS E HIGROSCOPICIDADE EM MADEIRA DE *ARAUCARIA ANGUSTIFOLIA* E *EUCALYPTUS CITRIODORA*.

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Resumo

Embora o conteúdo de umidade de equilíbrio da madeira e alta correlação com a temperatura e a umidade relativa do ar, esta característica pode ainda ser influenciada por outras propriedades da madeira, tais como o conteúdo de extrativos e a densidade básica.

Com o objetivo de determinar as relações entre estas características e a higroscopicidade da madeira de *Eucalyptus citriodora* e de *Araucaria angustifolia*, o conteúdo de extrativos solúveis em água e solúveis em álcool-benzeno, a densidade básica, e o conteúdo de umidade de equilíbrio de amostras de madeira destas duas espécies foram determinados para 5 condições diferentes de temperatura e umidade relativa.

Os dados foram analisados através de regressão linear. As conclusões mais importantes podem ser resumidas de acordo com o seguinte: a) o conteúdo de umidade de equilíbrio diminui com o aumento do conteúdo de extrativos; b) existe correlação entre a densidade básica e o conteúdo de umidade de equilíbrio apenas quando existe relação similar entre a densidade básica e o conteúdo de extrativos.

SPECIFIC GRAVITY;, EXTRACTIVES CONTENT AND HYGROSCOPICITY RELATIONSHIP OF *ARAUCARIA ANGUSTIFOLIA* AND *EUCALYPTUS CITRIODORA* WOODS.

Summary

Although the equilibrium moisture content of the wood had a strongly correlation with temperature and relative humidity of the air, it can be influenced by others wood characteristics such as extractive content and specific gravity.

Aiming to determine the relationship between these two characteristics and the wood hygroscopicity for E.citriodora and A.angustifolia, the water-soluble and alcohol-benzene-soluble extractive content, the specific gravity and the equilibrium moisture content at five different conditions of temperature and relative humidity were determined for samples of the two species.

The data were analysed through linear regression. The most important conclusions are summarized as follows: 1) The equilibrium moisture content decreases as the extractive content increases; 2) There is a correlation between specific gravity and equilibrium moisture content only if exists a similar relationship for the specific gravity with the extractive content.

Introduction

The change of physical and mechanical properties of the wood caused by the water sorption is a continuing obstacle to the efficient use of this material in furniture, joinery and so on. The mainly factors involveded in the change of wood moisture content are the temperature and the relative humidity of the air, but there are influences of some wood characteristics such as the chemical composition.

WANGAARD & GRANADOS (1967), CHOONG (1969), TAYLOR (1974), and JANKOWSKY & GALVÃO (1979), showed that the hygroscopic properties of wood can be attributed to the components of the wood. The bulking effect of extractive is evident in the fiber saturation point, when the moisture is correlated inversely with extractive content.

There are no clear information in the literature about the relationship of the specific gravity with the equilibrium moisture content and extractive. According to HIGGINS et al (1973), one of the mainly properties affecting the specific gravity of hardwoods is the content and distribution of extractives. FOELKEL et al (1975), verified that in some species of young Eucalyptus plantation, the specific gravity and the extractive content increases with the tree age.

MC MILLIN (1968), found that the correlation between specific gravity and extractives in Pinus taeda wood is affected by growth rate and distance from pith, whereas VERMAAS (1975), did not find this correlation for Pinus pinaster.

The objectives of this study were to determine the relationship between these wood characteristcs for one softwood species (Araucaria angustifolia (BERT) O. Ktze) and one hardwood species (Eucalyptus citriodora Hook).

Procedure

In this experiment it were used 15 samples of E.citriodora and 20 of A.angustifolia. The water-soluble and alcohol-benzene-soluble extractive content were determined following the ABCP standards, and the specific gravity following the water displacement method described by FOELKEL et al (1971).

The equilibrium moisture content values were obtained at temperatures of 40°C, 50°C and 60°C, and relative humidities of 40%, 60% and 79%. The data were analysed through linear regression.

A complete description of the experimental procedure can be found in JANKOWSKY (1979).

Results and Discussion

Table 1 shows the extractive content and the values of specific gravity and equilibrium moisture content. Tables 2 and 3 present the relationship between the variables analysed through simple and multiple linear regression, using the equilibrium moisture content obtained at 50°C of temperature

TABLE 1. Water-soluble (WEC) and alcohol-benzene-soluble (AEC) extractives content, specific gravity and equilibrium moisture content at temperature (T) of 40°C, 50°C and 60°C and relative humidities (RH) of 40%, 60% and 79% for *A.angustifolia* and *E.citriodora* woods.

SAMPLE Nº	ARAUCARIA ANGUSTIFOLIA								EUCALYPTUS CITRIODORA							
	Extractives Content (%)		SPECIFIC GRAVITY	Equilibrium Moisture Content (%)					Extractives Content (%)		SPECIFIC GRAVITY	Equilibrium Moisture Content (%)				
				T=40°C	T=50°C	T=50°C	T=50°C	T=60°C				T=40°C	T=50°C	T=50°C	T=50°C	T=60°C
	WEC	AEC		RH=60%	RH=40%	RH=60%	RH=79%	RH=60%	WEC	AEC		RH=60%	RH=40%	RH=60%	RH=79%	RH=60%
1	4.90	2.60	0.356	10.42	6.65	9.76	14.43	9.10	5.60	3.50	0.762	8.80	5.12	7.44	11.54	7.77
2	6.00	2.50	0.389	10.35	6.42	9.90	14.90	9.16	6.00	4.40	0.769	8.80	5.00	7.44	11.87	7.53
3	1.80	3.40	0.399	10.26	6.39	9.87	14.54	9.68	5.10	3.60	0.778	8.82	4.99	7.65	10.75	7.40
4	2.90	4.00	0.412	10.31	6.46	9.49	14.14	9.25	5.90	4.30	0.779	8.90	5.19	7.96	11.97	7.59
5	3.50	3.60	0.413	10.13	6.58	9.46	13.87	9.30	5.70	4.40	0.784	9.04	5.20	8.13	12.42	7.38
6	4.90	1.50	0.424	10.66	6.62	10.17	14.93	9.97	5.50	3.70	0.784	8.56	4.87	7.61	11.61	7.32
7	4.50	3.20	0.437	10.15	6.21	9.54	14.14	9.14	6.70	3.90	0.785	8.67	5.06	7.50	11.46	7.40
8	3.00	1.20	0.448	10.60	6.85	9.99	14.71	10.05	6.50	3.90	0.790	7.95	4.26	6.69	10.50	6.64
9	2.80	1.30	0.459	10.45	6.49	9.97	14.34	9.22	6.90	3.20	0.809	8.90	5.10	7.95	11.89	7.76
10	5.50	7.80	0.472	9.47	5.89	8.65	13.34	8.51	7.10	4.20	0.810	7.83	4.26	6.72	10.62	6.45
11	6.70	5.30	0.476	9.87	6.03	9.34	13.30	9.11	5.30	3.20	0.816	8.97	5.35	7.95	12.15	7.61
12	3.90	2.00	0.476	11.05	7.13	10.28	14.74	9.92	5.90	4.60	0.819	8.04	4.52	6.71	10.53	6.94
13	3.00	1.80	0.479	10.83	6.76	9.89	14.66	9.78	7.10	5.40	0.827	7.73	4.20	6.46	10.06	6.13
14	6.60	8.20	0.485	9,44	6.02	8.87	12.89	8.86	6.50	4.20	0.831	7.82	4.19	6.21	10.31	6.25
15	5.50	6.30	0.491	9,66	6.02	9.11	13.28	8.86	9.30	6.80	0.893	7.32	3.80	5.75	8.91	5.80
16	5.10	2.80	0.507	10.42	6.57	9.57	14.02	9.12	-	-	-	-	-	-	-	-
17	6.70	4.20	0.510	10.19	6.42	9.24	14.06	9.08	-	-	-	-	-	-	-	-
18	6.90	8.70	0.512	9.41	5.97	8.64	13.16	8.23	-	-	-	-	-	-	-	-
19	4.80	2.90	0.520	10.16	6.41	9.51	14.47	9.30	-	-	-	-	-	-	-	-
20	3.40	2.50	0.545	10.28	6.42	9.73	14.22	9.95	-	-	-	-	-	-	-	-
AVERAGE	4.62	3.79	0.461	10.21	6.42	9.55	14.11	9.28	6.34	4.22	0.802	8.41	4.74	7.21	11.11	7.06
STANDARD ERROR	0.34	0.51	0.011	0.10	0.07	0.10	0.14	0.11	0.27	0.24	0.009	0.15	0.13	0.19	0.25	0.17

and 60% of relative humidity. This relationship is similar for all conditions of temperature and relative humidity tested.

Looking at the simple linear regression it can verify that the equilibrium moisture content is negatively correlated with the extractive content for the two species. In the *A. angustifolia* wood the specific gravity is not correlated with extractive content and equilibrium moisture content. In the *E.citriodora* wood the correlation of equilibrium moisture content with specific gravity was slightly higher than the existing relationship between equilibrium moisture content and extractives content. Probably this happened because the correlation of extractives content with specific gravity.

This fact is shown in the multiple linear regression - analysis.

The results obtained agree with individual papers from WANGAARD & GRANADOS (1967), on extractives/hygroscopicity - relationship, and from HIGGINS *et al* (1973), on specific gravity/extractives relationship for hardwoods.

It was not detected the relationship between specific gravity and extractive content for *A.angustifolia* wood. - Probably this correlation depends on other factors, as reported by MC MILLIN (1968).

Conclusions

From the results and its discussion, the following - conclusions can be drawn:

1) The equilibrium moisture content decreases as the extractive content increases.

