SILVICULTURA

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IUFRO
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SBS

FAST GROWING TREES

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

ANAIS

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

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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.

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Caterpillar, Cat e ⊡ são marcas da Caterpillar Tractor Co.

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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

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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)

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P. 2.02-01	Productivity of Short-Rotations Forestry with Fast-Growing Eucalypts
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ENSAIOS DE PROCEDÊNCIAS DE *EUCALYPTUS GRANDIS* NO NORTE DE NOVA GALES DO SUL.

P.K. Ades
o Forestry Commision of New South Wales.
I.P.Burgess
o CSIRO, Division of Forest Research, Camberra
Austrália.

Resumo

Esse trabalho apresenta os resultados de dois ensaios de procedências de *Eucalyptus grandis* plantados nas proximidades de Coffs Harbour em Nova Gales do Sul. Houveram diferenças significativas em produtividades entre as procedências, sendo que, aquelas de locais de baixas altitudes nas áreas Sudeste de Queensland e Coffs Harbour apresentaram um bom comportamento. Também houveram indicações de diferenças significativas entre procedências de uma pequena amplitude geográfica nas proximidades de Coffs Harbour.

PROVENANCE TRIALS OF *EUCALYPTUS GRANDIS* IN NORTHERN NEW SOUTH WALES.

Summary

This paper reports the results of two *Eucalyptus grandis* provenance trials planted near Coffs Harbour New South Wales. There were significant differences in productivity between provenances, with those from low altitude sites in south-eastern Queensland and the Coffs Harbour areas performing well. There were also indications of significant differences between provenances from a small geographic range around Coffs Harbour.

INTRODUCTION

Eucalyptus grandis is widely planted on the north coast of New South Wales and is second in importance only to blackbutt (*E. pilularis* Sm.). In order to determine the best seed sources for use in the region, two provenance trials were established near Coffs Harbour in 1972. This paper reports on the growth of these trials at the age of 7 years 8 months.

MATERIALS AND METHODS

Seed was collected from twenty locations which are described in Table 1. They range from the extreme southern limit of the species at Minmi, near Newcastle on the central coast of New South Wales to Brooloo, south of Gympie in south-eastern Queensland. The greatest concentration of collections was in the Coffs Harbour area around latitude 30°15'S. *E. grandis* extends to north Queensland but no populations north of Gympie were sampled. (Burgess 1980).

At each location seed was collected from five dominant trees but these Parents were not intensively selected for either growth rates or form.

TABLE 1. Collection locations

Seedlot	Latitude (°S)	Longitude (°E)	Altitude (metre)
Minmi	32°52'	151°39'	30
Wallingat	32°20'	152°27'	30
Wang Wauk	32°13'	152°13'	150
Lorne	31°39'	152°32'	250
Queenslake	30°35'	152°48'	30
Tanban	30°52'	152°53'	30
Nulla Five Day	30°43'	152°32'	200
Newry	30°31'	152°58'	10
Bellinger River	30°27'	152°37'	70
Pine Creek	30°24'	153°03'	10
Tuckers Knob	30°22'	153°00'	110
Orara West	30°15'	152°57'	180
Cascade	30°14'	152°51'	580
Orara East	30°13'	153°06'	120
Newfoundland	29°55'	153°07'	80
Cherry Tree	28°53'	152°47'	180
Yabbra	28°34'	152°36'	400
Mebbin	28°26'	153°12'	120
Lower Stanley River	26°52'	152°48'	50
Brooloo	26°37'	152°25'	520

TABLE 2. Data for experimental planting sites

Site	Latitude °S	Longitude °E	Altitude (m)	Mean annual rainfall (mm)	Soil type	Previous vegetation
Wedding Bells	30°08'	153°06'	15	1430	Yellow podsolic derived from sandstone and shale.	*E. grandis*
Timmsvale	30°11'	152°50'	550	1750	Yellow podsolic derived from slates and sandstone.	*E. grandis* and *E. pilularis*

Table 3. Mean logarithm of Volume of the 10 tallest trees per plot at age 7 years 8 months (3 Replicates per site)

Both Sites		Wedding Bells		Timmsvale	
Lower Stanley River	7.08	Lower Stanley River	6.97	Tuckers Knob	7.28
Orara East	7.05	Orara East	6.97	Lower Stanley River	7.19
Orara West	6.96	Orara West	6.82	Nulla Five Day	7.17
Tanban	6.95	Tanban	6.82	Orara East	7.13
Newfoundland	6.93	Wallingat	6.81	Orara West	7.11
Mebbin	6.91	Newry	6.79	Tanban	7.09
Pine Creek	6.87	Newfoundland	6.78	Newfoundland	7.08
Newry	6.87	Mebbin	6.76	Mebbin	7.06
Lorne	6.82	Pine Creek	6.75	Pine Creek	7.02
Wallingat	6.82	Cascade	6.70	Queenslake	7.02
Cascade	6.81	Lorne	6.62	Pine Creek	6.99
Nulla Five Day	6.77	Brooloo	6.58	Newry	6.96
Tuckers Knob	6.72	Yabbra	6.57	Cascade	6.91
Brooloo	6.70	Wang Wauk	6.54	Cherry Tree	6.88
Yabbra	6.70	Nulla Five Day	6.38	Wang Wauk	6.83
Queenslake	6.69	Queenslake	6.32	Wallingat	6.82
Wang Wauk	6.68	Cherry Tree	6.21	Yabbra	6.82
Cherry Tree	6.55	Bellinger River	6.19	Brooloo	6.81
Bellinger River	6.46	Minmi	6.14	Bellinger River	6.72
Minmi	6.29	Tuckers Knob	6.13	Minmi	6.46
LSD P = 0.05	0.21		0.34		0.25
Actual volume range (cubic decimetres)					
	133.7 to 67.9		123.6 to 52.1		152.0 to 83.2

The trial sites were chosen as contrasting but representative of those commonly planted in the Coffs Harbour area. Wedding Bells is a low altitude site near the coast while Timmsvale is at higher altitude on the coastal escarpment. Table 2 contains details of the planting sites.

Planting was carried out in April-May 1972 using a randomised block design with 25 trees per plot and three replicates at each site. The trees were planted at a 2.4 x 2.4 m spacing. Survival in all plots was very high.

Both sites were assessed for height and diameter in January 1980 and this report is based on the volumes of the 10 tallest trees in each plot.

RESULTS AND DISCUSSION

Tree volumes were calculated using the simple conical equation:

$$\text{Volume} = 1/3\ \pi\ (\text{Diameter}/2)^2\ .\ \text{Height}$$

and an analysis of variance was carried out on the logarithmic transform of this data.

Means of the transformed data, least signficant differences and the actual range of mean tree volumes are presented in Table 3.

A number of points are worthy of comment.

(a) Provenances from the low altitude coastal areas around Coffs Harbour and south eastern Queensland have grown well on both the low and high altitude trial sites.

(b) The very poor performance of Tuckers Knob provenance on the Wedding Bells site may be attributed in part to one plot in which the trees failed to grow, probably due to machine compaction of the soil during site preparation.

Exclusion of that plot would bring the mean transformed volume figure up to 6.47, towards the lower middle range of values.

(c) Although both sites were planted within two weeks of each other the high altitude escarpment location at Timmsvale has shown much superior growth.

(d) Coffs Harbour is a seed source commonly planted in Brazil (K. G. Eldridge pers. comm.) but these trials indicate that there is significant variation between provenances collected from within that general area .

For example of the eight provenances collected from between 29°55' and 30°31'S., Orara East and Orara West are consistently excellent while Bellinger River is uniformly poor. In addition Tuckers Knob has performed very differently on the two sites even allowing for the one anomalous plot at Wedding Bells. Pine Creek is also somewhat variable between sites, being significantly poorer than Tuckers Knob at Timmsvale.

(e) The southern source Minmi is consistently poor as has been indicated in other trials (Clarke 1975).

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A OCORRÊNCIA NATURAL DE *EUCALYPTUS GRANDIS*, SEU PADRÃO DE DISTRIBUIÇÃO NAS FLORESTAS NATURAIS, SUAS CARACTERÍSTICAS E CONSERVAÇÃO.

I.P. Burgess

o CSIRO Division of Forest Research, Camberra Austrália.

Resumo

Este trabalho descreve a distribuição natural de *Eucalyptus grandis* na Costa Oriental da Australia, algumas características da espécie e seu estado de conservação na Austrália.

THE NATURAL OCCURRENCE OF *EUCALYPTUS GRANDIS*, ITS DISTRIBUTIONS PATTERNS IN NATURAL FORESTS, ITS CHARACTERISTICS AND CONSERVATION.

Summary

This paper describes the natural distribution of *Eucalyptus grandis* in east coastal Australia, some characteristics of the species and its conservation status in Australia.

INTRODUCTION

Like many eucalypts *Eucalyptus grandis* Hill ex Maiden has had a chequered nomenclatural career. The species was originally included in the concept of *E. saligna* Sm. based on a specimen collected in the Port Jackson, Sydney, area. Walter Hill (1862) described the species using a specimen collected by George Caley 'in the Sydney District' which on present day knowledge must have been north of Newcastle, New South Wales. Baker and Smith (1902) reduced *E. grandis* to a variety of *E. saligna*, var. *pallidivalvis* and finally Maiden (1918) resurrected it to specific status.

The most recent classification of the eucalypts, Pryor and Johnson (1971) lists *E. grandis* in the subgenus Symphyomyrtus, Section Transversaria, Series Salignae, code SECAB.

Closely related species are *E. saligna*, *E. deanei* Maiden, *E. botryoides* Sm. and *E. robusta* Sm. Natural hybrids are not uncommon particularly x *E. robusta (E. grandis* var. *grandiflora* Maiden) and x *E. saligna*.

While *E. grandis* and *E. saligna* are quite distinct in the southern part of their range, the north Queensland populations are more variable and difficult to ascribe to either species. However presently, the common decision by taxonomists is that they are closer to *E. grandis* but only extensive further testing will clarify the position.

Hybridisation has occurred in overseas plantations particularly x *E. urophylla* S.T. Blake and x *E. tereticornis* Sm. while artificial manipulation has successfully produced the cross x *E. pulverulenta* Sims. *E. grandis* x *urophylla* is now used for mass produced cuttings in Congo and Brazil.

E. grandis is commonly called Flooded gum, due no doubt to its growing in damp gully situations. Despite this the tree does not tolerate flooding! The common trade name of Rose gum refers to the deep pink to red colour of the heartwood.

NATURAL DISTRIBUTION

Due to past confusion with *E. saligna*, *E. grandis* has been recorded from as far south as Goulburn in N.S.W. (Maiden 1918). However for the species as it is presently recognised, the southern limit is near Newcastle N.S.W. at Minmi 32°52'S, 152°30'E. Populations are then distributed more or less continuously up the N.S.W. coast into southern Queensland, to the Rockhampton district at 23°S. Further north the distribution is rather patchy at Mackay, Eungella Tableland, on to Ingham, the Atherton Tableland and finally the Windsor Tableland north of Mossman at 16°S (J. Doran, pers. comm.) (Fig. 1).

Although *E. grandis* occurs mostly on the coastal lowland it is found at 1100 m on the Atherton Tableland (D. Kleinig, pers. comm.). The most inland population is found on the Carnarvon Range about 300 km from the coast at a latitude of 25°S (M.I.H. Brooker, pers. comm.).

In New South Wales and southern Queensland it is not found more than about 100 km from the sea (Meakins 1976), see Fig. 1.

As the species occurs over a wide natural range it grows on a number of soil types derived from various parent material such as slates, shales, sandstone, conglomerate, granite and basalt (Meakins 1976). However most of the soils are relatively fertile alluviums or are derived from volcanic rocks, with high fertility.

It is commonly found in gully bottoms and along creek banks in sheltered conditions. In some instances *E. grandis* occurs further up the ridges, apparently as a result of fire. In these instances it is more frequent on the eastern (seaward), moister aspect.

The climate over the bulk of the range is mostly subtropical with a summer predominant rainfall in the order of 1500 mm per annum.

Although frosts of -3°C are common within the natural range of the species the absolute minimum encountered is not known. There is some evidence that temperatures between -8°C and -11° killed young plantations west of Coffs Harbour in the mid 1960s. In Canberra *E. grandis* has withstood screen minimum temperatures as low as -10°C (Bureau of Meteorology. 1968). Similar temperatures in the southeastern area of U.S.A. have proved to be fatal. In Australia the temperatures gradually decline to the minima of mid-winter. A severe frost is always preceded by a series of cold nights which harden the species. In southeastern U.S.A., on the other hand, the temperature may suddenly drop from well above freezing to well below (Hunt and Zobel 1978). *E. grandis* cannot survive this extreme fluctuation which it does not encounter in its natural range. Figure 2, using data for selected extreme years at Bainbridge Georgia, U.S.A., Coffs Harbour and Dorrigo N.S.W., Australia illustrates this situation. Dorrigo, probably represents one of the coldest climates that *E. grandis* encounters within its natural range in Australia.

Representative meteorological data from three typical sites within the distribution of *E. grandis* are given in Table 1 (Bureau of Meteorology. 1975).

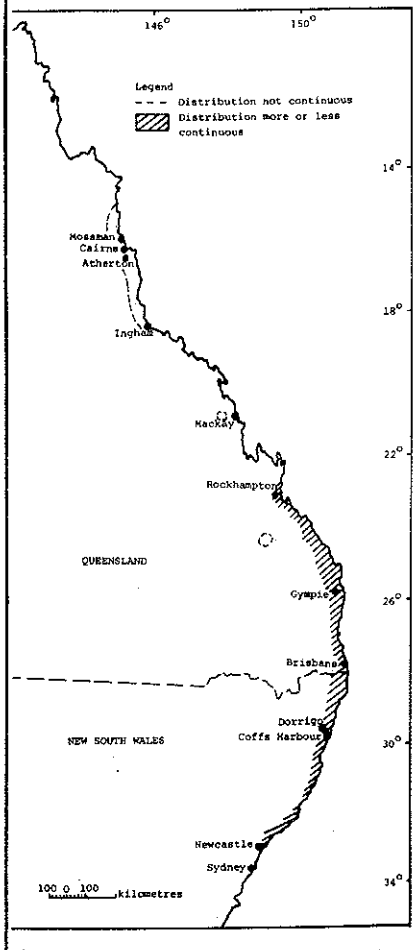


Fig. 1 Map showing the natural distribution of *E. grandis* in Australia

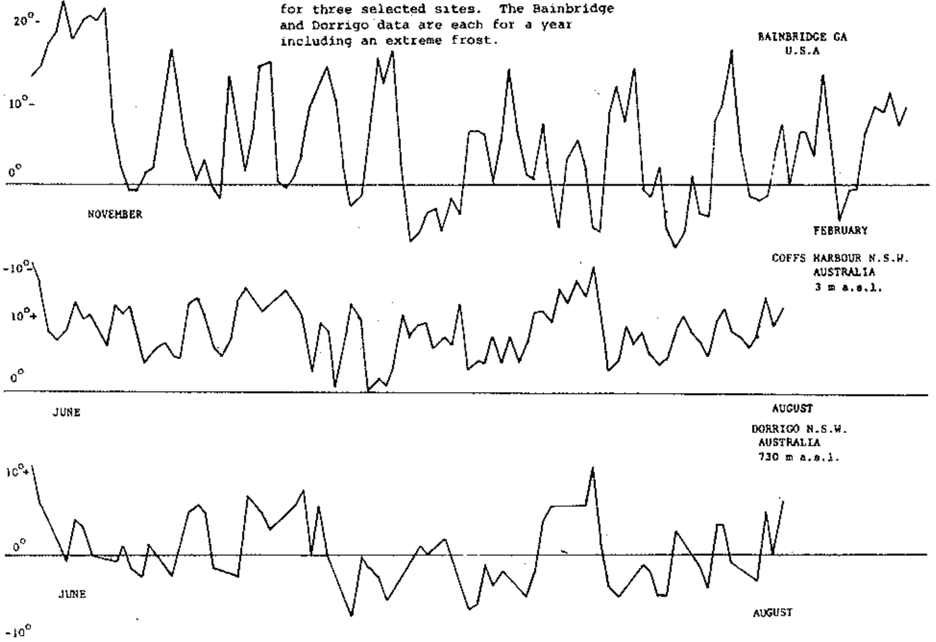


FIGURE 2

Daily winter minimum temperatures (°C) for three selected sites. The Bainbridge and Dorrigo data are each for a year including an extreme frost.

Table 1. Meterological data for three sites within the natural range of *E. grandis*. 'Locations are shown in Fig. 1; Herberton is close to Atherton'

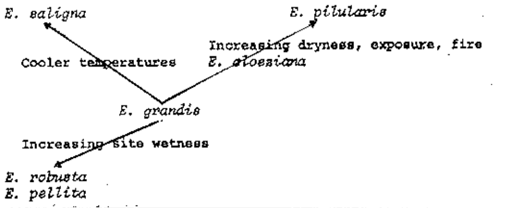
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Mean daily maximum °C											
Herberton, Qld	23.8	27.7	26.2	24.5	22.9	21.3	21.3	23.4	25.4	27.7	29.3	29.1
Gympie, Qld	30.8	29.7	29.2	27.4	24.5	21.9	21.3	23.2	25.4	27.6	29.8	30.2
Coffs Harbour, NSW	26.5	26.6	25.7	24.0	21.2	19.2	18.5	19.5	21.5	23.4	24.8	25.9
	Mean daily minimum °C											
Herberton, Qld	18.0	18.3	17.5	15.5	13.3	10.9	9.5	10.4	11.9	14.2	16.1	17.2
Gympie, Qld	19.9	20.0	18.2	15.0	11.2	8.1	6.0	8.0	10.7	14.6	16.9	18.8
Coffs Harbour, NSW	19.0	19.2	17.7	15.0	10.7	8.8	6.6	8.0	10.5	13.6	15.8	17.7
	Rainfall mm											
Herberton, Qld	237	232	209	83	42	33	22	17	15	25	72	137
Gympie, Qld	173	173	153	84	70	64	55	41	49	75	88	136
Coffs Harbour, NSW	215	251	250	191	134	126	65	105	68	105	100	149

FOREST TYPE

E. grandis is frequently found in relatively pure stands with an understorey of rainforest associated species. Under normal circumstances eucalypts do not regenerate under the conditions of low light and strong competition associated with such a stand. This leads to the common condition found of large overmature trees overtopping a well developed rainforest.

On such sites it would appear that some form of disturbance is necessary to regenerate the *E. grandis* component. Cremer (1960) and Gilbert (1959) have suggested that fire plays an important role in supplying the disturbance factor for similar associations of eucalypts and rainforest in Tasmania.

When *E. grandis* is found growing in a mixed eucalypt forest its associates are usually *E. pilularis* Sm. *E. robusta, E. saligna, E. pellita* F.Muell. and *E. cloeziana* F.Muell. *E. grandis* tends to occupy the more moderate sites as may be illustrated below.



While fire and disturbance may play an important role on these types of sites, an alternate theory has been put forth by Florence (1964). This suggests that the boundaries are to a degree static and are limited to specific edaphic conditions. For example *E. pilularis* does not invade the rainforest margin, where *E. grandis* is often found, because of its inability to tolerate increasing soil moisture and frequently associated pathogens.

SPECIES GROWTH AND CHARACTERISTICS

E. grandis is a tall rapidly growing smooth barked eucalypt. Veteran trees are found in excess of 60 m tall. Under plantation conditions in the Australian region, volume increments have been reported as high as 31.9 m^3ha^{-1}year, while a more general figure would be in the vicinity of 15-20 m^3ha^{-1} year (Borough *et al*. 1978), Table 2. In overseas plantations increments are often well in excess of this figure and may even be as high as 70 m^3ha^{-1} year (Anon. 1979).

The timber is used locally for cases (mostly for bananas) some house framing and furniture. It is proposed to use a large proportion of present and future plantations for pulpwood. To June 1979 only 1500 ha had been planted with this species in Australia.

The tree is fire sensitive and does not coppice readily in more mature trees. However young trees produce abundant coppice (Poynton 1957) and coppicing is a widely used silvicultural system in overseas countries. Under Australian conditions coppicing is strongly seasonal (Clarke 1975).

Normally *E. grandis* does not produce lignotubers in the seedling stage although the closely related *E. saligna* does. This feature is diagnostic in the N.S.W. populations but is not known with any certainty for the more northern populations.

Table 2. Growth of unthinned plantation of *E. grandis* at Coffs Harbour, N.S.W. (Borough *et al.* 1978)

Age (yrs)	Stems ha^{-1}	Mean dbh (cm)	Basal area m^2ha^{-1}	Dominant* height m	Volume** (merchantable) m^3ha^{-1}	Volume MAI $m^3ha^{-1}yr^{-1}$
5	1423	12.2	16.6		24	4.8
10	1134	16.3	23.8		106	10.6
16	1097	20.2	35.1	33.9	189	11.8
23	917	23.2	38.9	38.6	308	13.4
29	799	25.5	40.9	42.5	465	16.0

* Mean top height of the 10 tallest trees in the growth plot.

** Volume based on the bole length, height to the first major branch, not top height. This figure is substantially less than total volume but represents sawlog volume.

This species flowers at an early age, 2 to 3 years from seed. Unconfirmed reports have suggested a period as short as 6-8 months under some overseas conditions. Flowering normally occurs in the autumn to early winter months and is reasonably regular.

Seed may be collected 9-12 months after flowering. Viability is normally high and a kilo of uncleaned seed (seed and chaff) contains between 600 000 and 700 000 viable seeds. Seed may be stored in sealed containers at -10°C for at least 15 years without appreciable loss of viability.

Little is known about natural pollen vectors. Observation suggests that insects, including the domestic bee, play a dominant role (Pryor 1976). It is quite possible that birds (Hopper and Moran (submitted)) are more important than was originally suspected especially in the larger flowered species. Wind appears to make little if any contribution to direct pollen movement.

Also little is known about the breeding system of *E. grandis*. It has been generally suggested that most eucalypts are preferential outcrossers (Pryor 1976) although many trees which have been studied, are capable of setting viable selfed seed. More recent work using electrophoresis techniques (Brown *et al.* 1975; Phillips and Brown 1977; Moran and Brown in press) has shown that a number of eucalypt populations display a surprisingly high level of inbreeding. Hodgson (1975) concluded that inbreeding led to reduced seed yield, has little effect on early survival, causes depression in height growth and to some extent poorer stem straightness.

IMPORTANT NATURAL PESTS

A number of insects attack the species. This attack is often increased when the tree is grown in an artificial plantation in Australia. Young trees are attacked by the chrysomelids *Chrysophtharta cloeli* and *Paropsis atomaria* and the scarabs *Anoplognathus chlorophyrus* and *A. porosus* causing severe defoliation. The cossid moth *Xyleutes boisduvali* larvae tunnel into the wood of the tree and are in turn attacked by the yellow tailed black cockatoo *Calyptorhynchus funereus*. The cockatoo will frequently fell a tree in its effort to reach the cossid larvae.

Generally only minor damage is caused by other common insect pests such as the lerp insect.

It is considered that *E. grandis* is not particularly susceptable to the root rotting fungi *Phytophthora* sp.

CONSERVATION

As far as can be ascertained no presently commercially important populations of *E. grandis* are under direct threat of extinction. However, the continuing plantation program, even though it is only on a small scale, on the north coast of N.S.W. could pose a threat to the genetic integrity of some local populations. A degree of care is being exercised by using correct local seed sources. However there is evidence (Ades and Burgess - this conference) that there is significant variation between populations in that area.

The need to include parameters other than growth when considering population conservation is highlighted by the apparent resistance of the Atherton provenance to *Diaporthe cubense* in Brazil (Golfari 1975).

With the recent upsurge of interest in and dedication of National Parks and Flora Reserves in Australia the major populations of *E. grandis* are probably reasonably well protected.

Current and future co-ordinated provenance trials (Pederick - this conference) may identify important populations which need further *in situ* conservation.

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CLASSIFICAÇÃO DE *EUCALYPTUS.*

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Resumo

O método de classificação de Van Thielghen modificado por Bailey, permite somente a identificação de classe de uma planta.

Para identificar as espécies de Eucalyptus e para se fazer o seu melhor uso, os livros e o sistema de cartões de Blakely, Mueller e Rodges são de grande valia.

A tradução de "How to use the sorting key for identification of Eucalyptus" é uma chave de identificação desenvolvida a partir do método de Blakely e com sugestões de W. R. Acorsi estão incluídas neste trabalho.

O autor sugere um método misto: exame da antena umedecida sob aumento de 30x e consulta de chaves e cartões de identificação e de desenhos na literatura. Do conhecimento de espécies típicas, pode-se identificar híbridos e o que não é um trabalho fácil.

CLASSIFICATION OF *EUCALYPTUS.*

Summary

The Van Thieghen classification method as modified by Bailey permits on only to identify the class of a plant.

To identify the species of Eucalyptus and to make the best use of them, Blakely, Mueller and Rodger books and the card sorting systems are useful.

Here follows my translation from english "How to use the sorting key for identification of Eucalyptus", and also an identification key which I constructed from Blakely's method, on the suggestion of prof W Acorsi.

I sugest a mixed method:examination of the moistened anthers unders a 30 power lens and consultation keys, identification cards and drawings in the literature.

Knowing well the typical species we can classified hybrids, but it is no simple.

IDENTIFICAÇÃO DE EUCALYPTUS

I-Resumo
II-Material e métodos
III-Classificação do Reino Vegetal
IV-Cartões para identificação- Convenções para classificação dos Eucalyptus.
V-Chave para classificação de Eucalyptus comerciais.
VI-Bibliografia

II-Material e métodos

pela classificação de Van Thiegen modificada por Bailey, podemos chegar até a classe das plantas.

O livro de Blakely, os herbários, os cartões de identificação contribuiram muito para a classificação das espécies de Eucalyptus possibilitando o melhor uso das espécies.

Segue tradução do trabalho: "Como devemos usar os cartões para identificação dos Eucalyptus" e uma chave por mim organizada baseada em W F Blakely e sugerida pelo prof W Acorsi.

Este trabalho foi usado em palestras no Instituto de Biociências na cidade de Rio Claro Sp e em Espirito Santo do pinhal na Faculdade de Agronomia e Zootecnia "Manoel Carlos Gonçalves;

Em Rio Claro a convite do prof J T A Gurgel e em pinhal a convite do Diretório.

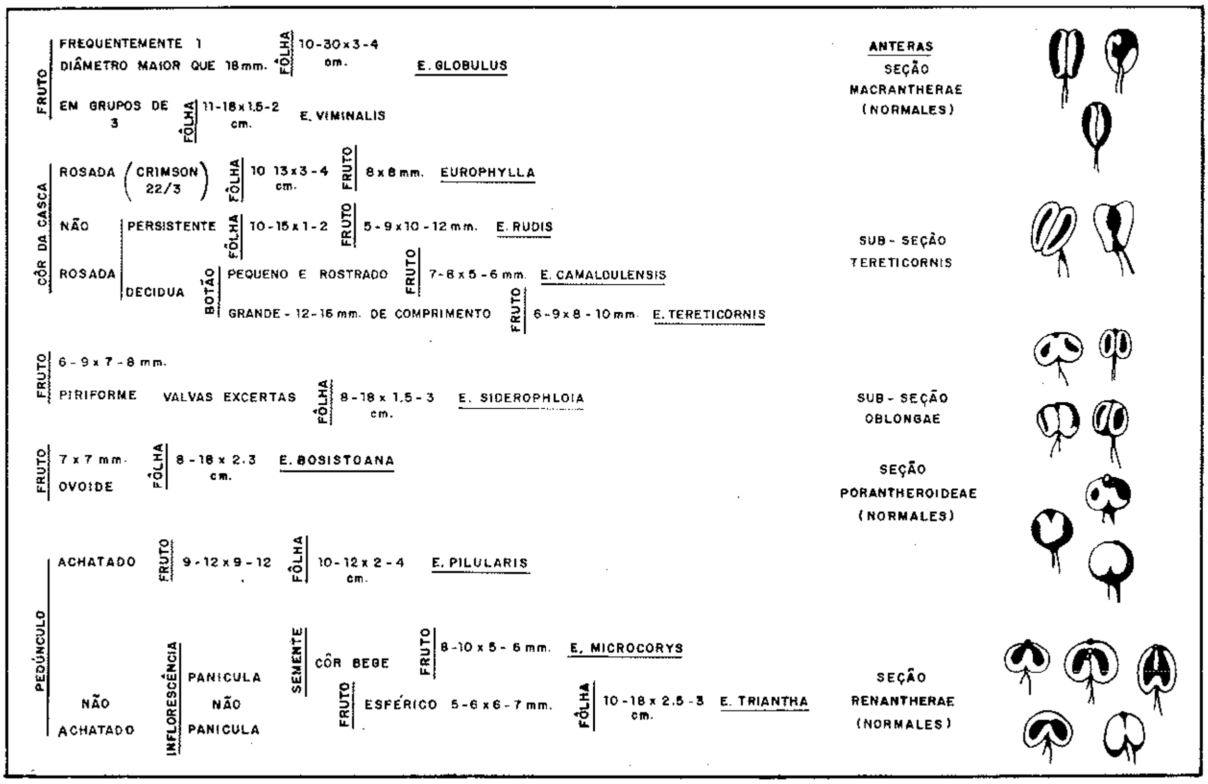
Na chave citamos a casca do E urophylla como decídua e de cor rósea, porém sabemos que este fator segundo cientistas da França pode variar com a altitude.

Quando o prof pryor esteve em visita ao Horto de Rio Claro nos comunicou que o E alba de Rio Claro originário de Java passaria a ser denominado de E urophylla.

O método usado para classificação é o método misto, a princípio o exame da antera em lupa de 30 aumentos sempre molhando antes a antera, depois o uso de cartões de identificação e finalmente exame de literatura e desenhos.

III-Classificação do Reino Vegetal

Talófitas-Algas;Fungos;Liquens
Briófitas-Musgos e Hepáticas
pteridófitas-Felicíneas;Equisetíneas;Licopodíneas
Espermatófitas-Ginospermas
Angiospermas-Monocotiledoneas e Dicotiledoneas



VI-Convenções para uso dos cartões de identificação

porte-Menor do que 8 metros:Arbusto - E dawsoni
Alem de 8 metros :Árvore Eucalyptus em geral

Casca-Decídua- E saligna
persistente- E robusta
Semi-fibrosa- E botryoides
Ironbark- E paniculata - Casca persistente e profundamente sulcada.

Meia casca- E urophylla - A que é decídua parcialmente, retendo a casca de 1/8 a 1/2 da árvore.
Stringbark- E triantha - Casca grosseiramente fibrosa.
Peppermint- E smith - Casca delicadamente fibrosa, frequentemente mostrando aparência reticulada, mas não profundamente sulcada.
Box - E albens - Casca com fibras mui próximas, tendendo para ser compacta, desenvolvendo grandes placas na parte inferior do tronco. As cascas novas são sub-fibrosas e ligeiramente escamosas e lisas nos pequenos ramos.
Outros tipos -Espêssa, macia e sub-fibrosa- E botryoides
Moderadamente espêssa, escamosa e curto fibrosa-E gummifera.
Cascas que não se enquadram en nenhuma categorias citadas.

Folhas adultas-Linear quando atinge 20 para 1 a relação comprimento largura.E linearis
Estreita lanceolada- Relação além de 10 para 1- E citriodora
Lanceolada- Relação entre 2 1/2 a 1 0 para 1 E robusta
Ovada- Relação de 1 a 2 1/2 de comprimento por 1 de largura- E cordata
Orbiculada- Relação 1 para 1- E cordata
Falcata- Curvas, em forma de foice- E falcata
Textura- Coriácea quando bem consistente e espessa- E robusta
Côr-A maioria das espécies de Eucalyptus possuem fôlhas com o mesmo tom em ambas as páginas, um número limitado mostra a parte superior mais escura;Há um tipo intermediário entre esses dois grupos como o E triantha
N B-As fôlhas adultas da maioria das espécies são alternas, folhas opostas são geralmente sésseis e menos frequentes.

Nervura-Fraca-Quando difícil de ser vista- E intermedia
Intermediária- Quando as laterais são rapidamente visiveis- E torelliana.
Visível- Grosseiras e em evidência- E gummifera
Ângulo entre as nervuras- Menor do que 20 graus-E dawsoni
Entre 25 e 60 graus - E saligna
Maior do que 60 graus- E robusta
NB-As nervuras laterais de acôrdo com o ângulo que formam com a nervura central podem ser: Transversais,longitudinais e obliquas.

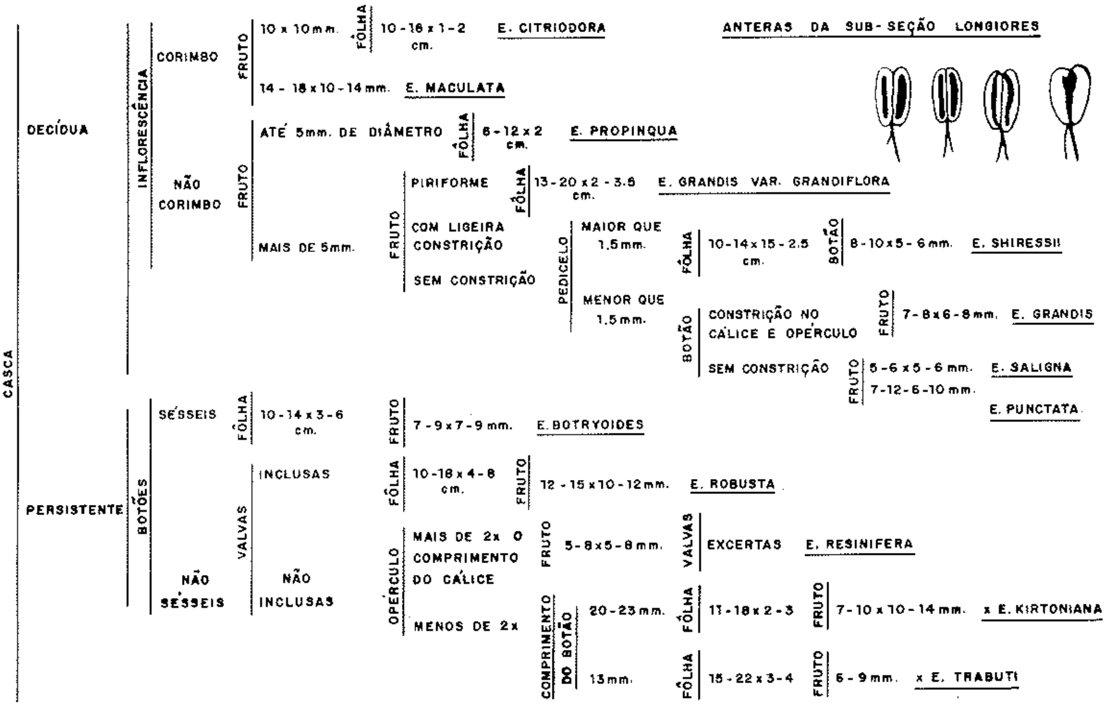
Inflorescência-panícula- E paniculata
Corimbo - E citriodora
Umbela - E tereticornis

Opérculo- Hemisférico a achatado- Quando o comprimento do opérculo não é maior que o diâmetro- E urophylla
Cônico a agudo-Quando o comprimento é maior que o diâmetro, porém não maior que o dobro- E tereticornis
Alongado- Quando o comprimento é maior que o dobro do diâmetro- E tereticornis
Marcas nos botões e frutos- Estriado ou angular- Com estrias,sulcos ou asas.
Rugoso- Com rugas ou protuberâncias.

Fruto-pedicelo-Ausente ou muito curto- Quando menor do que 1,5 mm E saligna
Curto- Quando menor de 6mm- E saligna
Longo- Quando maior de 6 mm E longifolia
Dimensão- pequeno-Quando o fruto não é maior que 5 mm- E propinqua
Médio- Diâmetro entre 5 e 11 mm- E citriodora
Grande-Diâmetro entre 11 e 18 mm E maculata
Muito grande- Quando maior que 18 mm E macrocarpa
Valvas- Abaixo do nível do fruto- E citriodora
Ao nível do fruto- E grandis
Acima do nível do fruto- E resinifera
Forma do fruto- Globular ou globular truncado- Com o comprimento igual a largura, ou menos comprido que largo e com o diâmetro do orifício menor do que o fruto. E citriodora
Ovoide- Mais comprido do que largo, a superfície continuadamente convexa- E maculata
Urceolado-Com constrição do orifício, formando pescoço- E intermedia

IDENTIFICAÇÃO DAS ESPÉCIES ECONÔMICAS DE EUCALYPTUS

Organizado por G. R. A. Cavalcanti



piriforme-Afilando próximo ao pedicelo com forma de pera- E paniculata

Cilíndrico- Mais comprido do que largo, porém com a mesma dimensão transversalmente em tôda extenção. E robusta.

Campanulado- Com forma de campânula- E globulus

Cônico a turbinado- Afilando uniformemente próximo a base- E conica.

Disco- O disco está localizado entre a linha de emergência das valvas e o anel estaminal.

NB-A largura do disco é classificada de acordo com a relação entre o disco e o raio do fruto.

Estreito-Quando o disco for menor que 1/4 do raio do fruto- E microcorys.

Intermediário -Quando o disco estiver entre 1/4 e 1/2 do raio do fruto- E propinqua

Largo- Maior do que a metade do raio do fruto-E citriodora

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ESTUDOS DE PROCEDÊNCIA DE *EUCALYPTUS GRANDIS* (HILL) MAIDEN NA ÁFRICA DO SUL.

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o D.R. de Wet Forestry Research Station, Sabie
Rep. of South Africa.

Resumo

Os estudos de procedência de *E. grandis* foram iniciados na África do Sul em 1973 quando uma série de âmbito nacional de testes foram feitas. Esta série foi obstruída pela presença de muitos lotes de sementes coletados uma ou poucas árvores matrizes assim como pela pobre representação de lotes de sementes convencionais na série. Entretanto, os lotes de sementes de *E. grandis* de Coffs Harbour, N.S. Wales, e Atherton, Queensland, mostraram crescimento superior aos 4 anos de idade em todos os locais onde foram plantadas. O estoque dos pomares de sementes da África do Sul mostraram relativamente pobre crescimento com forma superior.

A série de procedências altocline-latocline de *Eucalyptus grandis* de N.S. Wales foi plantada em dois locais em 1977. Esta série tem mostrado relativamente alta interação entre repetição x procedência nos 36 meses de idade e portanto não pode ser usada ainda para seleção de procedências superiores.

PROVENANCE STUDIES OF *EUCALYPTUS GRANDIS* (HILL) MAIDEN IN SOUTH AFRICA.

Summary

Provenance studies of E. grandis began in South Africa in 1973 when a country-wide series of trials was established. This series is handicapped, however, by the presence of many seedlots collected from only one or a few mother trees as well as poor representation of common seedlots across the series. Nevertheless, E. grandis seedlots from Coffs Harbour, N.S.W., and Atherton, Queensland, showed superior growth at four years of age at all sites where they were planted. South African seed orchard stock showed relatively poor growth but superior form.

The altocline-latocline series of E. grandis provenances from New South Wales was planted at two sites in 1977. This series has shown relatively strong replication x provenance interaction effects at 36 months of age and thus cannot be used yet to select superior provenances.

INTRODUCTION

Eucalyptus grandis (Hill) Maiden was first introduced into South Africa during the latter part of the 19th century under the name of Eucalyptus saligna Smith because, at that time, botanists did not recognise the existance of two separate species. Between 1897 and 1915 no less than 82 kg of seed was imported from Australia; nothing is known, however, about the origin of any of the seedlots. Investigations in old stands planted with these seeds revealed that a large proportion of the seed must have come from E. grandis, its morphological variants, or natural hybrids with E. saligna (Poynton 1979).

Within these stands, which became the sources of all locally collected seed, E. grandis showed a natural superiority in rate of growth and stem form. Because seed was collected from only the best trees, true E. grandis soon became the most widely planted of the varieties.

By 1978 there were 274 000 ha of E. grandis plantations in South Africa, most of which are owned by private timber growers and managed on short rotations for such products as mining timber, small poles and pulpwood. The Directorate of Forestry and Environmental Conservation, which for many years did not grow E. grandis commercially, has embarked on a large establishment programme in the Eastern Transvaal Region with the aim of growing large dimension sawlogs, pilings and large poles.

Short rotation crops are generally planted at 2,7 x 2,7 m and felled at the age of eight or 10 years. Regeneration is by coppicing, with the shoots being reduced to two or three per stump during the first year.

Long rotation E. grandis is planted also at 2,7 x 2,7 m to give an espacement of 1 330 stems/ha. This is reduced in four thinnings to 150 stems/ha by the age of 15 to 16 years. Clearfelling takes place at about the age of 25 years. Regeneration is by replanting after killing the stumps of the previous crop.

PROVENANCE TRIALS

The first "provenance" trial of E. grandis in South Africa consisted of a mixed species trial of three collections of E. grandis from stands of unknown origin in various parts of South Africa and five seedlots of E. saligna, three from South Africa of unknown origin, one from Pechy Height, Queensland, Australia, and one bulk collection from New Zealand.

The trial was planted at the Narrows State Forest in Zululand during 1959 but was abandoned in 1973 because of the poor representation of the species and the lack of knowledge of the true origins of most of the seedlots. The measurements taken during the 14 years of the experiment showed that the E. grandis rapidly asserted superiority over E. saligna. By age 14 years all three E. grandis seedlots had significantly greater volumes than those of E. saligna. Noteworthy was the fact that the E. grandis seedlot from Port Durnford State Forest in Zululand rose in ranking from sixth in total height at 3,8 years to first at 14 years, and from sixth to second in Mean Annual Increment. This shows that provenance trials of species to be grown on long rotations should not be concluded too early as some seedlots may only develop their full potential late in a rotation.

1973 SERIES

The first series of proper provenance trials of E. grandis and E. saligna was planted in 1973 using 13 Australian seedlots of E. grandis, two South African bulked seed orchard collections, and one Brazilian seedlot of unknown origin. Seven Australian and one Brazilian seedlots of E. saligna, together with one Zambian seedlot of E. grandis x E. camaldulensis, were included in the series (Table 1).

Trials were planted at nine locations in the Transvaal and Natal provinces. However, only three trials had sufficiently complete representations of seedlots and statistically acceptable designs to allow analysis. A detailed analysis of the first two measurements (at 38 and 50 months) will be published soon (K. Roeder, in press).

In the warm subtropical zone of Zululand, E. grandis had a superiority in average standing volume (over bark) over E. saligna although the difference was not statistically significant. Despite a very high variability within and between trials in Zululand, E. grandis appeared to be increasing its superiority over E. saligna. There were numerous changes in ranking of the provenances between the two measurements, but, on the whole, the general order of ranking remained similar.

In the more temperate Eastern Transvaal, E. grandis was not noticeably superior to E. saligna. In fact, at 42 months E. saligna had a slightly higher total standing volume than did E. grandis and contributed two of the five best volume producers of the trial (Table 2). The E. saligna seedlot from near Ulong, N.S.W. was significantly better in volume than any seedlot of E. grandis. Unfortunately this was a single tree collection and thus not a good indication of the true value of the Ulong provenance of E. saligna.

Among the E. grandis seedlots, that from Coffs Harbour, N.S.W., did consistently well in both major regions and at many minor sites. The exception was at Manzengwenya S.F. in northern Zululand where the trial was subjected to cycles of seasonal flooding and bad droughts.

The tree seedlots from Atherton, Queensland, did very well wherever they were planted. Unfortunately they were not included in the major trials in Zululand. The variation among the three seedlots can be explained by the fact that two of them were single tree collections.

Seedlots of E. grandis from South African seed orchards had much lower, if not statistically significant, survival rates and standing volumes than did the better of the imported seedlots. Their stem form rating, however, was superb. These results reflect the heavy emphasis placed on stem form during the early days of the E. grandis breeding programme in South Africa when stem straightness and freedom from end-splitting were the main selection criteria for plus trees to be used in the sawtimber tree breeding programme. The poor survival and high proportion of runts among these seedlots may be caused by inbreeding and selfing within the seed orchards (G. van Wyk, personal communication).

The results of this series of trials cannot be conclusive because of several faults in the series that throw doubt upon the value of the trials:

1) Many of the seedlots are single tree collections or contain seed of very few mother trees;

2) No commercial check was included to see if any seedlot was superior to regular plantation stock;

3) Only three of the nine trials had adequate representations of seedlots. Even then only eight of the 16 E. grandis seedlots were common in all three trials. This imbalance makes the study of genotype x interaction difficult.

4) The use of only three replications per trial was too few to overcome the very high variability found within and among plots.

This series of trials will be continued although their value for provenance studies is now limited.

ALTOCLINE-LATOCLINE SERIES

Of great potential value are the E. grandis altocline and latocline series planted in 1977 in the Northern Transvaal and Zululand with seedlots provided by the Forestry Commission of New South Wales. Eleven provenances, mostly of five separate families each, were supplied for each series (Table 3).

The families were planted at a 2,7 x 2,7 m espacement in 1 x 5 tree rows randomised within the provenance plots. The provenances were distributed in completely randomised block designs with four or five replications. A control group of five families from various regions of South Africa was included in both trials.

The trials at the J.D.M. Keet Forestry Research Station in the Northern Transvaal were planted in late January, 1977; those at the Port Durnford State Forest in Zululand were planted in March, 1977. Survival at both trials was very good.

STATISTICAL ANALYSIS

Height and diameter at breast height (DBH) of all trees were measured at both trials at the age of 36 months. Stem form (based on a six point scale) was assessed at the J.D.M. Keet F.R.S. A stem volume (over bark) was derived using a standard Departmental volume formula.

Table 2 : Mean standing volume production of E. grandis and E. saligna seedlots planted at three locations in South Africa.

Frankfort SF, Transvaal age 50 months		Kwa-Mbonambi SF, Zululand age 38 months		Pt. Durnford, Zululand age 38 months	
Seedlot number*	Volume in m³/ha	Seedlot number*	Volume in m³/ha	Seedlot number*	Volume in m³/ha
24314	86,6	24313	41,6	24931	73,0
24276	73,0	22695	41,0	24547	71,7
24275	72,2	24291	38,4	24547	67,2
24835	70,0	24274	36,0	22695	64,5
22695	67,5	24927	35,5	24273	59,4
24289	66,4	24273	34,2	24291	55,7
24939	64,0	24289	33,4	24927	53,0
24288	60,5	24315	32,9	24289	48,6
24317	60,5	24290	28,2	24312	44,7
24273	59,1	24547	23,2	24290	42,4
24274	57,7	24314	21,0	24315	42,2
24212	57,4	24931	19,9	24276	42,1
24291	57,3	24547	18,9	24313	41,8
24943	57,3	24276	18,9	24274	38,9
24277	56,2	24312	17,8	24314	32,7
24315	55,9	24317	16,4	24317	32,4
24931	54,3				
24942	51,4				
24504	50,6				
24290	50,0				
24547	49,7				
24927	46,5				
24949	44,9				
25570	43,7				
24313	43,4				
	Mean		Mean		Mean
E. grandis	58,3		33,2		50,6
E. saligna	59,1		24,9		44,5

* Underlined seedlots are E. saligna.

Vertical lines denote no significant difference at the ,05 level using Duncan's New Multiple Range Test.

Table 1 Details of seedlots in trials located at Frankfort, Port Durnford and Kwa-Mbonambi State Forests, South Africa

RSA number	Australian No.	Seed origin	Latitude (° ')	Longitude (° ')	Altitude (m)	Number of mother trees
22695	7823	N of Coffs Harbour, N.S.W.	30 10	153 08	20	1
24273	6697	NE of Bulahdelah, N.S.W.	32 18	152 18	150	?
24274	5664	NW of Casino, N.S.W.	28 40	152 45	520	1
24275	6952	E of Atherton, Qld.	17 03	145 34	850	10
24276	7488	Gympie, Qld.	26 30	152 40	420	?
24277	7242	Taree, N.S.W.	32 --	152 --	60-90	50
34^^^	8296	S od Atherton, Qld.	17 21	145 25	975	1
24289	9575	Coffs Harvour, N.S.W.	30 00	152 58	100	7
24290	9583	Kempsay District, N.S.W.	31 04	152 48	20	8
24291	9503	W of Coopernook, N.S.W.	31 50	152 37	330	?
24504	----	RSA Seed Orchard 1971				Bulk
24927	----	Brazil (2094)				?
24939	7810	N of Buladelah, N.S.W.	32 20	152 13	120	13
24942	8144	Belthorpe State Forest Qld.	27 10	152 45	450	1
24943	8197	Atherton Tableland, Qld.	17 10	145 30	1030	1
25570	----	RSA Seed Orchard 1972.				bulk
4312	7508	N of Batemans Bay, N.S.W.	35 40	150 15	30	1
24313	7808	N of Buladelah, N.S.W.	32 20	152 12	225	1
24314	7821	NW of Ulong, N.S.W.	30 09	152 49	500	1
24315	9145	N of Nowra, N.S.W.	34 50	150 34	300	?
24317	9371	Cessnock, N.S.W.	32 00	151 --	800	6
24835	7730	Barrengarry Mt. N.S.W.	34 40	150 30	600	10
24931	----	Brazil (no. 35)				?
24949	7988	N of Kyogle, N.S.W.	28 22	152 45	600	2
24547	----	Zambia				?

These data were then grouped to produce plot means for each variable to allow comparisons among provenances. Differences among families were not considered for this study. All analyses were done using the General Linear Models (GLM) option of SAS* 79 (Helwig & Council (ed) 1979).

If both replication and provenance main effects proved significant for a variable at a trial, a further analysis was done to detemine if replication x provenance interaction was present. If so, the provenance mean square was tested against the interaction mean square to determine whether differences among provenances were still significant. Variance components were also derived to indicate the relative size of the interaction component.

Those data sets for which differences among provenances were still significant despite interaction were subjected to the Duncan Multiple Range Test using the interaction MS as the error term.

THE ALTOCLINE SERIES

At the J.D.M. Keet F.R.S. only the linear model for mean stem form was significant although that for mean height was almost significant (Table 4). Interaction between replication and provenance was not important at this trial, thus allowing one to accept the ranking of the provenances for all variables as a true reflection of differences among provenances even when such differences cannot be statistically proven.

The altocline series at Port Durnford showed significant differences among provenances only for mean height (Table 5). In this case, however, the interaction effect was strong enough to eliminate this significance.

Table 3. List of seedlots from New South Wales used in the altocline & latocline series of E. grandis provenance trials in South Africa.

S.A. stock number	Australian number	Origin	Latitude (° ')	Longtitude (° ')	Altitude (m)	Provenance number
Altocline Series						
27706-10	194/33/252-256	Newfoundland S.F.	29 55	153 07	76	A 1
27711-15	194/33/257-261	Orara East S.F.	30 13	153 06	123	A 2
27716-20	194/22/262-266	Orara West S.F.	30 15	152 57	183	A 3
27721-23	194/33/267-269	Yabbra S.F.	28 34	152 36	396	A 4
27724-29	194/33/270-275	Wild Cattle Creek S.F.	30 14	152 51	580	A 5
27730-34	194/33/176-280	Newry S.F.	30 31	152 58	6	A 6
27735-39	194/33/281-285	Bellinger River S.F.	30 27	152 37	100	A 7
27740-44	194/33/286-290	Pine Creek S.F.	30 24	153 03	6	A 8
27745-49	194/33/291-295	Tuckers Knob S.F.	30 22	153 00	107	A 9
27804-06	194/33/350-352	Scotchman S.F.				A10
27807-11	194/33/353-357	ATherton S.F.			750	A11
CONTROL		South Africa				A12
Latocline Series						
27750-54	194/33/296-300	0.5 km N.W. of Minmi	32 52	151 39	31	L 1
27755-59	301-305	Wallingat S.F.	32 20	152 27	31	L 2
27760-64	306-310	Wang-Wank S.F.	32 13	152 13	153	L 3
27765-69	311-315	Queens Lake S.F.	31 35	152 48	30	L 4
27770-74	316-320	Lorne S.F.	31 39	152 32	250	L 5
27775-79	321-325	Tamban S.F.	30 52	152 53	30	L 6
27780-84	326-330	Nulla Five Day S.F.	30 43	152 32	200	L 7
27785-89	331-335	Cherry Tree S.F.	28 53	152 47	180	L 8
27790-93	336-339	Mebbin S.F.	28 26	153 12	120	L 9
27794-98	340-344	Lower Stanley RN SF	26 52	152 48	46	L10
27799-893	345-349	Brooloo, S.F.	26 37	152 25	519	L11
CONTROL		South Africa				L12

Table 4. Growth data for E. grandis altocline series from New South Wales planted at J.D.M. Keet F.R.S., Transvaal, South Africa. Age 36 months. Based on mean plots.

		Height (m)		DBH (cm)		Tree volume (OB) (m³)		Stem form 6 = best; 1 = worst	
Mean		15,7		11,5		,067		3,5	
S.D.		,99		,85		,013		,3	
C.V.		6,3		7,4		18,8		9,8	
Anova Model Pr>F		,052		0,147		,228		,0004	
	df	Ms	F	Ms	F	MS	F	MS	F
Replication	4	0.14	0,14	0,45	0,62	,00008	0,56	,40	3,41*
Provenance	11	2.47	2,52*	1,32	1,82	,00025	1,61	,44	3,78***
Error	44	0.98	0,72	0,72		,00016		,12	
Total	59								
Variance comp. (%) based on analysis of all trees.									
Rep.		0		0		0		6***	
Prov.		4**		2*		1		8***	
R x P		6		2		2		2	
Error		90		96		97		84	
Ranking of Provenances									
		A 8	16,8	A 3	12,0	A 1	,076	A 4	3,9
		A 9	16,3	A 8	12,0	A 9	,074	A 2	3,9
		A 6	16,2	A 1	12,0	A 3	,074	A 7	3,8
		A 3	16,2	A 9	11,9	A 8	,072	A12	3,8
		A 1	15,8	A12	11,8	A 6	,070	A 5	3,5
		A 2	15,7	A 6	11,6	A12	,069	A 3	3,5
		A10	15,7	A10	11,5	A10	,066	A 6	3,4
		A12	15,7	A 2	11,4	A 2	,066	A 9	3,4
		A11	15,5	A 4	11,3	A 2	,066	A 1	3,2
		A 5	15,4	A11	11,2	A 4	,062	A11	3,2
		A 4	14,9	A 5	11,0	A 5	,061	A 8	3,1
		A 7	14,1	A 7	10,2	A 7	,051	A10	3,1

THE LATOCLINE SERIES

All variables except mean height showed significant differences at the J.D.M. Keet F.R.S., and both replication and provenance effects were significant (Table 6). Interaction was present in both mean height and mean stem form but in neither case did it eliminate the significant differences among provenances.

On the other hand, the interaction effect was probably the cause of the lack of significant differences among provenances in the latocline series at Port Durnford (Table 7). At this trial interaction accounted for 8 to 16 % of the total variance, about three to eight times that of the provenance main effect.

RESULTS FROM ALTOCLINE-LATOCLINE SERIES

Variation for all variables measured in these trials at the age of 36 months both within and among plots was still very high. Relatively strong interaction effects were also present for some variables at one or both sites. One must be very careful therefore in interpreting the results.

Quite large differences do exist among provenances for all variables and appear to be similar at both sites. This indicates that certain provenances may be better at both sites than others. However, until more statistically valid results are available, no conclusions should yet be drawn as to the value of individual provenances. Experience in South Africa has shown that interaction and replication effects will probably diminish as the age of the trial increases.

Table 5. Growth data for E. grandis altocline series from New South Wales planted at Port Durnford State Forest, Zululand, South Africa. Age 36 months. Based on plot means.

		Height (m)		DBH (cm)		Stem volume (OB) (m³)	
Mean		12,3		11,2		,050	
S.D.		,67		,68		,007	
C.V.		5,6		6,1		14,4	
Anova Model Pr>F		,0093		,0013		,0036	
	df	MS	F	MS	F	MS	F
Replication	2	3,86	8,12**	10,58	22,66****	,00089	16,90***
Provenance	7	1,50	3,16*	,93	2,00	,00011	2,01
Error	13	,47		,47		,00005	
Total	22						
Variance components (%) based on analysis of all trees							
Rep.		8****		12****		12****	
Prov.		4		<1		1	
R x P		4**		0		2	
Error		84		87		85	
Ranking of provenances		A 2	13,0	A 8	11,5	A 3	,055
		A 3	13,0	A 3	11,5	A 9	,055
		A 8	12,0	A 9	11,5	A 8	,055
		A 9	12,6	A12	11,4	A 2	,052
		A12	12,2	A 2	11,3	A12	,052
		A 7	11,9	A 7	11,1	A 7	,048
		A11	11,6	A11	11,1	A11	,048
		A10	11,1	A10	9,9	A10	,039

Table 6. Growth data for E. grandis latocline series from New South Wales planted at J.D.M. Keet F.R.S., Transvaal, South Africa. Age 36 months. Based on plot means.

		Height (m)		DBH (cm)		Stem volume (OB) (m³)		Stem form (6 = best; 1 = worst)	
Mean		14,8		11,0		,057		3,4	
S.D.		,89		,95		,007		,3	
C.V.		6,0		8,6		11,7		9,9	
Anova model Pr>F		,0001		,0765		,0001		,0001	
	df	MS	F	MS	F	MS	F	MS	F
Replication	4	7,69	9,72****	2,91	3,22*	,00044	9,90****	,81	7,00***
Provenance	11	2,86	3,62**	1,09	1,21	,00019	4,50***	1,06	9,21****
Error	44	,79		,90		,00004		,11	
Total	59								
Variance components (%) based on analysis of all trees									
Rep		6****		1		3****		4****	
Prov		4**		1		4****		11****	
R x P		5****		4		1		3***	
Error		85		94		92		83	
Ranking of provenances		L 6	15,8	L6	11,7	L 6	,067	L12	4,1
		L 4	15,5	L 4	11,4	L 4	,064	L 9	4,0
		L 9	15,4	L 9	11,4	L 9	,064	L 8	3,8
		L10	15,3	L 2	11,3	L10	,063	L 7	3,8
		L 5	15,1	L10	11,3	L 1	,058	L 5	3,8
		L 1	15,0	L 1	11,2	L11	,066	L10	3,5
		L 8	15,0	L12	10,9	L 5	,055	L 4	3,4
		L12	14,7	L 8	10,8	L 8	,054	L 2	3,2
		L 7	14,7	L11	10,8	L12	,054	L11	3,1
		L11	14,1	L 7	10,7	L 7	,053	L 6	3,0
		L 2	13,6	L 5	10,6	L 2	,048	L 3	2,8
		L 3	13,3	L 3	10,0	L 3	,046	L 1	2,8

Table 7. Growth data for E. grandis latocline series from New South Wales planted at Port Durnford Forest, Zululand, South Africa. Age 36 months. Based on plot means.

		Height (m)		DBH (cm)		Stem volume (OB) (m^3)	
Mean		13,0		12,8		,069	
S.D.		1,05		1,20		,014	
C.V.		8,1		9,0		20,8	
Anova model Pr>F		,0025		,0005		,0004	
	df	MS	F	MS	F	MS	F
Replication		11,16	10,11****	15,98	12,00****	,0023	11,57****
Provenance	11	1,61	1,46	2,54	1,90	,0004	2,09
Error	32	1,10		1,33		,0002	
Total	46						
Variance components (%) based on analysis of all trees							
Rep		16****		12****		15****	
Prov		2		2		3	
R x P		16****		8****		10****	
Error		66		79		72	
Ranking of provenances							
		L10	14,4	L10	14,5	L10	,090
		L 6	13,6	L11	13,4	L11	,077
		L 2	13,3	L 6	13,2	L 6	,075
		L11	13,3	L12	13,2	L 2	,074
		L12	13,2	L 2	13,1	L12	,074
		L 4	13,0	L 9	13,0	L 4	,071
		L 9	13,0	L 4	12,8	L 9	,069
		L 3	12,6	L 3	12,5	L 3	,065
		L 5	12,6	L 1	12,3	L 1	,058
		L 8	12,4	L 8	12,1	L 8	,058
		L 1	12,3	L 5	11,8	L 5	,058
		L 7	11,7	L 7	11,1	L 7	,049

Indications are that the South African "provenance" has height and diameter growth about average for all trials. Stem form, however, as evidenced by the trials at the J.D.M. Keet F.R.S., is very good if not the best. This result tallies with that of the 1973 plantings and other experiences with progenies of South African selected E. grandis trees.

CONCLUSIONS

Despite the problems of both trial series, it is likely that some imported provenances of E. grandis do grow better than the seedlots from South Africa's E. grandis seed orchard or selected trees. There is potential then to add superior material into the present breeding programme.

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COMPARAÇÃO DE LOCAIS ENTRE AUSTRÁLIA E BRASIL VISANDO AO PLANTIO DE *EUCALYPTUS GRANDIS.*

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Resumo

Para determinar a correlação ecológica entre a distribuição natural do *Eucalyptus grandis* na Austrália e sua área de florestamento no Brasil, os seguintes fatores foram considerados: latitude, longitude, vegetação, temperatura e balanço hídrico (Thornthwaite e Mather 1955 – 300mm). Segundo o último fator é possível diferenciar 4 regiões:

Região 1: Precipitação uniformemente distribuída – pequeno déficit hídrico no verão (menor que 20mm). *Localização na Austrália:* centro-oeste de Nova Gales do Sul. *Área correspondente no Brasil:* sudeste do Rio Grande do Sul.

Região 2: Precipitação uniformemente distribuída – sem déficit hídrico. *Austrália:* nordeste de Nova Gales do Sul. *Brasil:* nordeste de Santa Catarina.

Região 3: Precipitação predominante no verão – pequeno deficit hídrico (menor que 20mm) na primavera (Austrália) ou no inverno (Brasil). *Austrália:* sudeste de Queensland. *Brasil:* planalto sudeste de São Paulo.

Região 4: Precipitação predominante no verão — deficit hídrico prolongado (até 80 mm) no inverno. *Austrália:* nordeste de Queensland. *Brasil:* nordeste do Espírito Santo, planalto nordeste de São Paulo, planalto norte de Minas Gerais e planalto Sul de Mato Grosso e Goiás.

As condições climáticas mais favoráveis para o *E. grandis* no Brasil, de acordo com os padrões australianos, são nas áreas com temperatura média anual entre 17°C e 21°C, com deficit hídrico menor que 20 mm. Existe uma excessão com as procedências de Atherton (Região 4); esta fonte geográfica, nas condições experimentais no Brasil, tem mostrado comportamento satisfatório na área com temperatura média anual de 23°C e defici hídrico menor que 80 mm, considerando que, estas duas condições extremas não ocorram ao mesmo tempo.

Summary

To determine the ecological correlation between the natural range of Eucalyptus grandis in Australia and its afforestation area in Brazil the following factors were considered : latitude, altitude, vegetation, temperature and water balance (Thornthwaite and Mather, 1955 - 300 mm). With respect to water balance it is possible to differentiate four regions :

Region 1. Rainfall uniformly distributed - little water deficit in summer (under 20 mm). Distribution in Australia : central east coast of New South Wales. Corresponding area in Brazil : south east of Rio Grande do Sul.

Region 2. Rainfall uniformly distributed - high water surplus - no water deficit. Australia : north east of New South Wales. Brazil : north east of Santa Catarina.

Region 3. Rainfall predominant in summer - little water deficit (under 20 mm) in spring (Australia) or in winter (Brazil). Australia : south east of Queensland. Brazil : southern tableland of Sao Paulo.

Region 4. Rainfall predominant in summer - extended water deficit (up to 80 mm) in winter. Australia : northeast of Queensland. Brazil : northeast of Espirito Santo, northeast tableland of Sao Paulo, northern tableland of Minas Gerais and southern tableland of Mato Grosso and Goias.

The most suitable climatic conditions for E. grandis in Brazil, according to the Australian patterns, are in areas with mean annual temperature between 17°C and 21°C, with no water deficit or less than 20 mm. There is an exception with the Atherton provenance (Region 4); this geographical source in the experimental tests in Brazil has shown a satisfactory performance in areas with mean annual temperature up to 23°C and water deficit less than 80 mm, provided that these two extreme conditions do not occur at the same time.

Introdução

Uma condição básica para o êxito do reflorestamento é a utilizaçao de determinadas espécies e de suas procedências geográficas adequadas a ecologia da região. Naturalmente a escolha definitiva dependerá de uma experimentação técnica e racionalmente conduzida. Para facilitar o trabalho experimental considera-se conveniente, comparar as condições ecológicas da área de ocorrência natural do Eucalyptus grandis , atualmente a espécie mais importante para o reflorestamento no Brasil, com às provalêntes nas áreas potenciais de plantio neste país.

Os fatores que tem sido utilizados para caracterizar esta correlação são : latitude, altitude, vegetação, temperatura e balanço hídrico.

Latitude

E. grandis mora naturalmente em povoamentos descontínuos e fragmentados, situados numa faixa costeira estreita que vai desde Newcastle, New South Wales (32° 35') ate Gympie, Queensland (26° 11'). A largura desta faixa é inferior a 100 km já que, afastando-se do litoral não se encontram para esta espécie condições favoraveis, devido sobretudo ao insuficiente índice pluviométrico.

Mais ao norte E. grandis reaparece em povoamentos isolados nas proximidades de Mackay (21° 06'), Cardwell (18° 15') e Atherton (17° 17'), Queensland. Em resumo, sua área de ocorrência desde Newcastle ate Atherton tem um comprimento de mais de 2.000 km.

No atlas de Carter, publicado em 1945, na folha dedicada às especies E. grandis e E. saligna , estão assinalados, alem das áreas de maior tamanho dois povoamentos nas proximidades de Cooktown (15° 28') e de Coem (13° 57'), Queensland. A existência de E. grandis nessas latitudes merece ser confirmada, já que estas procedências poderiam resultar muito valiosas para regiões de tipo tropical.

No Brasil o E. grandis é cultivado com êxito numa área extensa com latitude similar a australiana desde Rio Grande (32°.02'), RS, até o sul da Bahia (17° 00') e Brasília (15° 48'), DF.

A concordância na latitude entre o Brasil e a Australia é considerada fator importante, já que neste caso especial tem-se observado também afinidade nas condições de clima, solo e fotoperiodismo.

Altitude

Ao sul da sua área natural de ocorrência os povoamentos de E. grandis encontram-se desde o nível do mar até 300 m de altitude, atingindo até 600 m em Urbenville no limite norte de New South Wales. No sudeste de Queensland, entre Brisbane e Gympie, os povoamentos estão situados sempre acima de 300 m.

Nas planícies costeiras ao norte de Gympie, as condições de temperatura tornam-se desfavoráveis para E. grandis, que é observado apenas em colinas, planaltos e montanhas.

A oeste de Mackay, na Eungella National Forest, os povoamentos da espécie estão situados entre 700 e 900 m e no noroeste de Ingham, na Kirrama Forest, entre 600 e 700 m. Maior extensão tem os povoamentos de E. grandis no planalto de Atherton situados numa faixa de altitude entre 500 e 1150 m.

No sul do Brasil, nos estados de Rio Grande do Sul e Santa Catarina, os plantios de E. grandis situam-se em regiões de pouca altitude, pois no planalto interior, acima de 500 m a especie é afetada pelas geadas. Nos planaltos de São Paulo, Mato Grosso, Minas Gerais e Goiás as plantações estão situadas entre 400 e 1200 m, enquanto no norte de Espírito Santo e sul da Bahia estão a menos de 50 m sobre o nível do mar.

Vegetação

O E. grandis é encontrado em povoamentos puros ou mixtos, associado com outras espécies, frequentemente E. pilularis e Tristania conferta, e ocasionalmente E. saligna , E. microcorys , Toona ciliata var. australis e outras.

Ao sul de seu habitat a espécie participa da floresta esclerofila úmida,

Quadro 1. - Localização e dados climáticos de sitios dentro da área natural do E. grandis na Australia

	Latitude	Longitude	Altitude m	Temperatura média anual ° C	Precipitação média anual mm	Déficit hídrico anual (Thornthwaite 1955-300 mm
Port Stephens, NSW	32° 42'	152° 09'	10	17,8	1328	9
Wingham , NSW	31° 09'	152° 04'	24	18,2	1098	15
Coff's Harbour, NSW	30° 18'	153° 10'	21	18,5	1657	0
Kyogle , NSW	28° 30'	153° 03'	120	19,3	1325	12
Urbenville, NSW	28° 27'	152° 33'	550	17,0	1082	7
Brisbane , QLD	27° 28'	153° 02'	37	20,6	1021	10
Gympie , QLD	26° 11'	152° 40'	94	20,4	1173	7
Eungella, Mackay, QLD	21° 07'	148° 30'	800	19,2	1300	-
Atherton, QLD	17° 30'	145° 27'	740	20,1	1427	74

Quadro 2. - Localização e dados climáticos de sitios da área de cultivo do E. grandis no Brasil.

	Latitude	Longitude	Altitude m	Temperatura média anual °C	Precipitação média anual mm	Déficit hídrico anual (Thornthwaite 1955-300) mm
Bagé, RS	31° 20'	54° 06'	210	18,0	1286	7
Porto Alegre, RS	30° 02'	51° 13'	10	19,5	1317	21
Camboriú, SC	27° 00'	48° 38'	8	19,6	1513	0
Itapeva, SP	23° 59'	48° 53'	670	18,7	1223	0
São Roque, SP	23° 31'	47° 08'	830	16,8	1536	0
Taubaté, SP	23° 02'	45° 34'	580	20,1	1302	10
Rio Claro, SP	22° 25'	47° 34'	612	20,7	1266	8
Araxá , MG	19° 34'	46° 56'	960	18,9	1782	28
Viçosa , MG	20° 45'	42° 52'	658	18,8	1395	19
Itabira , MG	19° 37'	43° 13'	850	19,5	1495	35
Nova Friburgo , RJ	22° 17'	42° 32'	849	17,9	1534	7
Tres Lagoas , MT	20° 47'	51° 12'	313	23,1	1305	30
Linhares , ES	19° 22'	40° 04'	30	23,5	1268	31
Brasilia , DF	15° 47'	47° 56'	1160	20,4	1577	75

Quadro 3. - Localização e dados climáticos de sitios inaptos para E. grandis devido a excesso de calor e de déficit hídrico; aptos para outras espécies de eucaliptos.

	Latitude	Longitude	Altitude m	Temperatura média anual °C	Precipitação média anual mm	Deficit hídrico anual (Thornthwaite 1955-300) mm
Habana , Cuba	23º 08'N	82º 21'	20	25,2	1225	232
Nieuw Nickerie, Surinam	5º 52'N	57º 00'	25	26,5	1963	97
Santarem, PA	2º 25'S	54º 42'	20	26,0	2096	177
Natal, RN	5º 46'S	35º 12'	18	26,2	1546	303
Catende, PE	8º 41'S	35º 42'	169	25,6	1578	219
Maceió, AL	9º 40'S	35º 41'	46	25,4	1653	225
Alagoinhas, PA	12º 08'S	38º37'	140	24,6	1476	102

enquanto ao nordeste de New South Wales, sudeste e nordeste de Queensland, da floresta costeira ombrofila (pluvial). Os povoamentos estão localizados geralmente em vertentes úmidas ou em depressões e vales, ou ainda, nas margens de pequenos cursos de água, enquanto que nas encostas secas o E. grandis é substituido por outras espécies.

Considerando o tipo de vegetação natural, a espécie dá a impressão de crescer em áreas permanentemente úmidas ou com período curto de seca.

Na região de Coffs Harbour, no sub-bosque , abunda o feto arborescente Dicksonia antártica , espécie similar a Dicksonia selloviana (xaxim) típico da floresta pluvial do planalto sul do Brasil.

No setor meridional de Rio Grande do Sul, as plantações de E. grandis são encontradas principalmente em área de campo ; em Santa Catarina e Espirito Santo, na área da floresta costeira ombrofila ; no planalto do São Paulo e Minas Gerais, principalmente na área da floresta perenifolia estacional, porém também em áreas de cerrado e de campo altimontano.

Temperatura

No Quadro 1 pode-se observar que a temperatura média anual da área natural de E. grandis , situa-se entre 17º C e 21º C . Condições similares existem também nas areas de cultivo no Brasil (Quadro 2). Nas regiões mais quentes, as condições tornam-se menos favoráveis para o cultivo de E. grandis, sendo conveniente, neste caso utilizar a procedência de Atherton, QLD.

Nas regiões tropicais com temperatura média anual superior a 24º C (Quadro 3), as condições tornam-se completamente inadequadas para E. grandis. Nestas áreas a espécie é frequentemente atacada pelo fungo Diaporthe cubensis.

A temperatura media anual pode ser considerada índice satisfatório para delimitar as regiões aptas para a espécie, enquanto que as temperaturas médias, das máximas e das mínimas , usadas por alguns autores , parecem menos representativas.

No planalto sul do Brasil, nos estados do Paraná, Santa Catarina e Rio Grande do Sul, existem algumas áreas com temperaturas médias entre 17º C e 18º C, que não obstante resultam inaptas para E. grandis ; neste caso atuam como fatores limitantes as geadas que ocorrem com temperaturas mínimas inferiores a - 5º C .

Balanço hídrico

Utilizando-se os balanços hídricos, calculados de acordo com Thornthwaite e Mather (1955 - 300 mm), dos locais de ocorrencia de E. grandis , na faixa costeira dos estados de New South Wales e Queensland, foi possível delimitar 4 regiões diferentes com características que tem estreita analogia com regiões brasileiras donde é cultivada a espécie:

Região 1. - Entre 33º e 31º de latitude sul (Port Stephens, Bulahdelah, Wingham, Taree , NSW).
As chuvas - entre 1100 e 1300 mm por ano - são uniformemente distribuidas, embora predominando no semestre mais frio e declinando no período mais quente; por isso no verão, entre outubro e fevereiro, ocorre um pequeno deficit hídrico, geralmente inferior a 20 mm. Esta região australiana tem estreita analogia com o extremo sul do Brasil (Porto Alegre, Cachoeiras do Sul, Bagé, Pelotas, Rio Grande) e também com um setor da República do Uruguay (Fig. 2, A e B).

Região 2. - Entre 31º e 29º de latitude sul (Port Macquarie, Coffs Harbour, Lismore , NSW).
Nesta área observa-se o maior índices de precipitações - entre 1200 e 1700 mm por ano - e também o maior e mais prolongado excedente de água. Em anos normais, em nenhuma época do ano ocorre déficit hídrico (Fig. 2, C e D).
Na planície do rio Clarence, nas proximidades de Grafton, a região 2 sofre uma interrupção ecológica com povoamentos de eucalipto onde E. grandis é substituido pelos E. maculata e E. moluccana , Supõe-se que este fato seja devido ao elevado déficit hídrico ali existente , maior de 100 mm por ano.
Esta região por suas características é muito parecida com o setor costeiro dos estados de Santa Catarina (Florianopolis, Camburiú, Itajai, Joinville, São Francisco do Sul) e Paraná.

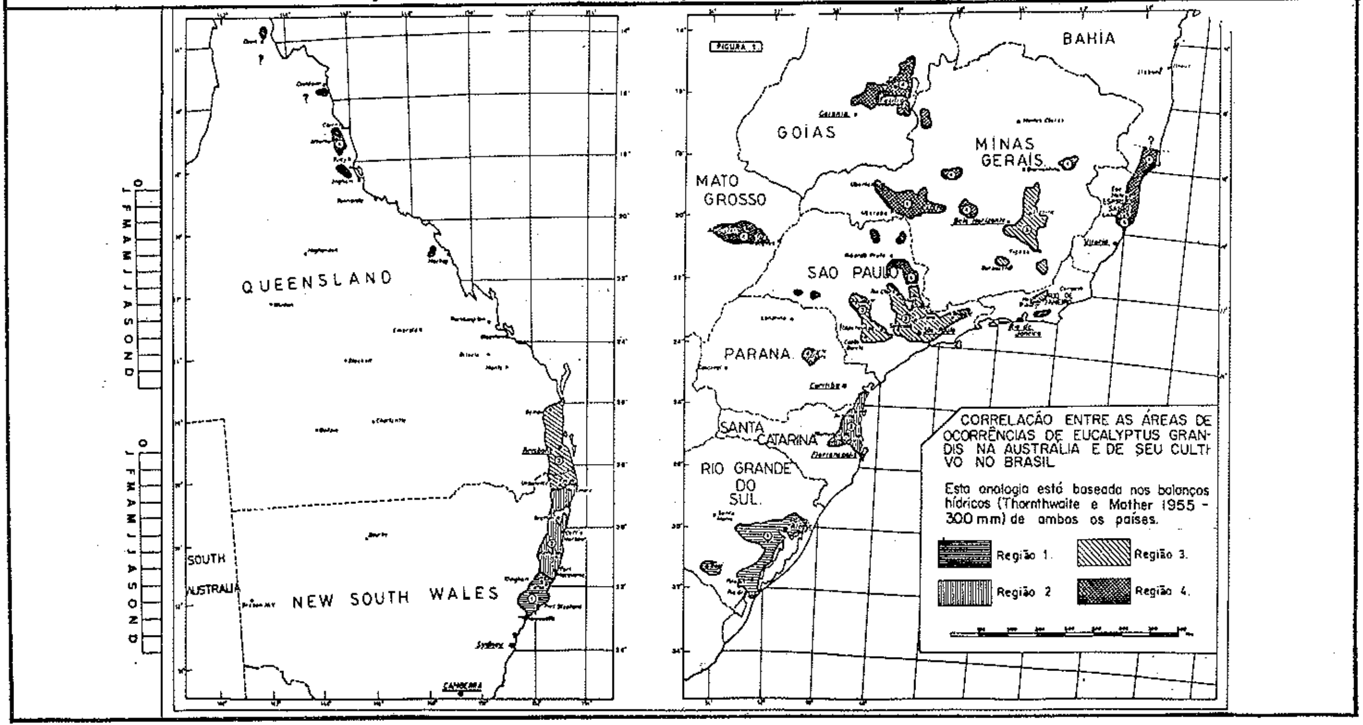
Região 3. - Entre 29º e 26º de latitude sul (Kyogle e Urbenville, NSW, Brisbane e Gympie, QLD)
As chuvas, entre 1000 e 1200 mm por ano, são já claramente de tipo periodico, declinando no inverno. Na primavera, entre outubro e novembro, constata-se um pequno déficit hídrico, inferior a 20 mm.
Esta região australiana por suas características tem analogia com o planalto sul de São Paulo (Capão Bonito, Itapotininga, Sorocaba, Lençóis Paulista, Salto, Rio Claro, Moji-Guaçu, Moji das Cruzes, Taubaté) e de Minas Gerais (Nova Lima, Santa Bárbara, Monlevade, Itabira). (Fig.3, A e B).

Regiao 4. - Entre 21º e 16º de latitude sul (serras a oeste de Mackay e Tully, planalto de Atherton e serras ao sul de Cooktown e norte de Coen, QLD).
As chuvas - entre 1300 e 1500 mm por ano - predominam no verão. O inverno é seco com um déficit hídrico de intensidade média, inferior a 80 mm.
Nesta região E. grandis ocorre numa faixa de altitude entre 550 m e 1150 m, não suportando o regime térmico das planícies costeiras com temperaturas médias anuais superiores a 23º C. Pelo tipo do balanço hídrico e pela latitude, esta região australiana tem afinidades com setores do planalto de São Paulo, Mato Grosso, Minas Gerais e Goiás e do litoral do Espirito Santo e Bahia. (Fig.3, C e D).

Resumindo, a pluviometria dentro da área de ocorrência australiana varia segundo os locais, entre 1000 e 1700 mm anuais, enquanto na area de cultivo no Brasil, entre 1200 e 1800 mm.

Conclusões

1. A pesar da amplitude geográfica da área de ocorrência natural de E. grandis, existe muita uniformidade entre as diferentes estações no que se refere as condições térmicas e hídricas; a temperatura média anual varia, por exemplo, entre 17º e 21º C e o déficit hídrico é inexistente ou irrelevante (menor de 20 mm por ano), com exceção de Atherton onde alcança níveis de 80 mm por ano. Porém, dentro da mesma área existem diferenças no suprimento estacional da água ; no sul, na altura de Newcastle, NSW, as chuvas são de tipo uniforme e há pequena seca no verão ; no norte em Atherton, QLD, as chuvas são periódicas e há seca prolongada no inverno. Em concordância com estas variações foram diferenciadas 4 regiões australianas, cujo balanço hídrico tem correspondência com várias áreas brasileiras (Fig. 1)



2. A analogia entre regiões australianas e brasileiras no entanto, não indica sua aceitação quanto a uso da semente. A escolha definitiva das procedências geográficas a serem utilizadas nos futuros plantios brasileiros, dependerá dos resultados da pesquisa, tarefa de longo prazo. Este trabalho já foi iniciado em alguns estados e deve ser extendido e ampliado para todas as regiões. A experimentação com as diferentes procedências, representa a primeira fase do processo de introdução, enquanto que a selecão de árvores superiores representa uma fase mais avançada.

3. Nas pesquisas iniciais, às vezes acontece, que uma procedência começa muito bem, mas seu comportamento decai depois de alguns anos, como foi observado no norte do Espírito Santo e em alguns locais de Minas Gerais, principalmente com a procedência de Coffs Harbour. Esta origem, oriunda de uma área com chuvas uniformemente distribuidas, grande excedente de água e ausência de déficit hídrico, exibe por alguns anos incrementos superiores as outras procedências, porém não parece indicada para regiões com seca acentuada no inverno. É possível que, em algumas áreas do planalto de São Paulo e de Minas Gerais, seja mais conveniente utilizar procedências das regioes australianas 3 e 4.

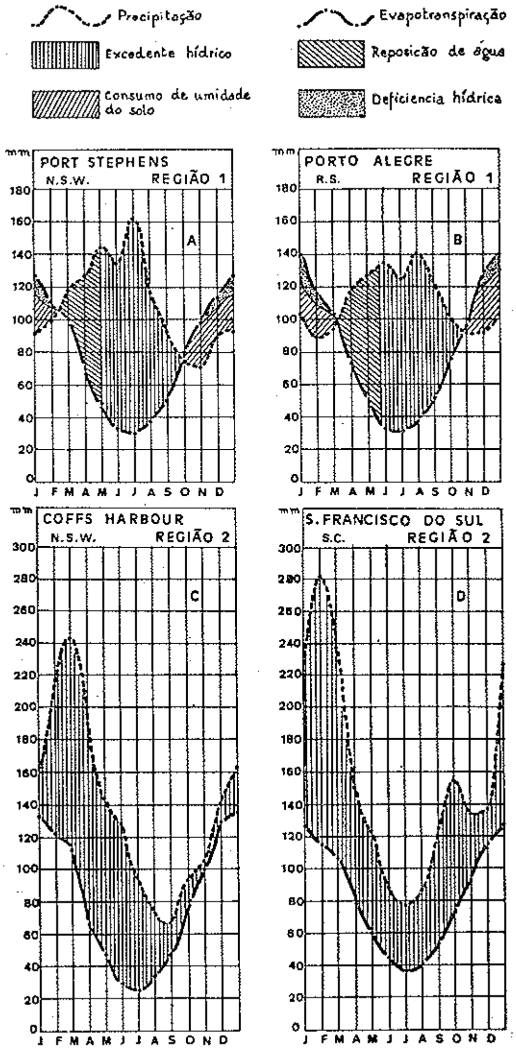
4. A procedência de Atherton, QLD, comporta-se melhor em regiões quase tropicais, como foi observado na costa norte do Espírito Santo. Nesta área tal origem apresenta elevada resistência ao *Diaporthe cubensis*, enquanto que as outras procedências do sul de Queensland e norte e centro de New South Wales são altamente susceptíveis.

5. *E. grandis* parece inadequado para regiões tropicais com temperatura media anual superior a 23° C, especialmente se combinadas com déficit hídrico superior a 80 mm anuais. No Brasil, em regiões tropicais com elevada umidade atmosférica o *E. grandis* tem-se revelado muito sensível ao *Diaporthe*, enquanto que as regiões tropicais secas tem incrementos inferiores a outras espécies e também tem apresentado vida curta. Nestas duas áreas ele pode ser substituído por outras espécies mais adequadas como : *E. urophylla*, *E. pellita*, *E. cloeziana*, *E. tereticornis*, *E. camaldulensis*, *E. citriodora*, *E. torelliana* e outras.

BALANÇO HÍDRICO

THORNTHWAITE E MATHER - 1955 (300 mm)

FIGURA 2.



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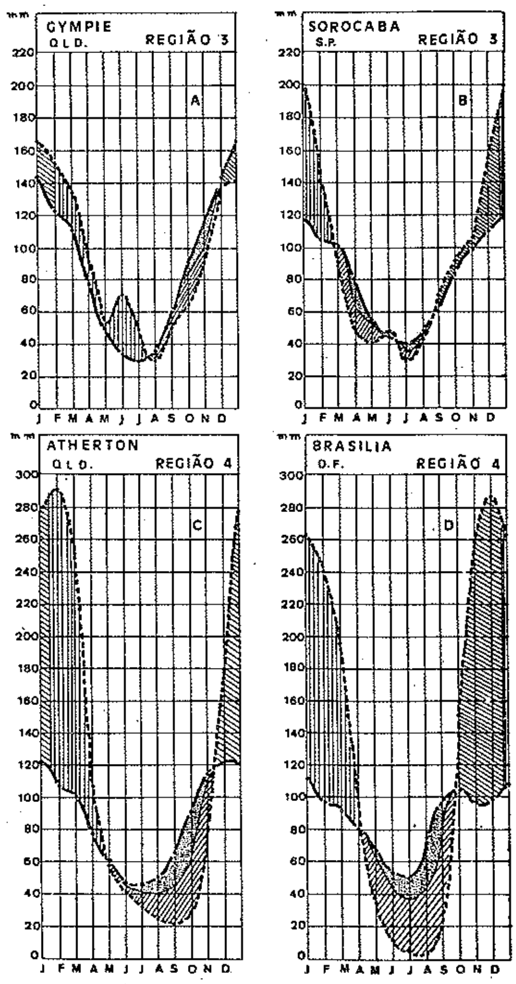
1963 - 65

FIGURA 3.



CORRELAÇÃO JUVENIL-ADULTA EM *EUCALYPTUS GRANDIS.*

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Resumo

Mudas de Eucalyptus grandis classificadas quanto a tamanho, cor e esgalhamento no viveiro, foram acompanhadas no campo até a idade de três anos, verificando-se sobrevivência, diâmetro e altura. Não houve correlações entre características no estágio de viveiro e mais tarde na idade de 6 meses e 3 anos, mas houve alguma correlação com a idade de 1 ano e dois anos.

JUVENILE-ADULT CORRELATION IN *EUCALYPTUS GRANDIS.*

Summary

Eucalyptus grandis seedlings were classified into seven classes depending on size, into two classes depending on color and into two classes depending on branching habit. After planting in the field, they were followed for three years, and correlations between early classification and later behavior in survival, diameter and height growth estimated. After half a year no more relationship was maintained to early classification, some relationship existed at age one and two years. At age three years, no relationship persisted.

Introdução

É prática comum selecionar mudas no viveiro antes do plantio, de maneira a plantar apenas as mais vigorosas. Essa atividade não tem ainda base científica que comprove a sua validade, e onde foram feitas observações empíricas não houve comprovação de que o método tenha mérito econômico.

Por outro lado, mudas de vigor superior talvez já demonstrem alguma característica própria no viveiro, que permita identificá-las nessa fase. Se isto for verdade, não haveria necessidade de se esperar até a idade adulta de uma árvore para selecioná-la. Ao menos, supostamente, uma seleção precoce ajudaria a definir mais cedo algumas, ou a maioria, das árvores mais promissoras para produção comercial e reprodução.

Em Pinus pinaster (3) não houve correlação entre vigor de mudas e produção no estádio adulto, porém a qualidade de madeira estava fortemente correlacionada no estado jovem e adulto. Em Pinus silvestris, Nanson (2) acha que é possível fazer alguma seleção precoce tanto para vigor quanto qualidade da madeira. Num estudo seguido por 59 anos (1) na mesma espécie; notou-se que o vigor da muda era relacionado ao tamanho da semente, e este efeito permanecia até a idade de 16 anos, desaparecendo depois. Ou seja, a correlação era forte do vigor inicial ao vigor até 16 anos, depois decaía.

Assim poder-se-ia selecionar cedo, se o corte fosse feito até a idade que mantivesse a correlação; mas dever-se-ia selecionar após essa idade se o corte fosse feito mais tarde. Em Eucalyptus grandis (5) a correlação entre o tamanho de muda e o da semente foi mantida durante trinta dias, tendo-se perdido completamente aos seis meses de idade.

Em Pinus americanos em que se fez estudos semelhantes aos anteriores, por cinqüenta anos, houve resposta parecida (4). Até 15-20 anos, nestes casos, o comportamento da muda era um, depois dessa idade não estava correlacionado ao tempo antes dessa idade.

Em nossos plantios de Eucalyptus spp. o corte final (em torno de 21 anos) é feito bem antes da árvore atingir a idade adulta. Assim é possível que nesse período haja uma correlação acentuada entre vigor da muda no viveiro e produção final até 21 anos. A ignorância geral a respeito, e a prática comum de seleção precoce, justifica em termos econômicos e genéticos definir se existe ou não uma correlação juvenil-adulta em Eucalyptus spp.

MATERIAL E MÉTODOS

Mudas de E. grandis, de origem rodesiana, semeadas em 4/10/76, foram selecionadas em viveiro, onde tiveram tratamento idêntico quanto ao tamanho, cor e forma.

Quanto ao tamanho tomaram-se as seguintes classificações: mudas até 10 cm, de 10 a 15 cm, de 15 a 20 cm, de 20 a 25 cm, de 25 a 30 cm, de 30 a 35 cm e maiores que 35 cm.

Quanto à cor foram classificadas como totalmente verdes ou muito vermelhas e, quanto à forma, em esgalhadas e sem galhos. Havia, pois, onze tratamentos assim numerados:

1. Mudas até 10 cm;
2. De 10 a 15 cm;
3. De 15 a 20 cm;
4. De 20 a 25 cm;
5. De 25 a 30 cm;
6. De 30 a 35 cm;
7. Maiores que 35 cm;
8. Mudas verdes;
9. Mudas vermelhas;
10. Mudas esgalhadas;
11. Mudas sem galhos.

Foram plantadas em área da Florestal Acesita S.A., em 21/12/76, no município de Conceição da Barra (E.S.), em delineamento experimental inteiramente casualizado, dez repetições e quatro plantas por parcela, com duas linhas de bordadura da mesma espécie, cem gramas de adubo por cova e espaçamento 3 x 1,5 m.

Depois de seis meses foram medidas a sobrevivência e a altura; depois de um, dois e três anos, a sobrevivência, altura e circunferência (CAP). Em anos subseqüentes serão avaliadas também a forma, qualidade da madeira e capacidade de rebrota.

RESULTADOS

CORRELAÇÃO JUVENIL-ADULTA

MEDIÇÃO: 6 MESES (MÉDIAS)

Nº.	TRATAMENTO	SOBREVIVÊNCIA	ALTURA (m)
1	M. até 10 cm	87,0	2,7
2	10-15 cm	85,5	2,9
3	15-20 cm	80,6	3,0
4	20-25 cm	84,0	3,3
5	25-30 cm	88,8	3,5
6	30-35 cm	87,0	3,1
7	Mais 35 cm	77,9	3,6
8	Mudas verdes	93,7	3,4
9	M. vermelhas	83,6	3,5
10	M. esgalhadas	79,1	3,2
11	M. sem galhos	90,3	3,5
	MÉDIA GERAL	85,2	3,3

OBSERVAÇÃO: valores transformados (arc sen$\sqrt{\%}$) da sobrevivência e corrigidos para 0 e 100%.
Teste de F não significativo a 5% pbb. para sobrevivência e altura.
Coeficientes de variação: Sobrevivência = 19,98% e Altura = 23,63

CORRELAÇÃO JUVENIL-ADULTA

MEDIÇÃO: 1 ANO (MÉDIAS)

Nº.	TRATAMENTO	SOBR.	CAP(cm)	H(m)
1	M. até 10 cm	74,2	15,9	5,6
2	10-15 cm	79,1	15,7	5,5
3	15-20 cm	67,5	16,1	5,3
4	20-25 cm	72,3	16,6	5,7
5	25-30 cm	80,6	20,1	6,5
6	30-35 cm	83,6	16,6	5,6
7	Mais 35 cm	68,6	18,9	6,4
8	Mudas verdes	82,1	18,5	6,3
9	M. vermelhas	73,9	18,9	6,0
10	M. esgalhadas	70,0	19,2	5,8
11	M. sem galhos	83,6	19,7	6,2
	MÉDIA GERAL	75,9	17,8	5,9

OBSERVAÇÃO: valores transformados (arc sen$\sqrt{\%}$) da sobrevivência e corrigidos para 0 e 100%.
Teste de F significativo a 5% pbb. para circunferência e altura e não significativo para sobrevivência.
Coeficientes de variação: Sobrevivência = 29,54%,
Circunferência = 17,21% e Altura = 14,58%.

CORRELAÇÃO JUVENIL-ADULTA

MEDIÇÃO: 1 ANO

TESTE DE DUNCAN(5%)

CIRCUNFERÊNCIA (cm)		ALTURA (m)	
TRAT.	MÉDIA	TRAT.	MÉDIA
5	20,1 a	5	6,5 a
11	19,7 a	7	6,4 a b
10	19,2 a b	8	6,3 a b c
9	18,9 a b c	11	6,2 a b c d
7	18,9 a b c	9	6,0 a b c d
8	18,5 a b c d	10	5,8 a b c d
4	16,6 b c d	4	5,7 a b c d
6	16,6 b c d	6	5,6 b c d
3	16,1 b c d	1	5,6 b c d
1	15,9 c d	2	5,5 c d
2	15,7 d	3	5,3 d

CORRELAÇÃO JUVENIL-ADULTA

MEDIÇÃO: 2 ANOS (MÉDIAS)

N.º	TRATAMENTO	SOBR.	CAP(cm)	H(m)
1	M. até 10 cm	62,6	30,6	12,1
2	10-15 cm	61,1	29,9	11,9
3	15-20 cm	57,7	28,1	11,6
4	20-25 cm	63,6	30,5	12,5
5	25-30 cm	73,9	36,0	13,1
6	30-35 cm	75,3	30,3	12,0
7	Mais 35 cm	63,7	33,5	12,8
8	Mudas verdes	77,2	31,4	12,7
9	M. vermelhas	70,9	30,9	12,0
10	M. esgalhadas	60,2	35,6	13,1
11	M. sem galhos	82,1	34,0	12,6
	MÉDIA GERAL	74,8	31,8	12,4

OBSERVAÇÃO: valores transformados (arc sen$\sqrt{\%}$) da sobrevivência e corrigidos para 0 e 100%.

Teste de F significativo a 5% pbb. para circunferência e não significativo para sobrevivência e altura.

Coeficientes de variação: Sobrevivência = 31,28%

Circunferência = 15,19% e Altura = 11,06%

CORRELAÇÃO JUVENIL-ADULTA

MEDIÇÃO: 2 ANOS

TESTE DE DUNCAN(5%)

CIRCUNFERÊNCIA(cm)

Trat.	Média
5	36,0 a
10	35,6 a b
11	34,0 a b c
7	33,5 a b c
8	31,4 a b c d
9	30,9 b c d
1	30,6 b c d
4	30,5 b c d
6	30,3 c d
2	29,9 c d
3	28,1 d

CORRELAÇÃO JUVENIL-ADULTA

MEDIÇÃO: 3 ANOS (MÉDIAS)

N.º	TRATAMENTO	SOBR.	CAP(cm)	H(m)
1	M. até 10 cm	53,2	32,7	14,7
2	10-15 cm	52,9	35,6	14,1
3	15-20 cm	52,9	32,6	13,7
4	20-25 cm	55,7	37,0	15,4
5	25-30 cm	72,3	41,5	15,5
6	30-35 cm	65,5	34,6	13,8
7	Mais 35 cm	56,2	41,0	16,3
8	Mudas verdes	70,5	34,7	14,8
9	M. vermelhas	55,4	37,3	15,2
10	M. esgalhadas	60,2	40,7	15,9
11	M. sem galhos	72,3	39,8	15,5
	MÉDIA GERAL	60,7	37,1	15,0

OBSERVAÇÃO: valores transformados (arc sen $\sqrt{\%}$) da sobrevivência e corrigidos para 0 e 100%.

Teste de F não significativo a 5% pbb. para sobrevivência, circunferência e altura.

Coeficientes de variação: Sobrevivência = 38,68%,

Circunferência = 22,93% e Altura = 13,00%

DISCUSSÃO E CONCLUSÃO

Até a idade de 3 anos os resultados não podem ser considerados definitivos, pois as árvores ainda não atingiram o estágio adulto. Mas já é possível chegar a algumas conclusões.

A cor e a forma das mudas não tiveram influência alguma sobre a altura, circunferência e sobrevivência das árvores, em todos os períodos que esses parâmetros foram avaliados.

Aos seis meses não houve diferença quanto a altura e sobrevivência, com a primeira acusando variação significativa somente após essa idade. A altura das mudas não afetou a sobrevivência em nenhum tratamento.

O efeito inicial das mudas no viveiro (diferentes tamanhos) que só acusa diferença significativa no primeiro ano.

O que permanece por mais tempo é a diferença em circunferência, indo até o segundo ano.

A competição até o terceiro ano não foi bastante pronunciada ao ponto de suprimir os tratamentos que estavam inferiores até o ano anterior, visto que eles se igualaram.

Em outras condições de local (temperatura, precipitação, solo etc.)e com espécies e espaçamentos diferentes, além de outras variáveis, os resultados podem diferir, especialmente quanto a sobrevivência, pois as mudas menores são mais sensíveis às condições do meio.

Mas, a tendência deve ser de se alcançar resultados aproximados a estes, isto é, a correlação desaparecer rapidamente nos primeiros anos.

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ESTUDOS DE PROCEDÊNCIA DE *EUCALYPTUS SALIGNA* e *E. GRANDIS* EM HAVAÍ.

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Resumo

Noventa espécies de *Eucalyptus* foram introduzidos no Havaí durante os últimos 100 anos. Poucos, se nenhum, são provenientes de coleções de sementes completamente documentadoras. *Eucalyptus saligma*, uma das mais produtivas dessas espécies, atualmente, é a espécie mais plantada comercialmente no Hawaí. Para iniciar um programa de seleção genética dessa espécie, semente de 10 fontes australianas conhecidas estão sendo empregadas para estabelecer uma base genética conhecida. Devido aos problemas potencialmente sérios com o cancro *(Diaporthe cubonsis)* coleções de procedências do *E. Grandis* estão sendo incluídos como uma fonte de resistência à doença. Plantações de testes estão sendo estabelecidas, mas ainda estão muito jovens para fornecer dados definidos.

PROVENANCE STUDIES OF *EUCALYPTUS SALIGNA* AND *E. GRANDIS* IN HAWAI.

Summary

Ninety species of *Eucalyptus* have been introduced into Hawaii during the past 100 years. Few, if any, are from fully documented seed collections. *Eucalyptus saligna*, one of the most productive of these species, is now the most widely planted commercial species in Hawaii. To initiate a genetic selection program in this species, seed from 10 known Australian sources are being used to establish a known genetic base. Because of potentially serious problems with a stem canker disease (*Diaporthe cubensis*) provenance collections of *E. grandis* are also being included as a source of disease resistance. Test plantations are being established, but are still too young to provide definitive data.

Introduction

Since the 1870's, 90 species of *Eucalyptus* have been introduced into Hawaii.[1] Several of these species have shown potential for high productivity on certain sites. Before 1945, most of the *Eucalyptus* trees planted in Hawaii were *E. robusta*. Today, about 11,500 acres of *E. robusta* are found in commercial forest plantations. In addition, about 2000 acres of older plantations of *E. globulus* have been established--mostly at elevations above 1500 m.

Since 1960, *E. saligna* has become the preferred species. The tallest broadleaved tree in Hawaii (and probably the entire U.S.) is a *E. saligna* growing on the west coast of the island of Hawaii. This tree has reached 72 m in 45 years.[1] On the north coast of the island, a growth plot of *E. saligna* contained an estimated stand volume of 1470 m^3/ha at 32 years of age. Height of the dominant and co-dominant trees on this plot averaged 60 m. On the island of Maui, in a 15-year-old spacing study, the mean annual increment at 2.4 m by 2.4 m spacing culminated at age 5 at 59 cu m/ha (Walters 1979).

The Hawaii Division of Forestry plans to use almost exclusively *E. saligna* in its ongoing planting programs. Some saligna logs will be chipped and exported for manufacture of paper; some will be used locally for construction lumber; and some will be burned for the generation of electric power.

Tree Improvement Program

A major concern in reforesting with *Eucalyptus* species in Hawaii is the seed source. The sources of the original plant introductions are poorly documented. These plantings were often made by ranchers, sugarcane growers and amateur horticulturists. Often several species were tried, in the same planting and those trees that grew well here were used as sources of seed for subsequent plantings. Some younger stands are variable enough to suggest that they are from seed of interspecific hybrids. Other stands are highly uniform as though of closely related origin. To begin a tree improvement program for *E. saligna* in Hawaii, it seemed clear that we would have to establish a more clearly defined genetic base.

There exists a disease problem in Hawaii that must be considered. On Kauai, the northwesternmost of the eight major islands in Hawaii, several *E. saligna* stands are infected with *Diaporthe cubensis*, a stem canker that eventually stops the tree from sprouting (Hodges et al. 1979). This disease has not been found on any of the other major islands here. Work in Brazil (Hodges et al. 1976) indicates that *E. grandis* is more resistant than *E. saligna* to this canker disease. While *E. grandis* has not been extensively planted in Hawaii, those specimens that are here grow as well as or better than *E. saligna*. We are including *E. grandis* in our program to give us a source of disease resistance should the canker disease spread throughout the island chain.

Provenance Studies

In 1978, we began establishing small rangewide provenance tests of *E. saligna* and *E. grandis*. We obtained from CSIRO, in Australia, 10 collections each of the two species (Table 1). We obtained an additional 15 *E. grandis* collections made by I. P. Burgess near Coffs Harbour, Queensland. These collections consist of five trees per stand from each of 15 stands (Table 2).

As of January 1980, we have used these seeds to establish three test plantations on the island of Hawaii--the largest and southeasternmost island in the Hawaiian chain. Two of the plantings are identical. They each contain the 20 seedlots from CSIRO (Table 1), and are laid out in randomized complete blocks with 12 replications of plots of four trees each. One planting (established in September 1979) is on the northeast coast at 340 m elevation an area with 5100-mm annual rainfall.

Table 1--Seedlots of *Eucalyptus saligna* and *E. grandis* obtained from CSIRO, Australia, and used in provenance tests, Hawaii, 1980

CSIRO seedlot number	Location	Lat°S	Long °E	Alt(m)	Mother trees
		Eucalyptus saligna			
7786	Windsor N.S.W.	32°55'	159°33'	300	12
10225	Cessnock N.S.W.	32°54'	151°24'	300	8
10733	Raymond Terrace N.S.W.	32°42'	151°43'	9	-
7808	Bulahdelah N.S.W.	32°20'	152°12'	210	12
11605	N. Raymond Terrace	31°55'	151°48'	225	39
11894	Gladfield Qld	28°00'	152°23'	1020	-
11756	Clifford Qld	28°30'	151°50'	240	-
12145	Connondale Qld	26°44'	152°31'	600	-
12064	S. of Calliope Qld	24°23'	151°00'	800	1
11025	S.W. Rockhampton Qld	23°49'	149°03'	860	4
		Eucalyptus grandis			
7810	Bulahdelah N.S.W.	32°20'	152°13'	120	11
7823	Coffs Harbour N.S.W.	30°10'	153°08'	18	12
11243	Tyalgum N.S.W.	28°27'	153°12'	100	6
10774	E. of Gympie Qld	26°14'	152°47'	400	6
12143	Crediton Qld	21°09'	148°30'	700	9
11035	N.W. of Cardwell Qld	18°08'	145°37'	600	4
12423	Tinaroo Falls Dam area Qld	17°11'	145°36'	800	13
12422	S.F.R. 310 Gadgarra Qld	17°15'- 17°17'	145°42'	680 700	20
12381	Wondecla area Qld	17°23'- 17°27'	145°27'- 145°28'	980 1040	13
12409	Ravenshoe area Qld	17°42'	145°28'	940	26

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[1] Skolmen, R. G. Personal conversation. U.S. Dep. Agric. For. Serv., Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif. 1980.

The second planting (established in November 1979) is on the southwest coast 100 km south of the first site at about the same elevation, but with only about 2500 mm annual rainfall. The rainfall is fairly evenly distributed throughout the year at both sites. The mean annual temperature is about 22° C at the sites and neither site has ever recorded a temperature below 9° C. We plan to establish two more plantings of this same material within the next 2 years.

The third established planting on Hawaii consists of the 10 CSIRO *E. grandis* seedlots (Table 1) and the 15 Coffs Harbour *E. grandis* seedlots (Table 2). The 25 seedlots are planted in a completely randomized design with 95 replications of 1-tree plots. The site is near the first *E. saligna/grandis* planting. We plan to repeat this type of planting on two or more sites, but with only about 50 replications per site.

Two plantations have also been established on the island of Kauai in the area where *Diaporthe cubensis* is prevalent. These two plantations contain five sources each of *E. saligna* and *E. grandis* and a few individual tree collections of seed from nearby infected and non-infected trees. Artificial inoculation techniques have been developed, and these seedlings will be screened for resistance to this disease.

We are also collecting and testing non-Australian seedlots of these species that have been developed in breeding programs in other countries. Collections that do well will also be included in our program.

Future Plans

For the next 3 to 5 years, we plan to evaluate between species differences, within-species variation, and seed source by site interactions. We will then begin selecting appropriate parents to use in establishing seed orchards and in developing new base populations for future selections.

Some of the seedlots being tested in Hawaii are being tested in other parts of the world by members of IUFRO *Eucalyptus* Working Groups. Hopefully, an awareness of the program in Hawaii will encourage cooperation with other members of these working groups.

Table 2--*Eucalyptus grandis* seedlots from Coffs Harbour Queensland, Australia, used in provenance studies in Hawaii, 1980

Seedlot[1]	Catchment system	Tributary	Location of sampling site	Latitude °S	Longitude °E	Altitude (m)	Long. dist to sea (Km)
EK	Hunter River	Minmi Creek	0.5 Km N.W. of Minmi	32°52'	151°39'	31	18.9
EL	Camden Haven - Stewarts River Complex	Herons Creek	Queens Lake S.F.	31°55'	152°48'	30	6.4
EM	Camden Haven - Stewarts River Complex	Black Creek	Lorne S.F.	31°39'	152°32'	250	27.4
EN	Macleay River	Clybucca Creek	Tanban S.F.	30°52'	152°53'	30	11.3
EO	Macleay River	Hickeys Creek	Nulla Five days S.F.	30°43'	152°32'	200	41.8
EP	Mary River	Yabba Creek	Brooloo S.F. 135	26°37'	152°25'	519	67.6
EQ	Clarence River (Orara Branch)	Halfway Creek	Newfoundland S.F.	29°55'	153°07'	76	14.5
ER	Clarence River (Orara Branch)	Taylor Creek	Orara East S.F.	30°13'	153°06'	123	7.2
ES	Clarence River (Orara Branch	Dry Creek	Orara West S.F.	30°15'	152°57'	183	17.7
ET	Clarence River (Northern Branch)	Bean Creek	Yabba S.F.	28°34'	152°36'	396	94.9
EU	Clarence River (Nymboida Branch)	Morora Creek	Wild Cattle Creek S.F. (Cascade)	30°14'	152°51'	580	32.2
EV	Kalang River	Lower Kalang River	Newry S.F.	30°31'	152°58'	6	15.5
EW	Bellinger River	1 Km below Dardanelles Creek	Bellingen River S.F.	30°27'	152°37'	100	66.0
EX	Bonville/Pine Creek	Lower Pine Creek	Pine Creek S.F.	30°24'	153°03'	6	3.3
EY	Bonville/Pine Creek	Upper Bonville Creek	Tuckers Knob S.F.	30°22'	153°00'	107	17.1

[1] Seedlot letters assigned by Institute of Forest Genetics, Placerville, California.

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VARIAÇÃO DA SOBREVIVÊNCIA E CRESCIMENTO EM ALTURA EM PROGÊNIES DE *EUCALYPTUS GRANDIS* (HILL EX MAID) DOS 18 MESES DE IDADE EM ZIMBABWE.

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Resumo

As progenies de *Eucalyptus grandis* em três locais em Zimbabwe mostraram considerável variação entre famílias aos 18 meses de idade na análise individualizada os testes. A sobrevivência em dois locais foi afetada por fatores adversos. A análise combinada dos 3 locais mostrou diferenças significativas entre famílias somente para altura e para a geração família x local tanto para altura e sobrevivência.

VARIATION IN SURVIVAL AND HEIGHT GROWTH IN EIGHTEEN-MONTH-OLD PROGENIES OF *EUCALYPTUS GRANDIS* (HILL EX-MAID) IN ZIMBABWE.

Summary

Eucalyptus grandis progenies at three sites in Zimbabwe showed considerable variation between families at age 18 months in analyses of individual tests, but survival was effected by extraneous factors at two sites. Analyses of the three sites combined showed significant differences between families for height alone, and family x locality interaction for both height and survival.

Introduction

Eucalyptus grandis Hill ex Maid. is a large fast-growing tree of the coastal regions of eastern Australia from latitude 33°S in New South Wales northwards into southern Queensland and, to a limited extent, northern Queensland to latitude 17°S. The species was introduced into Zimbabwe in about 1892 and has become the dominant hardwood in local plantation forestry but the provenance is not known of any commercial stand or woodlot (Barrett *et al.*,1975). A breeding programme for *E.grandis* was begun in 1962 with the selection of superior phenotypes and the collection of seed from them for the establishment of the first seedling seed orchard (Mullin *et al.*, in press). More recently a country-wide search for plus trees has been started and the first six open-pollinated progeny tests of these selections were established in 1977/78. The early results of three of these tests are described in this paper.

Materials and Methods

Seed origins

Seed for the tests was collected from 63 plus trees selected in privately owned stands and farm woodlots in Silvicultural Zones I – III (see Barrett and Mullin, 1968, for descriptions of silvicultural zones): 32 selections came from Mountain Home, Penhalonge District (Zone I), 21 from the Marandellas District (Zone II), and 10 from the Macheke District (Zone III). Also included in the tests were seven commercial-check seedlots comprising one from a seedling seed orchard, two from selected trees in commercial plantations in Zones I and III, and four non-select seedlots from widely separated stands in Zones I – IV.

The experimental sites

Soil and climatic details for three test sites are given in Table 1. The site at Mtao was formerly used for shifting agriculture and was partly covered with couch grass, *Cynodon dactylon* (L.) Pers., a sod-forming perennial that caused numerous deaths in Test 10F. At Chesa land preparation for replications 1 – 3 consisted simply of harrowing, while in replications 4 – 6 the site was deep ploughed and then harrowed.

Field designs

Six tests were planted between December 8, 1977, and January 2, 1978. Because of a plant shortage in one seedlot, the full complement of 70 families was included only in Tests 10A and 10D and the other four tests had 69 families. Each test was planted in a R.C.B. design with six replications of 10-tree, line plots spaced at 2,7 x 2,7 m. No statistical design was followed during the nursery phase but all sowing was done in one nursery and the seedlings were distributed to the various test localities for pricking out into polythene tubes which were removed at planting.

Field measurements

Height measurements were scheduled for all six tests at age 18 months but, due to circumstances beyond control, they could be done only in Tests 10D, 10E, and 10F.

Table 1. Descriptions of the progeny test sites.

Test No.	Locality	Mean temperatures °C	Mean annual rainfall, rain days, & evaporation	Soil
10D	Marandellas Lat. 18°10'S Long. 31°29'E Alt. 1 640 m	Max. 23,5 Min. 10,7 Annual 17,1	Rainfall 884,7 mm Rain days 90 Evap. 1 733,2 mm	deep sandy soil derived from granite; deposits of quartz gravel
10E	Chesa Lat. 20°03'S Long. 28°16'E Alt. 1 300 m	Max. 27,5 Min. 13,3 Annual 19,7	Rainfall 541,0 mm Rain days 63 Evap. 2 158,0 mm	porous, infertile aeolian sand to depth of 30 m or more
10F	Mtao H39 Lat. 19°24'S Long. 30°35'E Alt. 1 480 m	Max. 24,8 Min. 10,6 Annual 17,7	Rainfall 690,0 mm Rain days 74 Evap. 1 935,0 mm	very deep sand; formerly used for subsistence cropping

Table 2. Summary of survival and height growth in three progeny tests of *Eucalyptus grandis*.

Rep.	Test 10D		Test 10E		Test 10F	
	Percent survival	Mean height	Percent survival	Mean height	Percent survival	Mean height
1	99,14	4,47	81,88	3,47	72,75	2,06
2	97,71	5,31	74,49	3,72	76,09	1,91
3	98,00	5,67	73,04	4,16	77,83	2,15
4	97,86	5,77	64,78	3,64	83,19	2,13
5	94,29	5,26	69,57	3,79	76,23	1,76
6	98,14	5,38	66,23	4,16	80,29	1,46
Overall means	97,52	5,31	71,67	3,82	77,73	1,91

Results

Survival percent and mean height for each test are summarized in Table 2 and analyses of variance are given in Table 3. The analyses for survival were performed on transformed (arcsin) data. Significant differences between families were found in both traits but there were also large replication effects. In Test 10D a fall-off of site quality was responsible for mean height in one replication that was 1,0 m lower than the overall mean of the other five. The mean heights of individual families varied from 6,25 m to 4,47 m, while survival varied from 100 percent in 26 of the 70 families to 87 percent in one family. In 10E the replication effects in survival were due to 10 percent more failures in the three replications that had been deep ploughed; variation between families ranged from 93 percent (one family) to 33 percent (two families) in this section, and from 93 percent (three families) to 40 percent (one family) in the harrowed section. The replication effects for height in 10E were not associated with method of land preparation but with habitation and subsistence cropping on part of the site some years prior to planting. Replications 3 and 6, which had formerly been at least partly cleared for crops, had the best height growth, while the most recently cleared replications 1 and 4 had the poorest. Overall family mean heights in 10E varied from 4,44 m to 2,87 m. The reasons for the replication effects in 10F are less clearcut but are at least partly attributable to the presence of couch grass which can seriously reduce survival and early height growth in eucalypts. Survival of individual families in 10F ranged from 90 to 57 percent, and height growth from 2,66 m to 1,22 m. The combined analyses of the 69 common families revealed significant differences between families for height but not for survival. Family x locality interaction was significant in both traits.

Conclusions

In the combined analysis for height the errors from the different sites were homogeneous and the large, between-family differences at 18 months indicate considerable diversity, at least in this trait, within local stands of *E.grandis*. Survival in these trials has to some extent been affected by extraneous factors, which may have contributed to the heterogeneity of the error variances in the combined analysis, and the results for this trait should be treated with caution. There are indications that in the very porous, aeolian sands, where vertical drainage is excessive, it is advantageous to keep land preparation to a minimum so that capillary action will be maintained in the soil to supply more adequate moisture to the rooting zone following planting. One of the select commercial checks showed best overall height growth in the analysis of the combined trials but there were no significant differences between the 30 top-ranked families.

References

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Barrett, R.L., and Mullin, L.J., 1968: A review of introductions of forest trees in Rhodesia. *The Rhodesia Bulletin of Forestry Research*, No.1, 227 pp.

Mullin, L.J., Barnes, R.D., and Barrett, R.L., in press: The improvement of *Eucalyptus* in Zimbabwe-Rhodesia. *South African Forestry Journal*.

Table 3. Individual and combined analyses of variance for 18-month survival and height in three progeny tests of *Eucalyptus grandis*.

Test No.	Source of variation	DF	Mean square	F ratio	Mean square	F ratio
			18-month survival		18-month height	
10D	Replications	5	154,3513	2,12 N.S.	14,7975	54,07 ***
	Families	69	108,9879	1,40 *	0,9627	3,52 ***
	Error	345	72,9735		0,2737	
10E	Replications	5	2 174,9750	13,54 ***	5,5234	24,58 ***
	Families	68	305,7914	1,88 ***	0,6623	2,95 ***
	Error	339+	163,0401		0,2247	
10F	Replications	5	873,2728	6,22 ***	4,9329	19,48 ***
	Families	68	234,8503	1,67 ***	0,4922	1,94 ***
	Error	340	140,3033		0,2532	
Combined 10D,E,F	Localities (L)	2	82 943,69	364,10 ***	1 201,816	2 276,03 ***
	Families (F)	68	194,1209	0,85 N.S.	1,0702	2,03 ***
	F x L	136	227,8021	1,81 ***	0,5280	2,10 ***
	Pooled Error	1 019	125,7491		0,2513	

+ DF reduced because of the complete failure of one family in one replication, which necessitated a missing-value calculation.