2) For the *E.citriodora* wood there is a positive correlation between the specific gravity and the extractive content, which does not happen for the *A.angustifolia* wood.

3) The effect of the specific gravity on the equilibrium - moisture content is a reflex of its relationship with the extractive content.

TABLE 2. Models of regression, coefficientes of determination (r^2) and its significance for simple linear - correlation between equilibrium moisture content (EMC), specific gravity (SG), water-soluble (WEC) and - alcohol-benzene-soluble (AEC) extractives content.

SPECIE	VARIABLES CORRELATED	MODEL OF REGRESSION	r^2
Araucaria angustifolia	EMC x WEC	EMC = 10.4268 - 0.1900(WEC)	0.3859^{**}
	EMC x AEC	EMC = 10.2726 - 0.1909(AEC)	0.8849^{**}
	EMC x SG	EMC = 11.1448 - 3.4654(SG)	0.1356^{ns}
	SG x WEC	SG = 0.4163 + 0.0096(WEC)	0.0866^{ns}
	SG x AEC	SG = 0.4369 + 0.0062(AEC)	0.0834^{ns}
Eucalyptus citriodora	EMC x WEC	EMC = 10.3766 - 0.4992(WEC)	0.5049^{**}
	EMC x AEC	EMC = 9.5968 - 0.5652(AEC)	0.4994^{**}
	EMC x SG	EMC = 20.2926 -16.2973(SG)	0.5358^{**}
	SG x WEC	SG = 0.6437 + 0.0251(WEC)	0.6309^{**}
	SG x AEC	SG = 0.6952 + 0.0255(AEC)	0.5025^{**}

NOTE : ns = not significant
** = significant at 1% probability level

The equilibrium moisture content was obtained at 50°C of temperature and 60% of relative humidity.

TABLE 3. Models of regression, coefficients of determination (r^2) and its tests of significance for the multiple linear correlation expressing the equilibrium moisture content (EMC) as a function of the specific gravity (SG) and the water-soluble extractives content (WEC).

Araucaria angustifolia	Model of Regression	EMC = 11.4129 - 0.1898(WEC) - 2.1433(SG)
	r^2	0.5011
	$t(B_1)$	3.62**
	$t(B_2)$	1.33^{ns}
	F	8.54**
Eucalyptus citriodora	Model of Regression	EMC = 16.5459 - 0.2592(WEC) - 9.5927(SG)
	r^2	0.5784
	$t(B_1)$	$1.96^{(1)}$
	$t(B_2)$	2.29*
	F	8.11**

NOTE : ns = not significant
(1)= significant at 10% probability level
* = significant at 5% probability level
** = significant at 1% probability level

The equilibrium moisture content was obtained at 50°C of temperature and 60% of relative humidity.

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FAST GROWING TREES

A NECESSIDADE DE PROGRAMAS INTEGRADOS DE MELHORAMENTO GENÉTICO FLORESTAL EM RELAÇÃO ÀS ESPÉCIES, ÀS PROCEDÊNCIAS E ÀS PROPRIEDADES DA MADEIRA.

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Resumo

Os pontos principais discutidos neste trabalho dizem respeito à defasagem que existe entre a teoria e a prática nas áreas de melhoramento florestal, silvicultura e a indústria florestal. Do ponto de vista do administrador, é grande a necessidade de um trabalho interdisciplinar englobando melhoramento de árvores, silvicultura, manejo de solos e química técnica. É apresentado um modelo para o planejamento de uma plantação florestal com base nesta idéia de integração entre a comunidade de pesquisas, e também entre pesquisadores e pessoal de apoio. Finalmente, algumas linhas de desenvolvimento são sugeridas.

THE NEED OF INTEGRATED TREEBREEDING PROGRAMMES WITH REGARD TO SPECIES, PROVENANCE AND WOOD PROPERTIES.

Summary

The main tasks discussed in this paper is the gap between theory and practice within the field of treebreeding, silviculture and forest industry engineering. From a managerial point of view the need for interdisciplinary work focusing treebreeding, soil management, silviculture and chemistry/technical is very large. A model for planning of forest plantation is developed on the basis of the idea of integration within the research community and between research and practical working professionals. Finally some developement lines are suggested.

1. THE PLANTATION FORESTRY SITUATION

We need forest products for fuel and food in the third world and for sawlogs, pulp and paper all over the world. Some people believe that conservation is the greatest need if we want to build a good living. Nothing says that forests could not be used for production and conservation at the same time.

Never has the plantation of forest trees been carried out in such a heavy programme as today both in afforestation and reforestation projects. But still do we have tremendous areas of earlier forest land that looks like desert. And this happens even in south Europe. How can this be possible in a time when we probably know more about forestry than ever before?

At the same time we have the best forest scientists ever but we have not found a sufficient way to inform the foresters who carry out these big projects. Mistakes are still made, which should not be necessary if we could fill the gap between theory and practice and bring the knowledge of treebreeders to foresters out in the field and the results from the forest industry research people back to the breeders and silviculturists.

In 1977 we reached altogether some 4 million hectars plantation area. (1). According to Dr Fugalli, FAO we had some 80 million ha of man made forests 1979. The estimated increase until 1985 is some 40 million hectars. Roughly 50% of all manmade forests are in China and USSR and 50% in Africa, Asia and Latin America. One third of the increase 1980 - 85 is located to developing countries.

The potentials of forest production in the tropic are enormous, but there are big risks too. New forest countries are born and grow rapidly. This picture shows the wood production potential of some countries compared to Scandinavia (2). To build a good living standard in the developing countries we need forests for landconservation, timber and fuelproduction as well as for recreation and hunting. Dr King at FAO makes a strong point of the need for "Agroforestry". I hope he thinks of cooperation between forestry and farming. Nothing says it could not be done.

2. WHAT CREATES THE VALUE OF FOREST PLANTATIONS?

Ask the authorities and you will have many different answers. However, whether producing sawlogs, pulp- or fuelwood high density of the wood is important. We need highest fiber production in tons of dry substance on the area available.

The value of a forest is always combined with the owners possibility to deliver a good product with a certain uniformity at a time fitting the customer. (3)

To reach that goal we have to find the right species and the right provenance to be able to produce the right trees for the right purpose on the right site and combine this with the right management in every specific part of the world. That is impossible - oh yes, but we have to try!

Prof. Sten Nilsson at the Swedish University of Agricultural Sciences has presented a paper dealing with these problems. With help of a model created by the World Bank, he has made a study of the "forest industry enterprise of Sweden". He tries to cover the whole complex - wood supply, forest industry and market. At the same time he also puts a value to earlier woodwaste like branches, stumps and treetops for energyproduction.

Prof. Nilssons model [1)] has its biggest value as a base for discussions round necessary changes in industry structure. It is an optimizing model working after a linear programme technique. It minimizes the costs for wood supply at a given rate of income for the country or the region under analyse. Of course it is not a way to make decisions - just to analyse the problems.

The same technique could be used for building up hypothesis about the best way to carry out an afforestation programme in a developing country. This is newly made by Dr. N. Svanqvist in "Pulp and Paper in the ASEAN Region" SFS 153/80.

3. PRIORITY OF SPECIES

The big forest plantations are located to Brazil, USA, USSR, Japan, Scandinavia, Indonesia and Chile to mention those who cover more than 100 000 ha per year. Only a handfull of species of conifers and broadleaves are used. There are P. elliotti, taeda, carribea, radiata and patula. E. alba, saligna, grandis, globulus, viminalis and camaldulensis. There are some cypresses and some indigenous trees like Parana-pine, teak, gmelina etc.

We know that fastgrowing conifers and broadleaves can be used for medium quality sawlogs and separately or mixed for production of high quality paper. Thus they have to be used in developing countries.

In addition to these fast growing species we have to consider the need for reforestation with indigenous trees. (4) People out in the countryside want their own common trees. That is partly nostalgia - but nostalgia is important too. A national day for planting of indigenous trees in every country might be one way to start planting in a real big scale all over the world.

First priority must then be given to the task of producing seed of the most common fast growing and indigenous species. With only a dozen species it should not be hard to find the variants which give the best quality of wood for the purposes wanted in the actual region.

Wood density seems to be of outmost importance whatever the goal of production is - sawlogs, pulp- or fuelwood. Wood density is known as one of the point about trees where heredity is most certain. (A. Persson, SHS -78) [2)] (5).

For most purposes other wood properties seems to be of minor importance. Mainly it is a question of choosing between softwood and hardwood - i.e. long or short fiber. For sawtimber it is more or less a question of management and treatment in the stands as far as you have a reasonable good provenance for the local site.

The conclusions are as follows:
- Gather information from soil- and climate specialists, treebreeders and foresters.
- Choose the treespecies that gives the highest yield of dry substance under known siteconditions. Look for species with a provenance that gives good survival and resistance against fungus and insects.
- Let the technical people produce a product of good quality that is needed on the market - local or overseas.

4. PROVENANCE TRIALS IN SWEDEN

In western Europe forest plantation started some 200 years ago and in Scandinavia hundred years later. As far as we relied upon natural regeneration (6) the selection of species and provenance was not any big problem. But after two decades of seeding with seed of German origin in Sweden we woke up and saw that we had not the same fenotype in planted stands as we were used to in our natural regenerations (7). The methods used caused us big areas of low density stands (8). We still suffer from that period. The young stands of high quality forest we should have had to cover our need of wood year 2020 are not there (9). Swedish forest scientists (Schotte, Eiche, Langlet) had early pointed out the risks of using unknown provenances, but not until we found methods to bring P. silvestris to flower and produce cones three years after grafting (10) we saw the chance to produce seed of good quality from own provenance. The work with search for good fenotypes started under control of Dr Arnborg and Stefansson. The Swedish Tree Improvement Institute was founded and all big forest owners - the state and the industries started to build up seed orchards. This one belonging to MoDo was formed in 1948. (11) At the same time rigorous rules were formed regarding moving of seed to localities with harscher climate than that of same trees natural provenance.

In 1976/77 Dr Remröd has made an analysis of survival, growth and quality in provenance experiements with Pinus silvestris, planted 1951. (See appl,figl). Dr Remröd[3)] has found that:

- the forest trees by natural selection have adapted to the varying climatic conditions in an elongated country as Sweden,
- every tree has a genetically dependent growth rythm, which means that the trees start and terminate their annual growth in a programmed manner,
- by seed collection and plantation we do not use the old well adapted trees of the local provenance. We use their progeny and the dominating provenance problems in the north of Sweden is to find provenances of Pinus silvestris with sufficient surviving ability,
- the best criterion of choosing the right provenance is the highest production of solid wood per hectare and year.

A very brief summary is: when moving seed from forest trees from south to north in the northern hemisphere the progeny will grow better until you reach a certain point where they cannot stand the climatic stress any more. The result will be diseases and death (13 + 14). On the other hand, if you move seed from north to south the progeny will have a better survival, a better cone production, thinner bark, shorter needles and a tendency to higher wood density.

It seems as if all activities of a tree is dependent on the solar energy and the day and night rythm at the local site. This was also proved by Erkén[4)] and Stefansson in trials concerning Birch. The trees from seed of a northern provenance planted 1951 on latitude 2° south, fell their leaves about two weeks before the local trees and trees from seed collected 2° south have green leaves when frost comes and the local trees have changed to winterconditions.

It is very likely that the same things happens with trees in warmer climate in the southern hemisphere, when moved in opposite directions.

As an example I can tell that we in the MoBaSaproject in S:ta Catharina after intensive studies and consulting of the best known experienced foresters in the region bought seed from E. viminalis and planted the seedlings in November 1974 on some 1 000 ha (15). Nearly all trees were killed in the hard frost 1975. That caused us problems and changed the whole reforestation project from 50/50 Pine-Eucalypt to 100% Pine in monocultures. With this I want to point out that there are certain risks when moving seed only from the coastline of Brazil up to the highplateau on 1 000 m above sealevel.

Therefore, be careful when moving seed from better to a harscher climat. Use seed from roughly same latitude, altitude and climatic conditions and you probably avoid a lot of troubles. Never forget that production per hectare and year is what really counts.

5. SOME ASPECTS ON TREE BREEDING PROGRAMMES BASED ON UNKNOWN PROVENANCES:

In New Zealand 1977 we saw a famous team of research people making a very good scientific work when selecting outstanding cloons and producing millions of exactly the same Pinus radiata in the orchards. It worked there, but how did it work in the field? I visited Tasman Pulp and Paper Co, their tree nursery and plantations. I saw the problems. They had a so called "die back" of a certainly too high percentage in their young stands of P.radiata. And they did not know how to avoid these problems. Since that day I have asked myself how this could be possible in N.Z., where we have the most skilful treebreeders in the world? The breeding material used for field plantations was probably not well adapted to the soil-, site- and climateconditions? Could not this "die-back" problem have been avoided? The same problems might exist elsewhere too! This stresses the need for very careful selecting of good mothertrees of best possible provenance.

6. PLANTATION FORESTRY IN TROPICAL COUNTRIES, PHYSICAL AND BIOLOGICAL POTENTIALS AND RISKS

Dr Björn Lundgren[5)] at the Swedish University of Agricultural Sciences has presented a work on this title. He states the following conclusions:

- Plantation forestry will be an increasingly more important form of land use in tropial countries. The major establishment will take place in areas which are environmentally marginal to permanent agriculture.

- The interaction of soils and climate impose limitations to the successful introduction of sustained, high yielding forms of land use.

- Successful, profitable land use has only been accomplished by large capital and/or labour inputs in crop and soil management.

- Even if forest is the natural vegetation it is misleading to think that plantation forestry automatically is a suitable form of land use. Plantation forestry is, however, a possible form of land use, but will require as much input in soil and land management as various types of agriculture.

- There are risks when introducing new management systems and techniques developed under environmental conditions which are quite different without any thorough evaluation of their suitability.

- A soil and land management plan should be an integrated part of the general plan of operation for any project.

- There are large gaps in knowledge and experience of plantation forestry and environmental interactions.

- The wide-spread use of very few dominant tree species throughout the tropics makes it possible and natural with international cooperation.

Dr Lundgren points out some major field that need looking into. (App 2)(16).

7. DESIRABLE WOOD PROPERTIES FOR DIFFERENT USE OF WOOD.

IUFRO:S drafting committee no 5, October 1979 recommended "that recording of tests of wood properties of fast growing plantation broadleaved trees should be standardized internationally through the use of standard test cards, which record not only the results from the tests carried out but also environmental and genetic information on the test material. I am the first one to agree with this. There are certainly big difficulties in making comparisons because of lack of information about the material tested.

All tree-species have their own caracteristics - and show differences in suitability for pulp and paper production. The A.B.I.P.C.[6] summaries on these matters 1941 - 1977 (17) show correlation between:
- growing conditions and celldimensions
- celldimentions and paper quality
- density of wood and strenght and uniformity of paper
- growth rate and fiber lenght in spring- or latewood as well as with the localization of the wood in the stem

There is a lot of information like that in A.B.I.P.C. for the last 30 years but unfortunately not always combined with proper information on the material tested.

Looking through reports from swedish, finnish and japanese forest industry research laboratories you will find representative tests showing:

- the yield of different Eucalypt-and Pine-species in the sulphateprocess
- the quality of the fibers from different species
- the content of lignin and extracts

Altogether these tests show (17) that Eucalypt fiber with correct treatment gives a paper of reasonable strenght and good opaque points and there is no problem to make good pulp from fastgrowing Pine-species. Also tests are deficient in information about the origin of the wood. As wood properties partly is a result of interaction between soil, climate and management a better environmental and genetic information should be of value for forestry planning.

However, when evaluating pulp of different quality, the impression is that a presumptive customer has the following ranking scale: (18)

1. the price should be low for the quality offered
2. the delivery should be safe and in time
3. the uniformity in delivered pulp should be good
4. good quality for the special type of paper the customer will produce - like tearing strenght, stiffness, opacity etc.

Taking this appraisal into account the influence of woodproperties alone might not be of determining importance.

8. HOW TO MAKE USE OF ALL KNOWLEDGE WHEN BUILDING UP NEW FORESTS

A great need in the world is the utlilization of solar energy for production of fiber. As this production is a result of very complex interaction between soil- and climateconditions, species, provenance and woodproperties as well as management the conclusion and recommendation ought to be:.

BREED AND PLANT SEEDLINGS OF SPECIES AND PROVENANCE THAT PROBABLY WILL GIVE HIGHEST YIELD IN TONS OF DRY SUBSTANCE PER HECTARE AND YEAR.

MAKE SOMETHING VALUABLE OF THE WOOD WITH HELP OF SKILLFUL ENGINEERING AND GOOD MARKETING.

Having discussed a few matters which without doubt are relevant for most of the foresters who work in developing countries I am going to discuss how to fill the gaps between scientists and practical people in the forest field.

Scientists all over the world are working hard, but in very narrow strips.

Foresters, industrial engineers and marketing people try to do their best in their field. But none really tries "to tie the ropes together". There is a big need for integrated research and cooperation in all different fields from tree breeding to the ready product on the market. Interchange of ideas and mutual efforts for better information must be given high priority. We have to reach out of IUFRO. For that purpose it is of outmost importance to start planning the use of new medias.

8.1 New medias for better information in the 80-ies

The reason for existing information-gaps in the world are several. I leave the question whether the western world is more developed than the third world. Anyway people have that opinion. In my work in developing countries I have got the opinion that what is missing is knowledges - not natural resources. Often it is a question of knowledges of very simple nature. A teacher at a workshop-school in Jordan said to me: "The big difference to teach here and at home is that a 15-year old boy here never has seen a bolt or a screwnut and he does not know in what direction to draw it. At home the children are nearly born with that type of knowledges." The overshadowing problem is to teach the people small simple things and at the same time teach som leaders, who can develop methods and teach others.

If you accept this idea it is evident that modern computer technique must have a big mission in the third world. The Worldbank has already charged an english consulting firm, with work to make cost-benefit analyses for introduction of telecommunications in developing countries.

The system for transmission is possibly "Viewdata", which is a narrowband, interactiv telesystem where telephone cabels are used for transferring information which shows up on the viewers TV-screen.

Viewdata has an enormal potential. You can use it for information, teaching and also for twoway communication. What has made this possible is the drastical, technical developement that has taken place for storing and editing text and simple pictures. Viewdata used in a correct manner thus gives authorities and organizations the possibility to give information of all kinds via the receivers TV-screen. Using a casett-system it is possible to carry out effective technical information, anywhere. There we have the media necessary.

To get the information needed is easy today. By using a databank. Through "Dialog Information Retrieval Service" it is possible to have all information about scientific litterature covering for instance E. saligna and its pulpability, chemical composition or frost resistance, in just a few minutes Any big library in the western world has connection with suitable databanks and for a relatively small amount of money you can have information to cover written scientific work in the subject desired all over the world. The databanks and the view data system together give opportunities that humanity never had before. (19)

8.2 Bilateral cooperation in selected areas.

When starting up big afforestation projects we have to select areas where we possibly could find the most suitable motherstands to collect the seed wanted for the actual purpose.

Scientists and foresters in cooperation should be able to make this selection.