TESTE INTERNACIONAL DE PROCEDÊNCIA COM *EUCALYPTUS GRANDIS* E *E. TERETICORNIS.*

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Resumo

Testes cooperativos de procedência de *E. grandis* e *E. Tereticornis* foram organizados como um projeto do IUFRO working Party ou Eucalypt Provenances. A participação nestes testes é aberto aos pesquisadores e instituições em acordo para observar certos procedimentos padrões. Vinte e um lote de sementes de cada espécie estão disponíveis para os testes e 12 dessas foram denominadas de "padrões" para serem usadas nos testes. Os cooperadores podem escolher para usar os outros lotes de sementes bem como, e tem sido aconselhados a incluir lotes de sementes de fonte local para comparação.

As propostas para os testes aos membros inicialmente anunciadas aos membros da IUFRO Working Party em janeiro de 1979. As respostas para a participação nos testes das duas espécies foram semelhantes. As sementes foram agora distribuídas aos pesquisadores em 15 organizações (13 países) que concordaram se tornar cooperadores e instalar seus experimentos em 1 a 4 locais de teste cada. Até este Simpósio alguns dos testes já foram instalados.

IUFRO INTERNATIONAL PROVENANCE TRIALS WITH *EUCALYPTUS GRANDIS* AND *E. TERETICORNIS.*

Summary

Co-operative provenance trials of *E. grandis* and *E. tereticornis* have been organised as a project of the IUFRO Working Party on Eucalypt Provenances. Participation in the trials is open to research workers and institutions on agreement to observe certain standard procedures. Twenty one seedlots of each species have been made available for the trials and 12 of these have been designed as "standards" to be used in all trials. Co-operators may choose to use the other seedlots as well, and they have also been advised to include seedlots of local origin for comparison.

Proposals for the trials were first announced to members of the IUFRO Working Party in January 1979. Response for participation in trials of both species was quite similar. Seeds have now been distributed to workers in 15 organisations (13 countries) who have agreed to become co-operators and plant their experiments at 1 to 4 test sites each. At the time of this Symposium some of the trials have been planted.

PART 1. EUCALYPTUS GRANDIS

Introduction

Eucalyptus grandis, known in Australia as flooded gum, is one of the more successful species which have been planted as an exotic in subtropical countries. The fast-growing trees are of good form and the wood is suitable for timber, pulp and fuel, and is of moderate strength and durability. In addition to those countries where it is now well established,eg. Brasil and South Africa, the species is being tested in many other countries, and the extent of plantations is likely to increase.

The main area of its natural occurrence includes the coastal region of the northern half of New South Wales and southern Queensland. It also occurs in small areas further north in Queensland, near Mackay and on the Atherton tableland.

Despite the wide extent of its natural distribution and very large plantations in other countries there have been few publications on provenance variation in *E. grandis* before this Symposium. In view of the potential importance of the species in many countries it was proposed that the IUFRO Working Party on Eucalypt Provenances should organise a series of co-operative provenance trials.

The objective would be to establish field trials, by co-operative action, using the same seedlots at a number of different locations in order to obtain and disseminate information on provenance variation. Co-operators who established trials on their own land would benefit directly from their own results. By pooling and analysing results from different sites and different countries it might be possible to identify provenances of broad general adaptability or to identify provenances which are particularly suited to certain environmental conditions.

Seed collections

Before promoting the trials it was necessary to ensure that seedlots representative of the natural distribution would be available. It was not possible to make special seed collections for the purpose, nor was this necessary, for the CSIRO Division of Forest Research, Canberra, Australia, had stocks of 20 seed collections which represented the entire natural distribution. These seedlots were kindly made available for use in the proposed co-operative trials on the basis that each co-operator agreed to follow standard procedures and make the results available to the Working Party. An offer from the D. R. de Wet Forestry Research Station, Sabie, South Africa, to provide seeds from its clonal seed orchard was appreciated. These seeds, representing an improved cultivated form of the species for comparison with the provenances, were accepted as a useful addition to the trials. The 21 seedlots available for the trials are listed in Table 1 and their origin shown in Figure 1. Some notes on the climates at the seed collection sites are contained in the Appendix.

Twelve of the 21 lots were designated as "standards" which were to be included in all trials. The "standards" were selected on the basis of representation of the natural distribution, and preference for those lots derived from a larger number of parent trees. The number of 12 "standards" was chosen because it contained a satisfactory representation of the natural distribution and was not too large to pose problems for co-operators with limited experimental facilities or land. Co-operators could choose to use all the other seedlots up to the 21 offered.

Conditions for participation in the trials

General details of the proposed trials were made known in the Newsletter of the Working Party issued in January 1979 and a notice was placed in IUFRO News. Further details were distributed to workers who indicated interest. The response was sufficient to proceed with the trials.

Organisations or institutions were accepted as co-operators in the international provenance trials, for which seed would be made available, on agreement to undertake the following:

1. establish a provenance experiment on one or more sites to include at least the 12 "standard" provenances, and optionally up to all 21 provenances.
2. establish the experiments according to a standard design.
3. report to the co-ordinator on establishment of the trials.
4. undertake measurements according to a minimum schedule.
5. provide the co-ordinator with a duplicate copy of data and the calculated results of measurements.

Procedures for establishment and measurement of the trials

Co-operators were supplied with 5g of seeds of each provenance, though a larger amount was sent to co-operators who proposed to plant the trial at a number of locations. Co-operators were also advised to include in their experiments one or more of their best locally-collected seedlots (in cases where the species was already established in the country). Inclusion of such seedlots would enable a comparison to be made between the genetic quality of the local populations and the best provenances introduced in this experiment, and thus provide evidence on which to make decisions about future seed supplies.

For the nursery stage, co-operators were advised to replicate each seed lot and ensure uniformity of treatment to all seedlings. For the field experiments careful selection of areas of uniform site quality, particularly for each replication, was stressed.

It was proposed that the statistical design be that of complete randomised blocks. Each plot should contain 36 trees in a square of 6 x 6, of which only the internal 16 trees would normally be measured. The minimum number of replications should be 5. It was proposed that spacing be 3.0 x 2.5m, though this could be varied according to local experience. A minimum of two rows should be planted as a surround around the experiment.

It was suggested that after the trials were planted, leftover seedlings of each provenance be planted in large blocks, identified by markers, so that when results from the experiment were sufficiently advanced the trees of the best provenances could be used for seed production or tree selection.

The following minimum schedule of future measurements was specified:

1. seedling height immediately after planting.
2. plant height one year after planting.
3. plant height and diameter three years after planting.
4. and, at 5 years: height, diameter, presence of forks, and an assessment of stem straightness and branch persistence. The latter two characteristics would be scored on each tree on a 1 – 5 basis.

It was assumed that the objective of all co-operators would be to grow vigorous trees with long clear straight stems. Five years was considered to be a sufficiently long period for co-operators to make a committment.

TABLE 1 Provenance and seed data for 21 *E. grandis* seedlots available for use in IUFRO cooperative provenance trials
Twelve "standard" lots marked with an asterisk.

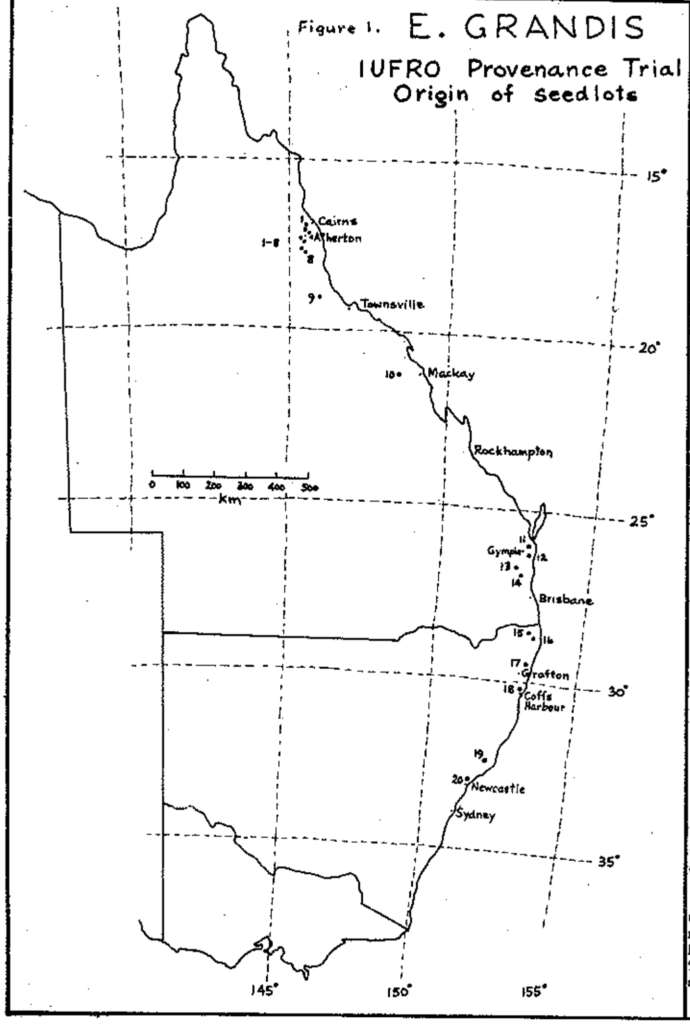
Prov. Expt. No.	CSIRO Seedlot Number	Provenance Location		Latitude $^{\circ}$S	Longitude $^{\circ}$E	Altitude (m)	Number of trees sampled	Soil type
* 1	S12380	East of Mareeba	northern Qld.	$17^{\circ}03'$	$145^{\circ}36'$	740	7	Deep red loam of volcanic origin.
2	12423	Tinaroo Falls Dam area	"	$17^{\circ}11'$	$145^{\circ}36'$	800	13	" "
3	12426	S.F.R. 700. Gillies Highway	"	$17^{\circ}13'$	$145^{\circ}42'$	730	10	" "
4	12422	S.F.R. 310, Gadgarra	"	$17^{\circ}16'$	$145^{\circ}42'$	690	20	" "
5	12383	Herberton area	"	$17^{\circ}20'$	$145^{\circ}24'$	1000	6	" "
* 6	12381	Wondecla area	"	$17^{\circ}25'$	$145^{\circ}27'$	1010	13	" "
* 7	12409	Ravenshoe area	"	$17^{\circ}42'$	$145^{\circ}28'$	940	26	Fine grey loam, some basalt.
8	12382	Tully Falls area	"	$17^{\circ}49'$	$145^{\circ}31'$	800	6	Deep red loam of volcanic origin.
* 9	12461	West of Paluma	"	$19^{\circ}00'$	$146^{\circ}00'$	900	–	–
* 10	12143	Crediton	"	$21^{\circ}09'$	$148^{\circ}30'$	730	11	Sandy brown loam overlying red clay.
11	10693	Northeast of Gympie	southern Qld.	$26^{\circ}07'$	$152^{\circ}42'$	76	3	Grey forest soil, pH approx. 5.
* 12	10694	Southeast of Gympie	"	$26^{\circ}18'$	$152^{\circ}46'$	75	4	–
* 13	10695	Kenilworth	"	$26^{\circ}40'$	$152^{\circ}33'$	530	2	pH5.
14	10696	Bellthorpe	"	$26^{\circ}52'$	$152^{\circ}42'$	460	2	–
* 15	11243	South of Tyalgum	northern N.S.W.	$28^{\circ}27'$	$153^{\circ}12'$	100	4	–
16	11244	South of Murwillumbah	"	$28^{\circ}33'$	$153^{\circ}23'$	300	5	–
17	11681	North of Woolgoolga	"	$29^{\circ}32'$	$153^{\circ}12'$	30	2	Clay aluuvium.
* 18	7823	North of Coffs Harbour	"	$30^{\circ}10'$	$153^{\circ}08'$	18	12	Grey-brown sandy loam, pH 5.5.
* 19	7810	North of Bulahdelah	"	$32^{\circ}20'$	$152^{\circ}13'$	120	11	Clay-silt, stony, derived from shale, pH 5.5.
* 20	11587	Port Stephens	"	$32^{\circ}55'$	$151^{\circ}48'$	6	2	Peat sands.
* 21	–	Seed orchard, South Africa		–	–	–		

S.F.R. is State Forest Reserve

NSW: New South Wales; Qld: Queensland

Figure 1. E. GRANDIS

IUFRO Provenance Trial Origin of Seedlots



Implementation of the trials

Workers from fifteen organisations from 13 countries (South and Central America 5, North America 1, Africa 3, and Asia 4) have agreed to become co-operators and to plant the complete experiment at 1 to 4 test sites each. The seeds have been distributed, and at the time of this Symposium, August 1980, some of the field experiments have been planted.

A similar project for trials with E. tereticornis was initiated concurrently with that for E. grandis. Details are given in Part 2. The response has been similar. Most co-operators are establishing trials with both species.

Some comments on possible future developments

The satisfactory continuation of this project depends on:

1. successful establishment and protection of the trials at the various locations of each co-operator,
2. continued interest and co-operation from each co-operator. Provision of results at the due dates,
3. ability of a project co-ordinator to arrange for the analyses and reporting of the results.

If projects of this type are considered to be useful and there is a demand to participate in provenance trials with other species, it is most important that a co-ordinator be found who is employed by an institution which has sufficiently broad responsibilities to include work of this type. Though Australia might seem to be a logical country from which to organise eucalypt provenance trials there is no organisation there which at present has a charter to undertake this work.

If such a service is required consideration should be given at this Symposium to ways and means of obtaining it. Recommendations may need to involve action by the international community. To illustrate the point, in order to ensure the collection and distribution of special eucalypt seed lots the FAO Panel of Experts on Forest Gene Resources recommended and FAO budgetted funds for a number of years to enable the CSIRO Division of Forest Research to undertake this work on behalf of the international community.

APPENDIX TO PART 1

Some notes on the climates at the seed collection sites for E. grandis

Site and climatic data for the seed collection sites may be of interest to co-operators for the purpose of comparison with the conditions at their experimental sites. Altitude and soil type are listed in Table 1.

Meteorological records, representative of the seed collection sites are sometimes not available. The sites may be distant from the nearest appropriate recording station, or the forest sites are at a higher altitude and experience higher rainfall and lower maximum temperatures than at the recording stations. Therefore the information on rainfall and temperature in Table 2 and Figure 2 should be regarded as indicative rather than absolute. For example, some of the sites on which E. grandis occurs inland from Coffs Harbour experience many frosts each year, which differs from the frost-free record at the recording station.

Throughout the distribution of E. grandis the climate is characterised by high summer rainfall (Figure 2). In northern Queensland the distinction between wet summers and dry winters is very marked. Further south, the proportion of rain falling in winter gradually increases, until at Newcastle the rainfall is distributed much more evenly throughout the year, though a predominant summer rainfall pattern still prevails. The month of maximum rainfall also becomes later, from February in the north to April in the south.

The northern seed sources, from the Atherton Tableland, occur at a higher altitude than those further south and the temperatures experienced are lower than might be expected from consideration of the latitude alone. Temperature regimes at Atherton resemble those at Gympie on the coast in southern Queensland.

PART 2. EUCALYPTUS TERETICORNIS

E. tereticornis, known in Australia as forest red gum, is a woodland and open-forest species which occurs on drier sites and is slower growing than E. grandis. It is closely related to E. camaldulensis and its properties and characteristics are very similar to those of that species.

It has a much more extensive natural distribution than E. grandis extending from Papua New Guinea to Victoria, a range of 29° of latitude. The climates change from a predominantly summer rainfall with very dry winter in northern Queensland to an equal distribution of rain between summer and winter in southern NSW, to a dry summer and wet winter in Victoria.

Table 2. Some rainfall and temperature data from meteorological stations representing the seed collection sites.

Seed collection site	Representative meteorological station	Mean Annual Rainfall (mm)	Mean monthly temperature (in shade, °C) January Max	January Min	July Max	July Min	Frosts per year
1 - 4, 6, 8	Atherton	1425	29.6	18.5	21.8	10.4	1.4
5, 7	Herberton	1115	28	18	21	9	1.4
10	Mackay	1675	30.3	23.3	21.9	11.8	0
11 - 14	Gympie	1146	31.4	19.3	21.9	6.0	3.5
15 - 16	Lismore	1347	30.0	18.6	19.9	6.5	0.5
17 - 18	Coffs Harbour	1658	27.0	19.1	18.8	6.6	0
19	Taree	1192	28.7	17.1	18.1	5.9	0.8
20	Newcastle	1142	25.8	19.1	16.5	8.2	0

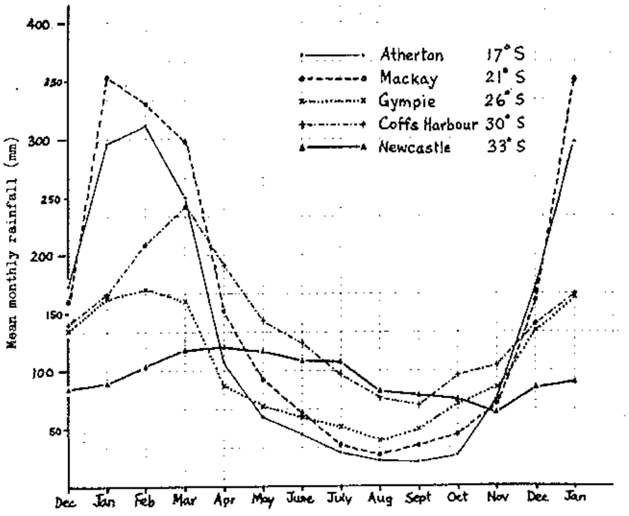


Figure 2. Distribution of rainfall throughout the year at five locations representing the natural distribution of E. grandis

In the cooler and drier areas the species tends to occur on alluvial flats subject to some flooding but not regular seasonal inundation. In the higher rainfall areas it grows on the lower slopes of hillsides, and as it approaches the tropics it extends to mountain slopes and plateaux. It prefers fairly rich alluvial soils, sandy loams or gravelly terraces which are moist but not waterlogged.

E. tereticornis has been planted in many countries with results that indicate it is a species well suited to many areas. With such an extensive natural range it is particularly important to know something about the suitability of various seed sources to environments when proposing to plant the species. Hence, provenance trials for this species were also planned as a IUFRO Working Party project.

Twenty-one seedlots representative of the natural distribution were available for trials (Tables 3 and 4; Figure 3), again, through the courtesy of CSIRO Division of Forest Research.

TABLE 3 - Provenance and seed data for 21 *E. tereticornis* seedlots available for use in IUFRO cooperative provenance trials. Twelve "standard" lots marked with an asterisk.

	Prov. Expt. N°	CSIRO Seedlot Number	Provenance Location		Latitude °S	Longitude °E	Altitude (m)	Number of trees sampled	Soil
	1	S10827	Bulolo plantation	Papua New Guinea	7°10'	146°40'	640	-	-
*	2	10826	Popondetta	"	8°55'	148°30'	50	-	-
	3	11051	Kapiano	"	10°05'	148°10'	20	-	-
*	4	10975 + 11953	Laura area	northern Qld.	15°26'	144°19'	105	6	Sandy loam (sandstones)
	5	10951 to 54	Cooktown area	"	15°41'	145°10'	120	4	Yellow loamy clay (near creek)
*	6	12376	South of Helenvale	"	15°43'	145°14'	160	13	Sandy soils
*	7	12377	Northwest of Mareeba	"	16°55'	145°19'	420	20	Grey sands
*	8	12189	Southwest of Mt Garnet	"	18°30'	144°45'	875	29	Red-brown loam
*	9	11034	West of Mackay	"	21°21'	148°18'	250	4	-
	10	12062	South of Calliope	southern Qld.	24°23'	151°00'	800	2	-
*	11	12502	North of Taroom	"	25°29'	149°46'	193	3	Fine-textured alluvium
*	12	10775 + 10816	Schacdt's Creek	"	26°18'	152°36'	150	10	Deep brown soil
*	13	10817	Barakula	"	26°19'	150°30'	375	9	Solodised solonetz soil, pH 5
	14	10781	Imbil	"	26°33'	152°40'	180	8	-
	15	11239	South of Casino	northern NSW	29°09'	152°59	40	9	Brown sandy loam
*	16	10837 + 10851	North of Woolgoolga	"	29°56'	153°11'	70	11	Grey soil
	17	10156	Cox's Gap	"	32°25'	150°14'	550	-	-
*	18	11583	North of Raymond Terrace	"	32°38'	151°45'	30	-	Clay, gravels
	19	10090	Wilton	southern NSW	34°14'	150°42'	300	-	Grey loam
*	20	10014	Marulan	"	34°42'	150°01'	630	-	-
	21	12836	Lochsport, Victoria		38°3'	147°37'	5	2	Leached sands near coast

NSW: New South Wales; Qld: Queensland;

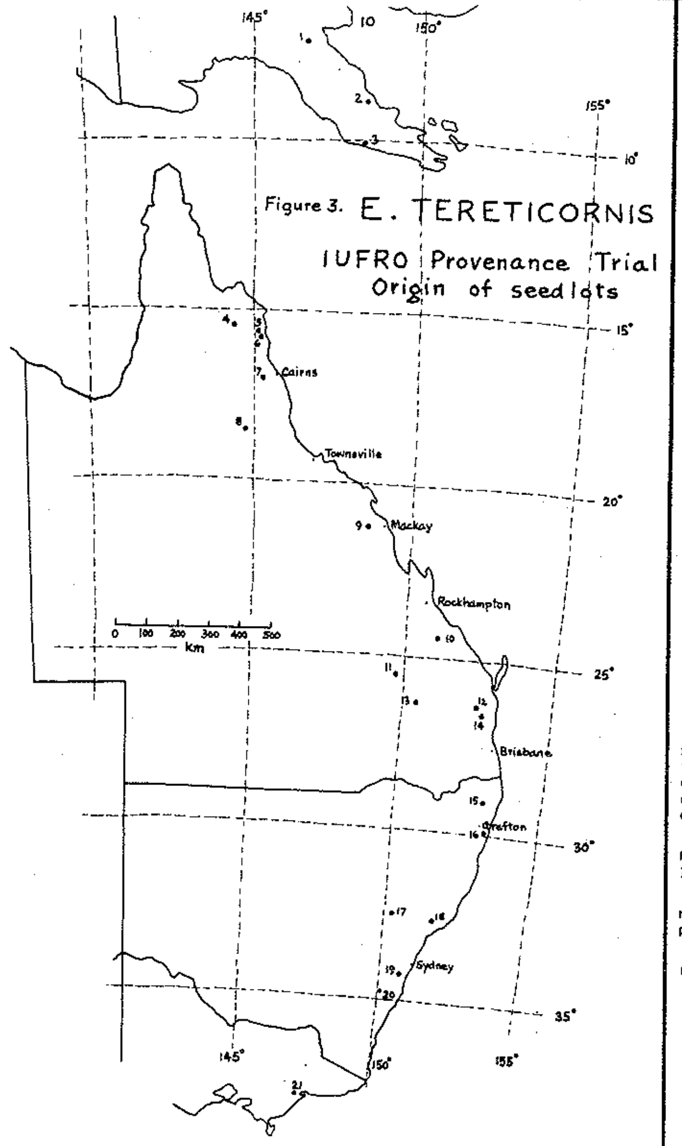


Figure 3. E. TERETICORNIS
IUFRO Provenance Trial
Origin of seedlots

Table 4. Meteorological data from recording station, nearest to, or representative of the collection site of the E. tereticornis seedlots.

Seed lot	Meteorological station	Annual rainfall (mm)	Temperature (°C) Jan Max	Jan Min	July Max	July Min	Highest (°C)	Lowest (°C)	No of frosts
3	Port Moresby	995	34	22	30	21	–	–	–
4	Laura	903	–	–	–	–	–	–	–
5, 6	Cooktown	1693	31	24	25	19	41	8.3	0
7	Mareeba	910	31	21	25	11	–	–	0
8	Mt Surprise	774	33	21	27	9	43	-3.8	0.5
9	Collinsville	766	33	21	25	8	–	–	–
10	Theodore	736	34	21	22	6	–	–	–
11	Taroom	681	33	20	21	4	–	–	–
12	Gympie	1148	31	20	21	6	44	-5	3.5
13	Dalby	673	32	18	19	4	–	-7.2	12.7
14	Imbil	1200	30	19	21	7	–	–	–
15	Casino	1090	31	19	21	6	–	-5	0.8
16	Grafton	959	31	19	21	6	45	-4.4	0.4
17	Muswellbrook	618	28	16	17	2	–	–	–
18	Cessnock	730	30	17	18	4	46	-6.1	14
19	Picton	797	29	15	17	2	46	-8.0	41
20	Braidwood	700	26	11	11	0	41	-9.7	66
21	Sale	609	25	13	14	3	45	-6.7	14.8

Conditions for participating in the E. tereticornis provenance trials were the same as those for E. grandis and the details were advertised concurrently. The list of co-operators who are undertaking the trials is almost identical to that for E. grandis and the experiments are at the same stage of advancement.

FAST GROWING TREES

TESTE DE ORIGENS, PROCEDÊNCIAS E PROGÊNIES DE *EUCALYPTUS GRANDIS* NO ESTADO DE SÃO PAULO.

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Resumo

Com o objetivo de selecionar as origens e procedências promissoras de Eucalyptus grandis Hill ex Maiden e de estudar o comportamento de progênies para o Estado de São Paulo - Brasil, foi instalado em 1975, um teste em Assis, Avaré, Bebedouro, Itirapina e Moji Guaçu, envolvendo 3 procedências, 13 origens e 8 clones específicos estes de pomares de sementes clonais da África do Sul.

As sementes da África do Sul foram recebidas do Departamento Florestal (Pretória), as da Austrália do CSIRO (Canberra) e a brasileira do Horto Florestal da FEPASA (Rio Claro).

O estudo foi feito com as medições do quarto ano da altura, diâmetro, tendência à derrama natural, porcentagem de sobrevivência, perfeição de fuste, ângulo de inserção dos galhos e fator de forma.

Entre os melhores tratamentos encontra-se o de Coffs Harbour (P18) e entre os piores, o de Rio Claro (P19).

Summary

To select the best provenances and to study the behaviour of progenies in the Sao Paulo State, a Eucalyptus grandis Hill ex Maiden provenance and progeny trial was established in 1975 at Assis, Avare, Bebedouro, Itirapina and Moji Guacu. It included 16 provenances and the families of clones from the South African clonal seed orchards.

The South African seeds came from the Department of Forestry (Pretoria), the Australian ones from the CSIRO (Canberra) and the Brazilian one from the FEPASA Experimental Station (Rio Claro).

The variables studied were height, DBH, natural pruning, survival, perfection of bole, angle of branches and form factor.

One of the best provenances was Coffs Harbour and among the poorest was Rio Claro.

Introdução

O Eucalyptus grandis Hill ex Maiden vem sendo plantado em diversos países, notadamente Brasil e África do Sul. Esses plantios visam principalmente a produção de papel, de chapas de fibras e de aglomerados e de carvão siderúrgico.

Cerca de 90% do plantio atual de eucalipto, no Estado de São Paulo, é feito com essa espécie e seu desempenho deve-se fundamentalmente às semelhanças entre as condições edafo-climáticas deste Estado e as das regiões de ocorrência na Austrália. O estudo de origens e procedências de E. grandis é um dos melhores métodos para a detecção de sua variação genética (Read Ap. Kageyama, 1977).

Para Pryor (1971) o E. grandis é a espécie de maior importância para cobrir as necessidades industriais e segundo Golfari e Pinheiro Neto (1970) o Estado de São Paulo tem condições ideais para a espécie, sendo a mesma, provavelmente a de maior futuro no Brasil.

Os objetivos deste trabalho são:

a. Estudar a variação genética entre origens, procedências e progênies das principais características nas regiões de Assis, Avaré, Itirapina e Moji Guaçu e

b. classificar as origens, procedências e progênies pelo seu comportamento em função das diversas características estudadas.

A Estação Experimental de Bebedouro não apresentou as medidas de 1979, razão pela qual a mesma não foi incluída nesta análise.

Material e Métodos

As médias mensais de temperatura, precipitação pluviométrica, o balanço hídrico, as coordenadas geográficas e a altitude de cada local foram apresentadas por Gurgel Filho et alii (1978). O tipo de solo e o tipo de clima para cada local são: Assis - Lea e Cwa; Avaré - Lea e Cwa; Itirapina - Lvr e Cwa e Moji Guaçu - Lva e Cwa.

As exigências climáticas do E. grandis foram determinadas através da literatura especializada (Hall et alii, 1963; Hall et alii, 1970 e Hall, 1972). Pelas analogias dos balanços hídricos de algumas origens representativas e os das Estações Experimentais do Instituto Florestal, foi possível escolher os locais de implantação dentre os mais indicados para o plantio do E. grandis (Camargo, 1960).

As sementes para o presente trabalho foram cedidas pelo CSIRO (Canberra-Austrália), pelo Departamento Florestal (Pretória - África do Sul) e pelo Horto Florestal da FEPASA (Rio Claro- Brasil).

Os tratamentos testados em Moji Guaçu não são os mesmos testados nos outros 3 locais, com exceção do P01 (de Warburton) que corresponde ao P01 dos outros locais e o P15 (de Rio Claro) que corresponde ao P19 dos outros locais. Os dados sobre os tratamentos foram apresentados em Gurgel Filho et alii (1978) (Anexo 1),sendo que dados complementares estão apresentados no quadro 1 deste trabalho.

A produção das mudas e o plantio no campo seguiram o critério técnico adotado pelo Instituto Florestal, sendo que cada Estação Experimental envolvida, produziu suas próprias mudas.

O delineamento estatístico foi o de blocos ao acaso, sempre com 4 repetições. Em Moji Guaçu, foram testados 7 tratamentos, em Itirapina 19 e em Assis e Avaré apenas 18 pela falha do T15 (de - Kenilworth). O número de plantas úteis por parcela foi de 12 e o espaçamento de 3,0 x 2,0m, tendo, o plantio no campo, sido efetuado em fevereiro de 1975.

Anualmente as árvores tiveram a altura e o DAP medidos. No 4º - ano, além dessas características, foram medidos também a porcentagem de sobrevivência, a tendência para a derrama natural, a perfeição de fuste, o ângulo de inserção dos galhos e o fator de forma, sendo esta última característica medida apenas em Moji Guaçu.

A perfeição de fuste foi avaliada de acordo com uma escala artificial de notas subjetivas que variou de 1 a 5 (Kageyama, 1977). Ao ângulo de inserção do ramo vivo mais inferior, foi dado o valor 1 para ângulo de 0 a 22,5^0, 2 de 22,5 a 45^0, 3 de 45^0 a 67,5^0 e 4 de 67,5^0 a 90^0. A tendência para a derrama foi avaliada pela distância entre o colo e o primeiro ramo vivo.

Quadro 1: Dados complementares sobre os tratamentos estudados

Tratamento	Nº de árvores matrizes	classificação original
Moji Guaçu P01	n	-
" " P05	5	-
" " P07	5	-
" " P09	5	-
" " P12	5	-
" " P14	5	-
" " P15	n	2884
outros locais P02	clone específico	G1
" " P03	" "	G6
" " P04	" "	G17
" " P05	" "	G19
" " P06	" "	G35
" " P07	" "	G38
" " P08	" "	G47
" " P09	" "	G58
" " P10	1	7823/1
" " P11	-	8306
" " P12	1	9783/121
" " P13	-	10360
" " P14	1	10693/1413
" " P15	1	10695/1424
" " P16	1	10696/1428
" " P17*	-	-

* = semente melhorada no Zomerkomst TreeBreeding Station (Africa do Sul) para serraria

n = número desconhecido

Os dados foram analisados, estatisticamente, sendo que para as características dendrométricas altura, DAP, derrama natural e porcentagem de sobrevivência, faz-se a análise de variância com aplicação do teste F , comparando-se as médias dos tratamentos pelo - teste de Tukey (Pimentel Gome, 1970). Os dados de porcentagem foram previamente transformados pela equação $y_{ij} = \text{arc sen} \sqrt{x_{ij}}$, onde x_{ij} é o número fracionário correspondente à porcentagem obtida na parcela de tratamento i do bloco j;

As observações de perfeição de fuste e ângulo de inserção foram analisados pelo teste de Friedman, mais apropriado para dados qualitativos. Como complementação do teste de Friedman, nos casos em que foram constatadas diferenças significativas entre tratamentos, foi aplicado o teste de comparações múltiplas (Campos, 1976).

Resultados

Comportamento das origens, procedências e progênies em Assis

A análise de variância complementada pelo teste de Tukey detectou uma diferença, ao nível de 5% para os dados de DAP e derrama. A origem P14 (NE de Gympie) foi a que apresentou o menor DAP (10,5cm). A pior derrama (8,1 m) foi apresentada pela procedência P01 - (Warburton).

Não foi constatada diferença entre os tratamentos quanto à média das alturas (o P05 - S/N 24380 - apresentou 16,8 m) e porcentagem de sobrevivência (o P06 - S/N 24381 e o P10 - N de Coffs Harbour - apresentaram 100%).

Quanto ao ângulo de inserção dos galhos, todos os tratamentos comportaram-se igualmente (o P05 - S/N 24380 - apresentou valor de 3,5). Quanto à perfeição de fuste ocorreram diferenças significativas ao nível de 1%. Pelo teste de comparações múltiplas, concluiu-se que os piores tratamentos são P12 com valor de 2,6 (Atherton) e P10 com valor de 2,9 (Coffs Harbour).

Comportamento das origens, procedências e progênies em Avaré

Foi observada diferença significativa entre as procedências Rio Claro (P19) com a média de 14,1 m e as origens Bellthorpe (P16) e Coffs Harbour (P18), respectivamente com as médias 16,8m e 16,7 m , quanto à altura.

Quanto ao diâmetro, o menor crescimento foi apresentado pela procedência Rio Claro (P19) com um valor de 10,0cm, com diferença significativa apenas em relação aos tratamentos P16 (Bellthorpe com 13,2cm) e P05 (S/N 24380 com 13,1 cm).

Quanto à derrama natural todos os tratamentos tiveram um comportamento semelhante (o P12 de Atherton, apresentou a melhor derrama com 10,2 m).

A procedência Rio Claro (P19) foi a que apresentou o menor índice de sobrevivência (60,0%). Quanto à perfeição de fuste (a P08 - S/N 24383 apresentou-se com valor de 3,0) e ao ângulo de inserção dos galhos (o P09 - S/N 24383 e o P11 do E. de Mareeba foram os melhores com valor de 3,0) não foi encontrada diferença significativa.

Comportamento das origens, procedências e progênies em Itirapina

As diferenças apontadas pelo teste de Tukey em relação às médias das alturas, foram ao nível de 5%. Desta maneira a maior altura foi apresentada pelo P18 - Coffs Harbour, com a média de 15,0m, apresentando significância em relação aos tratamentos P02 - (S/N 24376 com 10,2m), P03 (S/N 24377 com 10,5m), P08 (S/N 24383 com 10,8m), P09 (S/N 24384 com 10,8m), P10 (N de Coffs Harbour com 10,8m), P14 (NE de Gympie com 10,5m), P17 (S/N 25688 com 10,9m) e P19 (Rio Claro com 10,7m).

Quanto ao diâmetro o melhor tratamento foi o P18 (Coffs Harbour) com 11,2 cm, apresentando significância apenas em relação a P09 - (S/N 24384)com 7,6 cm e P19 (Rio Claro) com 7,5 cm.

A origem P18 (Coffs Harbour) apresentou ainda um desempenho melhor em relação à derrama natural, com um valor de 8,5m, com significância a 5% em relação aos tratamentos P02 = 6,0m, P05 (S/N 24380 com 6,3m), P06 (S/N 24381 com 6,2m) e P17 com 6,2m.

Usando-se o teste de Friedman, os tratamentos não apresentaram diferenças significativas quanto ao ângulo de inserção, porém apresentaram significância a 5% quanto à perfeição de fuste, sendo que apenas o P19 mostrou-se inferior aos demais. Este fato foi comprovado pelo teste complementar das comparações múltiplas.

Análise conjunta para altura e diâmetro

Para que fosse possível a análise conjunta, não foi considerada a origem P15 (Kenilworth), só plantada em Itirapina. Quanto ao diâmetro e altura, Itirapina mostrou-se significativamente inferior à Assis e Avaré.

A média dos diâmetros de todos os tratamentos em Itirapina foi de 8,7cm, observando-se em Assis e Avaré um valor de 11,9cm. A média das alturas de todos os tratamentos em Itirapina foi de 11,6m, em Avaré 15,5m e em Assis 16,2m.

Comportamento das origens em Moji Guaçu

Analisando estatisticamente a altura, o DAP, o fator de forma e a porcentagem de sobrevivência no experimento de E. grandis de Moji Guaçu, observa-se diferença significativa entre as origens australianas e a procedência Rio Claro (P15). Não foi observada diferença entre as origens australianas utilizadas: P02 (Queen Lake), P03 - (Wallingat River), P04 (Bantan), P05 (Nulla Five Day) e P06 (New Found Land). A procedência P01 (Warburton) mostrou-se semelhante ao comportamento das origens australianas.

Conclusões

1. As progênies sul-africanas (P02-P03-P04-P05-P06-P07-P08 e P09), as procedências sul-africanas (P01-P17), as origens (P10 - P11-P12-P13-P14-P15-P16 e P18) e as origens plantadas em Moji Guaçu (P05- P07- P09 - P12 e P14) constituem excelente material para trabalhos de melhoramento da espécie.

2. Considerando as condições do experimento em Assis, Avaré e Itirapina, o comportamento do E. grandis foi melhor nas duas pri-

Anexo 1: Dados disponíveis sobre as 3 procedências, 8 progênies e 13 origens.

Tratamento	Local	Latitude	Longitude	Altitude (m)
Moji Guaçu P01	Warburton			
" " P05	Queens Lake (N.S.W)	31°35'	152°48'	30
" " P07	Wallingat River (N.S.W)	32°20'	152°27'	31
" " P09	Tanban (N.S.W.)	30°52'	152°53'	30
" " P12	Nulla Five Day (N.S.W.)	30°43'	152°32'	200
" " P14	New Found Land (N.S.W.)	29°55'	153°07'	76
" " P15	Rio Claro			
outros locais P01	Warburton			
" " P02	clone específico G1			
" " P03	" " G6			
" " P04	" " G17			
" " P05	" " G19			
" " P06	" " G35			
" " P07	" " G38			
" " P08	" " G47			
" " P09	" " G58			
" " P10	N. de Coffs Harbour (NSW	30°10'	153°08'	18
" " P11	E. de Mareeba (QLD)	17°00'	146°00'	305
" " P12	Atherton (QLD)	17°15'	145°42'	655
" " P13	Mt George Dist. (NSW)	31°54'	152°11'	457
" " P14	NE de Gympie (QLD)	26°07'	152°42'	76
" " P15	Kenilworth (QLD)	26°40'	152°33'	533
" " P16	Bellthorpe (QLD)	26°52'	152°12'	457
" " P17	S/N 25688			
" " P18	Coffs Harbour			
" " P19	Rio Claro			

meiras localidades. Nas três localidades destaca-se entre outros, a origem P18 (Coffs Harbour).

3. Em todos os locais e nas condições do experimento, o pior tratamento foi o P19 (Rio Claro), justificando a procura de sementes em outros países, notadamente a Austrália.

4. Somente o experimento de Moji Guaçu têm condições de ser - transformado em área produtora de semente. Assis, Avaré e Itirapina apresentam uma base genética não aconselhável, recomendando-se nesses casos, a escolha de uma única árvore de cada tratamento para a inclusão em trabalhos avançados de melhoramento.

5. A procedência P17, melhorada na Zomerkomst TreeBreeding Station e as progênies (clones específicos) P02 - P03 - P04 - P05 - P06 - P07 - P08 e P09 não se mostraram melhores do que os outros - tratamentos, provavelmente devido às diferentes condições entre a África do Sul e o Estado de São Paulo, indicando que o plantio nas condições paulistas deve ser feito com semente melhorada para as - condições do Estado de São Paulo;

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TESTE DE PROCEDÊNCIA DE *EUCALYPTUS GRANDIS* EM MADAGASCAR.

A. Rakotomanampison.

Resumo

Uma série de testes de procedências de *E. grandis* foi instalada durante os períodos de 1972-1973 e 1973-1974 em diversas condições ecológicas.

Em razão da falta de sementes e problemas no viveiro, o número e o conjunto das procedências em cada ensaio varia de um local para o outro.

Contudo, um certo número de procedências é comum em todos os ensaios e permite ter uma idéia do comportamento da espécie em função das diversas origens envolvidas.

Os "sites" ecológicos escolhidos são bem contrastantes e os resultados obtidos são muito variados.

De um modo geral, pode-se notar a boa tendência das procedências australianas em sempre se classificarem entre as primeiras.

Das procedências oriundas de plantações locais algumas se comportam razoavelmente; a procedência de Amparafava, em especial, é bem inferior. As descendências de pomares clonais da África do Sul equiparam-se às melhores procedências australianas.

Do ponto de vista da influência do "ambiente", é necessário destacar o bom comportamento encontrado em Sandragato; isto se explica tendo em vista que o ensaio fica instalado em área de mata onde o humus e frescura do solo estão bem conservados.

Por outro lado, quando os ensaios são implantados em zonas de savana, o crescimento e a produção decrescem notavelmente. Isto prova que a espécie é bem exigente em relação ao solo, e a pratica da adubação será certamente necessária nessas condições.

ESSAI DE PROVENANCES D'*EUCALYPTUS GRANDIS* À MADAGASCAR.

Resumé

Une série d'essais de provenances d'Eucalyptus grandis a été installée au cours des deux campagnes 1972-1973 et 1973-1974 dans divers sites écologiques.

En raison de manque de semences ou d'échec en pépinière, le nombre et la composition de provenances dans chaque essai varie d'un site à l'autre.

Néanmoins, un certain nombre de provenances sont toujours présentes dans tous les essais et permettent d'avoir une idée du comportement de l'espèce à travers ses diverses origines.

Les sites écologiques retenus sont très diversifiés et les résultats obtenus sont très variés.

Mais d'une manière générale, on peut noter la bonne tenue des provenances australiennes qui se classent toujours parmi les premières.

Dans les provenances artificielles malagasy, certaines se comportent convenablement; mais celle d'Amparafara est particulièrement mauvaise. La descendance du verger de clones de l'Afrique du Sud vaut les les meilleures provenances australiennes.

Du point de vue effet du "milieu", il faut noter la bonne performance obtenue à Sandrangato, c'est-à-dire sur défrichement d'une formation forestière où l'humus et la fraîcheur du sol sont encore bien conservés.

Par contre, dès qu'on s'installe dans des zones de savane, la croissance et la production baissent notablement. Ce qui prouve que l'espèce est bien exigeante au point de vue sol, et l'apport d'une fertilisation serait certainement profitable dans ces conditions.

INTRODUCTION

La première introduction de l'Eucalyptus grandis à Madagascar remonte au début de ce siècle et probablement vers les années 1902-1904 dans la concession d'un Colon au lieu dit Marovitsika.

Par la suite, le Service des Eaux et Forêts a fait une introduction plus conséquente, notamment à partir de 1950 et surtout dans la région de Périnet, sur défrichement des forêts naturelles. L'espèce a été ensuite diffusée dans les divers arboreta entre 1951 et 1956.

La croissance obtenue dans la région de Périnet et dans certains arboreta a été spectaculaire. Dans un premier temps, la production qu'on a commencé à récolter à partir de 1965 a été surtout destinée pour les poteaux des lignes électriques après imprégnation de la créosote. Mais actuellement, on commence à l'utiliser pour faire des planches (débit en quartier), des chevrons.

Puis des plantations nouvelles sont en cours de réalisation pour la production de pâte à papier et du charbon de bois.

De tout ceci, il est devenu impératif de connaître les meilleures provenances pour chaque zone d'introduction et de connaître également la qualité de la production.

Compte tenu des résultats des premières introductions et des objectifs définis pour l'extension de l'espèce, cinq sites écologiques ont été retenus pour l'implantation des essais dont la réalisation a été échelonnée sur deux campagnes : 1972-1973 et 1973-1974. Pour la première campagne, le nombre de provenances comparé a été plus élevé; tandis que pour la deuxième, certaines provenances ont manqué.

SITES DES ESSAIS

Les caractéristiques des cinq sites sont les suivantes :

a)- Campagne 1972-1973

Elle concerne les trois sites suivants :

- SANDRANGATO

Situé à environ 950 m d'altitude, sous 19° 06 de latitude Sud et 48° 14 de longitude Est, il est encore dans l'emprise du domaine climatique de l'Est (tropical humide).

La pluviométrie annuelle est de 1.700 mm, avec seulement un mois sec (inférieur à 50 mm) qui est celui d'Octobre (40 mm). La température moyenne annuelle est de 19° C, avec comme moyennes des maxima et minima respectivement 24° 2 et 13° 8.

L'essai a été installé sur un défrichement de forêt naturelle plus ou moins dégradée par l'exploitation forestière. Mais dans son ensemble, le milieu est encore relativement bon car l'humus est bien conservé. On n'a pas brûlé les débris du défrichement.

- AMPAMAHERANA

Ses coordonnées sont les suivantes : altitude = 1.100 m; latitude = 21°,29 Sud; longitude = 47°,22 Est.

Climat : domaine climatique de l'Est d'altitude; pluviométrie annuelle = 1.642,1 mm, avec deux mois secs (Septembre = 46,8 mm et Octobre = 41,1 mm); température moyenne annuelle = 17°,7 C dont les moyennes des maxima et minima sont 23°,2 et 12°,2.

L'essai a été installé sur un sol très dégradé, couvert seulement par un mélange de bruyère (Philippia) et de graminées (Aristida).

- MAHELA

Ses coordonnées sont les suivantes : altitude = 10 à 20 m; latitude = 18°,57 Sud; longitude = 48°,59 Est.

Climat : domaine climatique de l'Est; pluviométrie annuelle = 2,917 mm et pas de mois sec. La température moyenne annuelle est de 24°,1, avec comme moyennes des maxima et minima respectivement 27°,4 et 20°,8.

L'état du sol où a été installé l'essai est encore pire que celui du précédent site : couverture herbacée clairsemée, apparition de nombreuses concrétions latéritiques en surface.

b)- Campagne 1973-1974

- ANDRANOKOBAKA

Les coordonnées sont les suivantes : altitude = 910 m; latitude = 18°,55 Sud; longitude = 48°,10 Est.

Climat : domaine climatique de l'Est; pluviométrie annuelle = 1.534 mm dont six mois secs, de Mai à Octobre. Température moyenne = 19°,8 C dont les moyennes des maxima et minima sont de 24°,80 et 14° C.

C'est une ancienne terrasse lacustre où le sol a été déjà appauvri par des cultures répétées du manioc. La couverture végétale est surtout herbacée (Aristida).

- MANDIALAZA

- altitude = 910 m
- latitude = 18°,36 Sud
- longitude = 48°,14 Est
- climat = presqu'identique au précédent, tant en pluviométrie qu'en température.

Il en est de même du point de vue sol.

PROVENANCES COMPAREES

En tout, on a disposé de 16 provenances dont 7 provenances australiennes envoyées par le C.F.I., 7 provenances artificielles malagasy et 2 provenances artificielles africaines.

Leur liste est la suivante :

Nom de la provenance	Pays d'origine	Coordonnées			N° national	N° C.F.I.
		Alt. (m)	Lat.	Long.		
Bulhadelah NSW	Australie	9	32°,42	152°,09	72.021	7.465
Bulhadelah -	-"-	122	32°,20	152°,13	72.022	7.810
Coffs Harbour -	-"-	18	30°,10	153°,08	72.023	7.823
Bellthorpe QLD	-"-	457	27°,10	152°,45	72.024	8.144
E. Atherton -	-"-	655	17°,15	145°,42	72.025	9.783
Kempsey distr NSW	-"-	24	31°,04	152°,45	72.026	9.583
W. Coopernook -	-"-	335	31°,50	152°,37	72.027	9.503
Ambohikely A-20	Madagascar	770	17°,38	48°,30	72.100	
Amparafara K-10	-"-	901	18°,55	48°,10	72.128	
Angavokely H-15 b	-"-	1383	18°,55	47°,44	72.127	
Angavokely E-14 c	-"-	1383	18°,55	47°,44	72.130	
Angavokely J-20	-"-	1383	18°,55	47°,44	72.131	
Ampamaherana C-9	-"-	1100	21°,29	47°,22	72.172	
Ampamaherana C-2	-"-	1100	21°,29	47°,22	72.173	
Amalika J-10	Malawi Afrique	1070			72.045	7.860 (*)
Verger de clones	Afrique du Sud	?	?	?	72.044	7.843 (*)

(*) - Ces numéros sont ceux du Malawi Forest Research Institute.

Les provenances australiennes viennent donc de la nouvelle Galle du Sud (N.S.W.) et de Queensland. Celles de Madagascar viennent de 4 stations forestières dont l'altitude est donnée sur le tableau ci-dessus.

La provenance 72.100 d'Ambohikely serait la descendance des peuplements de Marovitsika (concession du Colon). Il en est de même de celle d'Amparafara (72.128). Du point de vue climatique, cette dernière serait plus proche d'Andranokobaka, tandis qu'Ambohikely qui est au bord du lac Alaotra est plus sec car la pluviométrie est de 1.155,5 mm, avec 7 mois secs (d'Avril à Octobre).

Pour Angavokely qui est situé à 30 km à l'Est de Tananarive, à une altitude de 1.383 m, deux des trois provenances fournies sont plus ou moins connues.

La 72.130 serait la descendance d'une introduction faite de l'Australie en 1949. La 72.131 serait la descendance maternelle de l'arbre N° 637 ALZ de Périnet, une station à rapprocher de Sandrangato du point de vue climatique.

La pluviométrie d'Angavokely est de 1.386 mm, avec 7 mois secs également (d'Avril à Octobre). La température moyenne annuelle est de 17°,36, avec comme moyenne des maxima et minima 23°,2 et 11°,4.

Pour Ampamaherana, la provenance 72.172 aurait été introduite en 1952 de l'Ouganda et la 72.173 de l'Afrique du Sud en 1951.

Pour les provenances africaines, celle de l'Afrique du Sud serait donc la descendance d'un verger de clone, c'est-à-dire une origine déjà améliorée génétiquement; tandis que pour Amalika, il s'agit d'une récolte faite dans la parcelle 10-J, sans qu'on ait des indications précises sur les conditions climatiques du lieu.

REPARTITION DES PROVENANCES DANS LES CINQ SITES

En raison de peu de graines dont on disposait pour certaines provenances, on n'a pas pu les distribuer sur tous les sites. En outre, la réussite en pépinière n'a pas été très brillante, probablement à cause de l'état des graines. De ce fait, le nombre et la composition de provenances mises en compétition varient d'un site à l'autre. Voici par station la composition de chaque essai :

Provenances		Sandrangato	Mahela	Ampamaherana	Andranokobaka	Mandialaza
Bulhadelah	72.021	x		x	x	x
Bulhadelah	72.022	x		x	x	x
Coffs Harbour	72.023	x		x		x
Bellthorpe	72.024	x				
Atherton	72.025	x	x	x	x	x
Kempsey	72.026	x				
Coopernook	72.027	x	x			
Ambohikely	72.100			x		
Amparafara	72.128	x	x	x	x	x
Angavokely	72.127		x			
Angavokely	72.130	x		x		
Angavokely	72.131				x	x
Ampamaherana	72.172		x	x		x
Ampamaherana	72.173	x	x	x	x	x
Amalika	72.045	x				
V.C. Afr. du Sud	72.044	x				
Dispositif de l'essai		Lattice rectangulaire triple	Blocs complets	Blocs complets	Blocs complets	Blocs complets

Les trois provenances représentées sur tous les essais sont donc :

- Atherton 72.025
- Amparafara 72.128
- Ampamaherana 72.173

RESULTATS

Les résultats des dernières mensurations sont consignés dans les tableaux N° 1 à 5.

Les conclusions qu'on peut en tirer sont provisoirement les suivantes :

- Du point de vue sol, il faut pour l'Eucalyptus grandis, un sol forestier, c'est-à-dire profond, frais et riche en humus bien décomposé. Les performances obtenues à Sandrangato le prouvent, car on a pu atteindre en moyenne l'accroissement spectaculaire de 50 m3/ha/an.

Dès qu'on passe sur des sols de savane, la production baisse plus de la moitié, pour devenir presque nulle dans le cas des conditions de Mahela. Probablement, il faut apporter pour ces types de sol, de la fertilisation minérale et si possible avec un peu de fumure organique.

- Du point de vue climatique, les conditions de basse altitude (Mahela) semblent gêner profondément les provenances qui y ont été testées, car non seulement la croissance est lente, mais on remarque aussi le suintement des résines sur beaucoup d'individus.

Ce phénomène est également observé à Andranokobaka et à Mandialaza, là où la saison sèche est très longue.

- Sur le plan de performance proprement dite, on peut noter que d'une manière générale, les provenances australiennes sont en général les meilleures, car elles figurent toujours en tête du classement tant du point de vue hauteur que de la production.

Parmi les provenances malagasy, celle d'Ampamaherana portant le N° 72.173, c'est-à-dire d'origine Sud africaine, est certainement la meilleure. On peut lui adjoindre la provenance 72.130 d'Angavokely. Par contre, les provenances d'Amparafara 72.128 et d'Ambohikely 72.100 qui sont toutes deux des descendances de Marovitsika, sont franchement mauvaises.

A Sandrangato où elle a été présente, la provenance du verger de clone d'Afrique du Sud est excellente, quoi qu'elle a été dépassée par la provenance de Coffs Harbour surtout en productivité : 62,507 m3/ha/an contre 55,414 m3.

Sur le plan de la qualité de la production, les études sont en cours et seront connues ultérieurement.

TABLEAU N° 1 : Essai de Sandrangato
(mensuration de 1979 à l'âge
de 6 ans 2 mois)

Nom de provenances		N° national	Hauteur en m	G en m2	Vol./ha en m3	Accroissement/ha par an en m3
Coopernook	Australie	72.027	30,11	30,66	331,640	53,779
Kempsey	Australie	72.026	30,03	29,68	322,640	52,320
Amparafara	Madagascar	72.128	25,62	21,95	201,110	32,612
Bulhadelah	Australie	72.022	30,45	31,71	355,190	57,598
Bellthorpe QLD	Australie	72.024	29,62	31,23	332,950	53,992
Amalika Malawi	Afrique	72.045	28,95	30,24	298,560	48,415
Atherton QLD	Australie	72.025	29,21	29,54	268,760	43,583
Angavokely E 14 C	Madagascar	72.130	28,78	28,47	298,490	48,404
Bulhadelah	Australie	72.021	28,59	32,72	327,440	53,098
Coffs Harbour	Australie	72.023	29,73	33,19	385,460	62,507
Ampamaherana C-2	Madagascar	72,173	27,59	30,93	285,790	46,344
Verger de clones	Afrique du Sud	72.044	29,04	31,85	341,720	55,414

TABLEAU N° 2 : Essai d'Ampamaherana
(mensuration de 1980
à l'âge de 7 ans)

Nom de provenances		N° national	Hauteur en m	G en m2	Vol./ha en m3	Accroissement/ha par an en m3
Atherton	Australie	72.025	19,64	20,91	165,236	23,605
Coffs Harbour	Australie	72.023	19,58	21,84	173,041	24,720
Bulhadelah	Australie	72.022	21,40	22,35	176,595	25,228
Bulhadelah	Australie	72.021	20,15	24,55	201,052	28,722
Alaotra	Madagascar	72.100	16,46	12,13	79,901	11,414
Amparafara	Madagascar	72.128	16,18	13,11	85,526	12,218
Ampamaherana	Madagascar	72.172	17,54	16,37	115,091	16,441
Angavokely	Madagascar	72.130	19,56	20,19	162,126	23,160
Ampamaherana	Madagascar	72.173	18,27	21,87	161,446	23,064

TABLEAU N° 3 : Essai de Mahela (mensuration
de 1979 à l'âge de 6 ans)

Nom de provenances		N° national	Hauteur en m	G en m2	Vol./ha en m3	Accroissement/ha par an en m3
W. Coopernook	Australie	72.027	7,99	7,42	25,271	4,212
E. Atherton	Australie	72.025	10,05	6,91	31,652	5,275
Amparafara	Madagascar	72.128	5,47	3,91	8.533	1,422
Angavokely	Madagascar	72.127	7,22	6,52	19,914	3,319
Ampamaherana	Madagascar	72.173	9,53	9,49	36,302	6,134
Ampamaherana	Madagascar	72.172	7,26	5,34	16,113	2,685

TABLEAU N° 4 : Essai d'Andranokobaka (mensuration
de 1980 à l'âge de 6 ans)

Nom de provenances		N° national	Hauteur en m	G en m2	Vol./ha en m3	Accroissement/ha par an en m3
Bulhadelah	Australie	72.022	14,37	11,76	74,348	12,392
Atherton	Australie	72.025	15,61	18,35	110,650	18,442
Bulhadelah	Australie	72.021	15,16	15,47	105,287	17,548
Ampamaherana	Madagascar	72.173	13,69	14,60	76,170	12,695
Amparafara	Madagascar	72.128	11,08	9,43	39,673	6,612
Angavokely	Madagascar	72.131	12,14	10,52	55,821	9,303

TABLEAU N° 5 : Essai de Mandialaza (mensuration
de 1980 à l'âge de 6 ans)

Nom de provenances		N° national	Hauteur en m	G en m2	Vol./ha en m3	Accroissement/ha par an en m3
Bulhadelah	Australie	72.022	17,53	11,15	79,153	13,192
Coffs Harbour	Australie	72.023	18,51	12,45	92,775	15,462
Atherton	Australie	72.025	18,98	16,50	125,726	20,954
Bulhadelah	Australie	72.021	17,95	13,20	95,554	15,926
Ampamaherana	Madagascar	72.172	17,50	12,31	86,813	14,469
Amparafara	Madagascar	72.128	13,32	4,81	26,486	4,414
Angavokely	Madagascar	72.131	16,43	7,87	52,425	8,737
Ampamaherana	Madagascar	72.173	18,41	15,12	111,645	18,607

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COMPETIÇÃO ENTRE ALGUMAS POPULAÇÕES DE *EUCALYPTUS GRANDIS* HILL EX MAIDEN.

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Resumo

Foi instalado em 5 locais do Estado de São Paulo, um ensaio de 28 procedências e progênies de *Eucalyptus grandis* Hill ex Maiden, com sementes provenientes de Itirapina, Rio Claro e da Austrália.

Aos cinco anos de idade é discutido o seu desenvolvimento, procurando relaciona-lo com o zoneamento ecológico feito para o Estado de São Paulo. É mencionada a ocorrência de *Diaporthe cubensis* Bruner.

Summary

This paper deals with the study of 28 *Eucalyptus grandis* Hill ex Maiden provenances and progenies at 5 different areas of the Sao Paulo State. The seeds used came from Itirapina and Rio Claro in the Sao Paulo State and from Australia.

The results at five years of age were analysed and compared with data for the ecological zones of the State of Sao Paulo.

The occurrence of *Diaporthe cubensis* was noted.

Introdução

Devido à amplitude geográfica de sua ocorrência, aliada à precocidade e bom desenvolvimento, o *E. grandis* é a espécie mais utilizada nos reflorestamentos do Estado de São Paulo. Sua madeira, segundo RAMOS (1973), pode ser empregada em inúmeros setores industriais, inclusive para serraria.

Todavia, a cultura desta espécie apresenta alguns problemas, tais como a capacidade de cruzamento com espécies da mesma seção, segundo PIRES (1972) e a ocorrência do chamado cancro do eucalipto, provocado pelo fungo *Diaporthe cubensis*. Esta doença, vem causando grandes prejuízos nos plantios, em locais de clima úmido, de baixa altitude e temperatura média acima de 21 °C, segundo HODGES et alii (1973).

Depois de percorrerem os principais centros florestais do Brasil, GOLFARI et alii (1978), realizaram um zoneamento ecológico florestal, baseado nos fatores clima, vegetação e balanço hídrico. Os autores, subdividiram o território nacional em 26 regiões bioclimáticas, nas quais são indicadas as possibilidades de introdução das espécies do gênero *Pinus* e *Eucalyptus* no Brasil.

Os objetivos deste trabalho, são o de comparar diversas procedências e progênies de *E. grandis* em alguns pontos do Estado de São Paulo e detectar a ocorrência do cancro do eucalipto.

Material e Métodos

As sementes utilizadas no presente trabalho, foram obtidas, conforme a Tabela 1.

TABELA 1 - Procedência das sementes e distribuição dos tratamentos

Procedência e Progênie	Tratamento
Austrália (procedências)	27 e 28
Itirapina (progênies)	1 a 22
Rio Claro (progênies)	23 a 26

As sementes da Austrália, provieram da região de Coffs Harbour. O material de Itirapina colhido de árvores marcadas de área produtora de sementes, implantada em 1960. Os tratamentos de Rio Claro, provieram de matrizes selecionadas.

Na escolha dos locais para a instalação do projeto, procurou-se 5 pontos diferentes do Estado de São Paulo, com as seguintes características, como mostra a TABELA 2.

TABELA 2 - Dados edafo-climáticos dos locais de instalação do projeto, segundo VEIGA (1975)

LOCAIS	Altitude (m)	Precip. (mm)	Temp.Méd. (C)	Clima	Solo	Def.Hidr. (mm)
Assis	562	1.217	20,6	Cwa	Lea	4
Batatais	880	1.484	20,2	Cwa	LVa	54
Itapetininga	645	1.128	19,3	Cwa	PVLs	5
Itirapina	760	1.425	19,7	Cwa	LVr	23
Mogi Mirim	631	1.355	20,3	Cwa	LVa	19

As mudas foram produzidas em torrão paulista e levadas para o campo com uma altura média de 20 cm, plantadas sem adubação em janeiro de 1973.

O delineamento estatístico foi o de blocos ao acaso, com 28 tratamentos (populações) e 5 repetições para cada local. Adotou-se o sistema de 4 mudas por parcela, dispostas linearmente, com espaçamento de 3,0 x 2,0 m.

Resultados e Discussões

Os dados de DAP e altura aos 5 anos, abrangendo as 5 localidades, apresentaram uma diferença significativa ao nível de 5 %. Constatou-se pelo Teste Tukey, uma diferença ao nível de 5 % entre as médias do tratamento 26 para com os tratamentos 10, 16 e 18 para os dados de DAP. Para os dados de altura, houve diferença entre os tratamentos 16 e 26.

Fazendo uma comparação das médias do DAP e altura entre os locais de instalação, obteve-se os seguintes dados, conforme TABELA 3.

TABELA 3 - Médias do DAP e altura por local de instalação

Local	DAP cm	Altura m
Assis	10,60	12,36
Batatais	12,91	16,65
Itapetininga	10,03	12,58
Itirapina	10,93	14,21
Mogi Mirim	10,49	14,16

O Teste Tukey para as médias de DAP para os locais, apresentou uma diferença mínima significativa a nível de 5 %, sendo que os dados de Batatais se sobressaíram aos demais, que foram iguais entre si.

Para as médias de altura, o Teste Tukey mostrou uma diferenciação em 3 classes, com Batatais significativamente superior às demais localidades. Destas, Itirapina e Mogi Mirim foram semelhantes entre si e superiores em relação a Itapetininga e Assis, iguais entre si.

Comparando a classificação dos dados de altura encontrados nos 5 locais e o zoneamento proposto por GOLFARI et alii (1978), observou-se um perfeito enquadramento. Segundo o autor, as regiões de Assis e Itapetininga estariam fora da zona ideal desta cultura e foram as que mostraram os menores valores de crescimento.

Os valores de DAP e altura dos 28 tratamentos, agrupados por procedência das sementes, são mostrados na TABELA 4.

TABELA 4 - Dados de DAP e altura por procedência

Procedência	DAP cm	Altura m
Australia	12,16	15,27
Rio Claro	11,73	14,60
Itirapina	10,78	13,86

Na análise de variância para as médias de DAP e altura das procedências entre as 5 localidades, não houve diferença significativa.

A análise da incidência do cancro do eucalipto, mostrou os seguintes valores, conforme TABELA 5.

TABELA 5 - Incidência do cancro do eucalipto

Local	Incidência
Assis	20,0%
Batatais	18,7%
Itapetininga	0,0%
Itirapina	8,3%
Mogi Mirim	6,5%

Procurando observar se a incidência foi maior em relação as procedências, não chegou-se a nenhum resultado concreto. Foi constatado que o ataque do fungo foi indistinto para todos os tratamentos.

Conclusões

Houve diferença significativa entre os tratamentos nos locais de estudo, para DAP e altura.

Quando comparado entre os locais de instalação, constatou-se que os dados de DAP de Batatais foram superiores aos demais. Para à altura, encontrou-se 3 classes, sendo a primeira Batatais, a segunda Itirapina e Mogi Mirim e a terceira, Itapetininga e Assis.

Considerando as médias dos tratamentos por procedências, constatou-se que não houve diferença estatística entre as da Austrália, Rio Claro e Itirapina, tanto para o DAP como para a altura.

A incidência do ataque do cancro do eucalipto foi indistinta para os tratamentos e ocorreu em todos os locais, com exceção de Itapetininga.

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sessão III
session
grupo B
group

ESSAIS DE PROVENANCES d'*EUCALYPTUS UROPHYLLA* BLAKE REALISES A PARTIR DES PROVENANCES RECOLTEES PAR LE CENTRE TECHNIQUE FORESTIER TROPICAL.

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Resumé

The results obtained from the first introduction of Eucalyptus urophylla in French speaking African countries lead the Centre Technique Forestier Tropical to undertake from 1973 to 1975 a systematic survey of the dispersion area of these species.

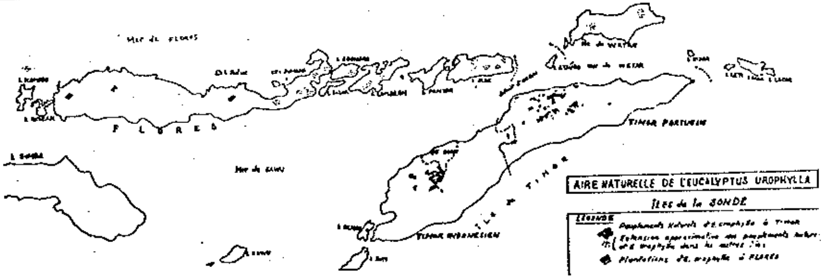
A comprehensive collection of different provenances was gathered with enable the undertaking a large programe of provenance trials to be undertaken.

The present paper gives information of the available results of trials obtained in French speaking tropical countries.

2 - INTRODUCTION

L'aire naturelle de l'Eucalyptus urophylla, comprise entre 7°30 et 10° de latitude Sud, 127° et 122° de longitude Est s'étend sur un groupe de sept iles qui forment l'extrêmité Sud-Est de l'Archipel des Iles de la Sonde ; Timor la plus massive et la plus montagneuse qui a près de 500 km de longueur ; Flores, Adonara, Pantar, Alor et Wetar sont de petites iles volcaniques dont les sommets ne dépassent pas 1500 mètres.

L'Eucalyptus urophylla est une espèce que l'on rencontre à basse et moyenne altitude à partir de 300 m sous forme de peuplements généralement purs sur des sols variés, basaltiques, schisteux, plus rarement calcaires. Sur l'ile de Timor l'espèce atteint les plus hauts sommets (Mont Tatamailu 2963 m, Mont Moutis 2320 m).



La situation géographique de l'aire d'origine, qui fait de cette espèce d'Eucalyptus l'une des deux s'approchant le plus des latitudes équatoriales, les bonnes performances de croissance observées en plantation et la bonne adaptation aux climats tropicaux humides de basse altitude, ainsi d'ailleurs que la vigueur particulière des hybrides dont elle peut être la source, explique l'intérêt croissant que suscite cette espèce pour des opérations d'afforestation dans les zones tropicales humides de basse altitude.

Le morcellement géographique de l'aire, l'isolement relatif des iles qui la composent, les variations altitudinales et climatiques qu'elles présentent, laissent présager l'existence d'une grande variabilité génétique suivant les provenances de cette espèce.

3 - LES ESSAIS DE PROVENANCE

Alors que l'espèce a été assez anciennement implantée au Brésil (Rio Claro), les premières introductions en Afrique francophone, réalisées par le C.T.F.T. l'ont été d'abord au Congo (en 1970 - 71 - 72). Ces premiers essais mettaient à chaque fois en comparaison les quelques provenances disponibles à l'époque, grâce aux récoltes effectuées par le Forestry Research Institute d'Australie.

L'intérêt des résultats obtenus a conduit le C.T.F.T. a réaliser dans une seconde phase et en liaison avec les Services Forestiers Indonésiens, une prospection systématique des différents sites écologiques composant l'aire d'origine de l'espèce (missions Cossalter 1973 - 1975), à constituer une collection très complète de semences (87 origines réparties sur les 7 iles, correspondant à 443 semenciers).

A partir de cette collection, tout un réseau d'essais comparatifs de provenances a pu être établi, intéressant tout d'abord la Guyane fran- la République populaire du Congo, la Côte d'Ivoire, çaise et le Gabon, mais également d'autres pays où les essais sont conduits sous la responsabilité des organismes de recherche nationaux (1).

Cette série d'essais revêt un caractère plus précis et plus exhaustif que les expérimentations précédentes et devrait permettre d'apprécier avec davantage de précision la variabilité de l'espèce non seulement au niveau provenance, mais également dans certains dispositifs au niveau familles et individus, les récoltes ayant été réalisées et conservées par descendances maternelles séparées.

Facteurs de milieu correspondant à quelques sites d'expérimentation

On a indiqué ci-dessous les données écologiques des principaux sites d'essais dont les résultats sont analysés dans ce document, afin de préciser les conditions des milieux dans lesquelles l'expérimentation a été effectuée.

CONGO

Pointe-Noire : 4°49 S, 11°54 E, alt. 16 m, climat guinéen forestier congolais méridional (Aubreville) Pluviométrie moyenne annuelle 1254 mm. Pluies de saison chaude. 3 mois secs (<30 mm). Température moyenne annuelle 25°C (minima 22°C, maxima 28°C). Evapotranspiration 743 mm. Hygrométrie 83 %

Sols sableux pauvres mais profonds et filtrants.

Loudima : 4°11 S, 13°05 E, alt. 165 m, climat guinéen forestier forestier congolais méridional (Aubreville). Pluviométrie moy. annuelle 1100 mm. Pluies de saison chaude (Novembre à Mai). 4 mois secs (<30 mm).

Température moyenne 23°C (Septembre), 27°C (Avril).
Sols argileux acides assez riches.

CAMEROUN

Edea : 4° N, 10°15 E, alt. 30 m, climat guinéen forestier côtier de basse altitude. Pluviométrie moyenne annuelle forte (2630 mm). 9 mois très pluvieux. 3 mois relativement secs (40 mm < P < 60 mm). Température moyenne annuelle 26°C avec variations de très faible amplitude. Sols ferralitiques lessivés, acides, sur roches métamorphiques ou éruptives anciennes (gneiss) parfois gravillonnaires ou hydromorphes.

COTE D'IVOIRE

San Pedro : 4°45 N, 6°38 W, alt. 20 m
Climat de transition guinéen forestier équatorial (Aubreville). Pluviométrie moyenne annuelle 1400 mm. Pluies de saison chaude. 2 mois secs (<30 mm). Température moyenne annuelle 26°C, avec faible amplitude annuelle (minima 23°9C en Août, max. 26°9C en Mars). Hygrométrie toujours supérieure à 75 %.
Sols argilo-sableux lessivés sur gneiss très fin.

GUYANE FRANCAISE

Sinamary : 5°17 N, 52°56 W, alt. 40 m, climat tropical humide d'Amérique (Aubreville). Pluviométrie moyenne annuelle 3103 mm. Pluies de saison fraîche , pas de mois sec (<30 mm). Température moyenne annuelle 26°C (minima 23°C, maxima 29°C). Hygrométrie 87 %. Sols ferralitiques.

MADAGASCAR

Mangoro : 18°38 S, 48°14 E, alt. 920 m, climat tropical semi-humide (type soudanoguinéen).
Pluviométrie moyenne annuelle 1610 mm. Pluies de saison chaude. 4 mois secs (<30 mm). Température moyenne annuelle 19°C (minima 12°C, maxima 25°C). Sols ferralitiques très désaturés sur migmatites schisteuses.

GABON

Kango : (zone côtière). 0°09 N, 10°08 E, alt. 40 m. Climat guinéen forestier équatorial avec saison sèche de 3 mois. Pluviométrie moyenne annuelle 2498 mm. Humidité relative moyenne (P < 30 mm) toujours élevée (> 80 %). Température moyenne annuelle 26°C. Variations mensuelles faibles. Sols sableux grossiers sur grès ou argileux sur marnes.

Franceville (plateaux intérieurs)
1°38 S, 13°34 E, alt. 426 m.
Pluvimétrie moyenne annuelle 1862 mm assez bien répartie. Saison sèche de 3 mois (< 30 mm).
Température moyenne annuelle 24°6. Variations mensuelles de faible amplitude. Hygrométrie moyenne mensuelle supérieure à 80 %.
Sols ferralitiques à évolution plus ou moins poussée argilo-sableux sur grès ou jaspes précambriens.

Réalisation des essais

Les essais ont été implantés dans des conditions parfois différentes suivant les pays :
sur savane après labour (Congo à Pointe-Noire et Loudima - Gabon à Franceville), sur forêt dense après défrichement manuel (Côte d'Ivoire, Cameroun, Guyane), après défrichement mécanisé (Gabon à Kango).

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(1) Le C.T.F.T. a ainsi fourni directement des lots d'essais aux pays suivants : Australie, Belize, Cameroun, Madagascar, Nicaragua, Nouvelle Calédonie, Philippines, République Centrafricaine. En outre, certains des lots d'essais récoltés par le C.T.F.T. ont été distribués par le Centre de Recherche forestière indonésien et le CSIRO à l'Afrique du Sud, Brésil, Ceylan, Chine, Colombie, Equateur, Guatemala, Inde, Congo, Liberia, Malaisie, Pérou, Iles Salomon, Vénézuéla.

Les dispositifs utilisés et l'importance des essais mis en place, fonction des possibilités et des moyens disponibles localement n'ont pas été partout totalement identiques. Dans la majorité des cas, les dispositifs d'essais mis en place permettent une appréciation de la variabilité non seulement au niveau provenance, mais également au niveau descendances maternelles (familles) et individus.

Ainsi au Congo où les essais ont été les plus complets, on a mis en comparaison 430 descendances appartenant à 86 provenances réparties sur les 7 îles de l'aire naturelle.

En Côte d'Ivoire, c'est 140 descendances appartenant à 52 provenances qui ont été testées. Dans les autres pays, le nombre des provenances testées est plus réduit, en raison des moyens limités dont on disposait.

Enfin, il faut indiquer que quelques essais ont encore un caractère trop récent pour que l'on puisse en tirer toutes les conclusions.

4 - RESULTATS

On constate d'une manière générale, une remarquable convergence des observations et des résultats obtenus en zone tropicale humide de basse altitude en particulier sur les points suivants :

Au niveau provenance, on note

- la forte variabilité dans les résultats des essais en fonction de la provenance, ce qui confirme la diversification très poussée des provenances que pouvait laisser présager les caractéristiques de l'aire d'origine.
- la bonne adaptation aux climats tropicaux humides de basse altitude d'un certain nombre de provenances correspondant à des zones d'altitude basse et moyenne (région de Remexio au Timor oriental, de Flores, Alor et Lomblen). Par contre, les provenances correspondant aux zones les plus élevées de l'aire d'origine (Monte Montis et Maubisse à Timor) se révèlent tout-à-fait inadaptées.
- la croissance et la forme sont excellentes notamment pour certaines des provenances de Flores (Monte Lewotobi - Monte Egon) et de la région occidentale d'Alor (Boka Afeng, Monte Moena),
- les provenances de Lomblen ont une bonne croissance mais une forme souvent très défectueuse (fût flexueux).

Au niveau famille et au niveau individuel, on note que la grande variabilité observée au niveau provenance, se retrouve également au niveau famille (descendances maternelles), ainsi qu'au niveau individuel. Remarquons que ceci constitue des circonstances favorables pour un programme de sélection ultérieur.

- enfin, indiquons que les dispositifs d'essai ont démontré la précocité et l'importance des phénomènes de compétition chez cette espèce. Certains des écartements adoptés dans les premiers essais mis en place (2,50 m × 2,50 m ou 4 m × 2 m), ne permettent pas de conduire les essais pendant toute la durée souhaitable. Des espacements plus importants doivent être adoptés pour les essais ultérieurs.
- des essais faits au Congo, les plus complets qui ont été mis en place, on peut extraire les données suivantes; en ce qui concerne Timor : les provenances donnant les meilleurs résultats en zone tropicale humide de basse altitude sont certaines provenances des régions de Remexio, d'Ermera et de Laclubar, d'altitude basse ou moyenne. Les provenances originaires de la région d'Aileu, d'altitude comprise entre 900 et 1350 m, présentent au Congo des signes de très mauvaise adaptation (dépérissements - présence de chancres suintants) alors que ces mêmes provenances arrivent en tête des résultats obtenus à Madagascar dans des conditions d'altitude plus élevées (900 m).

Les provenances correspondant aux zones les plus élevées de l'aire (région de Monte Montis et de Maubisse d'altitude comprise entre 1380 et 2030 m), se signalent, lorsqu'on les introduit en zone tropicale humide de basse altitude par une inadaptation d'autant plus forte que la région d'origine est plus élevée, se traduisant par des formes rabougries, des phénomènes de descentes de cimes, un taux de mortalité élevé.

Les essais correspondant aux provenances de Lomblen (région de Lembata en particulier) se caractérisent par une très bonne vitesse de croissance, un aspect végétatif vigoureux et homogène, mais également par une forme particulièrement défectueuse (fût très flexueux).

Les provenances de Pantar, Wetar et Alor font montre d'une variabilité importante, même au niveau infraprovenance, tant en ce qui concerne la croissance que l'aspect de l'écorce (présence fréquente d'individus à écorce lisse, qui offrent souvent une vigueur particulière).

La provenance Oulouta de Pantar a une bonne croissance mais une forme très moyenne.

La provenance Arnade de Wetar présente une bonne croissance mais aussi une forme particulièrement élancée; certaines provenances de la partie centrale (Marawa) et surtout occidentale d'Alor (Mont Moena - Afong) montrent une bonne croissance et une bonne homogénéité (Mont Moena) alors que les provenances de la partie orientale apparaissent plus médiocres.

Mais ce sont les provenances de Flores (région de Mont Egon et surtout Mont Lewotobi) qui fournissent dans la quasi-totalité des essais en zone tropicale de basse altitude les meilleurs résultats. En particulier certaines provenances se distinguent tout particulièrement tant par leurs performances de croissance ou par la forme de la cime, la régularité du fût, l'homogénéité des parcelles et leur état sanitaire.

Ces résultats ont conduit le C.T.F.T. à organiser en 1979 en collaboration avec les services forestiers indonésiens et en liaison avec le CSIRO australien, une nouvelle campagne de récolte concentrée sur les trois zones ouest Alor, Monte Lewotobi, Monte Egon. Cette campagne a permis de réunir pour chacune des trois provenances des lots de semences assurant une très bonne représentativité de chacune de ces provenances (30 à 50 semenciers par provenances).

Enfin, à partir du matériel rassemblé au cours des différentes campagnes de récolte de graines du C.T.F.T., on a constitué une collection de lots destinés à l'expérimentation en vue d'une distribution internationale.

5 - CONCLUSION

Les essais de provenances réalisés ont mis en relief la très grande variabilité génétique de l'Eucalyptus urophylla et les bonnes performances de certaines provenances en plantation dans les zones tropicales humides de basse altitude.

Les individus d'élite sont comparables aux beaux hybrides interspecifiques d'Eucalyptus.

La très forte productivité individuelle de certains génotypes permet de penser qu'une fois la technique de bouturage mise au point, ils pourraient être multipliés pour constituer une variété multiclonale très intéressante pour des opérations d'afforestation dans ces zones tropicales humides de basse altitude.

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SELEÇÃO DE ESPÉCIES DE *EUCALYPTUS* ATRAVÉS DE ANÁLISE DE REGRESSÃO.

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Resumo

Nos Estados de Minas Gerais e Espírito Santo, estão localizadas as mais extensas plantações de Eucalyptus, no Brasil. Muito embora essas plantações sejam importantes, devido às condições climáticas e de solo, o rendimento não é tão bom como o da região sul do Brasil.

Algumas espécies que crescem bem nos estados de São Paulo, Paraná e Rio Grande do Sul, não estão se comportanto bem, naquelas regiões. Para determinar as melhores espécies ou procedências para Minas Gerais e Espírito Santo, onze testes de espécies/procedências foram instalados em várias condições climáticas e de solo, em altitudes variando de 40 a 878 metros, temperatura média anual 19,1°C e 23,7°C, precipitação média anual 1132 a 1506 mm e deficiência média anual de 31 a 143 mm. As espécies procedentes da Austrália foram *E. grandis, E. urophylla, E. pilulares, E. dunnii, E. propincua, E. tereticornis, E. camaldulensis* e *E. pellita.*

Altitude do local das plantações foi a variável mais intimamente relacionada ao crescimento em altura, aos 3,5 anos de idade para o *E. camaldulensis, E. dunnii, E. grandis, E. pellita* e *E. tereticornis.*

A deficiência hídrica anual foi a variável melhor relacionada com o crescimento em altura somente para o *E. urophylla.*

Um conjunto de equações de regressão é apresentado de tal maneira que se pode predizer o crescimento, em altura de oito espécies estudadas, conhecendo-se as condições climáticas da região de interesse.

Pode se recomendar que esta técnica seja aplicada às variáveis do solo, porque existem evidências de que o teor de argila de amostras dos solos estão correlacionados à produtividade dos Eucalyptus.

SELECTING *EUCALYPTUS* SPECIES THROUGH REGRESSION ANALYSIS.

Summary

The most extensive eucalypt plantations in Brazil are located in the States of Minas Gerais and Espirito Santo. However, due to soil and climatic conditions, the yield of each species is not as great as obtained in the States to the south i.e. Sao Paulo, Parana, and Rio Grande do Sul.

To determine the best species and/or provenances for Minas Gerais and Espirito Santo, eleven species/provenances tests were established on sites with a variety of soil and climatic conditions, ranging from 40 to 878 meters of altitude, mean annual temperature from 19.1° to 23.7°C, mean annual rainfall from 1132 to 1506 mm and annual water deficit from 31 to 143 mm.

The seedlots, which were obtained from Australia, were from the species *Eucalyptus grandis*, *E. urophylla*, *E. pilularis*, *E. dunnii*, *E. propinqua*, *E. tereticornis*, *E. camaldulensis* and *E. pellita*.

The altitude of the plantation site was the variable most closely related to height growth at 3.5 years old for *E. camaldulensis*, *E. dunnii*, *E. grandis*, *E. pellita* and *E. tereticornis*.

The annual water deficit was the variable best correlated with height growth of *E. urophylla*.

A set of regression equations is presented in such way that one can predict height growth of the eight species studied, knowing some of the climatic conditions of the region of interest.

It is recommended that this technique should also be applied to soil variables, because there is some evidence that the clay content of the soil is correlated to *Eucalyptus* productivity.

INTRODUCTION

Any viable tree improvement program shout be based species, provenances and tree selection. Eucalypts, mostly from Australia, have been introduced in Brazil since 1909, and they are now showing excellent performance for wood production. With increasing land values, the the plantations are shifting from the traditional areas (States of Sao Paulo, Parana, Rio Grande do Sul), to regions where the climatic and soil conditions are more severe. In these regions, mostly in the Brazilian northeast, several species provenance trials were set up in different soil and climated conditions, in the States of Minas Gerais and Espirito Santo.

The objective of this paper is to report the relationship between climatic conditions and height growth of eight eucalypt species : *E. grandis*, *E. urophylla*, *E. pilularis*, *E. dunnii*, *E. propinqua*, *E. tereticornis*, *E. camaldulensis* and *E. pellita*. Those species are considered as potentially suitable for reforestation on tropical and sub-tropical lands.

SPECIES AND PROVENANCES TESTED

The eight species were selected from a set more than a dozen species established in a broad program established by the I.B.D.F. (Brazilian Forest Development Institute). The species and provenances are given in Table 1.

Table 2 shows the characteristics of the places where the seeds for the trials were collected. Except for *E. urophylla* and *E. camaldulensis*, the provenance of the species was the same in all the eleven trials. The two *E. urophylla* and *E. camaldulensis* provenances are similar in field performance.

CLIMATIC CONDITIONS OF THE PLANTATION SITE

Climatic characteristics are shown in Table 3. Trials were established at eleven locations. The mean heights at 3.5 years old are shown in Table 4 and the rank for each species within each location is shown in parenthesis.

REGRESSION ANALYSIS

The coefficients of determination (R^2) of height growth and each of the climatic variables, altitude (meters), mean annual temperature (°C), rainfall (mm) and annual water deficit (mm) are shown in Table 5, followed by the statistical significance.

The best linear models for each species are shown in Table 6, followed by the coefficient of determination. The models were selected through stepwise regression.

TABLE I - Species and provenance tested in eleven locations in the states of Minas Gerais and Espírito Santo, identified by their australian number.

	LAVRAS	ARACRUZ	P.CORRIDA	S.MATEUS	UBERABA	VIÇOSA	B.DESPACHO	PARAOPEBA	V.PALMA	CATAGUAZES	J.PINHEIRO
E. grandis	+ 48	+ 48	+ 48	+ 48	+ 48	+ 48	+ 48	+ 48	+ 48	+ 48	+ 48
E. urophylla	10135	10135	10140	10135	10140	10140	10140	10140	10140	10140	10135
E. pilularis	9492	9492	9492	9492	9492	9492	9492	9492	9492	9492	9492
E. dunnii	9370	9370	9370	9370	9370	9370	9370	9370	9370	9370	9370
E. propinqua	+ 3	+ 3	+ 3	+ 3	+ 3	+ 3	+ 3	+ 3	+ 3	+ 3	+ 3
E. tereticornis	+ 29	+ 29	+ 29	+ 29	+ 29	+ 29	+ 29	+ 29	+ 29	+ 29	+ 29
E. camaldulensis	10533	10266	10266	10266	10266	10266	10266	10266	10266	10266	10533
E. pellita	10955	10955	10955	10955	10955	10955	10955	10955	10955	10955	10955

Lavras - MG.
Aracruz - ES.
Pedra Corrida - MG.
São Mateus - ES.
Uberaba - MG.
Viçosa - MG.
Bom Despacho - MG.
Paraopeba - MG.
Várzea da Palma - MG.
Cataguazes - MG.
João Pinheiro- MG.

TABLE II - Characteristics of the australian locations where the seeds were collected.

SPECIES	AUSTRALIAN CODE	LOCATION	STATE	LATITUDE	LONGITUDE	ALTITUDE (m)
E. grandis	+ 48	Atherton Dist.	QLD	17°02'	145°37'	792
E. urophylla	10135	Maubisse	T.P.	8°54'	125°36'	1554
	10140	Keorema	T.P.	8°53'	125°32'	2072
E. pilularis	9492	Gallangowan	QLD	36°30'	152°20'	579
E. dunnii	9370	Mc Person R.G.	NSW	28°23'	152°19'	792
E. propinqua	+ 3	Rochampton S.D.	QLD	23°30'	150°33'	940
E. tereticornis	+ 29	Mackay D.	QLD	21°10'	148°20'	610
E. camaldulensis	10533	Vitoria River	N.T.	15°06'	131°07'	30
	10266	Petford Mareeba	-	-	-	-
		Road Nth	QLD	17°17'	145°59'	457
E. pellita	10955	S. Helenvale	QLD	15°45'	145°15'	36

T.P. - Portuguese Timor
QLD - Queensland
NSW - New South Walles
N.T. - Northern Territory.

TABLE III - Climatic conditions of the plantation's place.

LOCATION	ALTITUDE (m)	MEAN ANNUAL TEMPERATURE (°C)	MEAN ANNUAL RAINFALL (mm)	ANNUAL WATER DEFICIT (mm) - *
Lavras, M.G.	878	19,3	1411	31
Aracruz, E.S.	40	23,5	1287	57
Pedra Corrida, M.G.	213	23,6	1132	130
São Mateus, E.S.	50	23,7	1356	51
Uberaba, M.G.	820	22,0	1506	60
Viçosa, M.G.	650	19,1	1394	23
Bom Despacho, M.G.	742	21,3	1365	68
Paraopeba, M.G.	734	21,0	1182	75
Várzea da Palma, M.G.	478	22,9	1160	143
Cataguazes, M.G.	195	22,8	1235	68
João Pinheiro, M.G.	763	22,4	1345	114

(*) - Thornthwaite & Mather - (1954) - (300 mm).

TABLE IV - Height growth of the Eucalyptus species and provenances, in several locations in the States of Minas Gerais and Espírito Santo. Year - 1977; Age: 3.5 years. Ranks in parenthesis.

SPECIES	LAVRAS M.G.	ARACRUZ E.S.	PEDRA CORRIDA M.G.	SÃO MATEUS E.S.	UBERABA M.G.	VIÇOSA M.G.	BOM DESPACHO M.G.	PARAOPEBA M.G.	VÁRZEA DA PALMA M.G.	CATAGUAZES M.G.	JOÃO PINHEIRO M.G.	MEAN
E. grandis	10,7(1)	17,5(1)	14,6(2)	13,7(1)	10,3(1)	14,0(1)	10,1(1)	7,0(1)	6,8(1)	11,1(2)	5,0(3)	10,98
E. urophylla	10,0(2)	11,9(4)	7,7(6)	10,3(5)	9,3(4)	9,9(7)	7,4(6)	5,9(3)	6,4(3)	9,8(6)	3,1(7)	8,34
E. pilularis	9,1(3)	10,9(6)	11,2(5)	8,0(8)	10,1(2)	11,9(3)	7,8(4)	6,0(2)	6,0(4)	10,3(5)	5,5(2)	8,80
E. dunnii	9,0(4)	12,7(2)	15,0(1)	11,1(3)	9,5(3)	13,3(2)	7,0(8)	4,1(7)	5,8(5)	9,5(7)	3,0(8)	9,09
E. propinqua	8,2(6)	8,5(7)	11,2(5)	9,3(7)	9,1(5)	10,3(6)	9,1(2)	5,3(4)	6,6(2)	12,5(1)	4,7(4)	8,62
E. tereticornis	8,5(5)	12,7(2)	14,6(2)	10,4(4)	8,7(6)	11,5(4)	7,7(5)	4,6(6)	4,8(7)	10,8(3)	4,6(5)	8,99
E. camaldulensis	7,5(7)	12,3(3)	11,6(4)	13,4(2)	7,8(8)	6,8(8)	8,7(3)	7,0(1)	5,5(6)	10,3(5)	5,6(1)	8,95
E. pellita	6,7(8)	11,8(5)	12,7(3)	9,8(6)	8,0(7)	10,9(5)	7,1(7)	5,0(5)	6,6(2)	10,7(4)	4,0(6)	8,48
Mean	8,7	12,3	12,3	10,7	9,1	11,3	8,1	5,6	6,1	10,6	4,4	

TABLE V - Coefficients of determination (R^2) , as related height growth to the climatic variables.

SPECIES	ALT.	M.A.T.	R.F.	W.D.
E. camaldulensis	0,672**	0,213	0,004	0,086
E. dunnii	0,337*	0,000	0,000	0,082
E. grandis	0,418*	0,030	0,004	0,185
E. pellita	0,542**	0,005	0,042	0,035
E. pilularis	0,117	0,007	0,039	0,208
E. propinqua	0,226	0,011	0,000	0,084
E. tereticornis	0,394*	0,049	0,000	0,073
E. urophylla	0,223	0,000	0,086	0,451*

(*) - significant at 5% level.

(**) - significant at 1% level.

ALT. - Altitude (m)

M.A.T. - Mean Annual Temperature (ºC)

R.F. - Rainfall (mm)

W.D. - Water Deficit (mm).

TABLE VI - Best linear models for height growth of each Eucalyptus species, as function of climatic variables.

SPECIES	MODEL	COEFFICIENT OF DETERMINATION (R^2)
E. camaldulensis	HT = 20.6628 - 2.0048 (LALT)	0,7368
E. dunnii	HT = 10.2675 - 0.0086 (ALT) + 190.24069 (IWD)	0,6208
E. grandis	HT = 22.8181 - 2.5300 (LALT) + 165.1461 (IWD)	0,7181
E. pellita	HT = 8.2431 - 0.01 (ALT) + 0.0233 (RF2) + 93.5750 (IWD)	0,8094
E. pilularis	HT = 8.2491 - 0.0033 (ALT) + 127.1624 (IWD)	0,4749
E. propinqua	LHT = 1.7638 - 0.0017 (ALT) + 0.0087 (RF2) - 35.6160 (IALT)	0,7049
E. tereticornis	LHT = 2.2270 - 0.0009 (ALT) + 19.5149 (IWD)	0,5866
E. urophylla	HT = 14.1623 - 0.0044 (ALT) - 0.0482 (WD)	0,7672

HT = Mean Height Growth (meters) at 3.5 years old.

LHT = ln (HT).

ALT = Altitude (meters).

LALT = ln (ALT).

WD = Annual Water Deficit (mm).

IWD = 1/WD.

IALF = 1/ALT.

RF2 = Total Annual Rainfall Squared.

CONCLUSIONS

Eight eucalypt species and provenances were tested at eleven locations in the States of Minas Gerais and Espirito Santo, Brazil.

The relationship between height growth and climatic conditions of the plantation sites were studied through regression technique.

The following conclusions could be drawn :

(a) the altitude of the plantation site was the vaiable of major influence in the height growth of E. camaldulensis, E. dunnii, E. grandis, E. pellita and E. tereticornis.

(b) the annual water deficit influenced only the height growth of E. urophylla.

(c) the mean annual temperature and total annual rainfall did not influence height growth.

(d) it is possible to determine with high precision, growth performance of several eucalypt species knowing some of the climatic conditions of the region where it will be planted.

Although variability in soil properties was not considered in this work it is advisable that in future studies it should be considered.

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TESTES DE PROCEDÊNCIAS DE *EUCALYPTUS* NO SUDÃO.

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Resumo

Dos testes de procedências de eucalipto iniciados 12 anos atrás na região de Savana com baixa precipitação do Sudão, o *E. camaldulensis* de Queensland, Alice Spring e Austrália Ocidental apresentaram os melhores rendimentos em termos de sobrevivência, altura média e diâmetro e área basal. As procedências de Um Abdalla (local) e de Adelaide foram inferiores quanto aos parâmetros avaliados.

A procedência de *E. camaldulensis* (Australis A. 157) teve melhor desenvolvimento que as outras duas, Australian A. 217 e Moroco.

EUCALYPT PROVENANCE TRIALS IN SUDAN.

Summary

From the trials of Eucalypt provenances that were started 12 years ago in the Low Rainfall Woodland Savannah region of Sudan, the E. camaldulensis provenances Queensland, Alice Springs and Western Australia gave the best growth in terms of survival percent, mean top height, girth and basal area. The local variety Um Abdalla and Adelaide were interior.

As for E. tereticornis the variety (Australia A. I57) was more successful than the other two, Australia A. 2I9 and Morocco.

INTRODUCTION

Eucalyptus camaldulensis provinance trials in Sudan started in I966. The performance of 8 provinances of E.camaldulensis together with 3 provinances of E.tereticornis was studied for a period of I2 years. The list of the provinances are shown in the table below

Table I

List of provinances

No.	Name	Batch Number	Origin
I	E.camaldulensis	A.237	New South Wales (Australia)
2	" "	A.238	Victoria (")
3	" "	A.239	Queensland (")
4	" "	A.240	Adelaide (")
5	" "	A.24I	Western Australia
6	" "	A.242	Alice springs (")
7	" "	A.243	Alice springs (")
8	" "	---	Umm Abdalla (Sudan)
9	E.tereticornis	A.I57	Australia
I0	" "	A.2I9	"
II	" "	A. 58	Morocco

Location

The provinances trials were established in Southern Kordofan province at Umm Abdall which is determined by Lat. 12°N and Long. 31°E.

Description of planting site

(i) Aspect : Flat
(ii) Slope : Nil
(iii) Soil : Consists of a clayey topsoil, sometimes cracking mostly mixed with sand, above sandy loam and coarse sand which stays moist most of the year round.
(iv) Vegetation:

The natural vegetation is the *Combretum cordofanum* - *Dalbergia* - *Albizia* *sericicephalla* Savannah Woodland.

Climatic conditions

The provinances were planted in the Low rainfall Woodland Savannah region.

(i) Rainfall:

The area receives an ample amount of summer rainfall which might reach up to 806 mm per year (table 2). Seven raing months with July, August and September being the westest. The rainy days reach up to 63 days every year.

(ii) Temperature and relative humidity:

The region is warm most of the year round and this can easily be seen from the results of table 3. The maximum temperature is above 34°C throughout the year, and the minimum temperature is never below 10°C. Humidity is high during July, August, September and October. December up to April are the driest months.

METHOD

Each provinance was planted in a plot 9 X 9 sq m at spacing 1.5 X 1.5 m. The plots were replicated 3 times to give a total of 33 plots for the 11 provinances. The seeds were sown in polythene tubes in the nursery during January 1966. The soil used is a mixture of sand, clay with small percentage of animal manure. Transplanting of seedlings in the field was carried out early in July. The number of seedlings planted per plot was 49. The plots were thinned in 1974 at an age of 8 years.

Table 2
Monthly and annual average
rainfall and rainy days

Month	J	F	M	A	M	J	J	A	S	O	N	D	Total
Rainfall (mm)	0	0	1	16	74	109	154	192	160	95	0	0	806 mm.
Rainy days	0	0	0	1	6	9	10	14	15	8	0	0	63

Data collected during the first 2 years comprised survival % and height of plants and afterwards girth measurements were included. This was continued up to 12 years. Basal area of trees at an age of 12 years was calculated per feddan and hectare.

RESULTS

1. Survival % :

Counts of living trees was initially conducted 2 months after transplanting, at an age of one year and then successively every second year. The results are shown in table 4. The lowest survival percentage of the camaldulensis is attained by the local variety (Umm Abdalla) which ends its 7th year age with only 51% survival and when it is 12 years old it reached 44%. The very successful ones are the Queensland, Alice Spring and the New South Wales varieties. Victoria provinance seems to be better than Western Australia and Adelaide.

As for the tereticornis it is clear that number 9 has the highest survival percentage while the other two varieties attained low values.

2. Height growth :

Generally the provinances showed very fast growth up to the 7th year and after that the rate of growth slowed down a bit. The local variety Um Abdalla gave the lowest growth rate, where there is no significant difference between the other provinances except that Queensland and Alice Spring varieties are leading (table 5).

Considering tereticornis varieties number 9 gave fast growth than the other two.

Table 3
Max. and min. temperture (°C)
and relative humidity

	Jan.		Feb.		Mar.		Ap.		May		Jun.		Jul.		Aug.		Sep.		Oct.		NoV.		Dec.	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Tempt. C	38	10	39	10	40	15	42	15	42	16	34	20	40	19	34	19	34	17	36	14	36	14	37	12
R. Humidity																								
8 a.m.	57		36		26		38		69		84		91		95		91		91		81		43	
2 p.m.	5		5		5		5		5		17		32		48		42		30		5		10	

Table 4
Survival %

Sp.	Years							
	2 months	I	3	5	7	8	9	I2
I. E.camal. (NSW)	I00	96	92	87	87	86	86	84
2. " " (Victoria)	I00	92	80	80	80	80	77	74
3. " " (Queensland)	I00	I00	96	93	93	92	92	90
4. " " (Adelaide)	I00	96	88	87	74	73	70	6I
5. " " (WA)	I00	84	72	72	72	72	72	72
6. " " (Alice Spring)	I00	I00	I00	97	9I	9I	9I	85
7. " " (" ")	I00	I00	I00	98	90	88	80	88
8. " " (Um Abdalla)	I00	96	85	68	5I	49	49	44
9. E.teret. (Australia)	I00	I00	96	89	83	80	80	78
I0. " " (")	I00	84	72	6I	53	5I	49	42
II. " " (Morocco)	I00	80	72	66	57	57	57	57

Table 5
Mean top height (m)

Sp.	Age in years							
		I	3	5	7	8	9	I2
I. E.camal. (NSW)	0.50	2.I	6.9	I2.9	I7.9	I8.5	20.5	25.0
2. " " (Victoria)	0.58	2.2	6.4	II.5	I7.I	I9.0	20.7	24.2
3. " " (Queensland)	0.50	2.2	7.8	I4.2	I8.9	2I.2	23.7	27.5
4. " " (Adelaide)	0.47	I.7	6.2	II.4	I8.0	20.7	22.0	24.0
5. " " (WA)	0.49	I.7	6.6	II.8	I7.5	I9.5	2I.6	25.0
6. " " (Alice Spring)	0.5I	I.7	7.4	I4.8	I9.9	2I.8	23.3	27.I
7. " " (" ")	0.58	2.0	7.4	I3.6	I8.3	I9.6	20.7	23.8
8. " " (Um Abdalla)	0.49	I.7	4.7	08.3	I3.8	I5.9	I7.5	2I.2
9. E.teret. (Australia)	0.50	2.I	7.2	II.5	I9.0	20.0	23.0	25.2
I0. " " (")	0.42	I.2	5.I	I0.0	I5.5	I7.8	I6.2	20.8
II. " " (Morocco)	0.49	I.6	5.9	II.2	I7.7	I9.0	I9.9	2I.7

Table 6
Mean b.h. girth (cm)

Sp.	Age in years					
	3	5	7	8	9	I2
I. E.camal. (NSW)	I5	22.I	25.2	25.6	26.I	33
2. " " (Victoria)	I4	I8.5	23.6	24.3	25.7	29
3. " " (Queensland)	I9	29.3	34.4	34.9	35.3	37
4. " " (Adelaide)	I6	2I.9	23.9	24.I	26.2	30
5. " " (WA)	I7	26.I	29.9	3I.5	32.2	39
6. " " (Alice Spring)	I5	24.4	29.9	29.9	3I.9	35
7. " " (" ")	I8	25.5	27.4	28.I	30.3	34
8. " " (Um Abdalla)	I5	23.5	26.6	27.0	28.I	35
9. E.teret. (Australia)	I8	24.6	27.6	28.8	29.I	3I
I0. " " (")	I4	23.0	25.0	25.2	25.5	34
II. " " (Morocco)	I5	23	29.8	29.9	3I.2	34

Table 7
Basal area (sq.m)

Provinance number	No. of trees/ plot	No. of trees per fedd.	G (cm)	Basal area per fedd.	B.A/ha. (sq.m)
I.	42	I685	33	I4.II	33.66
2.	37	I486	29	I0.40	24.96
3.	45	I007	37	I8.97	45.52
4.	30	I204	30	8.30	I9.92
5.	35	I405	39	I6.43	39.43
6.	42	I665	35	I5.83	37.99
7.	44	I767	34	I5.72	37.72
8.	22	883	35	8.30	I9.92
9.	36	I445	3I	I0.69	25.65
I0.	2I	843	34	7.50	I8.00
II.	27	I083	34	9.38	22.50

3. Girth :

The increase in girth is very fast during the first 5 years, then it slowed dowed up to the 9th year and faster again due to the effect of thinning. Queensland variety is leading up to the 9th year seconded by Western Australia provinance and then **Alice Spring** (table 6). It seems that the varieties NSW, Western Australia, Um Abdall and E.tereticornis (No.I0) have benefited from thinnings more than the other provinances.

4. Basal area of trees:

The mean basal area per tree was calculated and from that the basal area per feddan and hectar was determined (table 7). As can be seen from the table the provinance Queensland has the highest coverage per hectare seconded by Western Australia variety and then Alice Spring. The local E.camaldulensis variety Um Abdalla and Adelaide gave the lowest basal area per hectare.

As for E.tereticornis number 9 is better than the other two varieties.

Discussion

The results of the experiment showed that the E.camaldulensis provenance Queensland, is superior to the other varieties as regards survival%, height growth, girth and basal area. The two varieties Alice Spring second Queensland in survival % height, and Western Australia provenance is number two in girth dimensions and basal area. The local variety Um Abdalla is inferior inspite of the fact that it gave high survival % up to the 3rd year. The other provenance which might be considered as inferior is the Adelaide variety.

As for E.tereticornis provenances number 9 (A.I57) is very successful compared to number I0 (A.2I9) and to the Morocco variety. Rates of mortalities is high among trees of the last two varieties (A.2I9 and Morocco).

ESTUDOS DE PROCEDÊNCIAS DE *EUCALYPTUS NITENS* (DEANE ET MAIDEN) MAIDEN NA ÁFRICA DO SUL.

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Resumo

Quatro lotes de sementes importados e um local de *E. nitens* foram plantados em três locais na região mais fria do Highveld do Transvaal Oriental da África do Sul em 1973. Um dos experimentos foi eliminado no primeiro inverno por severa geada.

Com base nas medições feitas 1977 nos dos ensaios remanescentes, não houve diferenças significativas entre procedências para altura ou DAP em ambos os locais. A variação para todas as variáveis foi muita alta.

Baseado nos cálculos por volume e produção de massa em madeira, as procedências de Barrington Tops, N.S.W. foram as com melhor desenvolvimento nos dois locais. O lote de semente da África do Sul e um dos dois de Nimmitabel, N.S.W. cresceram quase tão bem e os outros o fizeram pobremente.

PROVENANCE STUDIES OF *EUCALYPTUS NITENS* (DEANE ET MAIDEN) MAIDEN IN SOUTH ÁFRICA.

Summary

Four imported and one local collection of *E. nitens* were planted in 1973 at three locations in the colder regions of the Eastern Transvaal Highveld of South Africa. One trial was killed the first winter by severe frost.

Based on measurements taken in 1977 at the two remaining trials, no significant differences existed among provenances for height or DBH at either location. Variation for all variables was very high.

Based on calculations of volume and wood mass production, the Barrington Tops, N.S.W. provenance performed the best at both locations. The South African collection and one of the two Nimmitabel, N.S.W. provenances grew almost as well. The others did poorly.

INTRODUCTION

Eucalyptus nitens is a species of great potential importance in the cold but humid regions of the Transvaal Highveld. First introduced into South Africa in 1926, when a small quantity of seed was imported from New South Wales (Poynton, 1979), *E. nitens* has become a popular species among private timber growers on the Eastern Transvaal Highveld. The use of this species is limited, however, by a shortage of seed. Some private growers have imported commercial lots of seed, but most is collected from local stands of unknown origin. Because most growers produce mining timber and pulpwood, stands are generally felled at eight to ten years of age, which is before the more vigorous trees have begun to bear seed. This restricts the supply and degrades the quality of the seed.

PROVENANCE TRIALS

The only series of provenance trials of *E. nitens* old enough to analyse is that established in February, 1973, using six seedlots imported from the C.S.I.R.O. in Australia. Only four of these, however, produced enough seedlings to be included in replicated trials. A locally collected seedlot from Nelshoogte State Forest was included in the series (Table 1).

Trials of 5 replications of 36-tree plots were planted at Pan, Belfast and Jessievale State Forests in the Eastern Transvaal. Pan is considered to be cold but dry, Belfast very cold and humid, and Jessievale cold and humid (Table 2). During the first winter the trial at Belfast was completely killed by frost.

Of the two remaining trials, the one at Jessievale did much better than that at Pan. By 1977 the trees at Jessievale had an average height of 12,6 metres and an average DBH (o.b) of 12,0 centimetres. Survival was 96 per cent.

The trees at Pan, on the other hand, averaged 9,0 m in height and had a mean DBH (o.b.) of 10,1 cm. Survival was a relatively poor 38,9 per cent. Nevertheless, *E. nitens* at Pan had much better growth and a better survival rate than *E. deanii*, *E. fastigata* and *E. radiata* planted at the same time.

DIFFERENCES AMONG PROVENANCES

An analysis of Variance of the 1977 growth data (plot means) from the trial at Pan showed no significant differences among provenances. In all cases the error term was very large. No statistically valid conclusions can therefore be drawn. The growth data are presented in Table 3.

The trial at Jessievale also showed no significant differences among provenances for either height or DBH. Again variation was very high (Table 3).

In June, 1979 this trial was given a 40 per cent thinning by plot. Using DBH measurements only, the ranking and significant differences among provenances were as shown in Table 4.

Table 1

South African Stocknumber	Australian Reference	Origin	Latitude	Longitude	Altitude (m)
21550	-	Nelshoogte, R.S.A.	25°49'S	30°50'E	1370
24305	8414	Barrington Tops N.S.W.	34°00'S	151°50'E	1500
24306	8445	Nimmitabel N.S.W.	37°00'S	149°00'E	900
24307	8709	Nimmitabel, N.S.W.	37°00'S	149°00'E	1270
24308	9514	Braidwood, N.S.W.	35°30'S	149°25'E	970

Table 2 TRIAL SITES IN SOUTH AFRICA

Location	Latitude	Longitude	Altitude (m)	Annual Rainfall (mm)	Climate*	Frost
Belfast S.F.	25°39'S	30°02'E	1950	823	MH	Severe
Jessievale S.F.	26°14'S	30°31'E	1733	927	MH	Moderate
Pan S.F.	25°44'S	29°41'E	1737	760	MsH	Severe

* MH - Mesothermal Humid
MsH - Mesothermal sub-Humid

Table 3 Growth Data for Eucalyptus nitens grown at two locations in the Eastern Transvaal based on 16-tree inner plot means at 4 years of age (1977)

Pan State Forest	Height (m)	DBH (cm)	Volume/Tree (cm³)	Percent Survival
S.A. Stock number				
21550	8,7	9,1	0,020	42
24305	9,3	11,0	0,032	34
24306	9,6	11,1	0,034	34
24307	9,2	10,3	0,028	37
24308	8,4	9,2	0,020	42
mean	9,0	10,1	0,031	39
S.D.	1,0	1,3	0,009	17
C.V.	10,0	13,1	28,6	44.4
Jessievale State Forest				
21550	13,0	12,7	0,060	93
24305	13,1	13,1	0,064	97
24306	13,2	12,4	0,058	98
24307	12,5	11,7	0,049	96
24308	12,0	11,2	0,043	96
mean	12,8	12,2	0,054	96
S.D.	2,6	3,7	0,008	3
C.V.	20,4	30,9	14,5	3,1

Table 4 1979 Ranking of E. nitens Provenances growth at Jessievale State Forest based on DBH measurements only.

Before Thinning		After Thinning	
24305	16,5	21550	18,6
21550	16,1	24305	18,2
24306	15,6	24307	17,6
24307	15,5	24306	17,2
24308	13,6	24308	16,4

N.B. Provenances connected by a solid line are not significantly different from one another at the 5 % level of significance

Table 5 Growth data for selected E. nitens trees from each provenance grown at Jessievale State Forest at the age of 6 4/12 years.

S.A. Stock number	Mean DBH (cm)	Mean HTT (m)	Volume(o.b.) (m³)	Wood Density at 20 % total height (kg/m³)
21550	17,9	20,5	0,213	457,2
24305	19,0	19,5	0,205	468,8
24306	18,6	19,6	0,202	454,1
24307	17,8	19,6	0,194	439,5
24308	13,9	17,6	0,122	497,2
mean	17,4	19,3	0,184	463,4
S.D.	2,7	1,7	0,059	34,4

Table 6 Productivity of four year old E. nitens provenances at Jessievale State Forest based on 1977 growth data and 1979 wood densities.

S.A. Stock Number	Volume (o.b.) (m³/ha)	M.A.I. (m³/ha/yr)	Wood Mass (tonne/ha)	M.A.I. (tonne/ha/yr)	Percent of best Provenance Volume	Mass
24305	82,6	20,6	38,7	9,7	100,0	100,0
24306	75,6	18,9	34,3	8,6	91,5	88,6
21550	74,2	18,6	33,9	8,5	89,8	87,6
24307	62,6	15,6	27,5	6,9	75,8	71,1
24308	54,9	13,7	27,3	6,8	66,5	70,5

Three of the largest trees thinned from each plot were intensively sampled. Based on five replications of three trees each, significant differences among provenances were found for height, DBH, wood density at 20 per cent of height, and tree volume (over bark). Refer to Table 5.

PRODUCTIVITY

If one uses the growth data of 1977 and the wood density figures of 1979 one can derive some estimation of the volume and wood mass production of the various provenances. Wood mass production for each provenance was the average tree volume times average wood density times the average stocking for that provenance. Table 6 shows that as of 1977 the Barrington Tops provenance was superior to the others; the South African collection and one Nimmitabel provenance were about equal and the other two considerably inferior in both volume and wood mass production.

CONCLUSIONS

Eucalyptus nitens has shown itself to be a very desirable species for the colder humid regions of South Africa. Existing provenance trials are limited in extent but have pointed out that provenance differences do exist although they are not always statistically significant at young ages because of a high variability within plots. More comprehensive provenance and yield studies should be done.

REFERENCE

Poynton, R.J. 1979. Tree Planting in South Africa. Vol II The Eucalypts. Government Printer, Pretoria, 882 pp.

TESTE DE PROCEDÊNCIAS DE *EUCALYPTUS DEGLUPTA* EM PAPUA NOVA GUINÉ.

John Davidson

Resumo

Os testes de procedências de *Eucalyptus deglupta*, em Nova Guiné, ultrapassaram o ponto intermediário da idade da rotação estimada para produção de madeira para polpa. Os dados analisados neste trabalho envolvem idades até 7 anos. As procedências das regiões mais extensas de Nova Guiné tiveram comportamento inferior. As melhores procedências são originárias do extremo Nordeste e Noroeste da região de ocorrência natural, isto é, Costa Noroeste de New Britain e Nordeste de Mindanao. Futuras colheitas dessas localidades são recomendadas para plantações em regiões tropicais de baixa altitude. O comportamento das procedências diferiu entre localidades e não se encontraram interações procedências x localidade (genótipos x ambiente) significativas.

Medições posteriores do crescimento e da qualidade da madeira são necessárias para que conclusões mais definitivas sejam obtidas.

PROVENANCE TRIALS OF *EUCALYPTUS DEGLUPTA* IN PAPUA NEW GUINEA.

Summary

Provenance trials of *Eucalyptus dèglupta* in Papua New Guinea have passed the mid-point of estimated rotation age for pulpwood production. Data are analysed here up to age 7 years. Mainland New Guinea provenances have performed poorly. Best provenances originated from the extreme north-east and north-west of the natural range, i.e., north-east coast of New Britain and north-east Mindanao. Further collections from these localities are recommended for lowland tropical plantations. Performance of provenances differed among sites but there were no provenance x site (genotype x environment) interactions.

Further measurements of growth and wood quality are required before more definitive conclusions can be made.

INTRODUCTION

Eucalyptus deglupta Blume is a species which has great potential for planting in wet tropical lowlands after harvesting of rainforest. Growth rates are excellent (25-40 cu.m/ha/yr over 15 years) and the wood and bark are good sources of fibre for pulp. Some major industrial projects are now underway in the tropics based, at least in part, on reforestation using this species in fast-growing plantations over short rotations of 10-12 years.

Among the first major provenance trials established were those at three sites in Papua New Guinea (P.N.G.) in the 1970/71 planting season and repeated at two of the sites in the following year.

Results are presented here up to the age of 7 years which represents over half the projected rotation age for pulpwood production.

DESCRIPTION OF PROVENANCES

Nine provenances are represented in the five trials. Brief descriptions of some have been given by Davidson (1972, page 177) and Davidson and Fairlamb (1973). Available information is summarized in Table 1. Locations are given in Figure 1. Three figure batch numbers were assigned by the P.N.G. Office of Forests while those preceded by an 'S' are C.S.I.R.O., Canberra, Australia, numbers.

1. WILELO: Batch 325 collected March 1970, near Wilelo, New Britain, P.N.G.
2. KERAVAT: Batch 260 (S9379) collected May 1969 near Keravat, New Britain, P.N.G.
3. HAGEN: Batch 301 (S8861). This is a land race originating from Keravat or Warongoi, New Britain.
4. MINGENDE: Batch 206/207/208/209 (combined). These collections are from naturally grown trees in the highlands of P.N.G, at an altitude of 2500m.
5. PHILIPPINES (1): Batch 264 (S9291/S9292 combined). Batch S9291 came from a stand on the Caliwan River, Davao del Norte Province, Mindano 2 Km north and 1 km east of Extensive Enterprises Inc. Camp. Bathc S9292 originated from Road 2 about 50 km south of the Bislig Bay Lumber Co. Township on Mindanao.
6. PHILLIPINES (2): Batch 281 (S9408). Milbuk area, Cotabato Province, Mindanao, Phillipines, near kilometer post 23 of Kraan main line (a major logging road) in the Weyerhaeuser Phillipines Inc. concession area, Palimbang.
7. SULAWESI: Batch 265 (S9313) Palopo, Southern Sulawesi, Indonesia, on the bank of the Tampak River, upstream from Tampak village. The village is 2 km west of Ponuang village which in turn is 28 km south of Palopo.
8. RABA RABA: Batch 346 (S8863) P.N.G.
9. POTA GALAI: Batch 216/219 Pota Galai/Ko River, New Britain.

DESCRIPTION OF TEST SITES

1. Gogol: the Gogol Valley is about 30 km west of Madang, P.N.G. It contains the resource for the first large woodship industry in the country. The two trial sites are located near the Gogol River, latitude 5°14'S, longitude 145°27'E.

Rainfall in the area varies from about 2600 to 3400 mm per annum. At Madang the wet season is from November to May when the mean monthly rainfall is 400 mm and there is an average of 24 wet days per month. The less wet season occurs from June to November with a mean monthly rainfall of 230 mm and an average of 14 wet days per month.

The mean monthly maximum ambient temperature at Madang is 30°C. The highest temperature recorded is 33.7°C and the lowest is 18.9°C. Relative humidity at 0900 hrs averages 84 per cent and at 1500 hrs 75 per cent.

Both trials are on river terrace soils which are derived from recent alluvium and characterized by heavy clay texture, massive structure and variable drainage. Chemical analyses suggest that the soils are moderately fertile. The pH levels are neutral to mildly acid and the concentrations of exchangeable cations high. Phosphorus is low but adequate for tree growth. Surface soils (0-10 cm) have moderate to high concentrations of nitrogen but subsoils (50-60 cm depth) have low concentrations (Table 2). *E. deglupta* is not found here naturally. The site was clear felled and burnt prior to planting.

2. Keravat: two trials are located near Keravat, New Britain, approximately latitude 4°20'S, longitude 152°00'E, about 30 km south-west of Rabaul. The first trial (1970/71) was planted near the Vudal River. Soils are essentially deep, fine to medium textured generally well drained but with small areas of swamp caused by the very high water table near the river. Alluvial sorting has occurred close to the river.

The second trial was established on well drained terrace soils near the Keravat River. These are deep, medium textured and well weathered. Nutrient status of the two sites is similar and one set of analyses is given in Table 2. The main difference is that the Vudal River site is less well drained than the Keravat River one. Both sites formerly carried scattered trees of *E. deglupta* and the rainforest was clear felled and burnt prior to planting.

The area lies within the north west monsoon belt with higher rainfall between November and April. No month has less than 180 mm or more than 330 mm of rain. Annual rainfall figures for Keravat vary from 2800 mm to 3300 mm. Both ambient temperature (22°C mean monthly minimum, 31°C mean monthly maximum) and humidity (mean relative humidity 87 per cent at 0900 hrs and 78 per cent at 1500 hrs) are consistently high.

3. Dami: one trial was located here at approximately latitude 5°30'S, longitude 150°30'E. Dami experiences a very heavy wet period from November to March with up to 1000 mm of rain in January. The less wet season, though more distinct than at Keravat, averages over 100 mm of rainfall per month in most years.

The daily absolute range of ambient temperature is 17.8°C to 35.2°C.

Soils are the result of periddic emissions from the numerous volcanoes in the area. There is little profile differentiation and the sequence of horizons is an expression of volcanic deposition, variation being due to location in relation to the last centre of volcanic activity. Soil nutrient levels are given in Table 2.

Natural *E. deglupta* did not occur on this site previously. Drainage here was poorest of all sites.

EXPERIMENTAL DESIGN

Plots were square consisting of 36 trees at 2.5 m spacing with the inner sixteen trees being measured. Keravat 1970/71 and Dami 1970/71 trials were laid out in the field as balanced lattices but analysed as randomized blocks. All nursery results and remaining field trials were laid out and analysed as randomized blocks. Provenances represented in each trial were as follows:

1. Keravat, 1970/71: Wilelo, Keravat, Mingende, Philippines, Sulawesi and Raba Raba. Four replications of each except Mingende (2) and Raba Raba (3).

2. Keravat, 1971/72: Wilelo, Keravat, Mingende, Philippines (1 and 2), Sulawesi, Raba Raba and Pota Galai. Four replications of each except Sulawesi (2) and Pota Galai (2).

3. Dami 1970/71: Wilelo, Keravat, Hagen, Mingende, Philippines (1 and 2) and Raba Raba. Four replications of each except Mingende (3) and Raba Raba (3).

4. Gogol 1970/71: Keravat, Hagen, Philippines (1 and 2). Four replications of each.

5. Gogol 1971/72: Wilelo, Pota Galai, Keravat, Raba Raba, Mingende, Philippines (1 and 2) and Sulawesi. Four replications of each except Pota Galai (1) and Sulawesi (1).

MANAGEMENT

Trials were intended to be kept clean by brushing regularly. However, tending was variable. The trial at Dami suffered severe vine competition and waterlogging during the first two years. At all sites the cutting off of lower branches by tending crews has provided sites for entry of fungus into the heartwood in some trees.

DATA COLLECTION AND ANALYSES

Heights were measured at the end of the nursery stage then in the field at 6, 12, 18 months, 2 years, 2½ years and yearly thereafter to half rotation age. As trees became too high to use height rods it was necessary in some cases to measure only the tallest two trees per plot (200/ha) (called predominant height). There is a good straight line relationship between predominant height and mean height (in m), for example:

18 months: mean height = 0.92 predominant height - 1.3
r = 0.94 (significant at 0.1 per cent level)

30 months: mean height = 0.97 predominant height - 2.03
r = 0.92 (significant at 0.1 per cent level)

6 years: mean height = 7.61 + 0.31 predominant height
r = 0.65 (significant at 0.1 per cent level)

Diameters were measured at breast height overbark from 18 months onwards at the same time heights were measured.

Total stem volumes (cu.m) were calculated from mean total height (H in m) and mean diameter (D in cm) measurements through the regression:

$$\text{Total Volume} = 0.0005601 + 0.0000804\ D^2 + 0.0000205\ D^2H - 0.0000314\ H^2 + 0.0000111\ DH^2$$

The 1970/71 series of trials was thinned by systematically harvesting every second tree in the third year. Green and dry weights were obtained and wood density determined for percentile discs by water immersion method (Davidson 1972). These were later converted to whole-tree density values arithmetically (Davidson 1972).

No thinning was carried out in the 1971/72 series of trials.

Preceding analyses of variance, data were tested for normality by use of the Kolmogorov-Smirnov statistic and for homogeneity of variance (Sokal and Rohlf 1969).

Significance of each result was determined by consulting statistical tables (Rohlf and Sokal 1969).

Some treatments produced only enough stock to plant one or two replications in the field. Since the field design was always laid out in advance, these replications were planted but excluded from analyses of variance. These plots provide comparative information but, for example, one would hesitate to conclude that Pota Galai and Sulawesi provenances were the best based on a single observation.

Differences between replications (blocks) occurred in some cases. As a general rule these were not a matter of concern. Some tests were carried out analysing data by both completely random and randomized blocks procedures. In the randomized blocks design the variance due to blocks can be measured, while in the completely randomized design it is included in the residual (error) variance. When the relative efficiency of the randomized complete block residual variance with respect to completely randomized residual variance was tested, values between 120 and 140 per cent were obtained. Clearly, it was advantageous to retain the complete randomized blocks design and exclude these treatments with only 1 or 2 replications.

RESULTS

Growth

Nursery: Heights were measured in all trials at the end of the nursery stage (plants about 6 months old). The Keravat and two Philippines provenances grew consistantly well at all test sites. Growth was better at Dami and Keravat nurseries than at Gogol (Table 3).

Year 1: Tree heights were measured six months and one year after planting in the field. New Britain and Philippines provenances were performing better than New Guinea mainland ones, but this difference was not statistically significant in those trials which were showing a significant difference between blocks (replications)
New Britain sites were much better for growth than the mainland site.

Year 2: Heights and diameters at breast height (1.3 m) were measured at 18 months (except Gogol 70/71) and two years (except Gogol 71/72). New Britain and Philippines provenances were still performing better than New Guinea mainland provenances. The Raba Raba provenance was growing particularly slowly.

After 18 months of growth, very highly significant (0.1 per cent level) differences could be demonstrated between trial sites, while differences between provenances at all sites were significant (5 per cent level)

There was no provenance x site interaction for height or diameter growth at this age

Year 3: Three of the trials were measured at the end of two and a half years (Keravat 70/71, Keravat 71/72 and Dami 70/71 (2 years and 3 months)). There were significant differences between replications in all three trials. For the first time in the field, significant differences (at 5 per cent level) were shown between provenances for height growth in the Keravat 70/71 trial

Three of the trials were measured at the end of three years (Keravat 70/71 and Dami 70/71 and Gogol 71/72 (at 3 years and 3 months)). No significant differences were evident for height or diameter measurements except diameter at Dami The latter trials showed significant differences between replications.

Year 4 and 5: Following a change after three years from measuring the height of every tree in the plot to measuring the two tallest only ("predominant height") and the harvesting of every second tree in the Keravat, Dami and Gogol 1970/71 trials for wood quality investigations, there was a period where differences between provenances were hard to distinguish statistically. Measures also were reduced in frequency.

Despite these drawbacks, the mainland New Guinea provenances were still lagging behind the others and at Dami, the Raba Raba provenance had failed to survive the waterlogged conditions and vine competition.

At the end of 5 years only the Gogol trials were measured. Rankings were similar to the four-year measurements except that there were, statistically, very highly significant differences (0.1 per cent level) between provenances for predominant height growth in the 1971/72 trial.

Years 6 and 7: While the Raba Raba provenance (8) remained at or near the bottom in rankings for height and diameter growth, the Mingende provenance (4) moved up towards the middle ranking in some trials (Table 4)

Analyses of variance of trials at two sites (Tables 5 and 6) shows very highly significant differences (0.1 per cent level) between provenances for both height and diameter growth and significant differences (5 per cent level) between sites for diameter growth. There is still no significant provenance x site interaction to age 7 years. Increase in average height and diameter with time for all trials is illustrated in Figures 2 and 3.

Survival

There appear to have been two periods where deaths have occurred. The first is between planting and 18 months of age, the second later, after three years of age. The first is probably a result of weed competition and/or adverse soil or climatic effects, the second is more likely through disease or effects of competition between trees. By age 5 or 6 there are very highly significant differences between provenances for survival, expressed as the number of trees remaining per plot.

New Britain provenances and the Philippine provenance from south-east of Bislig Bay, Mindanao showed best survival. The other Philippines provenance and the remainder showed a lower survival rate. The trend in survival averaged for all trials is illustrated in Figure 4.

There is no significant difference among provenances for the number of trees of dominant crown class but there is a difference (significant at 5 per cent level) in the relative number of suppressed or overtopped trees still alive and standing. The figures indicate that suppressed trees die and disappear quickly in the Mingende and Raba Raba provenances (poor survival) and linger on in the Keravat, Philippines (Cotabato) and Sulawesi provenances (medium survival). There are very few suppressed trees in the Philippines (Bislig) and remaining New Britain provenances (high survival).

There are significant differences (5 per cent level) in survival between the Gogol and Keravat sites (Table 7). In the 1971/72 unthinned trials overall survival is better at Gogol. At Gogol the Wilelo provenance was worse while the Raba Raba and two Philippines provenances were much better than at Keravat. This indication of slight provenance x site interaction for survival is reflected in the appropriate mean square in Table 7 but the value is below the 10 per cent level of significance.

Bole Shape

Bole shape was assessed using the point scoring method described by Davidson (1972). Straightness, fluting and buttressing were determined during the sixth year of growth on the two 1971/72 trials

Trees were straighter at Keravat than at Gogol (by 3 points out of 25). There were no significant differences between provenances at either site but the difference between sites was significant at the 1 per cent level. Provenances with high scores were Raba Raba and Philippines (Cotabato

For fluting, differences between provenances were significant at Keravat (5 per cent level) and at Gogol (1 per cent level). There was no significant difference between sites. Provenances with more cylindrical stems came from New Britain and Philippines.

No significant differences between provenances or sites were evident for degree of buttressing.

Leaf Shape

There were significant (1 per cent level) differences between provenances for leaf width, length and area. New Guinea mainland provenances (Raba Raba and Mingende) had the largest, New Britain (Wilelo and Keravat) intermediate and Sulawesi and Philippines the smallest leaves.

Aerial Rooting Ability

E. deglupta, like *E. robusta* forms aerial roots particularly on swampy sites. There were significant differences between provenances in the number of aerial roots formed and the height up the bole they were found. Mingende provenance produced the most aerial roots (average 22 per stem), Wilelo and Philippines (Cotabato) an intermediate number (15-19 per stem), Raba Raba, Sulawesi, Philippines (Bislig) and Keravat virtually none (1-3 per stem). There was a positive correlation between number of roots and the distance up the bole that they occurred.

Wood Volume Production

When height and diameter are converted to volume per stem, the provenance rankings are inconsistent because trees are larger in the plots with few survivors. Also trees are larger in the trials which were thinned by 50 per cent about year 2.

Inclusion of stocking rates, leads to figures for volume/hectare which are more consistent in provenance rankings, with mainland New Guinea provenances generally at or near the bottom and Philippines (Bislig) and New Britain provenances at or near the top (Table 9).

TABLE 1. PROVENANCE DATA - 9 PROVENANCES

Provenance	Latitude	Longitude	Altitude (m)	Annual Rainfall (mm)	Mean Monthly Maximum Temperature °C	Mean Monthly Minimum Temperature °C	Number of Trees in Collection
1. Wilelo	5°35'S	150°15'E	10	3800	31	27	several
2. Keravat	4°20'S	152°00'E	5	2656	32	27	25
3. Hagen	5°51'S	144°09'E	1800	2622	25	14	10
4. Mingende	5°58'S	144°55'E	2500	2500	24	13	several
5. Philippines (i)	7°36'N	126°07'E	510	2600	27	26	8 + 1
6. Philippines (ii)	6°15'N	124°18'E	390	2550	28	26	4
7. Sulawesi	2°50'S	121°00'E	20	3000	30	26	10
8. Raba Raba	9°58'S	149°50'E	150	1494	33	28	several
9. Pota Galai	5°30'S	150°15'E	30	4200	31	27	1 - 2

TABLE 2. SOIL NUTRIENT LEVELS AT THREE TEST SITES

Locality	Depth (cm)	pH	P Olsen (p.p.m.)	Ca m.eq.%	Mg m.eq.%	K m.eq.%	Na m.eq.%	C%	N%	C/N
Gogol River Terrace	0-10	6.4	17.0	31.6	14.4	1.39	0.17	5.3	0.50	10.6
	50-60	6.7	8.0	28.2	15.7	0.60	0.49	0.7	0.10	7.0
Keravat River Terrace	0-10	6.6	15.8	21.5	0.4	0.51	0.46	4.1	0.65	6.3
	50-60	7.6	4.5	1.0	0.02	0.01	0.12	1.2	0.15	8.0
Dami	0-10	6.3	8.0	25.5	3.5	0.86	0.75	8.6	1.0	8.6
	50-60	6.2	4.0	7.5	0.5	4.48	0.55	2.1	0.23	9.1

TABLE 3. PLANT HEIGHT (M) AT END OF NURSERY STAGE

Keravat 70/71		Keravat 71/72		Dami 70/71		Gogol 70/71		Gogol 71/72	
3,6	0.31	5	0.39	1	0.37	6	0.23	6	0.27
2	0.30	2	0.37	5	0.35	3	0.18	5,8,9[1]	0.25
7	0.29	1,6	0.32	2	0.33	2	0.12	2	0.24
1	0.28	7	0.18	6	0.29	5	0.11	4	0.23
5	0.26	4	0.12	3	0.24			1	0.22
8	0.16	8	0.10	8	0.14			7[1]	0.19
4	0.11	9	0.07	4	0.12				

[1] Mean derived from one replication only.

Provenances: 1 Wilelo; 2 Keravat; 3 Hagen; 4 Mingende; 5 Philippines 9291/9292(1); 6 Philippines 9408 (2); 7 Sulawesi, 8 Raba Raba; 9 Pota Galai. Those means joined by the same line were not significantly different at the 1 per cent level.

TABLE 4 TREE DIAMETERS AT 6 AND 7 YEARS

6 Years				7 Years			
Keravat 71/72		Gogol 71/72		Keravat 70/71		Gogol 70/71	
Diameters:							
1	13.6	9	16.7[1]	7	19.2	5	20.3
5	13.2	6	15.6	3	18.8	2	19.8
7	13.2[2]	1	15.2	4	18.5[2]	6	18.8
4	12.5	5	14.8	5	18.4	3	16.4
2	12.4	7	14.6[1]	2	18.1		
9	12.2[2]	4	14.5	6	16.5		
6	11.9	2	13.5	1	16.0		
8	7.0[3]	8	13.1	8	15.6		
Heights:							
7	15.2[2]	9	33.0[1]	7	21.5	2	29.6
1	15.2	5	29.8	4	20.8[2]	5	27.0
5	15.1	7	29.0[1]	3	19.5	6	26.9
4	14.3	1,6	28.6	5	19.3[3]	3	25.0
6	14.0[2]	2	25.3	2	18.9		
2	13.6	8	24.7	8	18.3[3]		
8	8.7[3]	4	23.1	6	17.3		
				1	17.0		

[1] Mean derived from 1 replication only (not included in the analyses of variance).

[2] Mean derived from 2 replications only (not included in the analyses of variance).

[3] Mean derived from 3 replications.

Provenances: 1 Wilelo; 2 Keravat; 3 Hagen; 4 Mingende; 5 Philippines 9291/9292(1); 6 Philippines 9408(2); 7 Sulawesi; 8 Raba Raba; 9 Pota Galai. Those means joined by the same line are not significantly different at the 5 per cent level (Keravat 70/71, Gogol 70/71), 1 per cent level (Gogol 71/72) or 0.1 per cent level (Keravat 71/72).

TABLE 5 ANALYSIS OF VARIANCE FOR PREDOMINANT HEIGHT AT TWO SITES+

IN THE SIXTH YEAR OF GROWTH

Source	Degrees of Freedom	Mean Square	Variance Ratio	Significance
Sites	1	14.5	2.5	N.S.
Replications	3	10.0	1.7	N.S.
Provenances	5	79.0	13.6	***
Sites x Replications	3	3.6	0.6	N.S.
Sites x Provenances	5	14.1	2.4	N.S.
Replications x Provenances	15	5.0	0.9	N.S.
Remainder	15	5.8		
Total	47			

+Trials represented: Keravat 71/72 and Gogol 71/72.

N.S. Not significant at the 5 per cent level.

*** Very highly significant at the 0.1 per cent level.

TABLE 6 ANALYSIS OF VARIANCE FOR TREE DIAMETER AT TWO SITES+ IN THE SIXTH YEAR OF GROWTH

Source	Degrees of Freedom	Mean Square	Variance Ratio	Significance
Sites	1	15.56	5.72	*
Replications	3	4.09	1.50	N.S.
Provenances	5	23.51	8.64	***
Sites x Replications	3	2.05	0.75	N.S.
Sites x Provenances	5	5.48	2.01	N.S.
Replications x Provenances	15	2.10	0.77	N.S.
Remainder	15			
Total	47			

+Trials represented: Keravat 71/72 and Gogol 71/72.

N.S. Not significant at the 5 per cent level.

* Significant at the 5 per cent level.

*** Very highly significant at the 0.1 per cent level.

TABLE 7 ANALYSES OF VARIANCE FOR SURVIVAL AT TWO SITES, KERAVAT AND GOGOL DURING SIXTH YEAR

Source	Degrees of Freedom	Mean Square	Variance Ratio	Significance
Sites	1	27.0	5.59	*
Replications	3	2.5	0.51	N.S.
Provenances	5	71.0	14.70	***
Sites x Replications	3	0.9	0.19	N.S.
Sites x Provenances	5	10.9	2.26	N.S.
Replications x Provenances	15	4.8	1.0	N.S.
Remainder	15	4.8		
Total	47			

* Significant at the 5 per cent level.

*** Very highly significant at the 0.1 per cent level.

N.S. Not significant at 5 per cent level.

TABLE 8 SCORES FOR STRAIGHTNESS AND FLUTING AT TWO SITES

Straightness (score out of 25)				Fluting (score out of 25)			
Keravat 71/72		Gogol 71/72		Keravat 71/72		Gogol 71/72	
6	16.5	8	15.2	6	10.4	1	10.6
8	15.2	6	13.4	1,5	9.6	6	9.9
1	15.1	5	12.1	2	9.4	5	9.0
2	14.2	2	11.8	8	8.9	2	8.3
5	14.1	1,4	11.5	4	8.2	8	7.6
4	13.9					4	7.2

Highest score means straightest or most cylindrical bole.

There was a significant difference between replications for fluting in the Keravat trial.

Provenances: 1 Wilelo; 2 Keravat; 4; Mingende; 5 Philippines 9291/9292(1); 6 Philippines 9408(2); 8 Raba Raba. Those means joined by the same line were not significantly different at the 5 per cent level except Gogol 1971/72 for fluting (1 per cent level).

TABLE 9. WOOD VOLUME PER HECTARE AGE 5-7 YEARS (CU.M./HA.)

5 Years		6 Years				7 Years+			
Gogol 71/72		Keravat 71/72		Gogol 71/72		Keravat 70/71		Gogol 70/71	
9	229.6[1]	1	158.5	9	302.6[1]	7	208.0	5	134.3
5	157.9	5	137.0	5	196.6	2	151.6	6	109.8
1	144.0	9	130.5[2]	1	192.8	5	127.5	2	105.4
7	140.2[1]	2	107.9	7	190.2[1]	6	114.6	3	67.4
6	126.6	6	71.2	6	158.3	4	98.8[2]		
2	104.3	7	61.7[2]	2	111.1	1	91.0		
8	77.7	4	50.6	8	102.8	8	87.7[3]		
4	57.9	8	12.6	4	76.4	3	77.6		

+Keravat 70/71 and Gogol 70/71 trials thinned by 50 per cent of stems at about two years of age.

[1] Only one replication (not included in analyses of variance).

[2] Only two replications (not included in analyses of variance).

[3] Three replications.

Provenances: 1 Wilelo; 2 Keravat; 3 Hagen; 4 Mingende; 5 Philippines 9291/9292(1); 6 Philippines 9408(2); 7 Sulawesi; 8 Raba Raba; 9 Pota Galai. Those means joined by the same line are not significantly different at the 5 per cent level (Keravat 70/71 and Gogol 70/71) or 0.1 per cent level (remainder).

TABLE 10 WOOD DENSITY (KG/CU.M.)

Keravat 70/71		Gogol 70/71	
4	460[2]	6	362[3]
6	421	5	355
7	395	2	328[2]
8	394[3]	3	322
5	388		
2	360		
3	359		
1	333		

[2] Mean derived from 2 replications only (not included in the analyses of variance).

[3] Mean derived from 3 replications.

Provenances: 1 Wilelo; 2 Keravat; 3 Hagen; 4 Mingende; 5 Philippines 9291/9292(1); 6 Philippines 9408(2); 7 Sulawesi; 8 Raba Raba; 9 Pota Galai. Means joined by the same line are not significantly different at the 1 per cent level (Keravat 70/71) or 5 per cent level (Gogol 70/71).

TABLE 11 WOOD PRODUCTION (TONNES/HA DRY WEIGHT)

5 Years		6 Years				7 Years+			
Gogol 71/72		Keravat 71/72		Gogol 71/72		Keravat 70/71		Gogol 70/71	
5	66.5	5	57.7	5	82.8	7	83.4	5	56.5
7	55.4[1]	1	52.8	7	75.1[1]	2	53.0	6	42.6
6	49.0	2	38.8	1	64.2	5	51.4	2	31.9
1	48.0	6	27.6	6	61.4	4	46.2[2]	3	24.2
2	37.5	7	24.4[2]	8	40.5	6	44.3		
8	30.6	4	23.3	2	40.0	8	34.6[3]		
4	26.6	8	5.0	4	35.1	1	30.6		
						3	29.0		

+Keravat 1970/71 and Gogol 70/71 trials thinned by 50 per cent of stems at about two years of age.

[1] Mean derived from 1 replication only (not included in the analyses of variance).

[2] Mean derived from 2 replications only (not included in the analyses of variance).

[3] Mean derived from 3 replications.

Provenances: 1 Wilelo; 2 Keravat; 3 Hagen; 4 Mingende; 5 Philippines 9291/9292(1); 6 Philippines 9408(2); 7 Sulawesi; 8 Raba Raba; 9 Pota Galai. Means joined by the same line are not significantly different at the 5 per cent level (5 and 6 year results were not analysed).

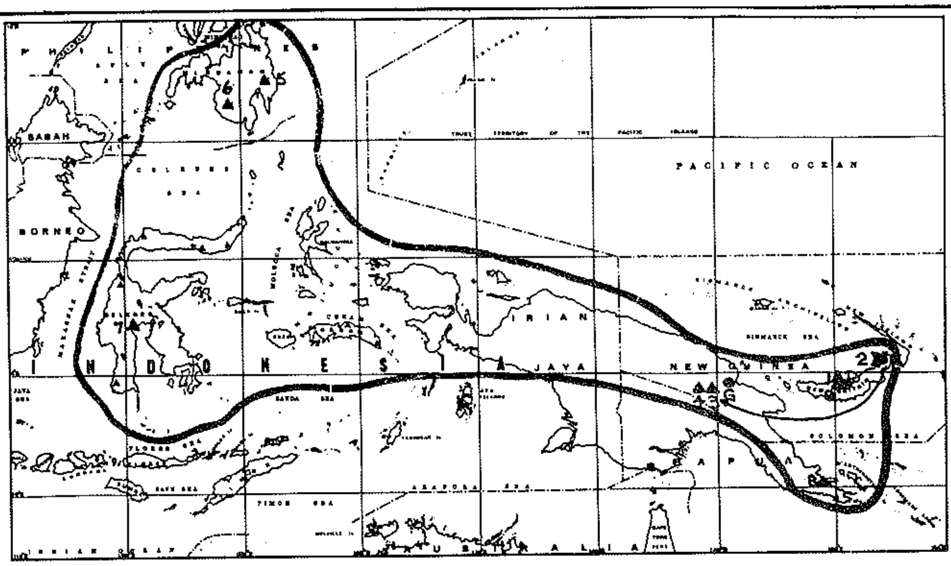

FIGURE 1. Map showing the natural distribution of *E. deglupta*. Numbers (triangles) refer to provenance collections as follows: 1. Wilelo; 2. Keravat, 3. Hagen, 4. Mingende, 5. Philippines(1), 6. Philippines(2), 7. Sulawesi, 8. Raba Raba and 9. Pota Galai. Letters (circles) refer to trial sites in P.N.G. as follows: K. Keravat, D. Dami and G. Gogol.

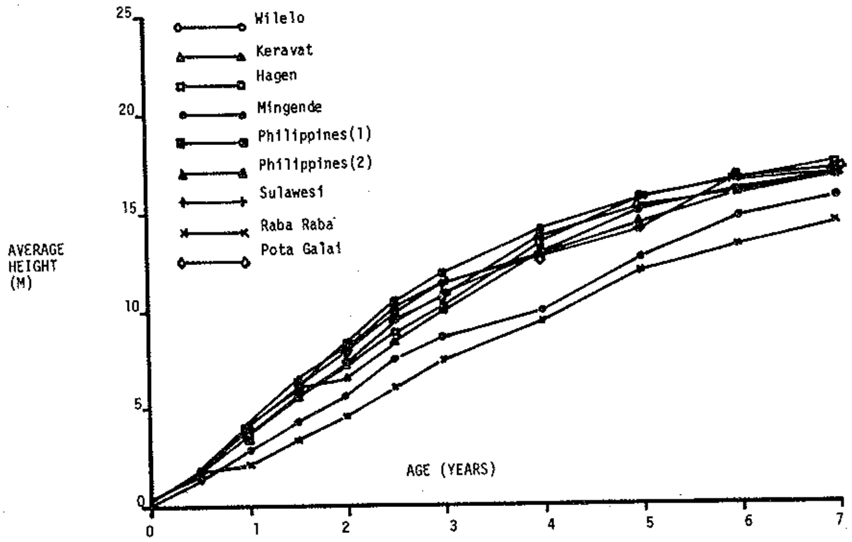

FIGURE 2. Average height growth over all trial sites

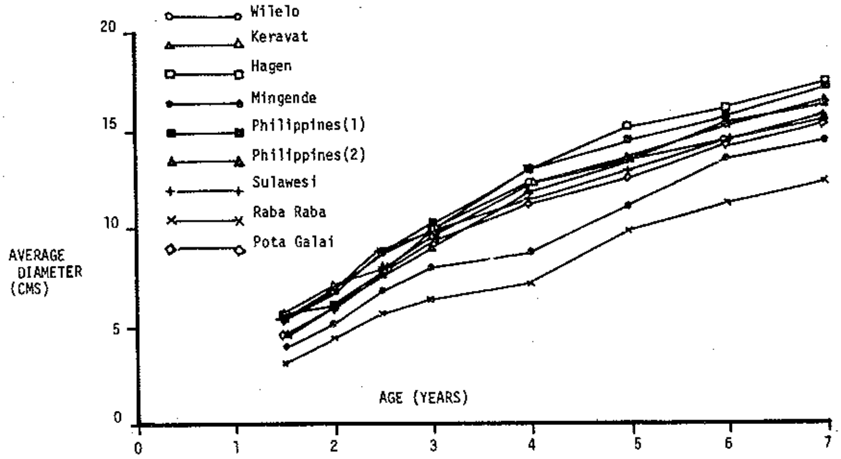

FIGURE 3. Average diameter growth over all trial sites.

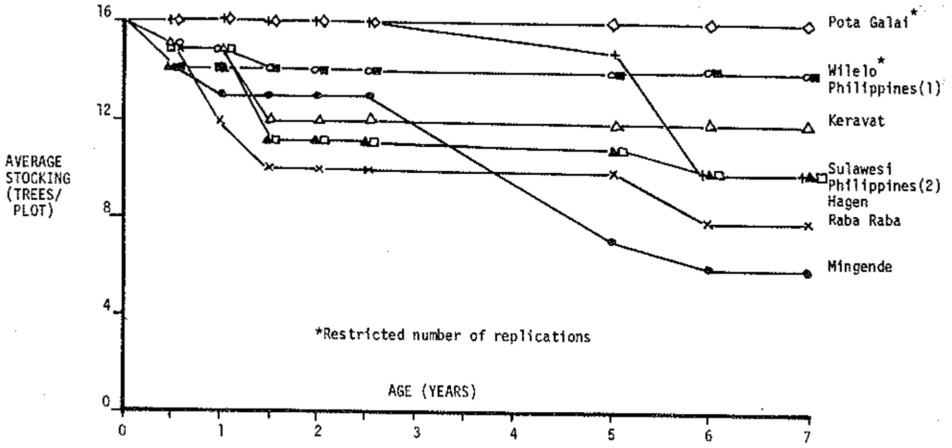

FIGURE 4. Average stocking per plot (original stocking 16 trees) over all trial sites.

WOOD DENSITY AND WOOD DRY WEIGHT PRODUCTION

There were significant differences (at 1 per cent level) between provenances for wood density at age two years (Table 10).

When these density results were used as a guide to wood density in later years, and combined with volume and stocking, an idea of the weight of dry wood produced per hectare was obtained (Table 11).

Although more data are required for the second half of the rotation, New Guinea mainland provenances seem generally poorer than the rest, and Philippines (Bislig) provenance performs well at both Keravat and Gogol sites. The Keravat provenance performs better at Keravat than it does at Gogol. At age 6 in the 1971/72 series of unthinned trials, more wood has been produced at Gogol than at Keravat (average 57.0 and 32.8 tonnes/ha dry weight respectively).

FURTHER WORK

More detailed provenance collections are required from Mindanao and New Britain now that the wide-ranging trials have indicated these are the best areas on which to concentrate. As a result of these trials suggestions on methods and design can be put forward.

At least 20 parent trees should be sampled to represent each provenance. Seed should be kept separate by parent but it is not necessary for provenance trials. Trees derived from mixed seed should be planted in square plots of 100 trees of each provenance in at least five blocks of a randomized block design.

Preferably, a comparison should be made with one of the provenances used in the present series of trials and with a bulk collection of present seed-orchard seed enable future decisions to be taken on breeding strategy.

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TESTES DE PROCEDÊNCIA DE *EUCALYPTUS CLOEZIANA* F. MUELL NA REPÚBLICA POPULAR DO CONGO.

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Resumo

A boa adaptação, o crescimento, a forma do tronco e as qualidades da madeira fizeram do *Eucalyptus cloeziana* uma espécie importante para o reflorestamento nas savanas – da República Popular do Congo.

Desde 1956, várias procedências australianas foram introduzidas pelo C.T.F.T. – Congo.

Especialmente o teste de procedência mais amplo foi estabelecido em 1977. As primeiras informações deste são apresentadas neste trabalho.

ESSAIS DE PROVENANCES D'*EUCALYPTUS CLOEZIANA* F. MUELL. EN REPUBLIC POPULAIRE DU CONGO.

Resumé

The good adaptation, the growth, the stem form and the qualities of the wood of *Eucalyptus cloeziana* made this species interesting for savannah afforestation in the People's Republic of Congo.

Since 1956, many Australian provenances of *Eucalyptus cloeziana* have been introduced by the C.T.F.T. - Congo.

In particular, a very comprehensive provenance trial has been established in 1977. We report here the first information on this test.

2 - INTRODUCTION

Les premières introductions d'Eucalyptus cloeziana au Congo, en 1956 et 1963, nous ont révélé la bonne adaptation de cette espèce aux conditions écologiques locales.

La croissance régulière et prolongée de la plantation de 1963, la forme généralement satisfaisante des arbres, les qualités technologiques assez remarquables d'Eucalyptus cloeziana et notamment sa durabilité, nous ont amenés à nous interesser d'une manière plus précise à cette espèce et à en introduire de nombreuses provenances.

En effet, l'aire naturelle d'E. cloeziana, en Australie, recouvre une large gamme de conditions écologiques et présente de nettes disjonctions. Ceci nous laisse supposer qu'il existe une grande variabilité génétique à l'intérieur de l'espèce.

Grâce à la collaboration des chercheurs australiens, nous avons pu mettre en place des essais de provenances en 1971, 1973, 1974 et 1977. L'essai de 1977 est particulièrement intéressant puisqu'il comporte 16 provenances récoltées sur l'ensemble de l'aire naturelle de l'espèce.

3 - LES FACTEURS DU MILIEU

La région de Pointe-Noire en République Populaire du Congo est située à environ 5° de latitude Sud ; elle est caractérisée par un climat presque équatorial avec cependant une saison sèche marquée (15 mai au 15 Octobre). La moyenne annuelle des précipitations est de 1254 mm, la température est assez constante (22 à 26°C) et l'hygrométrie reste élevée toute l'année.

Les plateaux côtiers sur lesquels sont installées les parcelles expérimentales et les boisements industriels récents portent une savane inculte parcourue par le feu en saison sèche.

Les sols sableux sont généralement pauvres, à faible teneur en argile, mais profonds et filtrants.

4 - LES PREMIERES INTRODUCTIONS

Eucalyptus cloeziana a été introduit pour la première fois au Congo en 1956. Cette introduction australienne d'origine inconnue s'est révélée parfaitement adaptée aux conditions locales mais présente une forme relativement médiocre et une croissance assez faible.

Une nouvelle introduction fut tentée en 1963. Elle nous a permis de découvrir les qualités de l'espèce :

- croissance régulière dans le temps même si elle parait lente au départ
- fût rectiligne
- élagage excellent
- houppier bien développé qui assure une totale couverture du sol.

Les caractéristiques du peuplement installé en 1963 sont éloquentes, à 16 ans nous obtenons les chiffres suivants :

- Hauteur totale moyenne	:	27 mètres
- Circonférence moyenne à 1,5 m	:	76 centimètres
- Surface terrière	:	45 m^2 par hectare
- Nombre de tiges à l'hectare	:	950.

Nous supposons que les deux provenances introduites en 1956 et 1963 sont des provenances du Sud Queensland région de GYMPIE.

5 - LES INTRODUCTIONS DE 1971 A 1974

De nouvelles introductions, portant au total sur 14 provenances, ont été réalisées en 1971, 1973 et 1974. Elles ne recouvrent pas la totalité de l'aire d'E. cloeziana.

Les provenances qui ont donné les meilleurs résultats sont :

- pour 1971 : CARDWELL du Nord Queensland côtier qui est très bien adaptée, homogène et de forme remarquable.
- pour 1973 : PALUMA du Nord Queensland côtier qui est adaptée, a une assez bonne croissance et surtout s'élague très bien.
- pour 1974 : MONTO du Sud Queensland côtier qui est adaptée, a une bonne croissance mais un élagage défectueux; la forme des troncs est généralement médiocre et la provenance hétérogène.

Les provenances qui se sont révélées inadaptées sont :

- HERBERTON, LAPPA, BAKERVILLE toutes du Nord Queensland intérieur.

Ces essais ne nous ont permis d'approcher la variabilité de l'espèce que de façon partielle car les provenances du Sud et du Centre Queensland y sont peu représentées et la dilution des introductions sur plusieurs années rend difficile les comparaisons.

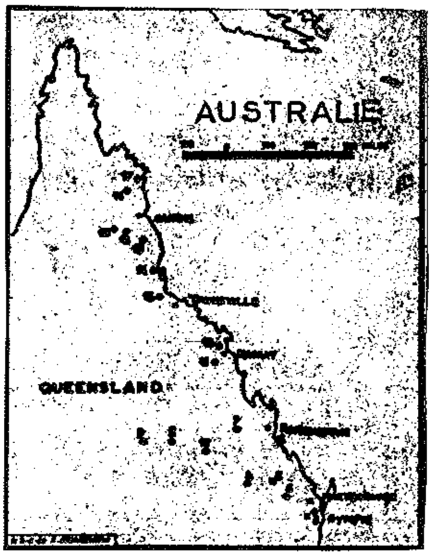
6 - L'ESSAI PROVENANCES DE 1977

En Novembre 1977, le C.T.F.T. a mis en place un essai provenance à l'écartement 3m x 3m.

Cet essai comporte 16 provenances bien réparties sur toute l'aire naturelle de l'espèce. Nous les avons regroupées par grandes régions de provenances, régions définies par J.W. TURNBULL.

Provenances	Latitude ° S	Longitude ° E	Altitude (en m)	Grandes régions de provenances définies par J.W. TURNBULL.
N-E Gympie	26° 7'	152° 42'	76	Sud Queensland côtier
Hungry Hills	25° 18'	151° 22'	310	
Monto	25°	151°	450	
W. Theodore	25° 1'	149° 45'	355	Centre Queensland intérieur
Carnarvon	24° 48'	148° 29'	360	
Fairview	24° 21'	147° 5'	400	
Jericho	24° 14'	146° 13'	490	
Blackdown Tableland	23° 14'	149° 7'	400	
Lake Elphinstone	21° 33'	148° 14'	380	
Eungella	21° 13'	148° 24'	740	Nord Queensland côtier
Paluma Mt Spec.	19° 1'	146° 17'	330	
Cardwell	18° 17'	145° 55'	120	
Ravenshoe	17° 42'	145° 29'	940	
Cooktown Mt Tolbert	15° 45'	145° 15'	200	
Bakerville	17° 23'	145° 15'	800	Nord Queensland intérieur
Lappa	17° 22'	144° 52'	650	
Reedy St George Creek	16°21'	144° 44'	700	Provenance intermédiaire entre N.Q. côtier et N.Q. intérieur.

Ces origines ont été par ailleurs portées sur la carte ci-après.



Toutes les provenances citées dans le tableau sont représentées sauf MONTO du Sud Queensland.Chacune d'entre elles est représentée par une ou plusieurs descendances et chaque descendance comporte 2 parcelles de 25 individus.

Les premières observations de terrain sont déjà riches d'enseignements.D'une manière générale, les provenances côtières qu'elles soient du Nord ou du Sud Queensland sont les mieux adaptées et les plus prometteuses.

On peut distinguer trois grands groupes de provenances :

- Les bonnes : GYMPIE-CARDWELL-PALUMA-COOKTOWN Mt Tolbert
- Les moyennes : HUNGRY HILLS-RAVENSHOE-BLACKDOWN TABLELAND-CARNARVON LAKE ELPHINSTONE-THEODORE
- Les mauvaises : LAPPA-JERICHO-BAKERVILLE-FAIRVIEW RAVENSHOE-REEDY St GEORGE CREEK.

Les provenances du Nord Queensland intérieur (LAPPA et BAKERVILLE) ont des caractéristiques morphologiques tranchées : petites feuilles étroites, couvert très mauvais, forme médiocre, écorce très claire dans la partie supérieure des tiges.

Les provenances du Nord Queensland côtier ont un feuillage dense, couvrant bien le sol, et ont généralement une forme correcte.

Les provenances HUNGRY HILLS et ELPHINSTONE sont très hétérogènes, mais certaines descendances sont valables.

Les provenances du Centre Queensland intérieur ont un feuillage peu dense et une forme relativement mauvaise.

La provenance GYMPIE est la mieux adaptée et la plus intéressante en ce qui concerne la forme,le couvert, la croissance. les résultats des mensurations à 30 mois sont éloquents.

Nous donnons en annexe le résultat des mensurations à 30 mois par provenance et pour les descendances les meilleures :

Hm : Hauteur moyenne en mètres

C150 : Circonférence moyenne à 1,50m en centimètres

7 - CONCLUSIONS

Les essais de provenances réalisés par le C.T.F.T. Congo confirment l'extrême variabilité génétique de l'espèce E. cloeziana.

ANNEXE

TABLEAU DES RESULTATS DES MENSURATIONS EFFECTUEES A L'AGE DE 30 MOIS

Provenance	N°s de descendance	Hm	C150 cm	%
N.E. GYMPIE	161 à 170 161 164	9,40 10.60 9.90	30 32.9 31.6	84.0 92.0 84.0
HUNGRY HILLS	75 à 84 75	9.20 9.80	30.0 30.4	86.0 92.0
W. THEODORE	74	8.90	27.3	76.0
CARNARVON	99 à 108	8.60	26.7	96.2
FAIRVIEW	151 à 160	8.50	25.7	77.0
JERICHO	95 à 98	8.10	24.7	65.5
BLACKDOWN TABLELAND	85 à 94	8.60	28.2	92.0
LAKE ELPHINSTONE	109 à 112	7.80	25.7	71.5
EUNGELLA	113 à 122	8:70	26.8	87.4
PALUMA	123 à 132	8.20	28.4	93.1
CARDWELL	183 à 192 186	9.6 10.3	30.4 32.5	83.2 86.0
RAVENSHOE	171	7.0	24.6	66.0
COOKTOWN MT TOLBERT	174 à 178	8.1	28.0	82.6
BAKERVILLE	179 à 182	8.4	21.3	74.0
LAPPA	133 à 142	7.2	21.5	56.2
REEDY ST GEORGE CREEK	145 à 150	7.6	21.6	66.3

Les bonnes performances de certaines provenances permettent déjà d'envisager l'utilisation de cette espèce pour l'afforestation des savanes congolaises en vue de la production de bois à usages multiples.

Le patrimoine génétique très important dont dispose maintenant la recherche congolaise ouvre d'importantes possibilités pour l'amélioration génétique de cette espèce.

C'est pourquoi nous étudions dès à présent les techniques de multiplication végétative de cette espèce, notamment le marcottage, afin de pouvoir rapidement mettre en place un premier verger à graines de cette espèce.

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Janvier 1979.

RECENTES COLETAS DE SEMENTES DE *EUCALYPTUS* E DISPONIBILIDADE DE SEMENTES PARA TESTES DE PROCEDÊNCIAS.

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Resumo

Três grandes programas de coleta de sementes desenvolvidos pela Divisão de Pesquisa Florestal da CSIRO durante o período de 1978 a 1980 são descritos neste trabalho. Estes cobrem a coleta de sementes das procedências de *E. microtheca*, *E. urophylla*, *E. camaldulensis* e *E. tereticornis*. Os objetivos diferiram para cada espécie; para o *E. microtheca*, coletas em grandes áreas de distribuição foram feitas para o primeiro estágio de testes internacionais de procedências para *E. urophylla*, uma amostragem adicional de segundo grau foi feita para as procedências mais promissoras para permitir introduções e testes mais amplos para esta espécie; e para o *E. camaldulensis* e o *E. tereticornis*, foram feitas amostragens intensivas de poucas procedências comprovadas para desenvolver ampla base genética para populações de conservação e seleção *ex situ*. Detalhes dos lotes de sementes disponíveis através destes programas e outras amplas coletas de sementes feitas durante este período são tabuladas neste trabalho.

RECENT SEED COLLECTIONS OF EUCALYPTS IN AUSTRALIA AND INDONESIA AND AVAILABILITY OF SEED FOR PROVENANCE RESEARCH.

Summary

Three major seed collection programs undertaken by the CSIRO Division of Forest Research during 1978 to 1980 are described. They cover the collection of *Eucalyptus microtheca*, *E. urophylla*, *E. camaldulensis* and *E. tereticornis* provenances. Objectives differed with each species; with *E. microtheca* range-wide provenance collections have been made for first-stage international provenance trials; with *E. urophylla* second-stage additional sampling of promising provenances has been undertaken to allow more widespread introduction and testing of this species, and with *E. camaldulensis* and *E. tereticornis* intensive sampling of a few proven provenances took place to provide a broader base for *ex situ* conservation/selection stands. Details of the seedlots made available by these programs and other broadly-based seed collections made during this period are tabulated.

2. *EUCALYPTUS MICROTHECA* SEED COLLECTIONS IN 1978-79 FOR INTERNATIONAL PROVENANCE TRIALS

INTRODUCTION

Species description

Eucalyptus microtheca F.Muell. (coolibah) varies in size from a small mallee only 2 m in height on the harshest sites to a over 20 m in height and up to 150 cm in diameter in the most favourable locations. It is characteristically a species of open-woodland formation on seasonally inundated sites around the edges of swamps and lagoons or in open belts along water courses.

Coolibah has a wide geographic range mainly within the arid and semi-arid zones of Australia. The range of latitude is 14-33°S with an altitudinal range of just above sea level to 700 m. The mean maximum temperature of the hottest month is in the range of 31-41°C while the mean minimum of the coolest is 4-14°C. Frost incidence varies from 0 to 18 per year. In the northern parts of its distribution there is a well-developed monsoonal rainfall pattern; elsewhere there is a summer maximum changing to a more even distribution towards the southeast. The mean annual rainfall ranges from 120 to 1000 mm.

Soils show a wide variation. Heavy grey or brown self-mulching, cracking clays predominate; other types are hard alkaline loamy or crusty duplex soils, uniform coarse-textured sands and gradational red earths.

E. microtheca is considered a useful species for shade and shelter on suitable sites throughout its natural range, and has proved satisfactory in dry country to the south. The timber is dark in colour, very dense, hard and has interlocking grain; it is durable and notably termite resistant. Currently it is only used to a limited extent for fencing and fuel.

Performance as an exotic

E. microtheca has been successfully grown in plantations in dry tropical and sub-tropical regions. It will tolerate heavy-textured, calcareous and gypseous soils and has responded well to irrigation in the Sudan, Pakistan and Iraq (FAO 1974; Turnbull and Pryor 1978). Other countries where it is reported to have been showing some promise are Iran and Tanzania. The main use is for fuel and poles, shelterbelts and soil stabilisation.

Coolibah has a wide natural distribution where it grows under diverse conditions. Even so, it is estimated that more than 90% of the seed of this species exported from Australia has originated from a limited part of the distribution in northern New South Wales. One private collector alone exports up to 200 kg of coolibah seed per year from this area. It is reasonable to assume, therefore, that the present performance of this species as an exotic may well be impaired by the limited range of seed sources in general use.

OBJECTIVES

As the geographic variation in *E. microtheca* had received little investigation, the main objective of the 1978-79 *E. microtheca* field trips was the exploration and collections of seed from a wide range of provenances to allow comprehensive, international provenance trials to be established in arid zones.

SEED COLLECTIONS

Five field trips were undertaken by parties from the Division of Forest Research during the summer and autumn period of 1978 and 1979. A total of 39.1 kg of coolibah seed was obtained from 303 mother trees in 73 provenances (Figs 1 and 2 and Table 1). Detailed information on the stands and individual trees is available on request.

The sample trees were chosen on the basis of larger than average seed crop and the need for a wide spacing between trees. The minimum distance between trees was about 20 m. Because of the consistently poor form of trees in the natural stands it was impractical to employ any phenotypic selection.

INTERNATIONAL PROVENANCE TRIALS

Grouping of provenances

In most countries where *E. microtheca* is of interest the emphasis will be on establishing simple provenance tests with the sole purpose of identifying the most suitable part of Australia from which to obtain seed for large scale planting projects.

The total of 73 provenances now available will be too great a number for most countries to handle in replicated trials. We therefore propose to bulk part of each seedlot with seed of similar provenances to form provenance groups. Figure 1 shows how the 73 different seedlots can be reduced to 21 by grouping together provenances which are adjacent and which have a similar climate.

Trials

International provenance trials are being organised under the auspices of the FAO/IBPGR Project on Genetic Resources of Tree Species for the Improvement of Rural Living with seed provided by CSIRO. Governments and institutes interested in participating in coordinated trials should contact the Forest Resources Division of FAO's Forestry Department (via delle Terme di Caracalla, 00100 Rome, Italy). We have suggested that in the first instance these trials should use the 21 bulked seedlots described above. More detailed studies of individual provenances in the best group may be undertaken subsequently.

3. *EUCALYPTUS UROPHYLLA* SEED COLLECTIONS IN INDONESIA IN 1979

INTRODUCTION

Species description

Eucalyptus urophylla S.T. Blake grows naturally on the mountain slopes and valleys of the Indonesian islands of Timor, Flores, Adonara, Lembata (Lomblen), Pantar, Alor and Wetar (Martin and Cossalter 1975). The range of latitude is 7½-10°S and that of altitude about 300-3000 m. The species exhibits its best development on deep, moist, well-drained soils at the lower and intermediate altitudes of its occurrence. Here tree heights can exceed 50 m with diameters of up to 2 m and straight, clear boles for a half or two thirds of tree height.

The distribution of *E. urophylla* is in the hot, humid climatic zone. The mean monthly maximum temperatures range from 27-29°C at 400 m to 17-21°C at 1900 m. The rainfall pattern is monsoonal with a well defined summer maximum. In Timor rainfall is between 1500 and 2500 mm with 2-4 months receiving less than 50 mm, but in the occurrences on the other islands rainfall is usually between 700 and 1500 mm with up to 7 to 8 months receiving less than 50 mm.

The wood is used for heavy construction and bridging in Timor (FAO 1980). It is widely used at the village level for house construction, furniture, poles and fuel.

Performance as an exotic

The performance of *E. urophylla* on suitable tropical and subtropical sites outside of its natural range is very promising. The chief attributes of the species are rapid growth, good form and the ability of some provenances to grow well at a low altitude in low latitudes. Early indications are that *E. urophylla* will shoot readily from the stump after harvesting (Martin and Cossalter 1976). Large plantations have already been established for pulp production as well as domestic fuel and building poles.

E. urophylla is showing great promise in the humid lowland areas in Brazil (FAO 1980) and in hot equatorial Africa (Martin 1978). The best results are being obtained from seed originating from low-altitude provenances, and particularly those from the islands other than Timor. There is also considerable potential for the planting of this species on suitable sites in the southeast Asia and Pacific region (Willan 1979).

OBJECTIVES

As seed supplies from previous collections in Indonesia were dwindling a joint Australia-Indonesian expedition was undertaken during 1979 to obtain broadly-based collections of the best provenances, and particularly those on Flores Island, for further provenance testing and conservation purposes.

SEED COLLECTIONS

A three-man party undertook collections in Indonesia in August 1979. Seed was collected from 70 trees from four sites; three on the island of Flores (Mt Mandiri, Mt Lewotobi, Mt Wukoh) and one on Adonara (Mt Boleng). In addition to individual tree collections bulk collections from several trees at each of two sites on Flores (Mt Mandiri and Mt Lewotobi) were gathered making the grand total of seed collected about 10 kg. Half of the seed collected was retained by the Indonesian Directorate General of Forestry, and half is held in the Division of Forest Research, CSIRO seed store in Canberra. A map of the collection sites, photographs and seed particulars are given in Figures 3 and 4, and Table 2. Detailed information on the stands and individual trees is available on request to CSIRO.

CONSERVATION STANDS

It is recommended that *ex situ* conservation/selection stands be established in tropical countries where the species has most potential to better ensure the future availability of seed. The establishment of such stands is described by FAO (1977) and the 70 individual tree seedlots obtained during this expedition would provide a suitable base for this purpose. If the technical resources are available then the establishment of open-pollinated seedling seed orchards as described by Eldridge (1975*a*) might be considered.

4. COLLECTIONS OF *EUCALYPTUS CAMALDULENSIS* AND *EUCALYPTUS TERETICORNIS* SEED FROM NORTH QUEENSLAND IN 1979-80 FOR *EX SITU* CONSERVATION/SELECTION STANDS

INTRODUCTION

Species descriptions

Eucalyptus camaldulensis is usually a moderately tall tree with a large diameter. It is the most widely distributed eucalypt on mainland Australia where it is confined chiefly to inland rivers and flood plains with a mean annual rainfall of less than 650 mm. The natural stands are harvested for sawnwood, railway sleepers and charcoal.

E. tereticornis is a tall forest tree often attaining a height of 45 m or more. It extends along the eastern coast of Australia from Victoria to northern Queensland and is also found in Papua New Guinea. The annual rainfall is 500-1500 mm. The chief use of the timber is in heavy construction and framing.

Performance as exotics

E. camaldulensis has been widely planted overseas and plantings in tropical countries are increasing now that the importance of using tropical provenances has been demonstrated. Choice of the correct provenance is of paramount importance in this species (Turnbull and Pryor 1978). Its rapid growth on poor soils with low rainfall (down to 400 mm) and good coppicing ability have contributed to its success as an exotic.

Australia-wide provenance seed collections of *E. camaldulensis* were commenced in 1964. Much of the seed obtained in 1964 and in later collections was distributed internationally and subsequent field trials indicated that the best seed sources for many tropical countries were located within Australian tropics (Lacaze 1978; Turnbull 1973; Eldridge 1975*b*; Doran and Boland 1978). Better-known tropical provenances include Petford and Gilbert River (Queensland), Katherine (Northern Territory) and Gibb River (Western Australia).

E. tereticornis has also been widely planted, particularly in areas with a summer rainfall and a moderate to severe dry season. It is usually reported to be less drought tolerant than *E. camaldulensis* but has similar attributes in rapid growth and good coppicing ability. International provenance trials have indicated that there are considerable differences in growth between provenances (Martin 1978). Better-known tropical provenances from north Queensland are Mt Garnet, Cooktown/Helenvale, and Kennedy River.

OBJECTIVES

Because of the international importance of these northern provenances the FAO Panel of Experts on Forest Gene Resources recommended that some form of conservation should be undertaken to ensure their survival and the availability of seed. Seed collections in 1977 had provided seed suitable for *ex situ* conservation/selection stand establishment (Doran and Boland 1978) but by 1979 stocks of Queensland seedlots were dwindling.

The main objective of the 1979-80 field trips was to obtain broadly-based seed collections (25 trees at each site) of *E. camaldulensis* at Petford and Gilbert River, and *E. tereticornis* at Helenvale and Mt Garnet.

SEED COLECTIONS

Two field trips to north Queensland were undertaken by parties from the Division of Forest Research during the summer of 1979-80. A total of 43 kg of *E. camaldulensis* and *E. tereticornis* seed was obtained from 100 mother trees in 4 provenances (Figs 5 and 6 and Table 3).

A .308 inch calibre rifle was used to shoot off seed bearing limbs from standing trees at each site. In general, seed was obtained from trees of average form although a wide range of form class was included in each collection. The distance between seed trees varied from a minimum of about 100 m to some kilometres. Detailed information on the stands and individual trees is available on request to CSIRO.

Fig. 1 *Eucalyptus microtheca* seed collection localities

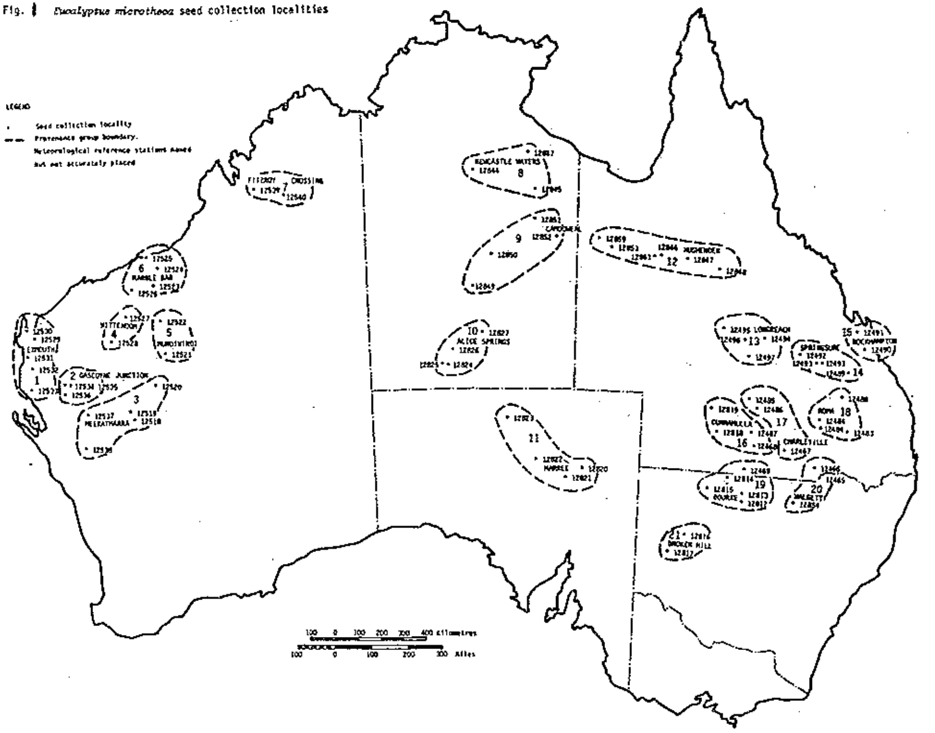
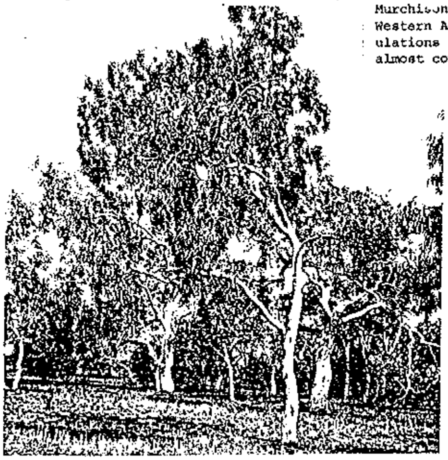


Fig. 2 - The photographs of *E. microtheca* below illustrate the remarkable variation within this species in the retention of rough bark. Over the greater part of its range coolibah retains a grey to black rough bark on the trunk and large branches for ½-4/5 of tree height. In contrast, populations in the Murchison and Pilbara regions of Western Australia and some populations in central Australia are almost completely smooth barked.



Trees in Provenance group 6 in the Pilbara region of Western Australia

Trees in Provenance group 21 in western New South Wales.

5. OTHER INFORMATION

Details of other broadly-based seed collections

Details of other broadly-based seed collections held in store at the Seed Section, CSIRO Division of Forest Research are given in Table 4.

Availability of seed

Samples of seed of all provenances described in this paper are available for exchange or purchase from -

Officer-in-charge
Seed Section
Division of Forest Research, CSIRO
PO Box 4008
Canberra, ACT 2600
Australia

6. ACKNOWLEDGEMENTS

The author gratefully acknowledges the financial support of the Food and Agricultural Organisation of the United Nations, the United Nations Environment Program and the Australian Development Assistance Bureau. The able technical assistance of Messrs E.C. Cole, D. Kleinig, P.N. Martensz and B.V. Gunn in making the collections is also appreciated.

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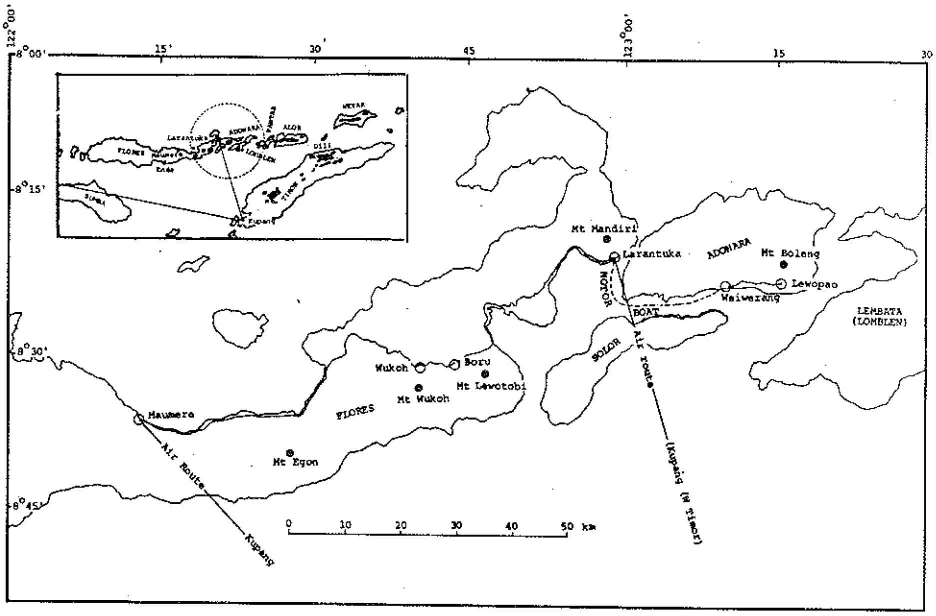

Fig. 3. E. urophylla seed collection localities and the air, road and sea routes taken by the party

Table 1 - Provenance and seed details for the 21 provenance groups of *E. microtheca*

Prov. group no.	Provenance group location		Latitude range (S)	Longitude range (E)	Altitude range (m)	No. of seed trees	Viable seeds/ gram
1	Carnarvon Basin	W.A.	22°18' - 24°42'	113°51' - 114°22'	10- 20	23	327
2	Gascoyne Jn. region	W.A.	24°41' - 25°02'	115°15' - 115°19'	70-100	13	400
3	Murchison region	W.A.	26°04' - 27°22'	115°51' - 119°21'	160-520	23	513
4	Pilbara region	W.A.	22°21' - 23°16'	117°42' - 118°29'	460-640	8	406
5	E. Gascoyne - Pilbara region	W.A.	22°38' - 22°53'	119°54' - 119°57'	400-600	10	284
6	Pilbara region	W.A.	20°06' - 21°13'	118°50' - 120°04'	30-170	20	487
7	W. Kimberleys	W.A.	17°51' - 18°11'	124°28' - 125°36'	100-120	8	139
8	Newcastle Waters - Barkly Tab.	N.T.	16°45' - 17°23'	133°25' - 136°05'	100-220	10	164
9	Central Aust. - Barkly Tab.	"	19°22' - 22°01'	133°28' - 137°01'	200-520	11	287
10	Alice Springs - Ayers Rock	"	23°51' - 25°11'	132°09' - 133°48'	457-520	16	682
11	Marree - Oodnadatta	S.A.	27°18' - 29°40'	134°57' - 138°23'	20-110	20	490
12	Mt Isa - Hughenden	Qld	20°06' - 21°03'	138°46' - 144°00'	150-400	12	269
13	Jericho - Blackall	"	23°21' - 24°24'	144°21' - 146°07'	193	18	274
14	Moura - Springsure	"	24°08' - 24°36'	147°47' - 149°57'	111	12	82
15	Fitzroy River	"	23°07' - 23°23'	150°09' - 150°32'	3- 40	6	70
16	Southwest	"	26°37' - 27°58'	144°05' - 145°09'	150-213	20	377
17	Charleville - W of Bollon	"	26°08' - 28°02'	145°40' - 147°25'	180-320	13	246
18	Roma - Taroom	Qld	25°38' - 26°59'	148°52' - 150°07'	186-280	12	120
19	Central N.S.W. - Qld border		28°58' - 30°03'	144°07' - 145°57'	90-150	25	367
20	Walgett, N.S.W. - N. Mungindi	Qld	28°36' - 30°05'	148°07' - 149°01'	130-180	15	237
21	Western N.S.W.		31°45' - 32°27'	142°25' - 143°11'	61-100	8	331

N.S.W.: New South Wales; Qld: Queensland; S.A.; South Australia; W.A.: Western Australia;
N.T.: Northern Territory

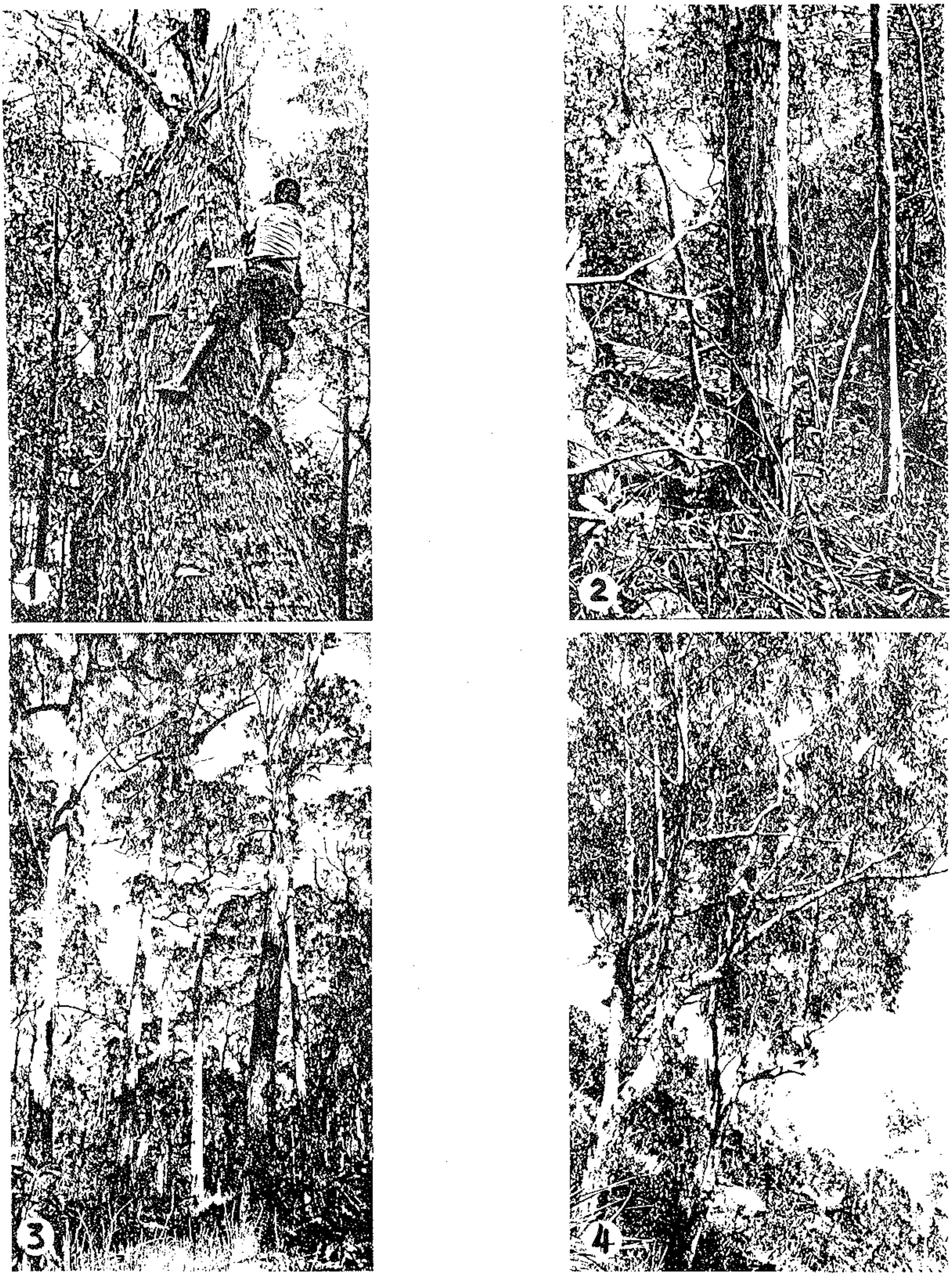

Fig. 4. *E. urophylla* in Indonesia: (1) Tree F1/7 on Mt Mandiri; the eucalypt fruits were plucked into bags from the branches cut down by the climbers. (2) Tree F1/8 on Mt Mandiri; the bark character was highly variable at this site. Trees with ½ and ¼ of the stem retaining rough bark were most plentiful, with the occasional occurrence of fully smooth barked and fully rough barked individuals. (3) A fine stand of trees at 470 m elevation on Mt Lewotobi. (4) Tree A1/8 clinging to the steep mountain slopes of Mt Boleng.

Table 2. Provenance and seed details for the four provenances of *E. urophylla* collected in Indonesia in August 1979

CSIRO seedlot no.	Provenance location	Latitude (S)	Longitude (E)	Altitude range (m)	No. of seeds trees	Viable seeds/ gram
12895	Mt Mandiri, Flores Is. Indonesia	8°15'	122°58'	280-550	26	505
12896	Mt Lewotobi, Flores Is. Indonesia	8°32'	122°48'	460-490	12	720
12897	Mt Wukoh, Flores Is. Indonesia	8°33'	122°35'	790-870	16	460
12898	Mt Boleng, Adonara Is.	8°21'	123°15'	760-1020	16	330

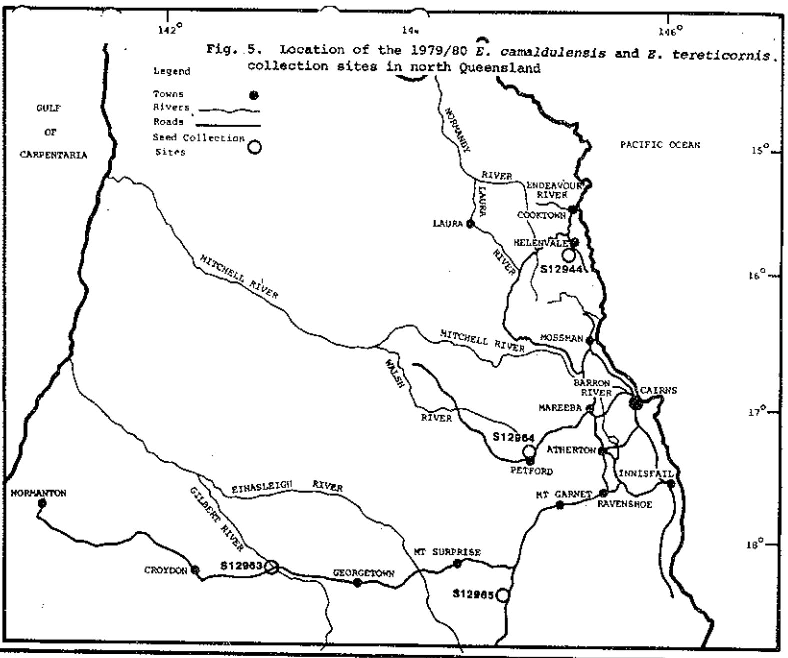

Fig. 5. Location of the 1979/80 *E. camaldulensis* and *E. tereticornis*. collection sites in north Queensland

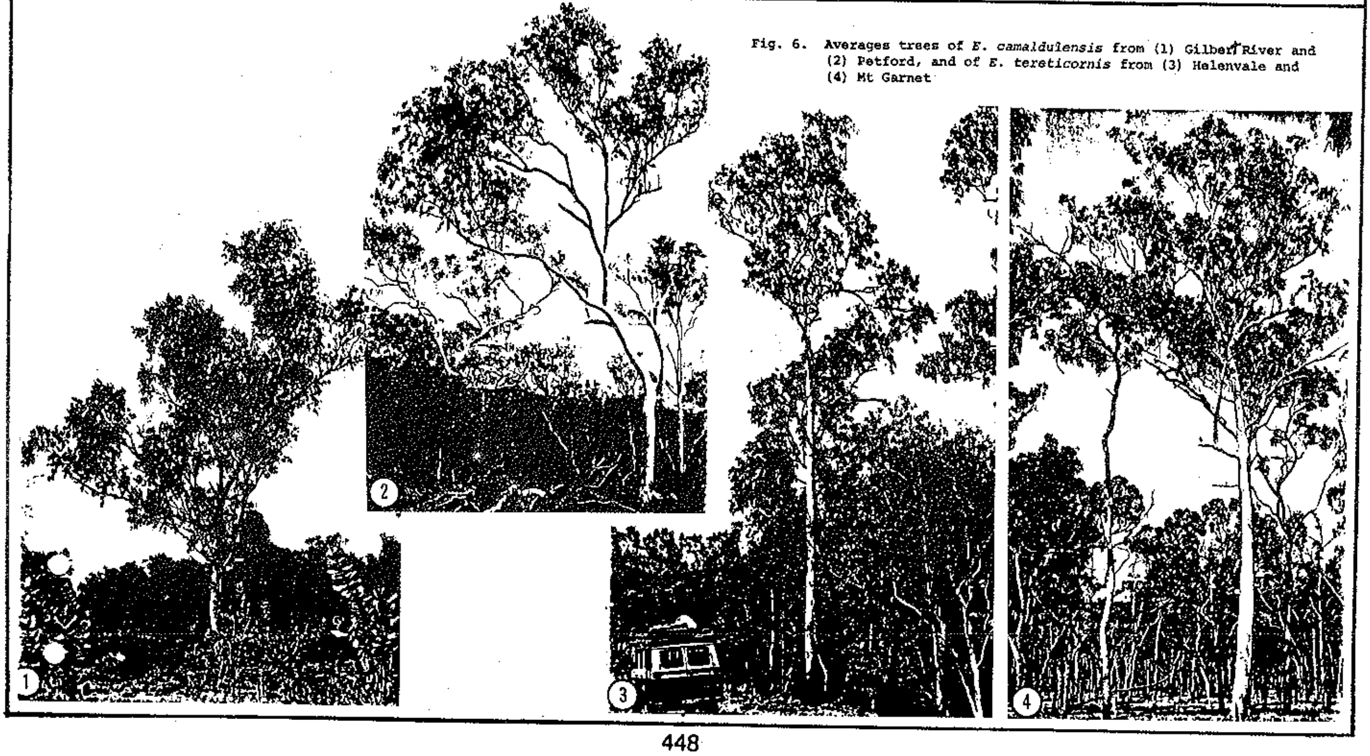

Fig. 6. Averages trees of *E. camaldulensis* from (1) Gilbert River and (2) Petford, and of *E. tereticornis* from (3) Helenvale and (4) Mt Garnet

Table 3. Provenance and seed details for two provenances of *E. camaldulensis* and two provenances of *E. tereticornis* collected in north Queensland in 1979/80

CSIRO seedlot no.	Species	Provenance location	Latitude (S)	Longitude (E)	Altitude (m)	No. of seed trees	Viable seeds/ gram
12963	*E. camaldulensis*	Beside the Gilbert River, 81 km west of Georgetown. Qld	18 ~~81~~°30'	142°52'	250	25	512
12964	*E. camaldulensis*	Beside Emu Creek, 7 km east of Petford. Qld	17°20'	144°58'	460	25	991
12944	*E. tereticornis*	Between 2-13 km south of Helenvale. Qld	15°46'	145°14'	120	25	1150
12965	*E. tereticornis*	Between 89-113 km southwest of Mt Garnet. Qld	18°30'	144°45'	800-830	25	497

Table 4. Provenance and seed details for other broadly-based seedlots held in store.

CSIRO seedlot no.	Species	Provenance location	Latitude (S)	Longitude (E)	Altitude (m)	No. of seed trees	Viable seeds/ gram
12181	*E. camaldulensis*	Katherine. N.T.	14°30'	132°15'	110	32	499
12186	*E. camaldulensis*	Petford Qld	17°20'	144°58'	460	25	563
+12962	*E. camaldulensis*	Petford Qld	17°20'	144°58'	460	34	755
12346	*E. camaldulensis*	Gibb River W.A.	16°08'	126°30'	430	20	1298
12968	*E. camaldulensis*	Burdekin River Qld	18°57'	145°03'	410	25	700
+12379	*E. citriodora*	Herberton-Irvinebank Qld	17°00'- 17°53'	144°56'- 145°35'	600-960	42	119
+12584	*E. cloeziana*	Cardwell Qld	18°17'	145°58'	75-100	21	130
12409	*E. grandis*	Ravenshoe Qld	17°42'	145°28'	940	26	470
12803	*E. pilularis*	Fraser Is. Qld	25°32'	153°00'	80	25	31
+12921	*E. pyrocarpa*	S.W. of Woodburn N.S.W.	29°09'	153°13'	125	25	++28
+12922	*E. pyrocarpa*	W.N.W. of Woolgoolga N.S.W.	29°56'	153°09'	200	25	++28
+12923	*E. pyrocarpa*	E. of Grafton N.S.W.	29°39'	153°15'	140	77	++28
+12924	*E. pyrocarpa*	W. of Woolgoolga N.S.W.	30°06'	153°04'	300	78	++28
12189	*E. tereticornis*	Mt Garnet Qld	18°30'	144°45'	875	29	655
+12948	*E. tereticornis*	N.W. of Mareeba Qld	17°00'	145°22'	450	44	-

\+ Seed supplied by private collection

++ Average viability of species

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INTERAÇÃO PROCEDÊNCIA/LOCALIDADE EM PLANTAÇÕES IRRIGADAS DE *EUCALYPTUS CAMALDULENSIS.*

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Resumo

Um teste de procedência de *E. camaldulensis* para estudar a interação genótipo/ambiente foi iniciado no Egito. Mudas de 29 procedências australianas e de uma raça local foram plantadas aos seis meses de idade em diferentes locais. Aos dois anos de idade, as plantas plantadas em solo argiloso tiveram melhor crescimento em altura e sobrevivência que aquelas plantadas num solo calcáreo arenoso. As diferenças entre procedências dentro dos locais e a interação (procedência/local) foram altamente significativas. Os resultados discutidos neste trabalho são em relação à origem das procedências.

PROVENANCE/SITE INTERACTION IN IRRIGATED PLANTATIONS OF *EUCALYPTUS CAMALDULENSIS.*

Summary

A provenance trial of *E.camaldulensis* was initiated in Egypt to examine genotype/environment interaction. Seedlings of 19 Australian provenances and a local land race were transplanted into two sites when they were 6 months old. At the age of two years, the plants grown on clay soil had far better height growth and survival than those grown on the sandy-calcareous soil. The differences between provenances within sites and the interaction (provenance x site) were also highly significant. The results are discussed in relation to the origin of the provenances.

INTRODUCTION

River red gum *(Eucalyptus camaldulensis)*, introduced into Egypt last century, is well adapted to local environmental conditions. Some trees planted adjacent to the River Nile may attain 150 cm in diameter and over 30 m in height. The species is traditionally planted as windbreaks, to provide shade and to supply fuel and wood for primitive carpentary.

A eucalypt breeding program is being undertaken by the Department of Forestry at Alexandria University. The first step has been the testing of different provenances of *E.camaldulensis* in various regions of the country, especially in the newly reclaimed desert areas. Because this species has been recognized to have great potentialities in the Mediterranean countries, authenticated collections of many provenances were made by the CSIRO ,Division Forest Research with the support of FAO. The seed lots are under test in 32 plantations in 15 other Mediterranean and tropical countries and the results were reported by Lacaze (1970) and (1977).

Until the mid 1960's there was little research aimed at making use of genetic variation to improve the yield and quality of *E.camaldulensis* plantations. The most comprehensive bibliography of genetic variation in this species was compiled by Eldridge(1972). He described 103 publications and reports, out of which 65 are specifically dealing with variation between populations and provenances. However, few publications have delt with genotype/environment interaction.

Although general recommendations have been made as to the suitable provenance (s) for different regions, it is felt that provenance trials are needed for some partcular sites. This paper is intended to report on the early results of a provenance trial on two different sites in north-west Egypt.

MATERIALS AND METHODS

Seeds of 19 provenances were obtained from the CSIRO Division of Forest Research (Table.1, Fig.1) and combined with a local land race collected in Alexandria, then they were sown separately in seed beds in the nursery. The germinants were transplanted into clay pots when they were 45 days old, then into the test plantations 4.5 months later. Two test sites were selected to represent major soil types in Egypt, namely: (i) the University farm, near Alexandria, with heavy clay, slightly alkaline soil (pH 7.2) and (ii) Nubariah farm, 70 km. S.W. of Alexandria, with sandy-loam, calcareous soil (30% $CaCO_3$). The seedlings were planted in a completely randomized design where each provenance was represented by five trees in each of the replicates. The trees were planted in farrows in order to facilitate irrigation which was applied biweekly during the summer(May-September). Mean annual rainfall (almost wholly winter rainfall at the two sites is 185 mm and 150 mm, respectively. Periodic hoeing was used to eliminate weeds and no fertilizer was added. Survival and tree heights were recorded every six months.

RESULTS AND DISCUSSION

The results reported herein are those taken 18 months after transplanting. There were highly significant differences, between the two sites, between provenances within each site, as well as their interaction for both height growth and percent survival. On the average, the trees grown on the clay soil were taller and had higher survival percentage than those grown on the sandy-calcareous soil, with average values of 402 cm and 191 cm, and 88% and 60% respectively, (Table. 1). This clearly indicates that clay soil is better suited for *E.camaldulensis* than the sandy soil, under the environmental conditions prevailing in northern Egypt. Clay soil also gave better results than did sandy-calcarous soil for a number of seedling characteristics in a pot experiment with some other eucalypt species (Moomen, 1971). Badran *et al.*(1972) were able to show that *E.camaldulensis* grown in lysimeters under varying levels of water table had better height growth and total dry weight on clay soil than on sandy calcareous soil. They also reported that the leaves of the former plants had higher nitrogen contents than those of the later plants.

The superiority of growth and survival on clay soil may be attributed to its high water holding capacity and its better nutritional status compared to the sandy soil. The plants grown on calcareous soil may also suffer from the high $CaCO_3$ content, which may lead to iron deficiency. In fact, chlorosis was noticed on those trees. Similarly, Karschon (1956) attributed chlorosis of *E.camaldulensis* grown on calcareous soil in Israel to lack of iron.

The best five provenances on the clay soil, in a decreasing order, were Wiluna (W.A.), Lake Albacutya (V.), Lake Coorong (V.), Mundiwindi (W.A.) and the local one (Alexandria) (Table.1). The first four provenances are known to perform well in the Mediterranean region, (Lacaze, 1977). "Wiluna" provenance grew nearly 1.3 times as fast as the local seed source, while their survival percentages were 84 and 100, respectively. On the other hand, Lake Albacutya had an average height of 487 cm and an average survival of 100%. Accordingly height growth and survival should be considered together as criteria for overall performance.

On the sandy-calcareous soil, the picture was a little different. Although provenances Mundiwindi (W.A.) and Wiluna (W.A.) were ranked first and second, provenances Silverton (NSW), Ayers Rock (NT) and Minleton (SA) occupied the next three postions (Table. 1). Similarily, in Iran Wiluna proved to be the best of three provenances tried in the temperate winter zone on clacareous soil, and in Israel additional provenances which did well on calcareous soil in drier areas were Silverton and Mundiwindi (FAO, 1976). The soil of Wiluna provenance is sandy-loam over limestone with pH 7-7.5, which may explain the superiority of the provenance on calcareous soil.

The local land race (Alexandria) was ranked eleventh for height on the calcareous soil, as it grew almost at half the rate of provenance Mundiwindi, and its survival was only 50% (Table.1). The differences in relative growth and survival of the provenances on the two soil types have been expressed as significant site x provenance terms in the respective analyses of variance. This shows , beyond doubt, the importance of provenance trails under different environmental and edaphic conditions. Although Lake Albacutya and Lake Coorong were highly recommended for the Mediterranean region (Lacaze 1977), they are not the best on sandy calcareous soil (Table.1).

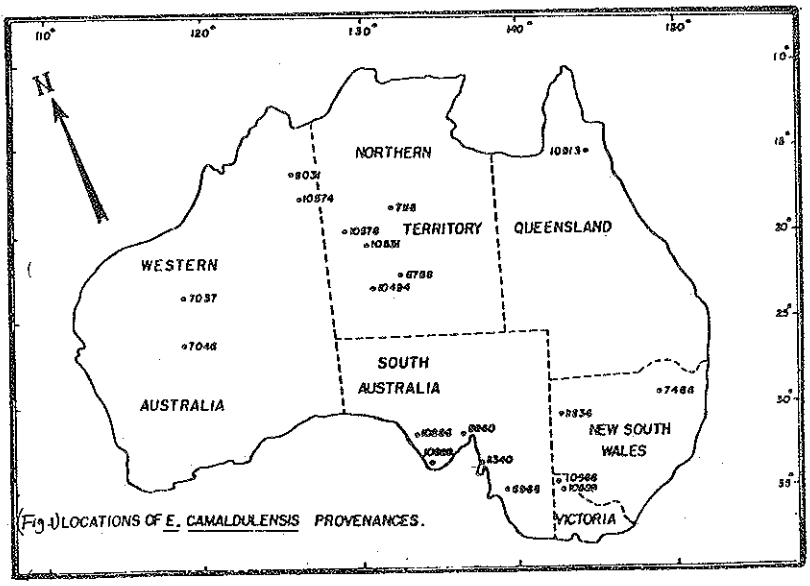
Table. 1. Growth of provenances of *E.camaldulensis* at two sites in Egypt at 2 years of age

Provenances					Growth after two years			
					Clay soil		Calc.sandy soil	
No.	Location*	Lat.	Long.	Soil	Height (cm)	Survival %	Height (cm)	Survival %
7046	Wiluna,W.A.	26° 34'	120° 03'	Gravelly	577	83	349	68
10666	Lake Albacutya,Vic.	35° 44'	142° 02'	Grey clay	487	100	169	37
10659	Lake Coorong,Vic	35° 45'	142° 23'	Grey clay	471	93	184	40
7037	Mundiwindi,W.A.	23° 05'	120° 08'	Gravelly red sand	461	92	351	73
23	Alex.,Egypt	31°N 15'	30° 00'	Clay	449	100	172	50
10494	Ayers Rock,N.T	24° 30'	133° 15'	River sands	448	96	245	79
7466	Moree, N.S.W.	29° 35'	149° 38'	Black soil	443	89	143	50
10574	Halls creek,W.A.	19° 34'	127° 41'	Sandy alluvium	441	70	152	31
10913	W. Almaden,Old.	17° 20'	144° 39'	Sandy	427	92	157	32
11836	Silverton,N.S.W.	31° 57'	141° 24'	Alluvium	418	96	252	89
8031	White Elvire River,W.A	18° 15'	127° 40'	Yellowish brown	409	80	180	30
10531	Napperby, CK.,N.T.	22° 49'	132° 36'	Sandy alluvium	388	84	131	64
8960	Wirrealoa,Ck.,S.A.	32° 29'	137° 45'	Red sandy	389	99	153	90
6788	SE.Alice Springs,N.T.	23° 38'	133° 35'	Silty and sandy	354	85	180	71
6966	Menengers Hill, S.A.	34° 29'	139° 10'	Granite	351	78	185	80
11340	Minlaton,S.A.	34° 47'	137° 36'	-	345	96	214	89
10885	Pt.Lincoln,S.A.	34° 35'	135° 38'	Limestone	310	86	170	90
10886	Mt.Wedge Rd.,S.A.	33° 28'	139° 05'	Limestone	300	90	191	40
7116	Tennant Cr.,N.T.	19° 31'	134° 14'	Sandy loam	293	73	98	15
10576	N.MT.Doreen,N.T.	21° 49'	131° 10'	Sandy alluvium	292	80	185	80
L.S.D	(.05)				70	12	91	18

*Arranged on the basis of average height growth on clay soil.

Analysis of variance (F values)

S. O. V.	Height growth	Survival
Site	336.64**	100.18**
Provenance	7.53**	6.06**
Site x Provenances	1.73*	6.20**



(Fig.1) LOCATIONS OF E. CAMALDULENSIS PROVENANCES.

While the inter-provenance variability is not new (c.f. Eldridge 1975 and Lacaze 1977), it is believed that the demonstration of provenance x site interaction is an important outcome of the present work. Though it is rather premature to draw definite conclusions at this stage, it will be interesting to follow the future growth of these provenances in order to see if any changes in rank occur.

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UMA ESTRATÉGIA PARA PROCEDÊNCIA DE EUCALYPTUS REGNANS *NA AUSTRÁLIA.*

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Resumo

Este trabalho descreve uma estratégia em dois estágios adotada para testar e usar a variação de procedência em *Eucalyptus regans* no Sudeste da Austrália.

No estágio 1, um grande número de procedências (49) são testadas em 12 locais para determinar os padrões de variação da distribuição e outras importantes interações procedência/local. No estágio 2, 20% das procedências superiores (avaliadas aos 5 anos de idade) serão reinstaladas nos testes que mantenham a identidade individual de famílias e são úteis para a transformação em talhões de produção de sementes e para a seleção de populações para melhoramento.

As sementes deverão ser disponíveis, de árvores selecionadas dentro dos testes do estágio 2, dentro de 15 anos após o estabelecimento do estágio 1. Nesse período, sementes comerciais serão obtidas dos melhores talhões naturais indicados pelo estágio 1. As exigências estatísticas para o estágio 1 não são compatíveis com a produção de sementes.

A PROVENANCE TESTING STRATEGY FOR EUCALYPTUS REGNANS *IN AUSTRALIA.*

Summary

The paper describes a two-stage strategy adopted for testing and utilising provenance variation in *Eucalyptus regnans* in S.E. Australia.

In Stage 1 a large number of provenances (49) are tested on 12 sites to determine the rangewide variation patterns and any major provenance x site interactions. In Stage 2 the best 20% of provenances (as assessed at age 5) will be re-established in trials which maintain individual family identity and are suitable for conversion to seed production stands, and for selection of breeding populations.

Seed should be available, from trees selected within Stage 2 trials, within 15 years of Stage 1 establishment. In the interim commercial seed will be obtained from the best natural stands as indicated by Stage 1. The design requirements for Stage 1 trials are not compatible with seed production.

INTRODUCTION

Eucalyptus regnans F.Muell occurs naturally in the S.E. Australian States of Victoria and Tasmania (Latitude 37°-43°S) (Hall et.al. 1970) It produced quality sawn timber suitable for joinery and furniture as well as construction purposes, and is also the most important eucalypt used in the Australian pulping industry (Hillis and Brown 1978).

In Australia most eucalypt forests are still regenerated naturally or by direct seeding, however several hundred hectares of *E.regnans* plantation are also established each year. Elsewhere the species has succeeded in trials at high altitudes in Sri Lanka, India and Kenya; in more temperate localities in South Africa and New Zealand (Streets 1962); and is one of three eucalypt species being planted on an increasing scale in New Zealand (Lembke 1977, Wilcox et.al. 1980). As *E.regnans* is rather intolerant of cold or drought the range of potential planting sites is restricted - one likely way of broadening this range is by correct choice of seed source, making use of natural adaptive variation within the species.

In 1973 the Australian Forest Research Institute (now CSIRO Division of Forest Research) commenced a rangewide provenance study of *E.regnans* (in co-operation with 2 State forest services, and 5 private Companies). This paper describes the strategy adopted for the project.

PROJECT OBJECTIVES

1. To delineate the best natural seed sources for planting on sites in Victoria and Tasmania.
2. To assess the extent of provenance by planting site interaction.
3. To provide populations upon which to base a selection and breeding programme, or from which to make supplementary selections for existing programmes (Cameron and Kube 1980).

SAMPLING

Seed was collected from 25 natural stands in Victoria and 23 in Tasmania so as to cover the geographic range. It was generally not possible to sample with respect to any obvious environmental gradients since the species' distribution is discontinuous. However, in the Central Highlands region of Victoria, high and low elevation samples were obtained. Earlier work (Ashton 1958 , Eldridge 1972) had demonstrated altitudinal clines for cold hardiness.

At each location seed was collected from an average of 14 trees (range 3-18). No attempt at phenotypic selection was made (other than that the trees should bear seed), so the collections approximate a random sample of the population in each area. Any such selection at this stage would inevitably vary between sites according to non-genetic factors such as seed crop and ease of collection, and so confound estimates of provenance mean performance.

The importance of spending time and effort at this seed collection stage must be emphasised. Except where the trial is part of a species screening project, or where considerable information is already available from other sources, it is short-sighted to cut costs by reducing the number of provenances under test. If the trial fails to adequately identify areas of major discontinuity or steep clines, or ignores marginal populations, then none of the objectives can be fully achieved. Follow up trials to "fill in the gaps" cause a substantial delay in applying results.

FIELD TESTING

Objectives 1 and 2 require testing over the major range of site types to be planted with the species. Apparently marginal sites should also be included as it becomes increasingly apparent that the natural habitat of eucalypts is a poor guide to their success in plantations. A marginal site is also useful, even if overall survival is poor, if it provides information on performance under conditions which occur with low frequence on better sites (e.g. cold, drought). Consultation with co-operators defined 5 suitable sites in Victoria and 7 in Tasmania for planting in 1977.

Before field designs could be specified 2 major decisions were required:

a) Whether or not to bulk seed from individual trees within provenances.

This reduces the number of seedlots under test, and hence simplifies design, but loses information on family within provenance performance - an important point with respect to objective 3) but not 1) and 2). Previous studies with *E.regnans* (Eldridge 1972) and *E.obliqua* (Brown et.al. 1976) successfully maintained family identity by employing cubic lattice designs. However, the number of families under test were substantially less than in the present study.

b) The required duration of the trials.

Because of expected competition effects between trees of different growth potential this question influences plot size. If the slower growing provenances are to be maintained far past the stage of canopy closure then plots have to be large enough to allow at least a single row of measured buffer trees around each plot. On the other hand if a decision regarding the most desirable provenances can be made soon after canopy closure then row plots are adequate.

At least in Victoria typical *E.regnans* planting sites have rather steep irregular topography, making the layout of large trials of complex design difficult. Plot size is thus a particularly important factor.

The following 2-stage strategy was adopted as the practical compromise which minimised loss of information:

Stage 1

Bulked provenance samples were used to establish short term trials on 10 sites. These trials will be evaluated after 5 years (1/4 < 1/3 of expected rotation age) to determine the most vigorous provenances, and the extent of provenance x site interaction for adaptation and early growth rate. A 7 x 7 balanced lattice design with 9-tree row plots was employed so that at 2 m x 3 m spacing each trial covers 2.6 ha. On the remaining 2 sites 30-tree rectangular plots were used in a lattice square design (area 4.4 ha). The latter two trials will allow continued assessment of all provenances to at least 2/3 rotation age.

Stage 2

As the species is likely to be grown on a relatively short rotation it is reasonable to assume that the most vigorous 20% of provenances at age 5 will include the most productive provenance at rotation age. After the 5 year assessments a second series of trials will be planted using the best 10 provenances at each site and maintaining family identity. If current work (Pederick 1976) shows that phenotypic selection in wild stands is worthwhile then a second series of seed collections from selected trees will be desirable. Otherwise stored seed from the original collection will be used.

The Stage 2 trials will provide the basis for individual tree selection if a more intensive breeding programme is desired. It is anticipated that seed-bearing Stage 2 trees will be available 12-15 years after establishment of the Stage 1 trials.

SEED SUPPLY

Information from age 1 growth and hardiness assessment of Stage 1 trials is already influencing choice of seed source (Griffin 1980). As more information becomes available co-operators will be able to define areas from which to obtain continuing seed supplies. In some cases this will not be possible as stands have been logged or are reserved, so seed production stands will be planted.

The Stage 2 trials may be designed so as to allow culling within and between families within each provenance, and use for seed production. In my opinion it is not possible to combine this seed production role with Stage 1 provenance tests, as suggested by Wilcox (1979), without severely compromising Objectives 1 and 2.

There are 3 main reasons for this:

a) In order to accommodate an adequate number of provenances; keep the trial within manageable size limits; and attain an evenly distributed stand after culling, very small plots must be used. This enforces selection for early growth rate. With the two-stage approach information from the older Stage 1 trials can, if necessary, be used to modify culling decisions in the Stage 2 trials.

b) The two-stage approach allows for more intensive selection within the best provenances because more trees are established than in Stage 1.

c) If the Stage 1 trial is culled to the best individuals, the genetic quality of seed produced from the resulting wide crosses is unpredictable - especially so in Eucalyptus where introgression with other species is a common phenomenon. The more conservative approach of breeding within selected provenances is therefore desirable at the current state of knowledge.

Although this testing strategy is designed within a particular framework of objectives and resources pertinent to S.E. Australia the questions addressed are considered to be of general applicability. For a more detailed discussion of provenance research planning see Burley and Wood (1976).

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SELEÇÃO DE ESPÉCIES DE EUCALYPTUS *PARA O NORTE DA CALIFÓRNIA.*

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Resumo

Um ensaio de competição de espécies de *Eucalyptus*, adequadas para regiões de baixa altitude e verões secos, é descrito neste trabalho aos 12 anos de idade. Trinta e seis espécies foram selecionadas para inclusão no teste, tendo como base sua resistência a geadas e forma das árvores. Coletas de sementes na área geral de ocorrência, normalmente em altitudes maiores, foram feitas para cada espécie. Uma plantação experimental foi feita em um local a 20 milhas da Baia de São Francisco, na direção do interior e caracterizado por verões secos e quentes e invernos úmidos e frios, típicos do Vale Central da Califórnia. Das 36 espécies testadas 21 foram consideradas sem potencial, após 12 anos de observações de campo. As 21 espécies incluem todas as 10 espécies do Oeste da Austrália e 10 das 11 espécies do subgênero *Monocalyptus* incluídas no ensaio. Em geral as coletas efetuadas nas maiores altitudes das regiões leste da Austrália tiveram melhor crescimento e sobrevivência.

SELECTION OF EUCALYPTUS *SPECIES FOR NORTHERN CALIFORNIA.*

Summary

A 12-year-old trial of Eucalyptus species suitable for low-elevation, summer-drought sites in northern California is described. Thirty-six species of Eucalyptus were selected for testing on the basis of potential cold-hardiness and tree form. General area seed collection, usually from higher elevations, were made for each species. A test plantation was established about 20 miles inland from San Francisco Bay on a site with the hot, dry summers and cool, moist winters typical of California's central valley. Of the 36 species tried, 21 were regarded as outright failures after 12 years in the field. The 21 failure species included all 10 of the species from western Australia and 10 of the 11 Monocalyptus species included in the study. In general, the higher elevation collections from eastern Australia had the best survival and growth.

Introduction

The purpose of this study was to compare and identify appropriate species of Eucalyptus suitable for planting on low-elevation sites in central California for forest products and landscaping.

A trial of 36 species of Eucalyptus carried out in the summer-drought climate of an inland northern California site has been evaluated after 12 years in the field (King and Krugman 1980). Highlights of the results are: 1) total failure of all 10 species from western Australia; 2) near total failure of all species of the subgenus Monocalyptus; and 3) the ability of the seven fastest growing species to recover from a record-breaking cold spell.

Methods

Australian foresters selected 36 Eucalyptus species on the basis of potential cold-hardiness and tree form, and provided us with general area seed collections. An attempt was made to collect seed from the higher elevations of most species.

A test plantation was established in cooperation with the U.S. Navy near Concord, California, about 20 miles inland from San Francisco Bay. The site is on good agricultural soil and has the hot, dry summer, and cool, moist winters typical of California's central valley. A recordbreaking cold spell (-9° C) occurred on the area in the winter of 1972-73, when the oldest trees were still less than 10 years old.

Thirty-one species were field-planted in 1965, using 10-month-old containerized seedlings. Trees were planted in randomized complete blocks with three replications of 16-tree plots. Replanting of fail spots was done in 1966 and a 32nd species added. In 1968, four additional species were planted.

Results

In the discussion of this test, the differences reported are not necessarily statistically significant. Because of problems in establishing this study, the tests of significance were not considered reliable (see King and Krugman 1980).

Western Australian Species

Western Australia with its dry summers seemed like a good source of *Eucalyptus* species for introduction onto this California site. Nevertheless, of the 10 western Australian species included in this test, 7 totally failed in both planting years. They were *E. brockwayii*, *E. diversicolor*, *E. dundasi*, *E. calophylla* (planted in 1965 only), *E. gomphocephala*, *E. redunca* var. *elata*, and *E. torquata*.

The other three western Australia species had few survivors in the 1965 planting; some success in the 1966 planting, but were practically eliminated after five seasons in the field. These three species are *E. oleosa*, *E. trancontinentalis*, and *E. salmonophloia*.

These species do not seem to be able to tolerate even the relatively light frosts (-2° C to -4° C) that occur annually on this site.

Subgenus *Monocalyptus* Species

In general, the 11 species of *Monocalyptus* had better early survival than the western Australian species, but they too were eliminated by a combination of repeated frosts, summer drought and weed competition after 8 years.

These species collections from New South Wales include: *E. andrewsii*, *E. fastigata*, *E. niphophila*, *E. obliqua*, and *E. radiata*.

Three species collection are from the Capital Territory: *E. pauciflora*, *E. robertsonii*, and *E. delegatensis*.

One species, *E. regnans* is from Tasmania; and one species *E. stellulata* is from Victoria.

The most notable exception in this subgenus is *E. coccifera* which still has about 40 percent survival of the 1965 seedlings after 12 years, but is rather slow-growing.

Pryor (1976) pointed out that with few exceptions, species of *Monocalyptus* seldom do well outside of Austraia. He attributed such failures to the lack of suitable mycorrhizal fungus in exotic plantations. No specific observations relating to Pryor's hypothesis about mycorrhizae were made in this study. Nevertheless, the 12-year mortality figures support Pryor's observation on the poor performance of *Monocalyptus* as exotics.

Northern Territory Species

Only one species, *E. polycarpa*, from the northern territory was included in this test and was a total failure. Of the 92 seedlings planted in 1965 and 1966, not one seedling survived through the first year.

Eastern Australian Species

Of the 14 species from eastern Australia, 7 had fair to good survival, but were too slow-growing for anything but landscaping trees. These include four species from Victoria seed collections: *E. behriana*, *E. fruticetorum*, *E. polyanthemos*, and *E. sideroxylon*. The other three species in this slow-growing group, *E. melliodora*, *E. resinifera*, and *E. robusta* were all from New South Wales' collections.

The seven species showing the greatest potential in terms of both survival and growth rate (Table 1) include three from Victoria collections: *E. camaldulensis*, *E. glaucescens*, and *E. nitens*; and three from New South Wales: *E. dalrympleana*, *E. grandis*, and *E. viminalis*.

The seventh species in this group is an *E. ovata* collection from Tasmania and is somewhat borderline in this group. While its survival has been only fair and its tree form poor, it has produced some of the largest trees in this test.

All of the eastern Australian species recovered well from the recordbreaking 1972 freeze.

Conclusions

Each species in this study was represented by only a single general area collection. Thus, comparison between species do not take into account genetic variation within species. There might be local provenances within slow-growing species that could outgrow the general collections used in this study.

In general, the higher elevation collections from eastern Australia did best in terms of survival and growth. *Eucalyptus grandis* was a slight exception in that it is not a high elevation species. This species is closely related to *E. saligna* and is successfully and widely planted in the tropics (Eldridge 1976). Nevertheless, it withstood the dry summers and 1972 cold spell encountered on this site and made excellent growth. Hall *et al.* (1963) noted that in tests at Canberra, *E. grandis* has shown resistance to temperatures lower than those occurring within its natural range.

Pryor (1976) suggested that the eucalypts have a wider ecological amplitude than they can normally display in their native habitat. But they are limited in expressing this amplitude by the competitive effects of other *Eucalyptus* species. Our data supports his contention that "... in making (*Eucalyptus*) introductions the natural range of the species is only a partial guide to what may be achieved as successful growth in the various conditions in which it might be planted" (Pryor 1976, p. 74).

Table 1--Survival and growth of the 10 fastest growing *Eucalyptus* species at Concord, California in 1977.

	Seedlings planted							
	Survival		Growth					
Species	1965	1966	1965			1966		
			Ht.	d.b.h.	Vol.	Ht.	d.b.h.	Vol.
	Percent		m	cm	cu m	m	cm	cu m
E. camaldulensis	-	65	-	-	1/	10.6	12.4	.06
E. dalrympleana	65	60	17.2	22.4	.29	8.1	8.9	.02
E. glaucescens	35	72	13.4	17.8	.15	9.8	9.9	.03
E. grandis	13	91	15.3	19.3	.20	11.6	12.7	.07
E. nitens	54	94	3.8	19.8	.19	13.2	16.8	.13
E. ovata	29	24	13.8	24.1	.28	11.8	16.0	.10
E. viminalis	83	75	14.1	17.0	.14	9.1	7.9	.02
E. melliodora	60	84	9.2	11.7	.04	7.8	8.4	.02
E. resinifera	23	60	8.5	11.7	.04	6.8	10.4	.03
E. robusta	23	65	7.7	11.9	.04	6.4	9.7	.02

1/ Volume equation derived from data in Metcalf (1924). Stem volume to a 2-inch (15 cm) top. Volume (cubic feet) = 0.00245 (diameter inches^2 height feet) - .3318. Volume then converted from cubic feet to cubic meters using 1 cubic foot = .02832 cubic meters.

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RESULTADOS DE DOIS ANOS DE TESTE DE ESPÉCIES/PROCEDÊNCIA DE EUCALYPTUS *EM SEIS LOCAIS DA COLÔMBIA.*

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Resumo

Um estudo de espécies/procedências de *Eucalyptus* foi estabelecido em seis diferentes altitudes, nível do mar até 2000 m, na Colômbia em 1977. As espécies utilizadas foram: *E. grandis, El saligna, E. camaldulensis* e *E. tereticornis.* Após dois anos, várias procedências de raças locais de *E. grandis* e de *E. camaldulensis* estavam se desenvolvendo muito bem. Apesar do *E. camaldulensis* geralmente crescer melhor abaixo de 1500 m de altitude, algumas procedências estavam crescendo tão bem quanto o *E. grandis* a 2000 m de altitude. As condições de solo e outros fatores dos locais parecem ser tão importantes quanto a altitude no desenvolvimento do eucalipto.

As melhores espécies/procedências estão tabuladas pela variação da altitude e com base nestes dados, alguns dos testes estão sendo transformados em talhões de produção de sementes de *E. grandis* ou *E. camaldulensis.* Testes de procedências adicionais foram plantados em 1979.

TWO YEARS RESULTS OF A EUCALYPTUS *SPECIES AND PROVENANCE TEST ON SIX SITES IN COLOMBIA*

Summary

A eucalyptus species/provenance study was established in 1977 at six different altitudes in Colombia from sea level to 2000 meters, with *E. grandis*, *E. saligna*, *E. camaldulensis* and *E. tereticornis*. After two year's growth many land race provenances of *E. grandis* and *E. camaldulensis* were doing very well. Although *E. camaldulensis* generally grows better below 1500 meters ASL, some provenances were growing as well as *E. grandis* at 2000 meters. Soil conditions or other local site factors appear to be as important as altitude in eucalypt development.

The best species and provenances are listed by altitude range and based on this data, some of the trials are being converted into single species seed stands of *E. grandis* or *E. camaldulensis*. Additional provenances trials were planted in 1979.

INTRODUCTION

In Colombia there exist potential areas for eucalyptus reforestation at low and middle altitudes (0-2000 meters ASL) in plantantions as well as in fencerows. There also exists a need for construction poles, lumber and pulp which could be produced from such reforestation. From previous studies and limited reforestation efforts it is known that *Eucalyptus camaldulensis* and *E. tereticornis* will grow on the Atlantic Coast and in the Cauca Valley near Cali at 1000 meters ASL., and also that *E. grandis* and *E. saligna* will grow on the Popayan altiplano at 1750 meters ASL.

A pilot study planted in 1975 showed early differences due to provenance in *E. camaldulensis* and *E. tereticornis* in plantings at 1000 and 1750 meters altitude and it became obvious that futher species/provenance research was needed (Ladrach, 1977). During this time period, seed trees were located in plantations of *E. camaldulensis* and *E. grandis* for local seed production. Additional seed was also obtained from C.S.I.R.O. in Canberra, Australia for provenance research. Using these two sources of seed, a study was designed to test several eucalyptus species by provenance (considering the local seed trees as provenances also) on six sites from sea level to nearly 2000 meters altitude along the length of Colombia (Figure 1).

PROCEDURE

The seed was sown in January, 1977, in the company nursery at Yumbo, near Cali, in the Cauca Valley with the following number of provenances per species: *E. grandis* (11), *E. saligna* (4), *E. camaldulensis* (13), *E. tereticornis* (2), and *E. deglupta* (1). Provenance data for each lot is given in Table I. The best Australian provenances from the 1975 pilot study were also included in the present study:

E. camaldulensis	W. Mt. Isa	QLD
E. camaldulensis	Leichhardt River,	QLD
E. tereticornis	Woolgoolga,	NSW
E. grandis	Woolgoolga,	NSW
E. saligna	Raymond Tract,	NSW

Each site was planted with rowplots of from 7 to 10 trees and with 3 or 4 replications in a randomized block design. Site descriptions and planting details are listed in Table II. Differences in planting designs between sites were due to space available and the use of non-company land for two of the trials. The trial at the Seminary of Medellin was installed and is maintained by INDERENA (Colombian Forest Service) personnel as a cooperative effort.

Height and diameter (DBH) were measured for all trials at the end of one and two years, and survival counts were made at the same time. Second year total volumes were also calculated using locally developed volume formulae. Since each site does not have the exact same number of provenances represented, separate analyses of variance were calculated by site, and afterwards, Duncan's multiple range test (Q=5%) was used to help stratify provenance differences. Average species differences were analyzed for the study as a whole, using a split-plot, randomized block analysis of variance.

RESULTS AND DISCUSSION

Total tree height and volume differences by provenance were significant on all six sites, as would be expected when several species are included (Table I & III). Survival differences were also significantly different on four of the six sites (Tables III & IV) and since the four lower altitude sites all have pronounced dry season these differences are important.

Local land race provenances have adapted well over the range of sites, in comparison with Australian provenances of the same species. Since the local seed trees had been planted from commercial seed imported from Australia, this tends to indicate that a simple seed tree selection program for commercial seed production can be quite profitable even when the land race eucalypts have only existed for one generation in their adopted country.

The provenances of *E. grandis* and *E. camaldulensis* that had performed well in the previous pilot study continued showing good results in this study. Local land races of these two species varied considerably in growth on a given site, compared to the Australian provenances. This was especially surprising in *E. grandis* since most of these seed trees had been selected from a single plantation, all of the same commercial seed source.

A general tendency had been expected between species in that *E. grandis* and *E. saligna* would perform better at the higher altitudes and *E. camaldulensis* and *E. tereticornis* would be better at the lower altitudes. In general *E. grandis* and *E. saligna* are best suited to altitudes above 1500 meters and *E. camaldulensis* and *E. tereticornis* to altitudes below 1500 meters, but notable exceptions to this trend can be cited. Both *E. camaldulensis* and *E. tereticornis* grew and survived well at the Seminary of Medellin (1935 mts. ASL) and in fact, their growth here was about the same as in Guachicona (1000 mts. ASL) and San Benito (sea level). Nonetheless, the best provenances of *E. camaldulensis* varied with changing altitude, except for EC66, which is among the best growers at all altitudes. Since trees in the land race EC66 plots show both *E. camaldulensis* and *E. saligna* characteristics, it is most likely that this is a hybrid which demostrates heterosis in both growth and survival over a wide range of ecological conditions.

Another exception to the species/altitude relationship can be seen from the general growth of all species on a given farm. The Estrella and Bajo de Oso farms have very poor growth for all species which is obviously not due to altitude, nor climate. The Estrella farm has red clay soils with a slight organic surface layer and even though the site was plowed, disced and fertilized before planting, the eucalyptus growth is not good. Soil texture appears to be an inhibitive factor in eucalyptus growth on this site. On the other hand, the Bajo de Oso farm is considered to have a milder climate and better soils than the San Benito farm, but the eucalyptus growth here is poor also. Since this is a cattle farm and the site was not plowed, but simply disced, soil compaction may be a limiting factor. Soil termites, which are common in cattle farms, were also found in the study area and had killed some trees the first year.

A species by site split plot analysis conducted for *E. grandis* *E. saligna*, *E. camaldulensis* and *E. tereticornis* on all six sites showed significant site and species differences (Table V). From the T-test comparisons of total height between species the following differences can be noted (Table VI, Figure 2):

E. grandis is better than *E. saligna* on medium altitude sites (1000 to 1750 mts.)

E. camaldulensis and *E. tereticornis* show no significant differences in height potential at any altitude tested.

E. grandis is superior to *E. camaldulensis* above 1500 mts., they are about equal between 1500 and 1000 mts., and *E. camaldulensis* is superior at lower altitudes. It should be mentioned however that *E. grandis* survival was very poor below 1500 mts.

A similar T-test comparison of tree height was made between farms by species. In nearly all cases there were significant differences between farms by species and also for all species combined (Table VII). This combined with the previous results, tends to indicate that there are still great differences between species and sites not well defined by the present study and that more research is still needed, especially in soil/site relationships. As an example: Although *E. camaldulensis* and *E. tereticornis* are doing well after two years at San Benito (sea level), their coloring and general appearance is not good, regardless of provenance. Older plantations in this farm show a similar poor coloring and many have failed in the past.

The best provenances found in this study are listed by species and by altitude range in Table VIII. Using these data, some of the trials are being converted to seed stands by species. In the Arcadia farm, all but the best provenances of *E. grandis* were culled after the second year measurement and among the best provenances only two individuals have been left per row as seed trees. This trial is isolated from other eucalyptus plantations and by this means improved seed will be produced from this study in the very near future. The trial in Guachicona will be culled similarly after the third year measurement, leaving only *E. camaldulensis* seed trees.

A land race of *E. deglupta* was also planted in the Guachicona farm trial and it shows some promise for the Cauca Valley. However, during a bagworm attack during the second year, *E. deglupta* was the only species completely defoliated, and this could be a detriment to its future use in fencerows near agricultural crops where the bagworm is a cronic pest.

CONTINUING STUDY

Another study was established in 1979 which involves individual species provenance tests for *E. grandis* (44 provenances), *E. viminalis* (11 provenances), *E. saligna* (25 provenances) and *E. globulus* (43 provenances). Each trial is isolated from the other so as to be able to convert them into improved seed stands at a later date. The *E. globulus* and *E. grandis* trials are also replicated at different altitudes.

LITERATURE CITED

Ladrach, W. 1977. First year results of two studies of *Eucalyptus* sp. in the Departments of Valle and Cauca. Research Report No. 26. Cartón de Colombia, Cali, Colombia 10. p.