What is needed is information and change of ideas between foresters, treebreeders, soil experts, metereologists, seeddealers, forest institutes, and laboratories for research and developement in forest industry. Today we have the technique for incredible quick information. How could we use it? My suggestions out of own experience in Scandinavia, Brazil and Africa are:

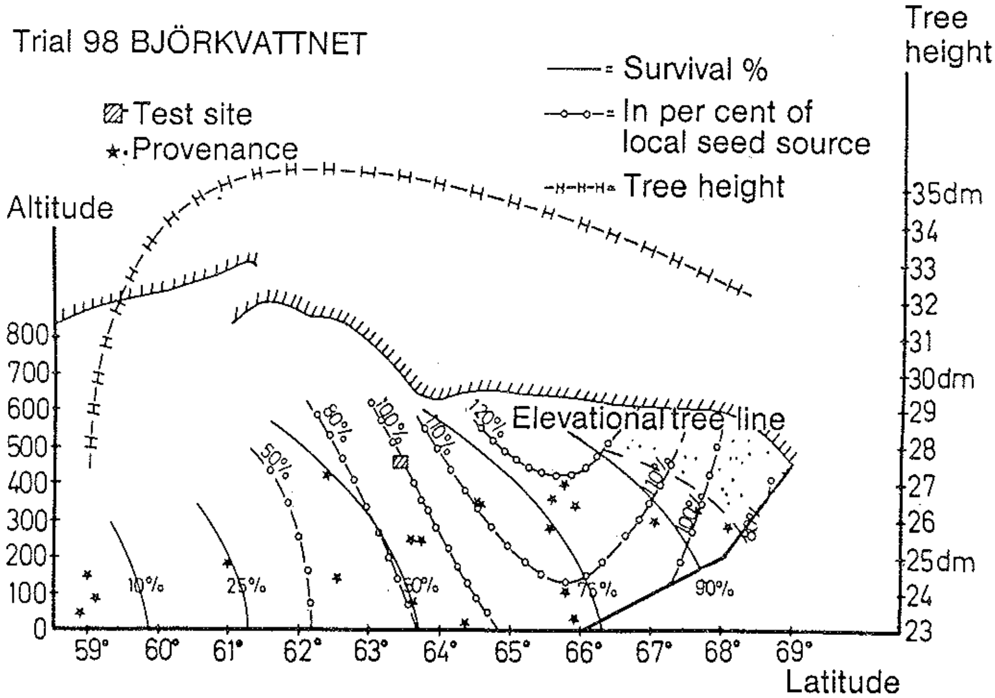
1. IUFRO should try to rank the most important tree species for areas where big afforestation projects are going on or planned.

2. As a start FAO should try to form a group of specialists in different topics to carry out the work. They should represent the topics of soil management, afforestation and silviculture, tree breeding, wood utilization and information. The number of persons involved should not be more than 5 or 6. New groups could be formed later if the experiences are good.

3. The members of the initial working group could for instance represent two specific areas, (20)), Parana and S:ta Catharina in Brazil and Alabama - Georgia, USA. These areas have both need of the same Pine and Eucalypt-species.

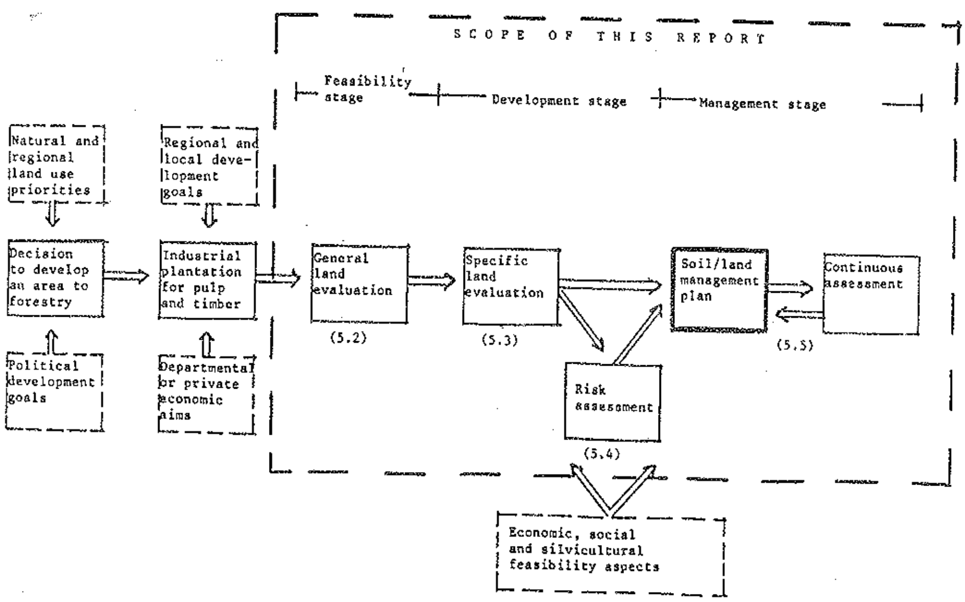
4. The head theam should be to make use of wellknown facts in science, forestry and industry in order to reduce the number of species and find good provenances to work with and thereby create chances to a better developement of special questions that seems of big importance in that area. Such cooperation would hopefully reduce the risks and help to avoid mistakes in plantation forestry and at the same time build goodwill among involved people.

Nothing is impossible if you really want it. Let's start trying!



Survival, treeheight and wood production per hectar in Björkvattnet related to the origin of the procenances. (Regr. 1, 7 and 19). J. REMRÖD -77

Figure · A schematic overview of the framework for land evaluation and soil management work in plantation forestry. Figures below the "boxes" refer to section numbers in this chapter.



Appendix 2

Lundgren, B.: PLANTATION FORESTRY IN TROPICAL COUNTRIES: PHYSICAL AND BIOLOGICAL POTENTIALS AND RISKS 1980

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FAST GROWING TREES

VARIAÇÃO DA DENSIDADE BÁSICA DE MADEIRA EM DIVERSAS PROCEDÊNCIAS DE *Eucalyptus grandis* HILL EX MAIDEN.

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Resumo

A densidade básica da madeira de plantações comerciais de treze procedências de *Eucalyptus* grandis Hill ex-Maiden foi estuada.

As procedências foram assim distribuidas: seis procedências da Rodésia, duas da África do Sul, uma de Angola, uma de Austrália e três do Brasil. Essas procedências foram plantadas em quatro localidades: Bom Despacho, Carbonita e Santa Bárbara (Minas Gerais) e Anchiete (Espírito Santo).

A avaliação da densidade irá indicar a(s) procedência(s) maia adequada(s) que a produção de carvão.

Summary

This study is intended to research the variation of the basic density of the wood in commercial plantations of 13 origins of Eucalyptus grandis Hill ex - Maiden.

The origins involved in this study are thus distributed:

06 origins from Rodhesia
02 origins from South Africa
01 origin from Angola
01 origin from Australia
03 origins from Brasil.

The origins in this study are planted in 4 (four) locations, as follows: Bom Despacho, Carbonita and Santa Bárbara - MG and Anchieta - ES.

The evaluation of the origin(s) with better Basic Density will show us an indication of the most suitable wood for charcoal production.

1 - Introdução.

A moderna silvicultura tem como objetivos principais a obtenção de madeira com alto rendimento volumétrico e com boas qualidades tecnológicas, num menor lapso de tempo.

Dentre os programas de reflorestamentos visando suprir as indústrias siderúrgicas de carvão vegetal, o gênero Eucalyptus tem sido largamente utilizado, em vista de sua numerosa relação de espécies adaptadas às nossas condições.

Dentre estas espécies, o Eucalyptus grandis Hill ex Maiden, tem sido uma das mais amplamente utilizadas, decorrente de sua adaptação e extensas áreas de diferentes condições ecológicas, com bom crescimento volumétrico, boa forma do tronco e qualidade da madeira.

O melhoramento da produtividade e qualidade da madeira são pontos fundamentais, dentro de um programa de melhoramento florestal.

A produção de carvão vegetal vem crescendo em importância e o seu consumo tem um aumento notável em vista do grande impulso das produções siderúrgicas.

Um estudo que busque associar o Melhoramento Florestal a Produção de carvão, evidentemente que o objetivo principal será o de se avaliar as variabilidades genéticas das qualidades da madeira (BRITO, 1978).

A densidade é um dos mais importantes fatores a ser encarado dentre as diversas propriedades físicas da madeira.

FERREIRA (1970), cita que nos estudos de Melhoramento e Genética Florestal, a densidade, por ser um carater herdável vem sendo empregada como índice de árvores matrizes e, nas determinações das variações populacionais, das variações dentro e entre indivíduos de uma mesma população.

HIGA (1973), FOELKEL (1971), citou que na determinação da densidade da madeira, a maioria dos autores tem preferido relata-la em termos de densidade básica, ou seja, a relação entre o seu peso seco em estufa a 105ºC e o respectivo volume em estado de completa saturação.

A determinação da densidade através de uma amostra extraida em um ponto fixo foi sugerido por MARDEN HARRIS (1965), citado por BRASIL (1972) e HIGA (1973).

NYLINDER (1965), em trabalho citado por HIGA (1973), acrescenta que sendo o DAP um padrão internacional utilizado em silvicultura, foi o mesmo escolhido para a maioria das pesquisas em andamento, como o nível de onde deveriam ser retiradas as amostras, por se tratar de um nível fixo, absoluto e fácil de ser trabalhado.

FERREIRA (1968 - 1970), concluiu que para determinação da densidade básica média de árvores de E.alba Reinw, E.saligna Smith e E.grandis Hill ex Maiden, tanto para o método destrutivo como para o não destrutivo, amostras tomadas ao nível do DAP podem estimar a densidade da árvores em idades diferentes.