FIGURE 1. EUCALYPTUS TRIAL LOCATIONS IN COLOMBIA

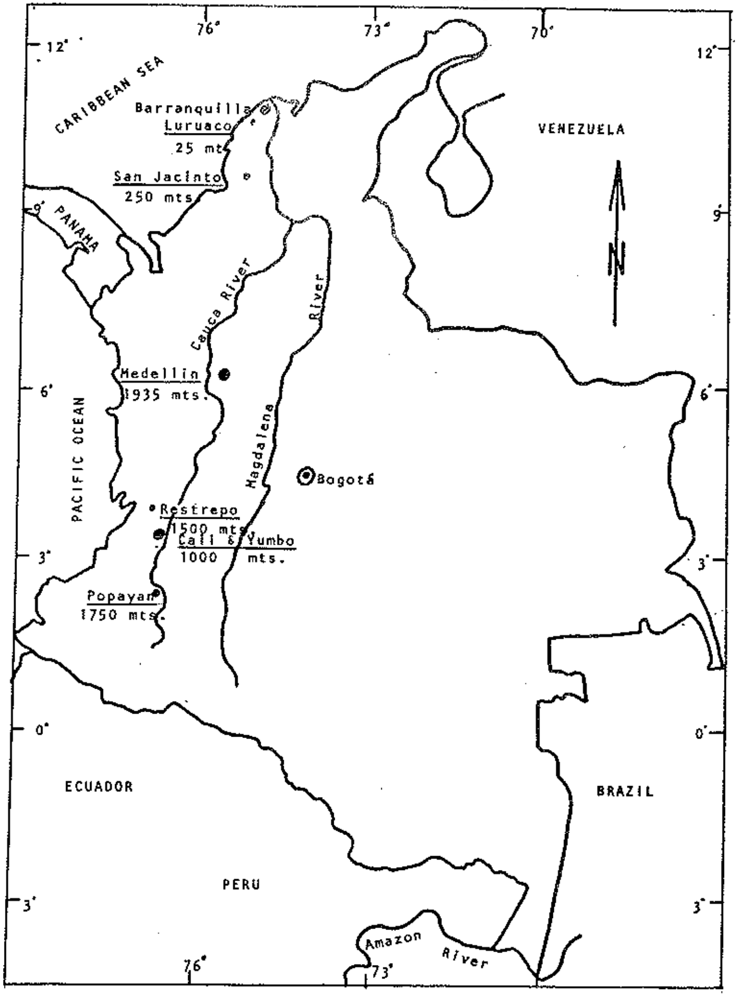
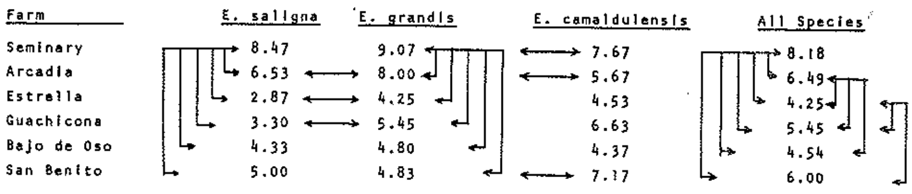


FIGURE 2. SIGNIFICANT DIFFERENCES IN TWO YEAR HEIGHTS (METERS) OF EUCALYPTUS BY FARM IN COLOMBIA*



Farm	E. saligna		E. grandis		E. camaldulensis	All Species
Seminary	8.47		9.07	↔	7.67	8.18
Arcadia	6.53	↔	8.00	↔	5.67	6.49
Estrella	2.87	↔	4.25		4.53	4.25
Guachicona	3.30	↔	5.45		6.63	5.45
Bajo de Oso	4.33		4.80		4.37	4.54
San Benito	5.00		4.83	↔	7.17	6.00

*/ Arrows connect values significantly different at the 5% level or better.

TABLE I. SUMMARY OF TWO YEAR HEIGHT GROWTH IN METERS, EUCALYPTUS PROVENANCE TRIAL 1-37, CARTON DE COLOMBIA

Species	Code	Provenance	Seminary	Arcadia	Estrella	Guachicona	Bajo de Oso	San Benito
E. grandis	EGR 10693	NE Gympie, QLD Australia	9.1	8.4	3.3	4.9	-	3.3
" "	EGR 10694	SE Gympie, QLD "		8.9	5.9		-	-
" "	EGR 10735	Woolgoolga, NSW "		7.9	4.9	5.8	5.0	-
" "	EGR 2	Popayan Cauca Colombia		7.1	6.4	5.8	-	4.6
" "	EGR 3	" " "	8.6	7.3	2.9	5.3	-	5.3
" "	EGR 4	" " "	9.8	7.7	2.7			3.3
" "	EGR 5	" " "			5.6			4.0
" "	EGR 6	" " "	8.8	8.1	6.1	6.1	-	6.1
" "	EGR 7	" " "		9.4	5.0	5.7		4.0
" "	EGR 8	" " "	9.0	8.2	6.7	4.4	6.2	4.4
" "	EGR HILL	- - Australia		7.5				5.5
E. saligna	ES 7808	Bulahdela, NSW "		7.3			-	-
" "	ES 10733	Raymond Tract NSW "		4.3	3.1	2.4	5.0	-
" "	ES 10698	Kenilworth QLD, "	9.0	8.0	3.3	3.9		7.0
" "	ES* 25	Yumbo Valle, Colombia		6.1			3.2	7.0
E. camaldulensis	EC 10544	Lennard Rv. WA Australia		4.9	3.8	4.6	4.1	6.2
" "	EC 10688	N. Cloncurry QLD, "	.	5.2	3.7	6.2		5.9
" "	EC 10689	N. Cloncurry QLD, "		5.9	4.1	6.2		7.1
" "	EC 10690	W. MT. Isa QLD, "	7.3	6.2	5.9	5.4	3.6	7.2
" "	EC 10927	Leichhardt Rv. QLD, "		5.8	4.3		4.0	7.3
" "	EC 30	Yumbo Valle, Colombia		5.5	3.9	6.7	5.7	8.9
" "	EC 32	" " "			5.1	6.9		8.2
" "	EC 35	" " "	7.4	6.3	4.3	6.9	4.1	6.4
" "	EC 40	" " "			3.3	6.9		7.2
" "	EC 41	" " "			5.7	7.5		6.1
" "	EC 47	" " "	8.2	6.0	5.8	7.2	5.3	5.9
" "	EC 63	" " "	6.9	4.0	3.8	8.1		8.8
" "	EC* 66	" " "	9.0	6.4	4.7	7.2	5.0	8.2
E. tereticornis	ET 9481	N. Stewart Br., NSW Australia	7.2	5.0	4.3	5.2	4.0	5.7
" "	ET 10884	N. Woolgoolga NSW "		6.3	4.5	6.5	5.1	8.4
E. deglupta	ED POP	Popayán, Cauca Colombia				4.4		

*/ These families appear to be hybrids of *E. camaldulensis* and *E. saligna*.

TABLE II. EUCALYPTUS PROVENANCE TRIAL LOCATION, DESCRIPTION BY FARM

Farm	Seminary	Arcadia	Estrella	Guachicona	Bajo de Oso	San Benito
Municipality	Medellin	Popayán	Restrepo	Yumbo	San Jacinto	Laruaco
Department	Antioquia	Cauca	Valle	Valle	Bolivar	Atlantico
Latitude	6°15' N	2°30' N	3°50' N	3°40' N	9°50' N	10°40' N
Longitude	75°40' W	76°40' W	76°40' W	76°30' W	75°5' W	75°15' W
Altitude ASL Mts.	1935	1750	1500	1030	250	30
Precipitation, mm.	1600	1950	1200	1200	1200	1200
Previous Vegetation	Cypress Plantation	Cypress Plantation	Pasture	In cultivation	Pasture	Pasture
Site Preparation	Burn, Scalp	Plow, Dis.	Plow, Disc	Plow, Disc	Disc	Plow, Disc, Bed
No. Provenances	12	26	27	25	19	30
No. Replications	4	3	3	3	3	3
Planting Date	July, 1977	June, 1977	June, 1977	Nov., 1977	May, 1977	May, 1977
Trees/Rowplot	7	8	8	8	8	10
Spacing, mts.	2.8 x 2.8	2.5 x 2.5	2.5 x 2.5	2.5 x 2.5	3.5 x 2.0	3.0 x 3.0
NPK 10-30-10 gm/tree	-	50	50	50	50	50
Borax gm/ tree	-	5	5	5	5	5

TABLE IV. SUMMARY OF TWO YEARS PERCENT SURVIVAL, EUCALYPTUS PROVENANCE TRIAL 1-37, CARTON DE COLOMBIA

Species	Code	Provenance	Seminary	Arcadia	Estrella	Guachicona	Bajo de Oso	San Benito
E. grandis	EGR 10693	NE Gympie QLD Australia	82	87	76	4	0	3
" "	EGR 10694	SE Gympie QLD "		83	81	0	0	0
" "	EGR 10735	Woolgoolga NSW "		87	80	8	4	0
" "	EGR 2	Popayan Cauca Colombia		58	67	0	0	20
" "	EGR 3	Popayan Cauca "	93	79	70	4	0	23
" "	EGR 4	" " "	75	70	85			7
" "	EGR 5	" " "			80			10
" "	EGR 6	" " "	64	87	54	8	0	43
" "	EGR 7	" " "		87	56	21		17
" "	EGR 8	" " "	68	67	56	8	8	37
" "	EGR HILL	" " "		83				57
E. saligna	ES 7808	Bulahdela NSW Australia		83			0	0
" "	ES 10733	Raymond Tract NSW "		62	62	8	4	0
" "	ES 10698	Kenilworth QLD "	68	70	71	8		3
" "	ES 25*	Yumbo Valle Colombia		91			29	43
E. camaldulensis	EC 10544	Lennard Rv. WA Australia		83	71	54	87	93
" "	EC 10688	N. Cloncurry QLD "		91	87	71		93
" "	EC 10689	N. Cloncurry QLD "		100	91	79		90
" "	EC 10690	W. Mt. Isa QLD "	96	95	89	75	81	97
" "	EC 10927	Leichhardt Rv. QLD "		95	75		92	97
" "	EC 30	Yumbo Valle Colombia		91	85	96	80	73
" "	EC 32	" " "			81	66		73
" "	EC 35	" " "	71	75	67	50	58	77
" "	EC 40	" " "			71	75		87
" "	EC 41	" " "			75	71		50
" "	EC 47	" " "	68	100	64	50	61	97
" "	EC 63	" " "	68	83	75	67		97
" "	EC 66*	" " "	72	87	100	62	46	80
E. tereticornis	ET 9481	N. Stewart Br. NSW Australia	50	83	71	29	37	80
" "	ET 10884	N. Woolgoolga NSW "		75	80	88	45	90
E. deglupta	ED POP	Popayan Cauca Colombia				84		

*/ These families appear to be hybrids of *E. camaldulensis* and *E. saligna*

TABLE III. SUMMARY OF ANALYSES OF VARIANCE BY FARM, FOR TWO YEAR OLD EUCALYPTUS PROVENANCES

FARM	HEIGHT	VOLUME	SURVIVAL[1/]
Seminary	.001	.001	N.S.
Arcadia	.001	.001	.01
Estrella	.05	.01	N.S.
Guachicona	.01	.01	.05
Bajo de Oso	.05	.01	.05
San Benito	.01	.001	.01

[1/] ARC-Sin transformation of percent survival for ANOVA.

.001 = highly significant

.01 = very significant

.05 = significant

N.S. = not significant

TABLE V. ANOVA FOR SPLIT PLOT, TWO YEAR HEIGHTS OF EUCALYPTUS SPECIES ON SIX FARMS IN COLOMBIA

Source	GL.	SS	MS	F
Farms	5	123.6578	24.7316	103.06 ***
Blocks/Farm	2	12.4503	6.2251	25.94 ***
Major Plot Error	10	2.3997	.2400	
Species	3	14.3839	4.7946	3.16 *
Species x Block	6	5.9786	.9964	.66 N.S.
Subplot Error	45	68.2825	1.5174	
Total	71	227.1528		

TABLE VI T-TEST COMPARISON OF SPECIES BY FARM FOR TWO YEAR HEIGHTS OF EUCALYPTUS IN COLOMBIA

Species Compared	Farm						Overall
	Seminary	Arcadia	Estrella	Guachicona	Bajo de Oso	San Benito	Difference
Grandis/saligna	N.S.	.001	.001	.001	N.S.	N.S.	.001
Grandis/camaldulensis	.01	.001	N.S.	N.S.	N.S.	.001	N.S.
Grandis/tereticornis	.001	.001	N.S.	N.S.	N.S.	.001	N.S.
Camaldulensis/tereticornis	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Camaldulensis/saligna	N.S.	.05	.001	.001	N.S.	.001	.05
Tereticornis/saligna	.05	N.S.	.001	.001	N.S.	.001	.05

.001 = highly significant at 0.1% level
.01 = very significant at 1% level
.05 = significant at 5% level
N.S. = not significant

TABLE VIII. PROVENANCES OF EUCALYPTUS RECOMMENDED FOR PLANTING IN COLOMBIA BY ALTITUDE, BASED ON GROWTH AND SURVIVAL RESULTS OF STUDY 1-37.

Atlantic Coast		Valle del Cauce (1000 mts)		Middle Altitudes (1500 to 1750 mts)		Upper Middle Altitudes (2000Mts)	
Species	Code	Species	Code	Species	Code	Species	Code
E. camaldulensis	EC 30	" "	EC 32	E. grandis	EGR 2	E. grandis	EGR 4
" "	EC 32	" "	EC 35	" "	EGR 3	" "	EGR 6
" "	EC 40	" "	EC 40	" "	EGR 4	" "	EGR 8
" "	EC 63	" "	EC 41	" "	EGR 6	" "	EGR 10693
" "	EC 66	" "	EC 63	" "	EGR 7	E. saligna	ES 10698
" "	EC 10689	" "	EC 66	" "	EGR 8	E. camaldulensis	EC 35
" "	EC 10690	" "	EC 10688	" "	EGR 10693	" "	EC 47
" "	EC 10927	" "	EC 10689	" "	EGR 10694	" "	66
E. tereticornis	ET 10984	E. tereticornis	ET 10884	" "	EGR 10735		
				E. saligna	ES 7808		
				" "	ES 10698		
				E. camaldulensis	EC 35		
				" "	EC 47		
				" "	EC 66		

TABLE VII. T-TEST COMPARISONS OF FARMS BY SPECIES FOR TWO YEAR HEIGHTS OF EUCALYPTUS IN COLOMBIA

Farms Compared	E. grandis	E. camaldulensis	E. tereticornis	E. saligna	Overall Difference
Seminary/Arcadia	.05	.001	.001	.001	.001
Seminary/Estrella	.001	.001	.001	.001	.001
Seminary/Guachicona	.001	.05	.001	.001	.001
Seminary/Bajo de Oso	.001	.001	.001	.001	.001
Seminary/San Benito	.001	N.S.	N.S.	.001	.001
Arcadia/Estrella	.001	.01	.01	.001	.001
Arcadia/Guachicona	.001	.05	N.S.	.001	.05
Arcadia/San Benito	.001	.001	.01	.001	N.S.
Estrella/Guachicona	N.S.	.001	.001	N.S.	.01
Estrella/Bajo de Oso	N.S.	N.S.	N.S.	.001	N.S.
Guachicona/San Benito	.05	.001	.05	.001	N.S.
San Benito/Bajo de Oso	N.S.	.001	.001	N.S.	.001

.001 = highly significant at 0.1% level
.01 = very significant at 1% level
.05 = significant at 5% level
N.S. = not significant

ESTUDOS DE PROCEDÊNCIAS DE EUCALYPTUS *no Kalimantan Oriental.*

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Resumo

Testes de procedência de *E. deglupta, E. urophylla* e *E. camaldulensis* foram instalados no Kalimatan Oriental e os resultados parciais dos testes aos 3, 2 e 1 anos de idade respectivamente são discutidos neste trabalho. As árvores de *E. deglupta* de Rock Pile (Papua Nova Guiné) e Bisling (Filipinas) são significativamente maiores e mais retas que as de outras fontes. As árvores de todas as procedências parecem igualmente suscetíveis ao ataque de broca do tronco (cerca de 40% de danos). Um teste aos 2 anos com clones de *E. deglupta* enraizados indicaram que o ganho genético relativo deve ser razoavelmente estável na variação de características dos locais. O *E. urophylla* e o *E. camaldulensis* têm crescido de maneira semelhante ao *E. deglupta*, com algumas diferenças distintas entre árvores de várias procedências.

EXAMINATION OF EUCALYPTUS *PROVENANCES IN EAST KALIMANTAN.*

Summary

Provenance trials were established in East Kalimantan for Eucalyptus deglupta, E. urophylla and E. camaldulensis; test results are for 3, 2 and 1 years, respectively. E. deglupta trees from Rock Pile (Papua New Guinea) and Bislig (the Philippines) were significantly larger and straighter than those from other sources. Trees from all provenances seemed equally susceptible to stem borer attack (about 40% tree damage). A 2-year test with clones of E. deglupta rooted cuttings indicated that relative genetic performance should be reasonably stable across the range of concession sites. Eucalyptus urophylla and E. camaldulensis have grown similarly to E. deglupta, with few distinct differences among trees from the various provenances.

INTRODUCTION

The concession area of P.T. International Timber Corporation of Indonesia, located near the equator in an area with a tropical moist forest climate, offers great potential for developing plantations of tropical or subtropical hardwoods. Planting programs began in 1974 with Eucalyptus deglupta, Albizia falcataria and Anthocephalus chinensis. In 1976, a provenance trial was initiated for E. deglupta, a tree native to the Philippines, eastern Indonesia and Papua New Guinea (PNG). Although E. deglupta exhibits favorable characteristics of rapid growth and reasonably high specific gravity, it is heavily attacked by a large stem borer, Zeuzera coffeae. Provenance tests were therefore conducted to compare trees from various sources with respect to (1) growth characteristics and (2) resistance to Z. coffeae.

In recent years new provenance trials and species comparisons have been established with other Eucalyptus species to identify possible alternative timber sources. The E. deglupta test and early results from the E. urophylla (native to Indonesia) and E. camaldulensis tests will be described here.

METHOD

The typical field design used in all tests involved large adjacent block plantings from each provenance. Two to four plots were installed in each block (25 trees per plot); in small blocks each tree was measured. All tests were planted on clayey and silty Ultisol soils, characteristic of the concession area in East Kalimantan.

Table 1. Growth characteristics of Eucalyptus deglupta from five provenances 3 years after planting in East Kalimantan.

Provenance	Average Tree Height (m)	Height ($s_{\bar{x}}$)	Diameter (cm)	Diameter ($s_{\bar{x}}$)	Volume (m^3)	Volume ($s_{\bar{x}}$)	Stem Borer Damage[1] (% trees)
Bislig, Philippines	18.6	(1.5)	16.3	(0.6)	.177	(0.032)	39
Rock Pile, Bonlo, PNG	17.9	(1.0)	17.2	(1.2)	.182	(0.036)	38
Pare-Pare, Sulawesi	14.4	(2.0)	14.7	(1.4)	.104	(0.035)	47
Fryar 13, Warongai, Kerevat, PNG	14.4	(1.0)	13.7	(1.0)	.092	(0.021)	40
Little Vudal Camp, Kerevat, PNG	14.3	(2.1)	14.8	(1.7)	.105	(0.039)	41

[1] Evaluated when trees were 2 years old.

Table 2. Correlation of Eucalyptus deglupta clone ranks for second-year height at individual sites with ranks for clone means across all sites (clones established as rooted cuttings from randomly selected nursery seedlings).

Site	Mean Height All Clones (m)	Clone Rank Correlation (r)
27	8.9	0.79*
29	8.8	0.86*
85	7.2	0.89*
24	7.1	0.71
84	3.5	0.57

* Significant at $p = 0.05$.

Trees in Provenance group 6 in the Pilbara region of Western Australia

Trees in Provenance group 21 in western New South Wales

Fig. The photographs of *E. microtheca* below illustrate the remarkable variation within this species in the retention of rough bark. Over the greater part of its range coolibah retains a grey to black rough bark on the trunk and large branches for 1/2-4/5 of tree height. In contrast, populations in the Murchison and Pilbara regions of Western Australia and some populations in central Australia are almost completely smooth barked.

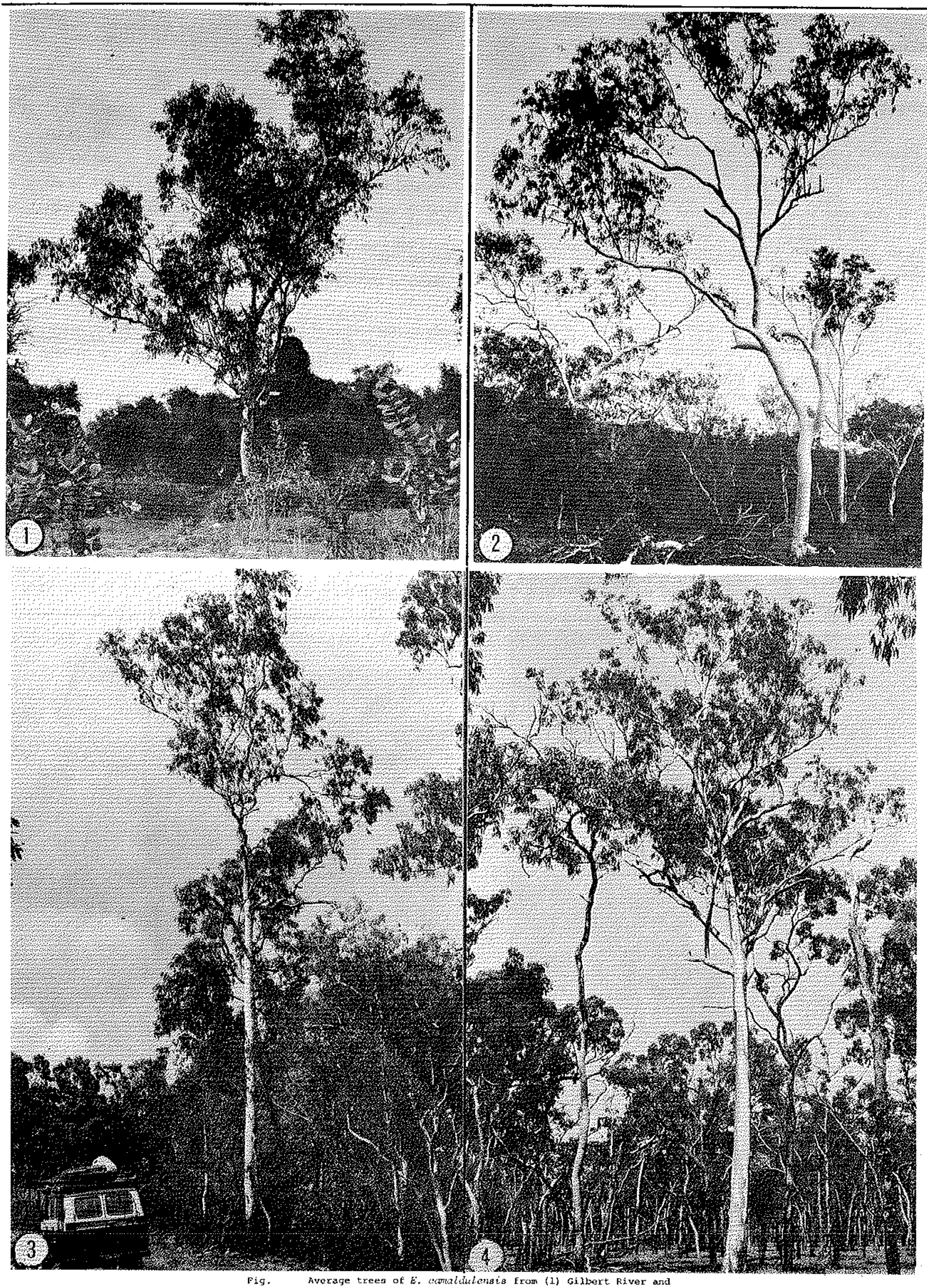

Fig. Average trees of *E. camaldulensis* from (1) Gilbert River and (2) Petford, and of *E. tereticornis* from (3) Helenvale and (4) Mt Garnet

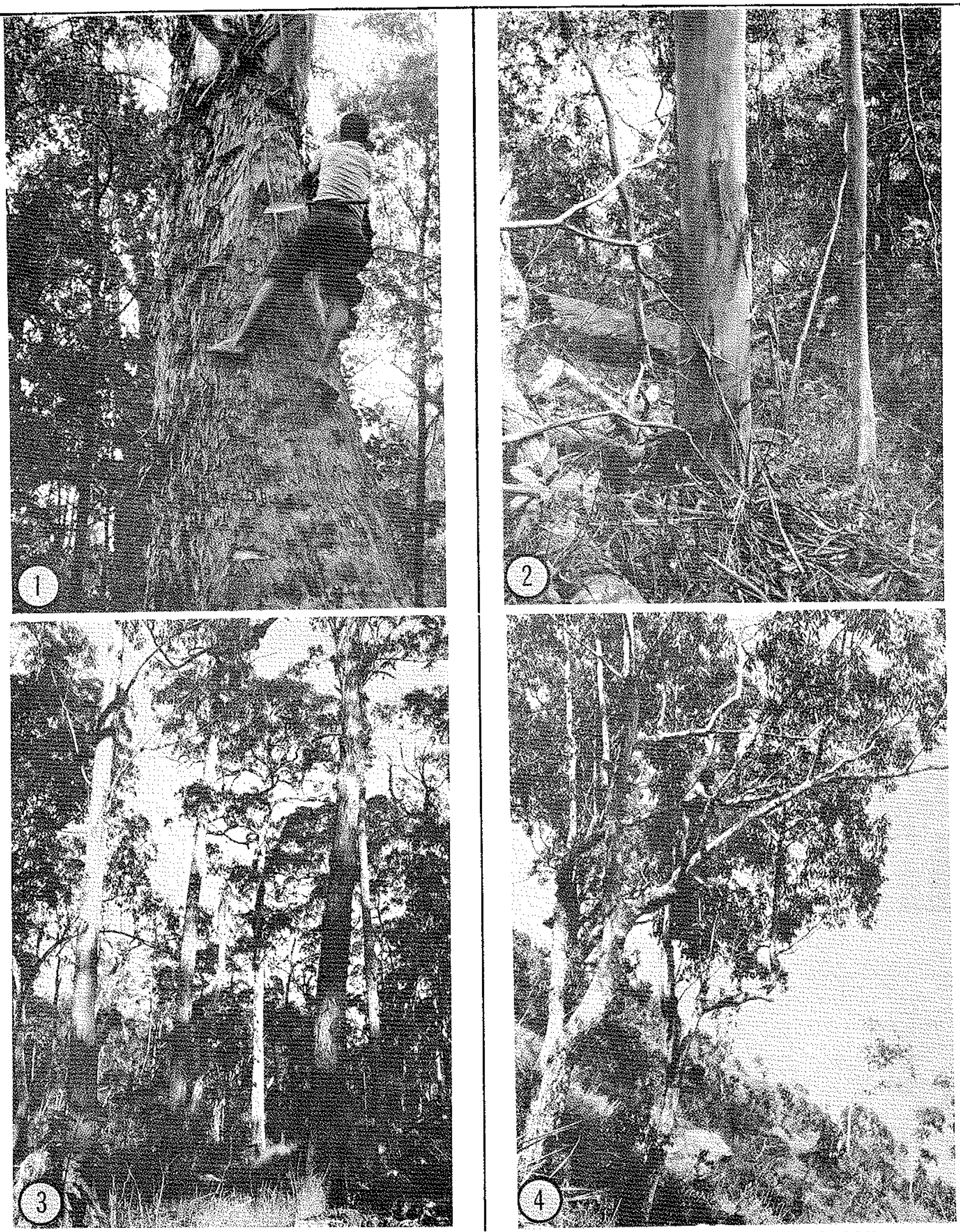

Fig. *E. urophylla* in Indonesia: (1) Tree F1/7 on Mt Mandiri; the eucalypt fruits were plucked into bags from the branches cut down by the climbers. (2) Tree F1/8 on Mt Mandiri; the bark character was highly variable at this site. Trees with ¼ and ¼ of the stem retaining rough bark were most plentiful, with the occasional occurrence of fully smooth barked and fully rough barked individuals. (3) A fine stand of trees at 470 m elevation on Mt Lewotobi. (4) Tree A1/8 clinging to the steep mountain slopes of Mt Boleng.

Table 3. Height and survival of Eucalyptus urophylla from eight provenances in two tests on the ITCI concession, East Kalimantan.

Seedlot	Provenance	Provenance Elevation (m)	1977 Test Two-year Height (m)	(s$_{\bar{x}}$)	Survival (%)	1978 Test One-year Height (m)	(s$_{\bar{x}}$)	Survival (%)
11885	Aruaoe	300	6.4	(2.0)	16			
11877	Alor	650	6.1	(1.9)	27	4.3	(0.7)	40
10144	N. Aileu	1200	5.8	(2.0)	29	4.1	(0.5)	62
9003	Dili	1100	5.0	(1.5)	23	3.4	(0.4)	54
11882	Pantar	600	4.9	(2.1)	5			
10136	Mt. Tatamailau	2700	3.0	(3.0)	11			
10140	Queorema	2100	2.9	(0.9)	13			
12362	Bessi-Laou	1250				3.4	(0.7)	60
	E. deglupta		6.0	(1.5)	76			

Table 4. Height, diameter and survival of Eucalyptus camaldulensis from seven provenances one year after outplanting on the ITCI concession, East Kalimantan.

Seedlot	Provenance	Height (m)	(s$_{\bar{x}}$)	Diameter (cm)	(s$_{\bar{x}}$)	Survival (%)
12346	Gibb River, W. Australia	4.7	(0.2)	5.0	(0.1)	88
12185	Dimbulah, Queensland	4.7	(0.6)	4.5	(0.5)	91
12141	W. Dimbulah, Queensland	4.6	(0.2)	4.7	(0.3)	91
11930	Mary River, N. Territory	4.3	(0.6)	5.3	(0.6)	92
12338	Matthison Creek, N. Territory	4.2	(0.5)	4.9	(0.8)	82
12437	Dunham River, W. Australia Australia	4.2	(0.3)	4.2	(0.3)	70
12183	SW Katherine, N. Territory	4.0	(0.2)	4.7	(0.7)	94

EUCALYPTUS DEGLUPTA

Five sources were compared in the 1976 provenance trial, three from Papua New Guinea and one each from the Philippines and Sulawesi. After 3 years, trees from Rock Pile (PNG) and Bislig (the Philippines) were much larger than trees from the other three sources; they averaged 16, 27 and 80% greater diameter, height and volume, respectively, than samples from the other provenances (Table 1). These differences have been maintained since the first year, when trees from the Rock Pile and Bislig provenances averaged 6.1 m height, compared with 4.6 m for the other three provenances.

After 2 years, incidence of stem borer attack ranged from 38 to 47%, suggesting that, for a nonspecific pest such as Z. coffeae, differential resistance within tree species may be small. However, observations of light insect damage in other species, such as E. tereticornis and E. urophylla, indicate large differences in susceptibility to attack. Stem malformations also may vary according to provenance -- trees from Bislig and Rock Pile sources exhibited 30% crooked stems, whereas those from the other sources had 43 to 56% crooked stems.

Although this trial was located on only one site, another test evaluated stability of performance across sites. Clones of rooted cuttings collected from a representative sample of nursery seedlings grown from the Pare-Pare source were used. After 2 years, clone heights ranged from 5.4 to 8.4 m. Clone ranks on four of the five sites were closely correlated with clone means across all sites (Table 2), suggesting that relative performance of trees from each provenance may also be reasonably stable across sites in the concession area.

EUCALYPTUS UROPHYLLA

This species is native to a limited geographical range on Timor and several smaller Indonesian islands. Two tests were installed in 1977 and 1978. In both, mortality during the first 6 months was exceptionally high and detailed statistical analysis was therefore impossible. Nevertheless, given that survival could be improved, overall results indicated that growth of some E. urophylla sources may be comparable to E. deglupta.

In the 1977 test with seven provenances replicated on two sites, the average 2-year height of trees from three sources (Alor, Aruaoe, N. Aileu) was similar to height of trees from the control seedlot of E. deglupta (Table 3). Nevertheless, average height (6.0 m) for both species is considerably less than for many E. deglupta planted on the concession, reflecting intense competition from contiguous vegetation. Performance of trees from the two high-elevation sources (Queorema, Mt. Tatamailau) was very poor, suggesting that seed should be collected below 1000 m elevation.

In the 1-year-old test there were no significant differences among trees from the four sources, although trees from Alor and N. Aileu again had the best performance (Table 3).

EUCALYPTUS CAMALDULENSIS

Seed from seven provenances of E. camaldulensis, from widely scattered areas across Australia, were planted in late 1978 (seed supplied by CSIRO, Canberra). After one year, heights ranged from 4.0 to 4.7 m and diameters from 4.2 to 5.3 cm (Table 4); however, there were no statistically significant differences among provenances. Height growth to date has been comparable to that for E. deglupta in surrounding operational plantations. Tests with E. camaldulensis and E. urophylla have not been in progress long enough for proper evaluation of resistance to stem borer.

FIRST RESULTS ON TRIALS OF EUCALYPTUS *INTRODUCTION CARRIED ON IN MADAGASCAR SINCE 1972.*

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Summary

Desde 1972, alguns ensaios de competição de espécies de *Eucalyptus* foram estabelecidos em Madagascar, envolvendo 50 espécies. Posteriormente, testes de procedências envolvendo *Eucalyptus urophylla*, *E. alba*, *E. camaldulensis*, *E. grandis* e *E. cloeziana* foram também implantados. Este trabalho somente se refere aos ensaios com as primeiras duas espécies.

*PREMIERS RESULTATS DES ESSAIS D'INTRODUCTION D'*EUCALYPTUS *A MADAGASCAR REALISES DEPUIS 1972.*

Resumé

Since 1972, some comparative trials on Eucalyptus species have been settled in Madagascar concerning more than 50 species. Furthermore, comparative provenance trials on Eucalyptus urophylla, Eucalyptus alba, Eucalyptus camaldulensis, Eucalyptus grandis and Eucalyptus cloeziana have been carried on. This paper only mentions the trials concerning the first two species.

INTRODUCTION

Les Eucalyptus ont été introduits à Madagascar depuis 1890-1895. Après 1950 de très nombreuses espèces furent essayées dans les arboretum et stations forestières du Service des Eaux et Forêts dont les résultats ont été publiés par Bernard CHAUVET. La présente communication donne les premiers résultats des essais réalisés après 1972.

LES FACTEURS DU MILIEU

Les caractéristiques des stations sont les suivantes :

Besakay

18°12' LS - 48°13' lE - Climat tropical semi-humide type soudano-guinéen (Aubreville) - Pluviométrie moyenne annuelle 1 053 mm - Température moyenne 27° - Altitude 978 m - Sols ferrallitiques désaturés.

Mangoro

18°38' LS - 48°14' lE - Climat tropical semi-humide type soudano-guinéen (Aubréville) - Pluviométrie moyenne annuelle 1610 mm - 4 mois secs (<à 50 mm) - Température moyenne 19° (minima 12°, maxima 25°) - Sols ferrallitiques typiques très désaturés sur migmatiques 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.

Manankazo

18°08' LS - 47°13' 1E - Climat tropical semi-humide d'altitude - Pluviométrie moyenne annuelle 1828 mm - 5 mois secs (<50 mm) - Température moyenne 17° (minima 12, maximum 22) - Altitude 1 850 m - Sols ferrallitiques carencés.

ESSAIS COMPARATIFS D'ESPECES

Au Mangoro

48 espèces ont été mises en comparaison provenant d'une campagne de récolte réalisée par le C.T.F.T.. Les espèces les plus intéressantes se révèlent être (9 à 10 m à 4 ans) :

Eucalyptus punctata ssp longirostrata
Eucalyptus grandis
Eucalyptus tereticornis
Eucalyptus punctata
Eucalyptus saligna
Eucalyptus signata
Eucalyptus robusta

Les Eucalyptus pilligaensis et planchoniana semblent également présenter une bonne croissance en hauteur (7,5 m à 4 ans). Les espèces les moins adaptées pour la zone écologique du Mangoro semblent être les suivantes :

Eucalyptus exserta
Eucalyptus fibrosa
Eucalyptus alba
Eucalyptus microtheca
Eucalyptus moluccana
Eucalyptus watsoniana
Eucalyptus acmenoïdes
Eucalyptus tenuipes
Eucalyptus populnea

A Manankazo

11 espèces ou provenances d'Eucalyptus ont été testées à Manankazo, zone d'altitude.

Les résultats obtenus montrent une relativement faible croissance de ces Eucalyptus plantés sur labour en plein, avec fertilisation mais sur sols très carencés.

Les résultats des hauteurs à 3 ans sont les suivants :

Eucalyptus andrewsii ssp campanulata (QLD, Aust.)	h = 7,30 m
Eucalyptus andrewsii ssp campanulata (NSW, Aust.)	h = 7,25 m
Eucalyptus signata	h = 6,80 m
Eucalyptus pilularis	h = 6,60 m
Eucalyptus cameronii	h = 6,50 m
Eucalyptus propinqua ssp propinqua	h = 6,40 m
Eucalyptus punctata ssp didyma	h = 6,30 m
Eucalyptus microcorys	h = 6,10 m
Eucalyptus 12ABL (tereticornis)	h = 4,40 m
Eucalyptus maculata	h = 4,40 m
Eucalyptus amplifolia	h = 3,90 m

D'autres essais ont été réalisés à Mahela sur la Côte Est ainsi qu'à Besakay (station voisine du Mangoro). Ce dernier essai donne à 6 ans les résultats ci-après :

Eucalyptus gummifera	h = 5,30 m
Eucalyptus grandis	h = 4,80 m
Eucalyptus botryoïdes	h = 4,30 m
Eucalyptus robusta	h = 3,90 m
Eucalyptus longifolia	h = 3,30 m
Eucalyptus tereticornis (Rwanda)	h = 3,20 m
Eucalyptus tereticornis (Rwanda)	h = 3,00 m
Eucalyptus punctata	h = 2,70 m
Eucalyptus maidenii	h = 2,70 m
Eucalyptus camaldulensis	h = 2,70 m
Eucalyptus citriodora (Rwanda)	h = 2,30 m

ESSAIS COMPARATIFS DE PROVENANCES D'EUCALYPTUS

Essai comparatif de provenances d'E. urophylla au Mangoro

(Essai N° 30 de 1975)

Le but de cet essai est de comparer les diverses provenances d'E. urophylla originaires du Timor Oriental, du Timor occidental, de l'Ile Adonara, de l'Ile Lomblen et de Flores.

L'expérimentation a été réalisée sur une terrasse sableuse dans la zone du Mangoro. La densité de plantation est de 1 100 tiges à l'hectare, avec 64 plants par parcelle et 3 répétitions, avec une fertilisation NPK au trou de plantation.

28 provenances d'E. urophylla avaient été reçues et semées. Seules 22 ont pu être mises en expérimentation. Chaque provenance est représentée par un ou plusieurs semenciers. Au niveau plantation nous n'avons retenu que la provenance.

La plantation a été effectuée en avril 1975. La mortalité observée en avril 1978 est inférieure à 5 %. Les résultats obtenus à 4 ans donnent des hauteurs moyennes variant de 4,28 m à 8,05 m.

Les provenances les mieux adaptées aux conditions écologiques de la terrasse de l'Ankona (Mangoro) semblent être celles issues d'altitude comprise entre 650 m et 1 000 m, avec une pluviométrie variant de 1 500 à 1 900 mm.

Les provenances les moins bien adaptées sont originaires de régions d'altitude comprises entre 1 500 et 2 000 m, avec une pluviométrie variant de 1 600 à 2 100 mm.

		Lat.	Long.	Alt. m	Pluviom. mm	Provenance
Meilleures provenances	73/81N	8°32'LS	122°48'LE	480	-	Ile de Flores
	73/30N	8°37'LS	125°41'LE	800	1500-2000	Timor Oriental
	73/28N	8°39'LS	125°39'LE	950	1900	Timor Oriental
	73/77N	8°27'LS	123°29'LE	700-750	-	Ile de Lomblen
Provenances médiocres	73/56N	8°53'LS	125°26'LE	1600	2100	Timor Oriental
	73/45N	8°50'LS	125°36'LE	1500	1400-1800	Timor Oriental
	73/66N	9°40'LS	124°10'LE	1400	1500-1800	Timor Occidental
	73/68N	9°35'LS	124°10'LE	1800	1700-2000	Timor Occidental

Essai comparatif de provenances d'E. alba au Mangoro

(Essai N° 31 de 1975)

Le but de cet essai est de comparer les diverses provenances d'E. alba originaires du Timor et de l'Ile d'Adonara.

La réalisation de cet essai s'est faite selon le même schéma que l'essai précédent : terrasse sableuse, labour en plein, fertilisation NPK, densité de plantation de 1 100 tiges/ha.

12 traitements ont été testés en un dispositif à trois répétitions. La plantation a été effectuée en avril 1975. Faute d'entretien notamment, l'expérimentation donne des résultats médiocres.

A trois ans 1/2, les hauteurs varient de 1,20 m à 2,50 m. En fait, trois groupes apparaissent :

N° de la provenance	Hauteur	Origine	Lat.	Long.	Alt. m	Pays
73/06N	2,50	Ossu	8°47'LS	126°23'LE	310-330	Timor Oriental
73/57N	2,20	Maliana	8°56'LS	125°10'LE	100	Timor Oriental
73/51N	2,20	Same	9°00'LS	125°40'LE	360	Timor Oriental
73/65N	2,20	Soe	9°50'LS	124°15'LE	830	Timor Occidental
73/03N	1,75	Baucau	8°30'LS	126°22'LE	500	Timor Oriental
73/50N	1,70	Same	9°04'LS	125°41'LE	70	Timor Oriental
73/75N	1,65	Belile	8°17'LS	123°16'LE	180	Ile d'Adonara
73/10N	1,65	Natar Bora	8°59'LS	126°01'LE	50	Timor Oriental
73/05N	1,60	Venilale	8°41'LS	126°22'LE	750	Timor Oriental
73/01N	1,20	Metinaro	8°32'LS	125°43'LE	5	Timor Oriental

Il faut noter qu'en plus de la mauvaise croissance de ces provenances d'E. alba, les arbres présentent sur le terrain une mauvaise forme.

Essai comparatif de provenances d'E. urophylla et alba au Mangoro

(Essai N° 40 de 1976)

43 lots d'Eucalyptus urophylla et 6 lots d'E. alba sont parvenus au C.T.F.T. de Madagascar en mai 1974. Par suite d'une mauvaise réussite en pépinière, nous n'avons pu réaliser que une ou deux parcelles de chacun des 43 lots survivants. Nous avons donc un essai comparatif de 16 provenances d'E. urophylla avec 2 répétitions et un "essai" conservatoire de 27 provenances d'E. urophylla et alba, avec une seule parcelle par provenance.

La plantation réalisée en avril 1976 a été faite selon les mêmes modalités que les précédentes.

La mortalité moyenne atteint 8 % en mars 1979 à 3 ans. A trois ans, les hauteurs moyennes varient de 3,80 m à 7,90 m pour les E. urophylla et de 1,70 m à 2,30 m pour les E. alba.

Les meilleures provenances testées au Mangoro comprennent les numéros suivants :

- avec 2 répétitions : les N° 73/40N, 73/24N, 73/25N, 73/29N, 73/26N, 73/27N sont tous originaires de la région de Remexio (Timor Oriental). Les coordonnées de ces provenances définissent un périmètre compris entre 125°38' et 125°39' de longitude Est et 8°38' à 8°44' de latitude Sud. L'altitude des semenciers varie de 1 130 m à 1 320 m ; la description phénotypique est toujours bonne à excellente.

- 1 répétition : les N° 73/41N et 73/42N donnent une croissance en hauteur proche des meilleures provenances avec 2 répétitions. Les coordonnées de ces deux provenances les situent dans la zone marginale du périmètre défini plus haut (125°34' à 125°37' de longitude Est et 8°38' à 8°39' de latitude Sud). L'altitude est identique à celle de ce périmètre (de 1 150 m à 1 250 m). La forme des semenciers est médiocre à mauvaise.

Les plus mauvaises provenances testées au Mangoro comprennent les numéros suivants :

- avec 2 répétitions : les N° 73/47N, 73/63N, 73/55N, 73/37N, 73/46N et 73/69N ont des coordonnées qui les situent à l'extérieur du périmètre des meilleures provenances (soit plus au Sud et à l'Ouest). La provenance 73/37N est plus à l'Est de cette zone, l'altitude est voisine (1 200 m).

Les N° 73/46N, 73/47N et 73/69N sont des provenances d'altitude (1 430 à 2 320 m).

Les N° 73/55N et 73/63N sont originaires d'une zone plus basse que celle de Remexio (1 040 à 1 090 m).

Mise à part la provenance 73/47N tous les semenciers ont une forme classée comme mauvaise à très mauvaise.

- avec 1 répétition : les trois provenances de Flores (73/82N, 73/83N, 73/86N) qui correspondent à une zône de faible altitude 400 à 750 m. La forme générale des semenciers est médiocre à mauvaise.

Deux provenances de Lomblen (73/78N, 78/79N), altitude de 750 à 930 m, la forme générale des semenciers est mauvaise.

Une provenance de Timor Oriental (73/53N), zone d'altitude (2 000 m), 1 seul semencier à l'origine de la parcelle était sous forme de taillis.

Il faut noter que dans cet essai , les E. alba en parcelles, ont une forme et une croissance très médiocres. Cependant, on remarque quelques E. alba dans des parcelles d'E. urophylla (hybride ou erreur à la plantation ?) qui ont une forme et une croissance très supérieures à la moyenne des E. alba et même voisines de celles des E. urophylla. Plusieurs hypothèses peuvent être envisagées [effet de compétition à la lumière, à l'enracinement, effet d'environnement des plants, effet génétique (hybride possible)].

On notera également le plus grand déséquilibre de l'E. alba par rapport à l'E. urophylla sur cette terrasse du Mangoro, puisque le taux de mortalité de l'E. alba est de $\frac{32}{203}$ = 15,8 % et celui de l'E. urophylla de 7,7 %.

CONCLUSION

Les expérimentations mises en place à Madagascar depuis 1972 montrent qu'un certain nombre d'espèces d'Eucalyptus peuvent être intéressantes. Les essais de provenances d'E. urophylla ont mis en évidence la variabilité génétique de cette espèce et montre que certaines origines pouvaient être très intéressantes.

D'autres essais de provenances intéressant E. camaldulensis, E. grandis et E. cloeziana ont été mis en place.

Les résultats obtenus avec E. grandis font l'objet d'une communication séparée.

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O EUCALIPTO NA REGIÃO DE MISIONES, NA ARGENTINA.

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Resumo

Dezoito espécies de eucaliptos foram analisadas em Puerto Piray, Província de Misiones, Argentina (26° S, 54° W, altitude de 210 m). As sementes utilizadas foram provenientes de Rio Claro, Brasil.

À idade de 20 anos, as que sobressairam foram o *E. alba* e o *E. grandis*, no que diz respeito à produtividade de celulose (364 e 300 toneladas por hectare, respectivamente). O *E. saligna* sobressaiu-se no que diz respeito aos seus atributos para a produção de celulose.

Desde que não se considera conveniente a propagação destas plantas por sementes, é razoável tentar-se a propagação vegetativa dos melhores exemplares, assim como a instalação de testes de procedência a partir das espécies mais produtivas, incluindo o *E. pilularis*, o qual produziu o melhor resultado individual no que diz respeito ao crescimento, a despeito de sua baixa taxa de sobrevivência.

EUCALYPTUS SPP. EN MISIONES (ARGENTINA).

Resumen

Eighteen species os Eucalyptus spp., grown from seeds from Rio Claro Brazil, were tested at Puerto Piray, Misiones province, Argentina (Lat. 26ºS, Long. 54ºW, 210 m altitude).

At 20 years of age the best species are E. alba and E. grandis for their productivity of pulp per hectare (364 and 300 ton/ha respectively) and E. saligna for its attributes for pulp production.

As it is not convenient to propagate these plants by seeds, the vegetative propagation of the best trees is suggested. In addition, the establishment of a provenance test with the most productive species, including E. pilularis (which produced the best individual growth rate, though its survival rate was very low) is recommended.

Se ensayaron dieciocho especies de Eucalyptus spp. en Puerto Piray provincia de Misiones, Argentina (26º lat. S, 54º long. W, 210 m snm), con semillas provenientes de Río Claro, Brasil.

A los 20 años de edad se destacan E. "alba" y E. grandis por su productividad de pasta por unidad de superficie (364 y 300 tn/ha respectivamente) y E. saligna por sus excelentes aptitudes papeleras.

Dado la no conveniencia de utilizar las semillas de estos ejemplares, se recomienda la propagación agámica de sus mejores individuos, como así también la realización de ensayos de procedencias con las especies más promisorias, incluyendo a E. pilularis que logró los mayores incrementos individuales, pero con muy baja sobrevivencia.

INTRODUCCION

Desde mediados del siglo pasado, en que se introduce por primera vez al país el *E. globulus*, se utilizó durante muchos años a este género como ornamental o para cortinas rompevientos. En la provincia de Misiones cobra impulso su estudio, a partir de la visita del eminente eucaliptólogo brasileño, don Edmundo Navarro de Andrade, efectuada en 1936. Dos años más tarde se instalan los primeros ensayos en la Estación Forestal Leandro N. Alem (IFONA), creada por ese entonces, con semillas provenientes del Brasil y de algunos árboles de *E. saligna* de la localidad de Apóstoles (Misiones). Ya en 1946 Celulosa Argentina inicia sus plantaciones industriales sobre la base de *E. grandis*, *E. saligna* y *E. "alba"*.

El objetivo de este trabajo es evaluar la productividad de varias especies ensayadas, como así también sus aptitudes industriales, a los efectos de obtener una orientación en los planes de mejoramiento de *Eucalyptus sp.*

MATERIALES Y METODO

En junio de 1955 se plantaron dieciocho especies a 2 m x 2 m, en parcelas con superficias desde 264 m^2 a 2.244 m2, en el Km 22 de la ruta provincial nº 16, Puerto Piray, Misiones (26º lat. S, 54º long. W, 210 m snm). El suelo es rojo profundo, ligeramente ácido y arcilloso. El clima es subtropical con una frecuencia media de 7 heladas por año, que pueden llegar a -6º C. La temperatura media anual es de 20º C y la precipitación media alcanza a los 1600 mm, distribuídos a través del año, con una ligera disminución en el invierno.

Las semillas provienen del Huerto Forestal de Río Claro (Brasil). Los cuidados de la plantación fueron los tradicionales para la región, no efectuándose ningún raleo, a excepción de las cortas de limpieza.

A los siete y a los veinte años se midieron los diámetros y las alturas, analizando también en esta última oportunidad el número de ejemplares por unidad de superficie con el objetivo de extrapolar los datos

ESPECIE	DIAMETRO MEDIO (cm)	ALTURA MEDIA (m)	VOLUMEN POR PLANTA (m^3)
Eucalyptus "alba"	19,4	25,5	0,4146
Eucalyptus grandis	19,1	25,5	0,4018
Eucalyptus botryoides	17,2	26	0,3323
Eucalyptus citriodora	16,7	23	0,2771
Eucalyptus microcorys	16,4	21	0,2440
Eucalyptus saligna	16,2	20,5	0,2324
Eucalyptus propincua	15,0	23	0,2235
Eucalyptus rudis	14,6	22	0,2026
Eucalyptus paniculata	14,5	21	0,1907
Eucalyptus acmenioides	15,2	19	0,1896
Eucalyptus maculata	14,2	21	0,1829
Eucalyptus crebra	12,9	18	0,1294

CUADRO I: Diámetro a 1,3 m (cm), altura total (m) y volumen por planta (m^3), de *Eucalyptus spp.* a los 7 años.

ESPECIE	D.A.P. (cm)	ALTURA (m)	VOL/PTA (m^3)	EJEMPL. (nº/ha)	VOLUMEN (m^3/ha)	I.M.A. (m^3/ha año)
Eucalyptus grandis	32,24	37,66	1,6909	884	1494,78	74,74
Eucalyptus "alba"	30,78	36,33	1,4868	985	1464,51	73,23
Eucalyptus propincua	25,05	31,67	0,8585	1364	1170,93	58,55
Eucalyptus saligna	27,63	33,33	1,0991	966	1061,73	53,09
Eucalyptus rudis	28,62	31,5	1,1146	909	1013,13	50,66
Eucalyptus botryoides	30,49	30,83	1,2381	726	898,83	44,94
Eucalyptus racemosa	29,7	31,8	1,2117	715	866,36	43,32
Eucalyptus microcorys	26,32	31,5	0,9426	856	806,88	40,34
Eucalyptus citriodora	24,49	31,16	0,8073	875	706,38	35,32
Eucalyptus paniculata	18,78	27,5	0,419	1300	544,65	27,23
Eucalyptus linearis	31,19	29,0	1,2187	379	461,87	23,09
Eucalyptus pilularis	37,5	36,5	2,2172	202	447,88	22,39
Eucalyptus maculata	23,24	27,5	0,6416	648	415,75	20,79
Eucalyptus acmenioides	23,62	24,33	0,5863	566	331,87	16,59
Eucalyptus camaldulensis	21,94	28,27	0,5878	454	266,88	13,34
Eucalyptus crebra	16,2	21,17	0,24	792	190,08	9,5
Eucalyptus viminalis	21,71	20,25	0,4123	303	124,92	6,25
Eucalyptus sideroxylon	12,86	14,17	0,1012	328	33,2	1,66

CUADRO II: Diámetro a 1,3 m - D.A.P. (m), altura total (m), número de ejemplares por hectárea, volumen por planta y hectárea (m3) a incrementos medios anuales (m3/ha año), agrupados en función de estos últimos, a los 20 años de edad.

a valores por hectárea. Posteriormente se cortaron tres árboles representativos de la mayoría de las especies y se los envió a laboratorio. Allí se extrajeron muestras a 1/10, 1/2 y 9/10 de la altura y se determinó el peso específico. Seguidamente el material fue descortezado y chipeado para luego soportar una cocción al sulfato (25% de sulfidez) en condiciones standard, con variación de álcali para producir pastas en el rango de Kappa 18-30. Luego de depuradas las mismas fueron ensayadas en holandesa bajo condiciones SCAN y evaluadas en aire a 50 % HR (Zilli,1979).

RESULTADOS

En la medición de los siete años se obtuvieron los resultados expuestos en el Cuadro I. Para el cálculo del volumen se adoptó un coeficiente mórfico de 0,55.

En el Cuadro II se incluyen, además de estos parámetros obtenidos a los veinte años, el número de ejemplares por hectárea (extrapolando los valores de las parcelas) y en función de ello, el volumen por hectárea y el incremento medio anual.

Los resultados obtenidos en laboratorio por el Ing. Zilli y colaboradores, en lo referente a volúmenes útiles sin corteza, peso específico y producción, tanto de madera seca como de pasta depurada por hectárea, se expresan en el Cuadro III. En todos los casos *E. "alba"* y *E. grandis* son los que manifiestan los mejores comportamientos.

En lo que respecta a las aptitudes papeleras, si bien han sido analizadas exhaustivamente (Zilli et all., op. cit.), se transcriben sólamente las concernientes a la fabricación de papel kraft, liner y para impresión, ya que el resto de los estudios exceden los alcances de este trabajo (Cuadro IV). Como referencia se incluyen los valores equivalentes de las maderas utilizadas normalmente.

DISCUSION

Dado que las semillas no provienen de los rodeles espontáneos de su zona de origen, los resultados con ellas obtenidos sólamente deben ser tomados como orientativos en los planes de mejoramiento de *Eucalyptus sp.*.

El *Eucalyptus "alba"* ensayado se trata en realidad de un híbrido espontáneo producido en Río Claro entre *E. urophylla* y *E. grandis*, *E. saligna*, *E. tereticornis*, etc. De acuerdo a Jacobs (1973) el *E. linearis* podría tratarse de *E. pulchella*. La otra duda en lo referente a la identificación de las especies se establece con *E. rudis*, que en su lugar de origen no sobrepasa los 15 m de altura y proviene de una zona teóricamente inadecuada para Misiones, sin embargo en esta expe-

ESPECIE	VOL/PLANTA (m^3) s/c	VOL/ha (m^3/ha)	PESO ESPECIFICO	PCCION. MADERA SECA (tn/ha)	PRODUCTIVIDAD (tn pasta/ha)
Eucalyptus "alba"	1,0	985	0,66	669,8	364,45
Eucalyptus grandis	1,0	884	0,62	548,08	300,56
Eucalyptus rudis	1,0	909	0,62	563,58	272,7
Eucalyptus propincua	0,46	627,44	0,7	439,21	233,33
Eucalyptus saligna	0,7	676,2	0,52	351,62	205,11
Eucalyptus citriodora	0,5	437,5	0,76	332,5	183,75
Eucalyptus botryoides	0,73	529,98	0,58	307,39	146,38
Eucalyptus microcorys	0,5	428	0,63	269,64	143,25
Eucalyptus paniculata	0,18	234	0,8	187,2	120,34
Eucalyptus maculata	0,37	239,76	0,69	165,43	92,64
Eucalyptus linearis	0,65	246,35	0,61	150,27	71,38
Eucalyptus acmenioides	0,33	186,78	0,67	125,14	62,57
Eucalyptus sideroxylon	0,04	13,12	0,57	7,48	3,74

CUADRO III: Volúmenes por planta y por hectárea (m^3) sin corteza, peso específico, producción de madera seca y de pasta depurada al 90 % (tn/ha)

ESPECIE	INDICE CUALITATIVO (VALOR EQUIVALENTE)		
	Para papel kraft	Para liner	Para impres. y escrit.
Eucalyptus "alba"	0,75	0,93	0,94
Eucalyptus grandis	0,69	0,89	0,88
Eucalyptus rudis	0,56	0,85	0,79
Eucalyptus propincua	0,75	0,91	0,84
Eucalyptus saligna	0,91	0,97	0,98
Eucalyptus citriodora	0,59	0,86	0,94
Eucalyptus botryoides	0,69	0,90	0,91
Eucalyptus microcorys	0,51	0,84	0,76
Eucalyptus paniculata	0,49	0,83	0,68
Eucalyptus maculata	0,70	0,83	0,94
Eucalyptus linearis	0,65	0,83	0,83
Eucalyptus acmenioides	0,54	0,84	0,85
Eucalyptus sideroxylon	0,39	0,74	0,75
Testigos:			
Eucalyptus camaldulensis	0,67	0,93	1,01
Eucalyptus saligna-grandis	0,8	1,07	0,94
Pino kraft (*Nivel base de referencia*)	1,0	1,0	1,0

CUADRO IV: Aptitudes para papel kraft, liner y para impresión y escritura, de las especies en estudio (a los 20 años) y de las maderas utilizadas actualmente (testigos). De Zilli y Ordoñez, 1979.

riencia supera en producción de madera seca a especies tales como E. propincua, E. saligna, etc., aunque en lo que hace a aptitudes papeleras la situación se invierte (Cuadro IV).

El E. pilularis es el que logró los mayores incrementos individuales, pero su baja sobrevivencia ha hecho que la productividad final de esta especie sea muy baja, hecho éste que también ocurre en algunas localidades del Brasil.

CONCLUSIONES

Se deben realizar ensayos de procedencias, fundamentalmente de las siguientes especies: E. grandis, E. saligna, E. propincua, E. pilularis, E. botryoides, etc.; además de todas aquellas otras potencialmente aptas, que no hayan sido incluídas en este trabajo.

En el caso de E. pilularis es necesario además determinar los factores responsables de la baja sobrevivencia, ya que los excelentes antecedentes que posee, tanto en productividad como en aptitudes industriales, la hacen una especie súmamente promisoria.

La semilla producida en estas parcelas no es conveniente utilizarla en función de las posibles segregaciones de caracteres indeseables, que pueden producirse en las nuevas generaciones, a raíz de las hibridaciones interespecíficas, hecho éste ámpliamente comprobado con el E. "alba".

Dado que en el ensayo existen ejemplares con excelentes características, se los deberá clonizar, mediante el enraizamiento de estacas y formar de este modo rodales de alta productividad, con aptitudes papeleras verificadas.

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COMPORTAMENTO DE 29 ESPÉCIES DE *EUCALYPTUS* (AT TWO SITES IN MINAS GERAIS).

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Resumo

O objetivo do presente trabalho foi estudar a interação de especie/local com 39 espécies e procedências de *Eucalyptus* em duas áreas ecológicas diferentes. As discussões dos resultados obtidos aos seis anos de idade e das diferenças entre espécies/procedências são apresentadas neste trabalho.

Summary

An experiment was established with 29 species of eucalypt in two different locations in Minas Gerais in order to determine the suitability of the species for the region and also the extent of species x location interactions between the two locations. A seedlot of each species was obtained from Australia, but an additional seedlot of 10 of the species collected at Rio Claro was also used in the trials. The results of the trials at 6 years of age are reported.

1 - Introdução.

O Eucalipto é uma das essências mais plantadas atualmente no Brasil, em consequência de seu rápido crescimento, boas qualidades da madeira e as suas varias aplicações e utilizações.

A escolha de uma espécie/procedência para as diversas regiões ecológicas, é um fator primordial na formação de florestas de alto rendimento por área.

A Cia.Siderúrgica Belgo-Mineira, desde o início da formação de seus Eucaliptais, teve o cuidado de instalar ensaios de comportamento de espécies do gênero Eucalyptus em diversos lugares ' de atuação da Empressa (OSSE, 1973).

Mais recentemente, somente o PRODEPEF introduziu aproximadamente 500 novas espécies e procedências (PRODEPEF, 1976).

BRIQUELOT (1973), afirma que em vista dos problemas hibridogênios decorrentes de cruzamentos intra e inter-específicos e, resultados de produção alcançados não estarem dentro da expectativa, surge a necessidade de se testar outras espécies e procedências ' de sementes.

Segundo GOMES (1977), partindo-se do princípio de que o número de espécies é grande e de diferentes aplicações, além de exigirem condições ecológicas especiais, admite-se não ser qualquer espécie que apresenta características adequadas para ser introduzida. Por outro lado, supõe-se que para cada diferente região ecológica, exista uma ou mais espécies que poderão ser introduzidas ' com êxito.

O crescimento em altura é o fator mais crítico para sobrevivência de árvores em competição, representando por isso, um dos índices mais seguros para dizer se a espécie foi ou não plantada em lugar adequadao (GOMES, 1977).

SAMPAIO (1963), em um estudo de comportamento com 24 espécies de Eucalyptus, cita como aquelas promissoras o E.grandis, E.alba, E.botryoides e E.saligna em vista de apresentarem bom desenvolvimento com bom crescimento em altura e diâmetro o E.maidenii' e E.resinifera, mas com alta percentagem de falhas.

OSSE (1973b), em experimentação com 15 espécies de Eucaliptos na região de Cel.Fabriciano, concluiu que as espécies que apresentaram melhores resultados em diâmetros, altura e volume, foram o E.alba e o E.grandis.

O autor recomenda as espécies E.microcorys e E.propinquà para cortes tardios, com bons resultados em cortes subsequentes, em vista de seu crescimento lento, mas com resultados altamente satisfatórios em sobrevivência.

GOLFARI (1975), cita para a região de Santa Bárbara o E.grandis e E.saligna como espécies introduzidas com êxito; o E.pilularis, E.microcorys e E.maculata como espécies introduzidas com êxito em regiões similares e como espécie com potencial para a região o E.dunnii.

Para a região de Cel.Fabriciano, cita o autor, o E.citriodora e E.tereticornis como aqueles de desenvolvimento comprovado, o E.maculata como espécie introduzida com êxito em regiões similares e, o E.urophylla, E.cloeziana, E.acmeniodes, E.drepanophilla' e o E.exserta como aqueles potenciais a serem testados.

Pryor (1964), admite que nas zonas secas, onde a precipitação é maior que 1500 mm, a floresta savana pode ser convertida para o E.grandis ou E.citriodora. Também aqui deve ser testado o E. torreliana, o E.camaldulensis e E.umbellata.

SPURR (1964) citado por GOMES (1977) cita que o crescimento das árvores, assim como os demais processos fisiológicos, aumentam a habilidade de sobrevivência.

SAMPAIO (1963), cita que o E.robusta, E.punctata, E.viminalis, E.pilularis e E.haemastoma em sua experimentação não foi possível realizar conclusões, em vista da baixa percentagem de sobrevivência que apresentaram.

2 - Material e Método.

2.1. Material.

O ensaio foi instalado em áreas de propriedade da Cia.Siderúrgica Belgo-Mineira e, situam-se nos municípios de Santa Bárbara e Coronel Fabriciano - MG dos quais os dados ecológicos médios são citados abaixo.

Quadro I - Dados ecológicos da regiões de Santa Bárbara e Cel.Fabriciano - MG.

Localidade	Latitude	Longitude	Altitude	Precip.Méd.Anual
Santa Bárbara	20°09'S	43°24'E	721 m	1273 mm
Cel.Fabriciano	19°34'S	42°28'E	239 m	1437 mm

A região administrativa de Santa Bárbara possue relevo forte ondulado e montanhoso com altitude média de 700 m.

A área é de Latossol Vermelho-Amarelo distrófico orto textura argilosa.

O clima da região foi classificado como Temperado umido, com temperatura média anual de 19,5°C e precipitação média anual em em torno de 1273 mm, e déficit hídrico variando de 40 a 200 mm.

Santa Bárbara situa-se na região do Alto Rio Doce.

A região de Cel.Fabriciano possue relevo variando de suave - ondulado a montanhoso, com altitude média em torno de 240 m.

A área de Latossol Vermelho-Amarelo distrófico e Latossol ' Vermelho-Amarelo e Escuro Distrófico e Eutrófico.

O clima da região foi classificado como subtropical umido, com chuvas de verão, com temperatura média anual em torno de 22°C e precipitação média anual em torno de 1450 mm, com déficit hídrico variando em torno de 30 a 90 mm anuais.

Cel.Fabriciano situa-se na região do Baixo Rio Doce.

A cobertura florestal primaria era constituida por Mata que, de acordo com os lugares seria como caducifolia, semicaducifolia e sub-peremifolia, para as duas localidades.

A análise do solo realizada nos locais de instalação dos experimentos fornecem os seguintes resultados.

Quadro II - Resultado de análise do solo no local do experimento em Santa Bárbara e Cel.Fabriciano.

Localidade	pH em Água	Eq.mg/100g de Solo			ppm		%
		Al	Ca	Mg	P	K	MO
Santa Bárbara	4,5	2,99	0,4	0,3	3	51	6,1
Cel.Fabriciano	6,5	0,05	4,2	0,7	5	133	2,7

Santa Bárbara possue Acidez elevada, alto teor de Alumínio ' trocavel, baixo teor de Cálcio, Magnésio, Fósforo, e Potássio. Cel. Fabriciano possue Acidez Fraca, Baixo teor de Alumínio trocavel , alto teor de Cálcio e Potássio, Médio teor de Magnésio e Baixo ' teor de Fósforo.

O material que foi testado no ensaio, são 29 procedências ' com sementes oriundas da Austrália e, 10 procedências com sementes de Rio Claro - SP.

A relação das espécies/procedências estão citadas no quadro III.

As mudas foram realizadas com semeadura direta em sacos plásticos e, adubação em viveiro foi de 5 kg/m3 terra de NPK 4:15:3.

O plantio foi realizado manualmente, com espaçamento 3 x 2 m, e a adubação foi 113 g/cova de NPK 9:26:5.

Quadro III - Relação dos tratamentos -Espécies/procedências, testados nos ensaios, e dados ecológicos.

Trat.	Espécies	Procedências	Nº Origem	Latitude	Longitude
01	E.cloeziana	Queensland	10449	-	-
02	E.phaeotricha	Queensland	10446	-	-
03	E.pilularis	Queensland	10448	-	-
04	E.resinifera	Queensland	10400	-	-
05	E.nesophylla	North Territory	10444	-	-
06	E.tetrodonta	North Territory	10445	-	-
07	E.botryoides	NSW	9270	-	-
08	E.drepanophylla	NSW	1610	-	-
09	E.microcorys	NSW	10399	-	-
10	E.robusta	NSW	9207	-	-
11	E.rudis	NSW	10356	-	-
12	E.tesselaris	NSW	3975	-	-
13	E.paniculata	-	-	-	-
14	E.siderophloia	-	-	36°20'S	149°07'E
15	E.melanophloia	-	-	27°[illegible]5'S	151°30'E
16	E.camaldulensis	-	-	17°33'S	124°45'E
17	E.maculata	-	-	32°46'S	151°45'E
18	E.deanei	-	-	34°05'S	150°31'E
19	E.citriodora	-	-	32°06'S	138°12'E
20	E.tereticornis	-	-	34°23'S	152°01'E
21	E.exserta	-	-	26°30'S	152°30'E
22	E.hemiphloia	-	-	33°50'S	150°30'E
23	E.acmenioides	-	-	-	-
24	E.punctata	-	-	32°45'S	151°04'E
25	E.terminalis	-	-	29°50'S	145°00'E
26	E.dunnii	-	-	30°10'S	153°31'E
27	E.grandis	-	-	31°45'S	152°11'E
28	E.trachyphloia	-	-	28°50'S	151°30'E
29	E.microteca	-	-	30°01'S	148°07'E
30	E.camaldulensis	Rio Claro	-	-	-
31	E.tereticornis	Rio Claro	-	-	-
32	E.saligna	Rio Claro	-	-	-
33	E.robusta	Rio Claro	-	-	-
34	E.citriodora	Rio Claro	-	-	-
35	E.maculata	Rio Claro	-	-	-
36	E.paniculata	Rio Claro	-	-	-
38	E.grandis	Rio Claro	-	-	-
39	E.alba	Rio Claro	-	-	-

2.2 - Método,

O Delineamento estatístico adotado foi o de Blocos casualizados com 3 repetições.

As parcelas são quadradas de 900 m2 com 150 plantas e com uma área útil de 216 m2 com 66 plantas mensuráveis.

Quadro IV - Médias das alturas, volume e percentagem de sobrevivência, das procedências de Eucalyptus, nos dois locais, aos 6 anos de idade.

Trat.	Santa Bárbara			Cel. Fabriciano		
	Altura (m)	Volume (m3/ha)	Sobrev. (%)	Altura (m)	Volume (m3/ha)	Sobrev. (%)
01	16,4	184,071	76,2	15,3	110,728	45,5
02	14,5	157,357	86,1	12,1	33,167	43,0
03	16,4	132,852	50,0	10,7	51,948	42,9
04	11,5	94,256	87,3	8,1	46,328	74,2
05	7,1	7,863	23,0	4,3	1,076	13,1
06	4,7	1,597	15,9	1,8	0,600	2,5
07	13,4	90,156	93,6	8,8	21,142	3,9
08	11,2	77,786	90,8	11,0	76,551	78,8
09	14,0	112,286	80,6	11,1	67,082	62,1
10	15,9	153,716	85,7	8,2	54,090	86,8
11	8,9	35,848	84,1	5,4	11,432	47,0
12	6,2	18,376	78,2	5,3	18,523	70,7
13	10,1	66,492	78,2	11,2	63,979	62,1
14	10,2	38,465	74,2	5,7	15,620	52,0
15	6,4	14,528	71,0	5,0	5,641	33,0
16	7,6	56,415	79,8	6,2	10,686	50,0
17	15,0	132,429	83,9	14,9	121,792	68,2
18	14,3	132,123	80,5	14,9	96,158	66,1
19	15,5	148,981	88,5	14,1	98,166	71,2
20	13,7	84,257	90,1	9,6	69,731	86,9
21	7,0	16,629	65,5	6,0	3,819	27,8
22	3,9	3,627	28,2	2,8	0,214	10,6
23	13,3	127,331	67,8	9,9	40,606	47,0
24	17,2	167,558	79,4	13,9	110,707	82,8
25	1,4	0,110	1,6	1,0	0,181	2,5
26	16,9	164,004	93,6	15,4	135,262	74,2
27	21,3	325,282	92,4	15,8	180,080	87,4
28	6,2	14,740	42,1	7,1	7,821	22,0
29	5,7	10,827	54,5	2,9	5,734	76,8
30	13,5	93,327	71,0	11,4	58,086	60,6
31	12,3	82,677	88,9	11,3	88,401	85,8
32	18,8	214,401	84,9	14,2	112,513	74,2
33	15,1	116,685	66,6	11,6	74,048	68,7
34	13,9	101,685	82,2	12,0	68,501	67,1
35	13,1	89,818	77,0	14,7	100,654	68,7
36	16,8	165,465	85,3	13,9	96,405	68,7
37	13,6	102,698	89,7	10,4	51,547	81,8
38	19,1	220,990	86,9	15,0	122,421	79,8
39	15,0	129,649	75,8	11,3	72,782	72,2

3 - Discussão dos Resultados.

3.1 - Santa Bárbara.

As espécies *E.grandis*, *E.cloeziana*, *E.saligna*, *E.punctata*, *E.dunnii*, sobressairam estatisticamente com bom desenvolvimento em altura, volume e com pequenas percentagem de falhas.

As espécies *E.botryoides*, *E.drepanophylla* e *E.tereticornis* , apesar de terem um crescimento inferior as anteriores, apresentaram com alta percentagem de sobrevivência.

O *E.pilularis* tem bom crescimento em altura e volume, mas apresenta uma baixa percentagem de sobrevivência.

As espécie *E.trachyphloia*, *E.terminalis*, *E.hemiphloia*, *E.tetrodonta* e *E.nesophylla* foram as que apresentaram as menores percentagens de sobrevivência.

As espécies *E.nesophylla*, *E.tetrodonta*, *E.tesselaris*, *E. Rudis*, *E.melanophloia*, *E.esxerta*, *E.hemiphloia*, *E.terminalis*, *E.trachyphloia* e *E.microtheca*, apresentaram um fraco crescimento em altura e volume e alta percentagem de falhas, características desfavoráveis, não sendo promissor para as regiões testadas.

Quadro V - Resultados de altura e volume para localidade de Santa Bárbara - MG, em ordem decrescente. *

Trat.	Volume	Trat.	Altura
27	325,282	27	21,3
38	220,990	38	19,1
32	214,401	32	18,8
01	184,071	24	17,2
24	167,558	26	16,9
36	165,465	36	16,8
26	164,004	01	16,4
02	157,357	03	16,4
10	153,715	10	15,9
19	148,981	19	15,5
03	132,852	33	15,1
17	132,429	39	15,0
18	132,123	17	18,0
39	129,649	02	14,5
23	127,331	18	14,3
33	116,685	09	14,0
09	112,286	34	13,9
37	102,698	20	13,7
34	101,685	37	13,6
04	94,256	30	13,5
30	93,327	07	13,4
07	90,156	23	13,3
35	89,818	35	13,1
20	84,257	31	12,3
31	82,677	04	11,5
08	77,786	08	11,2
13	66,912	14	10,2
16	56,415	13	10,1
14	38,465	11	8,9
11	35,848	16	7,6
12	18,376	05	7,1
21	16,659	21	7,0
28	14,740	15	6,4
15	14,528	28	6,2
29	10,827	12	6,2
05	7,863	29	5,7
22	3,627	06	4,7
06	1,597	22	3,9
25	0,110	25	1,4

* As médias seguidas por um traço não diferem significativamente entre si, ao nível de 5% de probabilidade, pelo Teste de Tukey.

Quadro VI - Resultados de altura e volume para localidade de Cel.Fabriciano - MG, em ordem descrescente *.

Trat.	Altura	Trat.	Volume
27	15,8	27	180,080
26	15,4	26	135,262
01	15,3	38	122,421
38	15,0	17	121,792
17	14,9	32	112,513
18	14,9	01	110,728
35	14,7	24	110,707
32	14,2	35	100,654
19	14,1	19	98,166
36	13,9	36	96,405
24	13,9	18	96,158
02	12,1	31	88,401
34	12,0	08	76,551
33	11,6	33	74,048
30	11,4	39	72,782
31	11,3	20	69,731
39	11,3	34	68,501
13	11,2	09	67,082
09	11,1	13	63,979
08	11,0	30	58,086
03	10,7	10	54,090
37	10,4	03	51,948
23	9,9	37	51,547
20	9,6	04	46,328
07	8,8	23	40,606
10	8,2	02	33,162
04	8,1	07	21,142
28	7,1	12	18,523
16	6,2	14	15,620
21	6,0	11	11,432
14	5,7	16	10,686
11	5,4	28	7,821
12	5,3	29	5,734
15	5,0	15	5,641
05	4,3	21	3,819
29	2,9	05	1,076
22	2,8	22	0,214
06	1,8	25	0,181
25	1,0	06	0,060

* As médias unidas por um traço não diferem significativamente entre si, ao nível de 5% de probabilidade, pelo Teste de Tukey.

Comparando-se as procedências introduzidas com as testemunhas de Rio Claro, notamos:

a) houve um ganho significativo em volume, altura e % sobrevivência para as espécies *E.grandis*, *E.maculata*, *E.citriodora* e *E.robusta*.

b) as espécies *E.tereticornis* e *E.punctata*, tiveram comportamento semelhantes, tanto em crescimento como em percentagem de sobrevivência;

c) as espécies *E.camaldulensis* e *E.paniculata* tiveram comportamento pior que as testemunhas tanto em altura e volume; a percentagem de sobrevivência foi semelhante.

3.2 - Cel.Fabriciano.

Analisando os resultados para a localidade, as espécies que se sobressaíram estatisticamente foram o *E.grandis*, *E.dunnii*, *E.cloeziana* e *E.maculata*.

O *E.grandis* teve bom desenvolvimento para as duas procedências testadas.

As espécies *E.drepanophylla*, *E.robusta*, *E.tesselaris*, *E.microtheca* e *E.paniculata* apesar de serem estatisticamente inferiores as melhores espécies testadas, possuem boas percentagens de sobrevivência.

O *E.citriodora*, *E.tereticornis* e *E.saligna*, tiveram desenvolvimento semelhante estatisticamente aos do primeiro grupo e, também, apresentaram boas percentagens de sobrevivência.

Em relação a produção de madeira as espécies abaixo não apresentaram diferenças significativas: *E.saligna*, *E.maculata*, *E. citriodora*, *E.deanei*, *E.tereticornis*, *E.drepanophylla*, *E.robusta*,*E. alba* e *E.punctata* (as duas procedências testadas), apesar das variações encontradas nas produções.

Pelo desenvolvimento apresentado, não prometem êxito para a região, as espécies: *E.trachyphloia*, *E.exserta*, *E.siderophloia* , *E.rudis*, *E.tesselaris*, *E.nesophylla*, *E.microtheca*, *E.hemiphloia* , *E.tetrodonta*, *E.terminalis* e *E.camaldulensis*.

Comparando-se as procedências introduzidas com as testemunhas, observou-se:

há diferenças genéticas entre os tratamentos.

Sugere possíveis ganhos genéticos com seleção das melhores ' espécies;

b) a significância para local, revela que uma melhoria em altura, poderá ser conseguida com a escolha adequada do local para plantio;

c) a significância detectada pela análise de variância para interação tratamentos X local revela que os genótipos reagem diferentemente frente as mudanças ambientais.

4 - Conclusão.

A análise dos dados apresentados nos permitem concluir:

a) as espécies que se mostraram promissoras foram o *E.grandis*, *E.cloeziana* e *E.dunnii* para as duas localidades; o *E.saligna* e *E.punctata* para Sta Bárbara e o *E.maculata* para Cel.Fabriciano;

b) as espécies que mostraram rendimento satisfatórios foram o *E.citriodora*, *E.robusta* e *E.drepanophylla* para os dois locais;o *E.botryoides* e *E.pilularis* para Santa Bárbara; o *E.deanei*, *E.tereticornis*, *E."alba"* para Cel.Fabriciano;

c) as espécies que não prometem êxito pelos rendimentos apresentados são:

E.trachyphloia, *E.exserta*, *E.siderophloia*, *E.rudis*, *E,tesselaris*, *E.melanophloia*, *E.nesophylla*, *E.microtheca*, *E.hemiphloia* , *E.tetrodonta*, *E.terminalis* e *E,camaldulensis* para os dois locais;

d) a análise de variância conjunta das alturas revelou diferenças significativas para os locais, tratamentos e, também, para a Interação Tratamentos X Local.

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EUCALYPTUS KARTZOFFIANA. L.JOHNSON ET D. BLAXELL E *E.GLOBULUS* LABILL SUBSP. BICOSTATA (TRAIDEN, BLAKELY E SIMMONDS) KIRKPATRIC, DOIS EUCALIPTOS COM AMPLAS POSSIBILIDADES PARA A ARGENTINA.

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Resumo

A plasticidade de algumas espécies de eucalipto que são capazes de crescer em diferentes climas e solos e debatida neste trabalho. *E. Kartzoffiana* e *E. Globulus* subsp. bicostata reunem estas características e os resultados obtidos nas diferentes regiões da Argentina indicam que pode se obter um incremento em altura de mais de 2 m/ano.

EUCALYPTUS KARTZOFFIANA. L.JOHNSON ET D. BLAXELL Y *E.GLOBULUS* LABILL. SUBSP. BICOSTATA (MAIDEN, BLAKELY & SIMMONDS) KIRKPATRIC., DOS EUCALIPTOS CON AMPLIAS POSSIBILIDADES PARA LA ARGENTINA.

Resumen

The plasticity of some species of eucalypt, which enables them to thrive in different climates and soils, is noted. E. kartzoffiana and E. globulus ssp. bicostata are two such species displaying wide daptation to different conditions in Argentina. More than two metres height growth per year may be expected.

Introducción

Cuando se estudian las posibilidades de una especie por medio de ensayos de introducción de origenes, es de interés que el área donde se puedan extrapolar los resultados, sea lo más amplia posible. Son bien conocidos los beneficios de la introducción de un origen adaptado a una zona, toda vez que ello se traduce en un incremento de la cantidad y calidad de la producción de madera. La obtención de orígenes de especies de eucaliptos se ha facilitado enormemente con la contribución de la División of Forest Research del CSIRO, en Australia. Sin embargo, debido al gran número de especies que comprende este género, es imposible tener una colección completa de orígenes, aún de las más importantes y en algunos casos el área natural de una especie es tan pequeña, que se consigue un solo origen.

Es por ello, que cuando se está explorando las posibilidades forestales de una zona y no es posible conseguir origenes de especies, resulte de interés contar con especies que hayan demostrado plasticidad. Los ensayos que incluyen especies que pueden crecer en diversos climas y suelos, se pueden considerar como etapa intermedia hasta que investigaciones más completas permitan indicar que orígenes o procedencias, de una o varias especies, son las más aptas para el area en estudio.

En la República Argentina especies como E. camaldulensis, E. viminalis, E. tereticornis, E. globulus y E. cinerea tienen gran difusión en todo el país, tanto para plantaciones comerciales como para montes o cortinas protectoras. La semilla usada en Argentina para todo destino provienen de introducciones realizadas hace más de 120 años desde Europa donde llegaron de Australia, en una época que este país tenía muy pocos centros poblados y no había posibilidades de que se obtuvieran distintos orígenes (Taylor 1961) (Zacharin 1978). La introducción de orígenes se inició en 1968 (Mendonza 1973).

Las especies más usadas en el mundo deben su difusión a que reunen características de plasticidad. Las dos especies consideradas en este trabajo E. kartzoffiana y E. globulus subsp. bicostata han tenido buen comportamiento en distintas regiones del país y algunas de sus características y datos de crecimiento se tratan a continuación por separado.

Eucalyptus kartzoffiana L. Johnson et D. Blaxell.

Esta especie descripta por L Johnson y D. Blaxell (1973) fué desconocida como tal, no obstante crecer en una región historicamente muy frecuentada como lo fue el valle de Araluen, durante la explotación del oro. Es un ejemplo de una especie que crece en un área muy pequeña. En 1966, el autor de este trabajo, estudió esta entidad creyéndola un híbrido entre E. viminalis y E. maideni. En el Departamento de Botánica de la Universidad Nacional de Australía, con la supervisión del Dr. L. Pryor, se hizo el análisis de las descendencias de los ejemplares considerados híbridos.

Contrariamente a lo esperado, se obtuvieron plantas muy homogéneas y no se observó segregación. En el área natural se vió que esta especie se hibrida con E. viminalis, hecho que más tarde se corroboró en los ensayos plantados en Argentina.

Los ejemplares juveniles desarrollaron muy bien y resistieron las pruebas a bajas temperaturas. Estas características indujeron a incluir esta especie en los ensayos plantados en distintos lugares del país y los resultados se muestran en cuadro N° 1. La semilla fue provista por el Departamento de Botánica de la Universidad Nacional de Australia y provienen de cuatro árboles coleccionados en distintos lugares en Araluen. En los ensayos se mantuvieron separadas en todos los sitios y como no hubo diferencías significativas en el crecimiento, se han promediado los datos.

Este eucalipto se destaca por su porte recto. Durante el crecimiento anual produce varios verticilos de numerosas ramas finas que persisten en el tronco. Plantas de cinco años mantienen la corteza y hojas de intenso color glauco. El estado adulto no ha sido observado todavía en los ensayos, pero en su lugar de origen es muy parecido a E. viminalis; desprende la corteza en largos flecos y se la distingue de esa especie por las hojas juveniles que son glaucas y muy anchas.

En el cuadro N°1 se aprecia que los crecimientos en las dos localidades de Jujuy, con régimen monzónico, son similares a los de Concordia donde las lluvias se distribuyen bien durante el año. Asimismo los suelos de Jujuy, donde estan los ensayos, son arcillosos y los de Concórdia arenosos. Lo mismo se puede decir para Ituzaingo. Para Ramallo el régimen de precipitaciones es parecido al de Concordia, pero el suelo es franco arcillo-limoso. Las bajas temperaturas no han afectado a las plantas y el caso más extremo se ha anotado en un ensayo en General Roca, Provincia de Río Negro, plantado en 1979 y que ha resistido varios dias con heladas, siéndo la mínima - 8° C.

Cuadro N° 1 - Valores medios de altura (m) D. A. P. (cm)
incremento medio anual (m) y fallas (%)
de Eucalyptus kartzoffiana, a distintas
edades, en cinco localidades de la Argentina.

Localidad (*)	Altura media (m)	D.A.P. (cm)	(edad)	Incr. Med. anual (m)	Fallas
Reyes (Pcia. Jujuy)	12,98	12,40	5	2,60	42
Sauzal (Pcia. Jujuy)	16,12	12,90	5	3,22	30
Ituzaingo (Pcia. Corrientes)	10,7	16,00	5	2,14	50
Concordia (Pcia. Entre Rios)	12,10	11,64	4	3,02	28
Ramallo (Pcia. Buenos Aires)	9,88	10,13	4	2,47	27

(*) Los datos sobre las localidades se muestran en anexo N°1.

Eucalyptus globulus subsp. bicostata (Maiden, Blakely & Simmonds) Kirkpatrick.

Esta especie se conoció como E. stjohnii, hasta que J. B. Kirkpatrick

(1974), luego de un extenso análisis reduce su condición de especie a subespecie de E. globulus junto con E. pseudoglobulus y E. maidenii. Estas entidades se consideraron siempre muy afines y al estado juvenil es casi imposible diferenciarlas. Son todas de interés forestal en muchas regiones del mundo, pero las más difundidas en orden de importancia son E. globulus y E. maideni.

E. globulus subsp. globulus fue el primer eucalipto introducido en Argentina, se difundió rápidamente en la provincia de Buenos Aires como cortina protectora, su forma es mala y es conocido el daño que sufre con las heladas. La zona apta en la Argentina se circunscribe al sudeste de la provincia de Buenos Aires. E. globulus subsp. maideni crece mejor y es mas resistente al frío, pero no se ha difundido. E. globulus subsp. bicostata es la mas resistente al frio de este complejo y tiene buen crecimiento y buena forma. Las pocas referencias existentes sobre esta subespecie destacan los caracteres mencionados.(Cremer, 1969), (Panetsos, 1970), (Powell, 1972) (Fishwick, 1976).

En Argentina se ha incluido este eucalipto en diferentes ensayos y sus resultados generales se ven en cuadro N°2.

Cuadro N°2 - Valores medios de altura (m), D.A.P. (cm) incremento medio anual (m) y fallas (%) de Eucalyptus globulus subsp. bicostata a distintas edades, en cinco localidades de la Argentina.

Localidad (*)	Altura media (m)	D.A.P. (cm)	Edad	Inc.Med. anual (m)	Fallas (%)
Reyes (Pcia. Jujuy)	14,33	11,78	5	2,86	40
Sauzal (Pcia. Jujuy)	11,50	10,12	5	2,30	35
Algarrobal (Pcia. Jujuy)	10,87	10,80	5	2,17	38
El Colorado (Pcia. Formosa)	11,37	13,20	5	2,27	6
Ramallo (Pcia. Buenos Aires)	8,64	8,51	4	2,16	9

(*) Los datos sobre las localidades se muestran en anexo N°1

Para los resultados de estos ensayos valen los mismos comentarios ya realizados para E. kartzoffiana al final de la página 2. También se plantó este eucalipto en Genral Roca y resistió temperaturas hasta -8°C.

De esta subespecie se instaló en Ramallo, Provincia de Buenos Aires, un ensayo con cinco orígenes que se detallan a continuación y que fueran consignados como E. stjohnii por la Division of Forest Research, CSIRO de Australia.

Lote N°	Localidad	Altitud (m)
S9539	Flagstaff Road, Stanley, Victoria (cerca de Beechworth)	580
S9540	Warrembayne S.F. SW Benalla, Victoria.	580
S9541	Toombullup, NE Mansfield,Victoria	850
S9574	Nullo Mtn, 20 millas E. Rylstone Central Tableland, Nueva Gales del Sur.	970
S10164	Wee Jasper, Goodradigbee River, Southern Highlands, Nueva Gales del Sur.	910

Los resultados de este ensayo se muestran en cuadro N°3 y ha sido extractado de un ensayo comparativo con las siguientes especies: E.camaldulensis, E. tereticornis y E. kartzoffiana. Se plantaron 5 bloques con 5 repeticiones de 8 plantas cada una, distanciadas 2,5x2,5m.

Cuadro N°3 - Valores medios de altura (m), D.A.P. (cm), incremento medio anual (m) y fallas (%) de cinco orígenes de E. globulus subsp. bicostata a los cuatro años deedad, en Ramallo, Provincia de Buenos Aires.

Lote N°	Altura media (m)	D.A.P. (cm)	Incr. Med. Anual (m)	Fallas (%)
S9539	8,98	8,74	2,24	30
S9540	9,03	8,75	2,26	30
S9541	8,09	7,82	2,02	30
S9574	8,77	8,72	2,19	30
S10164	8,38	8,53	2,09	27

El análisis estadístico de este ensayo indicó que nohay diferencias significativas entre los cinco orígenes probados. Los valores del cuadro N°2 corresponden a ensayos plantados con la mezcla de estos orígenes.

El análisis de la madera de este eucalipto reveló que es de gran calidad para la producción de pastas celulósicas (Velez-Repetti 1979).

Conclusiones

La plasticidad de algunas especies de eucaliptos no siempre está relacionada con la capacidad de la especie para ocupar grandes superficies en su area de origen. El E. kartzoffiana es un ejemplo de una especie circunscripta a un area pequeña mientras que E. globulus subsp. bicostata, si bien ocupa el área maś extensa de las cuatro subespecies de E. globulus, no parece tener mucha variación, según el análisis de un ensayo con cinco orígenes. Estos dos eucaliptos pueden crecer en distintos climas y suelos y en todas las localidades donde se ensayaron muestran incrementos medios similares o algo inferior a las mejores especies para cada localidad, pero tienen la ventaja de ser menos exigentes en suelos y además toleran mayores temperaturas bajo cero.

ANEXO N° 1

Características de las localidades donde se instalaron ensayos de E,kartzoffiana y E. globulus subsp. bicostata

Localidad	Latitud	Longitud	Altitud	Precipitaciones
Reyes (Pcia. Jujuy)	24° 08' S	65°18' W	1445	1008
Sauzal (Pcia.Jujuy)	24° 12' S	64°40' W	1040	850
Algarrobal (Pcia. jujuy)	24° 11' S	65°18' W	1255	940
Ituzaingo (Pcia. Corrientes)	27° 35' S	56°42' W	72	1716
El Colorado (Pcia. Formosa)	26° 12' S	58°42' W	76	1200
Concordia (Pcia. Entre Rios)	31° 23' S	58°23' W	37	1224
Ramallo (Pcia. Buenos Aires)	33° 29' S	60°01' W	36	986

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* * *

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TESTE DE PROCEDÊNCIA DE *EUCALYPTUS UROPHYLLA* S.T. BLAKE NO NORTE DE CORRIENTES, ARGENTINA.

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Resumo

Seis procedências de *E. urophylla* S. T. Blake foram testadas em Ituzaingo, nordeste da província de Corrientes, Argentina. Estes lotes de sementes variaram de 420 a 2430 m de altitude e mostraram diferenças significativas em crescimento no quinto ano. Contudo, as melhores procedências, as que variaram de 420 a 1200m, não mostraram diferenças significativas. No mesmo local, *E. grandis*, a espécie mais comum cresceu 25% mais.

ENSAYO DE ORIGENES DE *EUCALYPTUS UROPHYLLA* S.T. BLAKE EN EL NORTE DE LA PROVINCIA DE CORRIENTES, ARGENTINA.

Resumen

Six provenances of Eucalyptus urophylla S. T. Blake have been tested at Ituzaingo, in the north-east of Corrientes Province, Argentina. These provenances, originating from the range of 420 to 2430 m of altitude, showed significant differences in height growth after five years. However, there was no significant difference between the better provenances, i.e. those from 420 to 1200 m. At the same location E. grandis, the most commonly planted species, grew 25% faster than E. urophylla.

Introduction

El Eucalyptus urophylla ha concentrado la atención de los forestadores de las regiones tropicales debido al éxito obtenido en el Brasil con esta especie. Los incrementos volumétricos excepcionales y la resistencia a Diaporthe cubensis son las características sobresalientes de la especie (Pasztor 1975, Golfari, 1971). En Brasil, debido a las hibridaciones y a la escasa información sobre las variaciones de esta especie, se conoce el complejo de híbridos como "alba del Brasil". Pryor (1971) expresa que E. urophylla se introdujo con el nombre de E. alba, dando origen a la confusión existente. Este mismo autor aclara que E. decaisneana, otro de los nombres con que se conoce esta especie, nada tiene que ver con ella. S. T. Blake (1977) describe la especie con el nombre actual, que ya se estaba usando desde algunos años antes. Las primeras observaciones en el área natural fueron realizadas por M. R. Jacobs en 1963, Larsen en 1968 y L. Pryor y J. Turnbull en 1971 destacándose las variaciones en la presencia de corteza, según los gradientes altitudinales. B. Martin y C. Cossalter (1975) realizan un completo análisis de las variaciones observadas en E. urophylla y E. alba en su área de origen. Resulta interesante en este trabajo los estudios sobre las variaciones en la corteza, caracter que ya fuera mencionado por los otros especialistas que visitaron la región. En un rango altitudinal de 450 a 1000 metros se pasa de árboles gomeros (gums) en un 100 % a 25 % . Según S. T. Blake E. urophylla difiere de E. alba por su corteza rugosa, pero menciona la posibilidad de que se hibriden, coincidiendo con Martín y Cossalter. Con la variabilidad observada en esta especie va a resultar difícil investigar el material usado en otros paises y es de esperar que el estudio de las progenies de la colección realizada recientemente por J. C. Doran y D. A. Kleinig (1979) contribuya a entender su comportamiento.

La información reunida hasta la fecha indica que E. urophylla no tolera temperaturas bajo cero y por lo tanto existen muy pocas posibilidades de que crezca en Argentina, donde practicamente no se conocen zonas libres de heladas. No obstante, se consideró que el norte de la Provincia de Corrientes, próximo a la costa del Río Paraná, tiene baja frecuencia media de dias con heladas y resultaba una zona adecuada para ensayarla.

Material y Métodos

La semilla de E. urophylla fué facilitada por la Division of Forest Research del CSIRO, Australia y comprende los siguientes orígenes consignados como E. dacaisneana:

Lote N°	Localidad	Altitud (m)
9008	Flores, Indonesia	420
10135	S. Maubisse, Timor	1530
10139	Mt. Tatamailan, Timor	2430
10144	N. Aileu, Timor	1200
10145	Dili, Timor	1005
10146	Taco Lulic, Timor	795

El ensayo se plantó en un campo de Fiplasto Forestal S. A., situado a 20 Km. al oeste de Ituzaingo, localidad que se encuentra a 56° 42' de longitud oeste y 27° 35' de latitud sur y 72 m. s. n. m. Los datos climáticos se pueden comparar con los de Posadas, 80 Km. al este, donde los registros de 50 años indican 1716 mm. de precipitación media, bien distribuidas y sólo se presenta un pequeño déficit en los meses de enero y febrero. La temperatura media del mes más cálido es de 26°C y 15, 8°C del mes más frío.

El tipo de suelo es el que se conoce en la región como arenas grises; son ácidas y de baja fertilidad.

Como el terreno donde se instaló este ensayo es llano y muy homogéneo y siendo el número de plantas disponibles muy pequeño, se adptó un diseño de parcelas enteramente al azar. Las parcelas de 8 plantas, espaciadas a 3mx3m, se repitieron 5 veces.

Resultados

Los resultados de las mediciones alquinto año se muestran en el cuadro N° 1.

Cuadro N° 1 - Valores medio de altura (m), D. A. P. (cm), incremento medio anual (m) y fallas (%) de seis orígenes de Eucalyptus urophylla a los cinco años de edad, en Ituzaingo, Provincia de Corrientes.

Lote N°	Altura media (m)	D. A. P. (cm)	Incr. Med. Anual (m)	Fallas (%)
10145	10,60	10,90	2,12	12
10144	10,42	9,46	2,08	37
10146	10,10	9,62	2,02	65
9008	9,10	9,36	1,82	52
10135	8,76	9,56	1,75	45
10139	4,90	4,50	0,98	56

El análisis de variancia y test de Tukey de este ensayo revela diferencias significativas entre los orígenes. Los de mayor actitud son como era previsible, los de menor crecimiento. Resulta de interés, sin embargo, que los 4 orígenes que crecen entre los 420 y 1200 metros de altitud no tienen diferencias significativas .Pasztor (1975) tampoco encuentra diferencias significativas trabajando igualmente con procedencias de Timor, pero con un rango de altitud entre 1200 y 1800 metros y entre 900 y 2100. Los porcentajes de fallas son muy altos, excepto el origen de Dili, que también es el de mejor crecimiento. En el origen 10146 de Taco Tulic se observan tres ejemplares con todas las características de E. alba, pero no se puede saber si es una segregación o si se trata de semilla mezclada.

Conclusiones

Sobre la base de los datos de crecimiento de E. urophylla en otras latitudes, los obtenidos aqui son inferiores a los que se esperaba. Si bien el suelo donde se plantó el ensayo no es el más adecuado para eucaliptos, en el mismo lugar, un ensayo de orígenes y procedencias de E.grandis creció un 25 % más. Los arboles que forman este ensayo tienen, en general, buena forma. Tienen pocas ramas, pero son gruesas y se mantienen desde abajo. Resultará de interés hacer otros ensayos para encontrar orígenes más adecuados, pero deberá tenerse en cuenta que, la susceptibilidad a las heladas persiste como caracter adverso y el área donde podría plantarse esta especie en Argentina, es muy pequeña.

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RESULTADOS DE PESQUISA COM VÁRIAS PROCEDÊNCIAS DE *EUCALYPTUS UROPHYLLA* S.T. BLAKE, NO CENTRO-LESTE DO BRASIL.

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Resumo

Foi analisado o comportamento de algumas procedências de E. urophylla de uma ampla faixa altitudinal, de Timor leste e de ilhas adjacentes, em várias localidades da região Centro-Leste Brasileiro, sob diferentes condições climáticas e sob solos de Mata e de Cerrado.

Os resultados permitiram concluir que independente do local de teste, baixa ou alta altitude, solos de Mata ou de Cerrado, as procedências de baixa e média altitude apresentaram melhor desempenho, tanto em altura, diâmetro e sobrevivência.

Por outro lado, os resultados foram bastante superiores, quando testadas em ambiente de Mata do que em ambiente de Cerrado. As diferenças em altura, diâmetro e sobrevivência entre os extremos das procedências altitudinais foram mais evidenciados em áreas de Cerrado.

PROGRESS REPORT ON PROVENANCE RESEARCH OF *EUCALYPTUS UROPHYLLA* S.T. BLAKE IN THE CENTER-EAST REGION OF BRAZIL.

Summary

In this work the behaviour of some provenances of E. urophylla from a large altitudinal range in East Timor and from some nearby islands are analysed. These provenances were tested in different localities of the Central - East region of Brazil under different climatic conditions and under the Forest soil type and Woodland soil type (Cerrado).

The results indicated that, independent of environmental conditions, provenances from middle and low altitudes yielded a better performance in height and miameter growth and also in survival.

On the other hand, independent of the provenance used, the growth of trees on the Forest soil type was better than that on the Woodland soil type. The differences between provenances, in height and diameter and survival, particularly between the extremes of the altitudinal range, were greater on the Woodland vegetation type (Cerrado).

Introdução

Eucalyptus urophylla S. T. Blake ocorre naturalmente em Timor numa faixa altitudinal de 5000 até cerca de 3000 metros de altitude e também nas encostas montanhosas de outras ilhas da Indonésia à leste da linha de Wallace, entre as ilhas de Bali e Lombok entre as latitudes 10° e 6° Sul.

Esta espécie, introduzida em São Paulo, Brasil, no ano de 1919 tem sido bastante utilizada nos programas de reflorestamento, e se tornou mais importante quando essa atividade teve sua área extendida às regiões mais setentrionais onde a espécie além de mostrar um bom desenvolvimento apresentou baixa suscetibilidade ao cancro do Eucalypto, causado pelo fungo Diaporthe cubensis (Hodges e Reis, 1976).

Devido a estes fatos há grande interesse por parte de reflorestadores e também de pesquisadores, no melhor conhecimento da espécie no que diz respeito à sua variabilidade genética e adaptação a diferentes condições ecológicas.

Trabalhos de campo e em condições controladas com material de E. urophylla já evidenciaram a grande variabilidade existente dentro da distribuição da espécie não só por seus caracteres morfológicos como também no crescimento em altura e em diâmetro de mudas sob condições controladas (Hamzah, 1975, Moura, 1977), e em condições de campo, Martin e Cossalter, 1975, 1976 e Campinhos e Ikemori, 1977.

Neste trabalho, é examinado o desempenho em altura, diâmetro e sobrevivência de várias procedências de E. urophylla, as quais foram introduzidas na região Centro-Leste do Brasil, principalmente nos Estados do Espírito Santo, Minas Gerais, Goiás, Mato Grosso e Distrito Federal (Apêndice 1) e seus comportamentos vêm sendo observados ao longo destes últimos cinco anos.

Material e Métodos

O material de E. urophylla utilizado na experimentação é todo originário de áreas de Timor Leste, de uma faixa altitudinal compreendida entre 580 e 2740 metros e de ilhas adjacentes, através de coletas realizadas por diversos pesquisadores (Apêndice 2).

As mudas usadas nesta experimentação foram produzidas sob as mesmas condições ambientais em Sete Lagoas, Minas Gerais e transferidas para diferentes localidades, sob condições ambientais de Mata e de Cerrado, durante os anos de 74, 75, 76 e 77 (Apêndice 1). Na época da instalação dos experimentos não se tinha ainda conhecimento da grande variabilidade da espécie, estando assim o material em teste com um grande número de outras espécies e procedências.

As parcelas experimentais são formadas por 5 fileiras de 5 árvores, em espaçamento de 2 metros entre árvores e 3 metros entre fileiras, comportando assim 25 árvores ocupando uma área de 150 metros; as 16 árvores externas foram consideradas como bordadura e as 9 centrais como árvores úteis mensuráveis.

A adubação utilizada no campo foi a mesma para todas as localidades, constando de 70 gramas por cova da fórmula NPK 9-28/30 - 5, mais micronutrientes, Borax e Zinco.

Os experimentos foram implantados na mesma época, entre os meses de junho/julho correspondendo a época de menor precipitação.

Na análise dos dados um problema surgiu devido a desigual representação das procedências; algumas aparecendo em muitos dos experimentos e outras sendo representadas apenas em poucos. Qualquer análise combinada teria sido restrita a uma seleção das procedências que foram comuns para todos os locais. Procedências que aparecessem infreqüentemente seriam excluídas. Uma solução prática foi comparar cada procedência com todas as outras; e os dados para um dado par sendo retirado de todos os experimentos nos quais as procedências ocorressem; tal procedimento mostraria qual procedência teria a maior taxa de crescimen to em média, porém, também era desejável determinar se estas diferenças eram substancialmente significante. Porém como as variações ao acaso, das diferenças, dentro dos pareas não se apresentaram normalmente distribuídos, optou-se por um procedimento não paramétrico, no caso o "Wilcoxon Signed Rank Test", para as comparações pareadas (Sokal and Rolf, 1969). Os resultados são apresentados nas Tabelas 1, 2, e 4.

Resultados e Discussões

Tanto em crescimento em altura como em diâmetro (Tabelas 3 e 4) nota-se que procedências de *Eucalyptus urophylla* de altitudes na faixa de 300 a 1200 metros, independente do local de teste, ambiente de Mata com solos férteis ou ambiente Cerrado com solos pobres e ao nível do mar ou a 1000 metros de altitude, apresentam um desenvolvimento elevado quando comparado com procedências de altitudes acima de 1500 metros.

Essa mesma tendência foi observada nos trabalhos de Martin e Cossalter 1976, em duas localidades africanas.

Numa comparação entre as várias procedências os resultados mostram que independente do local de teste e do ano de plantio tanto em altura como em diâmetro, (Tabelas 3 e 4) as procedências 9008, 9016, 10144, das altitudes 420 metros, 580 metros e 1210 metros respectivamente, foram as que apresentaram os melhores resultados. Ao contrário, as procedências 10140, 10136 e 10139, todos de altitudes superiores a 2000 metros apresentaram resultados bastante insatisfatórios com o material apresentando um alto índice de nanismo (Foto 1), e baixa dominância apical. Essa constatação se refere principalmente às procedências 10139 e 10136 de 2470 e 2740 metros. A produção em volume da procedência 10139 foi de até 24,12 vezes menos quando comparado com o material de baixa altitude 9008, em Paraopeba, (área de Cerrado) e 6,61 vezes menos em Aracruz,ES, (área de Mata) (Tabela 3). Esses resultados mostram que independentemente da área de origem da semente houve sempre superioridade em produtividade de *E. urophylla* em áreas no ambiente de Mata em relação ao ambiente de Cerrado.

Em trabalhos anteriores, foi constatado que na fase juvenil essas diferenças de crescimento entre o material de baixa e alta altitude já são evidentes para as faixas de 600 a 2800 metros. Na fase de pós germinação (quatro semanas) foi encontrada uma tendência contrária em termo de crescimento, com as mudas provenientes de baixa altitude apresentando um desenvolvimento inferior àquelas de maior altitude, desenvolvimento esse relacionado com o tamanho da semente e conseqüentemente com o tamanho dos cotilédones. Com o decorrer do desenvolvimento do material esta tendência é revertida (Moura, 1977). Esta mesma tendência foi observada no presente trabalho e persiste até a fase adulta. Trabalhos conduzidos por outros pesquisadores, confirmam esta mesma situação, tanto para espécies de coníferas como de folhosas (Mirov et al 1950; Callaham e Liddicoet, 1961; Sweet, 1965; Corn e Hiesey, 1973; Ashton 1958; Eldridge 1969 e outros).

Em quatro locais, dois de ambiente de Mata e dois de ambiente Cerrado, os resultados de crescimento em altura com altitude da origem da semente mostraram uma correlação linear negativa significantes aos níveis de 1 e 5% (Figura 1).

Esta tendência gradativa de diminuição de crescimento com aumento da altitude sugere a existência de diferentes genotipos ao longo do transecto altitudinal. Certamente o clima tem uma função bastante importante na seleção dos caracteres genéticos os quais, combinados, levam a um crescimento mais rápido para as plantas de baixa altitude e mais lento para as plantas de alta altitude. O crescimento mais lento para as plantas sob ambiente de alta altitude está provavelmente associado com uma maior resistência às baixas temperaturas comuns as altitudes elevadas de Timor. Esta hipótese é suportada por um teste piloto sobre resistência à geada realizado pelo autor (não publicado), onde plantas de alta altitude sobreviveram melhor do que aquelas de altitudes inferiores a 2000 metros.

Examinando as Tabelas 1 e 3 verifica-se que a procedência 10146 de 800 metros, foi significantemente diferente daquelas procedências de sua mesma faixa altitudinal. Entretanto, verificando as fichas de coletas constatou-se que as sementes foram coletadas de um único indivíduo, não se constituindo assim em uma procedência e sim uma progenie de uma única família. Martin e Cossalter, 1976, testando este material na África encontraram as mesmas características de baixa produtividade apresentada por essa procedência nos diversos locais onde foi testada no Brasil.

Considerando apenas uma faixa estreita da distribuição altitudinal da espécie, as diferenças existentes nas populações não são facilmente demonstradas estatisticamente (Tabelas 1 e 3). Porém as diferenças de crescimento são bem evidentes quando os extremos das populações em termos de altitudes são comparadas (580 e 2470 metros). Entretanto se duas procedências vizinhas de altitudes diferentes são comparadas, as diferenças existentes são bem mais difíceis de serem explicadas. Eldridge (1969), Green (1969) e Paztor (1975) trabalhando com populações de diferentes altitudes dentro de uma faixa altitudinal estreita, menor que 1000 metros, das espécies *E. regnans*, *E. pauciflora* e *E. urophylla* respectivamente não conseguiram demonstrar nenhuma diferença significativa entre as populações testadas. Entretanto, diferenças significantes entre populações altitudinais, dentro de uma larga faixa altitudinal em condições tropicais, no Hawai, foi constatada por Corn e Hiesey (1973), trabalhando com mudas de *Metrosideros polymorpha*, cujas diferenças no tamanho de folhas e de crescimento em altura foram bem evidenciadas e coincidem com os resultados encontrados por Moura (1977) para mudas de *E. urophylla*.

Muito embora o material de *E. urophylla* procedente de outras ilhas próximas a Timor, tenha sido testado em apenas três localidades, e incluindo uma única procedência de Timor, 10136, da mais alta altitude e não o material de baixa altitude, no caso os mais produtivos, nota-se que apesar da pouca idade de teste este material apresentou grande potencial de crescimento. Isto sendo verdade, principalmente, para a procedência 9008 de 420 metros de altitude, de Flores, a qual dentre todas as procedências testadas foi a que apresentou os melhores resultados, muito embora quando comparada com outras procedências de Timor, 9016 e 10144 não apresentaram diferenças significativas ao nível de 5% (Tabelas 1 e 3).

A procedência 9016 de 580 metros de altitude, apesar de estar entre as procedências que mais se destacaram em crescimento em altura e diâmetro, apresenta, nos experimentos, uma segregação de dois tipos diferentes de árvores: uma com tronco claro, descamante (Foto 3), folhas largas, galhos grossos com características de *E. alba* e outra de tronco cor marron, casca persistente (Foto 4), com folhas e galhos finos, tipo *E. urophylla*. Esse material foi coletado numa zona de contato entre espécies de *E. urophylla* e *E. alba*, onde é comum ocorrer híbridos naturais.

Não só em termos de desenvolvimento as procedências de baixa altitude foram superiores, porém também na taxa de sobrevivência. Das comparações realizadas (Tabela 4), as procedências 10136, 10139 e 10140 de 2470 e 2100 metros respectivamente, foram as que apresentaram as menores taxas de sobrevivência; seguidos do material 10146, de 900 metros de altitude o qual mostrou um comportamento atípico também em crescimento em altura e diâmetro, para as procedências desta faixa altitudinal.

Conclusões

Os resultados apresentados permitem concluir que *E. urophylla* de uma faixa altitudinal de 300 a 1200 metros, independente do ambiente em que foi plantado, apresenta uma taxa de crescimento superior àquelas de altitudes acima de 1500 metros. Esta variação é gradual ao longo do transecto altitudinal evidenciando a

FOTO 1. Planta de E. urophylla com 3,5 anos de idade procedente da região do Monte Tatamailau, Timor, 2740 metros de altitude, plantado em Brasília,DF.

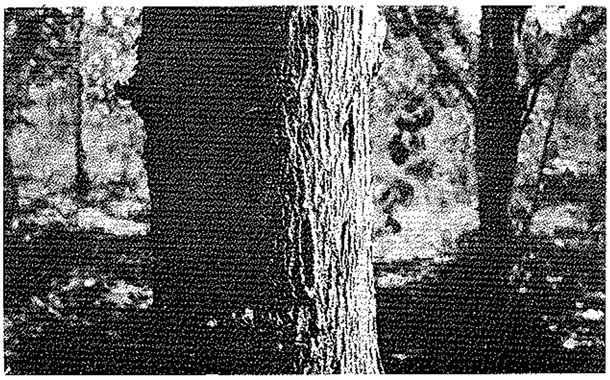

FOTO 2. Aspectos do tronco da procedência 9016, de 580 metros de altitude, com casco marrom persistente, boa derrama, tipo E. urophylla, plantado em Brasília,DF, com 3,5 anos de idade.

FOTO 3. Aspecto do tronco da procedência 9016 de 580 metros de altitude, com casca clara, descamante, galhos grossos persistentes tipo E. alba, plantado em Brasília,DF, com 3,5 anos de idade.

a existência de diferentes genotipos.

As diferenças entre as procedências foram mais visíveis entre os extremos das populações e menos marcadas dentro de uma estreita faixa altitudinal.

Independente da procedência testada, superioridade existiu quando os plantios foram realizados em ambiente de Mata.

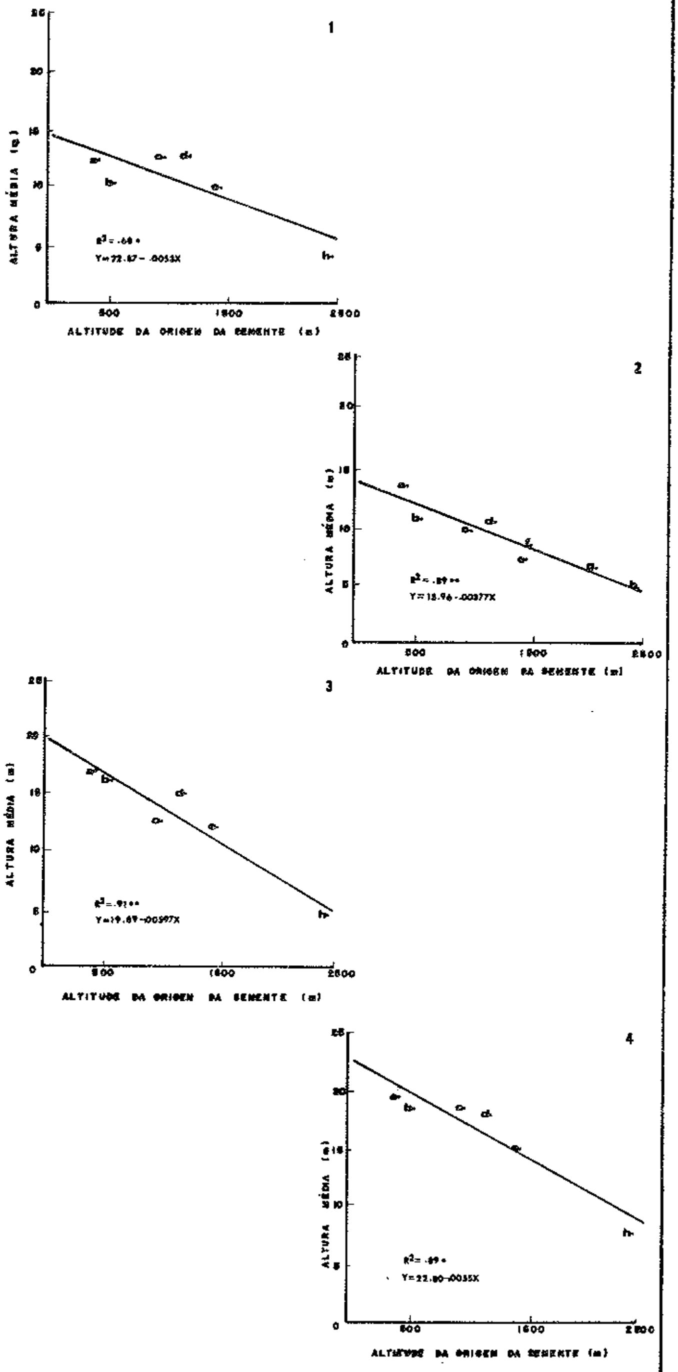

FIGURA 1 - Correlação entre a altitude da origem da semente, a=(420 m); b=(580 m); c=(1005 m); d=(1210 m); e=(1500 m); f=(1520 m); g=(2100 m); h=(2470 m); com a altura média de plantas de E. urophylla aos 3.5 anos de idade em quatro diferentes locais: 1= Brasília (DF) e 2= Água Clara (MS) em área de cerrado; 3= Pedra Corrida (MG) e 4= Aracruz (ES) em área de mata.

R^2 = coeficiente de correlação; * = significante ao nível de 5% . ** = significante ao nível de 1%.

TABELA I - COMPARAÇÕES ENTRE CRESCIMENTO EM ALTURA DE PROCEDENCIAS DE *E. UROPHYLLA* COM 2.5 - 4.5 ANOS

	8242 N Maubisse	9008 Flores	9016 Dili/Ermera	10135 S. Maubisse	10136 Mt. Tatamailau	10139 Mt. Tatamailau	10140 Hato Builico	10144 N. Aileu	10145 S. Dili	10146 Taco Lulic	11877 Alor	11879 Alor	11883 Pantar	11885 Wetar
8242 N Maubisse		4 ⬆ 1	4 ↑ 2	6 ⬅ 1		6 ⬅ 0	5 ⬅ 0	6 ⬆ 0	5 ↑ 1	3 ← 0				
9008 Flores	4 ⬅ 1		18 ← 7	18 ⬅ 1		9 ⬅ 0	9 ⬅ 0	6 ← 6	9 ⬅ 2	6 ⬅ 0				
9016 Dili/Ermera	4 ← 2	15 ↑ 7		25 ⬅ 5		7 ⬅ 0	6 ⬅ 0	7 ↑ 6	11 ← 4	8 ⬅ 1				
10135 S. Maubisse	6 ⬆ 1	18 ⬆ 1	25 ⬆ 5			9 ⬅ 0	9 ⬅ 0	15 ⬆ 1	14 ⬆ 2	6 ⬅ 0				
10136 Mt. Tatamailau											5 ↑ 1	5 ↑ 0	6 ⬆ 1	5 ⬆ 1
10139 Mt. Tatamailau	6 ⬆ 0	9 ⬆ 0	7 ⬆ 0	9 ⬆ 0			5 ⬆ 0	10 ⬆ 0	11 ⬆ 0	4 ⬆ 1				
10140 Hato Builico	5 ⬆ 0	8 ⬆ 0	6 ⬆ 0	6 ⬆ 0		6 ⬅ 0		6 ⬆ 0	10 ⬆ 0	5 ← 0				
10144 N. Aileu	6 ⬅ 0	8 ↑ 6	7 ← 6	15 ⬅ 1		10 ⬅ 0	6 ⬅ 0		9 ⬅ 2					
10145 S. Dili	5 ← 1	5 ⬆ 2	11 ↑ 8	14 ⬅ 2		11 ⬅ 0	10 ⬅ 0	8 ⬆ 2		9 ⬅ 1				
10146 Taco Lulic	5 ↑ 0	6 ⬆ 0	6 ⬆ 1	8 ⬆ 0		4 ⬅ 1	5 ↑ 0		9 ⬆ 1					
11877 Alor					6 ← 1							2 ↑ 1	4 ↑ 1	3 ↑ 2
11879 Alor					5 ← 0						2 ← 1		2 ← 1	3 ← 0
11883 Pantar					6 ⬅ 1						4 ← 1	2 ↑ 1		4 ↑ 2
11885 Wetar					6 ⬅ 1						3 ← 2	3 ↑ 0	4 ← 2	

Nesta tabela são apresentados os resultados obtidos através de comparações entre o crescimento médio em altura de cada procedência com os de outras procedências. Para um dado par de procedências os dados foram tomados nos locais onde ambas as procedências foram testadas. As setas estão apontadas para aquelas procedências cujas médias foram mais altas. A seta cheia indica que as diferenças entre as duas procedências foram significantes ao nível de 5% de acordo com o "Wilcoxon Signed Rank Test". O numeral na parte superior de cada quadro indica quantas vezes aquela procedência foi superior e o numeral na parte inferior do quadro, indica quantas vezes a mesma procedência foi inferior, nas comparações entre as médias do crescimento em altura.

TABELA 2

COMPARACÕES ENTRE CRESCIMENTO EM DIÂMETRO DE PROCEDENCIAS DE *E. UROPHYLLA* COM 2.5- 4.5 ANOS

	8242 N Maubisse	9008 Flores	9016 Dili/Ermera	10135 S. Maubisse	10136 Mt. Tatamailau	10139 Mt. Tatamailau	10140 Hato Builico	10144 N. Aileu	10145 S. Dili	10146 Taco Lulic	11877 Alor	11879 Alor	11883 Pantar	11885 Wetar
8242 N Maubisse		6 ⬆ 1	4 ↑ 2	4 ← 2		6 ⬅ 0	5 ⬅ 0	4 ↑ 2	4 ← 2	3 ⬅ 0				
9008 Flores	6 ⬅ 1		1 ← 9	8 ⬅ 1		10 ⬅ 0	6 ⬅ 0	9 ← 6	6 ⬅ 2	5 ⬅ 0				
9016 Dili/Ermera	4 ← 2	1 ↑ 9		24 ⬅ 4		11 ⬅ 0	12 ⬅ 1	9 ← 6	9 ← 8	6 ⬅ 1				
10135 S. Maubisse	4 ↑ 2	8 ⬆ 1	24 ⬆ 4			12 ⬅ 0	11 ⬅ 0	11 ⬆ 8	9 ↑ 6	4 ← 3				
10136 Mt. Tatamailau											6 ⬆ 0	5 ⬆ 0	4 ⬆ 0	6 ⬆ 0
10139 Mt. Tatamailau	6 ⬆ 0	10 ⬆ 0	11 ⬆ 0	12 ⬆ 0			6 ⬆ 0	7 ⬆ 0	11 ⬆ 0	4 ⬆ 1				
10140 Hato Builico	5 ⬆ 0	6 ⬆ 0	12 ⬆ 1	11 ⬆ 0				8 ⬆ 0	9 ⬆ 1	2 ⬅ 1				
10144 N. Aileu	4 ← 2	9 ↑ 8	9 ↑ 6	11 ⬅ 8		7 ⬅ 0	5 ⬅ 8		8 ⬅ 1	4 ⬅ 0				
10145 S. Dili	4 ↑ 2	9 ⬆ 2	9 ↑ 6	9 ← 6		11 ⬅ 0	9 ⬅ 1	8 ⬆ 1		5 ← 1				
10146 Taco Lulic	3 ⬆ 0	5 ⬆ 0	6 ⬆ 1	4 ↑ 5		4 ⬅ 1	2 ↑ 1	4 ⬆ 0	5 ↑ 1					
11877 Alor					5 ⬅ 0							2 ↑ 1	4 ↑ 1	3 ↑ 2
11879 Alor					5 ⬅ 0						2 ← 1		2 ← 1	2 ← 1
11883 Pantar					6 ⬅ 0						4 ← 1	2 ← 1		4 ← 2
11885 Wetar					6 ⬅ 0						3 ← 2	2 ↑ 1	4 ↑ 2	

Nesta tabela são apresentados os resultados obtidos através de comparações entre o crescimento médio em diâmetro de cada procedência com os de outras procedências. Para um dado par de procedências os dados foram tomados nos locais onde ambas as procedências foram testadas. As setas estão apontadas para aquelas procedências cujas médias foram mais altas. A seta cheia indica que as diferenças entre as duas procedências foram significantes ao nível de 5% de acordo com o "Wilcoxon Signed Rank Test". O numeral na parte superior de cada quadro indica quantas vezes aquela procedência foi superior e o numeral na parte inferior do quadro, indica quantas vezes a mesma procedência foi inferior, nas comparações entre as médias do crescimento em diâmetro.

TABELA 3: Dados médios de crescimento em altura, diâmetro e volume, de três procedências altitudinais de E. urophylla testados em Aracruz-Espírito Santo (área de mata) e Paraopeba-Minas Gerais (área de Cerrado) com 3,5 anos de idade. (Nos Apêndices 1 e 2 se encontram as descrições dos locais de coleta e de plantio, respectivamente).

Local / Nº Origem	Aracruz-ES				Paraopeba-MG			
	Alt. (m)	Diâm. (cm)	Sobr. (%)	Vol. (m^3/ha)	Alt. (m)	Diâm. (cm)	Sobr. (%)	Vol. (m^3/ha)
9008	19,32	16.35	90	276.55	11.32	11.42	100	101.55
10135	15.17	11.97	90	123.42	10.46	9.87	92	66.21
10139	7.80	8.79	88	41.84	3.93	3.24	92	4.21

Entre as procedências as que mais se destacaram em termos de crescimento em altura, diâmetro e sobrevivências foram as 9008 de 520 metros, a 10144 de 1210 metros e a 9016 de 580 metros. Esta última procedência apesar do bom crescimento é oriunda de uma faixa altitudinal onde é comum a existência de híbridos naturais entre E. urophylla e E. alba e, no campo apresenta segregações de dois tipos de árvores, semelhantes às duas espécies mencionadas.

Recomenda-se, com base nos resultados apresentados para plantios em condições subtropicais e tropicais, as procedências de E. urophylla de baixa ou média altitude, evitando-se porém àquelas de faixa altitudinal onde haja o contato entre os E. urophylla e E. alba.

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TABELA 4 - COMPARAÇÃO ENTRE PORCENTAGEM DE SOBREVIVÊNCIA DE PROCEDENCIAS DE E. UROPHYLLA COM 2.5 — 4.5 ANOS

	6242 N Maubisse	9008 Flores	9016 Dili / Ermera	10135 S. Maubisse	10136 Mt. Tatamailau	10139 Mt. Tatamailau	10140 Hato Builico	10144 N. Aileu	10145 S. Dili	10146 Taso Lulic	11877 Alor	11879 Alor	11883 Pantar	11885 Wetar
6242 N Maubisse		5 ↑ 2	4 ↑ 2	6 ⬅ 1		6 ⬅ 0	5 ⬅ 0	4 ↑ 2	4 ← 2	5 ← 0				
9008 Flores	5 ← 2		11 ← 9	12 ← 7		9 ⬅ 1	7 ← 2	15 ⬆ 4	10 ⬆ 2	5 ← 2				
9016 Dili/Ermera	4 ← 2	11 ↑ 9		23 ⬅ 8		11 ⬅ 0	9 ⬅ 2	9 ↑ 8	12 ← 6	7 ⬅ 0				
10135 S. Maubisse	6 ⬆ 1	12 ↑ 7	23 ⬆ 8			10 ⬅ 1	8 ← 5	10 ⬆ 4	14 ⬆ 3	7 ⬅ 0				
10136 Mt. Tatamailau											5 ↑ 2	3 ↑ 0	6 ⬆ 1	4 ↑ 2
10139 Mt. Tatamailau	6 ⬆ 0	9 ⬆ 1	11 ⬆ 0	10 ⬆ 1			4 ↑ 1	10 ⬆ 0	11 ⬆ 0	4 ↑ 1				
10140 Hato Builico	5 ⬆ 0	7 ↑ 2	9 ⬆ 2	8 ↑ 5		4 ← 1		3 ↑ 5	8 ⬆ 2	3 ← 0				
10144 N. Aileu	4 ← 2	15 ⬅ 4	9 ← 8	10 ⬅ 4		10 ⬅ 0	3 ← 5		4 ← 4	4 ← 1				
10145 S. Dili	4 ↑ 2	10 ⬅ 2	12 ↑ 6	14 ⬅ 3		11 ⬅ 0	8 ⬅ 2	4 ↑ 4		8 ⬅ 0				
10146 Taso Lulic	5 ↑ 0	5 ↑ 2	7 ⬆ 0	7 ⬆ 0		4 ← 1	3 ↑ 0	4 ↑ 1	8 ⬆ 0					
11877 Alor					5 ← 2							2 ↑ 1	4 ↑ 1	4 ↑ 1
11879 Alor					3 ← 0						2 ← 1		2 ← 1	2 ← 1
11883 Pantar					6 ⬅ 1						4 ← 1	2 ↑ 1		5 ↑ 3
11885 Wetar					4 ← 2						4 ← 1	2 ↑ 1	5 ← 3	

Nesta tabela são apresentados os resultados obtidos através de comparações entre porcentagem de sobrevivência de cada procedência com os de outras procedências. Para um dado par de procedências os dados foram tomados nos locais onde ambas as procedências foram testadas. As setas estão apontadas para aquelas procedências cujas médias foram mais altas. A seta cheia indica que as diferenças entre as duas procedências foram significantes ao nível de 5% de acordo com o "Wilcoxon Signed Rank Test". O numeral na parte superior de cada quadro indica quantas vezes aquela procedência foi superior e o numeral na parte inferior do quadro, indica quantas vezes a mesma procedência foi inferior, nas comparações entre porcentagem de sobrevivência.

Apêndice 1

Coordenadas Geográficas e Condições Climáticas dos Locais onde Experimentos com Espécies e Procedências de E. urophylla Foram Instalados no Período de 1974-1977.

Localidades	Latitude	Longitude	Altitude (m)	Média anual de temperatura (°C)	Média anual de precipitação (mm)	Deficit hídrico anual (Thornthwaite 1955 - 300mm) (mm)
Água Clara, MS	20° 27'	52° 53'	384	23.2	1360	35
Aracruz, ES	19° 48'	40° 17'	40	23.5	1287	57
Belo Oriente, MG	19° 13'	42° 22'	280	22.6	1230	89
Bom Despacho, MG	19° 39'	45° 15'	742	21.3	1365	68
Brasília,DF	15° 48'	47° 43'	1120	20.1	1622	87
Capelinha, MG	17° 40'	42° 32'	1050	19.3	1140	72
Cataguases, MG	21° 23'	42° 42'	195	22.8	1235	68
Cel. Fabriciano, MG	19° 31'	42° 37'	246	22.9	1247	98
Cristalina, GO	16° 47'	47° 34'	1150	20.1	1598	78
Curvelo, MG	18° 47'	44° 35'	650	22.1	1306	96
Florestal, MG	19° 54'	44° 24'	710	20.7	1482	87
Grão Mogol, MG	16° 54'	42° 53'	980	20.5	1188	98
Ipameri, GO	17° 43'	48° 10'	739	21.7	1473	95
Itamarandiba, MG	17° 53'	42° 52'	1068	19.1	1158	61
Lavras, MG	21° 14'	45° 00'	878	19.3	1411	31
Linhares, ES	19° 24'	40° 04'	25	23.6	1278	54
Nova Lima, MG	19° 57'	43° 53'	950	20.7	1472	71
Paraopeba, MG	19° 15'	44° 23'	734	21.0	1182	75
Pedra Corrida, MG	19° 07'	42° 21'	213	23.6	1132	130
Pedro Leopoldo, MG	19° 57'	44° 23'	710	20.5	1440	68
Perdizes, MG	19° 20'	47° 17'	1050	20.4	1482	45
Ribas do Rio Pardo, MS	20° 23'	53° 45'	365	23.4	1340	35
São Mateus, ES	18° 44'	39° 53'	50	23.7	1356	51
Serra do Cabral, MG	17° 43'	44° 30'	1120	18.8	1468	48
Sete Lagoas, MG	19° 28'	44° 15'	732	20.8	1209	62
Uberaba, MG	19° 45'	47° 55'	820	22.0	1506	60
Várzea da Palma, MG	17° 35'	44° 48'	478	22.9	1160	143
Vazante, MG	17° 58'	46° 55'	750	22.3	1405	93
Viçosa, MG	20° 45'	42° 53'	650	19.1	1394	23

Apêndice 2

Lista de Procedências E. urophylla Utilizada em Experimentação na Região Centro-Leste Brasileira no Período de 1974-1977.

Nº de Origem	País	Área	Altitude	Latitude	Longitude	Coletor	Ano de Coleta
8242	Indonésia	Norte de Maubisse/Timor	1520 m	8° 50'	127° 37'	Jacobs	1963
9008	Indonésia	Monte Egon/Flores	420 m	8° 40'	122° 30'	Larsen	1968
9016	Indonésia	Dili/Ermera/Timor	580 m	8° 39'	125° 27'	Larsen	1968
10135	Indonésia	Sul de Maubisse/Timor	1500 m	8° 54'	125° 36'	Turnbull	1971
10136	Indonésia	Monte Tatamailau/Timor	2740 m	8° 55'	125° 30'	Turnbull	1971
10139	Indonésia	Monte Tatamailau/Timor	2470 m	8° 55'	125° 30'	Turnbull	1971
10140	Indonésia	Hato Builico/Timor	2100 m	8° 53'	125° 32'	Turnbull	1971
10144	Indonésia	Norte de Aileu/Timor	1210 m	8° 38'	125° 36'	Turnbull	1971
10145	Indonésia	Sul de Dili/Timor	1005 m	8° 38'	125° 37'	Turnbull	1971
10146	Indonésia	Taco Lulic/Timor	805 m	8° 42'	125° 27'	Turnbull	1971
11877	Indonésia	Lamang/Pinaounge/Alor	650 m	8° 22'	124° 50'	Cossalter	1975
11879	Indonésia	Kel/Alake/Alor	800-850 m	8° 19'	124° 40'	Cossalter	1975
11883	Indonésia	OuLata/Pantar	600 m	8° 18'	124° 06'	Cossalter	1975
11885	Indonésia	Arvace/Wetar	300 m	7° 58'	126° 20'	Cossalter	1975

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TESTES DE PROCEDÊNCIA DE *EUCALYPTUS NITENS* (DEANE & MAIDEN) MAIDEN EM ZIMBABWE.

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Resumo

Nove procedências de *Eucalyptus nitens* e 3 de *E. regans* foram instalados em testes com repetições em dois locais em Zimbabwe. Aos 8 anos e 5 meses de idade existiram diferenças significativas entre procedências para altura, área basal e densidade básica mas não para as interações procedência/local. Duas grandes populações de *E. nitens* foram caracterizadas: uma de rápido crescimento com baixa densidade básica, compreendendo as procedências do Norte e do Sul de Nova Gales do Sul, e uma de crescimento menor com alta densidade básica do Centro-Leste de Vitória. Os lotes de sementes de *E. regnans* foram geralmente de taxa de crescimento intermediária às duas populações de *E. nitens* mas sofreram severos danos das geadas que ocorreram nos locais de plantio, e isto as afetaram adversamente na forma do tronco.

PROVENANCE TRIALS OF *EUCALYPTUS NITENS* (DEANE & MAID). MAID. IN ZIMBABWE.

Summary

Nine provenances of Eucalyptus nitens were established in replicated trials at two sites in Zimbabwe. At age 8^{5}/12 years there were significant differences between provenances in height, basal area, and basic density but there were no provenance x locality interactions. Two broad populations of E.nitens were distinguished: a fast-growing one with lower basic density, comprising the provenances of northern and southern New South Wales, and a slow-growing one with higher density from central and eastern Victoria.

Introduction

Eucalyptus nitens (Deane & Maid.) Maid. occurs naturally in four widely separated regions of south-eastern Australia from latitude 30°S in northern New South Wales to 38°S in central Victoria. The species' natural range was described by Pederick (1976; 1979) who distinguished six main provenances and identified a form that appears to warrant separation as a distinct variety from typical E.nitens. The species was introduced into Zimbabwe in 1963 from Mt.Erica, Victoria (Barrett and Mullin, 1968), and its good performance led to the acquisition of further seed for species and provenance trials over a wider range of sites. It has subsequently become the outstanding eucalypt in the high-altitude, cold localities of Zimbabwe where frost and exposure severely limit the choice of plantation species.

Materials and Methods

Seed origins

The origins of the seedlots used for the provenance trials are shown in Table 1 which lists the locally allocated seed stock numbers (S/N) in addition to those of the Forestry and Timber Bureau, now known as the CSIRO Division of Forest Research, in Canberra, Australia. Details of origin were supplied by F.T.B. but the provenance names have been interpreted from Pederick (1979). One E.nitens seedlot, S/N 2392, was obtained from a commercial supplier in N.S.W. but no precise details of origin were provided. Three seedlots of E.regnans F.Muell. were included as additional treatments in each trial to test the performance of this species against that of E.nitens in the very exposed conditions of Nyangui, but their results are not discussed in this paper.

Table 1. Origins of the seedlots used in the provenance trials.

Stock No.	F.T.B. No.	Latitude (S)	Longitude (E)	Altitude (m)	Provenance
2315	5683	37°52'	146°21'	1 036	Toorongo
2316	7393	32°00'	152°30'	1 585	Northern N.S.W.
2317	6200	37°54'	146°20'	1 067	Toorongo
2318	6199	37°26'	146°22'	1 189	Macalister
2319	6483	37°30'	148°30'	1 006	Errinundra
2320	8414	32°00'	151°50'	1 524	Northern N.S.W.
2321	8445	37°00'	149°00'	914	Southern N.S.W.
2322	8709	37°00'	149°00'	1 280	Southern N.S.W.
2392	-		Not available		New South Wales

The experimental sites

Soil and climatic details of the experimental sites are given in Table 2. The two sites are about 2,5 km apart with an altitudinal difference of 255 m; the meteorological station from which the climatic data were obtained is located midway between the sites at an altitude of 2 000 m. The higher site, because of its greater exposure, is probably a little colder than the meteorological station, with evaporation marginally higher.

Table 2. Descriptions of the provenance trial sites.

Trial No.	Locality	Mean temperatures °C	Mean annual rainfall, rain days, and evaporation	Soil
36	Nyangui E16 Lat.18°01'S Long.32°47'E Alt. 1 880 m	Max. 18,3 Min. 9,0 Annual 13,6	Rainfall 1 572,6 mm Rain days 120 Evap. 1 085,0 mm	doleritic clay loam, not more than 1,0 m deep
40	Nyangui O11 Lat.18°01'S Long.32°46'E Alt. 2 135 m	Max. 18,3 Min. 9,0 Annual 13,6	Rainfall 1 572,6 mm Rain days 120 Evap. 1 085,0 mm	0,3 m soil over multifractured shale outcrop

Field trial designs

Trial 36 contains all nine seedlots but S/N 2316 was omitted from Trial 40 because of a shortage of plants. A filler seedlot was substituted and both trials were planted on February 7, 1969, in a randomized complete block design with three replications of 36-tree square plots spaced at 2,44 x 2,44 m. No statistical design was followed during the nursery phase; the seed was drill-sown in boxes in June, 1968, and the plants were pricked out into polythene tubes which were removed at planting.

Measurements and determination of wood density

In July, 1977, when the trials were aged 8^{5}/12 years, heights and diameters were measured in the 16-tree inner plots and stem straightness was assessed by the seven-point scale described by Barrett and Mullin (1968). Immediately after these measurements each trial was thinned to 50 percent of original stocking and 10-cm-thick discs for wood density determinations were taken at breast height (1,3 m) from five trees in each plot over the range of diameters. Basic density was determined by the method described by Carter (1974).

Results

The results of the assessments are shown in Table 3. Significant differences between provenances in height, basal area, and basic density were found at both sites, but there were no differences in stem form and no provenance x locality interaction in any trait.

Table 3. Eucalyptus nitens Provenance Trials 36 and 40 at age $8^5/12$ years. Summarized data of individual and combined trials, and Duncan multiple range tests (5%) for height, basal area, stem form, and basic density.

Trial No. / Trait	36			40			36 & 40 combined		
	S/N	Mean	DMRT	S/N	Mean	DMRT	S/N	Mean	DMRT
Height (m)	2320	20,21		2320	16,89		2320	18,55	
	2322	20,16		2315	13,96		2322	17,05	
	2316	19,42		2322	13,94		2392	16,33	
	2392	19,42		2321	13,74		2321	16,06	
	2321	18,37		2392	13,25		2315	15,00	
	2315	16,03		2317	10,85		2317	13,19	
	2317	15,52		2319	10,67		2319	12,77	
	2319	14,87		2318	9,97		2318	10,61	
	2318	11,24		-	-		-	-	
$\bar{x}$	17,25			12,91			15,21		
s.e	1,1968			1,0059			0,7655		
Sig.of F ratio	***			**			**		
Basal area (m^2/ha)	2320	38,44		2320	31,49		2320	34,97	
	2316	35,75		2322	25,84		2322	29,71	
	2322	33,57		2321	22,87		2321	27,48	
	2392	32,14		2392	21,63		2392	26,88	
	2321	32,10		2315	15,84		2315	17,64	
	2317	19,87		2319	12,59		2317	15,53	
	2315	19,44		2317	11,20		2319	15,07	
	2319	17,56		2318	10,17		2318	10,07	
	2318	9,96		-	-		-	-	
$\bar{x}$	26,54			18,95			22,97		
s.e.	3,7831			3,0693			2,1746		
Sig.of F ratio	***			**			***		
Stem form	2317	4,01		2319	4,19		2319	4,08	
	2322	3,99		2320	4,04		2322	3,99	
	2319	3,96		2322	3,99		2315	3,85	
	2315	3,90		2392	3,98		2320	3,84	
	2321	3,77		2315	3,79		2317	3,82	
	2316	3,75		2321	3,69		2392	3,80	
	2320	3,64		2317	3,63		2321	3,73	
	2392	3,62		2318	3,56		2318	3,55	
	2318	3,53		-	-		-	-	
$\bar{x}$	3,80			3,86			3,83		
s.e.	0,1132			0,1395			0,0908		
Sig.of F ratio	N.S.			N.S.			N.S.		
Basic density (g/cm^3)	2317	0,512		2319	0,500		2317	0,506	
	2319	0,509		2317	0,500		2319	0,505	
	2315	0,500		2315	0,499		2315	0,499	
	2316	0,490		2320	0,484		2320	0,480	
	2320	0,476		2318	0,469		2318	0,463	
	2321	0,464		2322	0,462		2321	0,461	
	2318	0,457		2321	0,459		2322	0,457	
	2392	0,454		2392	0,459		2392	0,457	
	2322	0,452		-	-		-	-	
$\bar{x}$	0,479			0,479			0,479		
s.e.	0,0122			0,0068			0,0071		
Sig.of F ratio	*			***			***		

Generally these provenances have separated out fairly well into two broad populations, one comprising the seedlots from northern and southern N.S.W., and the other those from central and eastern Victoria. This is clearly seen at 5% in the Duncan multiple range test (D.M.R.T.) for basal area in the combined trials, and even more so at 1% (not shown) in the D.M.R.T.'s for both basal area and basic density. The N.S.W. population has shown the best growth rate in these trials, with a superiority over the Victorian population in mean height and mean basal area of some four metres and 15 m^2/ha respectively. The Victorian population produced wood of higher basic density than that of the N.S.W. seedlots, some of which were only marginally heavier than E.regnens grown at the same sites.

Conclusions

These trials have demonstrated the superior performance of N.S.W. E.nitens in Zimbabwe, which differs from the results reported by Pederick (1979) from his trials in Victoria, Australia, where the central Victorian provenances were the best. The differing results of the two series of trials are probably explainable as the effects of climatic adaptation. The summer rainfall pattern at the Nyangui test site, where 94 percent of the total annual precipitation falls between November and April, is more akin to conditions in the northern N.S.W. part of the E.nitens range. Reference to Hall (1972) indicates that Dorrigo and Brooklane Nursery in northern N.S.W. receive about 65 percent of their annual rainfall in the same months; further south, in the zone of uniformly distributed rainfall, Nimmitabel and Cooma (southern N.S.W. provenance) receive 51–59 percent of their rainfall in this period; and further south still the Errinundra, Macalister, and Toorongo provenances fall into the winter rainfall zone and receive only 36–48 percent of their rainfall between November and April. Temperatures at Nyangui are also more comparable with those recorded for northern N.S.W. and are appreciably warmer in winter than those recorded for the southern N.S.W. and Victorian parts of the E.nitens range, e.g. Cooma and Nimmitabel (southern N.S.W.), Bondi State Forest (Errinundra), Woods Point (Macalister), and Tanjil Bren (Toorongo). Besides their better growth rate, the N.S.W. provenances have wood of lower basic density, which is preferred in Zimbabwe for utility hardwoods.

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TESTE DE PROCEDÊNCIA DE *EUCALYPTUS NITENS* AOS CINCO ANOS DE IDADE NA ÁFRICA DO SUL.

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Resumo

Este trabalho relata os resultados até o quinto ano de um teste de procedência repetido em dois locais na região com o período de chuvas no verão na África do Sul. As 27 fontes de sementes australianas, principalmente progênies, foram representativas de seis procedências – Toorongo, Rubicon, Macalister, Errinundra, do Sul e do Norte de Nova Gales do Sul. Uma progênie da África do Sul de origem desconhecida também foi incluída no teste. Nos dois primeiros anos as procedências de Vitória – Toorongo, Rubicon e Macalister tiveram o melhor crescimento em altura mas no quinto ano as procedências de Rubicon e Macalister foram as piores e seus declíneos foram atribuídos à provável suscetibilidade, principalmente de suas folhas juvenis ao fungo manchador de folha. A procedência de Errinundra foi consistentemente mais pobre e mais suscetível à geada. Aos 5 anos de idade a maioria das procedências melhores foram as do Sul de Nova Gales do Sul.

A FIVE-YEAR OLD PROVENANCE TRIAL OF *EUCALYPTUS NITENS* IN SOUTH AFRICA.

Summary

This paper reports on the results up to five years of a provenance trial replicated on two sites in the summer rainfall region of South Africa. The 27 Australian seed sources, mainly from individual trees, were representative of the six provenances - Toorongo, Rubicon, Macalister, Errinundra, southern New South Wales and northern New South Wales. A South African family of unknown origin was also included. For the first two years the Victorian provenances from Toorongo, Rubicon and Macalister had the best height growth but by five years Rubicon and Macalister were the worst and their decline was probably attributable to susceptibility particularly of the juvenile leaves to a leaf spot fungus. The Errinundra provenance was consistently poor and very susceptible to frost. At five years the most vigorous provenances were those from New South Wales.

INTRODUCTION

Eucalyptus nitens has a great potential in parts of South Africa because of its fast growth and cold tolerance. It is particularly well suited to the highveld areas of the southeastern Transvaal where the annual rainfall of approximately 1 000 mm falls mainly in the summer, and the winters are dry with frost. It is generally grown on a short rotation of up to 10 years for pulpwood and minepoles. The species was first introduced to South Africa in 1926 with seed from New South Wales but plantings have remained on a relatively small scale partly because of limited and costly seed (Poynton, 1979). No seed is produced commercially in South Africa because flowering is very rare and probably only starts at an advanced age. The coppicing ability of the species is generally too variable for satisfactory re-establishment by this method so seed is in great demand.

With a view to establishing seed production areas and eventually seed orchards a provenance trial of sources from the whole natural range of the species was designed and established in 1975. The families or seedlots planted were part of a collection made by Dr L Pederick of Victoria for a study of natural variation in the species. In this study he recognised six provenances of which one known as "Errinundra" deviated sufficiently from the others to be given varietal status (Pederick, 1979a).

SEED SOURCES AND NURSERY

All six provenances were represented in the present trial by varying numbers of families as follows : northern New South Wales (2), southern New South Wales (2), Toorongo (8), Rubicon (6), Macalister (5), and Errinundra (4). The locality of each seedlot is given in Table 1. All were from single trees except for those from northern and southern New South Wales which were each bulked collections from three trees. A South African family was also included for comparison. This was from an unknown number of trees of unknown origin growing at Jessievale in the southeastern Transvaal.

All the seedlings were raised in the Wattle Research Institute nursery in Pietermaritzburg. Seed was germinated at a constant 23°C in flats filled with a mixture of sterilized sand and vermiculite, and seedlings at the first leaf stage were pricked out into plastic sleeves. All seedlots started to germinate in about three days and after two weeks the seedlings in each lot were very uniform but there was considerable variation between lots. This was probably due largely to differences in seed size since there was a positive correlation between seedling height and seed length both for seedlots or families ($r = 0,753$ for 26 df) and for provenances ($r = 0,784$ for 5 df). The Errinundra provenance had the smallest seed and the smallest seedlings.

The differences in seedling size meant that all families were not ready for pricking out at the same time. In some the germination was also poor and in others, particularly No 30, an excessive number of recessives necessitated a second and even third sowing before there were sufficient seedlings for planting. Consequently at planting some families were younger and smaller than others so nursery differences were carried over to the field. The worst affected were Nos 66, 104 and three replications of 83 which could only be planted out at Avondale more than a month later than the rest of the trial. Seedling recessives such as "albino", "three cotyledons", "yellow green" and "variegated" were noted in several families but no obvious recessives or abnormal seedlings were planted out in the field.

PLANTING SITES AND EXPERIMENTAL DESIGN

The trial was replicated on two sites. One at Dargle at 1 400 m on State Forestry land in the Lion's River district of Natal and the other on a privately owned farm "Avondale", situated at 1 500 m in the Ermelo district of the southeastern Transvaal. Both sites were suitable for the species but differed in their soil types. At Dargle the soil was a dolerite derived highly leached clay with a humic topsoil whereas at Avondale it was also highly leached but granitic with a sandy clay texture. Both were virgin sites with natural grass cover and were as uniform as possible. At Dargle, however, there were a few patches of obviously shallower soil and at Avondale, part of the experiment was on land that sloped down towards an old watercourse which proved to be a frost pocket.

The sites were prepared for planting by complete cultivation and were planted within the same two weeks in February and March, 1975. At each site a 3,0 x 2,5 m spacing was used and ten-tree single line plots were laid out in a randomized blocks design with six replications. No fertilizer was applied but insecticides were used to prevent termite damage.

MEASUREMENTS

The height of each tree at each site was measured at planting, at one year and at 2,25 years but at five years the height of only one tree per plot was measured, being the tree with a diameter that was average for the plot. Diameters of all trees were measured at three and five years. Frost damage occurred at Avondale during winter 1976 and the extent of damage was recorded in October 1976 when trees with more than two-thirds of the crown damaged were regarded as frosted.

Several characteristics associated with the juvenile leaves were scored particularly at Dargle where, because of its proximity to Pietermaritzburg, measurements were done at more frequent intervals. The most important of these was the glaucousness which was recorded on a subjective scale of 1 to 3, with 3 being very glaucous. Some families retained juvenile leaves for several years and the number of trees with only juvenile leaves was noted each time either height or diameter was measured.

No obvious recessives or small moribund trees were measured and families 66 and 104 which were planted late at Avondale, were excluded from all statistical analyses of height and diameter.

RESULTS

Results are given in Table 1. Survival after planting was good at each site but by five years only 86 per cent of trees at Dargle and 72 per cent at Avondale remained. Two factors were largely responsible for this decline. These were frost at Avondale and possibly a leaf-spot fungus of the *Mycosphaerella* type at both sites (Rijkenberg, 1979).

The trees were nearly 18 months old and still in juvenile foliage when heavy frost occurred at Avondale and there was an inverse relationship between the glaucousness of the leaves and frost damage ($r = -0,618$, 26 df). The families and the provenances differed significantly in their susceptibility to frost. The four families of the Errinundra provenance with almost non-glaucous juvenile leaves were severely frosted making this the most susceptible provenance with 46 per cent of the trees affected. However the southern New South Wales provenance and the local Jessievale family were both very resistant in spite of not having glaucous leaves. Within-provenance variation was evident in the Toorongo provenance where family 104 differed from the others in that the leaves were non-glaucous and susceptible to frost.

Errinundra was the first provenance to change to mature leaves and by three years had virtually no trees with only juvenile foliage. In the other provenances the change was slower and at five years 62,7 per cent of trees of Macalister and 42,2 per cent from Rubicon still had only juvenile foliage but both the New South Wales provenances and Jessievale had lost their juveniles. In the Toorongo provenance only family 30 remained with predominantly juvenile leaves.

At each measurement differences in height both between families and between provenances were significant at each site. At one year Macalister, Rubicon and Toorongo were the tallest and northern and southern New South Wales the poorest. But by five years the situation was reversed. Northern and southern New South Wales which were up to 17 m at Avondale were both significantly taller than the others and Macalister at only 10,8 m at Avondale and 10,2 m at Dargle was the worst. In spite of nursery differences being carried over to the field there was no relationship between height at planting and height at subsequent measurements.

Both families and provenances also differed in diameter at three and at five years. In each case and at both sites the New South Wales provenances were the best and Macalister the poorest.

The relative positions of families and provenances was the same at each site and there was no interaction with site.

DISCUSSION

The Victorian provenances of Rubicon and Macalister were initially very promising and their decline is interesting. Many of the trees were still producing only juvenile leaves, few of which persisted for any length of time so the trees looked bare with only small tufts of leaves at the ends of the branches and it is doubtful if the trees will survive to rotation age. The probable cause of this is a leaf spot fungus which has been identified as *Mycosphaerella* from a small group of trees of the same provenances planted near Pietermaritzburg. Juvenile leaves appear to be particularly susceptible and thus the retention of a juvenile form has had a distinct disadvantage. This is in direct contrast to results in Australia where the juvenile-persistent families and provenances such as Macalister and Rubicon were the most vigorous (Pederick *loc cit*).

Growth of the Errinundra provenance which was composed entirely of trees belonging to *var errinundra* was consistently poor throughout the trial. The change to mature leaves occurred at an early age so there was apparently no damage by fungus but it is the most susceptible of the provenances to frost. Since *E.nitens* is grown in South Africa in areas where frost occurs this provenance would be of doubtful value for commercial plantings.

At five years the most vigorous provenances were those from New South Wales and there was little to choose between the northern and southern provenances. They are both also very resistant to frost and apparently also to leaf spot fungus. The local Jessievale family was similar in vigour to the New South Wales provenances and very resistant to frost. This and the fact that the juvenile leaves were similar to southern New South Wales or even Errinundra suggest that its origin could have been in this region. The fact that early seed imports were also from New South Wales substantiates this and its origin has since been confirmed by chemical analysis to be southern New South Wales (Pederick, 1979b).

Differences between families in branching and self pruning have been observed but have not yet been assessed. For these characteristics the New South Wales provenances may not be the best. While Toorongo provenance has only average vigour some families from particular localities are very vigorous and should not be ignored in a breeding programme.

TABLE 1

Results of measurements at Dargle and Avondale

Locality	Family No (ex Pederick)	DARGLE						AVONDALE			
		Height 1yr (m)	Height 5yr (m)	Diam 5yr (cm)	Glaucousness	Trees with no mature leaves 1½yr %	Trees with no mature leaves 5yr %	Height 1yr (m)	Height 5yr (m)	Diam 5yr (cm)	Frost Damage %
		Northern New South Wales Provenance									
Barrington Tops	86	1,2	15,0	16,2	3,00	67,2	0	1,0	16,5	17,6	0
Ebor	87	1,0	15,6	16,3	2,83	94,7	0	1,1	18,2	20,3	6,7
Mean N.NSW		1,1	15,3	16,2	2,92	81,0	0	1,0	17,3	18,9	3,4
		Southern New South Wales Provenance									
Tallaganda	82	1,2	14,5	15,5	1,67	90,0	0	1,1	14,9	15,9	1,7
Tallaganda	83	1,1	14,9	17,1	2,00	81,7	0	0,9	15,8	14,8	1,8
Mean S.NSW		1,2	14,7	16,3	1,84	85,9	0	1,0	15,4	15,3	1,7
		Toorongo Provenance									
Toorongo Plateau	30	1,1	8,2	8,2	2,83	100,0	69,0	1,0	12,2	9,9	9,4
Toorongo Plateau	121	1,4	14,2	13,6	2,83	90,0	24,0	1,2	11,3	12,1	6,7
Toorongo Plateau	135	1,5	14,6	14,7	2,00	18,7	0	1,2	16,5	15,6	15,0
Mt. Toorongo	35	1,1	12,1	11,4	2,17	54,2	10,2	1,0	12,8	11,4	10,0
Mt. Toorongo	132	1,2	15,3	15,6	2,50	45,8	1,7	1,2	14,8	14,7	0
Christmas Creek	104	1,2	13,0	11,8	1,33	31,6	0	0,6	15,4	14,4	62,2
St. Gwinear	111	1,4	14,5	15,4	3,00	72,9	12,6	1,2	9,4	6,9	3,3
Tanjil Bren	36	1,4	15,0	15,7	3,00	23,7	0	1,4	15,4	11,1	11,7
Mean Tooronoo		1,2	13,4	13,3	2,46	54,6	14,7	1,1	13,5	12,4	14,8
		Rubicon Provenance									
Tweed Spur	11	1,2	12,9	13,2	3,00	93,3	17,0	1,2	17,5	15,6	1,7
Tweed Spur	13	1,2	13,8	12,9	3,00	96,7	20,6	1,1	15,2	13,0	8,3
Royston Road	14	1,4	13,6	14,0	2,50	86,7	15,5	1,2	16,0	13,8	0
Snobs Ck	17	1,2	9,8	9,7	2,67	98,3	54,6	1,1	9,7	8,8	23,3
Barneval Plain	18	1,3	11,0	10,3	2,83	100,0	73,8	1,3	12,1	10,8	0
Barneval Plain	19	1,2	10,4	9,7	2,67	100,0	71,6	1,1	12,5	10,4	5,0
Mean Rubicon		1,3	11,9	11,6	2,78	95,8	42,15	1,2	13,8	12,1	6,4
		Errinundra Provenance									
Gunmark Range	60	1,0	12,2	13,9	1,67	38,2	0	1,1	12,6	15,2	43,3
Gunmark Range	64	1,0	10,8	9,4	1,17	39,0	0	1,1	12,7	12,4	36,7
Gunmark Range	66	1,1	12,8	12,2	1,33	7,0	0	0,6	11,2	9,4	62,8
Ada River	72	1,2	11,4	12,2	1,33	3,5	0	1,0	12,8	10,9	40,2
Mean Errinundra		1,1	11,8	12,0	1,38	21,9	0	0,9	12,3	12,0	45,8
		Macalister Provenance									
Connors Plain	43	1,0	6,7	6,1	2,67	100,0	90,4	0,9	9,2	8,0	10,0
Barkley R Road	44	1,3	9,2	9,4	2,67	100,0	83,6	1,1	10,5	9,1	3,3
Barkley R Road	46	1,3	10,2	10,5	2,50	100,0	66,9	1,2	11,8	9,8	1,7
Barkley R Road	47	1,2	12,0	10,3	2,83	100,0	52,0	1,1	10,5	8,8	21,7
Mt.Useful	50	1,5	12,9	12,1	2,83	78,3	20,7	1,3	12,2	10,5	26,7
Mean Macalister		1,3	10,2	9,7	2,70	95,7	62,7	1,1	10,8	9,2	12,7
		South African Control									
Jessievale	-	1,3	14,7	15,7	1,33	93,3	0	1,0	15,7	17,4	1,7
Mean		1,2	12,5	12,7	2,36	71,6	32,2	1,1	13,6	12,6	14,8
SE of family means		0,60	0,67	0,97	0,19	5,50	6,90	0,60	1,02	0,98	10,70

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PROGRESSOS NO ESTUDO DE PROCEDÊNCIA DE *EUCALYPTUS GLOBULUS.*

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Resumo

Uma detalhada colheita de *E. globulus* e de espécies muito próximas, *E. bicostata, E. maidenii* e *E. pseudo globulus*, foi efetuada pela Forestry Commission da Tasmânia, durante 1975 e 1976, em cooperação com outras organizações australianas. Sementes dessa colheita foram distribuídas para muitas entidades e muitos testes de procedência foram instalados.

Os resultados preliminares destes experimentos demonstram considerável variação entre procedências. Grandes diferenças nas características da madeira para a poupa e celulose foram determinadas em relação às melhores procedências oriundas de pequenos povoamentos, na Costa Oeste da Tasmânia.

A maioria das plantações *E. globulus* originou-se de sementes do sudeste da Tasmânia, considera-se hoje que grande melhoramento genético poderia ser feito através da introdução de novos materiais.

PROGRESS WITH *E. GLOBULUS* PROVENANCE RESEARCH.

Summary

A detailed collection of provenances of E.globulus and the closely related species E.bicostata, E.maidenii and E.pseudoglobulus was undertaken by the Forestry Commission of Tasmania during 1975-76 in co-operation with other Australian organisations. Seed from these collections has been distributed to many organisations and many provenance trials have now been established.

Early results from these trials show considerable variation occurring between provenances. Large differences in pulping characteristics have been determined, with the better provenances coming from the small relict stands on the West Coast of Tasmania.

Most E.globulus plantations have originated from seed taken from the South East of Tasmania and it is likely that considerable improvement could be made by introduction of new material.

2. INTRODUCTION

E.globulus, or "Tasmanian Blue Gum", is one of the most widely planted exotic species in the world and plantations occur in temperate zones on several continents; Europe, Africa and South America. It is used for the production of pulp and paper, poles, fuel, essential oils, and it will provide a timber useful for heavy construction purposes. The estimated area of E.globulus plantation in the world is in excess of 600,000 ha.

E.globulus Labill. is closely related to three other species - E.maidenii F. Muell, E.bicostata Maid. et al, and E.pseudoglobulus Naudin ex Maiden which grade into each other at zones of contact. (Fig. 1). However, despite their similarities E.globulus is the main species presently used in industrial plantations.

Because of the importance of these species a detailed provenance collection was made during 1975-76 by the Forestry Commission of Tasmania in co-operation with other Australian organisations. Details of this study have been given by Orme (1977).

Since then work has continued and recent results, especially details of the pulping characteristics of provenances, have shown that there is considerable scope for genetic improvement of this species by initially selecting amongst better provenances.

3. METHODS

General

These have been described by Orme (1977). In brief, provenance collections have been taken from specific areas throughout the natural occurrences of the species. (Fig. 1 & Fig. 2). Ten well scattered trees have been used to represent a provenance, except for the small occurrences when five trees were sampled. Seed has been mixed to make up a sample to represent provenances. However, seed of all parent trees has been retained for use in subsequent improvement work.

Distribution of Seed for Trials

Because of the world-wide importance of this work, seed from the provenance collections for research has been made available on request to many organisations. These include:-

	Complete Provenances	Selected Provenances
1. Australia and New Zealand		
Forestry Commission of N.S.W.	/	-
Forests Commission of Victoria	/	-
West Australian Forestry Department	/	-
A.P.M. Forests Pty. Ltd.	/	-
C.S.I.R.O. Canberra	/	-
New Zealand Forest Service	-	/
2. Europe		
France INRA	-	/
France AFOCEL	-	/
Portugal CELBI	-	/
3. South America		
Colombia INDERENA	/	-
Colombia Carton de Colombia S.A.	/	-
Brazil Instituto Florestal	/	-
Uruguay Ministerio de Agricultura	/	-
4. South Africa Forestry Department	-	/
5. Nepal Forestry Department	-	/

Seed of E.globulus provenances is still available, though stocks of some of the E.maidenii, E.bicostata and E.pseudoglobulus collections have nearly gone.

Wood Properties

Wood samples were taken from all parent trees of the Tasmanian collections and pulping properties were determined in the laboratories of A.P.P.M. Ltd., Burnie, under the direction of the Research Manager, Mr. C. Turner. The following pulping properties were determined for each tree:- soda charge (% NaOH), % pulp yield, basic density, beating requirement, bulk, burst and tear strengths.

Provenance Trials

Provenance trials that have been reported so far are given in Table I.

Table I

Trials of E.globulus Provenances

Australia	Location	Established
Tasmania		
Forestry Commission	Scottsdale, N.E. Tas.	1977
F.C./A.P.P.M. Ltd.	Devonport, N. Tas.	1977
F.C./A.P.P.M. Ltd.	Burnie, N.W. Tas.	1977
F.C./A.P.M. Ltd.	Geeveston, S. Tas.	1977
Forestry Commission	Scamander, E. Tas.	1978
Forestry Commission	Strahan, W. Tas.	1979
F.C./A.N.M. Ltd.	Maydena, C. Tas.	1979

Known Trials of E.globulus Provenances

Australia (Contd.)	Location	Established
Western Australia		
Forestry Department	Manjimup	1980
Forestry Department	Busselton	1980
Forestry Department	Wellington Catchment	1980
Overseas		
Colombia		
INDERENA	Near Bogota	1979
Carton de Colombia S.A.	Near Popoyan	1979
Portugal		
Celbi	Figuiera da Foz	1979

Establishment of Seed Orchards

One seedling seed orchard of 5 ha. using 40 parent trees with above average pulp yield from seven provenances was established in Tasmania in 1979. The author has recommended that several seedling seed orchards of 10 ha. be set-up in Colombia to provide improved seed for that country. These would incorporate a mixture of 75 parent trees coming from ten Tasmanian provenances and 75 trees selected from Colombian plantations, (Orme, 1980). Since it is difficult to select "plus trees" for seed orchards because of uncertain silvicultural practices, either from natural forests in Australia or from plantations overseas, it is better to proceed using a seedling seed orchard where heavy selection is done in the actual orchard.

4. RESULTS

Growth

Five trials to compare the various provenances of E.globulus and related species have been set-up in Tasmania during 1977 and 1978. It is too early to accurately assess the performance of the various provenances. However, two year results from the fastest growing trial, near Scottsdale, are given in Table II.

TABLE II

R.P. 173

E.globulus Provenance Trial
Lone Star, Scottsdale, Northern Tasmania
Established November 1977

Mean Heights at October 1979

Rank	Provenance No.	Provenance	Species	Mean Ht. (m)	Sig. 5%
1	21	Otway, Vic.	globulus	3.89	
2	18	S. Flinders Is., Tas.	globulus	3.39	
3	22	Portugal	globulus	3.38	
4	27	Jeeralang, Vic.	pseudo-globulus	3.25	
5	13	Rheban, Tas.	globulus	3.22	
6	26	Wibens Hill, Vic.	pseudo-globulus	3.15	
7	11	Taranna, Tas.	globulus	3.13	
8	17	N. Flinders Is., Tas.	globulus *	3.12	
9	14	Seymour, Tas.	globulus	3.08	
10	6	Geeveston, Tas.	globulus	3.07	
11	9	Jericho, Tas.	globulus	3.03	
12	20	King Island, Tas.	globulus	2.99	
13	3	Leprena, Tas.	globulus	2.97	
14	1	Macquarie Harbour, Tas.	globulus	2.96	
15	8	Uxbridge, Tas.	globulus	2.96	
16	5	Channel, Tas.	globulus	2.92	
17	2	Henty River, Tas.	globulus	2.84	
18	16	St. Helens, Tas.	globulus	2.83	
19	7	Denison, Tas.	globulus	2.76	
20	4	Bruny Island, Tas.	globulus	2.72	
21	12	Swansea, Tas.	globulus	2.70	
22	10	Pepper Hill, Tas.	globulus	2.56	
23	15	Scamander, Tas.	globulus	2.47	
24	30	Mt. Dromedary, N.S.W.	maidenii	2.46	
25	32	Bimmil Hill, N.S.W.	maidenii	2.40	
26	28	Mt. Myrtle, N.S.W.	maidenii	2.40	
27	29	Tantawanglo, N.S.W.	maidenii	2.32	
28	31	Nerigundah, N.S.W.	maidenii	2.19	
29	25	Strath Bogie, Vic.	bicostata	2.19	
30	24	Toombullup, Vic.	bicostata	2.17	
31	23	Mt. Cole, Vic.	bicostata	2.16	

L.S.D. 5% = 0.49m

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* This species has been variously reported as bicostata by Curtis (1975), as pseudo-globulus by Kirkpatrick (1975). However, both Pryor (1978) and the author consider that it is really E.globulus.

Wood Properties

The most interesting point to arise from this work is that despite differences existing between the ages, histories and general environments of the trees, there has been general uniformity of pulping properties within provenances, and large differences between provenances. This is best illustrated graphically and is shown in Figure 3.

The results have extremely important implications for industrial plantations of E.globulus since the better provenances, in terms of pulp quality, are those coming from the West Coast of Tasmania rather than East and South East Coasts which are the probable origin for most of the world's E.globulus plantations. A full report on the technical aspects of this work is in preparation and will be published in due course.

5. DISCUSSION

Growth Rate

At the onset there were significant differences occurring, both between members of the globulus group and within the main species E.globulus. For Tasmanian conditions both E.globulus and E.pseudo-globulus appear to be far superior to either E.maidenii and E.bicostata. The early fast growth rates of the Otways provenance and others are still being maintained, and it should be possible to objectively assess the 1977 Tasmanian trials in two to three years time when they will be five or six years old.

By grouping the mean values for the height of each provenance from the Scottsdale trial into localities we get the following figures:-

Species and Provenance	Mean Heights at Age 2
E.globulus	
1. Otways, Victoria	3.89 m
2. Bass Strait Islands	3.17 m
3. S.E. Tasmania	2.93 m
4. W. Tasmania	2.90 m
5. E. Tasmania	2.86 m
6. Central Tasmania	2.85 m
	3.1 m
E.pseudo-globulus	3.20 m
E.maidenii	2.35 m
E.bicostata	2.16 m

This shows the superior initial performance of northern E.globulus provenances and E.pseudo-globulus at Scottsdale, but it must be remembered that these provenances are climatically similar to the test area.

Wood Properties

This work on E.globulus is the first undertaken at a provenance level in Eucalyptus and the emerging pattern is that significant differences in wood characters can be detected between provenances. The genetic component of these differences has yet to be determined but are likely to be also significant. A plot of % pulp yield against mean annual rainfall for the various provenances gives a value of $r^2 = 0.48$ which is an indication of the environmental component.

A recent study of wood samples collected from a seven year old provenance trial of E.obliqua near Scottsdale has shown that highly significant differences in soda requirement and pulp yields occur between provenances whilst little variation was exhibited within provenances, or families, Matheson (1980).

Material will be taken from all the Tasmanian provenance trials of E.globulus for testing and with these data it will be possible to accurately determine hereditabilities of pulping characters as well as G-E interactions.

Some of the trees in the collections had outstanding features. For example, Tree No. 2 from the Henty River had a pulp yield of 60% and a soda charge of 17%, which is much better than values for plus trees currently being used for breeding in Portugal. This illustrates the benefits of thoroughly testing provenances before commencing a breeding programme.

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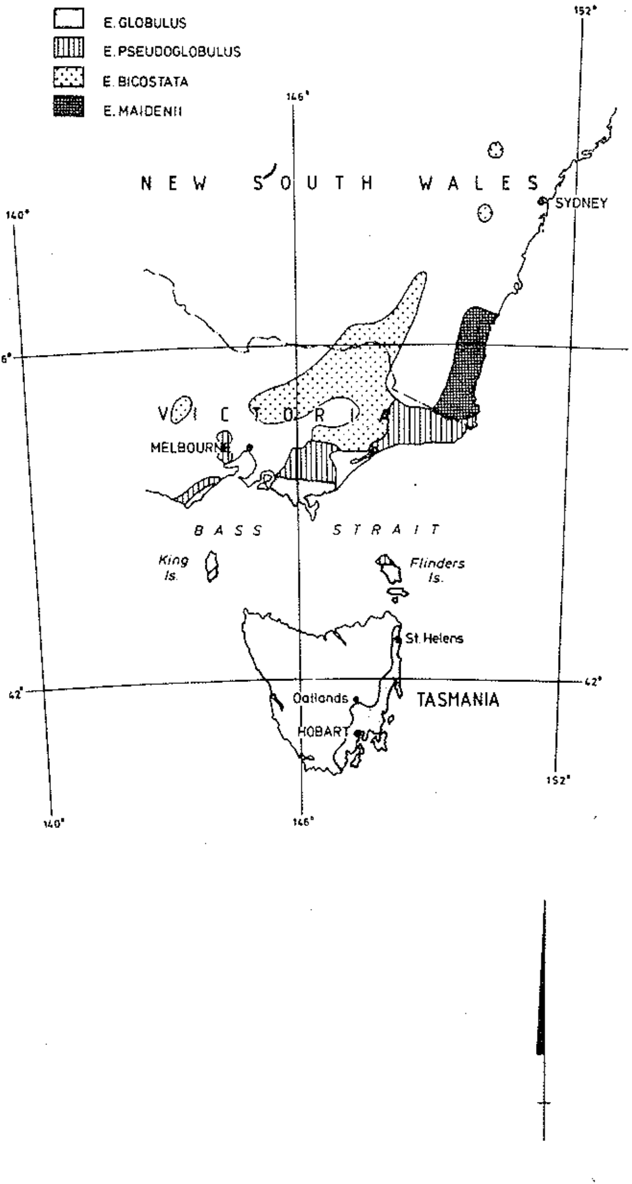
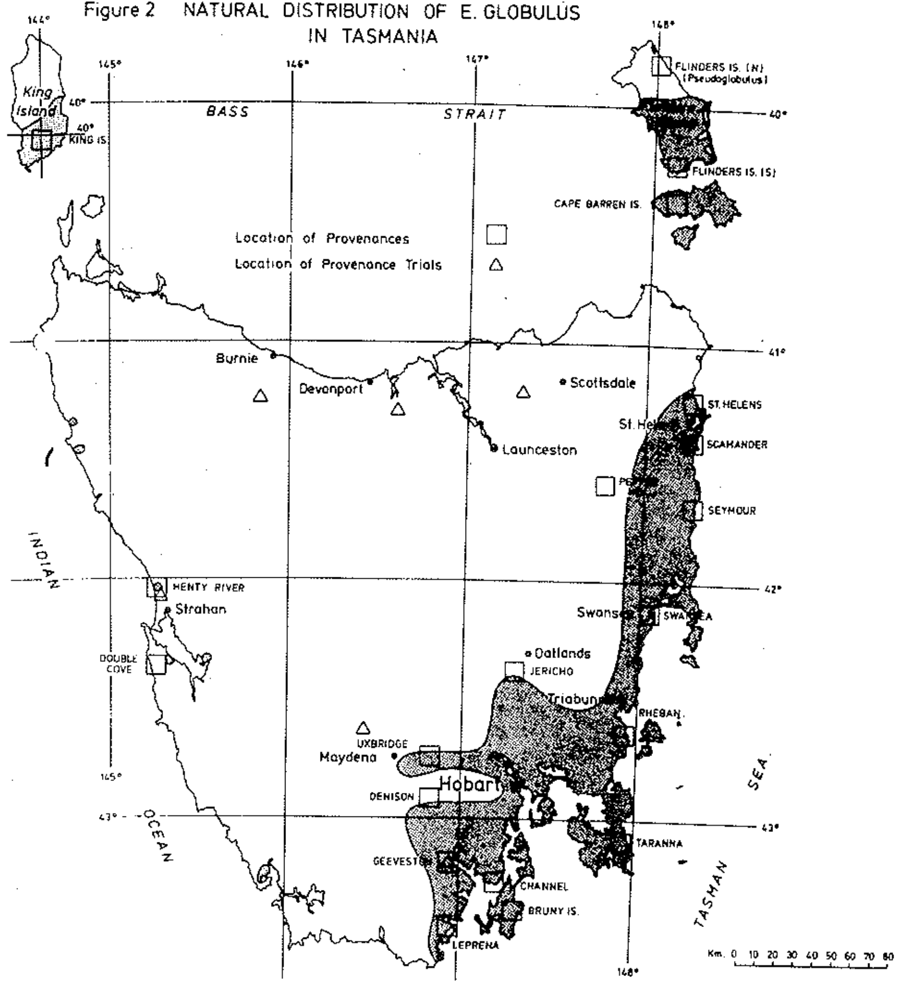
Figure 1 DISTRIBUTION OF E. GLOBULUS AND CLOSELY RELATED SPECIES



After Kirkpatrick (1975)

Figure 2 NATURAL DISTRIBUTION OF E. GLOBULUS IN TASMANIA



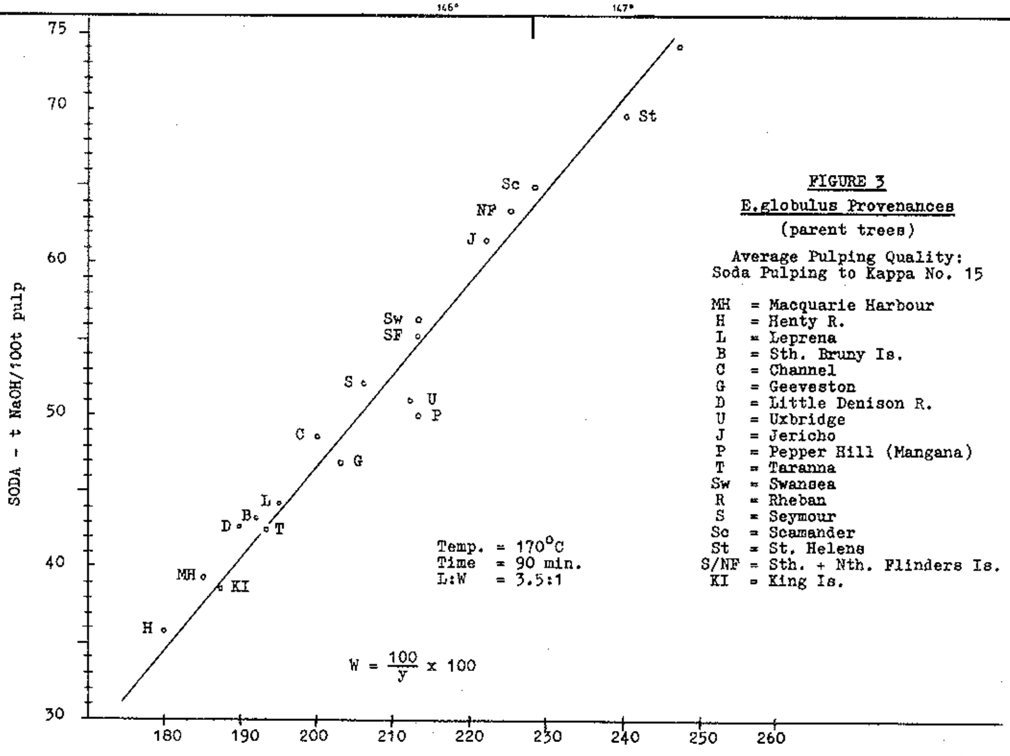


FIGURE 3

E.globulus Provenances

(parent trees)

Average Pulping Quality:
Soda Pulping to Kappa No. 15

TESTE DE PROCEDÊNCIAS DE *EUCALYPTUS PILULARES* SM — RESULTADOS DE 13 ANOS.

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Resumo

O comportamento de nove procedências australianas de Eucalyptus pilularis Sm e de duas introduzidas por Navarro de Andrade, crescendo em hortos da antiga Companhia Paulista de Estrada de Ferro, está sendo estudada através de um experimento implantado em Mogi Guaçu, Estado de São Paulo, em 1966.

Já foram analisados, em trabalhos anteriores, os resultados obtidos após 5 anos e a evolução do crescimento em altura e diâmetros até a idade de 8 anos (Pásztor, 1972, 1976, 1977).

O presente trabalho apresenta a evolução do crescimento em altura e diâmetro das procedências australianas, até a idade de 13 anos.

Summary

A provenance trial was established in 1966, at Mogi Guaçu, São Paulo State (47° 07' W longitude, 22° 11' S latitude, 580 m altitude) in order to analyse the growth characteristics of nine Australian provenances of Eucalyptus pilularis, and two introduced by Navarro de Andrade growing in plantations of the former Companhia Paulista de Estradas de Ferro.

The main conclusions drawn at age 5, and also the eight year progressive development in height and diameter growth of the provenances, have already been described by the author (1972, 1976 and 1977). Thirteen year progressive development in height and diameter growth of the Australian provenances are given in the present paper.

Introdução

O Eucalyptus pilularis é uma das principais espécies de madeira da Austrália, ocorrendo numa estreita faixa, ao leste deste país, atingindo ao norte a altura da Ilha Fraser, na Queensland e extendendo-se ao sul até Bega, em New South Wales.

Pásztor (1972, 1976, 1977) relata o desenvolvimento de nove procedências australianas de E. pilularis comparando-as com duas procedências introduzidas pelo Serviço Florestal da antiga Companhia Paulista de Estradas de Ferro, atual FEPASA.

O povoamento que foi implantado em Mogi Guaçu está sendo conduzido para produção de sementes.

Material e Métodos

As sementes australianas foram recebidas do Forestry and Timber Bureau, Canberra A.C.T. e as de Rio Claro foram colhidas no horto da antiga Cia. Paulista de Estradas de Ferro (atual FEPASA), conforme descritas no Quadro 1.

Quadro 1 - Procedências de Eucalyptus pilularis Sm

Lote nº	Localização	Latitude e Longitude	Altitude (metros)	Precipitação média anual (milímetros)
S. 6183	State Forest Reserve 809 Mt Florious, Qld.	27°15' S 152°40' E	600	1.780
S. 6184	State Forest Reserve, 616 Parish of Lockyer, NW of Gatton, Qld.	27°25' S 152°15' E	390	720
S. 6187*	State Forest, 349 - Corind Creek N. of Coffs Harbour, N.S.W.	30° S 153° E	145- 330	1.686
S. 6189*	Broken Bago State Forest Kendall, N.S.W.	31°31' S 152°40' E	180- 390	1.386
S. 6190	Coopernook State Forest N. of Taree, N.S.W.	31°48' S 152°38' E	30	1.206
S. 6193	State Forest, 426 Colymea, prox. Nowra, N.S.W.	34°56' S 150°30' E	60- 90	1.015
S. 6194	S.E. shore of St. Georges Basin W. of Jervis Bay, N.S.W.	35°09' S 150°39' E	0- 30	1.172
S. 6196	State Forest, 570 Broadwater, N. of Eden, N.S.W.	37°01' S 149°53' E	210	912
S. 6461	Whian Whian State Forest W. of Mullumbimby, N.S.W.	28°35' S 153°20' E	270	1.016
RC. 640	FEPASA - Serviço Florestal Rio Claro, São Paulo	22°25' S 47°33' W	612	968
RC. (1705)	FEPASA - Serviço Florestal Rio Claro, São Paulo	22°25' S 47°33' W	612	968

O número de lotes das procedências australianas são os mesmos usados pelo "Forestry and Timber Bureau, Canberra, A.C.T. - Seed Records".

R.C. - significa Rio Claro e os números referem-se aos números das árvores selecionadas no Serviço Florestal da Cia. Paulista de Estradas de Ferro (atual FEPASA).

* E. pilularis var pyriformis - recentemente descrita como espécie E. pyrocarpa L. Johnston et D. Blaxell.

O experimento foi instalado em Mogi Guaçu, longitude 47° 07' W, 22° 11' S, altitude 580 m. O solo é um latosol vermelho amarelo fase arenosa (Brasil, Ministério de Educação e Cultura, Comissão de Solos, 1960), profundo, bem drenado, de classe textural barro argilo-arenoso, ácido e de baixa fertilidade. O clima é do tipo Cwa, mesotérmico, de inverno seco (Godoy e Ortolani, sd.). A precipitação média anual é de 1.307,7 mm com ocorrência de seca de abril a setembro.

O experimento foi instalado em 1966, sendo o delineamento experimental utilizado o de blocos casualisados, compreendendo nove procedências australianas e duas de Rio Claro, com 3 repetições. As parcelas foram constituídas de 7 x 7 plantas iniciais, no espaçamento de 2,0 x 2,0 m. A linha externa de cada parcela foi considerada bordadura, ficando o número inicial de plantas úteis por parcela 25 mudas. A área total de cada parcela é de 196 m^2 e as plantas úteis ocupam uma área de 100 m^2.

O talhão foi submetido a cortes seletivos após 7 e 12 anos de plantio. As procedências de Rio Claro foram totalmente eliminadas.

Resultados

O Quadro 2 apresenta os valores médios da porcentagem de sobrevivência, do diâmetro ao nível do D.A.P., expressa em centímetros, da altura total, expressa em metros, da área basal expressa em m^2/ha, do volume expresso em m^3/ha e da densidade básica da madeira, expressa em g/cm^3, aos 5 anos de idade, segundo Pásztor (1972). Os dados referem-se à média de todas as plantas sobreviventes naquela idade.

Quadro 2 - Valores médios da porcentagem de sobrevivência, do diâmetro ao nível do D.A.P., da altura total, da área basal, do volume real da madeira com casca e da densidade básica da madeira, aos 5 anos de idade, segundo as procedências de E. pilularis Sm. (Média de todas as plantas sobreviventes)

Lote nº	Sobrevivência (%)	Diâmetro D.A.P. (cm)	Altura total (m)	Área basal m^3/ha	Volume m^3/ha	Densidade básica da madeira g/cm^3
S. 6183	77,33	12,97	15,84	25,60	162,067	0,522 ± 0,009
S. 6184	89,33	12,69	16,21	28,43	185,633	0,503 ± 0,011
S. 6187	76,00	12,18	14,49	22,09	128,600	0,517 ± 0,012
S. 6189	86,67	12,32	16,35	25,74	168,667	0,551 ± 0,015
S. 6190	85,33	12,33	14,75	25,65	152,967	0,510 ± 0,009
S. 6193	81,33	11,66	15,79	21,78	137,933	0,530 ± 0,009
S. 6194	86,67	12,28	15,82	25,69	162,567	0,516 ± 0,007
S. 6196	68,00	12,61	14,22	21,51	130,633	0,506 ± 0,009
S. 6461	80,00	12,71	14,38	25,23	144,567	0,523 ± 0,011
RC. 540	68,00	9,92	10,73	13,32	58,067	0,530 ± 0,005
RC.1705	50,67	11,76	14,34	13,99	78,867	0,536 ± 0,012

Os Quadros 3 e 4 apresentam, respectivamente, o desenvolvimento em altura total média e diâmetro médio, ao nível do D.A.P. durante 13 anos, tendo sido consideradas só as plantas remanescentes do corte seletivo, efetuado após 7 anos de plantio.

Quadro 3 - Desenvolvimento em altura total média, expressa em metros, durante 13 anos das procedências de Eucalyptus pilularis Sm.

Procedências	Idade em anos 1	2	3	4	5	6	7	8	10	11	12	13
S. 6183	5,65	10,23	12,75	15,55	18,11	18,70	18,99	23,40	24,00	25,95	27,47	30,97
S. 6184	5,56	10,28	12,92	16,33	18,66	19,52	20,15	24,08	25,59	29,27	29,69	32,81
S. 6187	4,85	9,51	12,02	15,32	18,10	18,70	19,06	23,37	24,57	28,59	28,63	34,03
S. 6189	5,86	10,52	12,63	17,08	19,82	19,98	20,97	25,60	26,28	28,14	31,24	34,43
S. 6190	6,02	10,93	13,55	16,19	18,16	18,98	19,49	25,77	24,42	29,28	29,31	32,07
S. 6193	5,27	10,05	12,56	16,18	19,03	20,11	20,46	23,90	24,71	27,60	27,77	33,00
S. 6194	4,61	9,22	12,27	15,17	17,05	18,01	18,60	23,00	25,25	27,15	27,33	29,74
S. 6196	4,40	9,41	12,70	15,87	17,85	19,02	20,00	25,10	25,22	27,20	18,18	31,28
S. 6461	5,76	10,47	12,77	15,00	16,76	18,75	19,39	24,90	25,28	27,60	28,03	30,33
RC. 504	2,75	6,17	10,00	12,68	14,43	15,23	15,38	20,50				
RC.1705	5,60	9,89	12,60	16,62	18,83	20,04	21,01	26,17				

Quadro 4 - Desenvolvimento em diâmetro médio, ao nível do D.A.P., expresso em centímetros, durante 13 anos, das procedências de Eucalyptus pilularis Sm.

Procedências	Idade em anos 1	2	3	4	5	6	7	8	10	11	12	13	*	**
S. 6183	5,0	9,1	12,3	13,7	14,8	15,4	15,9	18,0	21,6	22,2	22,3	27,6	30	14
S. 6184	4,3	8,8	11,1	13,5	14,9	15,6	16,4	19,0	21,2	22,7	22,9	26,6	27	17
S. 6187	4,0	8,1	11,4	13,8	14,9	16,1	16,8	19,4	23,6	25,3	25,3	31,7	24	10
S. 6189	4,6	8,7	10,9	13,3	15,4	15,9	16,2	17,9	20,4	21,4	22,9	26,4	24	12
S. 6190	5,0	10,0	12,3	14,4	15,7	16,4	16,8	18,9	20,8	22,8	22,8	26,9	21	11
S. 6193	4,6	8,5	10,9	13,2	14,3	15,1	15,5	18,3	20,6	21,6	21,7	27,9	24	12
S. 6194	4,0	7,5	10,0	12,5	13,1	13,8	14,3	16,9	20,2	20,7	21,4	25,4	30	15
S. 6196	4,1	8,4	11,4	13,9	15,5	16,8	17,7	20,0	22,2	24,0	24,0	27,3	18	14
S. 6461	4,8	9,2	11,9	13,9	15,4	16,3	16,8	19,3	21,6	22,4	24,4	28,8	27	13
RC. 504	2,3	5,7	9,0	11,8	13,3	13,9	14,4	16,2	-	-	-	-	12	-
RC.1705	4,6	9,8	12,6	15,7	17,3	18,5	19,4	23,1	.	-	-	-	12	-

* Número de árvores, por procedência, após o corte seletivo realizado aos 7 anos.
** Número de árvores, por procedência, após o corte seletivo realizado aos 12 anos.

Aos 12 anos após o plantio foi efetuado um novo corte seletivo para eliminação das árvores de desenvolvimento muito abaixo da média. O Quadro 5 apresenta as áreas basais atingidas pelas procedências australianas, e o número de plantas úteis remanescentes após 12 anos, como também as áreas basais e o número de plantas úteis remanescentes, aos 13 anos, um ano após o último corte seletivo.

Quadro 5 - Valores médios da área basal, expressos em m^2/ha, atingidos pélas procedências australianas de Eucalyptus pilularis Sm e número de plantas úteis remanescentes, após respectivamente 12 e 13 anos de plantio.

Lote nº	12 anos Área basal m^2/ha	12 anos Nº de plantas	13 anos Área basal m^2/ha	13 anos Nº de plantas
S. 6183	27,24	23	29,11	14
S. 6184	35,60	26	32,77	17
S. 6187	30,24	20	26,32	10
S. 6189	34,41	25	21,44	12
S. 6190	25,79	19	22,11	11
S. 6193	29,67	24	23,44	12
S. 6194	32,28	27	25,55	15
S. 6196	26,38	19	27,23	14
S. 6461	37,20	24	27,46	13

Os valores médios da área basal alcançados pelo talhão foram de 30,98 m^2/ha, aos 12 anos e 26,16 aos 13 anos, um ano após o desbaste seletivo. O número de plantas úteis caiu de 207 aos 12 anos, para 118 aos 13 anos. Os valores da altura total média do talhão passou de 28,03 m aos 12 anos, para 32,07 m aos 13 anos, e o diâmetro médio, ao nível do D.A.P., passou de 23,1 cm aos 12 anos para 27,6 cm aos 13 anos.

Discussão

Nas condições do experimento, segundo Pásztor (1972), as procedências australianas plantadas em Mogi Guaçu revelaram-se muito homogêneas. As análises de variância realizadas com os dados de cinco anos de idade, não demonstraram diferenças significativas em relação à sobrevivência, altura total, diâmetro médio e volume de madeira. A análise de covariância levada a efeito para ajustar o volume médio de madeira e sobrevivência confirmou a homogeneidade das procedências australianas. Entretanto, quando comparadas com as procedências de Rio Claro, as de origem australiana mostraram-se superiores em sobrevivência e vigor.

Dentre os lotes de sementes recebidas da Austrália, os de números S. 6187 e S. 6189 eram consideradas variedade "pyriformes" e posteriormente passaram à categoria de espécie recebendo a denominação de Eucalyptus pyrocarpa L. Jonhston et D. Blaxell.

Burgess (1973 e 1975) trabalhando com as mesmas espécies, usando 11 procedências e instalando os plantios em 8 localidades, concluiu que, em todos os locais de plantio as melhores procedências eram as de locais de mais elevado índice de qualidade (site index), tanto para o E. pilularis como para o E. pyrocarpa.

Uma avaliação fenotípica, realizada aos 5 anos de idade, nas parcelas do experimento instalado em Mogi Guaçu, revelou a superioridade das procedências S. 6183 e S. 6461 seguidas de S. 6189 (E. pyrocarpa) e S. 6194, em relação à uniformidade de desenvolvimento, padrão fenotípico de copa, ramos, desrama, baixa freqüência de plantas dominadas, de tortuosidades e de bifurcações (Pásztor, 1972).

As procedências S. 6461 de Whian Whian e S. 6189 de Broken Bago correspondem às duas das procedências de mais elevado índice de qualidade ("site index") citadas por Burgess (1975). Estas procedências juntamente com a S. 6184 e S. 6194 foram as que apresentaram maiores valores para a área basal aos 12 anos.

O talhão está sendo conduzido para produção de sementes. Devido a ocorrência contínua de morte de plantas, e à inferioridade revelada na avaliação fenotípica, as procedências de Rio Claro foram totalmente eliminadas da área. As duas procedências de E. pyrocarpa estão sendo conservadas porque na Austrália não são conhecidos híbridos entre as espécies E. pilularis e E. pyrocarpa (Burgess, 1975).

Como ocorrência anormal, estão aparecendo sintomas de anomalia fisiológica representados por cancros no tronco das árvores. O problema está sendo estudado pela Seção de Fitotecnia Parasitológica do Instituto Florestal.

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TESTE DE PROCEDÊNCIA DE *EUCALYPTUS MACULATA* HOOK — RESULTADOS DE 13 ANOS.

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Resumo

O comportamento de 13 procedências australianas de Eucalyptus maculata e de duas introduzidas por Navarro de Andrade, crescendo em hortos da antiga Companhia Paulista de Estradas de Ferro, está sendo estudado através de um experimento implantado em Mogi Guaçu, em 1966.

Os resultados obtidos após 5 anos de plantio e a evolução do crescimento em altura e diâmetro até a idade de 8 anos foram apresentados por Pásztor e Coelho (1977).

O presente trabalho apresenta a evolução do crescimento em altura e diâmetro das procedências australianas até a idade de 13 anos.

Summary

A provenance trial was established in 1966, at Mogi Guaçu, São Paulo State (47° 07' W longitude, 22° 11' S latitude, 580 m altitude) in order to analyse the growth characteristics of thirteen Australian provenances of Eucalyptus maculata and two introduced by Navarro de Andrade growing in plantations of the former Companhia Paulista de Estradas de Ferro.

The main conclusions drawn at age 5, and also the eight year progressive development in height and diameter growth of the provenances have already been described, Pásztor and Coelho (1977). The present paper gives the thirteen year progressive development in height and diameter growth of the Australian provenances.

Introdução

A espécie apresenta madeira de alta qualidade, bastante semelhante à do E. citriodora, é de alta densidade, sendo bastante usada para serraria, construções civis e cabos de ferramentas. Apresenta em geral bom desenvolvimento no Estado de São Paulo.

Materiais e Métodos

Foi instalado em Mogi Guaçu, S.P., um experimento com a finalidade de comparar o comportamento de 13 procedências de Eucalyptus maculata Hook, representando grande parte da área de ocorrência da espécie, com progênies de plantas crescendo nos hortos da antiga Companhia Paulista de Estradas de Ferro (atual FEPASA).

Os lotes de sementes representativos das procedências australianas foram recebidos do Forestry and Timber Bureau, Canberra, Austrália e as sementes da Companhia Paulista foram colhidas de duas árvores, entre as de melhor forma e crescimento.

O Quadro 1 indica a localização das procedências australianas e da Companhia Paulista, formando as latitudes, longitudes e altitudes, bem como a precipitação média das localidades.

O experimento foi instalado no município de Mogi Guaçu situado a 47° 07' de longitude oeste de Greenwich e 22° 11' de latitude sul. A altitude é de 580 m. O solo é do tipo latosol vermelho amarelo fase arenosa (Brasil, Min. Educação e Cultura, Comissão de Solos, 1960), profundo bem drenado, de classe textural barro argilo-arenoso, ácido e de baixa fertilidade. O clima é do tipo Cwa, mesotérmico de inverno seco (Godoy e Ortolani, sd). A precipitação média anual é de 1.307,7 mm com ocorrência de seca de abril a setembro.

O experimento foi instalado em 1966. O delineamento experimental utilizado foi o de blocos casualizados, compreendendo 15 procedências, sendo 13 australianas e 2 de Rio Claro, com 3 repetições. As parcelas eram constituídas de 7 x 7 plantas iniciais, no espaçamento de 2,0 x 2,0 m. A linha externa dos quatro lados de cada parcela foi considerada bordadura; o número inicial de plantas úteis por parcela foi de 25.

A área das parcelas é de 196 m^2 e as plantas úteis ocupam uma área de 100 m^2.

Anualmente foram feitas medições das plantas úteis para avaliação do crescimento em altura e diâmetro à altura do peito (D.A.P.), e anotado o número de falhas por parcela. A primeira medição foi feita um ano após o plantio.

O talhão foi submetido a cortes seletivos após 7 e 12 anos de plantio.

QUADRO 1 — Procedências de *Eucalyptus maculata* Hook

Lote	N.º	Código	Localização	Latitude e Longitude	Altitude (metros)	Precipitação média anual (milímetros)
S.	6164	"A"	State Forest Reserve, 186 Bingman, NW of Monto — Qld.	24°42' S 150°58' E	549-610	705
S.	6166	"B"	State Forest Reserve, 302 NE of Chinchilla — Qld.	26°15' S 151°00' E	396	691
S.	6167	"C"	State Forest Reserve, 12 Cherbourgh, S. of Murgon — Qld.	26°15'- 26°20' S 151°50'-151°55' E	366-396	743
S.	6168	"D"	State Forest Reserve, 809 Mt. Glorious, NW of Brisbane — Qld.	27°15' S 152°40' E	579-610	1 783
S.	6169	"E"	State Forest Reserve, 571 Barrow, Wof Southport — Qld.	27°57' S 153°22' E	122	1 366
S.	6170	"F"	Richmond Range State Forest NW of Casino, N S.W.	28°37' S 152°41' E	457	1 070
S.	6171	"G"	Southgate State Forest N. of Grafton N S.W.	29°33' S 153°01' E	46	881
S.	6172	"H"	Olney (East) State Forest NW of Wyong N S.W.	33°08' S 151°23' E	244-305	1 600-1.651
S.	6173	"I"	Currambene State Forest S of Nowra N S W	34°57' S 150°38' E	30	1 015
S.	6174	"J"	Kioloa State Forest NE of Batemans Bay N S W.	35°29' S 150°19' E	122	907
S.	6175	"K"	S. of Bermagui N S W	36°29' S 150°02' E	91	912
S.	6176	"L"	String Knob Road, Mt. Tara NW of Orbost V.	37°40' S 148°14' E	305	817
S.	6442	"M"	Timber Reserve 73033 N of Mudgee N S.W	32°13' S 149°40' E	457	610
R.C.	668	"N"	FEPASA Forest Service Rio Claro, SP — Brasil	22°25' S 47°33' W	612	968
R.C.	1007	"O"	FEPASA Forest Service Rio Claro, SP — Brasil	22°25' S 47°33' W	612	968

Os lotes S.6164 a S.6442 são de procedência australiana; R.C.668 e R.C.1007 são matrizes selecionadas em Rio Claro

Os números correspondem ao registro das procedências no Forestry and Timber Bureau, Canberra, Austrália, ou ao número do registro das matrizes selecionadas no Serviço Florestal da Cia. Paulista, em Rio Claro (FEPASA).

QUADRO 2 — Valores médios do número N de falhas, após a transformação em $\sqrt{N+0,05}$, da altura total, expressa em metros, do diâmetro ao nível do D.A.P., expresso em centímetros, da área basal, expressa em m²/parcela e do volume real, com casca, expresso em m³/parcela, em função das procedências de *Eucalyptus maculata* Hook nos cinco anos.

N.º de falhas $\sqrt{N+0,5}$		Altura total (m)		Diâmetro (D.A.P.) (cm)		Área basal m²/parcela		Volume m³/parcela	
	1% 5%		5%		5%		5%		5%
J	1,17	C	14,55	C	12,1	O	0,2042	E	1,491
K	1,34	O	14,33	O	11,6	G	0,2030	O	1,171
H	1,39	H	14,27	E	11,2	K	0,1998	C	1,148
G	1,76	E	14,26	A	10,9	C	0,1994	H	1,112
I	1,89	A	13,51	G	10,7	H	0,1960	G	1,107
D	2,00	G	13,49	H	10,4	E	0,1953	K	1,053
B	2,04	K	13,14	K	10,3	D	0,1807	J	0,904
M	2,15	M	12,87	L	10,3	J	0,1735	D	0,871
F	2,18	B	12,29	D	10,1	M	0,1670	M	0,858
E	2,41	J	12,19	M	10,1	F	0,1613	A	0,810
O	2,59	F	11,95	N	10,0	B	0,1521	F	0,759
L	2,73	D	11,57	F	10,0	L	0,1497	B	0,742
C	2,85	N	11,17	B	9,6	A	0,1462	L	0,664
A	3,11	L	11,13	J	9,4	I	0,1345	I	0,578
N	3,61	I	10,53	I	8,7	N	0,1047	N	0,516
F	**	F	n.s.	F.	n.s.	F.	n.s.	F	n.s
s	0,44	s	2,34	s	1,36	s	0,04	s	0,32
C.V.	20,0%	C.V.	18,4%	C.V.	13,1%	C.V.	15,5%	C.V.	34,4%

Os valores não incluídos num mesmo parêntesis são significativos ao nível de probabilidade indicado (Tukey). (segundo Pasztor & Coelho)

Resultados

Os resultados obtidos após 5 anos de plantio foram descritos por Pásztor (1976 e 1977) e estão resumidos no Quadro 2.

A evolução do crescimento em altura e diâmetro até a idade de 13 anos são apresentados nos Quadros 3 e 4.

As progênies de Rio Claro foram totalmente eliminadas do talhão devido a ocorrência de mortes e plantas fenotipicamente indesejáveis.

Discussão

Em relação à sobrevivência, após 5 anos de plantio, foram encontradas diferenças significativas, à níveis de 5 % e 1 % de probabilidade, entre as procedências. Em relação à sobrevivência as origens de Rio Claro estão entre as piores. Não foram encontradas, nas condições do experimento, diferenças significativas entre as médias das procedências, em relação à altura total, ao diâmetro, ao nível do D.A.P. e à área basal. Em relação ao volume real, com casca, apenas a procedência de Rio Claro (RC 688) diferiu da procedência (S. 6169), ao nível de 5 % de probabilidade, segundo Pásztor (1966 e 1967).

O talhão sofreu um corte seletivo aos 7 anos e outro aos 12 anos. Devido à ocorrência contínua de mortes e à inferioridade fenotípica verificada nas parcelas das progênies de Rio Claro, e ainda ao fato de se desejar conduzir o talhão para produção de sementes de procedência australiana, estas duas linhagens foram inteiramente eliminadas.

Estão ocorrendo sintomas de anomalia fisiológica devido à deficiência mineral, como foi constatado pela Seção de Fitotecnia Parasitológica do Instituto Florestal.

Quadro 3 Evolução do crescimento em altura total média, em metros, até a idade de 13 anos, em função das procedências de Eucalyptus maculata Hook, na região de Mogi Guaçu.

Procedências	Idade em anos												
	1	2	3	4	5	6	7	8	10	11	12	13	*	**
S. 6164	4,10	6,00	8,20	12,73	13,51	14,60	14,64	21,00	23,72	25,88	26,11	30,03	27	18
S. 6166	4,13	5,40	7,20	10,35	12,29	12,81	12,87	18,00	20,78	20,85	23,04	26,53	39	25
S. 6167	4,17	6,60	9,00	12,97	14,55	15,60	15,63	22,40	24,10	24,28	24,35	29,49	30	17
S. 6168	4,29	6,00	7,90	10,57	11,57	12,81	12,89	19,00	21,45	22,19	22,86	26,92	36	23
S. 6169	5,13	6,60	8,50	12,32	14,26	15,17	15,20	19,80	21,37	21,95	25,28	25,81	33	21
S. 6170	3,86	5,20	7,10	10,35	11,95	12,50	12,80	19,40	22,53	23,31	25,12	28,60	33	28
S. 6171	5,35	6,60	8,50	12,23	13,49	13,83	13,94	18,50	19,25	21,19	21,56	25,50	33	17
S. 6172	5,34	6,50	8,40	12,91	14,27	14,68	14,77	19,30	20,90	22,29	23,66	27,11	39	24
S. 6173	4,08	5,20	6,40	9,46	10,53	11,10	11,41	16,90	19,98	20,61	24,88	28,14	30	19
S. 6174	5,14	6,00	7,50	10,96	12,19	12,59	12,86	16,90	18,43	19,76	21,11	25,34	39	21
S. 6175	4,47	6,10	7,80	11,80	13,13	13,72	14,10	17,20	19,11	19,31	20,77	21,56	45	27
S. 6176	3,93	6,20	7,90	9,32	11,13	11,63	11,70	17,90	19,57	19,68	19,98	24,53	21	11
S. 6442	4,46	6,10	7,90	11,17	12,87	13,56	13,78	19,00	21,27	21,82	22,30	25,63	33	13
R.C. 668	3,50	5,00	7,40	10,01	11,17	11,39	11,52	15,00	16,89	16,97	19,42	-	21	7
R.C. 1007	4,11	6,60	8,80	12,26	14,33	14,85	14,92	21,60	23,99	24,16	25,89	-	27	19

(*) Número de árvores, por procedência, após o corte seletivo realizado aos 7 anos.

(**) Número de plantas, por procedência, após o corte seletivo realizado aos 12 anos.

Quadro 4 Evolução do crescimento em diâmetro, ao nível do D.A.P., em centímetros, até a idade de 13 anos em função das procedências de Eucalyptus maculata Hook, na região de Mogi Guaçu.

Procedências	Idade em anos											
	2	3	4	5	6	7	8	10	11	12	13	*	**
S. 6164	6,0	8,2	10,1	10,9	11,4	11,6	16,1	17,7	18,6	19,7	26,2	27	18
S. 6166	5,4	7,2	8,6	9,6	10,0	10,2	14,0	15,4	16,9	18,4	20,6	39	25
S. 6167	6,6	9,0	11,2	12,1	13,6	12,9	17,0	17,3	17,9	17,7	21,3	30	17
S. 6168	6,0	7,9	9,5	10,1	10,7	11,2	14,5	16,7	17,0	17,8	19,7	36	23
S. 6169	6,6	8,5	10,1	11,2	11,6	11,8	14,9	16,7	17,2	17,2	17,5	33	21
S. 6170	5,2	7,1	8,8	10,0	10,5	10,7	14,7	16,4	17,1	18,1	21,2	33	28
S. 6171	6,6	8,5	9,8	10,7	11,0	11,2	13,9	13,9	14,9	16,1	20,6	33	17
S. 6172	6,5	8,4	9,5	10,4	10,7	11,0	14,2	15,7	16,8	16,8	19,5	39	24
S. 6173	5,2	6,4	7,7	8,7	9,2	9,5	14,3	15,8	16,1	19,0	24,5	30	19
S. 6174	6,0	7,5	8,5	9,4	9,7	10,0	13,6	14,6	15,0	15,8	18,8	39	21
S. 6175	6,1	7,8	9,4	10,3	10,7	10,9	13,9	14,9	14,9	15,9	20,3	45	27
S. 6176	6,2	7,9	9,2	10,3	10,6	10,8	16,0	16,3	16,5	16,7	17,2	21	11
S. 6442	6,1	7,7	9,3	10,1	10,5	10,8	15,2	16,4	17,0	17,2	21,6	33	13
R.C. 668	5,0	7,4	8,9	10,0	10,4	10,6	15,2	16,9	16,9	16,7	-	21	0
R.C. 1007	6,6	8,8	10,5	11,6	12,0	12,2	16,9	17,1	19,3	19,9	-	27	0

(*) Número de árvores, por procedência, após o corte seletivo realizado aos 7 anos.

(**) Número de plantas, por procedência, após o corte seletivo realizado aos 12 anos.

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TESTE DE PROCEDÊNCIA DE *EUCALYPTUS* SPP.

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Resumo

Este trabalho refere-se ao estudo do DAP e altura, aos 3 anos, de 18 espécies de *Eucalyptus*, de 10 locais do Estado de São Paulo. Estão sendo apresentadas informações sobre a semente usada. Para cada local, espécie e característica analisada, são indicadas as procedências melhores classificadas e foi calculada a participação da variação genética entre procedências na variação total.

Summary

This paper deals with the study of diameter and height of 18 Eucalyptus species three years after planting in 1975, in 10 different areas of the Sao Paulo State. Information on the seeds utilized is given. For each location, species and characteristic, the best provenances are reported and the genetic contribution of the provenances in the total observed variance is calculated.

Introdução

As 18 espécies estudadas encontram-se entre as mais indicadas para o Estado de São Paulo, segundo Golfari e Pinheiro Neto (1970). O E. nitens nunca foi indicado, porém seu comportamento está sendo estudado no Parque Estadual de Campos do Jordao.

Para que seja possível a avaliação dos resultados e a obtenção de conclusões válidas para os futuros trabalhos, estão sendo apresentados dados sobre a semente e sua amostragem. Desta maneira estes dados mais os já existentes na literatura, dão completa informação sobre o material utilizado.

Na literatura existente sobre a eucaliptocultura no Estado de São Paulo, falta o estudo de procedências. Esse estudo fornece dados para, a curto prazo, aumentar a produtividade, pela indicação da melhor semente a ser utilizada.

Material e Métodos

As espécies estudadas são: E. alba, E. camaldulensis, E. citriodora, E. cloeziana, E. deanei, E. dunnii, E. maculata, E. microcorys, E. nitens, E. paniculata, E. pilularis, E. propinqua, E. punctata, E. resinifera, E. robusta, E. saligna, E. tereticornis e E. urophylla (Hall 1970).

Complementando as informações sobre as procedências envolvidas, contidas em Pires (1975) e Gurgel Filho et alii (1978), é apresentado o quadro 1.

Quadro 1: Informações sobre as procedências envolvidas.

Espécie	tratamento	nº de origem	nº de árvores envolvidas
E. alba	1	10141	1 (nº 202)
	2	10569	1
E. camaldulensis	1	6953	-
	2	6978 (697)	1
	3	7046	5
	4	9856/406	1 (nº 406)
	5	10266/1020	1 (nº 1020)
	6	10544/281	1 (nº 281)
	7	10557	1
	8	10671/333	1 (nº 333)
	9	10265/1014	1 (nº 1014)
	10	2157	-
E. citriodora	1	10268	1 (nº 1028)
	2	10530	-
	3	S/N 21161	*
	4	2874	-
E. cloeziana	1	24815	**
	2	9784/2	1 (nº 2)
	3	10269/1033	1 (nº 1033)
E. cloeziana	4	10270	10
	5	10692	1
	6	10691/1408	1 (nº 1408)
	7	S/N 25667	**
E. deanei	1	10340/1196	1 (nº 1196)
	2	10524	-
E. dunnii	1	5663	-
	2	9245	n > 1
E. maculata	1	6169	11
	2	6172	7
	3	6173	10
	4	6175	2
	5	9454	10
	6	9461	-
	7	S/N 21180	*
E. microcorys	1	6903	-
	3	7159	-
	4	S/N-22307	*
	5	E 456	-
E. nitens	1	9765	3
	3	10168	1
E. paniculata	1	S/N 24161	*
	2	2092	-
E. pilularis	1	9455	1 (nº 95)
	2	9457	1
	3	6183	11
	4	6176	-
	5	6187	-
	6	6194	-
E. propinqua	1	8718	-
	2	9460	2
	3	2724	-
E. punctata	1	8659	3
	2	9444	-
E. resinifera	1	8885	-
	2	9021	-
	3	10431	10
	4	S/N 20888	*
E. robusta	1	9427	-
	3	10176	-
	4	10273/1652	1 (nº 1652)
	6	2860	-
E. saligna	1	-	2
	2	7730	10
	3	10276	4
	4	10733	4
E. tereticornis	1	8140/3	1 (nº 3)
	2	8202/6	1 (nº 6)
	3	10245	-
	4	10263	-
	5	10732	n > 1
	6	10827	-
	7	2424	-
E. urophylla	1	9016	4
	2	10140	7
	3	10144	3
	4	10145	1
	5	10146	1
	6	———	-

(*) semente do melhor povoamento
(**) semente melhorada no Zomerkomst F.R.S., Transvaal.

A estimativa do componente residual da variância, devido à variação entre parcelas $\hat{\sigma}e^2$, a estimativa do componente da variância para as diferenças genéticas entre procedências $\hat{\sigma}p^2$ e a estimativa do componente da variância para as diferenças entre blocos $\hat{\sigma}b^2$, foram calculadas da seguinte maneira:

$$\hat{\sigma}e^2 = Q_3; \; \hat{\sigma}p^2 = \frac{Q_2 - Q_3}{B} \quad e \quad \hat{\sigma}p^2 = \frac{Q_1 - Q_3}{P}$$

sendo Q_3 o quadrado médio do resíduo, Q_2 o quadrado médio para procedências, Q_1 o quadrado médio para blocos, B o número de blocos e P o número de procedências.

Resultados

No quadro 2 são apresentados os coeficientes de variação (CV), os resultados do teste F para tratamentos (T), locais (L) e interação (I) e o percentual (P) da variação total que seria atribuída à variação genética entre procedências, valor este obtido pelas esperanças dos quadrados médios.

No quadro 3 são apresentados os resultados da aplicação do teste de Duncan.

Conclusões

Os resultados obtidos permitem as seguintes conclusões:

1. Devido a rotação curta do *Eucalyptus* usado para polpa, carvão e lenha, resultados de 3 anos são de valor para a escolha das procedências a serem empregadas em futuros reflorestamentos. Recomenda-se o estudo em idades mais avançadas, para a confirmação ou não dos resultados de 3 anos.

2. O número de árvores que forneceram semente para certas procedências, é pequeno. Mesmo assim os resultados obtidos dão uma - idéia do comportamento dessas procedências.

3. A eliminação das piores procedências e das piores árvores das melhores procedências para a transformação de cada teste em pequena área produtora de semente, é indicada com ressalvas, devido à pequena base genética envolvida. Quando apenas um indivíduo forneceu semente, apenas uma árvore superior deve ser selecionada.

4. Os coeficientes de variação indicam que os testes foram muito bem implantados e conduzidos, podendo-se confiar nos resultados. Exceção deve ser feita ao *E. saligna* em Lorena com C.V. = 44,1%.

5. Se for planejado o melhoramento das características que apresentaram F com significância para locais, como altura do *E. urophylla*, terá que ser feito um plano para cada uma das localidades envolvidas.

6. O percentual da variação total atribuída à variação genética entre procedências, mostrou um máximo de 90,3% para o DAP do *E. alba* em Itirapina.

7. Observando-se o Quadro 3, é possível indicar para cada característica, local e espécie, as procedências que conduzem à maior produção. Desta maneira somente os tratamentos 1, 9 e 5 do *E. camaldulensis* em L. Antonio apresentaram altura significativamente melhor.

8. Os dois tratamentos de *E. cloeziana* melhorados na África do Sul e os tratamentos dos melhores povoamentos sul-africanos, mostraram comportamento semelhante ao dos outros tratamentos, mostrando que o aumento de produtividade da eucaliptocultura em determinada área do estado de São Paulo, tem que se basear em um plano feito para essa região.

Quadro 2: Coeficientes de variação, resultados do teste F para tratamentos, locais e interação e percentual da variação total atribuída à variação genética entre procedências.

Espécie e local	característica	C V	T	L	I	P %
E. alba						
Assis	altura	19,1	ns	ns	**	0
	DAP	5,7	*	ns	**	0
Itirapina	altura	10,9	**	—	—	0
	DAP	9,9	**	—	—	90,3
E. camaldulensis						
Bebedouro	altura	18,7	*	ns	**	0
	DAP	20,2	ns	ns	**	0
L. Antonio	altura	10,0	**	—	—	0
	DAP	10,3	**	—	—	68,6
E. citriodora						
L. Antonio	altura	14,9	*	**	**	36,4
	DAP	16,5	ns	**	**	15,8
Manduri	altura	9,3	*	—	—	0
	DAP	14,9	ns	—	—	0
M. Guaçu	altura	5,3	**	—	—	0
	DAP	8,4	**	—	—	69,2
E. cloeziana						
Bebedouro	altura	8,9	**	—	—	46,1
	DAP	10,7	**	—	—	55,7
E. cloeziana						
L. Antonio	altura	19,3	**	—	—	19,3
	DAP	3,1	ns	—	—	53,6
E. deanei						
Avaré	altura	22,2	*	ns	ns	50,4
	DAP	19,1	**	**	ns	0
Angatuba	altura	9,7	*	—	—	42,3
	DAP	12,7	*	—	—	0
E. dunnii						
Manduri	altura	10,2	ns	*	ns	0,5
	DAP	13,1	ns	*	ns	4,1
M. Guaçu	altura	12,0	ns	—	—	0
	DAP	13,8	ns	—	—	0
E. maculata						
Angatuba	altura	23,7	ns	**	ns	16,9
	DAP	27,2	ns	**	ns	0
Avaré	altura	10,3	ns	—	—	2,0
	DAP	9,2	ns	—	—	12,1
E. microcorys						
L. Antonio	altura	5,9	ns	ns	ns	0
	DAP	8,9	ns	ns	ns	0
Manduri	altura	5,0	ns	—	—	0
	DAP	8,4	ns	—	—	0
E. nitens						
C. Jordão	altura	9,0	ns	—	—	0
	DAP	15,4	*	—	—	0
E. paniculata						
Angatuba	altura	12,7	ns	—	—	0
	DAP	12,6	ns	—	—	0
E. pilularis						
M. Guaçu	altura	12,5	*	—	—	42,5
	DAP	13,8	ns	—	—	7,3
E. propinqua						
Angatuba	altura	9,9	*	—	—	77,1
	DAP	11,7	*	—	—	75,1
E. punctata						
Avaré	altura	13,1	*	—	—	31,6
	DAP	4,3	*	—	—	56,0
E. resinifera						
Assis	altura	13,2	*	ns	ns	0
	DAP	10,5	*	*	ns	0
Itirapina	altura	14,0	*	—	—	0
	DAP	14,0	ns	—	—	19,5
E. robusta						
Avaré	altura	12,7	ns	ns	**	0
	DAP	17,0	ns	ns	ns	0
Manduri	altura	10,7	ns	—	—	0
	DAP	10,9	ns	—	—	28,1
E. saligna						
Lorena	DAP	44,1	ns	—	—	0
E. tereticornis						
M. Guaçu	altura	16,0	*	—	—	75,6
	DAP	15,8	*	—	—	78,1
E. urophylla						
Bebedouro	altura	14,1	*	**	ns	48,8
	DAP	13,3	*	ns	ns	52,3
L. Antonio	altura	14,3	*	—	—	58,1
	DAP	16,1	*	—	—	50,0

continua .....

(continuação do Quadro 2)

(CV) = coeficiente de variação
(T) = significância do teste F para tratamentos
(L) = significância do teste F para locais
(I) = significância do teste F para interação
(P) = porcentual
(ns) = não significativo
(*) = significativo a 5%
(**) = significativo a 1%

Quadro 3: Resultado da aplicação do teste de Duncan

ESPÉCIES	LOCAL	PRIMEIROS COLOCADOS COM SIGNIFICÂNCIA	
		altura	DAP
E. alba	Assis	1-2	1
	Itirapina	2	2
E. camaldulensis	Bebedouro	1-5-6-3-2-9-8-4	5-6-1-3-7-9-8-2-4
	L. Antonio	1-9-5	9-5-1-6-8
E. citriodora	L. Antonio	1-4-3	1-4-3
	Manduri	4-1	4-1-2-3
	M. Guaçu	1-4	4-1
E. cloeziana	Bebedouro	6-7	6
	L. Antonio	3-2	3-7-2-6
E. deanei	Avaré	1	1
	Angatuba	1	1
E. dunnii	Manduri	1-2	1-2
	M. Guaçu	1-2	1-2
E. maculata	Angatuba	1-2-5-3-6-7-4	1-5-7-3-2-4-6
	Avaré	5-3-1-2-7-6-4	5-7-1-2-6-3-4
E. microcorys	L. Antonio	1-5-4	1-3-4-5
	Manduri	1-5-4	1-3-4-5
E. nitens	C. Jordão	1-3	3
E. paniculata	Angatuba	1-2	1-2
E. pilularis	M. Guaçu	2-5-3-4-6	2-5-4-3-6-1
E. propinqua	Angatuba	1-2	1-2
E. punctata	Avaré	2	2
E. resinifera	Assis	1-2	1-2
	Itirapina	1-2	1-2
E. robusta	Avaré	6-1-3-4	1-6-3-4
	Manduri	3-4-1-6	1-4-3-6
E. saligna	Lorena		5-1-2-3-4
E. tereticornis	M. Guaçu	1-5-4	1-5-4
E. urophylla	Bebedouro	4-6-2-5-1	6-4-1-2-5
	L. Antonio	4-6-1-2	6-1-4-2

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TESTE DE PROCEDÊNCIA DE *EUCALYPTUS CAMALDULENSIS* DEHN. NA REGIÃO DO NORDESTE SEMI-ÁRIDO BRASILEIRO.

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Resumo

Relata-se experimento conduzido no Centro de Pesquisa Agropecuária do Trópico Semi-Árido (CPATSA); da Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), como parte do Programa Nacional de Pesquisa Florestal (PNPF), cujo objetivo é selecionar procedências de E. camaldulensis Dehnh de maior desenvolvimento e melhor adaptados a região semi-árida do Nordeste Brasileiro.

Estão sendo testados dez procedências de Eucalyptus camaldulensis Dehnh dos estados australianos de Queensland, Western Austrália e Northern Territory e raças locais de Eucalyptus grandis W. Hill ex Maiden e Eucalyptus urophylla S.T. Blake, provenientes de São Paulo - Brasil.

Os resultados obtidos aos seis meses mostram em ordem decrescente um maior crescimento em altura, para as procedências de Cooktown, N. Chillagoe, W. Dimbulah, Gilbert River estado de Queensland e N. Beverly estado de Western Austrália. A sobrevivência nesta idade foi de 100% para todos os tratamentos, à exceção da procedência de S.W. Katherine de Northern Territory com 98%.

Aos 12 meses, destacou-se no crescimento em altura além das anteriores, a procedência de Agnew RD do Western Austrália. A sobrevivência de E. grandis e E. urophylla entretanto diminuíu para 77% e 89% respectivamente, ao final da estação sêca.

Summary

Ten Australian provenances of Eucalyptus camaldulensis (from the States of Queensland, Western Australia and Northern Territory) were tested in the northeast semi-arid region of Brazil. A local race of E. grandis and E. urophylla were included for comparison.

The work was carried out at the Agricultural and Livestock Research Centre for the Brazilian Semi-Arid Tropics (CPATSA/EMBRAPA) as part of the National Forest Research Program (PNPF), with the objective of selecting provenances of E. camaldulensis well adapted to this region.

Results for height and survival at six months and one year after planting are presented. Significant differences in height between provenances were obtained. After one year four of the five Queensland provenances were the tallest and the two Northern Territory provenances the shortest, but survival was uniformly high (98 - 100%).

Height of E. grandis and E. urophylla was similar to that of the shortest E. camaldulensis provenances and their survival was much poorer (77% and 89% respectively).

INTRODUÇÃO

O Nordeste semi-árido Brasileiro é uma região que apresenta grandes variações edafo-climáticas, com uma área de aproximadamente 600.000 Km^2, com solos marginais impróprios a agricultura, cobertos por um tipo de vegetação denominada caatinga que se caracteriza por um baixo volume de madeira. Assim, Lima et al (1979) constataram um volume médio de 11,9 m^3 de madeira por hectare, na região de Santa Maria da Boa Vista - PE.

Considerando-se que o *E. camaldulensis* tem sido plantado com sucesso em regiões semi-áridas de Israel e países do Norte da África, Hall et. al (1970), e que ocorre em regiões de baixa precipitação e solos salinos na Austrália, segundo Golfari e Caser (1977), prevê-se ser essa espécie aquela de maior potencial para a região semi-árida do Nordeste. Por outro lado, a procedência desta espécie de Petford (6953), norte do estado de Queensland-Austrália, apresenta grande potencial para regiões de clima tropical como na Zâmbia e Madagascar, segundo Lacaze (1977). Testes realizados com esta procedência nas duas localidades referidas, apresentaram aos 4 anos de idade alturas de 5,60 m e 9,80 m respectivamente.

O presente trabalho tem como objetivo selecionar procedências de *E. camaldulensis* Dehnh, para reflorestamento do Nordeste semi-árido do Brasil.

MATERIAL E MÉTODOS

Este experimento foi instalado no campo Experimental do CPATSA, em Petrolina - PE, em março de 1979. Trata-se de local que apresenta clima tropical muito árido, segundo Hargreaves (1974), com um período sêco bastante prolongado. A precipitação média anual varia de 250 a 550 mm, com chuvas ocorrendo normalmente no período de fevereiro a maio, segundo Golfari e Caser (1977). A temperatura média anual é de 24° C. O solo é do tipo latossol vermelho amarelo, segundo classificação de Pereira e Souza (1968).

O delineamento adotado foi de blocos ao acaso, com doze tratamentos, constituidos por dez procedências de *E. camaldulensis* da Austrália, conforme tabela 1, uma de *E. grandis* e uma de *E. urophylla* de São Paulo - Brasil, sendo estas duas utilizadas como referência. As parcelas são lineares, de seis plantas, em oito repetições, com uma bordadura geral simples para todo o experímetro. O espaçamento utilizado foi de 3 m entre linhas e 2 m entre plantas na linha.

O preparo do terreno para plantio consistiu em uma aração seguida por gradagem cruzada. As covas foram feitas com enxada manual. No ato do plantio, aplicou-se 120 g de fertilizante de fórmula 5-14-3 por cova, misturado ao solo. Após o plantio as mudas foram irrigadas uma única vez com 3 litros de água por cova.

Registrou-se a altura e sobrevivência das plantas aos 6 e 12 meses de idade. Para a medição da altura aos 6 meses utilizou-se uma trena de aço graduada em centímetros e aos doze meses, uma escala de madeira graduada em decímetros.

Registrou-se também a precipitação mensal ocorrida no local até 12 meses de idade.

RESULTADOS E DISCUSSÃO

Pela tabela 2 constata-se que aos 6 meses as procedências de Cooktown (8214), N. Chillagoe (10912), W. Dimbulah (12140), Gilbert River (10923), estado de Queensland - Austrália e N. Beverly (10550), estado de Western Austrália, apresentaram um desenvolvimento em altura superior as demais não diferindo estatísticamente entre elas, destacando-se porém a procedência de Cooktown - QLD com uma altura de 1,73 m. A sobrevivência foi de 100% para todos os tratamentos, à exceção da procedência de S.W. Katherine - NT com 98%.

Aos 12 meses de idade, a procedência de Agnew RD-WA (9856) coloca-se junto aquelas que se destacaram aos 6 meses conforme se pode verificar na tabela 3. Esta procedência, juntamente com a de Gilbert River - QLD (10923), foram as que apresentaram maior índice de crecimento, equivalente a 20 cm/mês. Verificou-se queda na sobrevivência de *E. grandis* e *E. urophylla* para 77% e 89% respectivamente.

A mortalidade ocorrida nas duas espécies referidas provavelmente se deva ao fato de as mesmas requererem precipitações elevadas e com distribuição uniforme, tendo demonstrado não tolerar períodos sêcos prolongados. Essas espécies de elevado interesse para o reflorestamento em outras regiões do país atuaram como referência no presente trabalho. A tabela 4 mostra a precipitação registrada no local de experimentação do plantio até os 12 meses de idade.

As precipitações registrdas durante o período de 12 meses, podem ser consideradas como equivalentes às normais, da região, conforme tabela 5.

CONCLUSÕES

- As procedências de *E. camaldulensis* testadas neste ensaio apresentaram alta taxa de sobrevivência, na região semi-árida do Nordeste, até os 12 meses de idade.

- O *E. grandis* e *E. urophylla* apresentaram sobrevivência de 100% aos 6 meses, porém ao término do período sêco a mesma caiu para 77% e 89% respectivamente.

- A procedência de *E. camaldulensis* de Cooktown-QLD foi a que apresentou maior crescimento em altura aos 6 e 12 meses de idade, apesar de não diferir estatísticamente das de W. Dimbulah, Gilbert River estado de Queensland e N. Beverly e Agnew RD de Western Austrália.

- Entre as espécies estudadas, as mais promissoras são as originárias do norte do estado de Queensland, de regiões situadas entre as latitudes de 16º 10'S e 17º 10'S, conforme pode-se ver pelas tabelas 2 e 3.

TABELA 1 - Dados de E. camaldulensis Dehnh, E. Granadis W. Hill ex Maidern e E. urophylla S.T. Blake, componentes do ensaio.

TRATAMENTOS	ESPÉCIES	CÓDIGO AUSTRALIANO	ALTITUDE (m)	LATITUDE	LONGITUDE	ORIGEM
01	E. Camaldulensis	9856	490	28°45'	121°14'	AGNEW RD. - W.A.
02	E. Camaldulensis	10544	61	17°23'	124°45'	LENNARD RIVER - W.A.
03	E. Camaldulensis	10533	30	15°00'	131°07'	VITORIA RIVER - N.T.
04	E. Camaldulensis	10510	180	14°37'	132°07'	S.W. KATHERINE -N.T.
05	E. Camaldulensis	10023	30	17°10'	141°45'	GILBERT RIVER - QLD
06	E. Camaldulensis	12140	450	17°08'	144°59'	W. DIMBULAH - QLD
07	E. Camaldulensis	10550	340	16°34'	125°34'	N. OF BEVERLY - W.A.
08	E. Camaldulensis	10912	335	17°03'	144°32'	N. CHILLAGOE - QLD
09	E. Camaldulensis	10924	30	16°43'	142°00'	WYABBA CK - QLD
10	E. Camaldulensis	8214	427	16°10'	144°50'	KOOKTOWN - N. QLD
11	E. Grandis	-	-	-	-	SÃO PAULO - BR
12	E. Urophylla	-	-	-	-	SÃO PAULO - BR

Tabela 2 - Altura média e sobrevivência no campo, de E. camaldulensis, E. grandis e E. urophylla aos seis meses de idade.

ESPÉCIE	ORIGEM	COD. AUSTRALIANO	ALTURA MÉDIA(m) E ERRO PADRÃO*	SOBREV. (%)
E. camaldulensis	Cooktown - QLD	8214	1,73± 0,06 a	100
E. camaldulensis	N. Chillagoe - QLD	10912	1,73± 0,08 a	100
E. camaldulensis	W. Dimbulah - QLD	12140	1,67± 0,10 ab	100
E. camaldulensis	Gilbert River - QLD	10923	1,60± 0,07 abc	100
E. camaldulensis	N. Bervely - WA	10550	1,58± 0,06 abc	100
E. camaldulensis	Lennard River - WA	10544	1,37± 0,04 bcd	100
E. camaldulensis	Wyabba ck - QLD	10924	1,37± 0,03 bcd	100
E. camaldulensis	Agnew RD - WA	9856	1,32± 0,06 cd	100
E. camaldulensis	Vitória River - NT	10533	1,25± 0,11 dec	100
E. camaldulensis	S.W. Katherine - NT	10510	1,25± 0,04 dec	98
E. urophylla	São Paulo - BR	-	1,18± 0,07 dec	100
E. grandis	São Paulo - BR	-	1,02± 0,07 e	100

* Dados seguidos de uma mesma letra, numa mesma coluna, não diferem entre si, pelo teste de Tukey (P>0,05).

Tabela 3 - Altura média e sobrevivência no campo, de E. camaldulensis, E. grandis e E. urophylla aos doze meses de idade.

ESPÉCIE	ORIGEM	CÓD. AUSTRALIANO	ALTURA MÉDIA(m) E ERRO PADRÃO*	SOBREV. (%)
E. camaldulensis	Cooktown - QLD	8214	2,9± 0,09 a	100 a
E. camaldulensis	N. Chillage - QLD	10912	2,8± 0,11 ab	100 a
E. camaldulensis	W. Dimbulah - QLD	12140	2,8± 0,17 ab	100 a
E. camaldulensis	Gilbert River - QLD	10923	2,8± 0,09 ab	100 a
E. camaldulensis	N. Beverly - WA	10550	2,7± 0,07 ab	100 a
E. camaldulensis	Agnew RD - WA	9856	2,5± 0,08 abc	100 a
E. camaldulensis	Lennard River - WA	10544	2,4± 0,06 bc	100 a
E. camaldulensis	Vitoria River - NT	10533	2,4± 0,16 bc	100 a
E. camaldulensis	Wyalba CK - QLD	10924	2,3± 0,08 bc	100 a
E. camaldulensis	S.W. Katherine - NT	10510	2,0± 0,08 c	98 ab
E. camaldulensis	São Paulo - BR	-	2,1± 0,11 c	77 c
E. urophylla	São Paulo - BR	-	2,1± 0,08 c	89 b

* Dados seguidos de uma mesma letra, numa mesma coluna, não diferem entre si, pelo teste de Tukey (P>0,05).