FOELKEL (1971) estudando os dois métodos de determinação de densidade básica da madeira, concluiu que o método do máximo teor de umidade (não destrutivo), pela facilidade de execução pode ser empregada para determinação em larga escala. Porém deve ser tomado um especial cuidado no controle da absorção da água pelas amostras e, nesse particular, o método da balança hidrostática (destrutivo) é menos rigoroso.

BRASIL (1971), estudando o comportamento de E.alba Reinw, E. saligna Smith e E.grandis Hill ex Maiden, concluiu que não houve influência significativa do espaçamento na densidade básica da madeira.

FERREIRA (1972), SOUZA (1979), citou que árvores mais vigorosas tem em média maior densidade básica média do que as menos vigorosas.

BRASIL (1971), trabalhando com E.alba Reinw, E.saligna Smith e E.grandis Hill ex Maiden concluiu que a densidade básica média da madeira variou, independente das espécies para os dois locais estudados. Cita o autor que estas diferenças podem ser atribuidas à qualidade das sementes, utilizadas ou as diferenças ecológicas existentes entre os dois locais.

FERREIRA (1978), estudando a variação da densidade da madeira de populações de pinheiro, encontrou números diferentes de árvores necessárias à estimativa da densidade média das populações, variando em função da espécie e idade.

BRASIL (1972), FERREIRA (1972), citou que a densidade básica da madeira cresce no sentido casca medula sendo este crescimento mais acentuada nas camadas mais extensas e, que o aumento da densidade básica da madeira foi acompanhado pelo aumento de espessura das parcelas das fibras e pelo comprimento médio das fibras.

BRITO (1978), cita a existência de uma alta correlação entre a densidade da madeira e a densidade aparente de carvão, sendo uma maneura importante para se antever o comportamento do mesmo mediante avaliação da densidade de sua madeira.

COLLET (1955), citado por BRITO (1977), estudando uma série de madeiras demonstrou que a quantidade de carbono fixo, fornecido por unidade de madeira enfornada é função da percentagem de lignina da madeira.

BRITO (1977), em relação ao rendimento volumétrico em carvão, as madeiras deverão possuir além de um mais alto teor de lignina, uma mais alta densidade básica, para aumentar a quantidade de madeira seca colocada no formo de carbonização.

FERREIRA (1972) recomenda que nos programas atuais de melhoramento genético fosse incluido, além do controle das variações morfológicas o estudo de variação da qualidade da madeira.

2 - Material e Método.

2.1 - Material.

As amostras de madeira foram retiradas de árvores de plantios comerciais de rotina de 13 procedências de Eucalyptus grandis Hill ex Maiden, situado nas localidades de Bom Despacho - MG, Carbonita-MG, Sta. Bárbara-MG e Anchieta-ES, em áreas de propriedade de Cia.Siderúrgica Belgo-Mineira.

2.1.1 - Dados das Localidades.

2.1.1.1 - Bom Despacho - MG.

A área esta situada e aproximadamente 19º35' Latitude Sul e 45º17' Longitude Oeste.

O clima é subtropical úmido, com temperatura média anual de 20,8ºC, precipitação média anual de 1375 mm e com déficit hídrico entre 30 e 60 mm anuais.

O solo do local é um Latossolo Vermelho-Amarelo profundo, bem drenado e de baixa fertilidade.

O relevo é suavemente ondulado e a altitude média é de 700 m.

A cobertura vegetal primaria era constituida por cerrado.

2.1.1.2 - Carbonita - MG.

A área situa-se aproximadamente a 17º44' Latitude Sul e 43º14' Longitude Oeste.

O clima é subtropical úmido subúmido, com temperatura média anual entre 19-20,0ºC, precipitação média anual em torno de 1.150 mm e com déficit hídrico entre 60 e 120 mm anuais.

O solo do local é um Latossolo Vermelho Escuro orto, profundo, bem drenado e poroso.

O relevo é suavemente ondulado e a altitude média é de 600 - 1000 m.

A cobertura vegetal primaria era constituida por cerrados.

2.1.1.3 - Santa Bárbara - MG.

A área situa-se aproximadamente a 20º09' Latitude Sul e 43º24' Longitude Oeste de Grenwich.

O clima é temperado úmido, com inverno seco e chuvas no verão amplo, com temperatura média anual de 19,5ºC precipitação média anual em torno de 1273 mm, com déficit hídrico variando entre 40 e 200 mm.

O solo do local é um Latossolo Vermelho Amarelo distrófico orto, textura argilosa.

O relevo é forte ondulado e montanhoso com altitude média de 700 m.

A cobertura florestal primaria era constituida por mata caducifolia variando para semi-caducifolia a subperenifolia.

2.1.1.4 - Anchieta - ES.

A área situa-se aproximadamente a 20º19' Latitude Sul e 40º39' Longitude Oeste de Greenwich.

O clima é tropical úmido sem estação seca pronunciada, com temperatura média anual entre 20 e 23ºC, precipitação média anual em torno de 1207 mm.

O solo do local e o Latossolo Vermelho-Amarelo distrófico e associação de areia quartzosas marinhas distróficos.

O relevo é suave ondulado, com altitude média entre 6 - 20 m.

A cobertura florestal primaria era constituida pela Floresta Pluviol Tropical.

2.1.2 - Relação do Material Estudado.

A relação do material estudado consta do quadro I.

Quadro I - Procedências de E.grandis, País de origem, local de coleta e idade do material estudado as densidades básicas da madeira.

Procedência	País	Local da Coleta	Idade
Mtao Forest	Rodésia	Bom Despacho-MG	5
Triangle	Rodésia	Anchieta - ES	4
Macheke	Rodésia	Carbonita - MG	4
Umvukwe	Rodésia	Santa Barbara-MG	3
Selukwe	Rodésia	Bom Despacho-MG	3
Melsetter	Rodésia	Santa Bárbara-MG	3
Kwa-ubonambi	África do Sul	Anchieta-ES	4
Tzaneen	África do Sul	Santa Bárbara	4
Coff's Harbour	Austrália	Santa Bárbara	4
Angola	Angola	Bom Despacho-MG	3
Rio Claro	Brasil	Bom Despacho-MG	5
Mogi Guaçu	Brasil	Bom Despacho	4
Bom Despacho	Brasil	Bom Despacho	2

2.2 - Método.

2.2.1 - Coleta de amostras de madeira das árvores.

a) A coleta das amostras foi realizada pelo método destrutivo, em cada árvore amostrada retirou-se um disco de 3 cm de espessura na altura do DAP.

b) As amostras foram embaladas em sacos plásticos, individualizados por procedências.

2.2.2 - Determinação da Densidade Básica da Madeira.

A densidade básica da madeira foi determinada pelo método da balança hidrostática seguindo as operações.

a) Saturação dos discos até peso constante.

b) Realização das pesagens, peso úmido (Pu) e peso úmido imerso Pui).

c) Secagem dos discos em estufa à 105ºC até peso constante, obtendo-se o peso absolutamente seco (Ps).

d) A densidade básica da madeira é dada pela expressão.

$$Db = \frac{Ps}{Pu - Pui} \quad (g/cm3).$$

2.2.3 - Densidade Básica Média da Madeira das Procedências.

Com base em uma pré-amostragem, constituida por 10 árvores por procedência, estudou-se o número mínimo de árvores necessárias à amostragem casualizada, segundo FREESE (1970), e FERREIRA (1970), através da fórmula.

$$N = \frac{t^2 \, s^2}{d^2}$$

onde.

s^2 = Variância das densidades básicas médias das árvores da pré-amostragem.

t = Valor da tabela de distribuição de t para os graus de li

Quadro II - Tamanho da amostragem e densidade básica média, desvio e amplitude de variação de 13 procedências de Eucalyptus grandis Hill ex Maidem.

Procedências	Idade	Tamanho da Amostragem Nº mínimo	Nº utilizado	Densidade Básica Média	Desvio	Amplitude Variação
Mtao Forest	5	25	25	0,448	0,040	0,380 - 0,520
Triangle	4	18	25	0,416	0,037	0,320 - 0,500
Macheke	4	07	25	0,422	0,024	0,360 - 0,460
Umvukwe	3	18	25	0,394	0,029	0,350 - 0,460
Selukwe	3	20	25	0,400	0,032	0,340 - 0,450
Melsetter	3	[illegible]	25	0,380	0,031	0,330 - 0,460
Kwambonaombi	4	37	25	0,421	0,041	0,360 - 0,520
Tzaneen	4	20	25	0,439	0,027	0,370 - 0,490
Coff's Harbour	4	20	25	0,382	0,028	0,340 - 0,440
Angola	3	08	25	0,387	0,050	0,360 - 0,440
Rio Claro	5	23	25	0,480	0,032	0,410 - 0,530
Mogi Guaçu	4	10	25	0,413	0,023	0,380 - 0,460
Bom Despacho	2	12	25	0,369	0,023	0,330 - 0,420
	Média	17,92		0,412	0,032	
	S	8,05		0,031	0,008	0,320 - 0,530
	CV	44,90		7,582	25,048	

berdade de pré-amostragem, ao nível de 80 % de probabilidade de exatidão desejada.

Erro permissível = ± 0,01g/cm3.

N = Número de árvores necessárias para o erro permissível (d) e o nível de probabilidade de exatidão desejada.

O número de árvores necessárias e as densidades básica média acham-se relacionadas no quadro II.

3 - Discussão dos Resultados.

Para o estudo da variação da Densidade Básica da Madeira entre procedências de Eucalyptus grandis Hill ex Maiden, o trabalho demonstrou que o número de árvores necessárias à estimativa da densidade média variou entre procedências e idades (quadro II).