Tabela 4 - Precipitação mensal (mm) registrada até os 12 meses de idade do plantio*

Meses Anos	Jan.	Fev.	Mar.	Abr.	Mai.	Jun.	Jul.	Ago.	Set.	Out.	Nov.	Dez.	TOTAL
1979	-	-	28,3	118,4	18,4	16,5	5,0	0,0	2,7	0,6	51,5	54,8	298,2
1980	186,0	201,3	-	-	-	-	-	-	-	-	-	-	387,3
													685,5

* Dados coletados em um posto meteorológico a 5 Km da área experimental.

Tabela 5 - Precipitação mensal (mm) do período de 1970 a 1979 *

Meses Anos	Jan.	Fev.	Mar.	Abr.	Mai.	Jun.	Jul.	Ago.	Set.	Out.	Nov.	Dez.	TOTAL
1970	106,6	4,6	48,3	7,5	0,0	0,7	2,6	4,8	0,0	28,0	71,9	90,7	365,7
1971	28,7	50,2	107,4	185,0	3,1	0,9	2,1	8,0	24,8	11,1	12,9	15,3	449,5
1972	76,7	59,4	219,9	88,5	5,1	8,7	0,0	0,0	0,0	2,8	0,0	118,5	579,6
1973	26,7	10,9	229,4	101,6	38,5	12,4	13,5	16,4	-	2,0	13,3	72,3	537,0
1974	53,2	179,0	161,5	270,7	43,7	10,2	4,2	5,9	0,0	5,1	74,2	143,7	951,4
1975	68,9	73,9	215,3	148,7	7,9	17,2	58,2	1,2	4,0	14,7	-	29,2	639,2
1976	18,0	110,6	8,5	12,3	0,0	0,0	0,0	0,5	9,5	50,5	139,9	5,6	710,8
1977	131,8	27,8	123,3	86,3	44,8	171,1	11,3	4,1	22,4	0,0	31,5	84,5	584,9
1978	22,2	315,8	91,3	96,9	103,9	8,4	1,4	0,0	0,0	0,0	42,2	12,2	694,3
1979	118,1	96,4	28,3	118,4	18,4	16,5	5,0	0,0	2,7	0,6	51,5	54,8	510,7

* Dados coletados em um posto meteorológico a 5 Km da área experimental.

APENDICE

I. ANÁLISE DE VARIÂNCIA DOS RESULTADOS

1.1. - Altura aos 6 meses de idade (m)

FONTE DE VARIAÇÃO	G.L.	QM	F
Tratamentos	11	0,42179	14,31**
Blocos	7	0,14071	4,77**
Erro	77	0,02947	-
TOTAL	95		

** = altamente significativo (P<0,01)

CV = 12%

1.2. - Altura aos 12 meses de idade (m)

FONTE DE VARIAÇÃO	G.L.	QM	F
Tratamentos	11	0,83200	9,24**
Blocos	7	0,06660	0,74**
Erro	77	0,09001	-
TOTAL	95		

** = altamente significativo (P<0,01)

CV = 12%

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RESULTADOS PRELIMINARES DE ENSAIOS DE PROCEDÊNCIA DE *EUCALYPTUS SPP.* L'HERIT NO SUDESDE DO PARANÁ-BRASIL.

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Resumo

No ano 1976 foram implantados 4 ensaios de procedência com 8 espécies e 29 procedências de Eucalyptus spp. nas localidade de Rio Negro e Irati no Estodo do Paraná. As espécies testadas foram: E. dalrympleana, E. deanei, E. delegatensis, E. gunnii, E. nitens, E. regnans, E. st. johnii e E. viminalis, todas de procedência australiana. Foram testadas também 2 procedências brasileiras de E. viminalis: a) Canela(RS) e b) Rio Negro(PR). Após o primeiro ano de observação as 2 procedências brasileiras apresentaram o melhor equilíbrio entre sobrevivência e crescimento em ambos os locais. Porém em Rio Negro o E. viminalis (S8923) de Penola Reserve (South Australia) apresentou sobrevivência ainda superior às procedências brasileiras.

PRELIMINARY RESULTS OF PROVENANCE TESTS WITH *EUCALYPTUS SPP.* L'HERIT. in South-East of Paraná-Brazil.

In 1976 four provenance tests including 8 species and 29 provenances were carried out in Rio Negro and Irati, State of Paraná. Seeds from Australian sources were: E. dalrympleana, E. deanei, E. delegatensis, E. gunnii, E. nitens, E. regnans, E. st. johnii and E. viminalis. Seeds from Brazilian sources were E. viminalis from Canela (State of Rio Grande do Sul) and from Rio Negro (State of Paraná). After the first year of observation the Brazilian provenances showed the best homogeneous survival and growth throuthout the 4 tests. However, E. viminalis (S 8923) from Penola Reserve (South Australia) showed in one test at Rio Negro an even better survival and growth than the local provenances.

Introdução

Decorrente da acelerada devastação florestal do Sul do Brasil, em especial do Paraná, nas últimas décadas, houve a necessidade de implantar florestas de rápido crescimento para garantir o abastecimento das indústrias já implantadas, com matéria prima e oferecer perspectivas de suprimento satisfatório às futuras empresas que venham a se instalar na região.

A grande adaptabilidade dos Pinus spp e dos Eucalyptus spp faz com que estes sejam os dois gêneros mais utilizados em grande escala, entre todos aqueles introduzidos até agora no Brasil (JACOBS, 1973). Sobre isto GOLFARI (1974) observa, que as coníferas predominam na região temperada sul e os eucaliptos na região subtropical do Brasil. Esta distribuição não se deve segundo GOLFARI (1974) às limitações ecológicas, porque existem espécies de ambos os gêneros adaptáveis às duas regiões, mas sim, à falta de conhecimento dessas outras espécies. Entre as espécies de eucaliptos mais utilizados na região sul, encontram-se o E. grandis e E. saligna no Estado de São Paulo e o E. viminalis no Estado do Paraná, Santa Catarina e Rio Grande do Sul (GOLFARI & PINHEIRO NETO, 1970).

Considerando que a demanda atual de madeira no Brasil encontra-se orientada principalmente para a produção de polpa e papel e, ultimamente em forma crescente também para fins energéticos, as espécies de rápido crescimento, em especial os eucaliptos, são indispensáveis para resolver as necessidades do mercado. Porém, nem todas as espécies do gênerp Eucalyptus apresentam a mesma adaptação às diferentes condições onde são introduzidas, pois o ambiente da origem da espécie deve corresponder dentro de certos limites ao ambiente de introdução.

O problema da adaptação tem recebido só no último decênio, uma merecida atenção, pois foi nos anos 70 que no Brasil as empresas particulares, o Instituto Brasileiro de Desenvolvimento Florestal (IBDF) e o Projeto de Desenvolvimento e Pesquisa Florestal (PRODEPEF) estabeleceram testes de procedência com várias espécies de eucaliptos. Tendo em vista esta falta de conhecimento das espécies e procedências mais adaptáveis às condições locais do sul do Brasil, o presente trabalho teve como objetivo selecionar entre oito espécies de eucaliptos (E. dalrympleana, subsp. dalrympleana Maiden, E. deanei Maiden, E. delegatensis R.T. Baker, E. gunnii Hook.F., E. nitens Maiden, E. regnans F. Muell., E. st. johnii (R.T.Baker) R.T. Baker e E. viminalis Labill.) e 27 procedências de quatro Estados e um Território da Austrália (New South Wales, Victoria, South Australia, Tasmania e Australian Capital Territory), além de duas procedências brasileiras (E. viminalis de Canela e Rio Negro), as espécies e procedências mais adaptáveis em 2 locais do Sudeste do Paraná (Rio Negro e Irati), representativos das regiões 1 e 2 de GOLFARI (1970) respectivamente.

Material e Métodos

Procedências

As características geográficas da origem das sementes das 29 procedências de 8 espécies de Eucalyptus experimentadas no campo, encontram-se no quadro 1. As condições meteorológicas dos locais de origem das procedências testadas são descritas no quadro 2. Nestes quadros se observa que as temperaturas mínimas absolutas dos locais das procedências australianas são menores que a dos locais de ensaio e que o número de geadas nos respectivos locais de origem é muito superior àquelas de Rio Negro e Irati. Cabe notar que, além do aspecto da resistência contra o frio e geadas, tomou-se o cuidado de selecionar procedências que habitem locais nos quais a amplitude entre as médias máximas do mês mais quente e as médias mínimas do mês mais frio sejam semelhantes àquela de Rio negro e Irati. Igualmente foram consideradas na seleção as coordenadas geográficas e características ecológicas das procedências. As sementes das procedências autralianas (nº 1-20 e

23-29) foram fornecidas pelo Forestry and Timber Bureau de Camberra, A.C.T. O primeiro grupo (nº 1-20) foi recebido pelo Curso de Engenharia Florestal da Universidade Federal do Paraná. As sementes do segundo grupo (nº 23-29) foram recebidas pelo PRODEPEF o qual cedeu uma parte de suas mudas para serem incluidas nos ensaios deste trabalho e servir de complementação às pesquisas implantadas no Sul do Brasil por FISHWICK (1976). As sementes das procedências brasileiras que serviram como testemunhas e para as bordaduras foram as de nº 21 e 22, obtidas de povoamentos localizados em Canela (Rio Grande do Sul) e Rio Negro (Paraná) respectivamente e originárias de antigas introduções de sementes de E. viminalis da Australia, cuja origem exata é desconhecida.

QUADRO 1: Procedência do Eucalyptus spp. e as coordenadas geográficas do lugar de origem das sementes

Nº	Espécies	Código da Proced.	Lugar	Estado	Lat.S	Long.E	Alt(m)
1	E.dalrympleana	S 8847	Vulcan State For. 33 km ao sul de Oberon	N.S.W.	33º58'	149º40'	1219
2	E.dalrympleana	S 9988	825 m ao NE a cima de Ben Nevis	Tas.	41º24'	147º38'	914
3	E.delegatensis	S 9984	E.F.P. 865, Tasmanian Board Mills Consession, 8km ao ESE de Fingal	Tas.	41º36'	148º04'	518
4	E.delegatensis	S 9989	825 m ao NE a cima de Ben Nevis	Tas.	41º24'	147º38'	945
5	E.nitens	S10167	Barnawall Plain, Taggerty	Vic.	37º22'	145º56'	1170
6	E.regnans	S 8766	My Lloyd, perto de Maydena Meteor. Station	Tas.	42º49'	146º57'	610
7	E.st.johnii*	S 9540	Warrenbayne S.F. ao SO de Benalla	Vic.	36º46'	145º52'	580
8	E.st.johnii*	S 9541	Toombillup area ao NE de Mansfield	Vic.	37º03'	146º20'	850
9	E.st.johnii*	S 9574	Nullo Mt, 32km ao leste de Rylstone, Central Tablelands	N.S.W.	33º00'	150º00'	950
10	E.st.johnii*	S10115	Wee Jasper District, Southern Highlands	N.S.W.	35º09'	148º42'	910
11	E.viminalis	S 7470	23km ao leste de Inverell	N.S.W.	29º45'	151º20'	762
12	E.viminalis	S 8419	Bondi St.For., 22km ao sul de Bombala	N.S.W.	37º08'	149º11'	853
13	E. viminalis	S 8630	Nullo Mt.S.F. 460,20km ao leste de Rylstone Central Tablelands	N.S.W.	32º55'	150º20'	1067
14	E.viminalis	S 8839	Encostas de Mt. Canobolus,13km ao SSO de Orange	N.S.W.	33º50'	149º03'	991
15	E.viminalis	S 8899	Cann River Area, Swampy Flat, Thurra Road, Cape Everard	Vic.	37º45'	149º15'	9
16	E.viminalis	S 8905	Warburton, perto de Halesville Met. Station	Vic.	37º45'	145º42'	122
17	E.viminalis	S 8923	Penola Reserve, 1,65km ao NE de Penola Forest	S.A.	37º24'	140º50'	62
18	E.viminalis	S 8974	Wombat Road, 8km de H.Q. Brindabel. Range	A.C.T.	35º39'	148º28'	1189
19	E.viminalis	S 9167	Cathcart, perto de Bombala Met. Station	N.S.W.	36º50'	149º30'	762
20	E.viminalis	S 9393	Billapaloola, Tumut Area	N.S.W.	35º20'	148º25'	792
21	E.viminalis	CÂNELA	Flor.Nac.de Canela	R.G.S.	29º00'	50º30'W	920
22	E.viminalis	R.NEGRO	Est.Peq.Flor.de R.Negro	Paranã	26º00'	49º40'W	800
23	E.deanei	S 7785	Norte de Windsor	N.S.W.	32º55'	150º33'	300
24	E.delegatensis	S9991	Maggs Mountain, 50km ao SO de Deloraine	Tas.	41º45'	146º11'	884
25	E.delegatensis	S10068	Plateau Road, Tas.St. For. Taranna	Tas.	43º04'	147º55'	300
26	E.gunnii	S 9999	Clarence River	Tas.	42º07'	146º19'	732
27	E.st.johnii*	S 9539	Flagstaff Road, Stanley, perto de Beechworth	Vic.	36º11'	146º40'	580
28	E.viminalis	S 9438	Forest Lands St. For., aprox.33km ao SE de Tenterfield	N.S.W.	29º03'	152º01'	1100
29	E.viminalis	S 9986	E.F.P.865, Tas. Board Mil.Conces. 8km ao ESE de Fingal	Tas.	41º36'	148º04	518

Fonte: HALL (1972); e Seed Records - Forestry and Timber Bureau (1974)

* E. st. johnii = E. globulus subsp. bicostata

QUADRO 2: Procedência de Eucalyptus spp. e as características climáticas do lugar de origem das sementes

Nº	Espécie	Código da Proced.	Méd.max. mês mais quen. (ºC)	Méd.min. mês mais frio (ºC)	Temp.min. absoluta (ºC)	Freq. geadas* (dias/ano)	Prec. total anual (mm)
1	E.dalrympleana	S 8847	23.3	9.1	-2.9	10.9	1350.5
2	E.dalrympleana	S 9988	15.6	-1.7	-12.2	145	820.7
3	E.delegatensis	S 9984	22.2	2.9	-6.7	23	766.6
4	E.delegatensis	S 9989	15.6	-1.7	-12.2	145	820.7
5	E.nitens	S10167	-	-	-	-	1341.1
6	E.regnans	S 8766	21.6	0.9	-4.4	68	1229.4
7	E.st.johnii	S 9540	31.3	3.4	-3.9	8.7	666.0
8	E.st.johnii	S 9541	29.6	0.2	-	-	706.4
9	E.st.johnii	S 9574	31.2	1.3	-9.4	30.4	657.6
10	E.st.johnii	S10115	25.2	-3.7	-12.8	184	1304.3
11	E.viminalis	S 7470	30.8	0.2	-10.0	61.1	730.8
12	E.viminalis	S 8419	22.8	-2.8	-10.7	122.3	939.8
13	E.viminalis	S 8630	31.4	1.4	-9.4	30.4	609.6
14	E.viminalis	S 8839	28.9	-0.4	-11.1	63.4	800.6
15	E.viminalis	S 8899	24.7	3.6	-3.3	8	816.6
16	E.viminalis	S 8905	25.1	3.9	-3.9	-	1007.6
17	E.viminalis	S 8923	24.7	4.7	-4.7	80	661.2
18	E.viminalis	S 8974	24.7	-3.6	-12.8	184	1298.7
19	E.viminalis	S 9167	25.0	-1.1	-10.0	72.4	668.8
20	E.viminalis	S 9393	-	-	-	-	1310.6
21	E.viminalis	CANELA	26.8	6.4	-2.2	-	1600.0
22	E.viminalis	R.NEGRO**	27.1	7.2	-5.5	5	1337.0
23	E.deanei	S 7785	-	-	-	-	-
24	E.delegatensis	S 9991	22.3	0.9	-7.0	68	960.1
25	E.delegatensis	S10068	-	-	-	-	771.4
26	E.gunnii	S 9999	-	-	-	-	-
27	E.st.johnii.	S 9539	27.4	2.8	-4.4	14.6	920.2
28	E.viminalis	S 9538	27.5	1.2	-7.8	38.9	839.2
29	E.viminalis	S 9986	22.2	2.9	-6.7	23	766.6

* Baseado em 0ºC.

** Dados de 1946/61, exceto Temp. min. absoluta de 1975.

Fonte: HALL (1972), Seed Records - Forestry and Timber Bureau (1974), e MAACK (1968).

Locais dos ensaios

A pesquisa foi desenvolvida em 2 locais diferentes no Sudeste do Estado do Paraná: Estação de Pesquisas Florestais de Rio Negro da Universidade Federal do Paraná no município de Rio Negro e, na Floresta Nacional de Irati do IBDF no município de Teixeira Soares. As características geográficas e ecológicas destes locais são (RESTREPO, 1978):

	Rio Negro	Irati
1) latitude	26º00'	25º30'
2) longitude	49º40'	50º30'
3) altitude	800 m.s.n.m.	885 m.s.n.m.
4) Classificação climática		
- GOLFARI & PINHEIRO NETO (1970)	região 2	região 1
- Koeppen	Cfb	Cfb
5) topografia	plana	declivoso
6) drenagem	boa	boa
7) sitio	med.fertil,úmido	pobre,seco

Os dados meteorológicos anuais de ambos os locais durante o período de observação estão contidos no quadro 3. Neste pode-se observar que no ano 1976/77 as temperaturas mínimas chegaram a - 3,5°C em Rio Negro e - 2,2°C em Irati e as máximas a 36,5°C e 32°C respectivamente. Em ambos os locais as chuvas foram bem distribuidas e maiores que em anos normais. Ambos locais caraterizam-se por ausência de deficiência hídrica (GOLFARI et al., 1978).

Quadro 3: Dados meteorológicos gerais nos dois locais de ensaio entre 1º de janeiro de 1976 e 30 de junho de 1977.

	Local e ano			
	Rio Negro		Irati	
Parâmetro	1976	1977 (1º sem.)	1976	1977 (1º sem.)
Temperatura mínima absoluta (°C)	-3,5	0,5	-2,2	- 0,1
Temperatura máxima absoluta (°C)	35,0	36,5	31,0	32,0
Média temps.míns.mês mais frio (°C)	5,53	9,23	8,5	9,4
Média temps.máxs.mês mais quen.(°C)	30,06	32,86	26,5	29,6
Média temperaturas mínimas (°C)	11,82	15,19	12,38	14,18
Média temperaturas máximas (°C)	24,56	27,94	22,78	24,68
Nº dias temperatura < 0°C	5	0	4	1
Nº dias temperatura < 2°C	24	4	12	3
Temperatur média compensada* (°C)	17,28	20,27	16,63	18,38
Temperatura média solo 40cm (°C)	21,14	21,01	19,08	19,66
Umidade relativa média (%)	63,31	66,17	80,75	83
Precipitação total (mm)	1744,5	976,91	1900,0	808,3
Nº dias sem chuva	245	114	295	142
Precipitação máxima 24 horas (mm)	65,3	57,6	78,2	68,8

*Temperatura média compensada = (temp. 7h + 14h + 2 x 21h) / 4

Instalação dos ensaios

Tendo em vista o escasso nº de mudas de certas procedências, decorrente das baixas faculdades de germinação das sementes, obtou-se pela implantação de ensaios separados com nº de mudas diferentes, porém igual dentro de cada ensaio. O delineamento experimental obdeceu, nos 4 ensaios, ao de blocos casualizados completos com 4 repetições:

Ensaio 1: 21 procedências c/5 mudas/parcela - Rio Negro (mudas formadas em Rio Negro - UFPr)

Ensaio 2: 6 procedências, c/20 mudas/parcela - Rio Negro (Mudas formadas em Rio Negro - UFPr)

Ensaio 3: 9 Procedências, c/9 mudas/parcela - Rio Negro (Mudas formadas em Três Barras - PRODEPEF)

Ensaio 4: 12 procedências, c/5 mudas/parcela - Irati (mudas formadas em Rio Negro - UFPr)

Tinha-se como hipótese, além das usuais neste tipo de experimento, que caso os resultados de uma mesma procedência fossem semelhantes em dois ensaios com diferente nº de plantas por parcela, seria permissível confiar nos dados do ensaio com menor número de plantas por parcela para todas as procedências, ainda que algumas delas não estivessem incluídas no ensaio com maior número de plantas por parcela.

Análises estatísticas

A sobrevivência foi analisada pelo método de Qui Quadrado (x^2), primeiro em conjunto por ensaio e logo entre as procedências. A altura e o diâmetro do colo foi submetida a uma análise de variância e logo no caso dos Ensaios 1,3 e 4 ao teste de Bertlett e ao teste t de Student e, no caso do ensaio 2 ao teste de Duncan (STEEL & TORRIE, 1960). Na análise de altura e diâmetro foram consideradas só aquelas procedências que tinham pelo menos 3 repetições com mudas (aquelas que tinham as 4 parcelas com plantas, eliminou-se a menos representativa.

Resultados

No Quadro 4 pode-se observar que na comparação das médias entre espécies, o E. gunnii apresenta a maior sobrevivência e o E. viminalis apresenta a 2ª sobrevivênia mais alta porém com o coeficiente de variação mais baixo, superando por escassa margem E. nitens e E. deanei (com só uma procedência e só um local de ensaio cada um) enquanto que o E. regnans acusou mortalidade total na única procedência testada. O teste x^2 comprovou que há diferenças estatisticamente significativas na sobrevivência das procedências nos 4 ensaios. Confrontando a sobrevivência das procedências dentro de um mesmo ensaio, verificou-se que o E. viminalis - S 8923 não obteve só o valor absoluto mais alto, senão que difere estatisticamente de seu concorrente mais imediato o E. viminalis - proc. Canela. Uma comparação das sobrevivências entre os ensaios 1 e 2 demonstrou, que com exceção da procedência 17, não ficou comprovada a hipótese referente à semelhança da sobrevivência das respectivas procedências entre um e outro ensaio, que diferem unicamente no nº de plantas por repetição. Este fato demonstrou a grande variação individual existente dentro de uma mesma procedência de origem certificada (Quadro 5).

Quadro 4: Médias e coeficientes de variância da sobrevivência, altura e diâmetro do colo das espécies de Eucalyptus um ano após o plantio.

Especie	Sobrevivência		Altura		Diâmetro do colo	
	$\bar{x}$(%)	c.v.(%)	$\bar{x}$(cm)	c.v.(%)	$\bar{x}$(mm)	c.v.(%)
E.dalrympleana	6,56	78,35	30,77	49,01	3,00	39,00
E. deanei	16,67	-*	46,93	-*	4,59	-*
E.delegatensis	6,14	117,26	53,42	28,18	4,95	29,23
E. gunnii	22,22	-*	46,83	-*	4,75	-*
E. nitens	20,00	-*	21,33	-*	3,33	-*
E. regnans	0,00	-	-	-	-	-
E.st.johnii	7,09	95,06	30,25	61,29	3,73	47,99
E.viminalis	20,26	62,98	39,33	37,30	3,61	36,01

*só houve uma procedência e que foi implantada em um só local

Nas figuras 1 a 4 é possível acompanhar a queda na sobrevivência no decurso de 1 ano. Nestas chama atenção que das procedências semeadas e plantadas em Rio Negro a maioria apresenta uma acentuada mortalidade no mês de fevereiro no qual coincidentemente acusaram-se temperatura máximas de 36°C e uma temperatura média compensada de 25°C, aliada a uma precipitação de 255 mm. Embora em janeiro já houvesse ocorrido o mesmo fenômeno, a mortalidade verificou-se só no mês seguinte (fevereiro) igualmente quente e chuvoso. Por outro lado é característico para as procedências 1, 2, 5, 7, 8, 9, 10, 23, 24, 25, 27 e 28 (fig. 1-4) sua forte sensibilidade às geadas. Em um caso - procedência 25 (E. delegatensis S-10068)- a mortalidade foi tão acentuada que todos os indivíduos desta procedência morreram no mês de julho de 76 (fig. 3). Sua comprovada resistência às geadas nos locais de origem parece desaparecer no local de ensaio, provavelmente devido às grandes oscilações diárias de temperaturas. As temperaturas extremas chegaram em julho 76 a - 3,0°C e + 27,5°C respectivamente (RESTREPO, 1978). O outro motivo deve ter sido o plantio tardio das mudas (junho 76), deixando-lhes pouco tempo para se adaptar bem ao local, porque tanto as chuvas (volume e distribuição) como as geadas corresponderam a um ano normal.

Quanto às análises das alturas e diâmetro do colo, só foi possível detectar diferenças estatisticamente significantes na altura das plantas do Ensaio 2. O teste Duncan apontou diferenças entre a procedência (E. viminalis - S 8923, (59,93 cm) e E. viminalis - S 8839 (23,40 cm) e semelhanças com as procedências E. viminalis - Canela (46,03 cm) e E.viminalis - S 8630, (36,93 cm).

Os resultados de sobrevivência e crescimento de Irati, quando comparados com Rio Negro, demonstraram através de seus menores valores a influência negativa do sítio, que foi de menor qualidade. Em Irati a procedência E. viminalis - S 8905 superou levemente na sobrevivência à procedência de Rio Negro,

QUADRO 5: Médias e coeficientes de variação da sobrevivência, altura e diâmetro do colo das procedências até um ano após o plantio em Rio Negro-PR e Itati-PR.

		Sobrevivência		Altura			Diam.do colo	
Procedência		x̄	CV	x̄inicial	x̄final	CV	x̄	CV
		%	%	cm	cm	%	mm	%
Ensaio I								
1 E.dalrympleana	S 8847	0	-***	1.67	45.33*	45.00	4.25*	32.71
2 E.dalrympleana	S 9988	5.00	200.00	1.55	42.00	-***	3.75	-***
3 E.delegatensis	S 9984	5.00	200.00	2.60	43.00	-	4.00	-
4 E.delegatensis	S 9989	0	-	2.35	38.00	-	3.50	-
5 E.nitens	S10167	20.00	141.40	1.45	21.33	-	2.33	-
6 E.regnans	S 8766	0	-	1.77	-	-	-	-
7 E.st.johnii	S 9540	15.00	66.67	3.25	28.79	41.96	3.39	35.69
8 E.st.johnii	S 9541	0	-	2.65	-	-	-	-
9 E.st.johnii	S 9574	0	-	3.50	24.00*	-	2.75*	-
10 E.st.johnii	S10115	20.00	115.45	3.50	36.39	36.38	4.51	16.19
11 E.viminalis	S 7470	20.00	81.60	2.96	55.31	28.26	4.62	11.26
12 E.viminalis	S 8419	25.00	76.60	2.16	33.29	84.17	2.98	63.42
13 E.viminalis	S 8630	15.00	66.67	2.20	43.17	14.78	3.75	32.27
14 E.viminalis	S 8839	5.00	200.00	2.17	46.00	54.70	5.17	44.68
15 E.viminalis	S 8899	15.00	66.67	2.75	29.75	57.34	2.42	33.06
16 E.viminalis	S 8905	20.00	81.60	2.80	49.78	37.84	3.65	26.58
17 E.viminalis	S 8923	48.75	49.11	2.40	41.01	15.19	3.51	18.23
18 E.viminalis	S 8974	15.00	66.67	2.42	56.92	52.88	5.92	50.68
19 E.viminalis	S 9167	35.00	54.71	2.53	40.35	0.97	3.87	7.49
20 E.viminalis	S 9393	35.00	54.71	2.43	47.25	36.36	4.79	20.04
21 E.viminalis	CANELA	36.35	49.57	3.56	48.98	49.24	4.78	51.88
Ensaio II**								
7 E.st.johnii	S 9540	6.58	76.60	2.82	33.17	-	3.25	-
9 E.st.johnii	S 9574	7.76	66.75	2.85	41.46	-	3.67	-
13 E.viminalis	S 8630	12.06	53.81	2.17	36.93	29.14	3.00	43.67
14 E.viminalis	S 8839	25.00	0	2.24	23.40	27.05	2.43	15.46
17 E.viminalis	S 8923	43.03	46.83	2.51	59.93	15.35	4.20	30.48
21 E.viminalis	CANELA	21.38	38.87	2.78	43.03	20.68	4.70	24.47
Ensaio III								
4 E.delegatensis	S 9989	17.35	84.44	3.43	66.17	40.67	6.61	50.53
8 E.st.johnii	S 5941	8.33	127.61	10.83	69.56	-	7.75	-
23 E.deanei	S 7785	16.67	148.49	4.32	46.93	-	4.59	-
24 E.delegatensis	S 9991	8.33	199.88	4.43	66.50	-	5.67	-
25 E.delegatensis	S10068	0	-	5.74	-	-	-	-
26 E.gunnii	S 9999	22.22	107.92	6.49	46.83	31.70	4.75	29.26
27 E.st.johnii	S 9539	9.12	60.86	9.05	15.75	63.30	2.12	57.80
28 E.viminalis	S 9438	25.00	105.78	3.55	22.24	31.70	2.60	25.00
29 E.viminalis	S 9986	22.22	135.28	3.65	33.69	55.06	2.86	44.06
Ensaio IV								
1 E.dalrympleana	S 8847	10.00	115.50	2.24	20.25	-	2.00	-
2 E.dalrympleana	S 9988	11.25	116.89	1.60	15.50	-	2.00	-
7 E.st.johnii	S 9540	0	-	1.61	-	-	-	-
9 E.st.johnii	S 9574	11.25	116.89	2.44	15.25	-	2.50	-
10 E.st.johnii	S10115	0	-	2.57	10.83*	127.82	2.67*	47.19
11 E.viminalis	S 7470	0	-	2.63	-	-	-	-
12 E.viminalis	S 8419	5.00	200.00	1.78	66.00	-	6.00	-
13 E.viminalis	S 8630	10.00	115.50	1.85	5.25	-	1.00	-
16 E.viminalis	S 8905	22.50	116.89	1.78	21.00	51.33	2.33	49.36
17 E.viminalis	S 8923	0	-	1.85	27.38*	-	1.75*	-
20 E.viminalis	S 9393	10.00	115.50	2.70	26.00	97.08	2.67	77.90
22 E.viminalis	R.NEGRO	20.00	81.60	2.60	31.92	42.70	2.25	48.44

* Medições correspondentes às plantas do replantio, não consideradas na sobrevivência.

** Dados obtidos por subamostragem.

*** O coeficiente de variação foi só calculado quando a média final da sobrevivência era superior a 0% e/ou algumas das repetições não tinham média de altura ou diâmetro por motivo de mortalidade total da parcela.

FONTE: Restrepo, 1978.

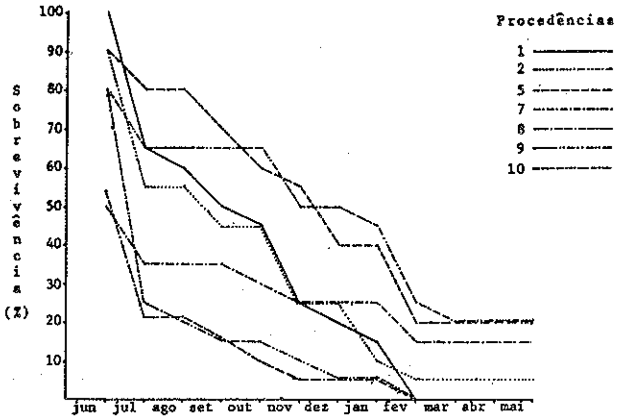

Fig.1: Percentagem de sobrevivência das procedências do Ensaio 1 no decorrer do primeiro ano após o plantio.

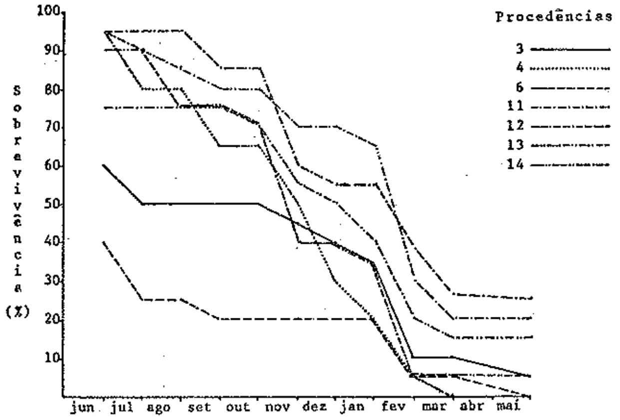

Fig.1: (continuação)

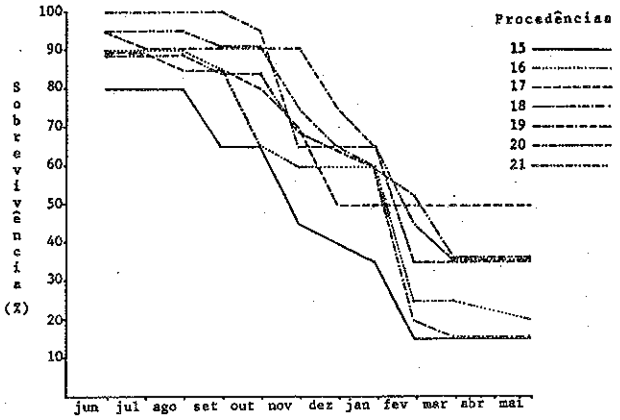

Fig.1: (continuação)

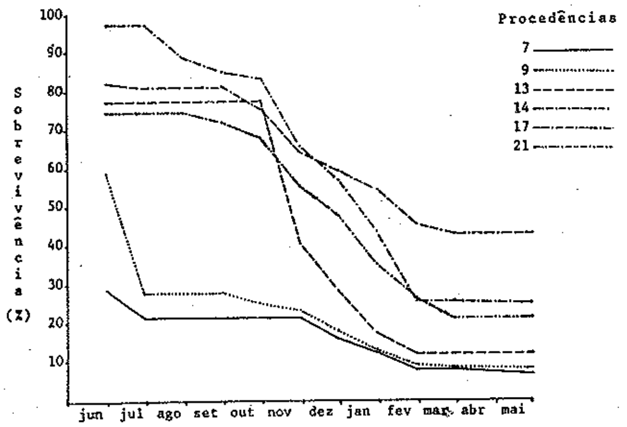

Fig.2: Percentagem de sobrevivência das procedências do Ensaio 2 no decorrer do primeiro ano após o plantio.

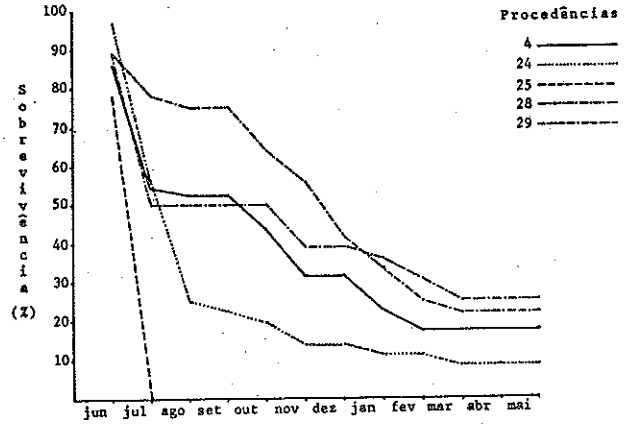

Fig.3: Percentagem de sobrevivência das procedências do Ensaio 3 no decorrer do primeiro ano após o plantio.

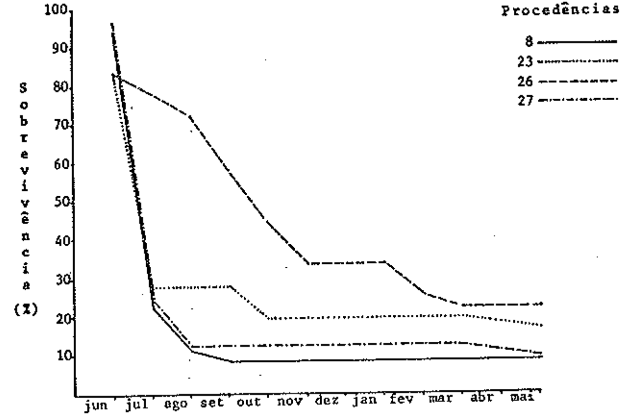

Fig.3: (continuação)

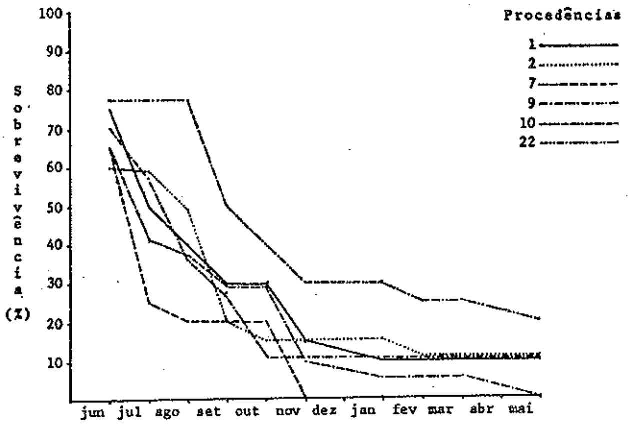

Fig.4: Percentagem de sobrevivência das procedências do Ensaio 4 no decorrer do primeiro ano após o plantio.

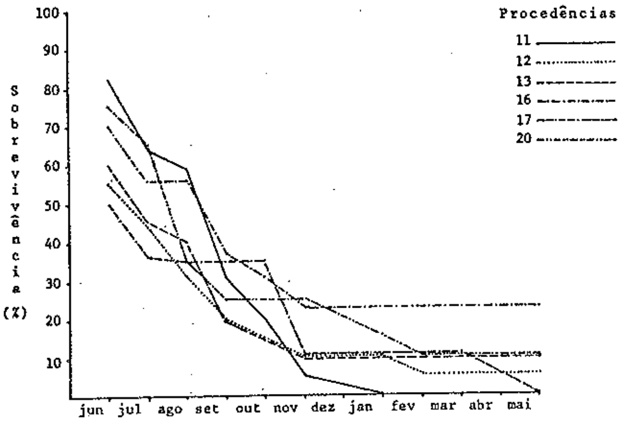

Fig.4: (continuação)

porém esta última apresenta-se com uma variação (CV%) menor na sobrevivência e altura superior à procedência australiana (Quadro 5).

A sobrevivência e desenvolvimento superior de E. viminalis de Canela,considerando os ensaios 1 e 2, demonstra sua boa adaptação à região, fato também comprovado por LEITE (1973) em uma pesquisa implantada em Lages (Santa Catarina - Brasil). No que se refere às procedências australianas neste aspecto não se comprovou totalmente a hipótese que as procedências de maior altitude ou latitude e temperaturas baixas fossem resistentes ao frio (ASHTON, 1958; PATON, 1972; PEDERICK, 1976). Estes resultados são semelhantes aos observados por FISHWICK (1976).

Conclusões

Em ambos os locais as procedências que serviram de testemunha brasileira (E. viminalis de Canela e E. viminalis de Rio Negro) estiveram por um lado entre as de melhor resistência ao frio e à estiagem invernal e aos calores do verão e por outro lado entre as de melhor crescimento, sendo ultrapassadas em Rio Negro por E. viminalis - S 8923 (tanto em sobrevivência como crescimento) e em Irati por E. viminalis - S 8905 (só em sobrevivência, porém estatisticamente semelhantes).

Foi observado que as procedências mais resistentes ao frio têm dificuldade de suportar temperaturas altas e, vice versa. Verificou-se também que o sítio de plantio teve influência tanto na percentagem de sobrevivência como na altura das plantas quando comparadas às mesmas procedências.

Recomenda-se fazer novas pesquisas com E. viminalis - S 8923 e S 8905 e com E. gunnii e E. nitens,pois embora estas últimas estavam representadas por uma só procedência, apresentaram-se promissoras.

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VARIAÇÃO EM *EUCALYPTUS VIMINALIS* EM RELAÇÃO À RESISTÊNCIA ÀS GEADAS E AO CRESCIMENTO.

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Resumo

Para selecionar procedências de *E. viminalis* resistentes às geadas e com rápido crescimento, destinada às regiões sudeste dos Estados Unidos, 98 lotes de sementes dessa espécie foram testadas, pela International Paper Company, durante o período de 1972-1979. Embora a precipitação anual e a sua distribuição estacional não sejam fatores limitantes para os crescimentos dos eucalyptus, nessa região, as temperaturas baixas e suas flutuações, durante o inverno, causaram prejuízos significativos a muitas das procedências do *E. viminalis*.

Flutuação, duração e época de ocorrências das geadas tiveram efeitos altamente prejudiciais aos eucalyptus muito mais do que a temperatura mínima absoluta. Houve uma grande variação entre as diferentes procedências de *E. viminalis* em relação a resistências às geadas e ao crescimento. As procedências mais resistentes, geralmente, não eram as melhores procedências em crescimento. Todavia, várias procedências comportaram-se muito bem, para ambas as características.

Devido à alta variação em relação às geadas e ao crescimento, o rendimento volumétrico do *E. viminal* está, hoje, muito abaixo do rendimento potencial da região sudeste dos Estados Unidos, e a utilização comercial desta espécie não é ainda recomendável, a menos que ninhagens mais resistentes às geadas possam ser desenvolvidas através de um programa de melhoramento genético.

VARIATION IN *EUCALYPTUS VIMINALIS* WITH RESPECT TO COLD RESISTANCE AND GROWTH.

Summary

To isolate frost-hardy, fast-growing provenances of E. viminalis for the southeast region of the U.S., 98 seed lots of this species were tested by International Paper Company during 1972-79. Although annual rainfall and its seasonal distribution were not limiting factors in growing eucalypts in this region, freezing temperatures and their fluctuations during the winter caused significant damage to many of the E. viminalis provenances.

Fluctuation, duration, and time of frost occurance had more damaging effect on eucalypts than absolute minimum temperatures. There was a great variation among different provenances of E. viminalis in respect to frost-hardiness and growth. The most frost-hardy sources were not necessarily the best provenances in growth rate. However, several provenances performed well in both characteristics.

Due to the high variation in frost-hardiness and growth, the actual yield of E. viminalis is much below the potential yield in the southeast region, and commercial utilization of this species is not recommended unless more frost-hardy strains are developed through a genetic improvement program.

INTRODUCTION

Studies in growing Eucalyptus species in the Southeast region of the United States as a potential fiber source began in 1971. These studies were conducted in collaboration with the North Carolina State University Hardwood Cooperative with the objective of growing eucalypts on upland sites where trees can be logged during the wet season when native hardwoods growing on the bottomland sites are not accessible.

The first Eucalyptus screening trial established by International Paper Company was planted at Bainbridge, Georgia in 1972. Since then, more than 10 member companies within the N. C. State Hardwood Co-op have attempted to isolate frost-hardy, fast growing eucalypts for the southern Atlantic and lower Gulf Coast regions (Hunt and Zobel, 1978).

The 1972 Eucalyptus screening trial drew considerable attention to E. viminalis because of its relative cold-hardiness and good growth. This study rejected any possibility of using some of the more desirable commercial species such as E. grandis, E. robusta, E. saligna, E. regnance, E. camaldulensis, or E. tereticornis, since all were killed by the freezing temperatures.

By 1979, more than 400 seed lots of 96 Eucalyptus species were tested by International Paper Company. Most of these species were also tested by other members of the N. C. State Co-op in different locations in the southeast region.

This paper will discuss variation in frost-hardiness and growth rate of E. viminalis seed lots tested by International Paper Company.

MATERIALS AND METHOD

Seed Sources

A total of 98 seed lots of E. viminalis were evaluated for frost-hardiness and growth during 1972-79. E. viminalis seed lots were from a wide range of natural habitats in Australia, and also from a number of plantations in Brazil, New Zealand, the Soviet Union and the Republic of South Africa (Table 1).

The maximum number of E. viminalis seed lots tested in a single screening trial was 49, planted in 1977. The next largest group was 44 lots tested in 1975 at Bainbridge, Georgia.

Table 1. E. viminalis seed lots tested by International Paper Company in the Southeast region of the U. S.

Origin		
Country	State or location	Number of seed lots
Australia	New S. Wales	30
Australia	Victoria	16
Australia	A. Capital Territory	3
Australia	Tasmania	7
Rep. S. Africa	-	3
Brazil	Rio Grande do Sul	20
New Zealand	Rotorua	1
Soviet Union	-	1
Miscellaneous	-	17

Seedling Production

Seeds were germinated in a tray containing a mixture of 3:1 sand: Redi-earth*. Seedlings were transplanted into Todd Speedling trays* when 2 cm high, using a soil mixture of 1:1:1 peat-moss, vermiculate, and Redi-earth. Containerized seedlings were grown for 12 to 14 weeks in a greenhouse and were about 15 to 17 cm high at the time of out-planting.

Experimental Locations

All of the 98 E. viminalis seed lots were planted in southwest Georgia and north Florida. Fourteen seed lots were also tested in other areas with 3 to 14 lots per test location (Table 2). In Bainbridge and north Florida several sites were used for both screening and growth trials while only a single screening trial was installed in each of the other locations.

Table 2. Distribution of E. viminalis seed lots in the experimental locations.

Experimental Locations			
City and/or State	County	Number of Seed lots*	Year of Installation
Bainbridge, GA	Decatur	98	1972-79
Richmond Hill, GA	Bryan	4	1975
North Florida	Calhoun & Jackson	23	1975
Bronson, FL	Levy	4	1975
South Mississippi	Harrison	4	1975
Central MS	Rankin	14	1975
Central MS	Jefferson	4	1978
Jena, LA	La Salle	4	1975
Olla, LA	La Salle	3	1978
Camden, AR	Ouachita	4	1975
Nacogdoches, TX	Nacogdoches	6	1975
South Alabama	Baldwin	7	1975

*Some seed lots were tested in more than one location.

Climate

Rainfall

The annual rainfall and its monthly distribution at the Bainbridge test area are given in Table 3. Seasonal drought is not uncommon at Bainbridge area during September, October, and November. On two occasions in the past ten years only one mm of rainfall was observed in October.

Table 3. Monthly rainfall distribution from 1970 to 1979 at Bainbridge, Georgia in mm.

Year	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1970	120	116	210	26	61	78	170	226	58	123	27	70	1285
1971	77	153	186	65	135	77	126	155	72	75	48	144	1313
1972	150	152	137	3	63	178	123	27	33	77	86	66	1095
1973	168	110	213	200	147	193	93	57	103	1	103	96	1484
1974	135	150	81	97	90	161	223	115	128	26	18	75	1299
1975	297	100	121	242	211	143	367	171	79	124	58	115	2028
1976	150	25	110	11	294	116	111	119	137	133	155	116	1477
1977	54	65	160	52	-	-	-	-	21	86	97	-	-
1978	142	69	133	96	145	172	153	56	19	1	87	92	1165
1979	205	151	38	159	210	87	159	162	226	19	76	74	1566

-Missing observation

Temperature

Average monthly temperature at Bainbridge is shown in Table 4. The lowest monthly temperature during the last 10 years was 5°C. High average temperatures during August, September, and October are generally associated with low rainfall (Fig. 1). There was a high incidence of frost at Bainbridge over the last 10 years, with a maximum of 56 frosts in the winter of 1976-77 (Fig. 2). The coldest temperature, -12°C, was recorded in mid-January, 1977. Fluctuation of temperature to below freezing is frequent during the winter. Figure 3 shows these fluctuations for four consecutive days each containing the absolute minimum temperature of the winter season. For the 1976-77 winter, a five-day temperature fluctuation is presented so that the sharp drop in temperature and also the lowest absolute minimum can be shown.

The absolute minimum temperature, the number of frosts per year, and the fluctuation of temperature to below freezing were even more severe at the other Eucalyptus testing sites installed by International Paper Company in the lower and upper Gulf Coast.

Table 4. Mean monthly temperature from 1970 to 1979 at Bainbridge, Georgia in °C.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1970	8	11	-	22	24	-	-	28	-	-	-	-
1971	12	13	14	19	-	-	27	27	26	-	14	17
1972	15	12	16	21	23	26	27	28	27	-	15	14
1973	11	11	18	18	23	27	28	27	27	21	18	11
1974	19	18	19	20	18	25	27	27	24	18	14	10
1975	13	15	16	19	25	26	27	27	25	21	16	11
1976	9	15	18	20	13	25	27	27	-	-	-	-
1977	5	-	-	-	-	-	-	-	-	18	16	10
1978	6	7	14	20	23	27	27	27	26	20	18	11
1979	5	10	15	20	22	25	27	26	24	19	15	10

-Missing observation

Experimental Designs

A completely randomized design was used in the 1972 and 1973 trials. For other studies, a randomized complete block design with 4 or more replications was used. Plot sizes were either 6-tree-row or 25-tree-square, with 2.6 x 2.6 meter spacing. All tree-remains were removed from the area, and the sites were cross-disked before planting. For the first two years, weed competition was regularly controlled by disk-cultivation.

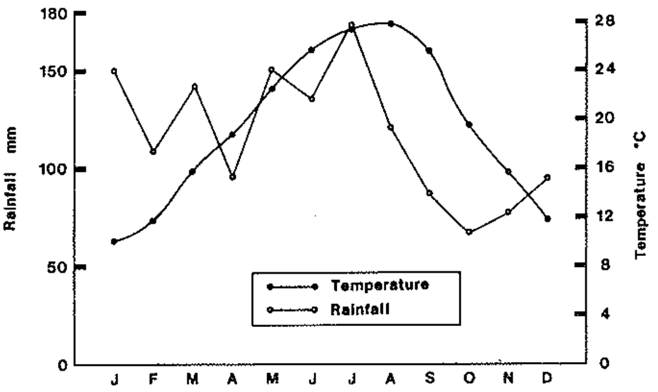

Figure 1. Average monthly rainfall and temperature at Bainbridge, Georgia.

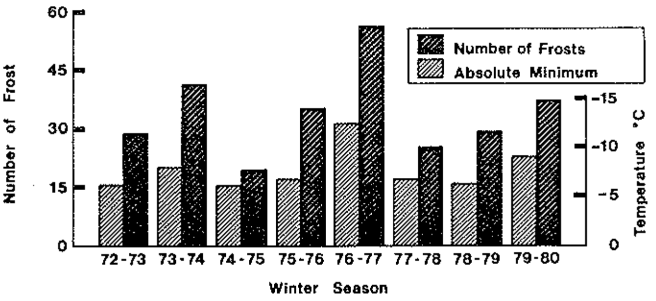

Figure 2. Absolute minimum temperature and number of frosts at Bainbridge, Georgia.

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* The use of these products does not imply endorsement.

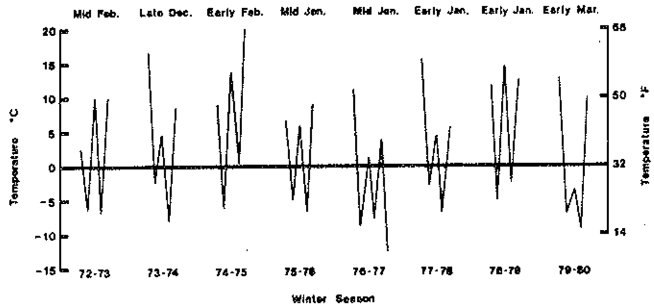

Figure 3. Temperature fluctuations for consecutive days (each containing the absolute minimum) at a Eucalyptus testing site at Bainbridge, Georgia.

Measurements

During the first year, trees were measured for total height, survival, and frost-hardiness. In the second year, total height and frost-hardiness were measured, and from the third year, total height, dbh, frost-hardiness and form were evaluated. A scoring system of zero to five was used for evaluation of frost-hardiness. Zero indicates trees killed by frost, with five being used for trees unaffected by freezing temperatures.

RESULTS AND DISCUSSION

Results of early tests in 1972 and 1973 showed that E. viminalis had a better growth rate than two other cold-hardy species, E. nova-anglica and E. macarthurii, but was inferior in cold-hardiness (Table 5).

Annual rainfall was not considered to be a limiting factor for growing E. viminalis since the minimum average of 1095 mm at Bainbridge was well above the precipitation rate of 635 to 890 mm in its natural habitat as reported by Hall et al. (1975). Distribution of rainfall was not of great concern except for a few occasions when summer drought affected the survival rates of newly established studies at Bainbridge.

Table 5. Average, maximum, and minimum height and d.b.h. along with frost-hardiness and survival of the promising Eucalyptus species seven years after planting.

Species and provenances	Surv %	Max Ht m	Min Ht m	Avg Ht m	Max dbh cm	Min dbh cm	Avg dbh cm	Avg Frost-Hardiness Score
E. viminalis EV-4-1	93	18.6	8.1	12.7	30.2	8.6	19.6	3.8
E. viminalis EV-2	60	13.1	7.4	11.5	26.7	10.2	21.3	3.6
E. nova-anglica 285-V	47	12.7	5.9	10.5	23.1	5.8	14.5	4.1
E. nova-anglica 285 VI	53	17.1	3.4	11.1	23.4	2.54	14.7	4.3
E. macarthurii	80	17.4	6.8	11.1	28.7	10.7	19.0	3.9

About 269 frosts have occurred in the Eucalyptus planting area at Bainbridge, Georgia from 1972 to date. A daytime temperature of 27°C has dropped as low as -4°C at night (Hunt and Zobel, 1978), causing significant damage to most of the eucalypts.

Fluctuation, duration, and time of frost occurance have had more damaging effect on E. viminalis (and many other eucalypts) than absolute minimum temperature. For example, the lowest temperature during the last eight years of Eucalyptus trials in Bainbridge was -12°C occurring January 18, 1977. On March 3, 1980 another extremely low temperature of -9°C occurred and the freeze lasted more than 48 hours. Although the absolute minimum temperature in 1980 was not as low as that of 1977, the long duration and the timing of the 1980 freeze caused more severe damage to E. viminalis.

Of 14 seed lots of E. viminalis tested in the lower and upper Gulf coast, none survived due mainly to the greater fluctuation of temperature to below freezing.

There is a great variation in frost-hardiness and growth of different E. viminalis provenances. This was first noticed in the 1972 and 1973 trials when some E. viminalis trees showed terminal damage due to freezing temperatures while other trees of different seed sources were killed almost to ground level (Hunt and Zobel, 1978). Provenance EV-4-1 performed better in cold-hardiness and growth than EV-2. Some of the individual trees grew more than double the height of others even when they belonged to the same seed lot (Table 5). Such variation became more evident after the planting of 44 seed lots in 1975 and 49 seed lots in 1977.

Four-year results from the 1975 trial showed a variation of 1.3 to 3.9 for average frost-hardiness score and a mean total height variation of 3.6 to 8.1 meters (Table 6). A frost-hardiness variation of 1.5 to 4.5 and a mean total height variation of 2.6 to 4.9 meters were observed for two-year old trees in the 1977 trial (Table 6).

Table 6. Part of the data on height and frost-hardiness from the E. viminalis seed source trials established in 1975 and 1977 at Bainbridge, Georgia.

Seed Lots	Avg F-H Score*	Avg Ht (m)	Rank F-H*	Rank Ht	Tallest Tree Ht (m)	Tallest Tree F-H Score*
1975 TRIAL WITH 44 SEED LOTS						
S8900	1.3	3.6	44	44	7.6	3
S9993	3.9	4.6	1	37	6.7	5
EV-10	2.9	6.1	26	7	14.6	5
277XIII	3.5	8.1	6	1	12.7	5
277XVI	3.6	6.8	4	3	11.8	5
277XVII	3.6	7.3	4	2	12.4	4
1977 TRIAL WITH 49 SEED LOTS						
13-76-4	1.5	4.0	49	26	7.0	2
USSR	4.5	4.1	1	24	7.3	5
8839	3.1	2.6	31	49	4.5	4
11746	2.8	4.9	36	1	7.4	4
10726	4.1	4.7	2	3	7.0	5
8978	4.1	4.6	2	5	6.7	4

*F-H score = frost-hardiness score (zero for trees killed by freezing temperatures, five for unaffected trees).

The seed lots showing the best frost-hardiness did not necessarily show the best growth. For example, lot S9993 in the 1975 trial ranked first in frost-hardiness but 37th for average height. Although the tallest tree in this experiment belonged to EV-10, this seed lot was very poor on average frost-hardiness (Table 6). Similar results were obtained for the 1977 trial. For example, the USSR source had the highest average frost-hardiness score but ranked 24th on average height, while lot 11746 which had the highest average height ranked 36th on average frost-hardiness (Table 6).

A number of seed lots such as 277-XVII and 277-XVI in the 1975 trial and 10726 and 8978 in the 1977 trial performed well in both frost-hardiness and growth. There was at least one tree in each of these seed lots (and also in a few other sources) which scored 4 or 5 for frost-hardiness and which also showed superior growth. These trees were selected to be part of a genetic base population, since, as pointed out by Franklin (1978), genetic adaptation of eucalypts to the southeast region must be achieved by selection and breeding. Grafts produced from these trees were planted in a clonal seed orchard in south Florida to produce improved frost-hardy seeds for the southeast region.

CONCLUSION

Although there is good potential for growing eucalypts in certain areas of the southeast region, none of the E. viminalis provenances tested so far are suitable for commercial planting, particularly in the upper and lower Gulf Coast areas. It is expected that the genetic improvement program can produce new strains of E. viminalis which would be more frost-hardy and exhibit more uniformity in growth rate.

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TESTE DE PROCEDÊNCIA DE *EUCALYPTUS SPP* NA REGIÃO DE MOJI-GUAÇU (SP)

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Resumo

Um ensaio com origens de sementes das espécies de Eucalyptus cloeziana, Eucalyptus camaldulensis e Eucalyptus tereticornis foi instalado na Estação Experimental de Moji-Guaçu, Estado de São Paulo. Os resultados obtidos após 3 anos mostram variações genéticas significativas das procedências em relação à altura média e diâmetro à altura do peito. As melhores procedências para esses parâmetros mostram ser: E. camaldulensis de Petford Q.L.D., E. tereticornis de N.W. Laura Q.L.D., E. cloeziana de S.W. Duaringa, E. tereticornis de Mackay - Dist. Q.L.D. e E. tereticornis de Cooktown Q.L.D.

Summary

A provenance trial with Eucalyptus cloeziana, Eucalyptus camaldulensis and Eucalyptùs tereticornis was established at the Experimental Station of Moji Guaçu (SP). An evaluation at the third year showed that there was signigicant genetic variation among the provenances in relation to the average height and D.B.H. The best provenances for these parameters were: E. camaldulensis (Petford Qld), E. tereticornis (N.W. Laura Qld), E. cloeziana (S.W. Duaringa), E. tereticornis (Makay District Qld) and E. tereticornis (Cooktown Qld).

Introdução

A ampla distribuição natural do Eucalyptus spp na sua região de origem, possibilita ocorrer grandes variações entre - procedências. O Instituto Florestal vem conduzindo experimentos no sentido de encontrar procedências que melhor se adaptem às condições do Estado de São Paulo. Golfari e Pinheiro Neto (1970), citam várias espécies possiveis de se adaptarem ao clima brasileiro, tais como o E. cloeziana e E. tereticornis para a região sul e norte do Estado de São Paulo e o E. camaldulensis para as regiões com clima sub-úmido e em solos inundáveis com drenagem deficiente. Teixeira e Cordeiro (1973) observaram que entre as procedências Australianas de E. camaldulensis a que melhor correspondeu ao parâmetro altura foi a de E. Petford, Q.L.D. Laurie ap. Eldridge (1975), refere-se a ensaios realizados na África tropical com diversas procedências da Austrália para o E. camaldulensis afirmando:as que se destacaram foram as de Katherine, Petford e Lake Albacutza, e corroborando a respeito da plasticidade dessa espécie Eldrige (1975) resume o progresso de um projeto da FAO no Metiderrâneo em que as trinta procedências testadas mostram ser as melhores para vinte e quatro "site". Ferreira (1979) esclarece que o E. tereticornis é recomendado parao plantio em todas as regiões bioclimáticas do Estado de São Paulo, excetuando-se aquelas onde ocorra geada, conclui ainda, que o E. cloeziana introduzido em Salto (SP), apresenta crescimento mais lento do que o E. grandis, E. saligna e E. urophylla.

O presente trabalho visa ao estudo de três espécies de Eucalyptus spp, com o objetivo de detectar as variações existentes tanto ao nível de espécie como dentre espécie, e seu aproveitamento como população base para programas de melhoramento.

Material e método

O ensaio foi instalado, em 1976, na Estação Experimental de Mogi Guaçu, unidade do Instituto Florestal de São Paulo, que possui as características constantes do Quadro 1:

QUADRO 1 - Características Edafo-climáticas do local da instalação.

Dados local: Mogi Guaçu	Localização:	Solo:
	Lat.S = 22º	Lat.vermelho-amarelo (LVa) fase renosa)
	Long. W = 47'	
	Alt.(m) = 600	

Temperatura: Média do mês mais quente = 23
Média do mês mais frio = 16.5

Precipitação: Média anual: 1.163,00
Média do mês mais seco (agosto) = 23,0

Tipo climático: Cwa mesotérmico inverno seco

Déficit Hídrico (mm) : 35

O delineamento estatístico empregado foi o de blocos ao acaso com 27 tratamentos (espécies e origens) e 7 repetições. Foram utilizadas parcelas lineares constituidas de 4 plantas por parcela.

Os parâmetros avaliados e analisados no presente trabalho, foram altura total e DAP aos 3 anos de idade.

Resultado e Discussão

A análise de variância para os dados de altura de plantas (Quadro III) revela valores de F. significativos entre tratamentos, tanto ao nível de espécies como de procedências dentro de espécies. Apesar da significância para a variação entre espécies, houve procedências com boa performance nas 3 espécies estudadas, em consequência da expressiva variação verificada para as procedências. Os melhores comportamentos foram para: E. camaldulensis de E. Petford Q.L.D., E. tereticornis de N.W. Laura Q.L.D., E. cloeziana de S.W. Duaringa Q.L.D., E. tereticornis de Mackay - Dist. Q.L.D e E. tereticornis de Cooktown Q.L.D.

Os resultados a essa idade não mostram tendências muito - nítidas para correlações entre localizações geográficas e performances, mostrando a importância de ensaios testando o - maior número de procedências representativas das espécies potenciais.

No quadro III são apresentados os resultados do Teste de Tukey para a altura total.

QUADRO II

Codificação e localização das procedências de E. cloeziana, E. camaldulensis e E. tereticornis.

Espécies	Nº Trat.	Localidade	Estado	Lat.	Long.	Alt. (m)
E. cloeziana	21	Gympie	QLD	26º11'	152º40'	-
	22	Cooktown	QLD	15º45'	145º15'	75
	23	NE GYmpie	QLD	26º08'	152º42'	76-137
	24	Gympie District	QLD	26º08'	152º46'	152
	25	Paluma	QLD	19º05'	146º20'	270
	26	S.W. Duaringa	QLD	23º55'	149º15'	240
	27	S.Helenvale	QLD	15º45'	145º15'	52
	28	S.E.Gympie	QLD	26º18'	152º46'	75
E. camaldulensis	33	Lenard Liver	W.A.	17º23'	124º45'	61
	35	S. of Billiluna	W.A.	19º34'	127º41'	300
	37	E. Prairie	QLD	20º50'	144º49'	457
	40	E.Petford	QLD	17º20'	144º57'	518
E. tereticornis	41	Belgo Mineira	-	-	-	-
	42	Bulolo Marobe	P.N.G.	7º10'	146º40'	640
	44	Maryborough Dist.	QLD	25º52'	152º10'	61
	45	N.W. Laura	QLD	15º52'	144º10'	110
	46	MAckay Dist.	QLD	21º20'	148º32'	762
	47	Helenvale	QLD	15º40'	144º10'	110
	48	Schacots C.K.	QLD	26º19'	152º36'	-
	49	Mackay Dist.	QLD	21º10'	148º20'	610
	50	Brisbane Dist.	QLD	26º50'	153º00'	30
	51	Rockhampton Sub.Dist	QLD	23º20'	148º20'	610
	52	Helenvale	QLD	15º25'	145º15'	120
	54	Bulolo P.N.G.	P.N.G	9º25'	147º08'	-
	55	Cooktown	QLD	16º10'	144º50'	366
	56	Kupiano-Oregan	P.N.G	10º05'	148º10'	-
	57	Barakula S.F.	-	-	-	-

QUADRO III - Significância dos diferentes tratamentos/espécie pelo Teste de Tukey para dados de altura total.

Trat.	Espécie e origem da semente	Teste de Tukey 1% Tratamentos **	Teste de Tukey5% Tratamentos **
40	E. camaldulensis Petford - QLD	23,50,21,22,42, 41,27,54,56 e 46	25,57
45	E.tereticornis N.W. Laura - QLD	23,50,21,22 e 42	41,27,54 e 56
26	E. cloeziana S.W.Duaringa QLD	23,50,21,22 e 42	41,27,54 e 56
49	E.tereticornis Mackay Dist.QLD	23 e 50	21 e 22
55	E. tereticornis Cooktown-QLD	-	23 e 50

(*) significativo ao nível de 5%
(**) significativo ao nível de 1%

A análise de variância para os dados de DAP mostram resultados semelhantes aos obtidos em altura, porém mais expressivos, com variações significativas entre espécies e entre procedências dentro de espécies. Os cinco melhores tratamentos para altura se repetem na avaliação para o DAP, com algumas trocas de posição entre elas, mostrando destaque para o E. cloeziana de S.W. Duaringa que, de terceiro lugar para altura, passou a primeiro em DAP, revelando uma diferença na relação altura: diâmetro para as diferentes espécies.

No Quadro IV são apresentados os resultados do Teste de Tukey para as diferenças entre média de diâmetros.

Conclusões

Os resultados obtidos no presente trabalho, aos 3 anos de idade, revelam haver variações genéticas significativas tanto entre como dentro das espécies.

As variações entre origens dentro das espécies foram bastante expressivas, mostrando a existência de origens com comportamento para as três espécies estudadas.

Os locais de origem das sementes não mostraram tendências para correlação com o comportamento no campo, não possibilitando extrapolação dos resultados para origens não testadas.

QUADRO IV - Significância dos diferentes tratamentos/espécie, pelo Teste de Tukey para os dados de diâmetro.

TRAT.	Espécie e origem da semente	Teste de Tukey 1% Tratamentos **	Teste de Tukey 5% Tratamentos *
26	E. cloeziana S.W. Duaringa	23,42,54,56,57, 41,50,46,35,52, 37,51,21,48,47, e 44	33
40	E.camaldulensis E. Petford	23,42,54,56,57, 41,50,46,35,52, 37,51 e 21	47 e 48
49	E. tereticornis Mackay Dist.	23,42,54,56,57, 41,50 e 46	35,52 e 37
22	E. cloeziana	23,42,54,56,57, 41,50 e 46	35,52 e 37
45	E. tereticornis N.W. Laura	23,42,54,56,57, 41 e 50	46 e 35
24	E. cloeziana Gympil District	23,42,54,56,67	41 e 50
55	E. tereticornis Cooktown	23,42,54,56,57,	41 e 50
28	E. cloeziana S.E. Gympil	23 e 42	54,56,57
27	E. cloeziana S. Helenvale	23 e 42	-
25	E. cloeziana Paluma	-	23 e 42

(*) significativo ao nível de 5%
(**) significativo ao nível de 1%

A avaliação do ensaio com idades mais avançadas possibilitará resultados mais conclusivos, o que trará definição do valor das origens para a região em estudo.

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COMPETIÇÃO DE ESPÉCIES DE *EUCALYPTUS* NA REGIÃO DE MOJI-MIRIM-SP

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Resumo

Foi instalado em Moji Mirim - SP, em solo onde havia anteriormente vegetação de cerrado, um ensaio de competição de oito espécies de Eucalyptus, a saber: E. botryoides Sm, E. camaldulensis Dehn, E. citriodora Hook, E. maculata Hook, E. paniculata Sm, E. propinqua Dea et Mai., E. saligna Sm, E. tereticornis Sm.

Após 8 anos de observações, são apresentados os dados de altura, DAP e sobrevivência.

Summary

In Moji Mirim, Sao Paulo State, Brazil, an experiment was established to study competition among the following eight species of Eucalyptus : E. botryoides Sm, E. camaldulensis Dehn, E. citriodora Hook, E. paniculata Sm, E. propinqua Deane et Maiden, E. saligna Sm, and E. tereticornis Sm.

After 8 years of growth, results are presented for height, DBH and survival.

Introdução

Com o desaparecimento no mercado madeireiro das chamadas madeiras de lei do sul do Brasil, o fornecimento atual vem sendo feito com madeiras trazidas da Amazônia, onerando enormemente o seu custo, em virtude do transporte rodoviário.

Segundo RAMOS (1973) a madeira de Eucalipto após ser devidamente tratada e seca, pode substituir em inúmeros fins, como material para serraria e construções rurais, as madeiras de qualidade superior.

Após observações de mais de 40 anos das primeiras introduções em Rio Claro, ANDRADE (1961), indica espécies de eucalipto de madeira densa para serem cultivadas em todo o Estado de São Paulo.

Em virtude do pouco desenvolvimento das nossas espécies nativas, geralmente exigentes de solo fértil, a sua cultura em escala industrial é inviável.

Após observações por todo o território nacional, GOLFARI et alii (1978) classificaram 26 regiões, de acordo com as condições bioclimáticas, indicando quais as espécies de Pinus e e Eucalyptus aptas para cada região.

Baseado nos fatos relacionados acima, este estudo tem por objetivo, pesquisar o desenvolvimento de algumas espécies de eucalipto de madeira densa, trazendo algum subsídio para os lavradores da região.

Material e Método

As espécies estudadas foram E. botryoides Sm., E. camaldulensis Dehn., E. citriodora Hook, E. maculata Hook, E. paniculata Sm., E. propinqua Deane et Maï., E. saligna Sm. e E. tereticornis Sm.

As sementes utilizadas neste estudo, foram originadas de árvores selecionadas de Rio Claro. As mudas foram produzidas em torrão paulista e levadas ao campo com altura média de 20cm.

Com exceção do E. saligna que funcionou como termo de comparação, por ser uma das espécies mais plantadas em nosso Estado e indicada para celulose, as outras espécies são produtoras de madeira densa, recomendadas para serraria e construções rurais.

Os dados de clima e solo do local são apresentados na TABELA 1, segundo VEIGA (1975).

TABELA 1 - Dados de localização e edafoclimatológicos do local:

Local	Lat. S	Long. W	Alt. m	Precip. mm	Temp. Média ºC	Clima	Solo	Def. Hidr. mm
Mogi Mirim	22º26'	46º57'	631	1.355	20,3	Cwa	LVa	19

O delineamento estatístico foi o de blocos ao acaso, com 8 tratamentos (espécies) e 3 repetições com espaçamento de 3,0 x 2,0m.

Analisou-se a perfeição do fuste, dando-se conceitos subjetivos de A para fustes retilíneos, B para fustes ligeiramente tortuosos e C para fustes com tortuosidade acentuada.

Resultados e Discussões

Os dados de altura, DAP, sobrevivência e perfeição do fuste, aos 8 anos de idade, são apresentados na TABELA 2.

TABELA 2 - Dados de altura, DAP, sobrevivência e perfeição do fuste

Tratamentos	Altura m	CR*	DAP cm	CR*	Sobrevivência *	Fuste
E. botryoides	19,1	4º	14,3	3º	78,5	B
E. camaldulensis	19,8	2º	14,5	2º	84,7	B
E. citriodora	19,2	3º	13,2	6º	79,7	B
E. maculata	17,9	7º	11,5	8º	55,5	C
E. paniculata	16,7	8º	13,3	5º	95,0	A
E. propinqua	19,9	5º	15,9	1º	64,9	B
E. tereticornis	18,6	6º	12,6	7º	89,2	B

Na análise de altura o Teste Tukey, constatou uma diferença entre as espécies E. saligna e E. paniculata e para o DAP, houve diferença entre o E. maculata e o E. propinqua.

Quanto à sobrevivência, houve uma grande variação entre os tratamentos com maior porcentagem de morte para o E. maculata e de menor para o E. paniculata.

(*) CR Classificação relativa entre os tratamentos.

Na classificação subjetiva com 3 classes para a perfeição do fuste, o E. paniculata foi o melhor, o E. maculata o pior e os demais alcançaram notas intermediárias.

Não houve uma concordância na classificação relativa dos tratamentos para os dados de altura e DAP, com exceção do E. camaldulensis, que permaneceu em segundo lugar.

Embora o E. saligna seja uma espécie de rápido crescimento, não se destacou dos demais tratamentos.

Segundo COLFARI et alii (1978), das espécies estudadas , somente o E. botryoides e E. paniculata são seriam recomendadas para o local. Todavia, como se pode observar na TABELA 2 , não foram as que apresentaram o menor desenvolvimento. O E. paniculata foi a espécie que apresentou o maior índice de sobrevivência se destacando das demais quanto à perfeição de fuste.

Conclusões

O E. maculata diferenciou-se do E. propinqua quanto ao DAP e o E. paniculata diferenciou-se do E. saligna quanto a altura.

O E. paniculata, apresentou os melhores índices de sobrevivência e perfeição de fuste, enquanto o E. maculata foi o pior para os mesmos parâmetros.

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VARIAÇÃO EM PROCEDÊNCIAS DE *EUCALYPTUS CLOEZIANA* F. MUELL.

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Resumo

E. cloeziana provou ser uma espécie comercial de valor na Austrália e fora dela. Tem grande potencial para plantações em áreas tropicais e subtropicais visando a utilização da madeira para serraria, postes, carvão e combustível. Testes de procedências têm sido estabelecidos recentemente e pouco se sabe da variação dessas procedências.

Este trabalho descreve a variação de procedências de *E. cloeziana* com base em medições da morfologia de árvores adultas em florestas naturais e de mudinhas produzidas em condições ambientais controladas. As relações entre procedências são a seguir exploradas através de respostas fisiológicas da mudinhas às diferentes temperaturas e condições de intensidade de luz e também através de investigações, utilizando-se isoenzimas.

Uma revisão de uma literatura existente em relação ao comportamento *E cloeziana* é apresentada e discutida, e recomendações são feitas para seleção de fonte de sementes para testes iniciais de procedência.

PROVENANCE VARIATION IN *EUCALYPTUS CLOEZIANA* F. MUELL.

Summary

E. cloeziana has proved to be a valuable commercial species in Australia and elsewhere. It has great potential for planting in tropical and subtropical areas for timber, poles, charcoal and fuel. Comprehensive provenance tests have been established only recently and little is known of its provenance variation.

The paper describes provenance variation in *E. cloeziana* on the basis of measurements of the morphology adult trees in natural forests and seedlings grown under controlled conditions. The relationship between provenances is further explored through physiological responses of seedlings to different temperature and light intensity conditions and by isozyme investigations.

The relevance of literature reports on the performance of *E. cloeziana* is discussed and recommendations on the selection of seed sources for initial provenance trials are made.

INTRODUCTION

There is a lack of published information on the natural distribution, autecology and genetic variability of *E. cloeziana*, although the species is utilised commercially in Australia and has proved a valuable exotic in some overseas countries (Turnbull and Pryor 1978). Compared to many eucalypt species it has been little tested as an exotic, but in a recent review of eucalypt planting it was concluded that *E. cloeziana* has 'a great role to play in the future, especially in humid tropical areas' (Martin 1977).

E. cloeziana has desirable timber properties. Its wood is yellow-brown, heavy, strong and very durable. The strength and durability of the timber and its ease of sawing make it suitable for a wide range of purposes (Hall *et al.* 1970). It has limited use for general construction purposes but can be used in heavy construction and is excellent for railway sleepers, mine timbers and poles. Poynton (1957) states that it has few equals as a telephone or transmission pole because of its strength, excellent form, and amenability to preservative treatment. Its density and colour make it only marginally suitable for paper pulp (FAO 1975), but it makes excellent charcoal (Martin 1977) and it could also find a use in fibreboard and particle board production.

This paper aims to summarise the results of an investigation of geographic variation in *E. cloeziana* (Turnbull 1979) so as to provide a basis for the rational selection of seed sources for provenance trials.

NATURAL DISTRIBUTION

The natural distribution of *E. cloeziana* was determined initially using herbarium records, published accounts and personal communications from foresters and other field workers. The boundaries were then defined during extensive fieldwork. The distribution is shown in Figures 1 and 2.

The occurrence of *E. cloeziana* in natural stands is confined to Queensland between latitudes 15°45' - 26°41'S and between longitudes 144°44' - 152°52'E. The altitudinal range is from 25-950 m. The species is most common in a narrow strip east of Gympie, in sandstone ranges from the Great Dividing range eastwards in southern Queensland and on the Atherton Tableland in northern Queensland. The distribution is characterised by a large number of relatively small disjunct populations.

New occurrences were found on Hinchinbrook Island and in the Drummond, Denham and Leichhardt ranges of central Queensland. The possibilities for locating as yet unknown populations of *E. cloeziana* have not been exhausted, even though several attempts were made during this study to find populations in what appeared to be likely situations. The stands are small and often occur in remote areas where vehicular access is difficult. It is improbable, however, that the extreme geographic boundaries will be extended beyond those currently known.

FACTORS AFFECTING THE NATURAL DISTRIBUTION

It is inferred from paleoclimatic evidence that there have been significant changes in the natural distribution of *E. cloeziana* in response to climatic fluctuations. The present distribution represents only the current balance between climate, geology and soils, the influence of man and competition with other species.

E. cloeziana occurs within climatic boundaries ranging from tropical to subtropical, and from humid to subhumid. Mean annual rainfall is from 520-2400 mm, predominantly in summer but with high variability. Mean annual temperatures are from 18-24°C and light frosts (to -5°C) are experienced in parts of the range.

The species occurs principally in hilly or mountainous topography on a range of geological formations but principally sandstone and granites. The soils are permeable and free-draining, acidic, and mainly of low fertility.

Several factors appear to affect the geographic boundaries of the *E. cloeziana* distribution. Low availability of soil moisture in the winter-spring period is significant in determining the western and probably the northern boundaries. Low temperatures in the south may limit its southern extension. A combination of soil moisture availability, soil fertility level, and fire frequency appear to combine in establishing the boundary between tall eucalypt forest, including *E. cloeziana*, and rainforest.

Aboriginal man may have had an impact on *E. cloeziana* distribution through his use of fire and European settlers have further reduced it through clearing for agriculture, timber exploitation, and exotic pine planting. Populations on the more fertile sites with a high rainfall have been most affected.

VARIATION IN THE ADULT PHENOTYPE

Some indication of the range of variation in phenotypic characteristics of *E. cloeziana* was provided by Blakely (1934) and Hall *et al.* (1970). The current study measured morphological characteristics of from five to ten trees in each of 21 populations throughout the natural distribution (see Figure 2).

The adult phenotype of *E. cloeziana* under natural conditions was found to be very variable between populations and no doubt reflected the wide range of environmental conditions throughout its habitat. The most obvious difference between populations was in tree form. On the most favourable sites the populations consist of straight-boled individuals over 50 m in height but at the other extreme the trees are crooked and less than 15 m tall. Substantial variation was also found within and between populations in characteristics such as leaf width, fruit size, seed weight and bark persistence on the stem.

The patterns of variation observed were complex. Some characteristics varied continuously, others discontinuously and some apparently at random. This finding is similar to those of some other studies (e.g. Kirkpatrick 1973) and is in accordance with the views of Burley (1965) that the multidimensional interactions of the plant and the environment will produce continuous and discontinuous patterns of variation according to the particular selection pressures operating.

Many characters showed variation which could be correlated with an east-west gradient of decreasing moisture availability from the coast to inland areas. Characters such as tree height, leaf width and seed size followed this trend. However, some discontinuities were detected, apparently associated with local changes in soil moisture and nutrient status. There was also differentiation between northern and southern populations in leaf length, the mean number of seed and chaff particles in the fruit, and the amount of bark retained on the trunk. The adaptive significance of this variation was not clear.

The extent to which variation in the adult phenotype represents adaption to the site condition through plasticity, or is the result of more permanent genetic adaption was difficult to estimate. Bradshaw (1965) has suggested that plasticity is important in some characters in some situations but permanent adaption by genetic change is more common. A more accurate assessment of the stability of the phenotypic characters observed in the natural stands can be made when the phenotypes of the provenances established in a range of environmental conditions are compared.

VARIATION IN SEEDLINGS

The first direct evidence of genetic differentiation between provenances came from the variation observed in the seedling progenies of twenty provenances grown in a single controlled environment. Variation in quantitative characteristics such as leaf size and shape, and growth rate showed marked differences between populations and some within provenance variability. The seedling characteristics had similar patterns of variation to the adult characters. For about ten weeks after germination seedling growth was influenced by seed weight but subsequently growth rate was more closely correlated with seed origin. Provenances from coastal or subcoastal areas grew faster than inland provenances under the favourable moisture and nutrient conditions of this experiment. Much of the morphological variation in the seedlings also followed this east-west trend but some ontogenetic characteristics and morphological features, such as the presence of absence of leaf hairs, indicated that there is genetic differentiation between northern and southern populations. The overall patterns of variation shown by the seedling study indicated that *E. cloeziana* is genetically a highly variable species. It is polytypic and and exhibits polymorphism in some characters. Ontogenetic characteristics suggest that northern populations may have been isolated from southern populations for a long period of time.

One interesting fact which emerged from the seedling study was the ability of *E. cloeziana* to produce lignotubers, contrary to a previous report (Chattaway 1958). Lignotuber formation was observed in some southern populations but further study is required to show the pattern of variation of this characteristic.

CLASSIFICATION OF POPULATIONS

The relationship of the populations to each other based on the phenotypic characters of the adult trees in natural stands and the seedlings grown under uniform environmental conditions was examined using methods of numerical taxonomy described by Milne (1976) and Williams (1976). The data were classified into groups using an intensely clustering strategy (MULCLAS program) and ordinated using principal coordinate analysis (GOWER program).

The resulting groups of populations had a strong geographic and ecological basis. In terms of similarities and dissimilarities of morphological and growth characteristics *E. cloeziana* can be classified into four major groups. Populations north of latitude 19°S can be divided into two groups, one made up of coastal and subcoastal populations, of which Cardwell is typical, and the other of inland populations on the harsh sites of the Atherton Tableland. In the south, the subcoastal populations near Gympie form a group with distinctive characteristics and the populations of inland areas comprise the other. There are, however, populations in the south e.g. Monto (5) and Hungry Hills (6), in the north e.g. Reedy St George (16), and in central Queensland e.g. Eungella (12), which do not fit conveniently into these groups and may be regarded as intermediate between them. This is a typical situation in eucalypts, and taxonomists, e.g. Johnson (1976) have recognised that clearly-defined taxa exist in certain habitats but may grade into each other in intermediate environments.

PHYSIOLOGICAL RESPONSES

Temperature

Seedling growth under a range of temperature regimes in a phytotron provided some understanding of the influence of this single environmental factor on *E. cloeziana* provenances. The optimum temperature for many seedling growth parameters was within the range 24/19°C to 30/25°C (day/night temperatures). Maximum dry weight production of all provenances was achieved within this range and there was an indication that the 27/22°C regime may be close to the optimum. There was little provenance-temperature interaction.

It is unwise to extrapolate the results of growth in the artificial environment of a phytotron to predict performance under the influence of the complex interactions of the natural environment. The results showed temperature to be a factor likely to restrict the use of *E. cloeziana* to tropical and subtropical areas where temperatures are relatively high during the growing season. Inherent variation in growth rate between provenances indicates that coastal and subcoastal provenances will produce more dry matter irrespective of temperature if the levels of moisture and available nutrients are adequate.

Light intensity

Seedlings of four provenances, Gympie (3), Carnarvon (10), Cardwell (14) and Lappa (15) were grown in a phytotron in the open and under shade cloth transmitting 7%, 20%, 30% and 40% natural light.

There was evidence of differences in response between provenances originating in habitats with contrasting light regimes. The results suggest *E. cloeziana* is a shade intolerant species and that maximum growth rates can be expected when the seedlings are exposed to full sunlight. The Gympie (3) provenance was the most adapted to tolerate moderate levels of shade among the four populations tested. Variation between provenances in some of the characteristics measured, e.g. changes in leaf area ratio, could be related to conditions in the natural habitats.

BIOCHEMICAL VARIATION

Isozyme analysis was used to provide estimates of the amount of genetic variation within populations and the extent of genetic divergence between them. Estimates of this nature add to, and either refute or support, information from quantitative characteristics on geographical patterns of variation (Feret and Bergmann 1976).

Seed and seedlings from seventeen poulations were analysed for six isozymes using starch gel zone-electrophoresis and the basic techniques of Brewbaker *et al.* (1968). Standard genetic distance (Nei 1972) was calculated for the measure of difference between populations as a function of gene frequencies.

The results of the isozyme investigations supported the geographic patterns derived from the studies of morphological and physiological characteristics. They indicated that there is major genetic differentiation between northern and southern populations. This conclusion was also supported by the pattern of variation of characteristics such as bark persistence on the stem and leaf length in mature trees, leaf hairs and some ontogenetic attributes in seedlings, and the germination rate of seeds at different temperatures. A secondary division between inland and coastal populations was most apparent in the south where the isozyme studies added to the evidence which showed marked differentiation of populations in the Gympie area. The isozyme study also indicated that there is less differentiation between northern populations than those in the south. This had been suggested by the greater uniformity of seed and fruit attributes in the northern stands but was not obvious in most other quantitative characters.

The average heterozygosity index (Nei 1975) showed genetic variation within populations of *E. cloeziana* was relatively uniform, in contrast to the marked differentiation between populations. This may be the result of adaption to a relatively narrow ecological niche within a locality and is consistent with a species which occurs in small populations with rather sharply defined boundaries.

The genetic diversity of *E. cloeziana* is comparable with estimates made for predominantly outbreeding, insect-pollinated eucalypt species (Brown and Moran 1979).

DISCUSSION AND CONCLUSIONS

The records available indicate that seeds from the Gympie region were the initial introduction of *E. cloeziana* into many countries. This was the case in Zimbabwe-Rhodesia and the Republic of South Africa (L.J. Mullins, Rhodesia Forestry Commission, personal communication). The majority of the experience with this species as an exotic is therefore limited to a very restricted part of its gene pool. This study has shown that the Gympie populations have distinctive characteristics which are not typical of the species as a whole. This conclusion has important implications for forest practice.

A review of overseas experience indicated that *E. cloeziana* seedlings have the disadvantage of being difficult to transplant and sensitive to damping-off fungi in the nursery (Turnbull and Pryor 1978). Problems of this nature were found in the current study to be more severe in seedlings of Gympie origin than in most other seed sources. It has been shown also that the dense, compact crown of young trees, which is reported to be useful to suppress competition at an early stage (FAO 1974) is a characteristic confined to the coastal and subcoastal populations, and is especially well-developed in the trees of the Gympie region. Finally, the remarkably straight stem form which makes *E. cloeziana* such an excellent species for pole production (Poynton 1957) is clearly seen in the natural forests around Gympie but is less evident in populations of harsher environments. These examples suggest that reports in the literature of the performance and silvicultural requirements of *E. cloeziana* should not be applied unreservedly to all seed sources.

The high level of genetic differentiation between populations which has been demonstrated is strong support for provenance trials to be initiated and evaluated before a seed source is selected for extensive plantation establishment or for an intensive breeding program.

Fig. 1 The natural distribution of *Eucalyptus cloeziana*.

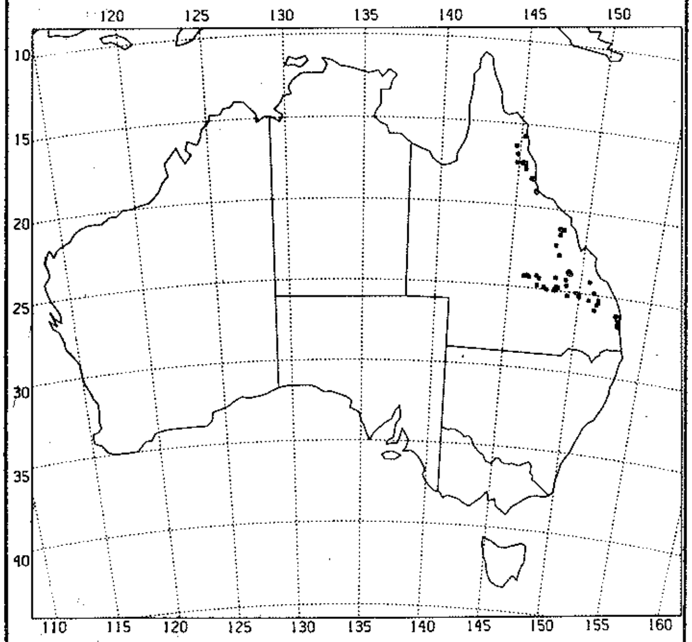
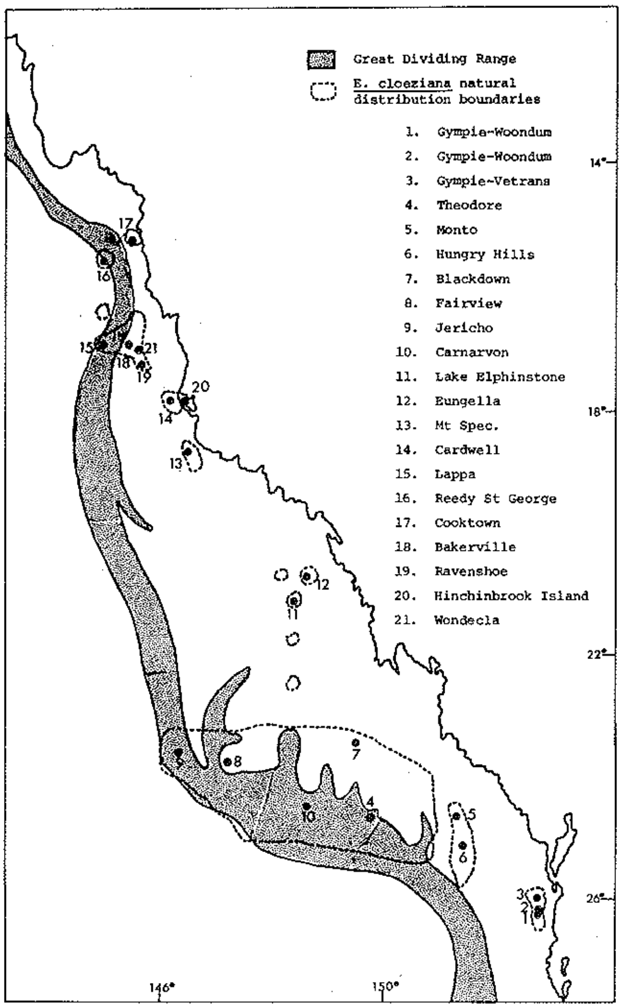


Figure 2 Location of sites sampled in this study



It is not possible to predict accurately the extent of genotype-site interactions which will undoubtedly occur when *E. cloeziana* is introduced into new environments. The study, however, provides information from which some general predictions can be made. Coastal and subcoastal provenances, such as Gympie, Monto, Mt Spec, Cardwell and Ravenshoe, will be most productive on sites with a short dry season, an annual rainfall over 1000 mm and a moderate level of soil fertility. Where site conditions are less favourable the capacity for survival during periods of stress may be a more important characteristic than an ability to grow rapidly. If conditions are not too severe populations from Hungry Hills, Blackdown, Eungella and Reedy St George may provide a good compromise between growth rate and survival but on extreme sites seed sources from Fairview and Lappa will be better adapted.

There was no evidence in this study to suggest that the growth rate of *E. cloeziana* provenances was correlated with their latitude of origin. The recommendation of the use of only tropical provenances in tropical areas, e.g. Willan (1979), appears therefore to have little basis. Detailed consideration of the environmental factors at each site, e.g. the severity of the dry season, will provide a more satisfactory basis for provenance selection for a particular location.

Where climatic matching is not attempted and it is desired to obtain a broad representation of variation of *E. cloeziana*, a trial using the following provenances is recommended: (1) Gympie (2) Monto or Hungry Hills (3) Theodore, Blackdown or Carnarvon (4) Fairview (5) Eungella (6) Cardwell or Mt Spec (7) Ravenshoe (8) Lappa. Seeds of these provenances are usually available from the CSIRO Seed Centre in Canberra.

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COMPORTAMENTO SUPERIOR PARA CRESCIMENTO INICIAL DE *EUCALYPTUS CAMALDULENSIS* DEHN (PETFORD) IN DEHRA DUM, INDIA.

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Resumo

Este estudo mostra que a procedência de Ptsford de *Eucalyptus camaldulensis* é distintamente superior em crescimento tanto no viveiro como no campo em Dehra Dum, em comparação a seis outros tratamentos com a mesma espécie ou espécies relacionadas e híbridos da espécie.

SUPERIOR EARLY GROWTH PERFORMANCE OF *EUCALYPTUS CAMALDULENSIS* DEHN. PETFORD PROVENANCE AT DEHRA DUN, INDIA.

Summary

This study shows that the Petford provenance of *Eucalyptus camaldulensis* originating from a place of that name in Queensland, Australia, is distinctly superior in growth performance in the nursery as well as in the experimental field at Dehra Dun, in comparison to six other treatments of the same or related species and species hybrids.

INTRODUCTION

There are several previous reports (Turnbull,1973;Eldridge, 1978) which indicate that the Petford provenance (S.6953) of *Eucalyptus camaldulensis* Dehn. originating from Northern Queensland, Australia, is consistently superior in performance in the moister tropical savannah conditions in Nigeria, Congo, Zambia, Zimbabwe(Rhodesia),Madagascar; it has also shown superiority in recent trials in Brazil, Laos, Mexico and in Nicaragua (Doran and Boland,1978). In a provenance trial at Dehra Dun, India, it proved one of the three leading provenances among a dozen tested till age 10 (Ghosh *et al*,1977). Using floral material from this trial, Venkatesh and Vakshasya, (1979) brought out the interesting fact that in the length of floral operculum, this provenance stood distinctly apart from the nine others studied.

In this paper is described the nursery and early field performance superiority of this provenance in comparison with six open pollinated families of *E.camaldulensis*-*E.tereticornis* F_1 and F_2 hybrids, Mysore Gum, *E.tereticornis* and *E.camaldulensis* single trees in an experimental trial at Dehra Dun.

MATERIAL AND METHODS

Bulk seed harvested "secondarily" from trees of Petford provenance in the aforementioned trial had been incorporated just for curiosity in a half-sib progeny trial started in 1976 at Dehra Dun and mainly consisting of fourteen open pollinated F_2 hybrid families derived from an equivalent number of F_1 hybrid trees belonging to two promising heterotic species crosses, FRI-4 (*E.tereticornis* X *E.camaldulensis*) and FRI-5 (*E. camaldulensis* X *E.tereticornis*). Also included as checks in this trial were open pollinated families of the original grandparent trees Ec$_2$PI and Et$_{14}$, one F_1 hybrid family of FRI-5 and a family derived from a selected average tree of Mysore Gum (*E.tereticornis*), the most widely planted eucalypt in India today.

TABLE 1

	Parameter	I	II	III	IV	V	VI	VII	Bar diagram
Nursery	7 mth. height (cm)	40.896	36.083	45.55	50.265	43.209	52.80	42.50	VI IV III V VII I II
	8 mth. height (cm)	76.188	66.854	83.927	92.082	80.837	78.16	81.354	IV III VII V VI I II
Field	1 yr. height (cm)	115.979	112.722	117.194	150.714	107.535	114.00	119.024	IV VII III I VI II V
	2 yr. height (cm)	271.915	234.722	207.391	300.357	240.000	238.298	175.912	IV I V VI II III VII
	2 yr. diam. (cm)	2.854	-2.702	2.151	3.665	2.767	2.664	2.070	IV I V II VI III VII

Index: I FRI-4-61; II Et.14; III F_1 of FRI-5; IV Petford; V FRI-5-96; VI MG 73; VII Ec_2PI.

All seedlots had been sown in earthenware pots during November 1976 and maintained in a glasshouse throughout the following three winter months. In March 1977, the three-month old seedlings had been pricked out individually into polythene container bags and kept in non-randomised lots in the open nursery till the final field planting in July 1977. A completely randomized blocks experimental design with 16-tree plots at 2m X 2m spacing replicated three times had been used for the field trial.

Two height measurements at 7 and 8 months age had been recorded in the nursery. The field measurements reported here include two height measurements each at the age of 1 and 2 years, and only one diameter measurement at age 2, half a metre from ground level. All surviving and undamaged plants were measured in each family plot but comparisons in this study have been limited to the Petford provenance, only one randomly chosen F_2 hybrid family each of FRI-4 and FRI-5, F_1 of FRI-5, Mysore Gum, Ec_2PI and Et14.

RESULTS

In table 1 are given the average values for height and diameter measurements at respective ages. It is seen that at 7 months the Petford treatment (IV) was second in height superiority but was statistically at par with the MG 73 family (VI) which had the highest mean height for any of the seven treatments at this age. During the following one month however, mean height increment was the highest in the Petford treatment which thereby surpassed the MG 73 family and came to occupy an exclusive first position which it maintained even at 1 year age. By the age of 2 years, FRI-4-61 family had grown up fast enough to attain the same bar as the Petford provenance but only for height. The first diametèr measurement at age 2 revealed that the Petford provenance was distinctly superior in this parameter as compared to the rest of the treatments.

DISCUSSION

The Petford treatment showed the best height and diameter growth performance. Moreover it had the most consistent growth increment pattern throughout the 2 year period. In striking contrast all the other six treatments were highly inconsistent. This is clear from their shifting relative positions in the bar diagram for height at successive ages. Both the F_2 hybrid families FRI-4-61 (I) and FRI-5-96 (V) were apparently slow to grow in the initial stages but improved with age. FRI-5 F_1 hybrid family (III) showed temporary superiority only at 8 months age but gradually declined thereafter. The Et_{14} family which was the poorest for height at both 7 and 8 months in the nursery, progressively improved with age. On theother hand MG 73 (VI) which showed initial promise at 7 months, rapidly declined to fifth place within a month. Ec_2PI family (VII) was near the top only at the age of 1 year but by age 2 had declined to the last position. In diameter also this family was the poorest.

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PROCEDÊNCIAS DE *EUCALYPTUS UROPHYLLA* S. T. BLACKE.

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. Engenheiro Florestal.

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Resumo

O E. urophylla é ainda pouco conhecido no Brasil, embora seja uma espécie com grande potencialidade para as regiões mais quentes e de elevados deficits hídricos do País.

Recentes introduções dessa espécie envolveram quase que exclusivamente procedências do ex-Timor português, possivelmente em razão da facilidade de comunicação e obtenção de sementes.

Entretanto, pouco ou nada se conhece quanto à introdução de procedências de E. urophylla originárias da Indonésia, ou seja, dos arquipélagos das Ilhas da Sonda onde essa espécie ocorre naturalmente.

No decorrer do ano de 1977, a Cia Vale do Rio Doce e Florestas Rio Doce enviaram uma missão mista à Indonésia, objetivando coleta de sementes desta espécie para estabelecimento de um banco genético, e experimentação para a seleção das melhores procedências/progênies.

EUCALYPTUS UROPHYLLA S.T. BLACKE PROVENANCES.

Summary

The E. urophylla is still not well knoun in Brazil, although it is a species that has a great potential for regions of the country that are very hot and have high water deficits.

Recent introductions of this species embraced almost exclusively provenances of the ex-Portuguese Timor, possibly due to facilitated communication and acquisition of seeds.

Nevertheless, little or nothing is known about the introduction of provenances of Endonesian E. maphylla *or, the archipelago islands of Sonda where this species grows naturally.*

Throughout 1977, the Cia Vale do Rio Doce and Florestas Rio Doce, sent a combined mission to Indonesia, with the objective of collecting seeds of this species to set up a genetic bank, and to carry out experiments for the selection of the best provenances progenies.

1. INTRODUÇÃO

O gênero Eucalyptus ocorre quase que exclusivamente na Austrália, com mais de 500 (quinhentas) espécies e inúmeras procedências e variedades.

Das espécies que ocorrem fora da Austrália, em número de 6 (seis), três aparecem no arquipélago da Indonésia, quais sejam,E. urophylla, E. alba e E. deglupta. Dentre estas, as duas primeiras ocorrem básicamente nas ilhas denominadas "da Sonda", ou seja, na Província de Nusa Tengara Timur, englobando as ilhas de Timor, Flores, Adonara, Lomblen, Pantar e Alor, conforme ilustrado no Anexo 1. Ocorrem também na ilha de Wetar, que administrativamente pertence à Província das Molucas.

A Indonésia, constituída de aproximadamente 13.000 ilhas, está localizada ao norte da Austrália, no continente asiático, nas seguintes coordenadas-geográficas: 95º a 145º de longitude este e entre 6º de latitude norte e 11º de latitude sul.

O clima da região varia de subtropical seco e tropical úmido, com três a seis meses de seca anualmente, sendo que a parte ocidental do País é mais úmida.

A Província de Nusa Tengara Timur apresenta uma precipitação média geral de 1.300 mm anuais, havendo entretanto, grandes variações pluviométricas de ano para ano, conforme ilustrado no Anexo 2.

A temperatura nessa Província varia de 20º C a 30ºC, em média.

2. Eucalyptus urophylla NA INDONÉSIA

Esta espécie ocorre básicamente nas ilhas, formando o arquipélago "da Sonda". Ela interessa ao Brasil em razão de seu bom desenvolvimento em regiões tropicais com chuvas periódicas, boas qualidades de madeira para carvão, serraria e celulose, larga plasticidade e, principalmente, resistência natural ao cancro provocado pelo fungo Diaporthe cubensis.

Há algumas incorreções quanto à denominação da espécie na Indonésia, uma vez que o E. urophylla é denominado E. alba e o E. alba verdadeiro é denominado E. platiphylla. Sabe-se que o E. platiphylla inexiste como espécie distinta, quer na Austrália, quer na Indonésia.

No Jardim Botânico de Bogor há duas árvores de E. urophylla em cuja placa de identificação se lê E. alba. Talvez aí resida o fato de o E. urophylla ter sido denominado, no Brasil, anteriormente, E. alba (Hídrido de Rio Claro), uma vez que, segundo consta, as sementes que deram origem à parcela de Rio Claro são provenientes da Indonésia, tendo sido colhidas dessas duas árvores, em Bogor.

O nome comum de E. urophylla na Indonésia varia de acordo com o local, sendo denominado Ampupu em Timor e Palawan-Mera em Flores, Adonara, Lomblen, Pantar e Alor

2.1. Timor

Até há bem pouco não se tinha quase que nenhuma idéia da ocorrência do E. urophylla na parte da ilha denominada Timor indonésio. No Brasil, especificamente, todas as procedências provenientes daquela ilha são originárias de ex-Timor português. Há alguma referência ao Timor indonésio apenas em trabalhos publicados pelo C.T.F.T., pouco profundos se comparados com as referências ao Timor português.

O fato é que no Timor indonésio há tantas ou mais procedências que no Timor português, concentradas, principalmente, nas regiões de Lelogama, MT. Timau e MT. Moutis, em altitudes que variam de 800 a 2.700 m, para o E. urophylla, e de 80 a 1.300 m, para o E. alba.

Há procedências de povoamentos puros das duas espécies, áreas com associações entre E. alba e E. urophylla onde ocorrem os hídridos, e associações do E. urophylla com outras espécies nativas. O E. alba não aparece associado com outras espécies nativas que não o E. urophylla. Fato bem claro também é que, sempre que associado com outras espécies nativas, inclusive E. alba, o E. urophylla é a espécie dominante.

Em Timor, os padrões fenotípicos dos eucalyptus são bem definidos e facilmente identificáveis. O E. urophylla tem casca rugosa em todo o tronco, folhas lanceoladas, com ponta recurvada, frutos pequenos e uniformes. O E. alba tem folhas arredondadas de tamanho variável, frutos de tamanhos também variáveis, com válvulas bastante proeminentes, casca lisa e clara. Os hídridos, nas "áreas de contato" das duas espécies, são identificáveis principalmente pelos dois tipos de casca presentes em todos os indivíduos, ou seja, rugosa até certo ponto e lisa no restante. Nesse caso, o tamanho e a forma dos frutos e das folhas apresentam grande variação.

A frutificação ocorre simultaneamente no E. urophylla e no E. alba, bem como nos hídridos, havendo grande possibilidade de cruzamento entre as espécies, quando próximas.

Os solos do Timor são originários de erupções vulcânicas, apresentando, com freqüênsia, afloramentos rochosos.

Nos locais mais protegidos, o grau de desenvolvimento do solo é maior, apresentando, conseqüentemente, vegetação mais exuberante.

Acima de 1.000 m, o clima varia de subtropical seco, na região de Lelogama, a subtropical úmido, na região de MT. Moutis, onde o inverno é chuvoso e a temperatura cai até 15º C nos dias mais frios.

2.2. Flores

O E. urophylla aparece nesta ilha, em povoamentos naturais, apenas na sua parte oriental, a partir de Maumere. No restante da ilha, a espécie é plantada em alguns locais, podendo-se encontrar povoamentos com mais de trinta anos de idade.

Ao contrário de Timor, a ilha de Flores apresenta vários vulcões ativos, cujas encostas são ocupadas por povoamentos puros de eucaliptos aparentemente mais jovens.

O clima é predominantemente tropical seco, sendo que o déficit hídrico aumenta de oeste para leste.

Os solos são aparentemente pouco desenvolvidos, sendo comum a presença de enormes blocos basálticos.

As principais procedências de E. urophylla estão concentradas nas regiões do MT. Egon, MT. Wukoh, MT. Lewotode e MT. Ilimandiri.

As características fenotípicas da espécie, nesta ilha, diferem bastante daquelas encontradas em Timor. Casca e frutos apresentam grandes variações, não sendo possível destacar indivíduos hídridos.

A maior parte dos indivíduos apresentam casca lisa na parte superior do tronco e rugosa na parte inferior.

Em altitudes superiores, os revestimentos com casca rugosa predominam, chegando a recobrir, inclusive, os ramos mais finos.

O E. alba aparece até as altitudes de 400 - 450 m, ocorrendo uma "área de contato" entre 450 e 550 m, dando lugar, em seguida aos povoamentos puros de E. urophylla até as altitudes de 1.350 m. a 1.450 m.

A frutificação ocorre simultaneamente nas duas espécies, não sendo, entretanto, uniformes, causando dificuldade na coleta de sementes, quando se definem procedências em faixas estreitas de altitude.

Nos locais mais protegidos, o E. urophylla aparece associado a outras espécies nativas, que não o E. alba, sendo sempre a espécie dominante nessas áreas.

2.3. Adonara

Nesta ilha, localizada a leste de Flores, nota-se a presença de E. urophylla apenas em dois locais. Um deles é denominado Ileboleng. Trata-se de um vulcão, ainda em atividades, que atinge a altitude de 1.670 m e cuja última erupção se deu em 1974, responsável pela eliminação de boa parte de cobertura florestal localizada nas suas encostas superiores.

Também se observa a ocorrência do E. alba e zonas de exploração agrícola até 550 - 600 m de altitude, aparecendo, a partir daí, os povoamentos puros de E. urophylla.

Acima de 950 m, toda a cobertura vegetal está práticamente, morta, podendo-se notar, ainda, árvores secas, queimadas pela elevada temperatura do solo, provocada pela emanação dos gases quentes do vulcão.

As variações das características fenotípicas aparecem aqui tanto quanto em Flores, havendo desuniformidade total quanto ao Tipo e coloração de casca e tamanho dos frutos.

Os solos são originários de erupções vulcânicas, aparecendo, com freqüência, afloramentos rochosos.

2.4. Solor

Nesta ilha, segundo informações locais, não ocorre o E. urophylla.

2.5. Lomblen

Esta é a quarta ilha da Província em dimensões, apresentando várias regiões de ocorrência do E. urophylla, das quais duas foram visitadas. A primeira região onde aparece os E. urophylla é o vulcão Ileape. Aqui, o E. alba se faz presente até a altitude de 650 m. Nesses povoamentos não foi observada qualquer frutificação. Entre 650 e 750 m, na encosta oeste do vulcão, aparecem plantios de coco, efetuados pela população local. Na sua face leste, acima de 750 m, aparece logo o E. urophylla, havendo uma faixa de contato como o E. alba entre 650 e 750 m. Em áreas compreendidas entre 750 e 950 m, o E. urophylla aparece sob a forma de povoamentos puros e contínuos.

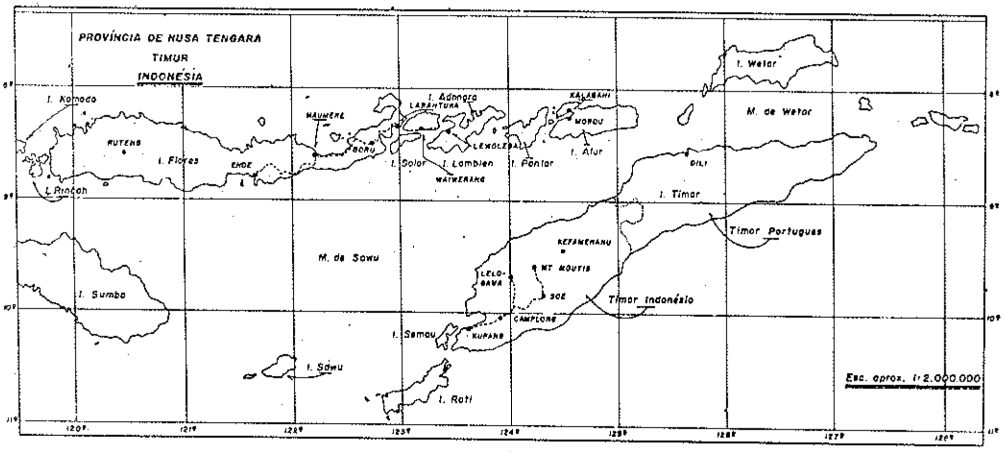
As variações fenotípicas nessa área não são tão pronunciadas como em Flores e Adonara. A presença da casca rugosa é mais uniforme, variando apenas o tamanho dos frutos e a coloração da casca.

O porte dos indivíduos é baixo e sua forma deixa a desejar, possivelmente em razão da idade dos povoamentos e dos fortes ventos que assolam a região em determinadas épocas do ano, notando-se que todas as árvores apresentam ramos e galhos quebrados.

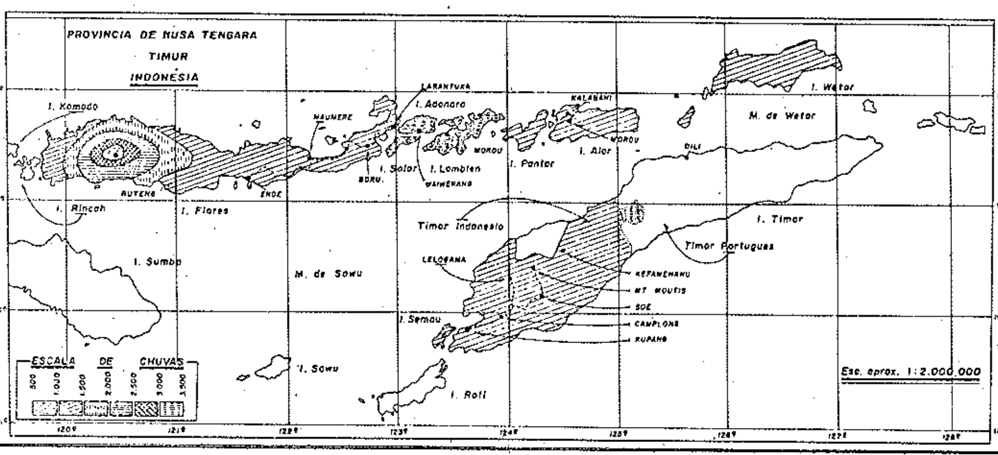
Acima de 1.000 m não há nenhum tipo de vegetação viva. Todas as árvores estão mortas, devido à elevada temperatura do solo, causada pela intensa atividade do vulcão.

A outra região visitada, denominada Lelawerang, está localizada a 30 Km de Ileape. Não se tratando de encostas de vulcão, tudo faz crer que, no passado, toda a ilha, nos locais de altitudes acima de 700 m, era coberta com E. urophylla. A exploração indiscrimi-

— ANEXO —



— ANEXO 2 —



nada pelo homem tem mudado o quadro original, transformando os maciços puros de *E. urophylla* em apenas manchas dispersas dos locais de difícil acesso para exploração.

Observa-se que a variabilidade das características fenotípicas é maior que em Ileape, não aparecendo nas redondezas o *E. alba*, embora se note, dentro dos povoamentos de *E. urophylla*, em certos locais, indivíduos com características de *E. alba*.

Nessa área, os solos são um pouco mais desenvolvidos que em Ileape.

2.6. Pantar

À medida que se avança para o leste, o grau de desenvolvimento nas ilhas diminui e aumentam as dificuldades de todos os tipos.

A ilha de Pantar não é servida por nenhuma via regular, quer marítima, quer aérea. Para se alcançar a ilha, deve-se alugar um barco, uma vez que não há meio de transporte mais rápido e barato.

O *E. urophylla*, nesta ilha, ocorre básicamente em três regiões, das quais apenas uma foi visitada.

A procedências visitada se encontra no local denominado Guman Palmen, ao sul da ilha, sendo que o *E. urophylla* ocorre a partir de 560 m de altitude, não havendo povoamentos de *E. alba* nas proximidades.

As variações são as mesmas quanto a casca e frutos. A população local tem o hábito de podar as árvores para que, rebrotando, produzam mais madeira para uso doméstico. Assim, a quase totalidade das árvores se encontrava podada, não se podendo caracterizar exatamente sua forma original.

Esses povoamentos não são muito extensos e contínuos, apresentando baixíssima densidade por unidade de área.

O solo apresenta-se bastante arenoso, com afloramentos rochosos em certos locais, podendo-se incluir que se trata de solos de origem vulcânica bastante evoluídos.

2.7. Alor

Ilha localizada no extremo nordeste da Província.

Encontra-se aqui a procedência de mais baixa altitude de todas as ilhas visitadas.

O *E. urophylla* ocorre disperso em manchas, que variam de alguns indivíduos a vários hectares, circundando ora por outras espécies nativas, ora por povoamentos de *E. alba*.

Observa-se claramente, que o *E. urophylla* ocorre nas manchas de solos melhores e bem desenvolvidas, ao passo que o *E. alba* surge nos locais pedregosos e em solos menos desenvolvidos.

Na localidade próxima à aldeia de Pintumas aparece um povoamento de *E. urophylla* a 370 m de altitude. Esse povoamento, totalmente circundado por maciços de *E. alba*, apresenta uma área de contato bastante clara e característica.

As variações do *E. urophylla* quanto a cascas e frutos também aqui são bastante pronunciadas, encontrando-se a mesma desuniformidade das procedências de Flores.

Não há vulcões ativos nessa ilha, embora os solos tenham cacacterísticas daqueles provenientes de erupções vulcânicas. Os afloramentos são freqüentes e característicos de rochas basálticas.

EUCALYPTUS UROPHYLLA NA COSTA DO MARFIM.

F. Wencelius.

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Côte d'Ivoire.

Resumo

Em 1974, o CTFT iniciou experimentação com o *Eucalyptus urophylla* na Costa do Marfim. Esta espécie mostrou uma grande variabilidade ligada à procedência, árvore matriz e condições de solo.

As melhores procedências foram as de baixa altitude das ilhas de Seor, Flores e Tomblem.

Esta espécie não suporta competição intensa e precisa de densidades abaixo de 600 fustes por ha.

O Eucalyptus urophylla se comporta melhor que o *Eucalyptus deglupta* mas precisa de um programa de seleção e melhoramento para ser usado em florestamentos em grande escala.

Summary

C.T.F.T. commenced experiments on *Eucalyptus urophylla* in Ivory Coast in 1974; this species has shown an extreme variability linked with provenance, mother-tree and soil conditions.

The best provenances are those from low altitude in the Alor, Flores and Lomblen islands of Indonesia.

The species cannot stand heavy competition and needs plantation densities below 600 stems per ha. *E. urophylla* is capable of better growth than *E. deglupta* but needs a programme of selection and improvement before being used on large scale afforestation.

EUCALYPTUS UROPHYLLA EN CÔTE D'IVOIRE.

Resumé

Le CTFT a initié en 1974 une expérimentation en Côte d'Ivoire sur *Eucalyptus Urophylla* dont le comportement est très variable selon la provenance, la descendance et les conditions édaphiques. Les meilleures provenances sont celles, de basse altitude, des îles d'Alor, Flores et Lomblen.

L'espèce est très sensible aux phénomènes de concurrence et ne doit pas être mise en place à une densité supérieure à 600 tiges/ha ; elle peut avoir des performances supérieures à celles *d'Eucalyptus deglupta* en plantation industrielle mais doit pour cela faire l'objet d'un important programme de sélection et d'amélioration.