Embora o número tenha variado de 07 a 37, em função do grau de exatidão desejada, neste trabalho utilizou-se 25 árvores por procedências, visando facilitar a amostragem.

Para as idades inferiores, o número de árvores necessárias e amostragem diminui, mostrando que a madeira juvenil produzida nos primeiros anos de vida das árvores é menos variável do que a madeira produzida nos anos subsequentes.

Analisando-se quadro II, nota-se que a variabilidade entre procedências de E.grandis é relativamente alta.

Os valores de densidade básica das árvores da população, baseadas em 25 árvores por procedência, foram analisadas, visando detectar diferenças entre as procedências em estudo.

Quadro III - Análise de variância dos dados de densidade básica média das 25 árvores por procedência.

Causa da variação	GL	SQ	QM	F
Procedências	12	0,28	0,0200	25,35 **
Resíduo	312	0,29	0,0009	
Total	324	0,57		

** Significativo ao nível de 1% de probabilidade.

Analisando-se as densidades básicas médias nota-se uma divisão em três grupos de classes de densidade, bem distintas em função da idade.

a) As plantações de 5 e 4 anos, no primeiro grupo, com destaque para os de 5 anos (0,480 - 0,413 g/cm3).

b) As procedências de 3 anos (0,400 -0,387g/cm3).

c) A procedência de 2, juntamente com uma de 3 e 4 (0,382-0,369 g/cm3) com a de menor idade tendo a menor densidade básica média.

Neste estudo, o principal objetivo foi estudar a existência de variação da densidade básica da madeira em diferentes procedências de E.grandis, em vista das diferentes qualidades genéticas do material utilizado e, as diferentes idades amostradas.

No quadro IV estão colocadas as procedências, médias e diferenças encontradas no teste de Tukey para uma melhor visualização entre procedências e idades.

Procedência	Idade	Db g/cm3	Diferenças significativas (Teste de Tukey ao nível de 1% de probabilidade.
Rio Claro	05	0,480	a
Mtao Forest	05	0,448	b
Tzaneen	04	0,439	b
Macheke	04	0,422	c
Kwambonambi	04	0,421	c
Triangle	04	0,416	c
Mogi Guaçu	04	0,413	c d
Selukwe	03	0,400	d e
Umvukwe	03	0,394	e f
Angola	03	0,387	e f
Coff's Harbour	04	0,382	f g
Melsetter	03	0,380	f g
Bom Despacho	02	0,369	g

4 - Conclusões.

Os resultados obtidos e discutidos neste trabalho, permitem concluir que:

a) Para o estudo da densidade básica média de procedências de E.grandis, o número de indivíduos por procedência e idade, necessários à amostragem, considerando-se um erro da ordem de ± 0,01 g/cm3 e 80 % de probabilidade de exatidão desejada, variou em função de procedências e idades.

Há uma tendência nas menores idades, que o número de indivíduos ser menos que as maiores.

b) Há um aumento significativo de densidade básica média em função da idade, comprovado pelos resultados altamente significativos encontrados.

c) Existe uma alta variação individual dentro das procedências.

d) Na escolha da procedência adequada para uma localidade, deve-se levar em conta as densidades básicas médias apresentadas, em vista das produções serem tomadas em peso seco.

e) Há possibilidade do Melhoramento Florestal selecionar e melhorar as diferentes procedências de E.grandis quanto a densidade básica da madeira.

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PESO DA MATÉRIA SECA, DENSIDADE BÁSICA E DIMENSÕES DE FIBRAS DE *Pinus caribaea* MOR. VAR. *hondurensis* BAR. ET GOLF.

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Resumo

Foram coletados dados de 45 árvores de *Pinus caribaea* Mor. var *hondurensis* Bar. et Golf, de 17 anos de idade, em diferentes espaçamentos, no Município de Mogi-Mirim, Estado de São Paulo, Brasil.

Não houve diferença na densidade básica da madeira entre os diferentes espaçamentos. A densidade básica média das árvores foi de 0,371 g/cm³ e pode ser estimada através da seguinte equação:

$$d_A = -0{,}008248 + 0{,}0000004646D^2H + 0{,}932934d_D$$

Onde: D x DAP (cm); H = altura total da árvore; d_D = densidade básica à altura do DAP.

O peso seco do tronco (P) sem casca e até ao nível de 0,008 m de diâmetro superior do tronco pode ser estimado pela equação:

$$P = 9{,}858582 + 0{,}008458D^2H$$

Onde: P é dado em kg; D é o DAP (cm) com casca; H é a altura total da árvore em metros.

Summary

Data were collected from 45 trees of 17 years old *Pinus caribaea* Mor. var. *hondurensis* Bar. et Golf. from different spacings - Mogi Mirim, São Paulo State, Brazil.

The wood specific gravity is not different for spacings. The mean specific gravity of trees was 0,371g/cm³ and can be estimated by the equation.

$$d_A = -0{,}008248 + 0{,}0000004646D^2H + 0{,}932934d_D$$

Where: D is dbh (cm); H is total tree height and d_D is specific gravity at dbh level.

The stem dry weight (P) without bark up to 0,08m of top diameter can be estimated by the equation:

$$P = 9{,}858582 + 0{,}008459D^2H$$

Where: P is given in kg, D is dbh over bark in cm and H is total tree height in m.

Introdução

O *Pinus caribaea* Mor. var. *hondurensis* Bar. et Golf., originário das Honduras Britânicas, Guatemala, Honduras e Nicaragua, foi introduzido no Brasil para atender à demanda de fibras longas. Plantado em regiões onde não há ocorrência natural de coníferas, vem apresentando bom desenvolvimento, chegando a atingir em algumas regiões 28m³ sem casca por hectare por ano (BERTOLANI & NICOLIELO, 1977).

Para melhor caracterizar a utilização tecnológica da madeira da referida espécie, há que se conhecer os seus parâmetros anatômicos, físicos e mecânicos. Dentre eles, salienta-se a densidade básica, de interesse pelas interrelações com outras propriedades da madeira e que pode ser influenciada por rítmo de crescimento, idades, quantidade de extrativos, espessura dos anéis e dimensões dos elementos anatômicos (KOCH, 1972).

O presente trabalho procura estudar alguns aspectos relacionados à qualidade da madeira de 45 árvores da citada espécie, amostradas em populações não desbastadas, com 17 anos de idade, implantadas a 3 diferentes espaçamentos iniciais na região de Mogi Mirim, Estado de São Paulo. São realizados estudos referentes às dimensões das fibras, variações longitudinal da densidade básica, determinações da densidade da árvore em função de valores dendrométricos, e estimativas de peso da madeira em função de diâmetro e altura.

Material e Métodos

Para o presente estudo foram amostradas 45 árvores de *Pinus caribaea* var. *hondurensis*, com 17 anos de idade, sorteadas em área experimental instalada pelo Instituto Florestal em Mogi Mirim, SP. O espaçamento inicial adotado no plantio foi de 1,5m X 1,0m para 15 dessas árvores, de 2,5m X 1,5m para outras 15 e de 3,0m X 2,5m para as 15 árvores restantes. O plantio foi realizado a partir de sementes originárias da região de El Peten, província de Poptun - Guatemala. As parcelas experimentais não haviam sofrido desbaste até o momento da amostragem.

A área do ensaio encontra-se localizada entre as coordenadas geográficas 22°26' lat. S e 46°57' long. W.Gr. O clima é Cwa segundo a classificação de Köppen. O solo é classificado como latosol vermelho-amarelo fase arenosa. A altitude é em média de 631m.

Das árvores amostradas retiraram-se discos de 2m em 2m e à altura do DAP. Com esse material foram determinados valores de densidade básica da madeira, pelo método da balança hidrostática. Foram também realizadas mensurações das fibras em três posições, da secção extraída à altura do DAP, a saber: A, próxima à medula; B, na posição mediana; C, próxima à casca. Para cada árvore foram determinados o DAP, a altura total, o volume comercial sem casca, a densidade básica e o peso de matéria seca até o limite de desponta de 0,08m. Foram testadas equações visando a estudar a variação longitudinal da densidade. Foram também testadas equações para estimativa do peso de matéria seca em função do DAP com casca e da altura total da árvore.

Resultados e Discussão

Para melhor caracterizar as árvores amostradas, constam na Tabela I os valores médios obtidos para as seguintes variáveis: DAP com casca (D), altura total (H), densidades básicas da árvore (d_A) e ao nível do DAP (d_D), volume comercial sem casca (V) e seu peso em matéria seca (P). Na Tabela 2 acham-se inseridos os coeficientes de correlação parcial simples obtidos entre as variáveis em estudo.

Tabela 1. Valores médios e desvios padrões de algumas variáveis obtidos para *Pinus caribaea* var. *hondurensis* em maciços não desbastados com 17 anos de idade, em cada espaçamento e no conjunto de espaçamentos.

Variável	1,5m X 1,0m Média	Desvio Padrão	2,5m X 1,5m Média	Desvio Padrão	3,0m X 2,0m Média	Desvio Padrão	Conjunto Média	Desvio Padrão
d_A (g/cm^3)	0,350	0,055	0,365	0,051	0,397	0,040	0,371	0,052
d_D (g/cm^3)	0,328	0,052	0,398	0,052	0,429	0,042	0,404	0,052
D (cm)	14,2	1,7	16,7	2,5	20,2	2,5	17,0	3,3
H (m)	19,5	2,1	19,0	2,2	21,6	1,4	20,0	2,2
V (dm^3)	125,9	38,3	147,7	46,1	216,4	46,6	163,3	57,9
P (kg)	45,3	16,4	55,1	22,0	87,0	24,8	62,4	27,6

As árvores sorteadas não revelaram diferença significativa entre os espaçamentos em estudo para altura total e para a densidade básica da árvore. Embora não comprovada estatisticamente, houve uma tendência da densidade em aumentar com os espaçamentos maiores. No que concerne ao DAP médio das árvores amostradas, o espaçamento de 3,0 X 2,5m superou significativamente o espaçamento de 1,5 X 1,0m ao nível de 5% de probabilidade, não se tendo verificado outras diferenças significativas.

Depreende-se da Tabela 1 que a densidade básica das 45 árvores estudadas em Mogi Mirim foi em média 0,0371 g/cm^3. Esse valor é inferior ao de 0,436g/cm^3 observado para a mesma espécie, por AMARAL et alii (1977) em 10 árvores de 14 anos de idade, na região de Agudos, SP. Com relação à densidade básica ao nível do DAP, que no presente trabalho foi de 0,404g/cm^3, o resultado também foi inferior ao de 0,469g/cm^3 obtido para a espécie por BARRICHELLO (1979), para 10 árvores na mesma região de Agudos. Cabe ressaltar que em ambos os trabalhos citados os povoamentos haviam sido submetidos a práticas de desbaste.

Quanto à Tabela 2, pode-se salientar os elevados valores de coeficiente de correlação parcial simples encontrados entre as densidades básicas da árvore e ao nível do DAP, entre volume e peso do fuste, e entre o peso e a variável combinada D^2H.

Visando ao estudo da variação longitudinal da densidade (d) em diferentes alturas (h) ao longo do fuste, foram testados os modelos relacionados na Tabela 3. Os modelos foram testados para as densidades obtidas nas 45 árvores, de 2m em 2m a partir da base e incluindo-se a correspondente ao DAP. Os valores obtidos para o coeficiente de correlação (r) constam na Tabela 3 para cada modelo testado.

Tabela 3. Coeficientes de correlação obtidos nos diferentes modelos testados para explicar a variação longitudinal da densidade de *Pinus caribaea* var. *hondurensis*.

Modelo Testado	ESPAÇAMENTO 1,0m X 1,5m	1,5m X 2,5m	3,0m X 2,5m	GERAL
Linear ($d = a + bh$)	-0,5841	-0,5932	-0,6588	-0,5666
Hiperbólico ($d = a + b/h$)	0,3804	0,4729	0,4025	0,3972
Bilogarítmico ($\ell og_e d = a + b\ell og_e h$)	-0,5310	0,5763	-0,5573	-0,5225
Semilogarítmico ($d = a + b\ell og_e h$)	-0,5298	-0,5931	-0,5751	-0,5314
Log Inverso ($\ell og_e d = a + b(1/h)$)	0,3721	0,4491	0,3770	0,3801
Monologarítmico ($\ell og_e d = a + b\ell og_e h$)	-0,5996	-0,5899	-0,6573	-0,5713
$y = a + b_1 h + b_2 h^2$	0,5841	0,6025	0,6656	0,5673
$\ell og\, y = a + b_1 h + b_2 h^2$	0,6005	0,5949	0,6709	0,5713

Optou-se pelo modelo linear que foi dos mais precisos e envolve maior rapidez e facilidade de computação. Esse modelo mostra a tendência biológica da densidade em decrescer com a altura, o que vem sendo descrito para espécies de *Pinus* por diversos autores, dentre os quais HEGER (1974) e AMARAL et alii (1977).

A Tabela 4 relaciona as equações lineares calculadas para exprimir a variação longitudinal da densidade.

Tabela 4. Equações lineares selecionadas e respectivos valores de F para exprimir a variação longitudinal da densidade em cada espaçamento e no conjunto de espaçamentos.

Espaçamento	Equação	F
1,5m X 1,0m	d = 0,403049 - 0,007984 h	63,71 **
2,5m X 1,5m	d = 0,412501 - 0,007633 h	70,59 **
3,0m X 2,5m	d = 0,449913 - 0,007904 h	115,82 **
Conjunto	d = 0,420017 - 0,007320 h	192,97 **

TABELA 2. Coeficientes de correlação parcial simples entre as variáveis testadas. Valores obtidos em cada espaçamento e no conjunto de espaçamentos para *Pinus caribaea* var. *hondurensis*, aos 17 anos de idade.

	Espaçamento 1,5 x 1,0m					Espaçamento 2,5 x 1,5m					Espaçamento 3,0 x 2,5m					Conjunto de Espaçamentos				
	H	d_D	d_A	V	P	H	d_D	d_A	V	P	H	d_D	d_A	V	P	H	d_D	d_A	V	P
D	0,6925	0,5286	0,5760	0,9090	0,8666	0,7111	0,2385	0,1243	0,8048	0,6793	0,5693	0,3307	0,3963	0,8801	0,8149	0,6797	0,4873	0,4851	0,9127	0,8658
H		0,5588	0,7910	0,7638	0,7910		0,5169	0,4126	0,7282	0,6848		0,6380	0,5505	0,7853	0,7974		0,6099	0,6435	0,7842	0,7719
d_D			0,9035	0,5235	0,7514			0,9675	0,6101	0,7802			0,9555	0,5618	0,7636			0,9469	0,6347	0,7645
d_A				0,5814	0,7811				0,5214	0,7192				0,5610	0,7778				0,6262	0,7561
V					0,9473					0,9617					0,9529					0,9724
D^2H					0,9082					0,7248					0,8784					0,8995

Nas Tabelas 5 a 8 estão reunidas as equações de densidade básica e de peso da árvore, obtidas através de diferentes modelos de regressão.

Tabela 5. Equações de peso e de densidade básica da árvore, obtidas para o espaçamento de 1,5m X 1,0m.

Equação	r^2	C.V.(%)
$P = -5,692349 + 0,404856V$	0,8974	12,03
$P = -7,545596 + 0,013086D^2H$	0,8249	15,71
$P = 38,260180 - 0,613486D^2 - 1,568699H + 0,040307D^2H$	0,8725	14,57
$\ell og_e P = -8,246781 + 1,449117\ \ell og_e(D^2H)$	0,9232	4,25
$P = 36,963138 + 0,10252D^2H + 106,715849d_D$	0,9025	12,20
$d_A = -0,013786 + 0,951556d_D$	0,8163	7,00
$d_A = -0,050132 + 0,020550H$	0,6258	9,99
$d_A = 0,089332 + 0,018416D$	0,3318	13,34
$d_A = 0,226051 + 0,000030834D^2H$	0,4044	12,60
$d_A = -0,007452 + 0,0000083411d_D$	0,8361	6,88

Tabela 6. Equações de peso e de densidade básica da árvore, obtidas para o espaçamento de 2,5m X 1,5m

Equação	r^2	C.V.(%)
$P = -12,838523 + 0,459990V$	0,9251	11,36
$P = 12,746841 + 0,007608D^2H$	0,5253	28,60
$P = -27,914267 + 0,007763D^2 + 2,827078H + 0,004857D^2H$	0,5496	30,29
$\ell og_e P = -2,590630 + 0,7626961\ \ell og_e(D^2H)$	0,5509	7,27
$P = -76,617171 + 0,05478D^2H + 253,944782d_D$	0,8504	16,71
$d_A = -0,007981 + 0,936565d_D$	0,9361	3,65
$d_A = 0,184500 + 0,009511H$	0,1703	13,16
$d_A = 0,323263 + 0,002513D$	0,0155	14,33
$d_A = 0,336637 + 0,0000051556D^2H$	0,0453	14,11
$d_A = -0,007303 - 0,0000030441D^2H + 0,977371d_D$	0,9501	3,36

Tabela 7. Equações de peso e de densidade básica da árvore, obtidas para o espaçamento de 3,0m X 2,5m.

Equação	r^2	C.V.(%)
$P = -22,974471 + 0,508049V$	0,9081	8,98
$P = 13,308294 + 0,008141D^2H$	0,07716	14,16
$P = 18,228794 - 0,198450D^2 + 2,459615H + 0,014845D^2H$	0,8389	12,93
$\ell og_e P = -3,666627 + 0,892078\ \ell og(D^2H)$	0,7327	3,57
$P = -87,503626 + 0,006226D^2H + 275,330892d_D$	0,9456	7,19
$d_A = 0,008604 + 0,906144d_D$	0,9130	3,07
$d_A = 0,063493 + 0,015440H$	0,3031	8,68
$d_A = 0,269590 + 0,006320D$	0,1570	9,54
$d_A = 0,332208 + 0,0000072050D^2H$	0,2350	0,09
$d_A = 0,012097 + 0,000001126D^2H + 0,874264d_D$	0,9176	3,11

Tabela 8. Equações de peso e de densidade básica da árvore, obtidas para o conjunto dos três espaçamentos

Equação	r^2	C.V.(%)
$P = -13,147517 + 0,462838V$	0,9456	10,42
$P = 9,858582 + 0,008459D^2H$	0,8996	19,51
$P = -15,882518 - 0,117279D^2 + 1,922925H + 0,01208999D^2H$	0,8374	18,44
$\ell og_e P = -4,239539 + 0,957963\ \ell og_e(D^2H)$	0,8056	5,74
$P = -64,440939 + 0,00646774D^2H + 214,813981d_D$	0,9275	12,16
$d_A = -0,010918 + 0,946707d_D$	0,8967	4,54
$d_A = 0,070329 + 0,015004H$	0,4142	10,81
$d_A = 0,243072 + 0,007508D$	0,2353	12,35
$d_A = 0,314433 + 0,0000091128D^2H$	0,2657	12,10
$d_A = -0,008248 + 0,000000464 6D^2H + 0,932934d_D$	0,8972	4,58

Infere-se dos resultados reunidos nas Tabelas 5 a 8 que a densidade básica da árvore pode ser estimada através do modelo $d_A = a + bd_D + cD^2H$ com maior precisão do que apenas em função de densidade ao nível do DAP para os três espaçamentos estudados.