INTRODUCTION

Le Projet de création d'une industrie papetière dans le sud-Ouest de la Côte d'Ivoire, prevoit la réalisation de plantations industrielles d'espèces à croissance rapide pour assurer la continuité de l'approvisionnement de l'usine en matière première après exploitation de la forêt naturelle.

Les essais d'élimination d'espèces, menés par le CTFT dans le cadre de ce projet sur la station de San Pedro, ont notamment porté sur une trentaine d'espèces d'Eucalyptus parmi lesquelles seul Eucalyptus deglupta pouvait être retenu ; afin d'élargir encore l'utilisation du genre, Eucalyptus urophylla a été expérimenté à partir de 1974 sur cette station. Cette expérimentation a eu pour base les importantes collectes de graines réalisées par le CTFT dans les îles de la Sonde.

MILIEU

La plupart de ces essais ont été implantés sur la station principale de San-Pedro (Latitude 4°45'N, Longitude 6°38'W) dont le climat (Guinéen Forestier groupe équatorial Attien occidental) comporte deux saisons des pluies, l'une de Mars à Juillet (maximum en Juin) et l'autre de Septembre à Décembre, la pluviomètrie annuelle moyenne est de l'ordre de 1.600 mm sur les 9 dernières années.

Les sols sont ferralitiques, le type remanié modal, issus de Gneiss très fins dont le faciés peut se confondre avec celui de micaschistes.

Pour la mise en place des essais, la végétation préexistante (Forêt dense floristiquement intermédiaire entre les forêts sempervirente et semi-décidue) a été abattue manuellement et brûlée.

ESSAIS MIS EN PLACE.

Les caractéristiques et les résultats des essais d'Eucalyptus urophylla sont présentés ici dans l'ordre chronologique de leur mise en place.

Essais comparatif de descendances (1974).

Cet essai fait intervenir 140 descendances venant de 52 provenances dans un dispositif en blocs complets randomisés, comportant 3 répétitions, où la parcelle unitaire contient 32 plants mis en place, à 4 m sur 2 m. ; 98 descendances sont effectivement répétées trois fois, elles viennent de 45 provenances :

Timor	:	35	Provenances s'échelonnant	entre 500 m et 2300 m	d'alti.
Flores	:	8	"	" 400 m et 900 m	"
Lomblen	:	2	"	" 520 m et 870 m	"

Aux descendances d'Eucalyptus urophylla a été ajouté, comme témoin, un traitement "Eucalyptus deglupta" (origine Côte d'Ivoire).

Les observations ont d'abord porté sur la hauteur (1975), la circonférence et la forme (1976) et ont fait l'objet d'une première publication (1) ; elles ont ensuite concerné le volume (1978 et 1979), la circonférence (Août 1979) et, devant l'importance qu'il prenait, sur le phénomène de descentes de cimes (Mai 1980) :

- Les cubages de 522 arbres abattus, toutes descendances confondues, dont la circonférence s'étend de 21 cm à 84 cm et la hauteur de 6 m à 31 m ont permis d'établir divers tarifs de cubage dont le mieux adapté est celui qui donne le volume papetier sur écorce (V), en m3, en fonction de la circonférence (C), en cm, selon la formule suivante :

$$V = 1.57235\ (-2) - 2.34835\ (-3)\ C + 1.14696\ (-4)\ C^2$$

- L'analyse des observations du mais d'Août 1979, sur le critère de la surface terrière, fait apparaître un effet "traitement" très hautement significatif, un effet "bloc" hautement significatif malgré une très forte variabilité au niveau d'un grand nombre de descendances (le coefficient de variation, sur les 3 répétitions, varie d'une descendance à l'autre de 1% à 93% alors qu'il est de 8% pour Eucalyptus deglupta).

L'effet "traitement" se décompose, d'une part, en un effet de la provenance caractérisé par la nette influence de son altitude sur les performances des descendances (cf. figure n° 1) et en un

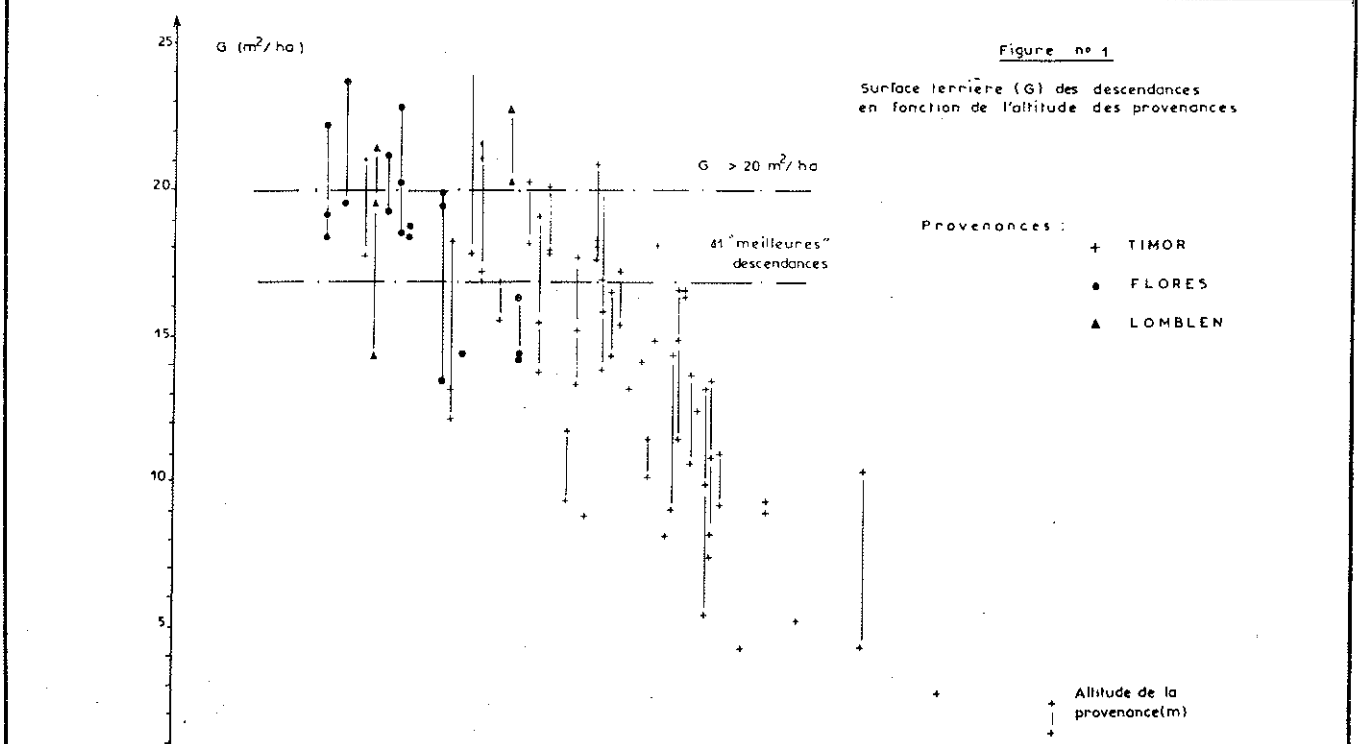

Figure n° 1

Surface terrière (G) des descendances en fonction de l'altitude des provenances effet de la descendance qui peut être très hautement significatif quelle que soit l'altitude de la provenance.

Le groupe de tête des descendances, ne différant pas significativement l'une de l'autre selon le critère envisagé, est constitué de 41 descendances :

Timor : 23 descendances venant de 12 provenances
Flores : 14 descendances venant de 6 provenances
Lomblen : 4 descendances venant de 2 provenances

L'altitude des provenances dont viennent les descendances du groupe de tête varie de 400 m à 1.250 m.

Le volume sur pied, pour ce groupe de tête, varie de 172.1 m3/ha à 243.0 m3/ha alors qu'il est de 223.3 m3/ha pour Eucalyptus deglupta.

- Les observations du mois de Mai 1980 ont porté, d'une part, sur 420 arbres pris au hasard sur l'ensemble du dispositif qui ont fait l'objet de cotations précises quant à l'importance du phénomène de descente de cime et à la place de l'arbre dans le peuplement et, d'autre part, sur les 16 descendances dont la surface terrière dépassait 20 m2/ha lors des observations du mois d'Août 1979 :

. Si l'on considère comme "dépérissants" les arbres affectés d'une forte descente de cime, l'analyse des 420 observations individuelles montre que 2 % des arbres dominants le sont, pour 30 % des arbres de remplissage et 85 % des arbres dominés. Les arbres dominants, qui forment 38 % de la population observée, représentent 2 % des arbres dépérissants et 76 % des arbres sains.

. Parmi les 16 "meilleures" descendances de l'essai, le rapport du volume de l'arbre sain moyen à celui de l'arbre moyen atteint de descente de cime varie de 1.4 à 2.6, ce rapport étant très lié et inversement proportionnel à la fraction (V %) du volume total du peuplement atteinte de descente de cime. Pour ces 16 descendances, dont la productivité ne diffère pas significativement, l'étendue des caractéristiques de peuplement est à 6 ans la suivante:

Caractéristiques de peuplement	Minimum	Maximum
Nombre total de tiges/ha	787	1.029
Surface terrière (G) en m2/ha	20.9	26.1
Volume total sur écorce (V) en m3/ha	203.0	262.5
V % (cf définition donnée plus haut)	12	55

Le paramètre V % est significativement lié à la descendance et, au niveau de la parcelle unitaire, au volume (V) et, en sens inverse, à la densité du peuplement (N).

Cet essai montre l'extrême variabilité du comportement d'Eucalyptus urophylla sur la station de San-Pedro en fonction de la provenance, d'une part, et du pied-mère, d'autre part ; selon l'origine des graines les performances de cette espèce peuvent être supérieures à celle d'Eucalyptus deglupta ; les descentes de cime et la mortalité, constatée après l'âge de 5 ans sur des parcelles plantées à raison de 1.250 tiges par ha, ne sont pas pathologiques ; elles sont liées à une très forte concurrence et n'affectent que les arbres dominés, elles sont aggravées par des facteurs stationnels interférant plus ou moins avec les facteurs génétiques selon le degré d'adaptation aux conditions écologiques de San-Pedro des descendances étudiées.

Verger à graines de familles (1975).

Parmi les descendances testées dans le précédent essai, 19 ont été retenues sur la base de leur croissance en hauteur au cours des 6 mois suivant la plantation et sur celle de la quantité de graines encore disponible en Côte d'Ivoire à la fin de cette période.

Ces 19 descendances viennent de 13 provenances dont 6 de Timor (7 descendances), 5 de Flores (9 descendances) et 2 de Lomblen (3 descendances) ; afin de servir de base à la constitution d'un verger à graines de famille, elles ont été mises en place dans un dispositif monoarbre où chaque descendance est représentée par environ 110 plants, ceux-ci étant mis en place à raison de 625 à l'ha.

Parmi ces 19 descendances, 11 seulement figurent dans le groupe de tête de 41 descendances défini par l'analyse des observations réalisées en Mai 1979 dans l'essai comparatif de descendances de 1974 évoqué plus haut, parmi ces 11 descendances, 1 vient de Timor, 8 de Flores (4 provenances) et 2 de Lomblen (2 provenances).

Seules ces 11 descendances devraient être conservées pour constituer ce verger à graines où les premières fructifications ont été observées en 1978 ; la première récolte n'a pu avoir lieu que sur un arbre et a donné lieu à la mise en place d'une parcelle de comportement de la première descendance ivoirienne d'Eucalyptus urophylla en 1979 sur le point d'appui de Sassandra.

Les observations de descentes de cime sur les 5 "meilleures de ces 11 descendances montrent que la valeur moyenne du paramètre V % est de 2 % alors que, pour les mêmes descendances, elle est de 30 % dans l'essai comparatif de descendances de 1974 où la densité du peuplement est double ; ici aussi, seuls les arbres dominés sont atteints.

Bien que cela ne corresponde pas au but de sa mise en place ce verger à graines de famille permet de confirmer les conclusions apportées par l'essai comparatif de descendances de 1974 au sujet de l'influence de la concurrence sur le comportement d'Eucalyptus urophylla.

Essai comparatif de descendances (1976).

Cet essai fait intervenir 30 descendances venant de 9 Provenances dans un dispositif en blocs complets randomisés, comportant 3 répétitions, où la parcelle unitaire contient 32 plants mis en place à 3 m sur 2.75 m ; 20 Descendances sont effectivement répétées 3 fois, elles viennent de 8 provenances dont 6 d'Alor (16 descendances) et 2 de Wetar (4 Descendances).

Les observations ont porté sur la circonférence (Janvier 1980) et, pour les meilleures provenances, sur le phénomène de descente de cime (Mai 1980).

- L'analyse des observations du mois de Janvier 1980 donne les mêmes conclusions, que celles apportées par le précédent essai du même type, quant à la signification des effets "traitement" et "blocs", l'irrégularité de la variation intradescendance et l'influence de l'altitude de la provenance sur les performances.

- Les 8 "meilleures" descendances, sur la base de la précédente analyse, viennent de 3 provenances d'Alor ; elles ont fait l'objet d'observations sur les descentes de cime qui affectent des arbres dont la circonférence moyenne varie de 27 cm à 36 cm d'une descendance à l'autre alors que celle des arbres sains varie de 37 cm à 45 cm.

Pour ces 8 descendances, l'étendue des caractéristiques de peuplement est à 4 ans la suivante :

Caractéristiques de peuplement	Minimum	Maximum
Nombre total de tiges/ha	846	960
Surface terrière (G) en m2/ha	9,7	13,3
Volume total sur écorce (V) en m3/ha	79,2	120,0
V % (cf-définition donnés plus haut)	1	28

Sur cet essai, les conclusions, sur le déterminisme du phénomène de descentes de cimes, sont les mêmes que celles qui ont été données plus haut ; du fait du plus jeune âge, cependant, le phénomène est beaucoup moins marqué .

Essais de comportement 1976 et 1977.

En même temps que le précédent essai, étaient mis en place côte à côte 7 parcelles de comportement à des espacements échelonnés de 2,5 m x 2,5 m à 4 m x 4 m ; à l'âge de 3 ans et 9 mois la productivité ne varie pas d'une parcelle à l'autre (# 95 m3/ha) alors que le diamètre moyen varie de 12 cm à 16 cm de la plus faible à la plus forte densité .

Une parcelle de comportement a été plantée à 4 m x 4 m en 1977 à partir d'un mélange de "bonnes" descendances ; à 2 ans et 3 mois, les caractéristiques de peuplements sont les suivantes = N = 520 tiges/ha, diamètre de l'arbre moyen = 13 cm, G = 6.5 m2/ha, V = 55.0 m3/ha.

Essais récents.

En plus de la mise en place, déjà évoquée, d'une première descendance du verger à graines de familles, des parcelles de comportement de boutures d'Eucalyptus urophylla ont été plantées en 1979.

En 1980 ont été mis en place sur la station de San Pedro un parc à clone et deux tests clonaux qui font intervenir 19 clones d'Eucalyptus dont 5 d'Eucalyptus urophylla, résultat d'une première sélection d'arbres dans les plantations de 1974.

CONCLUSION

Eucalyptus urophylla a sur la station de San Pedro un comportement très variable selon la provenance des graines, la descendance au sein des provenances et les conditions édaphiques qui lui sont proposées.

Les meilleures provenances pour la Côte d'Ivoire sont celles de basse altitude ; les provenances des îles d'Alor, Flores et Lomblen donnent les meilleurs résultats.

L'espèce est très sensible aux phénomènes de concurrence et ne doit pas être mise en place à une densité supérieure à 600 tiges/ha ; elle peut avoir des performances supérieures à celles d'Eucalyptus deglupta en plantation industrielle pourvu que soit exploitée sa très grande variabilité génétique par un programme de sélection et d'amélioration qui, du fait de la médiocre efficacité des tests précoces, doit être de longue haleine.

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TESTES DE PROCEDÊNCIA DE *EUCALYPTUS DEGLUPTA, E. UROPHYLLA* E *E.ALBA* EM PORTO RICO.

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Puerto Rico.

Resumo

Como parte de um teste de procedência internacional, 3 espécies de *Eucalyptus* foram testados em dois "sites" em Porto Rico, um deles uma combinação de Tanana argiloso e Coloso argilo-barroso (subtropical molhado), o outro um mayo barro-arenoso (subtropical úmido). Ambos os "sites" representam grandes áreas reflorestáveis em Porto Rico. Cinco procedências para *E. deglupta* Blume e para *E. mophylla* Blake e 2 para *E. alba* Reinw ex Blume foram plantadas em 1971. O *E. deglupta* e o *E. mophylla* cresceram bem em ambos os "sites", com variações devido tanto ao "site" quanto às procedências. A altura e o diâmetro médio variaram respectivamente de 16,6-24,0 m e 14,2-21,7cm. O crescimento do *E. alba* foi menos expressivo com altura média de 13,9 m e diâmetro médio de 12,6 cm.

EUCALYPTUS DEGLUPTA, E. UROPHYLLA E *E.ALBA* PROVENANCES TESTED IN PUERTO RICO.

As part of an international provenance trial, 12 provenances representing, 3 - Eucalyptus species were tested in Puerto Rico on 2 sites, one a combination of Tanama clay and Coloso silty clay loam (subtropical wet), the other a Mayo sandy loam (subtropical moist). Both sites represent large reforestable areas in Puerto Rico. The trials contained five provenances each of E.deglupta and E.urophylla and 2 provenances of E.alba and were outplanted in 1971. E.deglupta and E. urophylla grew quite well on both sites, with variation due both to site and to provenance. After 8 years mean heights and diameters ranged from 16.6-24.0m and 14.2-21.7 cm respectively. E.alba growth was less impressive with mean heights of 13.9m and mean diameters of 12.6cm.

Eucalyptus deglupta Blume is found from 10°N to 11°S, from 118°E to 153°E, and from near sea level to 2500m. Important differences between isolated populations were reported by Davidson (1973). The species tolerates a wide range of soil - conditiond but grows best on wet sites with good drainage. A vigorous colonizer it requires full overhead light and recently disturbed sites. Most natural stands receive 2500 to 5000 mm of rainfall annually and occur where there is no prolonged dry season. This species has excellent form, prunes well naturally, produces good sawtimber, maintains high volumes in plantations, and may grow to 45m height and over 50cm in 15 years (Davidson 1968, Grijpma 1969, Turnbull 1970).
E.urophylla Blake occurs from 8°S-10°S and from sea level to 3000m.
Most natural stands receive 1000 tp 1500mm of rainfall annually and endure no severe dry season. This species, which exhibits considerable provenance variation, appears suitable for pulp production and for most general wood products, therefore it is considered along with E.deglupta as among the better low latitude eucalypt species (FAO 1976). It was formely called E.decaïsneana (Davidson, 1976).
E.alba Reinw, ex Blume ranges from 6°S to 17°S and from sea level to 500 m or more. Though its natural distribution overlaps that of E.urophylla, and there was formerly some confusion, it is a quite separate species.
On account of its wide geographic range makes it is a potentially interesting species for provenance study. Natural stands receive from 750 to 2000 mm of rainfall annualy with a dry season, which can be severe, of up to 8 months.

Table 1. Origin of Eucalyptus provenances tested in Puerto Rico

SPECIES	FTB CODE	ITF CODE	PROVENANCE	LATITUDE	ALTITUDE	SOIL
E.deglupta	8862	B	Papua New Guinea (Goroka)	6°02'S	1815m	-
E.deglupta	8863	C	Papua New Guinea (Raba Raba)	9°58'S	150m	-
E.deglupta	9291	D	Philippines (Mindanao)	7°36'N	515m	sandy-silty, sand alluvial fan
E.deglupta	9379	F	New Britain (Keravat)	4°19'S	0-90 m	river flat
E.deglupta	9408	G	Philippines (Mindanao)	6°15'N	390m	sandy loam
E.urophylla	8994	H	Indonesia (Timor)	8°37'S	635m	schist
E.urophylla	9003	I	Indonesia (Timor)	8°47'S	1090m	schist
E.urophylla	9008	J	Indonesia (Flores)	8°40'S	420m	recent volcanic
E.urophylla	9010	K	Indonesia (Timor)	9°37'S	1240m	limestone
E.urophylla	9016	L	Indonesia (Timor)	8°39'S	575m	schist
E.alba	8992	M	Indonesia (Timor)	8°42'S	360m	slate pH 8
E.alba	9007	N	Indonesia (Flores)	8°40'S	120m	-

As is the case with E.urophylla, this species is an active hybridizer (FAO 1976) Both E.urophylla and E.alba are described by Martin and Cossalter (1975-1976). The objective of this study was to compare the survival growth in height and diameter (DBH), and survival of the different provenances of these 3 low latitude eucalypts in order to judge their suitability for plantations in Puerto Rico.

PROCEDURE: The Australian Forest Research Institute of Canberra and the United Nations Food and Agriculture Organization set up an international provenance trial of these species and collected the 12 seedlots used in this study (Table 1) in 1969. The seedlots are listed in table 1. In January 1971 part of each of the seed lots we received was sown and the resulting seedlings grown in polyethylene bags, were outplanted at Rio Abajo in August.

At Rio Abajo, which is in the northwestern karst region of the island, about half of the trees were planted on a slope with Tanamá clay (Lithic Tropudalf), and the others were planted on an adjacent flat with Coloso silty clay (Aeric Tropic Fluvaquent). Altitude is about 300 m, and life zone is subtropical wet with 2500mm rainfall annually (Ewel and Whitmore 1973).

Seed for a second planting was sown in April 1971 and the seedlings were outplanted at Yabucoa in November 1971.

The Yabucoa site, about 50m elevation, is a Mayo sandy loam (Typic Dystropet). The life zone is subtropical moist with an estimated 2000mm anual rainfall. The two sites represent large areas of Puerto Rico that could support commercial timber plantations. They also represent two of the four major soils available for reforestation on the island.1/

The five provenances each of E.deglupta and E.urophylla were planted at both sites. The two provenances of E.alba were planted at the Yabucoa site only. The trees were planted in four-tree line plots with 12 replications. After 2 years they were examined for height growth and survival (Whitmore and Macia 1975). Hieght growth and diameter growth were also measurea after 5 and 8 years and the results were evaluated by analysis of variance and Duncan's multiple range test (Figueroa and Whitmore, 1980). This report summarizes the 2 year, 5 year and 8 year results.

RESULTS - Average survival, height and diameter of the provenances after 2, 5 and 8 year are shown in Table 2, as well as an indication of wind damage. Statistical significance of differences after 8 years is shown in Table 3.

CONCLUSIONS - Eight years after outplanting, the results of this trial lead us to certain conclusion.

1. Eucalyptus alba is inferior to the other two species, in both height and DBH growth, on the one site where it was tested.
2. Height and DBH growth of some provenances of E.deglupta and some of E.urophylla was excellent. These two species may offer a great a deal of promise for industrial plantations in Puerto Rico.
3. Both of these species should be tested on additional sites as there are certain soils on which they perform poorly.
4. One provenance of E.urophylla (L) grew quite well on one site and quite poorly ont the other, while some provenances of both species (H, D,F) grew well on both sites. These should be included in further adaptability tests.
5. An eight-year rotation is feasible for E.deglupta and E.urophylla on optimum sites. By the eight year they certainly have reached merchantable size. However, since growth continues steadily through the eight year, a longer rotation may be a more economic option.
   Eight year height increments at Yabucoa seem to be decreasing, but this is largely due to removal of largest trees by the hurricane or for utility pole trials.
6. Survival, a parameter affected by hurricanes, grazing cattle, accidents due to weeding procedures, and harvest of six of the largest trees for utilization tests, is at acceptable for most of the provenances. It also is a parameter which can be improved by cultural practice. The fact one of the best provenances (H) was hardest hit-by wind probably means simply that large trees fall first in a hurricane (although some taller provenances did resist well).
7. E.deglupta appears to be gaining on E.urophylla at Yabucoa, but this is due to the hurricane, which felled many of the larger specimens of E.urophylla.

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1/ A third site was located at Guzman in the Caribbean National Forest at an elevation of 330m and an estimated anual rainfall 0f 2400mm. The life zone is subtropical wet and the soil is in the Los Guineos series (Epiaquic Tropohumult). This site demonstrated the effect of a poor soil on the performance of these species. The plantation averaged 3 cm yearly height growth and was abandoned two years after outplanting. Characteristics of the site include heavy clay, poor drainage, and compaction due to grazing.

Table 2.

Height (m), diameter (cm) and survival (%) trends using 2nd, 5th, and 8th year data, by site and provenance. Final column shows wind damage (number of trees damaged). These are trees damaged beyond possible recovery, are considered dead, and are excluded from height and DBH calculations. Note that the Yabucoa site was directly affected by Hurricanes David and Frederick just prior to measurement in 1979. DBH was not measured in 1973.

SITE	PROVENANCE	HEIGHT			DBH		SURVIVAL			Damage as of October 1979
		1973	1976	1979	1976	1979	1973	1976	1979	
RIO ABAJO										
	E.deglupta B	4.9	17.1	25.7	14.5	22.2	73	54	29	09
	E.deglupta C	3.7	15.3	20.8	11.5	14.9	90	60	48	03
	E.deglupta D	5.7	17.9	26.9	16.0	24.2	73	70	57	01
	E.deglupta F	5.0	16.3	22.0	14.2	20.1	82	67	55	04
	E.deglupta G	3.8	15.2	25.2	14.7	22.8	81	40	33	01
	E.urophylla H	3.4	14.1	21.6	13.7	19.2	83	55	38	03
	E.uróphylla I	3.2	10.3	13.3	9.3	12.6	73	48	48	01
	E.urophylla J	5.3	14.7	19.3	12.7	16.4	79	68	68	01
	E.urophylla K	4.5	13.3	16.8	10.6	13.3	65	69*	48	06
	E.urophylla L	3.8	10.8	13.3	9.6	10.6	68	39	39	0
YABUCOA										
	E.deglupta B	2.2	12.5	18.1	11.4	16.7	67	56	33	05
	E.deglupta C	2.2	11.6	16.0	9.5	13.9	67	58	35	02
	E.deglupta D	3.2	15.1	19.8	14.0	17.6	92	92	83	01
	E.deglupta F	3.0	14.5	19.4	11.2	18.4	69	67	58	03
	E.deglupta G	2.4	12.5	18.0	14.1	15.7	77	60	52	02
	E.urophylla H	3.8	14.9	20.5	16.2	25.2	81	79	44	15
	E.urophylla I	3.2	14.3	17.9	14.5	18.7	79	83*	54	11
	E.urophylla J	3.6	17.0	21.6	16.3	23.2	85	88*	56	10
	E.urophylla K	3.5	14.3	18.3	13.4	18.2	81	79	69	04
	E.urophylla L	3.7	15.4	22.0	16.8	23.7	79	79	62	07
	E.alba M	3.1	10.9	14.0	9.3	12.8	85	69	40	11
	E.alba N	3.0	11.7	13.9	9.7	12.5	75	73	56	04

* A few trees that were "dead" in 1973 were alive and well in 1976.

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Table 3.

Provenance performances (height and diameter means) 8 years after outplanting at Rio Abajo and Yabucoa. Means not followed by the same letter are significantly different at the $p < 0.05$ level, according to Duncan's multiple range test.

PROVENANCE	MEAN HEIGHT	PROVENANCE	MEAN DBH (cm)
		RIO ABAJO	
E.deglupta D	26.9 a	E.deglupta D	24.2 a
E.deglupta B	25.7 ab	E.deglupta G	22.8 a
E.deglupta G	25.2 ab	E.deglupta B	22.2 ab
E.deglupta F	22.0 abc	E.deglupta F	20.1 abc
E.urophylla H	21.6 abc	E.urophylla H	19.2 abcd
E.deglupta C	20.8 abc	E.urophylla J	16.4 bcde
E.urophylla J	19.3 bcd	E.deglupta	14.9 acde
E.urophylla K	16.8 ce	E.urophylla K	13.3 de
E.urophylla I	13.3 de	E.urophylla I	12.6 de
E.urophylla L	13.3 e	E.urophylla L	10.6 e
		YABUCOA	
E.urophylla L	22.0 a	E.urophylla H	25.2 a
E.urophylla J	21.6 a	E.urophylla L	23.7 a
E.urophylla H	20.5 ab	E.urophylla J	23.2 a
E.deglupta D	19.8 ab	E.urophylla I	18.7 b
E.deglupta F	19.4 ab	E.deglupta F	18.4 b
E.urophylla K	18.3 bc	E.urophylla K	18.2 b
E.deglupta B	18.1 bc	E.deglupta D	17.6 b
E.deglupta G	18.0 bc	E.deglupta B	16.7 bc
E.urophylla I	17.9 bc	E.deglupta G	15.7 bcd
E.deglupta C	16.0 cd	E.deglupta C	13.6 cd
E.alba M	14.0 cd	E. alba M	12.8 d
E.alba N	13.9 d	E.alba N	12.5 d
		RIO ABAJO	
Site Mean	20.4		17.6
Species Means			
E.deglupta	24.0		20.7
E.urophylla	16.6		14.2
		YABUCOA	
Site Mean	18.4		18.2
Species Means			
E.deglupta	18.4		16.5
E.urophylla	20.0		21.7
E.alba	13.9		12.6

VARIAÇÃO DE PROCEDÊNCIAS DE *EUCALYPTUS FASTIGATA* DEANE E MAIDEN EM RELAÇÃO À RESISTÊNCIA À GEADAS.

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Resumo

Mudinhas de 18 procedências de *E. fastigata*, oriundas de sua região de distribuição natural (doze lotes de sementes), de plantações da Nova Zelândia (5 lotes) e da África do Sul (um lote), foram submetidas às geadas artificiais, em ambientes controlados no outono, inverno e primavera. Os prejuízos causados às mudinhas, individualmente, foram avaliados visualmente, em todas as estações do ano. As procedências mais resistentes foram as de Oberon (1220 m) e Barrington Tops (1430 m), Nova Gales do Sul. Procedências de mais altas altitudes e/ou localidades mais interiores foram geralmente as mais resistentes. As duas procedências mais resistentes por mudas de plantações foram Kaingaroa Forest (Nova Zelândia) e Draycott (África do Sul), ambas de localidades com climas de inverno rigoroso. A severidade das geadas, que se verificou, pelo prejuízo das mudas, mostrou uma significância para a interação entre procedência e estações anuais. Por exemplo, um lote de semente do Planalto de Errinundra perto de Bendoc, em Vitória, foi classificado em terceiro lugar, como resistente à geada no inverno, mas somente em 15º na primavera.

Geadas de inverno com temperaturas de menos de -10°C foram toleradas pela procedência mais resistente (Barrington Tops), enquanto que as mesmas geadas a -6°C causaram severos prejuízos à procedência menos resistente (Robertson). Seis lotes de sementes de *E. regnans* F. Mueel — incluídos neste estudo — foram geralmente mais receptíveis a prejuízos provocados pela geada do que *E. fastigata.*

PROVENANCE VARIATION IN FROST RESISTANCE OF *EUCALYPTUS FASTIGATA* DEANE & MAID.

Summary

Seedlings of 18 provenances of *Eucalyptus fastigata* Deane & Maid. from its natural range (12 seedlots), from New Zealand exotic stands (five seedlots), and from South Africa (one seedlot) were subjected to artificial frosts in controlled-environment rooms in autumn, winter, and spring. Frost injury to individual seedlings was scored visually.

At all seasons, the most frost-resistant provenances were from Oberon (1220 m) and Barrington Tops (1430 m), New South Wales. Provenances from the higher altitudes and/or more inland native localities were generally the hardiest. The two hardiest exotic provenances, Kaingaroa Forest (New Zealand) and Draycott (South Africa), were both from localities with comparatively harsh winter climates.

Severity of frost damage showed only a minor degree of provenance x season interaction. One example was a seedlot from the Errinundra Plateau near Bendoc in Victoria which ranked third for frost hardiness in winter but only fifteenth in spring.

Winter frosts of -9°C were endured by most seedlings of the hardiest provenance (Barrington Tops), while -6°C caused severe damage to the most frost-tender provenance (Robertson). Six seedlots of *Eucalyptus regnans* F. Muell. included in the study were generally more susceptible to frost damage than *E. fastigata*.

INTRODUCTION

Eucalyptus fastigata Deane & Maid. known variously as "brown barrel" or "cut-tail" in Australia is a tall forest tree of the ash group of eucalypts. The most extensive stands occur on moist fertile sites at altitudes of 900-1200 m in New South Wales, extending to the Errinundra Plateau and adjoining hills of East Gippsland, Victoria. It is a major tree species of the wet sclerophyll forests of the eastern flanks of the New South Wales tablelands and escarpments, where it grows in association with many other eucalypts.

The species has been grown successfully on a small scale throughout New Zealand where it is one of the healthiest and most adaptable of the eucalypts tried and has good potential for pulp-wood and timber. However, it could be confidently planted more on level, readily-cultivated sites of the central North Island volcanic plateau if more frost-resistant strains could be found or developed.

As part of the search for desirable seed sources of *E. fastigata*, several native and exotic seedlots were artificially screened to assess their relative and absolute tolerances to frosts.

MATERIALS AND METHODS

Seedlots

Details of the 18 *E. fastigata* seedlots studied are shown in Table 1, and a locality map of the Australian provenances is given in Figure 1. The 12 seedlots from Australia sample some important parts of the species' natural distribution though there were no representatives of the northernmost stands of the New England Tablelands on the basalt plateau in the vicinity of Ebor and Guy Fawkes between Armidale and Coffs Harbour, and, further south, near Yarrowitch, east of Tamworth; of the stands in the Brindabella Ranges of the Australian Capital Territory; or of eastern outliers near the New South Wales coast (e.g., Cambewarra Mountain (lat. 34° 47') near Nowra, and Mt. Dromedary (lat. 36° 28') near Bodalla.

Six seedlots of *Eucalyptus regnans* F. Muell., chosen to represent its full range of hardiness, were included in the study as "controls".

Seedlings

Seed was sown at Rotorua in December 1978. Two hundred seedlings per seedlot were raised in pots and transported to Palmerston North where they were grown on in preparation for artificial frost screening. A random sample of 60 seedlings per seedlot was set aside for each of three separate frost screenings in 1979:- autumn (May), winter (July) and spring (October).

Artificial frosting technique

Full details of how the frost rooms at the DSIR Climate Laboratory in Palmerston North are used for frosting eucalypts have been given by Rook *et al.* (1980). The seedlings were hardened off outside, and subjected to artificial "white" frosts of three different severities per season:

	Light	Medium	Heavy
Autumn	-3°C	-4°C	-5°C
Winter	-6°C	-7.5°C	-9°C
Spring	-2°C	-3°C	-4°C

These particular temperatures were chosen from results of pilot runs.

Experimental design

Approximately 18 seedlings per seedlot were frosted at each temperature at each season in a series of "runs" accommodating 3-5 seedlings x 18 seedlots. Seedlings were individually randomised within runs.

Assessment of frost damage

Damage was assessed visually on a 0 to 5 scale as follows:

0	no foliage damage
1	some leaves slightly damaged
2	10-30% of the foliage killed
3	approximately 50% of foliage killed
4	approximately 90% of foliage killed
5	shoot dead

Trees were then classified into two categories:

0	scores of 0, 1, or 2: not sufficiently damaged to prevent normal recovery and growth, or
100	scores of 3, 4, or 5: "severely frosted", i.e., with lasting damage, or killed.

Statistical analysis

Individual-tree data for each season were processed in analyses of variance with the objective of estimating variance components and testing the significance of differences among seedlots in frost resistance, measured by mean frost score (0-5) and percentage of trees severely frosted (0-100%). An additional analysis of variance was made, combining the data from the -4°C autumn frost, the -7.5°C winter frost, and the -3°C spring frost; this gave a test for season x provenance interaction.

RESULTS AND DISCUSSION

A summary of results is shown in Table 2. The highlight is the outstanding hardiness of the Barrington Tops and Oberon seedlots from New

South Wales. Detailed results from each frost level at each season are omitted here, but the following figures for percentage of trees severely frosted show how well the Barrington Tops provenance performed in the winter, relative to a frost-tender lot from Robertson:

	-6°C	-7.5°C	-9°C
Barrington Tops (122)	17%	28%	33%
Robertson (54)	94%	100%	100%

Extrapolation of these results to field conditions suggests that frosts as severe as -10°C or even lower would probably still be tolerated by most well-hardened Barrington Tops seedlings, while frosts of only -7°C would more or less destroy all Robertson seedlings. Thus, there could be a range as great as 3°C in tolerance of winter frosts in the seedlots tested, offering excellent scope for provenance selection of practical significance to the success of planting programmes.

There were clear differences in frost resistance among provenances at all three seasons. However, as shown below, the winter frosts gave the best differentiation among provenances:

	Provenance variance component for frost score (0-5)	Percentage of total variance
Autumn	0.1021	9.7%
Winter	0.5764	32.2%
Spring	0.2452	16.8%

Thus, provenance selection may not be so effective against unseasonable frosts, which often occur in the central North Island of New Zealand in spring (e.g., November) or autumn (e.g., March) when trees are dehardened and growing rapidly, as against winter frosts.

Two of the exotic provenances, Draycott (South Africa) and Kaingaroa (New Zealand), were among the more hardy seedlots at all seasons. Both seedlots were collected from plantations growing on harsh sites prone to severe ground frosts.

Results with the native Australian seedlots generally indicated that the greatest resistance to frost occurs in the highest-altitude populations (cf. Boden, 1958; Sherry and Pryor, 1967). There is also a suggestion that the most "continental" populations (e.g., those furthest from the sea, or west of, or closest to, the main dividing range) are the hardiest. Although lying well east of the main dividing range, the isolated Barrington Tops Plateau undoubtedly has a harsh winter climate, and the E. fastigata stands there occur in the higher-altitude forests, immediately below open woodland dominated by Eucalyptus pauciflora Sieb. ex Spreng. subsp. pauciflora (Fraser and Vickery, 1939).

Provenance x season, and provenance x frost-level interactions were generally of minor occurrence (Table 2), the only instances of note being the erratic behaviour of Code No. 61 (Robertson) and Code No. 73 (Bendoc). Other seedlots of these provenances were more consistent, so the interactions cannot necessarily be explained as provenance variation in seasonal patterns of hardening and dehardening. For practical purposes, the hardiest provenances were very consistent.

Results from the six E. regnans provenances included in the study are not reported here in detail. However, as indicated in Tables 2 and 3, and confirming what is common knowledge among nurserymen, E. fastigata is generally the hardier species.

A broad comparison of the frost hardiness of the two species (Table 3) shows E. fastigata to be clearly the hardier in autumn and winter. In spring, however, some southern provenances of E. fastigata (e.g., Bendoc, Victoria) apparently dehardened rather rapidly and several were actually more frost-tender at this time of the year than some of the hardier E. regnans provenances, and could thus be especially vulnerable to late spring frosts.

How applicable are these artificial frost results likely to be to natural frosts in the field? With E. regnans, very good agreement was found between frost-room and field results (Rook et al., 1980), so it could be expected that the same would apply in the related E. fastigata. Five of the E. fastigata seedlots studied here (47, 54, 58, 59, 60) were included in species trials planted on several sites in New Zealand in 1977. On sites that experienced damaging winter frosts in 1978, Code No. 58 from Oberon, New South Wales, was clearly the hardiest (personal observations, M.D.W.) in accord with its high ranking in the artificial frosts.

APPLICATIONS

In 1980, plantings of the Barrington Tops and Oberon seedlots totalling 12 ha will be established in Kaingaroa Forest in the central North Island. These could eventually be valuable local seed sources. Meanwhile, New Zealand growers of E. fastigata using seedlots collected from what is currently the main local seed source, Oakura, Taranaki, should be aware that it is a strain of only intermediate hardiness for the species. Seedlots from some "traditional" seed sources such as Robertson, New South Wales, should obviously be used only on sites not subject to severe winter frosts.

The 18 provenances studied are under evaluation as individual families in field trials, with the goal of breeding strains of the species with improved growth, stem form, branching habit, as well as frost resistance. Of concern is the degree to which superior frost hardiness may be associated with comparatively slow growth.

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FIG. 1

LOCALITIES OF AUSTRALIAN PROVENANCES OF EUCALYPTUS FASTIGATA STUDIED, WITH THEIR FROST RESISTANCE RATINGS

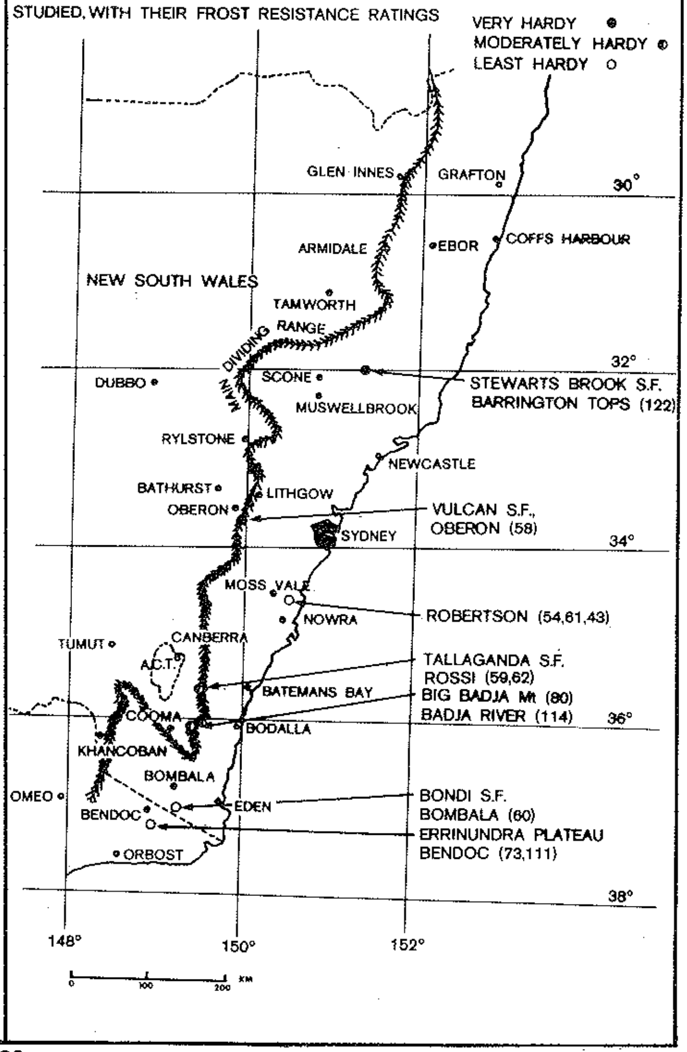


Table 1 - List of *E. fastigata* provenances

Code No.	Seedlot Number[1]	Origin[2]	Alt. (m)	Lat. (S)	Long. (E)	D.F.S.[3] (km)
47	R 74/1031	Kaingaroa, NZ (C) (Compt. 122)	460	38°31'	176°35'	76
54	HO 76/14	Robertson, N.S.W. (C)	760	34°35'	150°36'	33
58	HO 68/616 (= S. 8587)	Oberon, N.S.W. (10) Vulcan S.F.	1220	33°54'	149°48'	130
59	HO 68/617 (= S. 8588)	Rossi, N.S.W. (13) Tallaganda S.F.	1070	35°28'	149°35'	85
60	HO 68/618 (= S. 8589)	Bombala, N.S.W. (13) Bondi S.F.	910	37°08'	149°12'	85
61	HO 71/755 (= S. 9652)	Robertson, N.S.W. (9)	730	34°35'	150°36'	33
62	FRI 77/2110 (= S. 9504)	Jinero Trig, N.S.W. (7) Tallaganda S.F.	970	35°30'	149°25'	85
73	FRI 77/2138 (= S. 12101)	Bendoc, Vic. (6) Errinundra Plateau	1070	37°10'	148°55'	75
80	FRI 77/2139 (= S. 11811)	Big Badja Mt, N.S.W. (7)	1070	36°13'	149°29'	58
110	FRI 77/2214	Oakura, NZ (11) (McAlpine's)	125	39°08'	173°59'	6
111	HO 77/21	Bendoc, Vic. (C) Errinundra Plateau	1120	37°16'	148°53'	75
113	HO 78/20	Robertson, N.S.W. (C)	670	34°35'	150°36'	33
114	HO 78/22	Badja River, N.S.W. (C)	1000	36°31'	149°29'	58
122	HO 78/46 (= FRI 78/2284)	Barrington Tops, N.S.W. (7) Stewarts Brook S.F.	1370	31°50'	151°20'	118
123	AK 78/119	Ngahinapouri, NZ (4) O'Reagans's	40	37°53'	175°15'	39
130	FRI 78/2296	Natal, South Africa (6) Draycott near Estcourt	1500	29°00'	29°45'	150
131	GTI 52, 53, 84, 85, 87, 88	Rotorua, NZ (6)	305	38°09'	176°15'	48
132	GTI 89-92	Tikitere, NZ (4)	350	38°04'	176°22'	33

1 CSIRO, Canberra seedlot numbers shown thus: (S. 8587)

2 Number of seed trees in seedlot shown in brackets. (C) indicates commercial seedlot from unspecified number of seed trees.

3 Estimated distance from sea.

Table 2 - *E. fastigata* provenances ranked in order of frost resistance (mean score) averaged over medium-severity frosts in autumn, winter and spring

Rank	Code No.	Origin	Mean score (0-5)	Trees severely frosted (%)	Ranking by mean score[1] per season: Autumn	Winter	Spring
1	122	Barrington Tops	1.76	22.2	2	1	1
2	58	Oberon	2.08	29.4	1	2	2
3	130	Draycott (S.A.)	2.74	46.3	3	4	6
4	114	Badja River	3.07	61.1	6	5	3
5	47	Kaingaroa (NZ)	3.13	66.7	5	7	4
6	80	Big Badja Mt.	3.30	59.3	4	6	9
7	110	Oakura (NZ)	3.30	68.5	7	9	5
8	61	Robertson	3.46	68.5	8	17	7
9	73	Bendoc	3.46	70.4	10	3	15
10	132	Tikitere (NZ)	3.63	77.8	11	11	8
11	59	Rossi	3.69	75.9	12	16	13
12	62	Jinero Trig	3.69	85.2	13	8	12
13	60	Bombala	3.79	81.1	17	10	18
14	123	Ngahinapouri (NZ)	3.81	81.5	18	12	11
15	54	Robertson	3.81	83.3	9	18	17
16	131	Rotorua (NZ)	3.85	79.6	14	14	14
17	111	Bendoc	3.94	86.5	16	13	16
18	113	Robertson	4.02	85.2	15	15	10
		Least significant difference (.05)	0.61	17.5			
		General mean: *E. fastigata*	3.36	68.3			
		General mean: *E. regnans*[2]	4.07	90.0			
		Hardiest *E. regnans* lot[3]	3.74	85.2			
		F-test, provenances	8.38**	9.16**	5.47**	17.00**	6.37**
		F-test, provenace x environment interaction[4]	1.81**	1.25 n.s.	1.82*	1.73*	2.33**

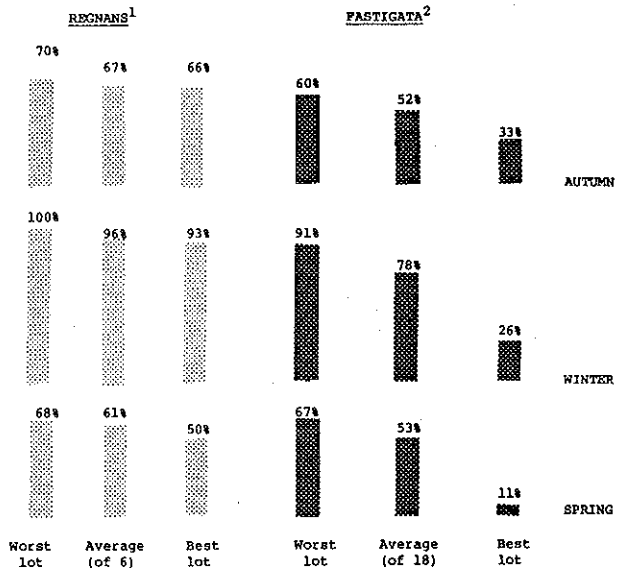
1 Averaged over the light, medium and heavy frost levels.

2 Mean of 6 seedlots.

3 Lot 203 - selected hardy families from southern Tasmania.

4 Provenance x season interaction (combined analysis) or provenance x frost-level interaction(individual season analysis).

Table 3 - Comparison of *E. regnans* and *E. fastigata* in seasonal frost hardiness as measured by average percentage of seedlings severely frosted by light, medium, and heavy frost levels



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1 *E. regnans*: worst seedlot - Weld River, Tas. (Code 201); best seedlot - composite of hardy selected families, Tas. (Code 203).

2 *E. fastigata*: worst seedlot - Bendoc, Vic. (Code 111); best seedlot - Barrington Tops, N.S.W. (Code 122).

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IV
B

HERITABILITIES AND CORRELATIONS BETWEEN CHARACTERS IN PROGENIES OF EUCALYPTUS GRANDIS FROM AUSTRALIA, SOUTH AFRICA AND BRAZIL.

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Resumo

Herdabilidades em sentido restrito e correlações genotípicas, fenotípicas, e ambientais entre altura e c.a.p. foram estimadas em três populações de Eucalyptus grandis, plantadas em três áreas ecologicamente distintas. As herdabilidades em altura foram geralmente superiores às herdabilidades em c.a.p. sendo mais altas na população australiana, e mais baixas na população brasileira. Houve alta correlação entre altura e c.a.p..

Summary

Narrow-sense heritabilities and genotypic, phenotypic and environmental correlations between height and girth at breast height were estimated in three populations of Eucalyptus grandis, in three widely distinct planting sites. Height heritabilities were generally higher than girth heritabilities, being the highest in the Australian population, and the lowest in the Brazilian population. There was a high correlation between height and girth at breast height.

Introduction

Little is known about genetic parameters in Eucalyptus spp. in Brazil. Planting of eucalypts has, however, been a major forest investment in central Brazil, especially with Eucalyptus grandis. The species is also being used for very diverse purposes, such as supporting poles and scaffolding in construction, charcoal for the heavy industry, pulp for the paper industry, sawlogs and others (6). The genetic improvement for these ends must be based on Knowledge about genetic parameters and structure.

Eucalyptus grandis for planting in Brazil comes from three immediate sources: "Brazilian" populations, generally known as the "Rio Claro source"; South African and Rhodesian populations, being now the most generally planted ones; and Australian populations, usually in smaller numbers because of limited seed availability (T). For any of these, genetic variability, phenotypic variability and correlations between characters have to be known (1, 2) for supporting knowledge for a genetic improvement program. Gains and tree improvement action strategies have to be based on such knowledge (4). The genetic structure of the population is also important in determining stategies (8).

This work aimed at determining genetic parameters (11) in the three populations of Eucalyptus grandis of Australian, South African and Brazilian origins in the widely distinct environments of Espírito Santo State, of the Rio Doce Valley in Minas Gerais State and of Jequitinhonha Valley in Minas Gerais State. These are all areas of paramount importance in large afforestation progrms in south-eastern Brazil. Correlations between girth at breast height and height (3) were also sought.

Materials and Methods

82 specific progenies were planted, being 18 progenies from Viçosa, Minas Gerais State, Rio Claro source, 32 progenies from eight populations from Queensland, Austrália; and 32 progenies from a clonal seed orchard from the Republic of South Africa. They were planted in a spacing of 5 x 4 m, in complete randomized blocks, with 10 replications, and three plants per plot. Each replication contained one plot of each of the 82 progenies. Populations were also analyzed. The planting sites were: 1) Minas Novas in Jequitinhonha Valley, latitude 17°30'S; longitude 42°45' w.G.; altitude [illegible] m; subtropical humid subhumid climate (7); 2) Açucena, Rio Doce Valley, latitude 19°05'S.; longitude 42°07'w.G.; altitude 180 m; tropical dry-subhumid climate (7); Conceição da Barra, northern Espírito Santo State, latitude 18°13'S; longitude 39°55' w.G.; altitude 10 m; tropical subhumid humid climate (7).

Twelve months after planting, girth at breast height and height were measured. Data were grouped by population origin in each site. Covariance analysis was performed (9); Genetic variances were calculated (10); Genotypic, phenotypic and environmental correlations were also calculated (5).

Results

Heritability results for height and girth at breast height at twelve months are presented in Table 1.

Table 1. Narrow-sense heritabilities for height (H) and girth at breast height (G.B.H.) at age 12 months.

Characters	Population	Planting site	Heritability
H	Viçosa	Jequitinhonha Valley	0,56
GBH	Viçosa	"	0,53
H	Viçosa	Rio Doce Valley	0,68
GBH	Viçosa	"	0,69
H	Viçosa	Espírito Santo	0,33
GBH	Viçosa	"	0,65
H	Austrália	Jequitinhonha Valley	0,76
GBH	Austrália	"	0,75
H	Austrália	Rio Doce Valley	0,69
GBH	Austrália	"	0,66
H	Austrália	Espírito Santo	0,73
GBH	Austrália	"	0,72
H	South Africa	Jequitinhonha Valley	0,79
GBH	South Africa	"	0,74
H	South Africa	Rio Doce Valley	0,62
GBH	South Africa	"	0,57
H	South Africa	Espírito Santo	0,69
GBH	South Africa	"	0,66

The genotypic, phenotypic and environmental correlation estimates between height and girth at breast height in each population and planting site are shown in Table 2.

Table 2. Genotypic (G), phenotypic (P) and environmental (E) correlation estimates between height and girth at breast height in each population and each planting site.

Site	Correlation	Population Viçosa	Australia	South Africa
Jequitinhonha V.	G	0,917**	0,945**	0,951**
	P	0,914**	0,931**	0,913**
	E	0,913**	0,913**	0,869**
Rio Doce V.	G	0,970**	0,738**	0,869**
	P	0,916**	0,820**	0,884**
	E	0,867**	0,890**	0,875**
Espírito Santo	G	1,107**	0,907**	0,956**
	P	0,902**	0,881**	0,928**
	E	0,880**	0,853**	0,906**

** Significant at 1% probability level.

Conclusions

There was a genotype-environment interaction, since each population behaved differently in each site. The Australian origin was best in all plantation sites, and next was the South African, and last the Brazilian origin, except in Espírito Santo, where South African was last, and Brazilian was second. However, the material studied was still young of age, and the above situation may change.

Heritabilities calculated show a very strong genetic control of both characters. Both for height and girth at breast height, the Australian origin showed a larger variability than both the South African and Brazilian sources, where selection in one and inbreeding in the other have occurred.

All correlations between height and girth at breast height were high and significant, with genotypic correlations higher than phenot ypic ones. Therefore, only diameter may be measured in an improvement program.

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HERITABILITY ESTIMATES AND CORRELATIONS BETWEEN CHARACTERS IN EUCALYPTUS GRANDIS.

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Resumo

A partir de mudas obtidas de 124 matrizes de polinização aberta em Eucalyptus grandis, estabeleceram-se ensaios de progênie em dois locais no estado do Espírito Santo. Medidas efetuadas nas árvores matrizes e suas progênies até a idade de 30 meses revelaram fraca correlação entre as árvores matrizes e suas progênies no viveiro, tendendo a aumentar com a idade. Correlações entre altura e d.a.p. nas idades de 6, 18 e 30 meses nas progênies foram altas. A altura no viveiro tinha alguma correlação apenas com altura a idade de 6 meses, mas nenhuma com altura mais tarde. Herdabilidades em sentido restrito variaram de 0,33 a 0,59 para alturas e diâmetros da idade de 6 meses a 30 meses e para taxa de crescimento Herdabilidade para resistência a Diaporthe cubensis foi de 0,65 mm local e 0,77 em outro. Houve interação genótipo ambiente significativa para diversos caracteres.

Summary

Seedlings obtained from 124 Eucalyptus grandis open pollinated mother trees were planted at two sites in Espírito Santo State. Measurements performed on mother trees, and on progenies until age 30 months showed a weak correlation between mother trees and their progenies in the nursery, with a trend to increase with age. Correlations between height and d.b.h at age 6, 18 and 30 months among progenies were high. Height in the nursery had some correlation with height at age 6 months but none with height at later ages. Narrow - sense heritabilities varied between 0,33 to 0,59 for heights and diameters from age 6 months to 30 months and growth rate. Heritability for resistance to Diaporthe cubensis canker was 0,65 in one location and 0,77 in another. A significant genotype - environment interaction was found for several characters.

Introduction

Very little is known about the inheritance of important charactes in the genus Eucalyptus (9), although this is of paramount importance in planning a tree improvement program.

Guimarães (4) found considerable variation of wood volume production between progenies of Eucalyptus alba, E. tereticornis, E. grandis and others. There was also genetic variation among and within open-pollinated families and populations of E. regnans, for growth and form of trees, and low heritabilities were found for growth rate, diameter and branching habit (1). Van Wyk (9) using a 15 x 15 diallel progeny test in E. grandis, found sufficient additive genetic variance in the population for all characters studied. There were also significant values for specific and general combining abilities for height, diameter, volume and crown diameter at age 15 months. Kedharnath and Vakshasya (6) in an open-pollination progeny test in E. tereticornis, found genetic variation between families for height and diameter growth in the third and fourth year. Correlation coefficients between the characters were high, positive and significant. They found low values for narrow-sense heritabilities: 0,26 and 0,25 for height at ages 3 and four years, and 0,17 for diameter.Eldridge(1) found a heritability value of 0,2 for diameter in E. regnans at age 5 years. Van Wyk (9) also found low narrow-sense heritability values for growth rate and crown size. Nothing is known about the inheritance of the resistance of E. grandis to the canker caused by the fungus Diaporthe cubensis Bruner, describec by Hodges et al. (5). The disease strikes this and other Eucalyptus species starting at age 5 months, and by the time of harvesting, there may be losses above 30% of the population (3).

The correlation between characters shows what happens to characters, if selection is carried out at other characters (2,7). Therefore total, genotypic and environmental correlations are important in tree improvement programs. For the estimation of such correlation coefficients, genetic variance and covariance components estimates have to be determined. Stonecypher (8) proposed several genetic statistic procedures for these estimates, among then the use of open-pollinated or control-pollinated progeny tests.

This work aimed at estimating the correlations between different characters, and their heritabilities in Eucalyptus grandis planted in Espírito Santo State.

Materials and Methods

Seeds were collected from 124 two-years old open-pollinated mother trees of Eucalyptus grandis, origin of the Republic of South Africa, planted on property of Aracruz Florestal,S.A, in Aracruz, Espírito Santo State. Plants were planted in the field in two locations; one in Aracruz and the other in São Mateus, set up in randomized blocks, with five replications. Each replication contained 124 plots of three plants, in a spacing of 3 x 2 m. To design was followed in the nursery, except for keeping different progenies identified. The following characters were measured: height and diameter of mother trees at the time of seed collection; seedling height in the nursery before planting taken from 20 seedling per progeny; average height per plot at age 6 months; average height and diameter per plot at ages 18 and 30 months; growth rate; percentages of trees with canker caused by Diaporthe cubensis at age 30 months.

Variance and covariance analyses were performed, for each site separately and for both sites together. Variances obtained from expected mean square values were used do compute heritability. In this case broad sense and narrow sense heritabilities coincide, because open-pollinated progenies were used.

Results

Heritability estimates are presented in Table 1

Table 1 - Narrow-sense heritability estimates, based on family means.

Characters	Heritabilities		
	Site		
	Aracruz	S.Mateus	Joint
Height at age 6 months	0,45	0,46	0,37
Height at age 18 months	0,43	0,33	0,52
Diameter at age 18 months	0,44	0,40	0,53
Height at age 30 months	0,58	0,47	0,54
Diameter at age 30 months	0,48	0,57	0,59
Growth rate	0,46	0,37	0,52
Resistance to Diaporthe cubensis	0,65	0,77	0,65

Simple correlations between characters are presented in Table 2

Table 2 - Simple correlations between characters: height of mother tree (HM); diameter of mother tree (ØM); height in the nursery (Hn); height at age 6 months (H6); height at age 18 months (H18); diameter at age 18 months (Ø18); height of plant at age 30 months (H30); diameter at age 30 months (Ø30); and growth rate (GR), in a joint analysis for both planting sites.

Characters	HM	ØM	Hn	H6	H18	Ø18	H30	Ø30	GR
HM	-	0,4785**	0,0212	0,0092	0,0260	0,0353	0,0612	0,0389	0,0252
ØM		-	0,1281	0,0638	0,0113	0,0580	0,0443	0,0561	0,0273
Hn			-	0,0122	-0,0194	-0,0040	-0,0064	-0,0022	-0,0462
H6				-	0,5736**	0,6577**	0,6177**	0,5920**	0,6130**
H18					-	0,8070**	0,7924**	0,6742**	0,8678**
Ø18						-	0,8383**	0,8179**	0,8685**
H30							-	0,8594**	0,8944**
Ø30								-	0,7768**

** Significant at 1% probability

The genotypic, phenotypic and environmental correlations are presented in Table 3

Table 3 - Estimations of genotypic (rG), phenotypic (rP) and environmental (rE) correlations between characters:height at age 6 months (H6); height at age 18 months (H18): diameter at age 18 months (Ø18); height at age 30 months (H30); diameter at age 30 months (Ø30), and growth rate (GR).

Characters		H18	Ø18	H30	Ø30	GR
H6	rG	0,7086**	0,9127**	0,5065**	0,7000**	0,5633**
	rP	0,6140**	0,6102**	0,4534**	0,5249**	0,4486**
	rE	0,3889**	0,4550**	0,3005**	0,3019**	0,2626**
H18	rG		0,9482**	0,9162**	0,8120**	0,9720**
	rP		0,8740**	0,8845**	0,8566**	0,6489**
	rE		0,7716**	0,7180**	0,5379**	0,9262**
Ø18	rG			0,8787**	0,9519**	0,8556**
	rP			0,8167**	0,8674**	0,8446**
	rE			0,6922**	0,7157**	0,7620**
H30	rG				0,9471**	0,9238**
	rP				0,8747**	0,8429**
	rE				0,7253**	0,7457**
Ø30	rG					0,8506**
	rP					0,7560**
	rE					0,5560**

** Significant at 1% probability.

Variance analyses, both by location and joint analysis were significant at 1% probability for families. Also the site x family interaction was significant at 1% probability. The species is hight sensitive to local differences. This tends to increase with age. Family variance components were always smaller than environmental components. Heritability estimates varied little with site.

There was a weak correlation between mother trees and progeny at any age, but increased with age. Nursery seedling heights did not correlate with heights or diameters at later ages, except with age at months. Correlations between characters starting at age 6 months increased with age and were positive. Genotypic correlations were higher than phenotypic correlations. All correlations were high, positive and significant at probability 1% by the "T" test. Correlation coefficien between heights at 6 and 18 months were larger than between heights at 6 and 30 months; the same happened for diameter at these ages.

Conclusions

Heritability estimates were high enough to justify an improvement program based on selection, for the characters studied. Since heritabilities were increasing with age, it is to be expected that a later stage a selection program would be still more effective. Heritability was especially high for resistance to canker, which allows for a hypothesis to be drawn that few genes are involved with this character, or that additive genetic variance is very high. Selection against susceptibility is justified, if it is kept in mind that fungi may adapt much faster to new situations, and thus viralence may also increase. Diameter and height are highly correlated among themselves starting at age 6 months. Seedling height in the nursery is no indication for tree behavior later on, but height at six months already is a good indicator. If early selection were practiced, if should be done after the age of six months, but the later the better. Still, with flowering time starting at age 2 years with wide spacing in this species, improvement through recurrent selection should yield fast results.

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METHODS OF ESTABLISHING GENETIC BASE POPULATIONS FOR SELECTION - DESIGNS FOR LONG-TERM, EX-SITU MAINTENANCE OF EUCALYPT GENE POOLS AND BREEDING POPULATIONS.

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Resumo

Apresentam-se razões para o estabelecimento e manutenção de populações genéticas base a longo prazo de Eucalyptus spp. no Brasil. Há razões tanto genéticas quanto econômicas. Propõe-se e discutem-se dois tipos de populações genéticas base: um tipo em que árvores de procedências distintas podem cruzar-se e formar novas recombinações; e outro tipo em que os descendentes de procedências distintas são mantidos "puros".

Summary

Reasons are presented for the establishment and maintenance of long-term genetic base populations of Eucalyptus spp. in Brazil. There are both genetic and economic reasons. Two types of genetic base populations are proposed and discussed: one type in which trees from different provenances are allowed to interbreed, forming new recombinations; and another one in which descendants of different provenances are maintained "pure".

Introduction

The introduction of exotic species, especially pines and eucalypts in Brazil, tends to follow a pattern based on: 1. Introduction of several provenances and provenance trials; 2. Selection and improvement of the best provenance; 3. Establishment of seed production areas and seed orchards of the best individuals from the best provenance. Few people are as yet interested in the long-term effects of such a program, because the immediate effects are astounding; frequently yielding an improvement of over 20% by simply planting seeds from a seed production area in eucalypts.

Another pattern followed in Brazil with eucalypts is even more common: 1. Purchase of seeds from the Rio Claro source; 2. Selection of some stands for seed production areas, sometimes for seed orchards. Since the Rio Claro source has fallen in disfavor because of frequent hibridization problems, dysgenic selection and inbreeding, many large companies have started out planting Rio Claro material, eventually switching over to new introductions, most frequently Eucalyptus grandis from the Republic of South Africa and Zimbabwe-Rhodesia.

In any one of the above mentioned cases, the selection carried out on Rio Claro source eucalypts or African source eucalypts, or even one-provenance source Australian eucalypts, will erode some of the genetic variability existing, thus jeopardizing the possible improvement of future tree generations. Worse still, there is a strong desire to plant vegetatively propagated trees from a few superior phenotypes. It does not matter immediately if such superior individuals are superior general combiners, or even if they are hybrids or not. If these trees are used for future seed production, this may result in no further improvement, or in much segregation due to hybridization.

It is clear that selection will diminish genetic variability (4, 6), but a program based on selection draws on genetic variability for it's raw material. Therefore, if a tree improvement program is based on short-term goals as described above, it will defeat it's long-term purpose. In Brazil, with eucalypt rotations at seven or eight years (tending to be shortened still!), "long-term" may be less than twenty years.

Short-term improvement programs are frequently little concerned with adaptati of forests to future situations. A forest tree geneticist might, for instance, foresee a shortage of phosphate fertilizers in the future for application in forestry. Or he could reckon with such environmental changes as aridity from north-eastern Brazil creeping onto adjoining regions, such as northern Minas

Gerais State. He could then draw on existing gene pools and select trees adapted to low phosphate soils and long dry spells. If, however, the geneticist is committed only to a quick improvement in wood quantity and quality, he will achieve his goal by selecting a small number of superior phenotypes and by propagating these vegetatively. The chance of a disease or pest suddenly striking an exotic forest is very large (7), and increases with a narrow genetic base(3), such as exists in a vegetatively propagated forest. Natural forests live and co-adapted with their environment (6); a situation which no longer prevails once the forest is exotic. Artificial selection pressure reduces natural variability in addition to the new environment's selection pressure. Both forces not only bring about narrowing of the genetic base, but artificial selection also reduces the chance of adaptation of the forest to it's new environment (2.). The decrease in natural variability, especially in an exotic environment, is irreversible (6). The potential of a forest resulting from strong selection, to adapt continuously to environmental changes is threatened, especially if displaced from it's natural environment.

Man is domesticating trees, often irreversibly changing their genetic structure, and creating a dependence of trees from man. This may be desirable for plantation forests of specific utilization, but must not imply that wild material is eliminated. However, wild material of *Eucalyptus* spp. does not occur in Brazil, and it is unrealistic to rely upon Australia and Indonesia for a constant supply of seeds from natural forests (5). These countries have their own conservation goals, which may differ from Brazilian needs. *Eucalyptus* spp. seed arriving in Brazil usually are imported from South Africa or Zimbabwe-Rhodesia and that represents one gene pool which must be narrowed by selection to the diverse Brazilian situations.

The situation is clear: 1. Brazil does not have natural eucalypt forests; 2.Th eucalypt forests existing in Brazil represent a small part of the natural variabili of the species; 3. Countries supplying seeds to Brazil represent a small part of the genetic diversity, often after formation of a land race adapted to their conditions. For future uses Brazil has to count on a good supply of eucalypt seed with a wide genetic diversity to attend to different needs. Uses of eucalypts in Brazil range as widely as use for charcoal, pulp, lumber, fuelwood,posts, all often derived from one species, as is the case of *Eucalyptus grandis*. Plantations in Brazil also tend to be from one species, because seeds are readily available, and not from the species best suited for a specific use, because seeds are not available.

Land races form in few generations in eucalypts in Brazil, as mild selection programs with large success have shown. Therefore, the import of some ten thousand kg of seed a year from Africa is not justified, if Brazil can produce it's own, improved seed. It is, however, necessary to keep a broad genetic base to adapt to future situations, fluctuations in demand of different products by the market, new uses for forests, new diseases and other unknown factors. To meet these needs in the long run a wide genetic base population and specific breeding populations have to be well planned now, when seeds of distinct populations with diverse genetic structures are still available.

Genetic base populations

Based on seggestions by Libby(4), Brune (1) has proposed that fast gains would be obtained, while maintaining a wide genetic base if: 1. Plantations were set up by mixing plants from different origins of one species for recombination to occur; 2. F_1 populations derived from these be set up in different environments 3. F_2 and future generations, where segregation and recombination had occurred, be submitted to selection pressures to attend environmental and artificial demands, and thus specific goal breeding populations (orchards or seed production areas) be set up. These should supply seeds for commercial plantations. The breeding populations could receive gene influx from any origin, from the original P_o, F_1 or F_2 plantation or even commercial, if desirable genotypes prevail.

Since generations run fast in some of the most common eucalypts in Brazil (*E. grandis*, *E. citriodora*, *E. urophylla*, *E. saligna* all flower at age two years in wide spacing in many states), and considering much overlapping in flowering time of different individuals the formation of land races by such a scheme.is quick. Gains would also be large, especially early on, when a very large variability is available. By contrast, a selection program based on a population of one origin will run out of genetic variability faster, and may have to resort to an original source later, if this one still exists, which is doubtful. The disadvantage of such a scheme is that, once recombination has occurred, the old specific sources may no longer be available as "pure" sources.One source of seed may be exactly what is needed later on, or more genotypes from one origin may be desired in larger amounts. Results may also be different if plants of different origins are allowed to recombine and form a land race for a few generations;or if different populations of diverse origins are kept isolated to form several adapted land races, and these are then brought together to recombine. In this latter case the combinations of trees from two or more land races may be more desirable than the end product of many "origins".

In any of the above schemes, the adaptation to specific Brazilian conditions and the formation of land races first, and selection for specific needs second, is more desirable than the use of imported seeds directly in commercial production plantations, where no adaptation has occurred.

In order to insure a proper genetic variability for immediate and future use, it is suggested: 1.That genetic base populations be set up of *Eucalyptus* spp, sampling the widest possible range of occurence in their native habitat; 2. That these populations be set up following two schemes, one by mixing different origins, and one by maintaining distinct origins separated and isolated; 3. That generations succeed each other as fast as possible,with only mild artificial selection and interference, so as to form different land races for future uses; 4. That these populations be set up in different environmental situations in this country.

Seeds from these populations should ensure a relative independence of Brazil from wild stands in the future, and in many cases substitute for these with the advantage of adaptation to specific conditions here. These populations should supply material for breeding populations at any stage when this is desired. It is important to make a distinction between the maintenance of genetic base populations, whatever their origin, which serve genetic conservation goals; and breeding populations, which serve the purpose of genetic improvement and seed production for commercial uses; and commercial plantations, which are planted for production.

Companies will often be only interested in seeds for commercial plantations, derived from breeding populations. They may also be much interested in setting up their own breeding populations, such as orchards and seed production areas. Genetic base populations, by whatever scheme, should be primarily the responsability of the Government, or it's official agencies. Since the saving of foreign currency is implied, and an insurance against the loss of foreign supply is insured, agencies such as IBDF or EMBRAPA or some universities or state forest services should be interested in keeping their own genetic base populations. One additional advantage Brazil has over some countries is the fast sequence of many eucalypt species generations. Other countries planting fast growing exotics already adopt gene conservation measures, for instance Australia and Zealand with regards to *Pinus radiata*.

Conclusions

Since much of the Rio Claro source of eucalypts, introduced to Brazil early in this century, suffers from a narrow genetic base and later genetic mismanagement such as dysgenic selection and hybridization, a new genetic base with proper management is needed. Wide genetic variability should be imported from many species, and different origins should be maintaned separate for a few generations, while others should be allowed to recombine and segregate for a few generations, in different environments. Breeding populations can be derived from genetic base populations at any stage, but should not interfere with these. It is expected that breeding populations set up after land races formed, will be more effective than before land races formed.

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PROGRESSO NO MELHORAMENTO DE *EUCALYPTUS DEGLUPTA.*

John Davidson.

Resumo

Este trabalho atualiza as informações apresentadas na 3a. Consulta Mundial de Melhoramento Florestal, Canberra, Austrália, março de 1977. A alogamia é considerada predominante em *Eucalyptus deglupta* e o programa de melhoramento é conduzido em função dessa premissa. As melhores procedências para regiões tropicais de baixa altitude são Mindanao (Filipinas) e New Britain (Papua Nova Guinê). Foram implantados pomares de sementes através de estacas enraizadas, alporquia, enxertos e mudas.

O delineamento dos pomares e seu manejo são descritos bem como a produção de sementes durante um período superior a 2 anos. As primeiras estimativas da herdabilidade, no sentido restrito, foram obtidas em ensaios de campo. Estas estimativas médias foram 0,46 para densidade da madeira e 0,29 para crescimento em diâmetro; para outras características os valores são mais inferiores.

PROGRESS IN BREEDING *EUCALYPTUS DEGLUPTA.*

Summary

This paper updates information presented to the Third World Consultation on Forest Tree Breeding, Canberra, Australia, March 1977. Outcrossing is still considered to predominate in *Eucalyptus deglupta* and the breeding programme is conducted accordingly. Best provenances for the lowland tropics are from Mindanao, Philippines and New Britain, Papua New Guinea. Seed orchards have been established by cuttings, marcots, grafts and seedlings. Seed orchard layout and management are described and seed production over a two year period is assessed. First estimates of narrow-sense heritability have been obtained from field trials. These average 0.46 for wood density and 0.29 for diameter growth but are much lower for other traits.

INTRODUCTION

Breeding *Eucalyptus deglupta* was reported on last in a case study presented as an invited special paper to the Third World Consultation on Forest Tree Breeding, Canberra, Australia, March 1977 (Davidson 1977).

Breeding strategy was described and illustrated in Fig 1 of that paper. No new initiatives have been made but grafted and seedling seed orchards and progeny trials in Papua New Guinea (P.N.G.) are now five years old and seed orchards in the Philippines are seven years old.

Data are now becoming available on provenance performance and seed orchard establishment, management and yield. A detailed paper on provenance performance is presented elsewhere at this Symposium and Workshop, the remaining topics are discussed here.

BREEDING SYSTEM

Flowers of *E. deglupta* are bisexual and observations over several years indicate the main pollination vectors are insects and birds. The main mobile insect visiting flowers of *E. deglupta* is the green tree ant. Though not particularly hairy this species does become covered in sticky nectar and secretions while foraging in search of food and honeydew produced by aphids and scale insects. Their larvae are sticky and they are moved long distances by the adults to provide sticky silk secretions to glue leaves together to build or repair nests. Colonies range for several hundred metres and often extend over more than 100 trees. Bees are of increasing importance as pollination vectors because more and more commercial bee introductions are made to P.N.G.

Of the birds, the Eclectus and Red-Cheeked Parrots and the Rainbow and Scaly-Breasted Lorikeets are present in large numbers, particularly in the seed orchard during flowering. As well as acting as pollen vectors they are particularly fond of the blossoms of *E. deglupta* and sometimes destroy a considerable quantity when they are present in large flocks.

Flowers of *E. deglupta* are able to withstand emasculation and bagging. No artificial selfs have been produced to date though viable seed has been obtained from artificial crossing. However, attempts at artificial self pollination of eucalypts have been successful on almost every other tree tested (Pryor 1957; Guimaraes and Kerr 1959; Eldridge 1970; Hodgson [illegible] 1976).

Pryor (1976) considered the genus to be outbreeding. Some quantitative estimates using allozyme variants have been obtained. Brown *et al* (1975) found an outcrossing rate of 0.76 in four populations of *E. obliqua* while Phillips *et al* (1977) obtained a value of 0.67 for three populations of *E. pauciflora* indicating a substantial portion of seed has resulted from outcrossing, though field observations of flowering and pollen vectors in *E. regnans* by Aston (1975) suggest that self pollination might be higher than such estimates indicate.

In the absence of evidence to the contrary, outcrossing is still considered to predominate in *E. deglupta* and the breeding programme is conducted accordingly.

CHOICE OF PROVENANCE

Significant provenance variation is evident in *E. deglupta* (Davidson 1980, this Symposium).

The best provenances for use in plantations planned for pulpwood production in the lowland wet tropics are from the extreme north-west (Mindanao, Philippines) and north-east (north coast, New Britain, P.N.G.) parts of the natural range. Seed sources so far collected from mainland New Guinea lowlands and highlands areas have proved inferior. The Keravat provenance performs well on New Britain while a Philippines (Bislig) provenance and other New Britain provenances perform well on a coastal mainland site in mainland P.N.G. and at Bislig Bay, Mindanao.

The breeding programme in P.N.G. is presently concentrated entirely on the Keravat, New Britain provenance with superior trees selected from plantations, while the Paper Industries Corporation of the Philippines (P.I.C.O.P.) has seedling orchards of several mixed Mindanao provenances including Bislig, New Bataan, Cabadbaran and Zamboanga sources collected initially from the wild.

SEED ORCHARD ESTABLISHMENT

Seed orchards have been established using grafts, cuttings, marcots and seedlings.

P.I.C.O.P. seed orchards are established and extended by marcotting (Plates 1 and 2). Selected trees have been taken from several Mindanao sources (Plate 3) and parts of the 50 ha orchard are now seven years old (Plate 4).

In P.N.G. both grafted and seedling seed orchards have been established. Research continues into the stimulation of coppice shoots by wounding and injection of hormones into standing trees using a special tool (Plate 5) and induction of coppice on cut stumps (Plate 6). (*E. deglupta* is considered a non-coppicing species in nature.) Coppice shoots from up to 5 years old have been rooted successfully under intermittent mist spray without special culture media (Plate 7).

Spacing in seed orchards of *E. deglupta* has been 12-15 m triangular (Plates 4 and 8). In the P.N.G. seedling orchard, four representatives of the same family were planted on the corners of a 0.5 m square situated at each planting location. The reasons for this were:

i. Eldridge (1970) had reported reduced height growth of selfed progenies relative to outcrosses for *E. regnans*. Thus it was considered desirable to wait as long as possible to allow possible inbred, less heterozygous individuals to be placed at a selective disadvantage and succumb, leaving the remainder with a higher average heterozygosity.

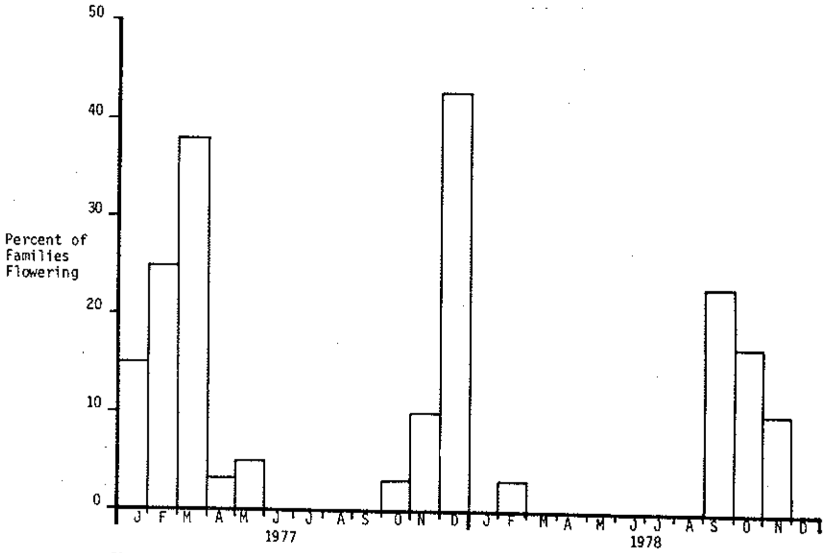

FIGURE 1. Percent of families flowering in a seedling seed orchard of E. deglupta at Bulolo, P.N.G., on a monthly basis, for the years 1977-78.

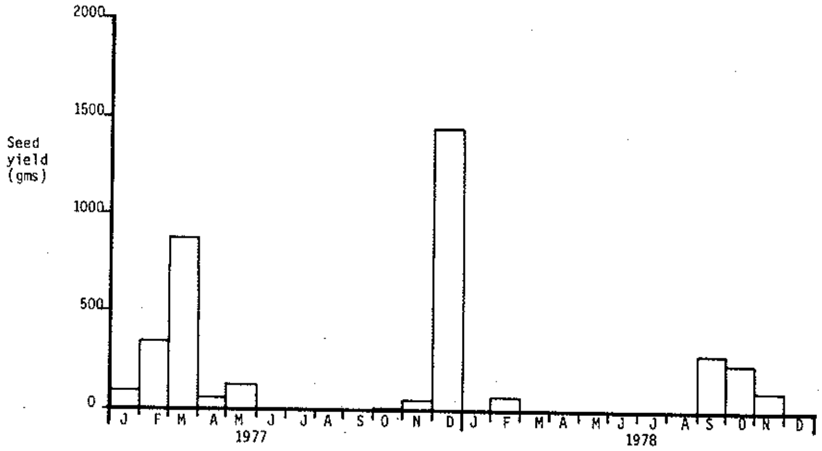

FIGURE 2. Seed yield from a seedling seed orchard of E. deglupta at Bulolo, P.N.G., on a monthly basis for the years 1977-1978. Area of orchard is about 5 ha.

ii. Seedlings in each family of known female parentage, would almost certainly be the result of random mating with nearby male parents of unknown and variable pedigree. To cull three out of the four individuals leaving only the best, was an easy method of early upgrading of the quality of the orchard.

iii. Having four chances to ensure the survival of a representative at the designated spot on the grid ensured there were fewer 'holes' in the orchard layout, thus increasing the chance of effective crossmating.

Lopping and tying down of the branches has not been an entirely successful tool in management of seed orchards of this species. Growth is too vigorous and apical dominance is very strong. However, at the spacing used in the orchard and as a result of attempts at lopping and regular harvesting of seed and vegetative material, increased branching and broad spreading crowns have developed (Plate 8) and seed collection has not been difficult, so far, by climbing or using tall, aluminium ladders. Flowers are in terminal or axilliary panicles and small capsule-laden branches are easily removed by long-handled pruning shears.

Because of the large number of viable seeds per gram and relatively cheap labour, compared to that in western temperate countries, mechanical assistance in seed harvesting has not been introduced to date.

If wheeled machinery was to be introduced in the future, spacing would need to be increased to about 20 m triangular.

SEED ORCHARD YIELD

E. deglupta flowers and sets viable seed as early as 9-14 months from planting. Records for the seedling and grafted orchards planted at Bulolo in mid-1975, commenced in October 1976 when the first major flush of buds was observed in the seedling orchard (some of the grafts flowered after only one month in the field).

Seed harvest records are presented in Figs 1 and 2 for a two-year period 1977-78, covering three major flowering flushes.

By the end of 1978, only 63 per cent of families had produced seed. Of these, 36 per cent had set seed once, 40 per cent twice and 24 per cent all three times. A maximum of 43 per cent of families has flowered in any one cycle. Not all representatives of a family flowered at the same time. On any one individual a maximum of 40-70 per cent of branches were in bud or in flower at any particular time.

The seed produced by 5 ha of orchard in 1977 (about 3 kg in 1977) was sufficient to produce 4 million plants. Allowing for wastage and culling these would establish 2,000 ha of pulpwood plantation.

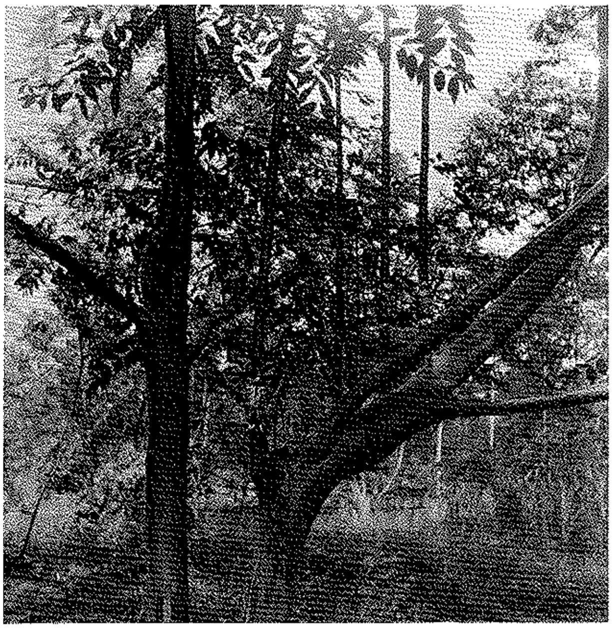

Plate 1: A tree in the P.I.C.O.P. seed orchard at Bislig Bay, Mindanao. Three fresh marcots are shown and scars have been left where others have been removed.

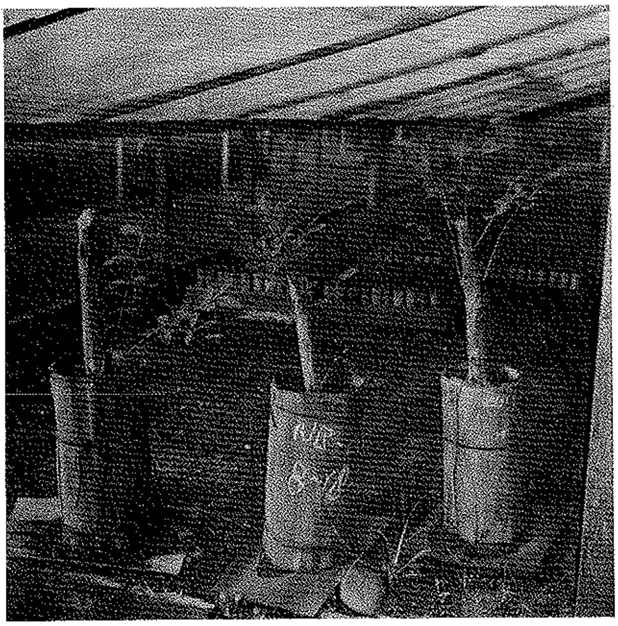

Plate 2: Marcots are transferred to large veneer tubes in the P.I.C.O.P. nursery after severing from the parent tree. These are 3-4 cm diameter and have sprouted well.

HERITABILITY

Narrow-sense heritability estimates are now becoming available for several trials (Plate 9).

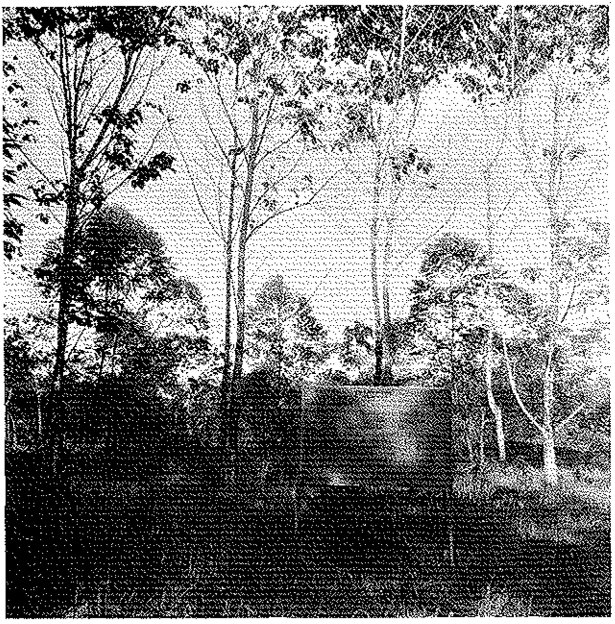

Plate 3: Portion of the seed orchard at P.I.C.O.P. Behind the boundary trees are recent additions to this 50 ha orchard. Spacing is about 15 m x 15 m.

Plate 4: Portion of the same orchard as shown in 3. This is Block 4 containing some of the earlier (1973 established) trees. Note the form of the trees caused by continual cutting for seed and vegetative material.

Height growth: h^2 = 0.27 (2 year old progeny, 2 sites, 38 families, unequal replication, random design), 0.04 (3 year old progeny, 41 families, unequal replication, random design), 0.07 (2 year old progeny, 39 families, unequal replication, random design). Average (n = 3) = 0.13.

Diameter growth: h^2 = 0.64 (2 year old progeny, 2 sites, 38 families,

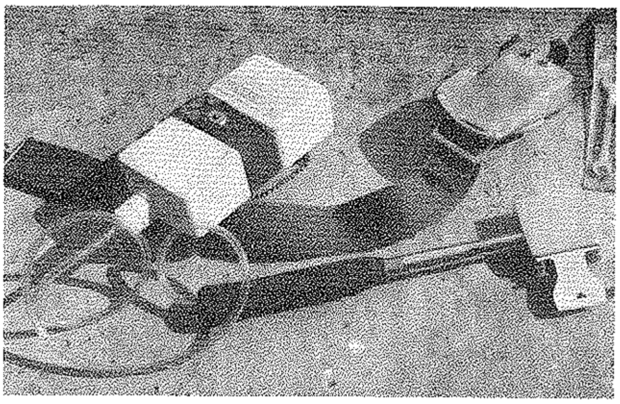

Plate 5: Injector axe used for wounding and injecting trees to stimulate production of coppice shoots.

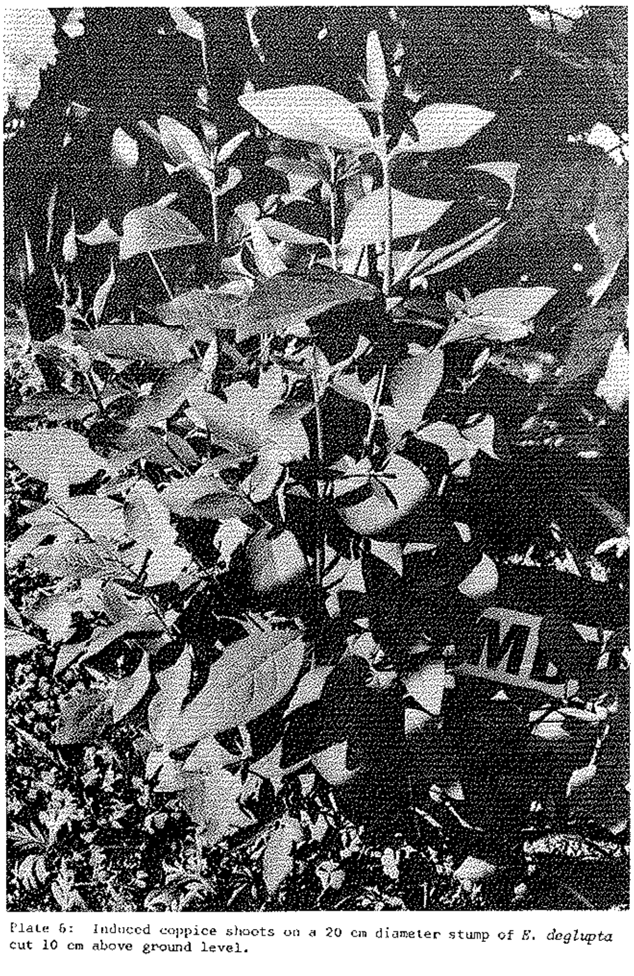

Plate 6: Induced coppice shoots on a 20 cm diameter stump of *E. deglupta* cut 10 cm above ground level.

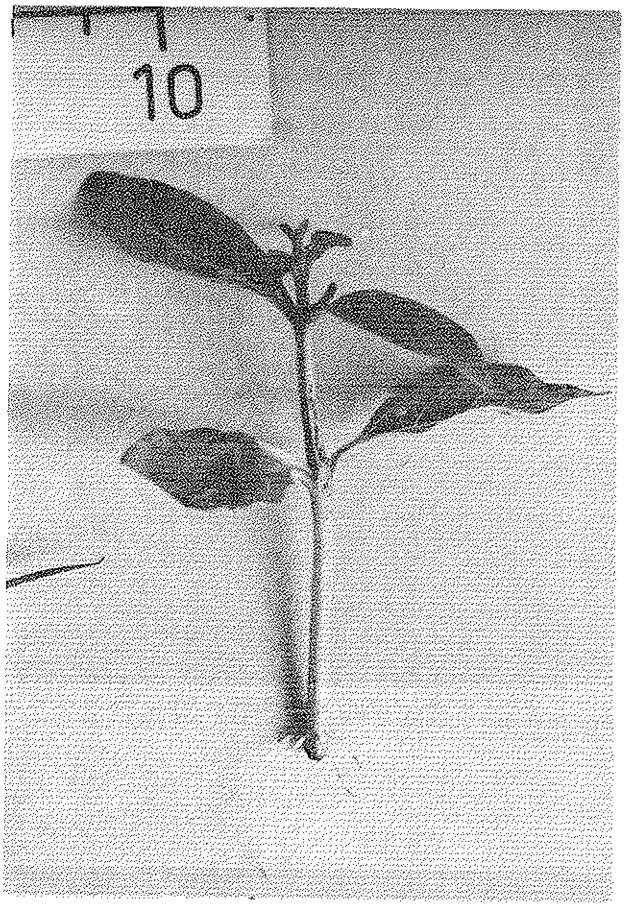

Plate 7: Formation of roots on the fourth node of a coppice shoot after 14 days under mist spray in a medium of sand and peat.

Plate 8: A view within the seedling seed orchard at Bulolo, P.N.G. Following lopping and several collections of seed and vegetative material a much-branched crown has resulted.

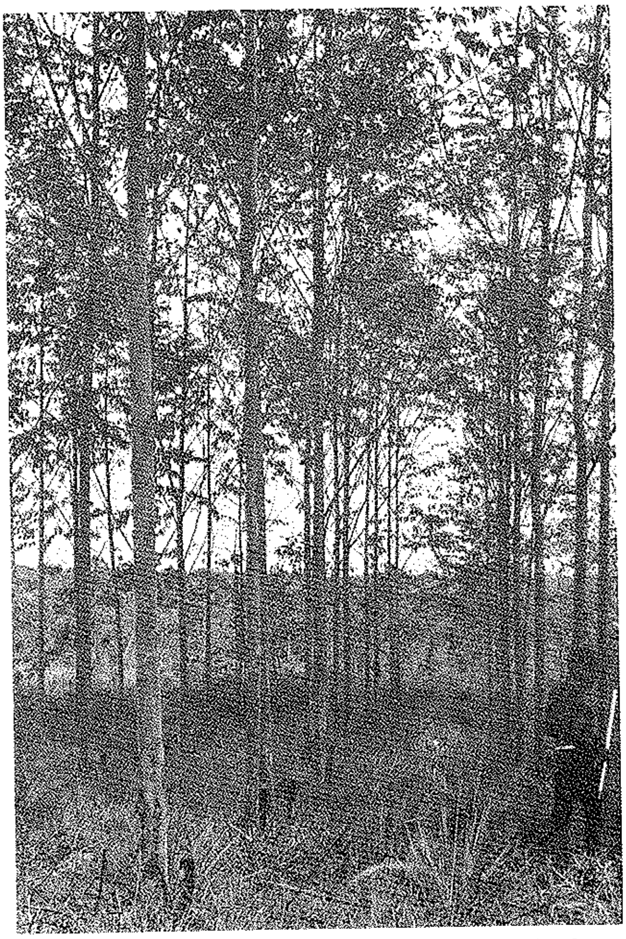

Plate 9: Half-sib progeny of plus trees of *E. deglupta*,24 months of age. Parent trees were selected on the basis of growth rate, straightness, cylindrical bole, fine branches and wood quality. The layout is single tree random location.

unequal replication, random design), 0.34 (2 year old progeny, 34 families, 10 replications, completely random, single tree plots), 0.08 (3 year old progeny, 41 families, unequal replication, random design), 0.06 (2 year old progeny, 39 families, unequal replication, random design), 0.38 (2 year old progeny, 34 families in 3 randomized blocks), 0.22 (2 year old progeny, 43 families in 7 randomized blocks). Average (n = 6) = 0.29.

Wood density: h^2 = 0.54 (2 year old progeny, parent offspring regression, n = 74), 0.81 (2 year old progeny, 8 families, 3 randomized blocks), 0.14 (2 year old progeny, 28 families, 2 replicates, completely random design), 0.35 (2 year old progeny, unequal replication, random design). Average (n = 4) = 0.46.

Straightness: h^2 = 0.12 (2 year old progeny, 42 families unequal replication, completely random design).

Fluting: h^2 = 0.09 (2 year old progeny, 42 families, unequal replication, completely random design).

Judging from the narrow-sense heritability figures so far obtained, emphasis should be placed on wood density and diameter growth as selection parameters as these are major parameters contributing to economics (volume and weight of wood fibre/ha) and most likely to result in positive gain from an improvement programme.

GENOTYPE X ENVIRONMENT INTERACTION

Almost no genotype x environment interaction has been found in half-sib progeny at two sites and geographic races at five sites (provenance trials).

FURTHER WORK

Further seed collections are required from Mindanao and New Britain for provenance studies and establishment of large blocks (over 500 ha) as base populations for future breeding work.

A trial comparing bulk seed orchard seed and several Mindanao and New Britain provenances is urgently required. Based on past work, these trials should be established at two sites, at least, and consist of 100 tree plots in five randomized blocks.

Future provenance collections should contain at least 20 parents.

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O MELHORAMENTO DE *EUCALYPTUS DEGLUPTA* NA COSTA DO MARFIM.

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Resumo

Um programa de melhoramento genético com *E. deglupta* foi iniciado em 1974 na Costa do Marfim. Este trabalho apresenta os primeiros resultados obtidos e as principais linhas do futuro programa.

Dados de crescimento de testes de procedências indicam um bom crescimento para as procedências de Keravat, Bulolo Valley e Congo Loudima (uma progênie da parcela 2K). Seis a sete procedências introduzidas em 1974 e 1975 apresentaram maior vigor que uma introduzida em 1966 de Papua-Nova Guiné.

São apresentados os primeiros resultados do estudo da floração. Enquanto não se tem melhor conhecimento do sistema de reprodução, está sendo aplicado um método de propagação sexuada baseado no estabelecimento de pomares clonais e no controle de progênies.

A propagação vegetativa de material genético selecionado também está prevista. Este método será melhor se o sistema reprodutivo envolver uma taxa satisfatória de autogamia.

Summary

A tree improvement programme was started on E.deglupta in 1974 in Ivory Coast. This paper presents the first results gained and the main outlines of the future plans.
Growth data from the provenance trials indicate a good vigour of provenances from Keravat, Bulolo Valley and Congo Loudima (a progeny from plot 2 k) Six among the seven provenances introduced in 1974 and 1975 were more vigorous than the one previously introduced in 1966 from Papua New Guinea.
The first results of the flowering study are given. In waiting for a better knowledge of the breeding system, a sexual propagation method is aplied and has led to the establishment of clonal seed orchards and the control of progenies.
Vegetative propagation of selected material is planned. This method will be better if the breeding system allows a satisfactory rate of autogamy.

L'AMELIORATION DE L'*EUCALYPTUS DEGLUPTA* EN CÔTE D'IVOIRE.

Resumé

Un programme d'amélioration de l'Eucalyptus deglupta a été mis en route en 1974 en Côte d'Ivoire. Cette note rend compte des travaux réalisés et donne les grandes lignes de l'orientation future du programme.

On peut retenir de l'étude de provenances, la bonne croissance des provenances de Keravat, Bulolo Valley et d'une descendance de Loudima (Congo). 6 des 7 provenances introduites en 1974 et 1975 sont plus vigoureuses que la provenance introduite en 1966 et dont l'origine serait la Papouasie Nouvelle Guinée.

Les 1ers résultats d'une étude de la floraison sont donnés. En attendant de mieux connaître le système de reproduction, les travaux sont orientés principalement vers une voie sexuée aboutissant à la constitution de vergers à graines de clones avec contrôle de la valeur des descendances. Le bouturage industriel de matériel sélectionné est envisagé. Il constituera la voie privilégiée de l'Amélioration si le système de reproduction de cette espèce admet une part non négligeable d'autogamie.

INTRODUCTION

De nombreux eucalyptus ont été introduits en Côte d'Ivoire et sont expérimentés dans le but de la production de bois de pâte à papier. L'Eucalyptus deglupta est certainement l'une des espèces les mieux adaptées sur les sols sablo-argileux ou schisteux de la forêt dense côtière à l'Anguédédou et San Pedro où la production est respectivement estimée à 37,5 m^3/ha/an et 43 m^3/ha/an à l'âge de 6 ans. Un matériel végétal de source assez imprécise (la Nouvelle Guinée Via le Congo) est à l'origine de ces résultats appréciables qu'un programme mis en route en 1974 vise à améliorer en exploitant la grande variabilité (Davidson, 1972) entre races géographiques et entre individus.

ETUDE DE PROVENANCES

Au total, 7 provenances sont étudiées dans le cadre de 2 essais :

- Le 1er mis en place en 1974 à San Pedro route de Grand Bereby, comporte les provenances suivantes : Nouvelle Bretagne n° 480 (FTB n° 6518), KERAVAT n° 673, KAPIURA RIVER n° 518, BULOLO VALLEY n° 534, LOUDIMA 20 M n° 525 et 2 K n° 526. Ces deux dernières provenances sont Congolaises, l'origine 1ère étant la Papouasie Nouvelle Guinée.
- En 1975 la provenance OSSIMA (PNG Batch 552) est mise en étude comparative à San Pedro (Binié), avec KAPIURA RIVER (PNG Batch 518), KERAVAT (PNG Batch 665), un tout venant de San Pedro et des descendances maternelles de semenciers de l'Anguédédou et Dabou. Signalons la mise en place tardive en septembre au lieu de juin de la provenance OSSIMA.

Un dispositif avec 3 blocs complets randomisés est adopté pour chaque essai. Les parcelles unitaires sont constituées de 32 plants (1er essai) ou 40 plants (2è essai) à 4m x 2m d'écartement.

Sites d'Installation

Les sites d'installation (latitude 4° 45' N, longitude 6° 37' W, altitude 40m) sont caractérisés par un climat tropical forestier comportant deux saisons des pluies (avril-juillet et septembre-novembre) et deux saisons sèches (décembre-mars et juillet-septembre). La pluviosité moyenne annuelle varie entre 1700 et 1900m. Les sols sont ferrallitiques fortement désaturés et les roches mères en partie granito-gneissiques, en partie schisteuses.

Evaluation-Résultats

L'évaluation des provenances est faite au niveau de la croissance en hauteur puis en circonférence mesurée à 1,50 m du sol. Les résultats sont portés en Annexes I et II. On peut observer:

- la bonne croissance de Loudima 2 K (n° 526) qui se maintient en tête de classement jusqu'en 1979.
- La faible croissance de Kapiura River dans le 1er essai. Dans le 2è essai par contre, cette provenance connait une croissance relativement bonne et est de ce point de vue, comparable à Keravat.
- La mauvaise croissance du tout venant de San Pedro et pour des raisons déjà évoquées, de la provenance OSSIMA.
- Les autres provenances constituent un groupe toujours homogène.

Des variations morphologiques existent entre les provenances, particulièrement au niveau des feuilles: variations dans les dimensions et parfois dans la colèration des petioles et nervures.

Contrairement aux autres provenances, OSSIMA possède des feuilles aux limbes arrondis, rappelant la forme décrite par Davidson (1977$_1$) pour la variété Schlechteri.

La corrélation est bonne entre la longueur et la largeur des feuilles au niveau arbre chez 4 des 6 provenances de l'essai de 1974. La forme générale de leurs feuilles est relativement constante. Chez les 2 autres provenances (Loudima 20M et Keravat)les variations inter-arbres et intra-arbres sont par contre importantes. Enfin au niveau des dimensions moyennes les feuilles de Kapiura et Nouvelle Bretagne(n°480) sont les plus courtes et les plus étroites; celles de Keravat (n°673) et Bulolo Valley étant par contre les plus grandes.

En resumé, nos essais ont porté sur un nombre limité de populations présentant d'importantes variations morphologiques (qui devront être mieux évaluées) et des caractéristiques de croissance intéressantes. Les résultats obtenus dans d'autres pays à climats tropicaux humides particulièrement en Papouasie-Nouvelle Guinée(Davidson 1973$_1$)et à Puerto Rico(Whitmore, 1973) s'accordent pour reconnaître les bonnes performances de provenances des Celèbes, de Mindanao et de Nouvelle Bretagne. Pour opérer un choix plus judicieux, de nouvelles provenances devraient être introduites à partir des zones non encore explorées.

REPRODUCTION SEXUEE

Dans le verger à graines de clones, on observe annuellement 2 cycles de reproduction avec 2 maxima de floraison en Février-Mars et Juillet-Août suivis de 2 fructifications avec récoltes de graines en Juin-Juillet et Octobre-Novembre.

Les 2 cycles se succèdent sans interruption en juin-juillet de sorte que le plant chargé de fruits issus de la 1ère floraison, porte sur les jeunes pousses, des boutons floraux du 2è cycle. La floraison dans le verger dure près de 2 mois du fait d'une asynchronie marquée de certains clones. Elle dure de 12 à 15 jours au niveau de l'inflorescence et 6 à 8 jours pour une fleur prise isolément.

A la suite de tests récents réalisés sur des inflorescences d'un clone, nous avons pu constater que la pollinisation libre pendant les deux premiers jours de floraison n'était pas efficace; elle l'est par contre à partir du 3è jour. Les plants portant des fleurs à différents stades de vieillissement donc un pollen capable de germer et féconder, cette inefficacité temporaire de la pollinisation est certainement due à une réceptivité tardive du stigmate (à partir du 3è jour suivant l'anthèse); il y a protandrie.

Une certaine auto-fertilité du même clone a été mise en évidence dans des conditions de pollinisation contrôlée (Diabaté, 1980). Ce résultat devra être vérifié sur plusieurs clones avant toute généralisation. L'existence de l'auto-fertilité dans les peuplements et les vergers à graines ne serait pas pour autant prouvée.

MULTIPLICATION VEGETATIVE

Le Greffage

Les 1ers essais de greffage, ont été réalisés en 1975-76 à partir de greffons provenant d'arbres plus âgés de 9 et 10 ans. Quelques réussites étaient enregistrées avec la seule greffe en couronne.

Les essais sont repris en 1977-80 avec des greffons provenant de clones rajeunis par bouturage. Les taux de réussites sont portées à 45 % (greffes en couronne) et 23 % (greffe latérale). Les résultats avec la greffe en fente terminale et la greffe en écusson sont étonnement faibles et inconstants.

L'expérimentation sur le greffage de scions âgés sera reprise en insistant particulièrement sur la greffe en écusson qui, selon Davidson (1977$_3$) conviendrait bien au matériel âgé. La cime des plants obtenus dans ces conditions ressemblerait à celle des arbres adultes. Elle améliorerait donc les conditions d'étude de la floraison et faciliterait les opérations de croisements contrôlés et éventuellement de récolte de graines en verger.

Le Bouturage

Au vu des résultats des 1ers essais de greffage, il était difficile d'envisager cette technique pour la propagation en 1975 des phénotypes sélectionnés en 1974. nous avons donc entrepris de bouturer ce matériel. On a obtenu :

- moins de 10 % d'enracinements après 45 jours de brumisation avec les rameaux d'arbres âgés de 9 ans et plus.
- 25 à 50 % d'enracinements en 30 jours avec des rameaux de plants bouturés provenant du bouturage de rameaux d'arbres plus âgés de 9 ans ou avec des rejets de souches hautes de même âge.
- 75 à 90 % d'enracinements en 2 à 3 semaines avec des rejets du collet ou de souches d'arbres âgés de 11 ans. Des taux comparables sont obtenus avec des rejets de plants provenant d'un 1er bouturage de rameaux d'arbres âgés de 9 ans. (Diabaté, 1978).

En définitive les taux d'enracinements sont en rapport avec le niveau de réjuvénilisation de l'ortet. Les plants bouturés obtenus, même ceux provenant de matériel peu rajeuni, constituent en plantation des arbres bien équilibrés du moins dans leur partie aérienne. Les résultats des essais sont intéressants et permettent d'envisager l'amélioration de l'Eucalyptus deglupta par la voie du bouturage industriel technique bien éprouvée au Congo sur certains Eucalyptus (Martin et Quillet 1974, Chaperon et Quillet 1977$_2$). C'est dans ce cadre que sont mis en place en 1980 un parc à bois et un 1er test clonal.

SELECTION INDIVIDUELLE

Les 1ères sélections sont faites en 1974 dans des peuplements dont l'origine première est la Papouasie-Nouvelle Guinée. Au total 23 arbres sont sélectionnés sur la base de caractères phénotypiques externes. Des variations ont été mises en évidence (Davidson, 1977$_2$ et 1973 SR$_2$) pour ces caractères qui sont le diamètre, la hauteur totale, la longueur du fût libre de branches, le diamètre de la cime, la rectitude du fût et les cannelures.

De nouvelles sélections tenant compte de ces caractères et de la qualité du bois sont en cours.

VERGERS A GRAINES

Un verger à graines de clones bouturés est mis en place en 1975 et 1976 à Sassandra dans d'excellentes conditions d'isolement. Il est constitué de 23 clones représentés chacun par 15 ramets. L'écartement est de 5m x 5m. Le gain génétique dépend de l'héritabilité-encore iconnue- des caractères sélectionnés; il ne peut être à présent estimé. En attendant, ce verger nous assure depuis fin 1977, une production abondante de graines de qualité supposée stable (on admet la prédominance de l'allogamie).

Depuis 1977, les branches des cimes sont rabattues à la faveur des récoltes de graines dans le verger. Il parait néanmoins de plus en plus évident que ces manipulations n'amélioreront pas pour longtemps les conditions de récolte des graines. Nous envisageons donc à court terme la création d'un nouveau verger à graines à partir des phénotypes sélectionnés en 1979-80 et des clones choisis à l'issue des études de descendances en cours. D'autres vergers suivront dont la structure sera fonction des conclusions à l'étude du système de reproduction de l'espèce.

ESSAIS DES DESCENDANCES

3 essais sont constituées à partir de descendances obtenues par pollinisations libres en peuplements ou dans le verger à graines.

Dans le 1er essai, l'étude porte sur des descendances maternelles de 8 semenciers et 8 arbres plus de l'Anguédédou et de Dabou. Les 4 provenances du 2è essai de provenances sont incluses dans le dispositif déjà décrit(page 2).

Le 2è essai mis en place à Binié en 1978 est limité à une descendance clonale, un tout venant de l'Anguédédou et 2 descendances du verger(graines en mélange de plusieurs clones, récoltées en 1977 et en 1980). Chaque descendance est répétée 3 fois, la parcelle unitaire comportant 64 plants à 3m x 3m d'écartement.

Le 3è essai installé à San Pedro Route de Grand Bereby en 1980, comprend 15 descendances de clones librement pollinisés dans le verger à graines et un tout venant de San Pedro. Les descendances sont ici constituées de graines récoltées sur un ou plusieurs ramets. Le dispositif en lattice équilibré comporte 16 traitements répétés 5 fois chacun et des parcelles unitaires de 16 plants à l'écartement de 4m x 4m.

Des résultats de croissance ne sont disponibles que pour le 1er essai(voir tableau II en annexe). On constate que le tout venant de San Pedro et les descendances des arbres plus 57-1 et 57-2 connaissent une mauvaise croissance.

Les descendances des mêmes clones seront à nouveau évaluées dans le cadre d'un autre essai pour contrôler leur stabilité. L'élimination des clones les moins performants sera alors faite au vu des résultats de ces différents tests et des conclusions à l'étude de la biologie florale des clones.

CONCLUSION

Les provenances de Keravat, Bulolo Valley et New Britain (n° 480) ont une bonne vigueur en général mais compte tenu de la très large variation géographique(Davidson, 1977$_2$ et SR$_2$), on ne saurait exclure l'éventualité d'une meilleure réussite de nouvelles provenances.

L'expérimentation sur le bouturage est concluante mais des efforts doivent être faits pour une connaissance approfondie de la biologie de la Reproduction.

Jusque-là, les travaux d'Amélioration génétique ont été menés dans le cadre d'une classique sélection récurrente avec comme étapes : la sélection d'arbres plus, leur propagation et installation en un verger à graines(23 clones), le contrôle de la valeur des descendances qui sera suivi de l'élimination des clones indésirables et l'adjonction de nouveaux phénotypes pour élargir le pool génétique. C'est là un aspect de la stratégie décrite par Davidson (1977$_2$) pour l'Amélioration de l'Eucalyptus deglupta. Cette méthode ne sera efficace que si les critères de base de la sélection individuelle ont une forte héritabilité. Dans le cas contraire, priorité sera donnée à la voie végétative(Chaperon, 1977) basée sur la recherche, le bouturage et le testage de combinaisons génétiques appropriées. Cette méthode connait un début d'application en Côte d'Ivoire avec la mise en place récente d'un parc à bois et du 1er test clonal.

ANNEXE I : Essai Provenances San Pedro - 1974

Hauteur(m) Juin 1975 N°		Circ.moy.(cm) Mars 1976 N°		Circ.moy.(cm) Mars 1979 N°		Circ.moy.(cm) Mars 1980 N°	
6	6,04	6	31,82	6	47,48	2	52,18
4	5,43	4	29,44	2	47,36	1	51,97
3	5,42	3	29,05	4	46,71	4	51,05
5	5,35	2	28,56	1	46,22	6	50,20
2	5,22	1	28,12	5	45,53	5	48,81
1	5,01	5	28,60	3	41,56	3	45,95
	ppds 5% = 1,69		Test Tukey-Hartley		Test Tukey-Hartley		Test Tukey-Hartley

ANNEXE~~S~~ II : Essai Provenances - Descendances Binié (1975)

Hauteur moyenne(Octobre 1976) Circonférence moy.(Juil.1979)

N°	Hauteur moy.(m)	Test Tukey-Hartley Dif. Signif.(0,05)	N°	Circonf. moy.(m)	Test Tukey-Hartley Dif. Signif.(0,05)
S7	7,36		S7	41,30	
D-4	6,94		D-1	41,13	
S8	6,89		S2	40,84	
586 *	6,77		D-3	39,67	
55-1	6,76		586 *	39,66	
57-9	6,66		55-1	39,45	
S4	6,55		D-4	39,00	
D-3	6,37		585 *	38,70	
S6	6,29		S1	38,52	
D-1	6,27		57-9	38,31	
D-2	6,21		D-2	38,28	
S3	6,12		S4	38,22	
S1	5,80		S6	37,99	
585 *	5,76		S8	37,88	
S2	5,66		S5	35,52	
57-1	5,50		57-1	35,20	
57-2	5,12		SP *	34,17	
SP *	5,04		S3	33,00	
S5	4,90		584 *	30,71	
584 *	4,54		57-2	30,55	

Provenances : N° 1 (FTB 8518) Nouvelle Bretagne, N° 2 (PNG Batch 9673) et N° 586 (PNG Batch 665) Keravat, N° 3 (PNG Batch 518) et N° 585 (PNG Batch 518) Kapiura River. N° 4 (PNG Batch 9534) Bulolo Valley, N° 584 (PNG Batch 552) Ossima. N° 5 (Parcelle 20M), N° 6 (Parcelle 2 K) Congo Loudima. SP : Tout venant de San Pedro.

Descendances d'arbres plus : D-1 à D-4; 55-1; 57-1 à 57-9; de semenciers : S1 à S8.

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PROGRAMA COM *EUCALYPTUS GRANDIS* NA CHAMPION PAPEL E CELULOSE S.A.

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Resumo

A CHAMPION PAPEL E CELULOSE S.A., em convênio com instituições de pesquisa e universidades vem desenvolvendo um programa de pesquisa com *Eucalyptus* na região de Mogi-Guaçu desde o início da década de 1960.

Definido o *Eucalyptus grandis* como uma das espécies mais potenciais para essa região, ensaios de procedência mostraram Coff's Harbour como uma das mais adequadas, e extensas plantações dessa origem foram implantadas, e vêm sendo utilizadas como populações base para o programa de melhoramento em desenvolvimento com a espécie.

Foram instaladas "Áreas de Produção de Sementes", com intensidade de seleção em torno de 1:10, e selecionados indivíduos superiores com intensidades de seleção de 1:5000, que foram reproduzidos vegetativamente nos Pomares de Sementes. Os primeiros resultados dos ensaios de progênie de polinização livre mostraram variações genéticas expressivas para crescimento e retidão do tronco, permitindo a predição de ganhos genéticos significativos. A variação da densidade básica da madeira ao nível de árvores superiores e de progênies indica a possibilidade de inclusão dessa característica no segundo ciclo de seleção.