Os resultados inseridos nas referidas Tabelas mostram também a boa precisão com que o peso pode ser estimado em função do volume, e permitem indicar a estimativa do peso de matéria seca em função do modelo $P = a + bD^2H$ que envolve medições de

Tabela 9. 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 caribaea* var. *hondurensis* até o limite de desponta de 0,08m, calculados para árvores de 3 diferentes espaçamentos, com idade de 17 anos.

DAP (cm)	ALTURA TOTAL (m)															
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
8	15,2	15,8	16,3	16,8	17,4	17,9	18,5	19,0	19,6	20,1	20,6	21,2	21,7			
9	16,7	17,3	18,0	18,7	19,4	20,1	20,8	21,5	22,1	22,8	23,5	24,2	24,9			
10	18,3	19,1	20,0	20,8	21,7	22,5	23,3	24,2	25,0	25,9	26,7	27,6	28,4			
11	20,0	21,1	22,1	23,1	24,1	25,2	26,2	27,2	28,2	29,3	30,3	31,3	32,3	33,3		
12	22,0	23,2	24,4	25,6	26,9	28,1	29,3	30,5	31,7	33,0	34,2	35,4	36,6	37,8		
13			27,0	28,4	29,8	31,3	32,7	34,1	35,5	37,0	38,4	39,8	41,3	42,7		
14			29,7	31,4	33,0	34,7	36,3	38,0	39,7	41,3	43,0	44,6	46,3	47,9		
15				34,6	36,5	38,4	40,3	42,2	44,1	46,0	47,9	49,8	51,7	53,6		
16				38,0	40,1	42,3	44,5	46,6	48,8	51,0	53,1	55,3	57,4	59,6	61,8	63,9
17				41,6	44,0	46,5	48,9	51,4	53,8	56,3	58,7	61,1	63,6	66,0	68,5	70,9
18				45,4	48,2	50,9	53,7	56,4	59,1	61,9	64,6	67,4	70,1	72,8	75,6	78,3
19				49,5	52,6	55,6	58,7	61,7	64,8	67,8	70,9	73,9	77,0	80,0	83,1	86,2
20									70,7	74,1	77,5	80,9	84,2	87,6	91,0	94,4
21									77,0	80,7	84,4	88,1	91,9	95,6	99,3	103,1
22									83,5	87,6	91,7	95,8	99,9	104,0	108,1	112,2
23									90,4	94,8	99,3	103,8	108,3	112,7	117,2	121,7
24										102,4	107,3	112,1	117,0	121,9	126,7	131,6
25										110,3	115,5	120,8	126,1	131,4		
26										118,5	124,2	129,9	135,6	141,3		
27										127,0	133,1	139,3	145,5	151,6		

campo de apenas DAP com casca (D) e altura (H), com precisão próxima à obtida com a inclusão de mais a variável densidade ao nível do DAP (d_D) no modelo.

Bons resultados na estimativa de peso eram já de se esperar com base em trabalhos desenvolvidos em Eucaliptos por VEIGA & BRASIL (1980) e VEIGA, BRASIL & FERREIRA (1980 e em *Pinus elliottii* var. *elliottii* por BRASIL, VEIGA & COELHO (1980).

Na Tabela 9 estão reunidos os valores da estimativa do peso de matéria seca em função do DAP com casca e da altura total, obtidos através da equação $P = 9,858582 + 0,008459D^2H$ para o conjunto de espaçamentos. Os valores delimitados entre linhas cheias referem-se à distribuição original dos dados de campo.

Com relação às dimensões das fibras, os resultados obtidos acham-se sintetizados nas Tabelas 10 a 13.

Tabela 10. Valores médios e desvios padrões referentes ao comprimento das fibras, por secção e no conjunto de secções. Valores expressos em mm, obtidos a partir de 15 árvores em cada espaçamento.

	A		B		C		GERAL	
Espaçamento	Média	Desvio Padrão	Média	Desvio Padrão	Média	Desvio Padrão	Média	Desvio Padrão
1,5 X 1,0m	2,39	0,21	4,05	0,52	5,72	0,76	4,05	1,48
2,5 X 1,5m	2,32	0,21	3,82	0,57	5,43	0,61	3,86	1,37
3,0 X 2,5m	2,42	0,36	3,94	0,47	5,42	0,78	3,93	1,36
Conjunto	2,38	0,26	3,94	0,52	5,52	0,72	3,95	1,39

Tabela 11. Valores médios e desvios padrões referentes ao diâmetro das fibras, em cada secção e no conjunto de secções. Valores expressos em µm, obtidos a partir de 15 árvores em cada espaçamento.

	A		B		C		GERAL	
Espaçamento	Média	Desvio Padrão	Média	Desvio Padrão	Média	Desvio Padrão	Média	Desvio Padrão
1,5 X 1,0m	54,77	5,48	62,50	4,93	62,16	8,32	59,81	7,24
2,5 X 1,5m	52,84	9,42	59,33	6,07	54,96	6,58	55,71	7,82
3,0 X 2,5m	56,90	7,24	65,79	12,19	62,16	9,34	61,62	10,27
Conjunto	54,84	7,57	62,54	8,59	59,76	8,68	59,05	8,83

Tabela 12. Valores médios e desvios padrões correspondentes ao diâmetro do lúmen das fibras, em cada secção e no conjunto de secções. Valores expressos em µm obtidos a partir de 15 árvores em cada espaçamento.

	A		B		C		GERAL	
Espaçamento	Média	Desvio Padrão	Média	Desvio Padrão	Média	Desvio Padrão	Média	Desvio Padrão
1,5 X 2,0m	45,04	5,72	49,86	6,37	44,70	9,98	46,53	7,79
2,5 X 1,5m	41,12	6,26	45,52	7,21	37,90	8,87	41,51	8,00
3,0 X 2,5m	46,81	7,24	51,50	13,04	42,36	12,42	46,51	10,56
Conjunto	44,32	6,73	48,96	8,21	41,65	10,68	44,98	9,14

Tabela 13. Valores médios e desvios padrões correspondentes à espessura da parede das fibras, em cada secção e no conjunto de secções. Valores expressos em µm obtidos a partir de 15 árvores em cada espaçamento.

	A		B		C		GERAL	
Espaçamento	Média	Desvio Padrão	Média	Desvio Padrão	Média	Desvio Padrão	Média	Desvio Padrão
1,5m X 1,0m	5,23	0,47	6,81	0,25	8,70	1,54	6,91	1,76
2,5 X 1,5m	4,83	0,82	6,55	0,87	8,42	1,62	6,60	1,91
3,0 X 2,5m	5,05	0,55	7,05	1,25	10,35	3,46	7,49	3,05
Conjunto	5,04	0,64	6,81	1,07	9,16	2,48	7,00	4,06

O comprimento médio das fibras não variou com os espaçamentos estudados (Tabela 10). Os valores médios obtidos de 4,05 , 3,86 e 3,93mm, respectivamente para os espaçamentos de 1,5 X 1,0m, 2,5 X 1,5m e 3,0 X 2,5m. Por outro lado, o comprimento cresceu significativamente no sentido medula - casca, apresentando valores médios de 2,38, 3,94 e 5,52mm, nas posições A, B e C.

No que concerne ao diâmetro das fibras e diâmetro do lúmen, cujos valores médios acham-se relacionados nas Tabelas 11 e 12 , não foram encontradas diferenças significativas entre os espaçamentos, nem tampouco entre as posições A, B e C estudadas.

Depreende-se da Tabela 13 que, de modo análogo ao comprimento, a espessura das paredes das fibras aumentou no sentido medula - casca. Os valores médios foram de 5,04, 6,81 e 9,16µm respectivamente para as posições A, B e C. Não houve diferença significativa pelo teste de Tukey entre a espessura das paredes nos espaçamentos estudados.

C o n c l u s õ e s

Com base nos resultados e discussão , podem ser extraídos as seguintes conclusões a respeito das 45 árvores amostradas em três diferentes espaçamentos, de populações não desbastadas de *Pinus caribaea* var. *hondurensis* com 17 anos de idade, da região de Mogi Mirim, SP:

a) A densidade básica não variou com os espaçamentos adotados, embora mostrasse ligeira tendência de aumento nos espaçamentos maiores.

b) A densidade básica média das árvores foi de 0,371g/cm³.

c) A densidade básica da árvore (d_A) pode ser estimada em g/cm³, através da equação:

$$d_A = -0,008248 + 0,00000004646D^2H + 0,932934d_D$$

onde D exprime o DAP com casca em cm, H exprime a altura total em m e d_D é a densidade básica do disco ao nível do DAP.

d) A densidade (d) de uma secção do fuste decresceu com a altura (h) em que a secção foi extraída, obedecendo ao modelo linear:

$$d = 0,420017 - 0,007320h,$$

onde d é expresso em g/cm³ e h em m

e) O comprimento, o diâmetro das fibras , o diâmetro do lúmen e a espessura das paredes das fibras não variou com os espaçamentos. Os valores médios para a espécie foram respectivamente 3,95mm para o comprimento, 59,05µm para o diâmetro, 44,98µm para o diâmetro do lúmen e 7,00µm para a espessura das paredes das fibras.

f) O comprimento e a espessura das paredes aumentou no sentido medula-casca.

g) O peso em kg de matéria seca (P) da parte comercial do fuste até o limite de desponta de 0,08m, pode ser estimado pela equação:

$$P = 9,858582 + 0,008459D^2H$$

onde D exprime o DAP com casca, em cm e H a altura total , em m.

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