A metodologia para polinização controlada já está bem definida, e os estudos envolvendo hibridação inter-específica foram iniciados em 1974.

As pesquisas básicas tais como o estudo de dispersão de pólen, fenologia do florescimento e frutificação, influência do espaçamento e efeito da abelha na polinização vêm sendo efetuadas.

Os aspectos ligados ao manejo vêm sendo estudados principalmente visando a regeneração das cepas em cortes sucessivos.

THE RESEARCH PROGRAMME WITH *EUCALYPTUS GRANDIS* HILL EX-MAIDEN AT CHAMPION PAPEL E CELULOSE S.A.

Summary

CHAMPION PAPEL E CELULOSE S.A., in convenious with research institutions and Universities, has developed a research programme with Eucalyptus in the region of Mogi-Guaçu, since the decade of 1960.

Eucalyptus grandis revealed to be one of the most potential species in this region and the provenance trials showed Coff's Harbour to be one of the most adequate. Large populations of such origin were established and have been utilized as base population for the breeding programme with the species.

"Seed Production Areas" with selection intensity of 1:10 were established and superior individual trees were selected with selection intensity of 1:5000. These superior trees were vegetatively propagated in "Seed Orchards" and open pollinated progeny trials were established. The expressive genetic variations within the material has permited to predict significative genetic gains in volume and straightness. The variation observed for wood density at superior trees and progenies levels has indicated selection possibilities for this characteristics in the second cycle of selection.

The methodology for controlled pollination is already well defined and the studies involving interspecific hybridity were started in 1974.

Basic research such a pollen dispersion, flowering and fructification fenology, influence of spacing, and the bees effect in the pollination are being developed. The aspects joined with the management are being studied mainly purposing the regeneration of the stumps in successive cuttings.

1. Historical

Due to the necessity of improving the productivity of the established forests, the CHAMPION PAPEL E CELULOSE S.A. started a work of reintroducing species, looking for the substitution of possibly hybrid material which had been utilized in the programmes of reforestations. Then, the well known pure species were reintroduced, as the others untested yet, but potentially able to provide satisfactory results.

The trials were made in the region of Mogi-Guaçu - SP (Lat.22º 20' and Long. 46º 57'), and the results showed Eucalyptus grandis, Coff's Harbour provenance, Australia, as the most adequate species, (Table I).

TABLE I - Volumes obtained by the most recommendable species reintroduced from Australia, expressed in stereos per hectare, at the age of 7 years

SPECIES	VOLUME PER HECTARE (IN STEREOS)*	VOLUME PER HECTARE PER YEAR (IN STEREOS)*
E. grandis	406,75	56,49
E. saligna	262,22	35,77
E. robusta	278,10	37,95
E. resinífera	263,02	35,88
E. Microcorys	191,97	26,19

* Timber without bark and diameter above 6 cm

Adapted from "Aspectos Gerais dos Benefícios da Pesquisa Florestal para uma Empresa"
- Comunicação Técnica nº 9 - PRODEPEF

From these results base populations were stablished (about 1:300 ha), and the works of tree improvement and management were started.

2. Establishement of Seed Production Areas

Since E.grandis was considered as priority in the reforestation programme of this company, has been defined the necessity of improved seed production to continue the works with the species. Seed Production Areas, then, were selected in the original population, reaching a total about 100 ha. The selection criterion for the thinnings in these areas, according to orientation from I.P.E.F. (Forest Studies and Researchs Institute) and U.S.P. (State University of São Paulo), was made basically by the growth and the tree form The first thinning was introduced at the age of 4 years and this treatment eliminated 70% of individual trees (SEE TABLE II). At the 6th year of age, a new selection thinning was made, remaining around 10% of the original population. The last thinning was made at the age of 9 years. At this time about 10% of remaining trees were eliminated, being considered mainly the phytosanitary aspect in the selection.

TABLE II. Diferentials of selection for diameter at breast height observed in the first thinning in seed production areas of E.grandis (4 years old)

"SITE"	AVERAGE DBH OF THE ORIGINAL POPULATION (CM)	AVERAGE DBH SELECTED (CM)	DIFERENTIAL OF SELECTION (CM)
I	11,10	13,69	2,59
II	9,15	10,85	1,70

The initial spacing in these areas was of 6 m^2 per plant, reaching after the selection and thinning 60 m^2 per tree. This opening in the spacement produced, apparently, a decline in the seed germinative power, probably due to the pollination efficiency, when compared with areas of closed spacements. These aspects related with pollen dispersion has being studied by PACHECO et alii (1980), in work that has being developed in Champion, in convenious with CENA - Nuclear Energy Center in Agriculture, and USP, through the marking with radiosotopo ^{32}P, and swarms installation. The preliminary results of this trial have showed that the dispersion of pollen is very large reaching distances over 300 m. The biggest concentration, however, seems to be placed about 100 m from the pollination source.

The studies about flowering of E.grandis have been made in conve nious with State University of São Paulo (UNESP) and USP. The works had begun in 1979, and according to Aguiar and Kageyama (1980), the preliminary results show that the fructification in Seed Production Areas of Champion eccours during whole year. The biggest frequency occurs from July to January, with peaks in August and December. Still according to these authors, the variation tree to tree is very large. MORA and FERREIRA (1978) got similar results with E.urophylla.

The seed yield in these areas (S.P.A) has showed significative variations from one year to another, but with tendency to gradual increasings. In 1977 the average production achieved about 11,0 kg/ha, in 1978 the average dropped to 10,0 kg/ha; finally in 1979, the production reached 15,0 kg/ha. It was found that the relation fruit/seed is about 14,0 : 1,0, and the number of harvested trees in each year is from to 20% of the existing total, resulting about 600 grams of seeds per tree, with about 800 fertile seeds per gram. This small number of harvested trees per year is mainly due to the harvest system, which is characterized by the cutting of brunchs with fruits This practice eliminates the productions in the following years.

3. Selection of Superior Trees and establishement of the Seed Orchard

To continue the program with E.grandis, 140 superior trees were selected. They have tested through its progenies, and reproduced vegetatively, possibiliting the establishment of seed orchards. The criterion observed in intensity the selection were mainly the growth, the form and phytosanitary aspects. The intensity of selection adopted was 1:5000.

The vegetative propagation of these selected trees was made through graft, where were utilized the methods of "budding" and "complicated -English". The number of replications was 16 per method from each selected tree. Indeed, a very large individual variation to incompatibility in the graft has been observed varying from 0 to 100% the levels of success in the individuals. In relationship to the tested methods, the initial survival showed favourable significants differences for the "budding" to the complicated-English". The survival was 60% to the former and 45% to the second. One year after the orchard installation the survival average dropped about 45 and 35%, respectively, remaining the existing variations between clones.

In experimental test, parallelly with the studies involving the Seed Orchard, as proposed by KAGEYAMA and SILVA (1980), a special seed production area was established with the direct utilization of the superior selected trees. Forty (40) trees were located from selection intensity of 1:5000 and 5 dominant trees, located in a distance up 6 m in relationship to the female superior tree, were selected for the pollen production. Afterwards the other individual trees were eliminated from the population. The result was the establishment of 40 seed producer groups, where each superior tree receives pollen from 5 dominant trees near it. This experimental model has a target a short time seed production with a significatively high yield per tree, in addition to a possibility to admit an estimation of gain probably superior than that obtained in usual seed production areas and inferior than seed orchards.

4. Open Pollination Progeny Trials

Selected trees progenies studies has been conducted since 1976. Basically, these tests are looking for obtaining estimatives of general capacity of combination of selected trees (permiting reselection of clones and installation of orchards of 1,5 generations) and knowing the structure of the population through the genetic parameters determination.

KAGEYAMA et alii (1979), in "Progeny trial of E.grandis - Preliminary Results", reported that at 12 months of age, the progeny of best growth had an average height of 6,37 m, and the worst growth - 3,83 m, in the city of Brotas, State of São Paulo. This average variation, very wide, shows good possibilities for selection at progeny level in the trial. The observed gains, with the utilization of progenies of selected trees, are according to the theoretical previsions. It corresponds to 5,94% in height, only with selection of the female side. It also shows that including the selection of the male side, throughout the installation of the Clone Seed Orchard, it's possible to predict the double of this gain, which is equivalent to 11,88%, representing a very significative value.

The basic density of wood is another characteristic that has been studied. The analysis with Eucalyptus grandis show already some satisfactory results. This way in work in convenious with IPEF and USP, MORA et alii (1978), studying the basic density of superior trees in the city of Mogi-Guaçu, Champion's areas, found an amplitude of variation from 0,333 to 0,509 g/cm^3 , with the average of 0,429 g/cm^3. It was not observed significative correlation between the basic density and the vigour of selected trees, showing an independence for these characteristics. From these results the basic density begun also to be studied in a progeny level, looking for its inclusion in the second cycle of selection. The characteristics concerning to the potential of regeneration are also being studied in progenies.

Finally, still relative to progenies, it has been conducted a trial with the purpose to obtain subsidies for checking the breeding programme with Eucalyptus grandis. The main objective is to analyse the performance of progenies from trees with different selection intensity, purposing to check the efficiency of the selection in the population. The preliminary results, at the age of 7 months had not showed still a defined tendency as a progressive increasing in gains relative to a crescent selection intensity.

5. Management to Successive Rotations

In a comparative analyse, considering results obtained in several years, for large commercial areas, Eucalyptus plots that in first rotation showed low yield, in the second rotation showed a better productivity about 30% (average of 3 years) higher. These results, however, has been obtained with possibly hybrid material, remaining to knowledge about the conduct of populations of Eucalyptus grandis with genetic purity and high productivity in the first rotation. Regenerations problems specially Eucalyptus grandis, after successives cuttings, seems very significative. There is no doubt about its high sensibility, mainly, according to the cutting time in sandy soils. In the region of Mogi-Guaçu, there are experimental and practice evidences that the best cutting time is situated in the months of higher rainfall, that is, from September to February (TABLE III).

TABLE III - Average Height of the sprouting and survival of the stumps of Eucalyptus grandis according the cutting time in the region of Mogi-Guaçu (6 months of age).

PARAMETER	CUTTING TIME		
	MAY	AUGUST	NOVEMEER
Survival (%)	60	80	100
Height of the Sprouting (m)	0,94	2,75	3,28

The interplanting of seedlings in substitution to the dead stumps is an alternative that has been studied for the recuperation of areas with low coppice after the cutting. Experimental results have showed, after an initial phase, when the growth rhythm of the sprouting is more accentuated, that there is an equalization in the development of the seedlings and the regenerated stumps (TABLE IV).

TABLE IV - Data of growth in height of sprouting and interplanted seedlings with Eucalyptus grandis in the region of Mogi-Guaçu in different ages.

PARAMETERS	AGE		
	3 MONTHS	7 MONTHS	16 MONTHS
Average height of the sprouting(m)	1,1	2,6	6,0
Average hieght of the interplanted seedlings (m)	0,6	2,1	5,2
Difference (%)	45	19	13

An important aspect, which difficults the interplanting system, is related with the fast regeneration of the stumps, it also varies in function of different climatical stations and from the natural individual variations. In the region of Mogi-Guaçu, about 40% of the stumps of E.grandis, in average, start the sprouting after period more than 60 days after the cutting.

As already mentioned before, due to this individual variation in the regeneration capacity, besides the management alternatives being tested, the breeding perspectives of this characteristic are very favourable. The studies are being developed in a level of progenies, and the efforts are directed to the re-selection, with the installation of seed orchards of future generations.

6. Inter-specific Hybridization

The provenances of Eucalyptus grandis with genetic purity have showed results for basic density, in average, inferior than that possibly hybrid (E.grandis - from Rio Claro) (TABLE V). The regeneration capacity of the stumps of this hybrid material has been also superior, showing a minor susceptibility for the climatical variations.

TABLE V - Estimatives of basic density in different provenances of Eucalyptus grandis, 6 years old

SPECIES - PROVENANCE	BASIC DENSITY (g/cm^3)
E.grandis - South Africa	0,405
E.grandis - Coff's Harbour (Australia)	0,428
E.grandis - Rio Claro (Brasil)	0,493

Considering these aspects, and reporting the necessity of utilization of hydromorfic soils, and being the hybrid from E.grandis and E.robusta a praticable alternative, it was started a program of hybrid production with species. The preliminary results are already being reached in works from convenious with IPEF and USP, under orientation of Prof. Mário Ferreira. Studies about controlled pollination were started in 1974, and actually the methodology is already well determined. The first field trials were installed in 1978, and involved inter-specific cross-breeding with E.grandis, E.saligna, E.urophylla and E.robusta. The data, 2 years and 8 months old, showed superiority in the height for the hybrid of E.grandis x E.saligna (average height of 15,50 m) relatively to the pure E.grandis. In relationship to the basic density, the best treatment, at this same age, was the hybrid of E. grandis x E.urophylla (0,502 g/cm), BRIGATTI and FERREIRA (1980).

Studies about rooting of stakes are being conducted parallelly with the works about controlled pollination and hybridity. It has been special managed for superior trees of Eucalyptus grandis and vegetative multiplication of the hybrid with best performance. The studies about rooting of stakes are also being conducted under orientation of IPEF and USP. The best tested treatments have showed a percentage of rooting, from the sprouting of stumps, about 50% for the E.grandis. Actually, due to our climatical conditions, the biggest difficulties have been found in the adaptation stage for the establishment in the field.

7. Final Considerations

Results from species with genetic purity reintroduction, and from breeding and management works, have been significants, mainly with E.grandis.

Since 1974, CHAMPION CELULOSE E PAPEL S.A., started a whole reform of low productivity populations established in near mill areas.

They were replaced by high field population. Hence, forests formed for possibly hybrid species, with a growth rate of 24 stereos/hectare/year (diameter above 6 cm, without bark at the age of 7 years, were replaced by improved seeds plantations, mainly from Eucalyptus grandis.

The new population, reached a mean annual increment (M.A.I.) of 41 stereos/hectare/year at the age of six years.

These pretty compensatory results, open optimist perspectives for the programme continuation they are also justifying works being developed in CHAMPION PAPEL E CELULOSE S.A.

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UM NOVO MÉTODO DE MELHORAMENTO EM EUCALIPTO: "Área de Produção de Sementes Especial".

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Summary

A new method of tree improvement, the "special seed production area", is discussed in this paper. The proposed method is being studied in a Eucalyptus grandis Hill ex Maiden population, in the region of Mogi Guaçu (S.P.)

The main objective of this area is associated with the production, in a short period of, time, of seeds of high genetic quality. The estimated genetic gains in this method are superior than those of the seed production areas.

Different selection intensities are utilized on both sexes for the establishment of the special seed production area. The selected trees with a high selection intensity, which function as the female trees, are surronded by a group of trees selected under a low selection intensity, which function as male trees.

INTRODUÇÃO

Os métodos de melhoramento em espécies florestais têm sido bem padronizados, de empregos generalizados e não têm sofrido grandes alterações nos diferentes países, ficando as modificações restritas a pequenas variações, isto em função das características apresentadas pelas espécies.

SHELBOURNE (1973), em descrição dos diferentes métodos de melhoramento, mostra as diversas possibilidades de utilização e combinação da seleção para a produção de sementes de vários graus de melhoramento. Esse autor especifica os ganhos genéticos possíveis de serem obtidos através da instalação de Áreas de Produção de Sementes (APS) e de Pomares de Sementes Clonais (PSC), mostrando que esses devem ser os estágios subsequentes para avanços genéticos com seleção intra-populacional. Os ganhos previstos por SHELBOURNE (1973), para os PSC, para volume de madeira, são de aproximadamente 12%, e praticamente a metade desse valor para APS.

Especificamente para o eucalipto, ELDRIDGE (1975) relata os métodos usuais de melhoramento, detalhando as particularidades existentes. O autor mostra ainda as dificuldades de se obter estágios avançados de melhoramento em curtos períodos de tempo.

Um método de melhoramento que fornecesse ganhos intermediários entre APS e PS, e que demandasse um curto período de tempo para seu estabelecimento, seria uma alternativa bastante interessante para aumentar as possibilidades de produção de sementes melhoradas.

O presente trabalho tem por objetivo propor um novo método de melhoramento, "Área de Produção de Sementes Especial", aplicável em populações de eucaliptos onde a exploração se faça através de corte raso, e a regeneração por talhadia simples.

DESCRIÇÃO DO MÉTODO

Os povoamentos de eucaliptos implantados com o objetivo de fornecer matéria prima para indústrias de celulose, e energia para siderurgias, tem sido explorados através da realização de cortes rasos, com a utilização de brotações de touças nas rotações seguintes. Em populações adequadas para seleção de árvores superiores (com alta intensidade de seleção), e considerando a existência de um certo número dessas árvores, após a realização do corte, não haveria possibilidade de seu aproveitamento para produção de sementes, a não ser através de propagação vegetativa em pomares clonais.

A seleção de um determinado número de árvores no estrato dominante, junto às árvores superiores, num raio de até 10,0 m, as quais não seriam abatidas na época do corte, além de não prejudicar o sistema de exploração, forma um núcleo produtor de sementes. As árvores do estrato dominante agem nesse esquema como masculinas (fornecedoras de pólen), e a árvore superior como feminina (produtora de sementes).

O conjunto de núcleos produtores de sementes forma a "Área de Produção de Sementes Especial" (APSE). Na APSE a seleção tem diferentes intensidades nos dois sexos, ou seja, no lado feminino a intensidade de seleção é bem alta, acima de 1:1000, e no lado masculino esse valor é semelhante ao de APS usual (em torno de 10%).

RESULTADOS E DISCUSSÃO

Uma APSE foi instalada, experimentalmente, em uma população de *Eucalyptus grandis*, procedência Coff's Harbour, na região de Mogi Guaçu - SP, contendo 40 núcleos de produção de sementes, e portanto com um total de 240 árvores. A área foi estabelecida a partir de 1978, e a primeira produção de sementes está prevista para 1980.

A seleção no lado feminino, para a APSE estabelecida, foi de 1: 5.000, e para o lado masculino foi de 1:10. As características dessas árvores, e da população original, são apresentadas na Tabela 1.

Tabela 1. Dado de altura média e diâmetro a altura do peito médio para a população original, árvores masculinas e árvores femininas de APSE de *Eucalyptus grandis* aos 6 anos de idade.

POPULAÇÕES	PARÂMETROS			
	Altura (m)	Desvio Padrão (m)	DAP (CM)	Desvio Padrão (CM)
População Original	23,1	3,511	14,1	3,384
Árvores Masculinas i.s. = 1:10	26,5	2,726	17,6	2,790
Árvores Femininas i.s. = 1:5.000	28,7	2,250	22,4	2,678

Para efeito de previsão de ganhos genéticos na APSE, e comparação com aqueles estimados para APS e PS, pode-se assumir que, em média, segundo a maioria dos autores, as herdabilidades para DAP e altura seriam da ordem de 0,10 e 0,20, respectivamente. Isso considerado, e utilizando-se a fórmula clássica para cálculos de ganhos genéticos ($G_S = d_S \times h^2$), podemos obter as estimativas de avanços nos tres métodos de melhoramento (APS, PS e APSE), conforme pode ser observado na Tabela 2.

Tabela 2. Estimativas de ganhos genéticos em Área de Produção de Sementes(APS) Pomar de Sementes(PS)e Área de Produção de Sementes Especial(APSE)

MÉTODO DE MELHORAMENTO	GANHO GENÉTICO (%)	
	Altura	D.A.P.
APS	2,94	2,48
PS	4,85	5,89
APSE	3,89	4,18

Nas estimativas obtidas para APSE, os ganhos foram desdobrados considerando-se as diferentes intensidades de seleção nos dois sexos. Assim, cada intensidade de seleção foi analisada de forma independente para cada sexo. O ganho genético total é a somatória dos ganhos individuais para cada sexo.

CONSIDERAÇÕES FINAIS

O método proposto, conforme salientado, apresenta-se como uma alternativa que pode ser considerada viável para produção de sementes melhoradas a curto prazo. A incompatibilidade verificada na propagação vegetativa por enxertia, particularmente acentuada em *Eucalyptus grandis*, pode tornar o método mais atrativo.

Algumas das restrições ao método estão associadas ao atual desconhecimento da eficiência da polinização cruzada nessas áreas, bem como às dificuldades de colheita de sementes e à sua aplicação somente nas condições de manejo especificadas.

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INTRODUÇÃO DE POPULAÇÕES GENÉTICA-BASE DE *EUCALYPTUS SPP.*

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Resumo

Este trabalho estuda a introdução de população genética básica de 5 espécies de *Eucalyptus (E. grandis, E. camaldulensis, E. tereticornis, E. cloeziana* e *E. citriodora).* Os principais objetivos do estudo são: a) conservação de material genético básico; b) recombinação e aumento da base genética; c) estudo da variação genética entre origens; d) estudo da variação genética entre progênies de meio-irmãos e e) estudos das progênies de árvores superiores objetivando posterior seleção.

Summary

Introduction of basic genetic material of 5 species of Eucalyptus , have been made as follows:

- Eucalyptus grandis
- Eucalyptus camaldulensis
- Eucalyptus tereticornis
- Eucalyptus cloeziana
- Eucalyptus citriodora

The purpose of the experiment are:

- Storage of basic genetic material
- Recombination and enlargement of the genetic base
- Study of the genetic variation among origins
- Study of the genetic variation within half-brother progenies
- Study the progenies of the superior trees for the purpose of selection.

1 - Introdução.

O desenvolvimento de um Programa de Melhoramento Florestal e Produção de Semente geneticamente Melhorada, depende fundamentalmente do material disponível a trabalhar.

A Base de Melhoramento Florestal é a seleção, que atua sobre a variabilidade genotípica, por intermédio da variabilidade fenotípica.

A seleção é a evolução ao desejo do homem e representa a mais útil ferramenta de que se utiliza o melhorista.

No momento em que o Melhoramento é praticado, sob forma de seleção, a base genética torna-se estreita, e o Melhoramento ficará restrito a algumas gerações.

A variabilidade natural é necessária em povoamentos, para ' que estes possam defender-se contra riscos desconhecidos, tais como clones parcialmente testados a doenças e pragas introduzidas ' ou adaptadas em larga escala. (HEYBROEK, 1977 citado por Brune, 1979).

Existem variações naturais entre espécies e dentro de uma mesma espécie.

As variações dentro das espécies, são altamente importantes', em vista da definição da procedência de semente.

Normalmente, a variação natural é devida as Áreas Geográficas, Localidade dentro de Áreas Geográficas, variação entre árvores e variação dentro da árvore (Ferreira, 1976).

Há necessidade de se preservar a variabilidade natural como um reservatório, de que se pode lançar mão, no caso de qualquer mudança na exigência do mercado (Brune, 1979).

Segundo Ferreira, 1976, encontram-se populações de árvores de uma determinada espécie, diferentes de outra população da mesma espécie, em várias características adaptativas, o que é chamado de variação Ecotípica.

Essas diferenças são abruptas e os "ecotipos" são isolados ' geneticamente, isto é, as populações não trocam pólen entre si.

A conservação das recursos genéticos "ex situ" é imperativa, especialmente porque não é realista confiar na preservação das populações na Austrália (Turnbull, 1977 citado por Brune, 1979) e em outros Países.

O estabelecimento de populações genéticas-base de espécies / procedências, pode ser utilizado na obtenção de sementes de forma relativamente rápida e econômica, com um determinado grau de qualidade (Pinto Jr., 1978).

A criação de novas variabilidades, com introdução em novos ' locais, será bastante importante no futuro, quando então essa variabilidade natural existente tiver sido explorada, ou em condições especiais; quando determinadas características devem ser transferidas de uma procedência para outra (Kageyama, 1976). Uma vantagem que o estabelecimento de populações bases pode trazer, é que no futuro, pode-se obter uma geração de indivíduos já submetidos a uma seleção natural e outra silvicultural (Pinto Jr., 1978).

Um fator importante a ser considerado, refere-se à alta variabilidade genética que deve existir no estabelecimento de populações genéticas-base (pinto Jr., 1976).

2 - Justificativa de Pesquisa.

A ausência de material genético básico, para desenvolvimento de trabalhos de Melhoramento Florestal e Produção de Sementes, determinou a coleta de sementes em árvores selecionadas representantes da variabilidade natural "in situ".

A coleta das sementes foi realizada com registro do local e' árvores coletadas, de tal forma que a mesma possa ser novamente colhida.

O uso intensivo de material de base genética estreita, resulta em cruzamento consanguineos, determinando uma degenerescência' da espécie.

Do ponto de vista genético, normalmente, populações de origem distinta, diferem em suas frequências genéticas. Há, então, pelo menos duas razões para uma mistura de populações puras exóti - cas; para que se possa manifestar melhor adaptação em gerações fu turas; para que haja a possibilidade de recombinação de caracteres, consequentemente seleção de indivíduos bem melhores que os ancestrais (Brune, 1979).

3 - Objetivos.

a) Estocar material genético-base de grande variabilidade natural.

b) Recombinação e ampliação de base genética.

c) Estudar a variação genética entre procedência.

d) Estudar a variação genética dentro de progênies de meio-iramõs.

e) Estudar progênie de árvores superiores, visando seleção.

4 - Considerações.

A preservação do material genético básico é um fator importantíssimo, em vista dos fatores observados:

- necessidade de grande variabilidade natural;
- risco de dependência de importação de sementes;
- fonte de material, para novas situações e/ou exigências de mercado;
- recombinação e ampliação da base genética;
- variação entre procedências;
- variação entre progênies;
- estudar progênies de árvores superiores.

O modo como devem ser preservados os recursos genéticos, podem ser abordados de maneiras diferentes. No caso de essências exóticas, como os Eucalyptus, a conservação dos recursos genéticos dá-se "ex situ", isto é, fora da área de ocorrência da espécie.

As populações básicas iniciais ou populações genéticas básicas devem compor-se de um grande número de indivíduos, preferencialmente da maior parte de toda variabilidade genética existente.

Uma das linhas de estocagem do material prevê a instalação do material básico, em espaçamento amplo, para que haja uma maior recombinação e produção precoce de frutos, montado em dilineamento adequado (parcelas individualizadas com grande casualização).

Neste método teremos informações imediatas como, a indicação da melhor procedência, precocidade e época de floração e produtividade da espécie.

Por este método, tão logo haja a frutificação, serão colhidos os frutos das melhores procedências, nas melhores árvores e dentro destas.

Não haverá eliminação do material inferior e sim, uma seleção de quais indivíduos deverão ser colhidos os frutos.

As sementes do F_1 (primeira geração) deverão ser misturados e plantados em novo povoamento, maior que o primeiro, para haver grande segregação, recombinação e produção.

A seleção dos melhores indivíduos faz-se a partir da produção do F_2 (segunda geração) que deverão ser plantadas em todas as áreas ecológicas para permitir a adaptação às mais distintas situações.

As seleções serão drásticas e intensas à partir do F_2 e F_3, para propiciar melhoramento rápido.

Tomar muito cuidado, para que as populações originais (população base) e F_1 (primeira geração) sejam mantidas isoladas, para que se possa recorrer a estas, e enriquecer os trabalhos em determinada situação.

Outra linha de estocagem de material, seria a manutenção de todas as procedências, separadamente, por diversas gerações, de modo que houvesse uma adaptação, favorecidas pela seleção natural e uma leve seleção artificial.

Após algumas gerações, estas "raças locais" seriam agrupadas em uma nova população para recombinação.

Este método traz o inconveniente de que teria se esperar por diversas gerações de árvores, para caracterizar a adaptação local, separadamente em locais distintos.

O método de condução das populações genéticas-base, deve ser bem definido no início do programa, para que se possa alcançar o máximo dos objetivos; no entanto, o desenvolvimento deste trabalho é mutável, de acordo com nova política da empresa, mercado e objetivos a serem alcançados.

O desenvolvimento do método de estocagem do material genético básico, assume uma situação bem distinta, em vista da maioria das empresas estarem interessadas na obtenção de sementes com boas qualidades genéticas, em um curto espaço de tempo, com boas características, como taxa de crescimento, resistência a pragas e/ou doenças e qualidade da madeira.

Em vista disto, deve-se procurar um termo de acordo entre os trabalhos a longo prazo de Melhoramento, e a utilização imediata do material para produção de sementes.

5 - Material Introduzido.

Os trabalhos experimentais de introdução de espécies, para os diferentes locais de atuação das empresas, não foram ainda esgotados. Percebe-se a cada nova introdução que algumas espécies tem desenvolvimento diferente a cada novo local testado.

Nota-se que o ponto fundamental no desenvolvimento dos trabalhos de introdução de espécies, são aqueles a nível de PROCEDÊNCIAS. Certas espécies são descartadas de imediato, sem que se tenha esgotado as suas procedências da variabilidade natural.

Para o desenvolvimento de um trabalho de Melhoramento Florestal, abrangendo áreas extensas, com diferentes condições ecológicas, e grande consumo de sementes, deve-se introduzir material básico, com uma gama de espécies, assegurando qualquer mudança futura.

As introduções recentes feitas pela Empresa, envolvem as espécies de *E.grandis*, *E. camaldulensis*, *E.tereticornis*, *E.saligna* e *E.citriodora* e, foram implatadas em convênio como o IBDF.

Nos quadros I, II, III, IV e V, estão relacionadas as árvores e/ou procedências, número de colheita Australiano, data da colheita, altura e diâmetro das árvores colhidas, Latitude, Longitude, Altitude e Descrição da Área de Coleta.

Quadro 1 - Sub-projeto 01 - *Eucalyptus grandis* - Características das árvores e local de colheita.

Trat.	Número de Colheita	Data da Colheita	Altura Árvores.	Diâmetro	Latitude	Longitude	Altitude	Área da coleta
01	DK 343	16-09-77	32 m	60 cm	17º18'S	145º42'E	580 m	Gadgarra S.F., Butchers Creek area, C.15 km E of Yungaburra.
02	344	16-09-77	25 m	35 cm	17º18'S	145º42'E	580 m	Gadgarra S.F., Butchers Creek area, C.15 km E of Yungaburra.
03	345	16-09-77	32 m	60 cm	17º10'S	145º42'E	580 m	Gadgarra S.F., Butchers Creek area, C.15 km E of Yungaburra.
04	346	16-09-77	21 m	60 cm	17º18'S	145º42'E	580 m	Gadgarra S.F., Butchers Creek area, C.15 km E of Yungaburra.
05	347	16-09-77	33 m	100 cm	17º16'S	145º26'E	1000 m	Mt.Baldy(Rifle Range road), 5km w of Atherton, near Walsh Falls.
06	348	17-09-77	40 m	76 cm	17º49'S	145º31'E	800 m	27 km SSE Ravenshoe along Tully Falls road(Logging area to W of Main road).
07	349	17-09-77	40 m	76 cm	17º49'S	145º31'E	800 m	27 km SSE Ravenshoe along Tully Falls road(Logging area to W of Main road).
08	350	17-09-77	33 m	90 cm	17º49'S	145º31'E	800 m	27 km SSE Ravenshoe along Tully Falls road(Logging area to W of Main road).
09	351	17-09-77	35 m	50 cm	17º49'S	145º31'E	800 m	27 km SSE Ravenshoe along Tully Falls road(Logging area to W of Main road).
10	352	17-09-77	33 m	76 cm	17º49'S	145º31'E	800 m	27 km SSE Ravenshoe along Tully Falls road(Logging area to W of Main road).
11	353	17-09-77	36 m	84 cm	17º49'S	145º31'E	800 m	27 km SSE Ravenshoe along Tully Falls road(Logging area to W of Main road).
12	354	19-09-77	21 m	30/20cm	17º36'S	145º28'E	940 m	4,0 km Nw of Ravenshoe Towards Tumoulin.
13	355	19-09-77	36 m	76 cm	17º38'S	145º31'E	900 m	4,8 km Se of Ravenshoe Towards Tumoulin.
14	356	19-09-77	30 m	76 cm	17º49'S	145º31'E	800 m	27 km SSE of Ravenshoe along Tully Fally road(Logging area to W of main road).
15	357	20-09-77	38 m	96 cm	17º49'S	145º31'E	800 m	27 km SSE of Ravenshoe along Tully Tally road(Logging area to W of main road).
16	432	30-09-77	40 m	89 cm	17º42'S	145º29'E	950 m	Quandong L.A. (near Mt.Pandanus).C.10 km S of Ravenshoe.
17	433	30-09-77	33 m	150 cm	17º42'S	145º29'E	950 m	Quandong L.A. (near Mt.Pandanus).C.10 km S of Ravenshoe.
18	434	30-09-77	36 m	51 cm	17º42'S	145º29'E	950 m	Quandong L.A. (near Mt.Pandanus).C.10 km S of Ravenshoe.
19	435	30-09-77	36 m	76 cm	17º42'S	145º29'E	950 m	Quandong L.A. (near Mt.Pandanus).C.10 km S of Ravenshoe.
20	436	30-09-77	36 m	51 cm	17º42'S	145º29'E	950 m	Quandong L.A. (near Mt.Pandanus).C.10 km S of Ravenshoe.
21	437	30-09-77	41 m	155 cm	17º42'S	145º29'E	950 m	Quandong L.A. (near Mt.Pandanus).C.10 km S of Ravenshoe.
22	438	30-09-77	33 m	53 cm	17º42'S	145º29'E	950 m	Quandong L.A. (near Mt.Pandanus).C.10 km S of Ravenshoe.
23	439	30-09-77	29 m	46 cm	17º42'S	145º29'E	950 m	Quandong L.A. (near Mt.Pandanus).C.10 km S of Ravenshoe.
24	440	30-09-77	33 m	61 cm	17º42'S	145º29'E	950 m	Quandong L.A. (near Mt.Pandanus).C.10 km S of Ravenshoe.
25	441	30-09-77	30 m	63 cm	17º42'S	145º29'E	950 m	Quandong L.A. (near Mt.Pandanus).C.10 km S of Ravenshoe.
26	448	03-10-77	37 m	71 cm	17º20'S	145º25'E	1100 m	Herberton Range S.F. C.7 km NE of Herberton towards Atherton.
27	449	03-10-77	34 m	89 cm	17º20'S	145º25'E	1100 m	Herberton Range S.F. C.7 km NE of Herberton towards Atherton.
28	450	03-10-77	37 m	69 cm	17º20'S	145º25'E	1100 m	Herberton Range S.F. C.7 km NE of Herberton towards Atherton.
29	451	03-10-77	20 m	46 cm	17º21'S	145º24'E	900 m	4,3 km NE of Herberton-Atherton(South Branch of Wild River).
30	452	03-10-77	33 m	56 cm	17º21'S	145º24'E	900 m	4,3 km NE of Herberton-Atherton(South Branch of Wild River).
31	453	03-10-77	37 m	80 cm	17º21'S	145º24'E	900 m	4,3 km NE of Herberton-Atherton(South Bransh of Wild River).
32	479	05-10-77	27 m	46 cm	17º03'S	145º36'E	740 m	13,1 km SE along Davies Creek road from the Mareeba/Kuranda road.
33	480	05-10-77	27 m	46 cm	17º03'S	145º36'E	740 m	13,2 km SE along Davies Creek road from the Mareeba/Kuranda road.
34	481	05-10-77	23 m	35 cm	17º03'S	145º36'E	740 m	13,3 km SE along Davies Creek road from the Mareeba/Kuranda road.
35	482	05-10-77	27 m	46 cm	17º03'S	145º36'E	740 m	14,0 km SE along Davies Creek road from the Mareeba/Kuranda road.
36	483	05-10-77	26 m	43 cm	17º03'S	145º36'E	740 m	14,1 km SE along Davies Creek road from the Mareeba/Kuranda road.
37	484	05-10-77	33 m	51 cm	17º03'S	145º36'E	740 m	14,9 km SE along Davies Creek road from the Mareeba/Kuranda road.
38	485	05-10-77	23 m	33 cm	17º03'S	145º36'E	740 m	15,0 km SE along Davies Creek road from the Mareeba/Kuranda road.
39	535a	17-10-77	27 m	36 cm	17º23'S	145º27'E	1040 m	9,5 km E of Wondecla along Ralley road.
40	535b	17-10-77	26 m	50 cm	17º23'S	145º27'E	1040 m	8,8 km E of Wondecla along Ralley road.
41	536	17-10-77	24 m	48 cm	17º24'S	145º27'E	980 m	9.0 km E of Wondecla along Ralley road.(North Nigger Creek).
42	537	17-10-77	30 m	100 cm	17º24'S	145º27'E	980 m	9.5 km E of Wondecla along Ralley road (North Nigger Creek).
43	538	17-10-77	32 m	52 cm	17º24'S	145º27'E	980 m	9,4 km E of Wondecla along Ralley road (North Nigger Creek).
44	539	17-10-77	23 m	90 cm	17º24'S	145º27'E	980 m	9,4 km E of Wondecla along Ralley road (North Nigger Creek).
45	540	17-10-77	23 m	87 cm	17º27'S	145º27'E	1000 m	8,7 km SE of Wondecla towards Millaa Millaa.
46	541	17-10-77	27 m	49 cm	17º27'S	145º28'E	1000 m	10,0 km SE of Wondecla towards Millaa Millaa.
47	543	17-10-77	17 m	58 cm	17º27'S	145º28'E	1000 m	10.2 km SE of Wondecla towards Millaa Millaa.
48	544	17-10-77	26 m	60 cm	17º27'S	145º28'E	1000 m	10.3 km SE of Wondecla towards Millaa Millaa.
49	545	17-10-77	09 m	15 cm	17º27'S	145º28'E	1000 m	10.3 km SE of Wondecla towards Millaa Millaa.
50	546	17-10-77	26 m	40 cm	17º27'S	145º28'E	1000 m	10.3 km SE of Wondecla towards Millaa Millaa.

Quadro 11 - Sub-projeto 02 - *Eucalyptus camaldulensis*.

Trat.	Número de Colheita	Data da Colheita	Altura Árvores	Diâmetro	Latitude	Longitude	Altitude	Área da coleta
01	DK 360	22-09-77	14 m	30/25 cm	17°20'S	144°28'E	460 m	Emu Creek,. 2.3 km E.of Petford - Dimbulah
02	361	22-09-77	8 m	18 cm	17°21'S	144°54'E	500 m	3,2 km W of Petford - Lappa (Oak Creek)
03	362	22-09-77	9 m	23 cm	17°21'S	144°54'E	500 m	4,0 km W of Petford - Lappa (Oak. Creek)
04	401	24-09-77	9 m	15 cm	17°21'S	144°19'E	780 m	Walsh River 3 km N of Watsonville (W.of Herberton)
05	496	11-10-77	8 m	15 cm	17°24'S	144°54'E	600 m	Sunnymount Station, 5 km S of Lappa (S W of Petford)
06	497	11-10-77	15 m	42 cm	17°23'S	144°57'E	480 m	5,0 km SE of Petford - Emuford
07	498	11-10-77	20 m	50 cm	17°24'S	144°58'E	480 m	7,4 km SE of Petford - Emuford.
08	528	14-10-77	9 m	20 cm	16°27'S	144°46'E	500 m	38,0 km NW of Mt. Carbine - Lakeland
09	529	14-10-77	11 m	23/20 cm	16°27'S	144°46'E	500 m	38,0 km NW of Mt.Carbine - Lakeland
10	499	12-10-77	15 m	20/33 cm	16°22'S	144°44'E	380 m	Spring Creek, 50 km NW of Mt.Carbine - Lakeland
11	P.1	17/20-1-76	11 m	34 cm	17°20'S	144°58'E	460 m	Emu Creek 31.3 km W of Dimbulah - Petford (2.3 km E of Petford)
12	2	17/20-1-76	9 m	45 cm	17°20'S	144°58'E	460 m	Emu Creek 31,3 km W of Dimbulah - Petford (2,3 km E of Petford)
13	3	17/20-1-76	9 m	33 cm	17°20'S	144°58'E	460 m	Emu Creek 31,3 km W of Dimbulah - Petford(2,3 km E of Petford)
14	5	17/20-1-76	8 m	29 cm	17°20'S	144°58'E	460 m	Emu Creek 31,3 km W of Dimbulah - Petford (2,3 km E of Petford)
15	6	17/20-1-76	12 m	30 cm	17°20'S	144°58'E	460 m	Emu Creek 31,3 km W of Dimbulah - Petford (2,3 km E of Petford)
16	7	17/20-1-76	17 m	56 cm	17°20'S	144°58'E	460 m	Emu Creek 31,3 km W of Dimbulah - Petford (2,3 km E of Petford)
17	8	17/20-1-76	14 m	54 cm	17°20'S	144°58'E	460 m	Emu Creek 31,3 km W of Dimbulah - Petford (2,3 km E of Petford)
18	10	17/20-1-76	15 m	46 cm	17°20'S	144°58'E	460 m	Emu Creek 31,3 km W of Dimbulah - Petford (2,3 km E of Petford)
19	11	17/20-1-76	12 m	33 cm	17°20'S	144°58'E	460 m	Emu Creek 31,3 km W of Dimbulah - Petford (2,3 km E of Petford)
20	12	17/20-1-76	15 m	45 cm	17°20'S	144°58'E	460 m	Emu Creek 31,3 km W of Dimbulah - Petford (2,3 km E of Petford)
21	14	17/20-1-76	20 m	37 cm	17°20'S	144°58'E	460 m	Emu Creek 31,3 km W of Dimbulah - Petford (2,3 km E of Petford)
22	15	17/20-1-76	17 m	57 cm	17°20'S	144°58'E	460 m	Emu Creek 31,3 km W of Dimbulah - Petford (2,3 km E of Petford)
23	17	17/20-1-76	15 m	31 cm	17°20'S	144°58'E	460 m	Emu Creek 31,3 km W of Dimbulah - Petford (2,3 km E of Petford)
24	18	17/20-1-76	21 m	71 cm	17°20'S	144°55'E	460 m	Emu Creek 31,3 km W of Dimbulah - Petford (2,3 km E of Petford)
25	19	17/20-1-76	26 m	80 cm	17°20'S	144°58'E	460 m	Emu Creek 31,3 km W of Dimbulah - Petford (2,3 km E of Petford)
26	21	17/20-1-76	15 m	57 cm	17°20'S	144°58'E	460 m	Emu Creek 31,3 km W of Dimbulah - Petford (2,3 km E of Petford)
27	J.D. 208	17-01-76	13 m	50 cm	17°12'S	144°58'E	500 m	9,3 km W of Dimbulah - Petford
28	209	17-01-76	10 m	52 cm	17°12'S	144°58'E	500 m	9,3 km W of Dimbulah - Petford
29	210	17-01-76	18 m	95 cm	17°12'S	144°58'E	500 m	9,3 km W of Dimbulah - Petford
30	211	17-01-76	13 m	73 cm	17°12'S	144°58'E	500 m	20,1 km W of Dimbulah - Petford
31	212	17-01-76	12 m	33 cm	17°19'S	145°03'E	500 m	22,7 km W of Dimbulah - Petford
32	213	17-01-76	6 m	19 cm	17°19'S	145°03'E	500 m	22,7 km W of Dimbulah - Petford
33	214	17-01-76	19 m	55 cm	17°19'S	145°03'E	500 m	22,7 km W of Dimbulah - Petford
34	215	17-01-76	10 m	35/50 cm	17°19'S	145°03'E	500 m	25,5 km W of Dimbulah - Petford
35	216	21/22-1-76	12 m	49 cm	17°24'S	145°09'E	680 m	8 km W of Irvinubank - Petford -
36	217	21/22-1-76	18 m	39 cm	17°24'S	145°09'E	680 m	8 km W of Irvinebank - Petford
37	218	21/22-1-76	21 m	49 cm	17°24'S	145°09'E	680 m	8 km W of Irvinebank - Petford
38	219	21/22-1-76	21 m	51 cm	17°24'S	145°09'E	680 m	8 km W of Irvinebank - Petford
39	220	21/22-1-76	9 m	34 cm	17°24'S	145°09'E	680 m	8 km W of Irvinebank - Petford
40	221	21/22-1-76	17 m	120 cm	17°24'S	145°09'E	680 m	8 km W of Irvinebank - Petford
41	222	21/22-1-76	18 m	47 cm	17°24'S	145°09'E	680 m	8 km W of Irvinebank - Petford
42	223	21/22-1-76	18 m	30 cm	17°24'S	145°09'E	680 m	8 km W of Irvinebank - Petford
43	224	21/22-1-76	14 m	29 cm	17°24'S	145°09'E	680 m	8 km W of Irvinebank - Petford
44	225	21/22-1-76	12 m	32 cm	17°24'S	145°09'E	680 m	8 km W of Irvinebank - Petford
45	226	21/22-1-76	14 m	42 cm	17°24'S	145°09'E	680 m	8 km W of Irvinebank - Petford
46	227	21/22-1-76	17 m	61 cm	17°24'S	145°09'E	680 m	8 km W of Irvinebank - Petford
47	228	21/22-1-76	12 m	31 cm	17°24'S	145°09'E	680 m	8 km W of Irvinebank - Petford
48	229	21/22-1-76	11 m	28 cm	17°24'S	145°09'E	680 m	8 km W of Irvinebank - Petford
49	230	21/22-1-76	18 m	34 cm	17°24'S	145°09'E	680 m	8 km W of Irvinebank - Petford
50	231	21/22-1-76	18 m	35 cm	17°24'S	145°09'E	680 m	8 km W of Irvinebank - Petford

Quadro III - Sub-projeto 03 - Eucalyptus tereticornis.

Trat.	Número de Colheita	Data da Colheita	Altura Árvores	Diâmetro	Latitude	Longitude	Altitude	Área da coleta
01	DK 341	14-09-77	24 m	63 cm	16°55'S	145°19'E	400/400m	C.4-10km WNW of Mareeba(Head waters of Mitchell Riv.)Boyle Creek
02	342	15-09-77	12 m	30 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
03	359	21-09-77	8 m	25 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
04	420	28-09-77	17 m	58 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
05	421	28-09-77	26 m	76 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
06	422	28-09-77	21 m	53 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
07	423	28-09-77	17 m	74 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
08	424	28-09-77	27 m	76 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
09	425	28-09-77	26 m	76 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
10	446	01-10-77	21 m	37 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
11	447	01-10-77	23 m	80 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
12	466	04-10-77	23 m	60 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
13	467	04-10-77	15 m	55 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
14	468	05-10-77	20 m	100 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
15	469	05-10-77	17 m	35 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
16	470	05-10-77	15 m	60 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
17	471	05-10-77	21 m	76 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
18	472	05-10-77	14 m	46 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
19	487	06-10-77	17 m	70 cm	16°55'S	145°19'E	400/400m	Marianne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
20	488	06-10-77	21 m	50 cm	16°55'S	145°19'E	400/400m	Marienne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
21	489	06-10-77	24 m	75 cm	16°55'S	145°19'E	400/400m	Marienne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
22	490	07-10-77	21 m	65 cm	16°55'S	145°19'E	400/400m	Marienne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
23	491	07-10-77	26 m	90 cm	16°55'S	145°19'E	460/400m	Marienne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
24	530	15-10-77	14 m	37 cm	16°55'S	145°19'E	400/400m	Marienne Creek, Sandy Creek, Saronsen Creek, Two Mile Creek
25	531	13-10.77	21 m	45 cm	15°45'S	145°15'E	155 m	4,7 km S of Helenvale-Bloomfield (c.30 km S of Cooktown).
26	513	13-10-77	20 m	30 cm	15°45'S	145°15'E	155 m	5,6 km S of Helenvale - Bloomfield (c.30 km S of Cooktown)
27	514	13-10-77	11 m	20 cm	15°45'S	145°15'E	155 m	5,1 km S of Helenvale - Bloomfield (c.30 km S of Cooktown)
28	515	13-10-77	11 m	15 cm	15°45'S	145°15'E	155 m	5,0 km S of Helenvale - Bloomfield (c.30 km S of Cooktown)
29	516	13-10-77	27 m	60 cm	15°45'S	145°15'E	170 m	3,7 km S of Helenvale - Bloomfield (c.30 km S of Cooktown)
30	518	14-10-77	24 m	70 cm	15°46'S	145°14'E	150 m	6,6 km S of Helenvale - Shiptons Flat(c.30 km S of Cooktown)
31	519	14-10-77	27 m	90 cm	15°46'S	145°14'E	150 m	6,6 km S of Helenvale - Shiptons Flat(c.30 km S of Cooktown)
32	520	14-10-77	25 m	50 cm	15°46'S	145°14'E	150 m	6,3 km S of Helenvale - Shiptons Flat(c.30 km S of Cooktown)
33	521	14-10-77	24 m	45 cm	15°46'S	145°14'E	150 m	6,1 km S of Helenvale - Shiptons Flat(c.30 km S of Cooktown)
34	522	14-10-77	18 m	50 cm	15°46'S	145°14'E	150 m	6,1 km S of Helenvale - Shiptons Flat(c.30 km S of Cooktown)
35	523	14-10-77	21 m	56 cm	15°45'S	145°14'E	150 m	4,3 km S of Helenvale - Shiptons Flat(c.30 km S of Cooktown)
36	524	14-10-77	24 m	72 cm	15°45'S	145°14'E	150 m	3,9 km S of Helenvale - Shiptons Flat(c.30 km S of Cooktown)
37	525	14-10-77	28 m	90 cm	15°43'S	145°14'E	150 m	1,4 km S of Helenvale - Bloomfield (c.30 km S of Cooktown)
38	526	14-10-77	23 m	52 cm	15°41'S	145°10'E	145 m	10,0 km NW of Helenvale - Lakeland (c.25 km SSW of Cooktown)
39	527	14-10-77	17 m	50 cm	15°41'S	145°10'E	145 m	10,2 km NW of Helenvale - Lakeland '2.25 km SSW of Cooktown)
40	531	16-10-77	18 m	56 cm	16°57'S	145°20'E	420 m	8 km WNW of Mareeba
41	547	18-10-77	14 m	50 cm	16°57'S	145°70'E	420 m	2 km WNW of Mareeba
42	PG2	01-76	21 m	61 cm	18°36'S	144°45'E	900 m	89,2 - 112.8 km SW of Mt. Garnet Towards Hughenden
43	3	01-76	24 m	82 cm	18°36'S	144°45'E	900 m	89,2 - 112.8 km SW of Mt. Garnet Towards Hughenden
44	10	01-76	20 m	57 cm	18°36'S	144°45'E	900 m	89,2 - 112.8 km SW of Mt. Garnet Towards Hughenden
45	11	01-76	18 m	41 cm	18°36'S	144°45'E	900 m	89,2 - 112,8 km SW of Mt Garnet Towards Hughenden
46	12	01-76	17 m	42 cm	18°36'S	144°45'E	900 m	89,2 - 112,8 km SW of Mt Garnet Towards Hughenden
47	14	01-76	17 m	51 cm	18°36'S	144°45'E	900 m	89,2 - 112,8 km SW of Mt Garnet Towards Hughenden
48	19	01-76	21 m	43 cm	18°36'S	144°45'E	900 m	89,2 - 112,8 km SW of Mt Garnet Towards Hughenden
49	25	01-76	24 m	66 cm	18°36'S	144°45'E	900 m	89,2 - 112,8 km SW of Mt Garnet Towards Hughenden
50	26	01-76	23 m	58 cm	18°36'S	144°45'E	900 m	89,2 - 112,8 km SW of Mt Garnet Towards Hughenden

Quadro IV - Sub-projeto 04 - *Eucalyptus cloeziana*

Trat.	Número de Colheita	Data da Colheita	Altura Árvores	Diâmetro	Latitude	Longitude	Altitude	Área da Coleta
01	DK 358	19-09-77	21 m	40 cm	17°41'S	145°29'E	950 m	Quandong L.A.(near Mt.Pandanus), c. 10 km S of Ravenshoe.
02	363	22-09-77	7 m	51 cm	17°23'S	144°53'E	600-700m	Slopes of Mt.Cottell, 1,6-25 km W of Lappa, c 6 km SW of Petford
03	364	22-09-77	9 m	40 cm	17°23'S	144°53'E	600-700m	Slopes of Mt.Cottell, 1.6-25 km W of Lappa, c 6 km SW of Petford
04	365	22-09-77	5 m	13 cm	17°23'S	144°53'E	600-700m	Slopes of Mt.Cottell, 1.6-25 km W of Lappa, c 6 km SW of Petford
05	366	22-09-77	9 m	30 cm	17°23'S	144°53'E	600-700m	Slopes of Mt.Cottell, 1.6-25 km W of Lappa, c 6 km SW of Petford
06	367	22-09-77	9 m	15 cm	17°23'S	144°53'E	600-700m	Slopes of Mt.Cottell, 1.6-25 km W of Lappa, c 6 km SW of Petford
07	368	22-09-77	11 m	38 cm	17°23'S	144°53'E	600-700m	Slopes of Mt.Cottell, 1.6-25 km W of Lappa, c 6 km SW of Petford
08	369	22-09-77	12 m	25 cm	17°23'S	144°53'E	600-700m	Slopes of Mt.Cottell, 1.6-25 km W of Lappa, c 6 km SW of Petford
09	370	22-09-77	12 m	37/30cm	17°23'S	144°53'E	600-700m	Slopes of Mt.Cottell, 1.6-25 km W of Lappa, c 6 km SW of Petford
10	371	22-09-77	14 m	48 cm	17°23'S	144°53'E	600-700m	Slopes of Mt.Cottell, 1.6-25 km W of Lappa, c 6 km SW of Petford
11	372	22-09-77	11 m	52 cm	17°23'S	144°53'E	600-700m	Slopes of Mt.Cottell, 1.6-25 km W of Lappa, c 6 km SW of Petford
12	373	22-09-77	11 m	30 cm	17°23'S	144°53'E	600-700m	Slopes of Mt.Cottell, 1.6-25 km W of Lappa, c 6 km SW of Petford
13	374	22-09-77	12 m	56 cm	17°23'S	144°53'E	600-700m	Slopes of Mt.Cottell, 1.6-25 km W of Lappa, c 6 km SW of Petford
14	375	22-09-77	14 m	33 cm	17°23'S	144°53'E	600-700m	Slopes of Mt.Cottell, 1.6-25 km W of Lappa, c 6 km SW of Petford
15	376	22-09-77	6 m	20 cm	17°23'S	144°53'E	600-700m	Slopes of Mt.Cottell, 1.6-25 km W of Lappa, c 6 km SW of Petford
16	377	22-09-77	8 m	23 cm	17°23'S	144°53'E	600-700m	Slopes of Mt.Cottell, 1.6-25 km W of Lappa, c 6 km SW of Petford
17	378	23-09-77	15 m	30 cm	17°21'S	145°25'E	960 m	6,0 km NE of Herberton towards Atherton
18	386	23-09-77	14 m	30 cm	17°24'S	145°21'E	1000 m	6,1 km W of Herberton - Irvinebank
19	387	23-09-77	12 m	23/25cm	17°23'S	145°20'E	900 m	9,0 km W of Herberton - Irvinebank
20	392	23-09-77	11 m	30 cm	17°23'S	145°18'E	800 m	12,1 km W of Herberton - Irvinebank
21	393	23-09-77	15 m	39 cm	17°23'S	145°17'E	780 m	12,7 km W of Herberton - Irvinebank
22	395	23-09-77	14 m	46 cm	17°23'S	145°16'E	820 m	14,0 km W of Herberton - Irvinebank
23	402	24-09-77	9 m	38 cm	17°23'S	145°15'E	800 m	Hale's Siding/Irvinebank Intersection c.16 km W of Herberton
24	403	24-09-77	11 m	34 cm	17°23'S	145°15'E	800 m	16,3 km W of Herberton - Irvinebank
25	404	24-09-77	11 m	30 m	17°23'S	145°15'E	800 m	16,8 km W of Herberton - Irvinebank
26	405	24-09-77	11 m	43 cm	17°23'S	145°15'E	800 m	17,0 km W of Herberton - Irvinebank
27	406	24-09-77	8 m	23 cm	17°24'S	145°15'E	760 m	18,1 km W of Herberton - Irvinebank
28	413	24-09-77	9 m	20 cm	17°24'S	145°21'E	960 m	5,3 km W of Herberton - Irvinebank
29	415	26-09-77	11 m	24/23cm	17°35'S	145°18'E	700 m	6,9 km W of Wild River Crossing on Ravenshoe/Mt Garnet road along Silver Valley road - Herberton
30	417	26-09-77	11 m	38 cm	17°30'S	145°17'E	700 m	17,0 km W of Wild River Crossing on Ravenshoe/Mt Garnet road along Silver Valley road - Herberton
31	428	30-09-77	21 m	38 cm	17°42'S	145°29'E	950 m	Quandong L.A. c.10 km S of Ravenshoe(near Mt.Pandanus)
32	429	30-09-77	21 m	33 cm	17°42'S	145°29'E	950 m	Quandong L.A. C.10 km S of Ravenshoe(near Mt.Pandanus)
33	430	30-09-77	26 m	51 cm	17°42'S	145°29'E	950 m	Quandong L.A. c.10 km S of Ravenshoe (near Mt.Pandanus)
34	431	30-09-77	30 m	46 cm	17°42'S	145°29'E	950 m	Quandong L.A. c.10 km S of Ravenshoe (near Mt.Pandanus)
35	442	30-09-77	26 m	71 cm	17°42'S	145°29'E	950 m	Quandong L.A. c.10 km S of Ravenshoe (near Mt.Pandanus)
36	443	30-09-77	34 m	61 cm	17°42'S	145°29'E	950 m	Quandong L.A. c.10 km S of Ravenshoe (near Mt.Pandanus)
37	444	30-09-77	23 m	33 cm	17°42'S	145°29'E	950 m	Quandong L.A. c.10 km S of Ravenshoe (near Mt.Pandanus)
38	464	03-10-77	6 m	15 cm	17°22'S	145°13'E	800 m	21,8 km W of Herberton on Petford road (near Hales Siding)
39	502	13-10-77	18 m	63 cm	15°45'S	145°15'E	200 m	4,7 km S of Helenvale - Bloomfield (c.30 km S of Cooktown)
40	503	13-10-77	14 m	76 cm	15°45'S	145°15'E	200 m	4,7 km S of Helenvale - Bloomfield (c.30 km S of Cooktown)
41	504	13-10-77	20 m	89 cm	15°45'S	145°15'E	200 m	4,7 km S of Helenvale - Bloomfield (c.30 km S of Cooktown)
42	505	13-10-77	14 m	38 cm	15°45'S	145°15'E	200 m	4,7 km S of Helenvale - Bloomfield (c.30 km S of Cooktown)
43	506	13-10-77	17 m	63 cm	15°45'S	145°15'E	200 m	4,7 km S of Helenvale - Bloomfield (c.30 km S of Cooktown)
44	507	13-10-77	20 m	60 cm	15°45'S	145°15'E	200 m	4,7 km S of Helenvale - Bloomfield (c.30 km S of Cooktown)
45	508	13-10-77	13 m	49 cm	15°45'S	145°15'E	200 m	4,7 km S of Helenvale - Bloomfield (c.30 km S of Cooktown)
46	509	13-10-77	13 m	51 cm	15°45'S	145°15'E	200 m	4,7 km S of Helenvale - Bloomfield (c.30 km S of Cooktown)
47	510	13-10-77	8 m	33 cm	15°45'S	145°15'E	150 m	6,8 km S of Helenvale - Bloomfield (c.30 km S of Cooktown)
48	511	13-10-77	12 m	33 cm	15°45'S	145°15'E	150 m	5,8 km S of Helenvale - Bloomfield (c.30 km S of Cooktown)
49	512	13-10-77	15 m	51 cm	15°45'S	145°15'E	150 m	5,6 km S of Helenvale - Bloomfield (c.30 km S of Cooktown)
50	532	17-10-77	17 m	35 cm	17°25'S	145°27'E	920 m	5,6 km E of Wondecla Along Kalley Road (SE of Herberton).

Quadro V - Sub-projeto 05 - *Eucalyptus citriodora*.

Trat.	Número de Colheita	Data da Colheita	Altura Árvores	Diâmetro	Latitude	Longitude	Altitude	Área de Coleta
01	DK 379	23-09-77	17 m	36 cm	17°21'S	145°25'E	960 m	5,2 Km NE of Herberton - Atherton
02	380	23-09-77	15 m	25 cm	17°22'S	145°25'E	900 m	3,7 km NE of Herberton - Atherton
03	381	23-09-77	12 m	18 cm	17°23'S	145°24'E	920 m	2,9 km NE of Herberton - Atherton
04	382	23-09-77	6 m	11 cm	17°23'S	145°23'E	900 m	1,1 km SW of Herberton - Irvinebank
05	383	23-09-77	8 m	8-13 cm	17°24'S	145°23'E	900 m	1,8 km SW of Herberton - Irvinebank
06	384	23-09-77	9 m	18 cm	17°24'S	145°22'E	880 m	3,4 km SW of Herberton - Irvinebank.
07	388	23-09-77	14 m	23 cm	17°23'S	145°19'E	850 m	11,0 km W of Herberton - Irvinebank
08	389	23-09-77	15 m	30-10cm	17°23'S	145°19'E	860 m	11,5 km W of Herberton - Irvinebank
09	390	23-09-77	20 m	28 cm	17°23'S	145°18'E	800 m	12,0 km W of Herberton - Irvinebank
10	391	23-09-77	21 m	36 cm	17°23'S	145°18'E	800 m	12,1 km W of Herberton - Irvinebank
11	396	23-09-77	9 m	15 cm	17°23'S	145°15'E	780 m	14,4 km W of Herberton - Irvinebank
12	398	24-09-77	20 m	36 cm	17°23'S	145°19'E	860 m	1,6 km N of Watsonville - Walsh River (W of Herberton)
13	399	24-09-77	12 m	18 cm	17°22'S	145°19'E	860 m	1,8 km N of Watsonville - Walsh River (W of Herberton)
14	400	24-09-77	11 m	18 cm	17°21'S	145°19'E	800 m	3,0 km N of Watsonville - Walsh River (W of Herberton)
15	407	24-09-77	9 m	23 cm	17°25'S	145°14'E	780 m	21,0 km W of Herberton - Irvinebank
16	409	24-09-77	17 m	27 cm	17°25'S	145°14'E	760 m	21,1 km W of Herberton - Irvinebank
17	411	24-09-77	11 m	10-13cm	17°23'S	145°11'E	740 m	2,5 km SW of Hales Siding (C.20 km W of Herberton)
18	412	24-09-77	14 m	13-18-18cm	17°23'S	145°11'E	740 m	2,0 km SW of Hales Siding (C 20 km W of Herberton)
19	416	26-09-77	17 m	33 cm	17°30'S	145°17'E	700 m	17,0 km N of wild R. Crossing on Ravenshoe/Mt.Garnet road along Silver Valley rd. - Herberton.
20	419	26-09-77	14 m	45 cm	17°26'S	145°18'E	850 m	27,1 km N of wild R.Crossing on Ravenshoe/Mt.Garnet road along Silver Valley rd. - Herberton.
21	426	29-09-77	15 m	24 cm	17°39'S	145°29'E	860 m	5,0 km S of Ravenshoe - Mt.Pandanus - Wooroora road
22	454	03-10-77	14 m	23-18cm	17°22'S	145°11'E	740 m	24,4 km W of Herberton - Petford
23	455	03-10-77	17 m	28 cm	17°22'S	145°11'E	740 m	24,4 km W of Herberton - Petford
24	456	03-10-77	18 m	25 cm	17°22'S	145°11'E	740 m	24,4 km W of Herberton - Petford
25	458	03-10-77	19 m	23 cm	17°22'S	145°11'E	740 m	24,0 km W of Herberton - Petford
26	459	03-10-77	12 m	18 cm	17°22'S	145°11'E	740 m	23.9 km W of Herberton - Petford
27	460	03-10-77	15 m	23 cm	17°22'S	145°11'E	740 m	23,7 km W of Herberton - Petford
28	461	03-10-77	15 m	25 cm	17°22'S	145°12'E	740 m	23,4 km W of Herberton - Petford
29	462	03-10-77	15 m	20 cm	17°22'S	145°12'E	740 m	23,2 km W of Herberton - Petford
30	463	03-10-77	12 m	18 cm	17°22'S	145°12'E	740 m	23,2 km W of Herberton - Petford
31	465	03-10-77	17 m	33 cm	17°22'S	145°13'E	760 m	21,3 km W of Herberton - Petford
32	473	05-10-77	11 m	20 cm	17°01'S	145°35'E	700 m	6,9 km SE along Davies Creek road from Mareeba - Kuranda road
33	474	05-10-77	9 m	18 cm	17°01'S	145°35'E	700 m	7,7 km SE along Davies Creek road from Mareeba - Kuranda road
34	475	05-10-77	9 m	18 cm	17°01'S	145°35'E	700 m	7,9 km SE along Davies Creek road from Mareeba - Kuranda road
35	476	05-10-77	12 m	36 cm	17°01'S	145°35'E	700 m	9,0 km SE along Davies Creek road from Mareeba - Kuranda road
36	477	05-10-77	11 m	15-13cm	17°01'S	145°35'E	700 m	9,2 km SE along Davies Creek road from Mareeba - Kuranda road
37	478	05-10-77	11 m	18 cm	17°01'S	145°35'E	700 m	9,3 km SE along Davies Creek road from Mareeba - Kuranda road
38	492	08-10-77	6 m	15 cm	17°00'S	145°18'E	600 m	4,8 km NW along Tyrconnell road, c. 13 km W of Mareeba
39	553	22-10-77	14 m	25 cm	17°43'S	145°05'E	660 m	5,3 km SW of Mt.Garnet - Greenvale
40	554	22-10-77	14 m	30 cm	17°43'S	145°05'E	660 m	5,3 km SW of Mt.Garnet - Greenvale.
41	555	22-10-77	10 m	15 cm	17°43'S	145°05'E	680 m	6,0 km SW of Mt.Garnet - Greenvale
42	556	22-10-77	20 m	50 cm	7°53'S	144°56'E	560 m	32,0 km SW of Mt.Garnet - Greenvale

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TESTE DE PROGÊNIE DE *EUCALYPTUS SPP* — RESULTADOS PRELIMINARES

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Resumo

Este trabalho, teste de progênies, está sendo desenvolvido num programa conjunto com o IPEF e envolve as seguintes espécies e locais:

ESPÉCIE	LOCAL
E. grandis	Bom Despacho — MG
E. tereticornis	Bom Despacho — MG
E. teriticornis	Carbonita — MG
E. grandis	Bom Despacho — MG
E. saligna	Bom Despacho — MG
E. microcorys	Bóm Despacho — MG

Os resultados de desenvolvimento das progênies, assim como do desenvolvimento das progênies, assim como do desenvolvimento das progênies agrupadas pelas origens, são discutidos neste trabalho.

Summary

Tests of progenies installed under a joint program with the Institute for Forest Research and Studies - IPEF, involves the following species of Eucalyptus:

SPECIES	LOCATION
E. grandis	Bom Despacho - MG
E. tereticornis	Bom Despacho - MG
E. tereticornis	Carbonita - MG
E. grandis	Bom Despacho - MG
E. saligna	Bom Despacho - MG
E. microcorys	Bom Despacho - MG

Observations of the measureable features were made and the results of the individual developments of the progenies are herein described, as well as the joint development of the origins of groups of progenies.

1 - Introdução

O Eucalipto é um dos gêneros mais utilizados em reflorestamento, para produção de madeira como matéria prima para diversas finalidades.

Em função de suas características de rápido crescimento, qualidade da madeira, muitas de suas espécies tem se destacado para diferentes regiões, nos programas de plantios.

O Eucalyptus grandis Hill ex Maiden é uma das espécies amplamente utilizadas em vista de sua adaptação as mais diferentes condições, em uma ampla faixa de variação. Nas condições do Cerrado Central, o E.grandis vem sendo utilizado em sua grande extensão, obtendo resultados significativos de rendimento e, apresentando uma faixa ampla de Densidade Básica da Madeira.

BRITO (1978),cita a existência de uma alta correlação entre a Densidade Básica da Madeira e a Densidade Aparente do carvão, sendo de maneira importante para se antever o comportamento do mesmo mediante avaliação da Densidade de sua Madeira.

O Eucalyptus saligna Smith é uma espécie muito próxima do E. grandis Hill ex Maiden nos seus aspectos botânicos, ecológicos e silviculturais.

A área de adaptação e implantação sobre-põe-se a área do E. grandis, tendo no entanto preferência por solos ferteis, profundo e bem drenado.

O Eucalyptus tereticornis Sm. vem sendo testado de longa data, tendo em vista que sua madeira é densa e, atende as exigências tecnológicas para produção de carvão vegetal, sendo inclusive usado em alguns Países para celulose (GOLFARI; 1975), tendo,no entanto, que ser melhorado geneticamente a forma do fuste, e estudado quanto ao espaçamento a ser utilizado.

O Eucalyptus microcorys F. Muel é uma das melhores espécies quanto ao incremento e forma, com excelente capacidade de regeneração, alta densidade básica da madeira.

Segundo OSSE (1973), apresenta ótimos resultados em cortes subsequentes devido ao seu crescimento e boa capacidade de regeneração.

Segundo VIVEKANANDAN (1975), os objetivos de Teste de Progênies vão determinar cada parâmetro genético quantitativo,como herdabilidade, habilidade de combinação e correlação genéticas e; identificar os melhores progênies.

A estimativas sobre herdabilidade, habilidade de combinação e correlações genéticas são essenciais para calcular o ganho genético e construção de indicação de seleção.

Segundo PINTO Jr. (1978), a produção de sementes florestais, melhoradas genética e fisiologicamente, aliadas à técnicas silviculturais adequadas, desempenham um papel importantíssimo na obtenção de florestas importadas de alto rendimento por área, formados num menor período de tempo.

O Teste de Progênie é um meio seguro de se produzir sementes geneticamente melhoradas.

Após os resultados do Teste de Progênie, selecionam-se as melhores famílias e, os melhores indivíduos dentro dessas famílias, os quais irão compor o Pomar de Sementes por mudas.

SHELBOURNE (1973), citado por PINTO Jr. (1978), relata que em pomar de mudas de polinização aberta e desbastado, o risco de ocorrer endogamia é inferior, quando comparado ao pomar por mudas de polinizações controladas, onde os cruzamentos seriam somente entre membros de uma mesma família de meio-irmãos.

2 - Material e Método.

2.1 - Material.

Os Testes de Progênies foram instalados em convênio com o Instituto de Pesquisas e Estudos Florestais, com as espécies de *Eucalyptus grandis* Hill ex Maiden (dois projetos), *Eucalyptus tereticornis* Sm. (dois projetos), *Eucalyptus saligna* Smith e *Eucalyptus microcorys* F. Muel.

O material foi instalado em áreas da Cia.Siderúrgica Belgo - Mineira, situadas nos municípios de Bom Despacho-MG e Carbonita - MG.

2.1.1 - Dados das Localidades.

2.1.1 - Bom Despacho - MG.

A área esta situada a aproximadamente 19º35' Latitude Sul e 45º17' Latitude Oeste.

O clima é subtropical umido, com temperatura média anual de 20,8ºC, precipitação média anual de 1375 mm e com déficit hídrico que varia 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 700m.

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 e subtropical umido, sub-umido com temperatura média anual entre 19 e 22,0ºC, precipitação média anual em torno de 1.150 mm e com déficit hídrico variando entre 60 e 120 mm anuais.

O solo do local é um latossolo Vermelho Escuro orto, profundo, bem drenado e parosão.

O relevo é suavemente ondulado e a altitude média é entre ' 600 - 1000 m.

A cobertura vegetal primaria era constituida por cerrado.

A relação dos materiais estudados estão nos quadros I a VI.

2.2.- Método.

O delineamento estatístico utilizado foi o Latice, com parcelas lineares de 10 plantas, ao espaçamento 3,0 x 2,0 m.

O número de repetições em todos os projetos foi no mínimo de 3.

Quadro I - Relação dos tratamentos, procedências e resultados de dados mensuráveis de Teste de Progênie de *E.grandis* aos 3,5 anos de idade,projeto 26417,na região de Bom Despacho - MG.

Trat.	Procedência	Vol.Cilindro (m3/ha)	Altura (m)	CV_h (%)	Sobrev. (%)	Brotação (%)
01	Champion	222,998	15,3	13,2	80,0	93,0
02	Champion	241,806	14,7	12,3	83,3	65,0
03	Champion	227,834	14,8	8,4	90,0	100,0
04	Champion	223,917	14,6	13,4	93,3	87,0
05	Champion	220,466	15,8	7,4	73,3	100,0
06	Champion	212,339	15,5	7,7	80,0	93,0
07	Champion	251,034	15,6	7,7	86,7	75,0
08	Champion	190,966	13,6	15,6	90,0	66,0
09	Champion	180,667	13,2	16,3	83,3	78,0
10	Champion	260,388	15,2	14,5	90,0	100,0
11	Champion	219,405	13,9	9,8	90,0	85,0
12	Champion	226,223	14,4	10,1	96,7	100,0
13	Champion	171,648	13,5	19,2	90,0	83,0
14	Champion	219,266	14,5	8,2	96,7	92,0
15	Champion	161,185	12,9	23,3	80,0	39,0
16	Champion	221,793	15,1	8,8	93,3	83,0
17	Champion	196,000	14,1	9,3	96,7	77,0
18	Champion	254,011	15,9	7,4	90,0	87,0
19	Champion	313,807	15,4	14,8	93,3	47,0
20	Champion	175,565	13,9	12,4	90,0	63,0
21	Champion	177,291	14,2	12,2	83,3	92,0
22	Champion	118,440	11,7	25,7	80,0	74,0
23	Champion	208,921	13,8	16,4	90,0	57,0
24	Champion	331,178	16,5	4,6	93,3	84,0
25	Champion	222,200	14,5	25,0	86,7	100,0
26	Champion	195,457	13,9	12,4	90,0	63,0
27	Duratex	187,571	14,3	16,5	86,7	73,0
28	Duratex	174,939	13,0	10,3	90,0	58,0
29	Duratex	191,735	14,4	15,8	86,7	75,0
30	Duratex	142,654	13,6	15,2	80,0	74,0
31	Duratex	171,333	13,2	17,8	96,7	65,0
32	Duratex	153,298	13,7	11,6	86,7	100,0
33	Duratex	132,608	13,8	8,6	60,0	67,0
34	Duratex	167,351	14,6	10,0	80,0	73,0
35	Duratex	213,793	14,4	18,4	93,3	92,0
36	Duratex	200,356	14,6	16,1	93,3	100,0
37	Duratex	198,870	14,2	10,9	90,0	65,0
38	Duratex	141,996	11,9	14,1	90,0	53,0
39	TC Rodésia	205,996	14,5	13,7	86,7	92,0
40	TC Rodésia	124 [illegible]62	12,9	15,1	80,0	75,0
41	TC Rodésia	178,268	13,9	12,4	86,7	54,0
42	TC Rodésia	88,506	11,2	20,1	66,7	62,0
Média		198,063	14,2	13,4	86,7	78,0
S		47,2	1,1	4,8	7,7	16,2
CV		23,8	7,8	35,9	8,9	20,8

3 - Discussão dos Resultados.

3.1 - E.grandis, projeto 26417.

O comportamento das progênies de árvores selecionadas em populações de coff's Harbour,demonstram o potencial do material genético para as condições do estudo. As médias das alturas dos progênies das árvores selecionadas de Mogi-Guaçu e Salto foram de 14,5 m e 13,8 m, mostrando não haver uma diferença marcante entre as procedências do material.

A comparação das médias dos progênies, das árvores selecionadas com a média da Testemunha Comercial da Rodésia, mostra uma diferença bem acentuada em torno de 8,4 % em altura.

As diferenças contrastantes entre progênies da Champion foram de ordem de 170% entre médias de volume e, para as da Duratex, foram de 60%.

Foi realizado um desbaste no ensaio e, encontramos percentagem de brotação variando de 39% a 100% para as condições do estudo.

3.2 - E.grandis, projeto 26639.

No ensaio foi estudado progênies de árvores superiores das '

Quadro II - Relação dos tratamentos, procedência e resultados de dados mensuráveis de Teste de Porgênie de *E.grandis* com 1 ano de idade, projeto 26639, em Bom Despacho - MG.

Trat.	Procedência	Vol.Cil.(m3/ha).	Alt.(m)	CV_h(%)	Sob.(%)
01	Rio Doce	9,548	4,4	29,3	100,0
02	Rio Doce	27,208	6,1	12,4	100,0
03	Rio Doce	20,932	5,7	19,3	100,0
04	Rio Doce	21,835	6,0	21,6	96,7
05	Rio Doce	27,131	6,5	12,6	100,0
06	Duratex-Aust.	22,411	6,0	17,4	100,0
07	S.Silvano-Dur.	27,478	6,4	8,9	96,7
08	S.Silvano	21,511	5,8	21,1	100,0
09	S.Silvano	20,530	5,6	18,6	96,7
10	S.Silvano	18,530	5,7	10,2	100,0
11	S.Silvano	15,732	5,2	29,1	96,7
12	S.Silvano	17,551	5,5	15,9	96,7
13	S.Silvano	13,621	4,8	26,7	96,7
14	Duratex-Salto	27,946	6,4	14,3	100,0
15	Duratex-Salto	26,991	6,5	8,5	100,0
16	Duratex	24,255	5,9	18,7	100,0
17	Duratex	25,229	6,4	13,2	100,0
18	Duratex	22,359	6,1	21,9	93,3
19	Duratex	13,368	5,3	29,1	83,3
20	Duratex	21,839	5,8	17,8	100,0
21	Duratex	28,258	6,5	9,4	100,0
22	Duratex	30,897	6,6	9,7	93,3
23	Duratex	31,480	6,6	14,1	100,0
24	Duratex	18,000	6,0	12,3	96,7
25	Duratex	23,205	6,0	19,9	100,0
26	Duratex	26,141	6,6	10,2	100,0
27	Duratex	17,036	5,4	25,9	96,7
28	Duratex	22,500	5,8	24,8	100,0
29	Duratex	32,436	6,9	8,5	96,7
30	Duratex	27,855	6,4	17,4	96,7
31	Duratex	29,318	6,5	14,8	100,0
32	Duratex	29,279	6,9	8,6	93,3
33	Duratex	25,546	6,1	17,5	100,0
34	Duratex	18,410	5,9	12,3	100,0
35	Duratex	30,642	6,5	9,4	96,7
36	Flonibra	25,692	6,1	20,8	100,0
37	Flonibra	21,273	5,8	18,2	100,0
38	Flonibra	16,706	5,5	20,8	90,0
39	Flonibra	23,491	5,9	20,9	96,7
40	Flonibra	15,532	4,9	41,3	86,7
41	Flonibra	24,473	6,0	33,9	96,7
42	Flonibra	21,865	6,2	13,7	93,3
43	Flonibra	29,592	6,5	20,9	96,7
44	Floniba	22,052	6,0	19,9	100,0
45	Flonibra	21,405	5,7	25,6	100,0
46	Flonibra	13,813	4,8	37,4	96,7
47	Flonibra	15,478	5,5	25,4	93,3
48	Flonibra	26,654	6,3	19,1	96,7
49	Flonibra	22,727	6,2	23,3	100,0
50	Flonibra	20,660	5,9	16,1	100,0
51	Flonibra	23,631	6,7	21,2	96,7
52	Flonibra	29,651	6,6	11,0	96,7
53	Flonibra	25,716	6,2	20,6	100,0
54	Flonibra	30,198	6,4	18,6	100,0
55	Flonibra	26,734	6,3	15,6	100,0
56	Flonibra	26,295	6,4	19,8	93,3
57	Flonibra	22,031	5,9	27,6	100,0
58	Flonibra	11,924	4,5	25,9	100,0
59	Flonibra	18,417	5.4	33,7	100,0
60	Flonibra	18,239	5,5	26,8	100,0
61	Champion	17,963	5,7	25,3	93,3
62	TC - CAF	26,517	6,2	23,4	96,7
63	TC-Rodésia	10,962	5,7	14,7	96,7
64	TC-Rodésia	22,392	5,8	14,0	100,0
	Média	22,980	6,0	19,3	97,6
	S	5,5	0,5	7,4	3,4
	CV	23,8	9,2	38,1	3,5

Empresas Flonibra, Florestas Rio Doce, Duratex duas localidades ' Salto e São Silvano, e usadas como testemunha da Austrália Duratex, Champion, CAF e Rodésia.

Reunindo-se os progênies por procedência, nota-se que as médias das alturas foram, Duratex - Salto 6,22m, Flonibra 5,89m, Rio Doce 5,74 m e Duratex - São Silvano 5,57 m.

As testemunhas apresentaram resultados equivalentes.

As diferenças contrastantes encontrou-se entre progênies de Duratex - Salto e Rio Doce com 56% superiores em altura média.

3.3 - E.tereticornis, projeto 26526 e 26510.

Nos ensaios são testados progênies de árvores superiores das Localidades de São José e Mococa-SP.

Analisando os progênies em grupos (procedências) nota-se uma homogeneidade muito grande entre os materiais das duas procedências, com altura média dos progênies semelhantes, aos 2 anos de idade.

Em relação as duas localidades em estudo (Bom Despacho e Carbonita), notou-se uma diferença acentuada em favor do primeiro e,

Quadro III - Relação dos tratamentos, procedências e resultados de dados mensuráveis de Teste de Progênie de *E.tereticornis*, com 2 anos de idade, projeto 26526, em Bom Despacho - MG.

Trat	Procedência	Vol.cilindro (m3/ha)	Altura (m)	CV_h(%)	Sobrev. (%)
01	São José	37,641	6,0	20,0	97,8
02	São José	33,750	6,1	14,6	95,6
03	São José	41,565	6,4	17,7	96,7
04	São José	35,362	5,7	30,9	93,3
05	São José	39,888	6,3	16,9	100,0
06	São José	31,817	5,5	28,2	94,4
07	São José	30,536	6,0	17,7	95,6
08	São José	31,643	5,9	33,3	84,4
09	São José	41,634	6,1	28,8	92,2
10	São José	39,928	6,5	14,8	97,8
11	São José	36,771	5,9	17,6	98,9
12	São José	37,853	6,3	21,1	96,7
13	São José	38,341	5,9	22,6	94,4
14	São José	23,899	5,2	36,4	86,7
15	São José	37,298	6,4	16,8	98,9
16	São José	46,375	6,2	20,8	95,6
17	São José	41,678	6,9	19,1	90,0
18	São José	39,091	6,3	22,3	94,4
19	São José	29,081	5,6	33,5	83,3
20	São José	31,611	6,0	23,9	94,4
21	São José	40,588	6,3	21,4	97,8
22	São José	27,451	5,6	22,4	94,4
23	São José	50,006	6,8	18,0	100,0
24	São José	35,010	6,1	19,6	97,8
25	São José	45,029	6,6	18,5	95,6
26	São José	39,545	6,0	25,0	98,9
27	São José	54,321	6,8	22,1	96,7
28	Mococa	33,381	5,9	22,5	94,4
29	Mococa	33,709	5,7	23,7	100,0
30	Mococa	32,677	5,8	25,3	96,7
31	Mococa	40,012	6,6	23,2	94,4
32	Mococa	28,733	5,7	25,3	87,8
33	Mococa	36,508	6,4	20,0	98,9
34	Mococa	35,299	6,2	16,6	94,4
35	Mococa	34,676	6,1	21,3	93,3
36	Mococa	50,646	6,8	16,3	97,8
37	Mococa	40,018	6,6	20,2	91,1
38	Mococa	42,882	6,7	19,3	94,4
39	Mococa	40,280	6,9	22,5	97,8
40	Mococa	46,768	6,7	14,5	98,9
41	Mococa	33,065	5,7	33,8	94,4
42	Mococa	42,372	6,7	15,9	100,0
43	Mococa	18,786	5,0	30,9	73,3
44	Mococa	43,226	6,7	16,5	94,4
45	Mococa	50,613	7,2	15,4	96,7
46	Mococa	26,480	5,7	23,9	88,9
47	Mococa	26,895	5,7	22,3	93,3
48	Mococa	22,563	5,1	32,5	81,1
49	Mococa	39,627	6,5	19,0	95,6
Média		22,2	6,2	94,3	37,1
S		5,6	0,5	5,3	7,5
CV		25,4	8,1	5,6	20,2

Quadro IV - Relação dos tratamentos, procedências e resultade dados mensuráveis do Teste de Progênie de *E.tereticornis* com 2 anos de idade, projeto 26510, na região de Carbonita - MG.

Trat.	Procedência	Vol.Cilindro (m3/ha)	Altura (m)	CV (%)	Sobrev. (%)
01	São José	9,509	4,3	24,3	100,0
02	São José	10,102	4,5	16,8	96,7
03	São José	4,159	2,9	38,8	78,9
04	São José	8,558	4,3	25,8	94,4
05	São José	7,437	3,9	24,5	97,8
06	São José	10,274	4,2	22,9	97,8
07	São José	11,805	4,4	23,0	100,0
08	São José	8,845	3,8	29,1	95,6
09	São José	9,459	4,4	21,0	96,7
10	São José	6,286	3,7	39,7	95,6
11	São José	10,439	4,2	20,5	98,9
12	São José	10,179	4,4	16,0	94,4
13	São José	8,612	4,1	27,0	97,8
14	São José	11,232	4,6	17,8	96,7
15	São José	13,576	4,5	19,4	95,6
16	São José	7,853	3,8	34,0	92,2
17	São José	7,306	3,8	30,8	97,8
18	São José	9,362	4,0	27,1	98,9
19	São José	12,589	4,5	26,2	94,4
20	São José	11,755	4,7	20,9	98,9
21	São José	8,886	4,0	30,3	93,3
22	São José	7,627	3,9	23,8	97,8
23	São José	7,900	4,0	20,2	95,6
24	São José	8,058	4,0	19,8	100,0
25	São José	10,589	4,3	20,3	97,8
26	São José	7,913	4,0	21,2	94,4
27	São José	10,164	4,2	18,9	96,7
28	São José	8,234	4,0	23,2	93,3
29	São José	14,932	4,7	20,2	96,7
30	Mococa	7,847	3,9	24,1	98,9
31	Mococa	8,018	4,0	25,7	97,8
32	Mococa	9,407	4,1	27,4	97,8
33	Mococa	12,973	4,6	23,6	100,0
34	Mococa	7,788	3,9	28,9	93,3
35	Mococa	9,702	4,3	21,5	100,0
36	Testemunha	9,057	3,9	29,7	97,8
37	Mococa	10,192	4,5	18,4	97,8
38	Mococa	10,301	4,2	23,6	100,0
39	Mococa	12,557	4,7	20,1	96,7
40	Mococa	12,197	4,7	23,7	97,0
41	Mococa	9,996	4,2	30,4	97,8
42	Mococa	13,315	4,7	21,3	94,4
43	Mococa	11,489	4,7	25,0	97,8
44	Mococa	11,322	4,5	19,7	97,8
45	Mococa	9,074	4,1	36,7	87,8
46	Mococa	12,224	4,6	20,5	100,0
47	Mococa	3,756	3,0	35,9	90,0
48	Mococa	11,805	4,6	18,2	98,9
49	Mococa	13,265	4,7	22,0	98,9
Média		9,800	4,2	24,5	96,4
S		2,3	0,4	5,7	3,7
CV		23,5	9,5	23,1	3,8

Quadro V - Relação dos tratamentos, procedência e resultados dos dados mensuráveis do Teste de Progênie de E.saligna com 1 ' ano de idade, projeto 26638 em Bom Despacho - MG.

Trat.	Procedência	Vol.Cil.(m3/ha)	Alt.(m)	CV_h(%)	Sob.(%)
01	Riocell	6,660	3,6	36,9	76,7
02	Riocell	10,125	4,5	24,5	76,7
03	Riocell	5,444	3,7	36,6	70,0
04	Riocell	1,394	2,1	39,0	70,0
05	Riocell	7,635	3,3	50,9	100,0
06	Riocell	6,311	3,2	35,7	96,7
07	Champion	9,740	3,9	38,9	93,3
08	Champion	19,796	5,2	23,7	93,3
09	Champion	5,650	3,5	28,4	86,7
10	Champion	7,968	3,6	40,8	90,0
11	Champion	12,956	4,1	33,9	93,3
12	Champion	12,795	5,0	27,6	80,0
13	Champion	6,995	3,7	30,2	96,7
14	Champion	12,991	4,6	27,6	90,0
15	Champion	10,430	4,5	20,5	90,0
16	Champion	8,914	3,7	40,3	93,3
17	Champion	10,985	4,0	49,8	76,7
18	Champion	13,069	4,6	22,4	90,0
19	Champion	9,467	4,3	28,4	86,7
20	Champion	7,121	3,7	31,8	90,0
21	Champion	22,849	5,5	20,6	93,3
22	Champion	9,924	4,0	45,4	86,7
23	Champion	8,105	4,0	20,9	96,7
24	Champion	8,506	4,0	25,4	96,7
25	Champion	6,050	3,2	46,5	96,7
26	Champion	5,648	3,4	32,6	90,0
27	Champion	6,569	3,4	41,4	90,0
28	Champion	13,246	4,4	31,6	90,0
29	Champion	13,837	4,5	23,3	96,7
30	Rio Doce	7,985	4,0	30,9	73,3
31	Duratex	9,848	3,6	39,2	100,0
32	Duratex	14,077	4,5	19,7	100,0
33	Duratex	10,898	4,1	29,8	86,7
34	Duratex	10,805	4,4	31,9	86,7
35	Duratex	12,268	4,6	30,5	80,0
36	Duratex	10,738	4,2	28,0	80,0
37	Duratex	5,404	3,1	46,1	93,3
38	Duratex	6,182	3,0	50,2	96,7
39	Duratex	14,439	4,7	20,2	96,7
40	Duratex	8,244	3,8	30,0	96,7
41	Duratex	2,692	2,7	44,9	83,3
42	Duratex	5,997	3,6	25,1	96,7
43	Duratex	8,498	3,9	34,5	80,0
44	Duratex	9,817	4,3	32,4	80,0
45	Duratex	7,922	4,1	21,7	73,3
46	Duratex	11,080	4,5	17,6	93,3
47	Duratex	7,446	3,8	28,3	93,3
48	Duratex	15,361	4,8	19,1	96,7
49	Duratex	4,925	2,9	33,8	93,3
50	Duratex	16,774	5,0	19,6	100,0
51	Australia	10,345	4,0	25,5	96,7
52	Itatinga	10,669	3,8	43,7	93,3
53	Itatinga	17,996	5,2	22,4	83,3
54	Itatinga	7,995	4,4	23,2	63,3
55	Itatinga	10,692	4,4	20,3	93,3
56	Itatinga	8,721	3,5	41,9	96,7
57	Itatinga	14,080	5,0	21,9	96,7
58	Itatinga	13,320	4,2	29,9	93,3
59	Itatinga	19,196	5,2	16,7	90,0
60	Itatinga	18,708	5,1	28,1	66,7
61	Itatinga	12,800	4,3	31,7	100,0
62	Itatinga	14,082	4,9	20,6	90,0
63	Itatinga	8,831	4,5	20,7	00,0
64	Itatinga	11,581	4,1	30,2	96,7
65	Itatinga	8,486	4,0	22,4	100,0
66	Itatinga	11,437	4,2	25,4	90,0
67	Itatinga	13,815	4,9	21,7	86,7
68	Itatinga	11,088	4,3	28,6	86,7
69	Itatinga	11,760	4,7	24,8	83,3
70	Itatinga	9,604	4,2	21,3	90,0
71	Itatinga	8,397	4,4	24,4	70,0
72	Itatinga	14,315	4,9	20,2	93,3
73	Itatinga	7,902	3,7	35,6	90,0
74	Itatinga	14,668	4,6	16,7	100,0
75	Itatinga	6,852	3,6	25,1	96,7
76	Itatinga	8,976	4,2	27,3	73,3
77	Itatinga	9,093	4,3	23,8	83,3
78	Itatinga	11,490	4,8	14,1	93,3
79	Itatinga	10,542	4,3	22,6	90,0
80	Itatinga	12,536	4,4	29,6	93,3
81	TC-Itatinga	10,689	4,3	21,6	93,3
	Média	10,457	4,1	29,3	89,5
	S	3,9	0,6	8,8	7,9
	CV	37,0	15,1	29,9	8,9

revela que uma melhoria da altura média pode ser conseguida com a escolha adequada do local de plantio.

A altura média dos progênies em Bom Despacho foi de 6,2 m e em carbonita foi de 4,2 m.

3.4 - E.saligna, projeto 26638.

No ensaio são testados progênies de árvores superiores das ' Empresas Riocell, Champion, Duratex, Itatinga (horto), e foram ' usadas como testemunha da Rio Doce, Australia e comercial Itatinga.

Analisando em grupos de procedências em média das alturas temos Itatinga 4,42 m, Champion 4,12 m, Duratex 3,98 m e Riocell ' 3,40 m.

As testemunhas tiveram para Itatinga 4,30 m e Rio Doce e Australia 4,00 m.

As progênies da Riocell foram as que tiveram comportamento ' inferior, podendo ser atribuido ao fato de estar em região ecológica diferentes àquelas onde foram selecionadas as Matrizes.

Quadro VI - Relação dos tratamentos, procedência e resultados de dados mensuráveis de Teste de Progênie de E.microcorys com 1 ano de idade, projeto 26637 em Bom Despacho - MG.

Trat.	Procedência	Vol.Cilindro (m3/ha)	Altura (m)	CV_h (%)	Sobrev (%)
01	Tatuí	4,438	3,6	13,1	90,0
02	Tatuí	3,885	3,2	18,7	93,3
03	Tatuí	5,475	3,6	13,0	93,3
04	Tatuí	4,881	3,4	16,3	92,2
05	Tatuí	5,097	3,5	15,1	96,7
06	Tatuí	5,025	3,5	17,8	96,7
07	Tatuí	4,711	3,4	18,3	93,3
08	Tatuí	5,633	3,6	11,4	95,6
09	Tatuí	5,107	3,5	15,9	91,1
10	Tatuí	5,939	3,5	16,3	95,6
11	Tatuí	4,799	3,4	15,8	94,4
12	Tatuí	4,982	3,4	17,8	88,9
13	Tatuí	7,348	3,2	16,3	93,3
14	Tatuí	4,780	3,4	18,1	91,1
15	Tatuí	5,954	3,7	14,4	92,2
16	Tatuí	5,522	3,6	14,2	94,4
17	Tatuí	5,004	3,6	12,1	88,9
18	Tatuí	4,762	3,4	15,5	93,3
19	Tatuí	4,710	3,4	14,5	95,6
20	Tatuí	4,087	3,3	14,6	92,2
21	Tatuí	4,716	3,4	13,6	87,8
22	Tatuí	4,033	3,3	17,4	88,9
23	Tatuí	5,333	3,6	16,0	90,0
24	Tatuí	6,344	3,8	13,8	95,6
25	Tatuí	4,703	3,5	13,2	90,0
26	Tatuí	4,392	3,4	16,9	90,0
27	Tatuí	4,130	3,3	15,8	94,4
28	Tatuí	4,318	3,3	17,2	88,9
29	Tatuí	5,649	3,7	13,8	91,1
30	Tatuí	4,833	3,5	18,4	86,7
31	Tatuí	4,842	3,7	15,6	84,4
32	Tatuí	4,871	3,5	17,7	87,8
33	Tatuí	3,878	3,4	19,3	78,9
34	Tatuí	4,609	3,5	20,0	78,9
35	Tatuí	4,513	3,5	20,4	76,7
36	Tatuí	6,277	3,8	16,1	86,7
37	Tatui	5,858	3,6	15,6	93,3
38	Tatuí	5,122	3,5	16,3	68,9
39	Tatuí	4,036	3,4	17,0	83,3
40	TC-CAF	5,719	3,3	16,3	86,7
41	TC-CAF	6,073	3,8	15,2	86,7
42	TC-CAF	6,682	3,9	11,8	94,4
	Média	5,073	3,5	15,9	90,3
	S	0,8	0,2	2,2	4,8
	CV %	15,5	4,7	13,8	5,3

3.5 - E.microcorys, projeto 26637.

No ensaio são testados progênies de árvores superiores de Tatui e testemunha comercial da CAF.

O comportamento das progênies, testados são muito semelhantes, em vista do coeficiente de variação encontrada.

A testemunha da CAF teve comportamento semelhante à media ' das progênies.

As diferenças maiores entre média de progênies foram de ordem de 15 % de superioridade, mostrando uma grande homogeneidade do material.

4 - Conclusões.

a) Os resultados preliminares mostram o potencial das populações para seleção e melhoramento.

b) As variações entre grupos (procedências) de progênies foram notadas nos ensaios de E.grandis (26639) e E.saligna (26638), assim como variações entre progênies dentro do local.

c) Nos ensaios de E.tereticornis (26526 e 26510) e E.grandis (26417) não houve diferenças entre procedências testadas, mostrando possibilidade de seleção e Melhoramento em todos os locais.

d) Nos ensaios de E.tereticornis (26526 e 26510) houve uma diferença acentuada nos dois locais testados e, ganho em altura ' poderão ser conseguidos na escolha do melhor local.

e) O Teste de Progênie de E.microcorys revela alta homogeneidade do material testado, detectando-se diferenças em altura de somente 15% entre médias de progênies.

f) A variação entre médias de progênies em altura foi alta, nos ensaios abaixo, mostrando boas possibilidades de seleção ao nível de progênies dentro de ensaio e, foram de ordem de:

- E.grandis (26417) = 170%.
- E.grandis (26639) = 56%.
- E.tereticornis (26526) = 41%.
- E.tereticornis (26510) = 62%.
- E.saligna (26638) = 147%.

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PROGRESSOS RECENTES NO ESTUDO DOS SISTEMAS DE REPRODUÇÃO EM *EUCALYPTUS.*

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Resumo

Neste trabalho, as recentes pesquisas australianas no sistema de cruzamento, fenologia do florescimento, ecologia da polinização de *Eucalyptus* spp, são revistas e algumas de suas implicações no melhoramento são discutidas.

RECENT ADVANCES IN THE STUDY OF EUCALYPT BREEDING SYSTEMS.

Summary

In this paper recent Australian work on the mating systems, flowering phenology and pollination ecology of eucalypt spp. is reviewed and some of the implications for tree breeding discussed.

INTRODUCTION

In its narrow sense 'breeding system' is a descriptive term referring to the mode of sexual reproduction of a species (inbreeding/outcrossing) (e.g. Bawa 1979). This can be investigated through studies of floral morphology, or more quantitatively through the use of genetic markers (e.g. Brown *et al.* 1975). Knowledge of a species' breeding system is of practical importance because of its genetic consequences, and the implications for seed production management. If, however, the tree breeder is to use such knowledge in planning breeding strategy it is also necessary to understand the mechanisms through which the breeding system is maintained. Investigation of reproductive biology, phenology, and pollination ecology is therefore an implicit component of breeding system studies. Recent Australian work on *Eucalyptus* spp. is reviewed in this paper, and implications for tree breeding discussed.

BREEDING SYSTEM ESTIMATION

Although the few eucalypts investigated have generally proved to be self fertile under controlled pollination conditions (Eldridge 1976; Hodgson 1976b), Pryor (1976) considered the genus to be outbreeding. Quantitative estimates using allozyme variants have now been obtained for several species (Table 1) and outcrossing has indeed been shown to predominate. Over the 5 species so far tested an average of 75% of seed is estimated to have resulted from outcrossing. Note that, with the exception of *E. stoatei*, all the species investigated are part of the subgenus *Monocalyptus*, so the validity of generalisation to other subgenera remains to be investigated.

Table 1. Estimates of the outcrossing rate ($\hat{t}$) for five eucalypt species

Species	P*	$\hat{t}$	Source
E. delegatensis	4	0.79	Moran (unpublished)
E. obliqua	4	0.76	Brown *et al.* (1975)
E. pauciflora	3	0.67	Phillips *et al.* (1977)
E. regnans	1	0.69	Moran and Griffin (unpublished)
E. stoatei	1	0.82	Hopper and Moran (1981)
	mean	0.75	

*P = number of populations

It must be emphasised that this is an estimate of effective outcrossing in the population of viable seed and young germinants. It could well underestimate the proportion of selfs at the time of fertilisation, and over-estimate that at a later stage in the vegetative development of the population. Field observations of flowering and pollen vectors (Ashton 1975; Griffin 1980; Hopper and Moran 1981) suggests that self pollination must be higher than such estimates indicate.

In order for outbreeding to occur the flowering of two or more individuals must be synchronised; they must be close enough for pollen transfer to occur; and a suitable vector must be available to effect this transfer. Weather, population structure, and fluctuations in pollen vector populations might therefore be expected to introduce both spatial and temporal variation in rates of outcrossing.

Spatial variation

The available data on between-population variability in the mating system are shown in Table 2. Populations of *E. delegatensis* did not vary significantly in outcrossing rate, whereas some of the *E. obliqua* populations did. Allard *et al.* (1977) have correlated levels of outcrossing in some grasses with site aridity, suggesting that the amount of outcrossing is a genetic adaptation to the environment. Data of Phillips and Brown (1977), (Table 3) is of interest in this respect. Three samples of *E. pauciflora* separated by several kilometres, but forming part of a continuous stand along the top of the Brindabella range in the ACT, were analysed for their mating system parameters using seed and seedling allozyme markers. The outcrossing rates were the same for the seed markers but for the seedling markers the two lower elevation populations had significantly lower rates of selfing. Apparently heterosis was more intense at the lower altitudes.

In another study of intrapopulation structure three areas of an *E. delegatensis* stand were sampled and progeny assayed to determine outcrossing rates (Table 3). The sampled areas were less than 300 m apart from each other. In this case the estimates are quite high and not significantly different from each other despite heterogeneity between areas in allelic frequencies at some loci (Moran 1981).

Temporal variation

The temporal variation in the mating system within eucalypt populations can be determined by measuring outcrossing rates of distinct seed crops. In Table 4 outcrossing estimates are given for three sequential seed crops of a population of *E. delegatensis*. The overall estimate was 77% outcrossing in the population but the estimates for the individual crops were significantly different from each other with the effective rate increasing from 66% in the youngest crop A to 85% in the oldest crop C. Two factors could account for these differences. The first would be differences in the rate of outcrossing in the different seasons (i.e. temporal variation). The second factor could be differential viability of inbred as opposed to outcrossed seed since the fertilisation events in the oldest crop. The available data does not discriminate between these two possibilities. The importance of the seed storage phase within the canopy, for future regeneration in natural populations, has been emphasised by Ashton (1975). It is therefore of considerable importance to determine whether selection against selfed individuals does occur within this stage of the life cycle.

Table 2. Estimates of the outcrossing rate ($\hat{t}$) for 4 populations in each of two species

Species	Population			
E. obliqua[A]	Furner 0.84	Daylesford 0.83	Murdurnna 0.74	Gibraltar 0.64
E. delegatensis[B]	Mt Macedon 0.82	Pilot Hill 0.78	Ben Lomond 0.70	Cromwell Knob 0.86

[A] Data from Brown *et al.* (1975)

[B] Data from Moran (unpublished)

Table 3. Outcrossing estimates in subdivided populations

Species	Areas					
	Population	Source	1	2	3	Mean
E. pauciflora[A]	Brindabella	Seed	0.62	0.62	0.67	0.64
	Range (ACT)	Seedling	0.62	0.83	0.84	0.76
E. delegatensis[B]	Cromwell Knob (Vic.)	Seed	0.85	0.93	0.81	0.86

[A] Data from Phillips and Brown (1977)

[B] Data from Moran (1981).

Table 4. Estimates* of the outcrossign rate ($\hat{t}$) and their standard error in three crops in the Pilot Hill population (NSW) of *E. delegatensis*

	Crop			
	A	B	C	Total
$\hat{t}$	0.66	0.78	0.85	0.77
S.E.	±0.05	±0.05	±0.06	±0.03

A = most recent crop; C = oldest crop

*Data from Moran and Brown (1980)

Inbreeding depression effects

The concept that the proportion of inbred and outcrossed individuals in the population may change through time has been emphasised in this paper because inferences regarding genetic structure are frequently based only on breeding system estimates at the time of seed maturation. From the evolutionary viewpoint it is the structure of the parental population at the time of regeneration that is important, and selection pressures during stand development may cause this to be radically different from that in the progeny seed. In both *E. pauciflora* (Phillips and Brown 1977) and *E. delegatensis* (Moran and Brown 1980) heterozygosity in the progeny was in fact less than in the parental population. The regeneration ecology of eucalypts provides ample opportunity for the operation of differential selection pressures as young seedlings are frequently subject to intense competition in the early years of stand development. For example, Ashton (1976) estimated that *E. regnans* stands may carry over 2 000 000 germinants per hectare, reducing to 15 000 at age 10 and 100 at age 150. He further determined that trees constituting the mature stand at age 200 are likely to have been present in the predominant crown class at age 40.

Reduced height growth of selfed progenies relative to outcrosses has been observed experimentally for *E. grandis* (Hodgson 1976b) and for *E. regnans* (Eldridge 1970), and these differences were even more marked in a progeny test of *E. regnans* at age 10 years (Table 5). It is thus likely that the inbred, less heterozygous, individuals will be those at a selective disadvantage, and that average heterozygosity of the surviving population will thus increase with stand age.

Table 5. Crown classification of trees in an *E. regnans* field trial* aged 10 years

Family type	N#	Total no. trees planted	No. per crown class				
			Dominant	Co-dominant	Sub-dominant	Suppressed	Dead
Self	4	96	1	18	23	16	38
		% D + C/D	20				
		% Mortality					40
Open-pollinated	4	96	13	44	11	11	17
		% D + C/D	59				
		% Mortality					18
Outcross	1	24	2	17	3	0	2
		% D + C/D	79				
		% Mortality					8

#N = number of families

*Date from Eldridge and Griffin (1981)

FLOWERING PHENOLOGY

Within populations the similarity of the flowering phenologies of different individuals will determine their potential for interbreeding. Phenological observations are therefore an integral component of our understanding of breeding systems. Species within the genus *Eucalyptus* show great variation in flowering time (Blakely 1965). Although the peak flowering season may be regular some species can flower intermittently over the greater part of the year and vary widely from one stand to another. In *E. diversicolor* single trees may flower for 6 months with a 2-3 month peak and the main flowering period for stands may fluctuate between August and May (Loneragan 1979). In stands of *E. microcorys* some flowering occurred throughout the year with a 4-month peak in summer (Van Loon 1966). Davis (1969) reported that maximum flowering in *E. stellulata* in New England, NSW occurred from February-May but usually some flowers are undergoing anthesis at any time. Ashton (1975) showed that flowering season in the *E. regnans* population at Wallaby Creek (Vic.) varies from 2.5 to 4.5 months with as much as 3-4 weeks fluctuation in starting and finishing times.

Griffin (1980) showed that within a stand of *E. regnans* order of flowering was repeatable from one year to the next, and that the population tended to be subdivided into groups of trees with similar peak flowering time. Moreover in this stand, even in a heavy flowering year, 15% of the trees were excluded from the breeding population as they did not flower at all and 8.2% of potential crosses between flowering trees could not have occurred because of complete temporal isolation. With the correlation of flowering times between adjacent individuals there should be an increase in the probability of mating between relatives. This factor could be decisive in maintaining the sub-population heterogeneity of allele frequencies observed in *E. delegatensis* (Moran 1981) and *E. obliqua* (Brown *et al.* 1975).

Protandry has been considered common in eucalypts (Pryor) and would tend to reduce the rate of selfing but experimental confirmation of protandry is available for few species (Hodgson 1976a; Griffin and Hand 1979).

POLLINATION ECOLOGY

While the relatively unspecialised nature of the *Eucalyptus* flower suggests that insects, birds, and small mammals may all act as pollen vectors, there have been few systematic field studies of pollination ecology in the genus. Faegri and Van der Pijl (1979) claim that *Eucalyptus* is predominantly ornithophilous and Ford *et al.* (1979) estimated that up to 200 species could at least in part be pollinated by birds. Even small-flowered species are visited by birds (Churchill and Christensen 1970; Ashton 1975; Hopper and Burbidge 1979; Bond and Brown 1979; Ford *et al.* 1979; Hopper 1980). and in some species floral structure, nectar production, and flowering time appear to favour bird rather than insect vectors. For example, *E. incrassata* in South Australia produces most of its nectar early in the morning when honey eaters are active. *E. caesia* in Western Australia flowers in winter when temperatures do not favour insect activity, and honey eaters forage on this species in large numbers (Hopper, pers. comm.). The flower of *E. stoatei* appears to be well adapted to bird pollination (Hopper and Moran 1981). Larger insects cannot enter the large pendulous flowers of the species as the stamens form a dome over the floral cup and access is possible only to the probing beaks of honey eaters - 10 species of which have been recorded as visitors. In this study honey eaters were found to visit only 1-5 flowers per tree, with 18% of inter-flower movements occurring between different trees. The majority of such movements are not between nearest neighbours. It is likely that the dominant pollen vectors also vary in time and space. For example, Ashton (1975) observed flocks of honey eaters visiting *E. regnans* but in a more isolated stand such birds were not observed over several flowering seasons (Griffin 1980). Nevertheless adequate seed set did occur in the latter case - presumably through the activity of numerous bees, fly and feetle species.

The extent to which the floral biology of *Eucalyptus* acts as a buffer against fluctuations in populations of particular vectors warrants study, because of the implications for seed orchard management.

SOME IMPLICATION FOR BREEDING STRATEGY

The mixed mating system of *Eucalyptus*, and particularly the opportunity for temporal and spatial variation in the system, raises problems for provenance and progeny testing using open pollinated seed. If one provenance sample is less vigorous than another this may reflect useful adaptive variation or merely an ephemeral difference in the proportion of inbreds in the seed crop. Similarly an unwarranted assumption of random mating may cause over estimation of additive genetic variance (Namkoong 1966).

The mixed mating system, and subsequent inbreeding depression expressed by a proportion of the population, also presents a problem for the plantation manager. This is because nursery practices are usually designed to maximise the number of germinants producing plantable plants - and hence many inbred individuals, which would be selected against in nature, find their way into plantations. The optimistic corollary is that large realised gains await us if inbreeding effects can be minimised. This might be accomplished by reducing one or more of:

1. the proportion of fertilisations by related gametes,
2. the inbreeding depression resulting from such fertilisations,
3. the proportion of inbreds in the planting stock.

1. Seedling or clonal orchards containing many unrelated individuals, or plantations with a broad genetic base, should minimise inbreeding effects by ensuring that each between-tree vector flight occurs between non-relatives. In natural stands, and particularly in plantations based on seed from single or a few trees, many such 'outcrosses' will still result in a degree of inbreeding. Multiple grafting has been suggested (Hodgson 1976c) as a way in which vectors working within a single tree crown could still effect outcrosses. It is also particularly important to identify pollen vectors which make inter-tree flights and to ensure that they are present at flowering time on the seed orchard site. Matching of flowering times of selections within the orchard is of course essential if outcrossing is to be promoted.

2. Since inbreeding depression results from a higher frequency of genotypes with deleterious recessive alleles in the homozygous state (Falconer 1960), the extent in a particular progeny will depend on the parental genotype(s). Selections to be used in a seed orchard could therefore be screened by selfing and growing the resulting progeny in comparison with their outcrossed siblings. Whether this would need to be done each generation would depend upon the number of action of genes involved in the inbreeding depression phenomenon.

3. Within a species some individuals set selfed seed more readily than others. Once the physiology and genetics of this system is understood it may prove possible to increase self incompatibility in the breeding and seed production populations through selection.

Other action may be possible during the fertilisation to planting stock production phase of the seed crop. For example, if lethal elleles are expressed in inbreds while the seed is on the tree, then delayed harvesting may increase the effective proportion of outcrosses in the crop. Seed should also only be collected following years of heavy flowering since that from trees flowering in isolation, or out of season, is bound to be most self-fertilised.

Once seed is germinated it is possible to cull deformed or weak individuals. The major difficulty lies in identifying selfs which, at the nursery stage, express only a somewhat reduced growth rate. It would be desirable to investigate germinative characteristics of selfed and outcrossed seed to see whether any discrimination is possible prior to pricking out. Subjecting seedlings to stress, and thereby allowing clearer expression of deleterious alleles, might also be worth considering.

Finally, the problem can be completely circumvented at least in some species by establishing plantations with vegetative propagules of selected genotypes.

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ENSAIO COMPARATIVO DE PLANTAS PRODUZIDAS POR SEMENTES EM MANDURI, SP, COM PLANTAS PROVENIENTES DE SEMENTES MELHORADAS PRODUZIDAS EM POMAR CLONAL NA ÁFRICA DO SUL, DE *EUCALYPTUS SALIGNA SM.*

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Resumo

A qualidade das sementes de Eucalyptus saligna Sm, procedentes de pomares clonais, estabelecidos na República da África do Sul, "Department of Forestry", está sendo comparada com a das sementes produzidas em Manduri, SP, por um povoamento constituído de progênies de árvores "plus", que já haviam sido submetidas a teste de progênie no Serviço Florestal da antiga Companhia Paulista de Estradas de Ferro, atualmente incorporada à FEPASA.

Os ensaios foram estabelecidos em Itapetininga e Luiz Antonio.

Os valores da altura total média, aos 18 meses, das diversas famílias, foram comparados por análise de variância e teste de Tukey. Foi feita uma análise fenotípica das plantas em Luiz Antonio, procedendo-se à contagem de falhas e do número de plantas tortas e bifurcadas.

Summary

The purpose of this work is to compare the seed quality of Eucalyptus saligna Sm from a clonal seed orchard, established in South Africa, with seed collected in Manduri, SP, from one plantation composed of progenies of "plus trees", growing on the Forest Service of the former Companhia Paulista de Estradas de Ferro (now FEPASA). These trees were already progeny tested and proved to be among the best.

Mean total height of the families measured at 18 months, were compared by a variance analysis and Tukey test.

Phenotypic valuation of the plants in the field was made. Survival, number of straight, crooked and forked stems were also assessed.

Introdução

A necessidade de atender à demanda de sementes de eucaliptos levou o Instituto Florestal, em anos anteriores, a estabelecer plantações utilizando o material introduzido por Navarro de Andrade. Dentre as espécies mais procuradas situava-se o Eucalyptus saligna. A antiga Companhia Paulista de Estradas de Ferro já havia iniciado um trabalho de melhoramento, selecionando nos seus diversos hortos os melhores fenótipos da espécie e submetendo-os a teste de progênie.

Sementes destas "árvores plus" forneceram as mudas para o estabelecimento de um pomar, em Manduri, SP. A identidade das diversas famílias foi preservada.

A oportunidade de se avaliar a qualidade das sementes surgiu com o recebimento de diversos lotes de sementes melhoradas, provenientes de pomares clonais do "Department of Forestry" da República da África do Sul.

Material e Métodos

As mudas de Eucalyptus saligna Sm foram formadas com sementes de pomares clonais recebidas da África do Sul e com sementes colhidas de um povoamento estabelecido em Manduri, formado de progênies de árvores "plus" selecionadas no antigo Serviço Florestal da Companhia Paulista de Estradas de Ferro (atualmente incorporada pela FEPASA). As árvores "plus" escolhidas para o fornecimento de sementes, para o plantio de Manduri, foram as que apresentaram progênies de maior desenvolvimento em altura e diâmetro aos 5 anos de idade, num teste levado a efeito na antiga Companhia Paulista. O plantio de Manduri foi feito conforme o esquema usado antigamente na Companhia Paulista e também no Instituto Florestal, isto é, de 10 em 10 metros, eram plantadas 4 mudas nos vértices de um quadrado de um metro de lado. Através de seleções, 3 das mudas seriam eliminadas, resultando num espaçamento de 10 m x 10 m. (Pásztor, 1962)

No que se refere às sementes coletadas do povoamento de Manduri, o procedimento foi o seguinte: de cada família escolheram-se 5 árvores de bom desenvolvimento e após a colheita de suas sementes, estas foram misturadas constituindo os lotes representativos destas famílias, que foram em número de 6 a saber:

[*] A - 1440; B - 1445; C - 1473; D - 1478; E - 1528 e F - 1572.

Os lotes de sementes da África do Sul foram: G - 28.638; H - 28.639; I - 28.640; J - 28.641; K - 28.642 e L - 23.849. Conforme indicação recebida deste país, os cinco primeiros lotes são compostos de sementes coletadas de plantas "plus", e o último lote é uma mistura de plantas "plus" e imediatamente inferiores a "plus", localizadas em pomares de sementes clonais (sementes melhoradas).

As mudas foram produzidas e os ensaios instalados em Itapetininga e Luiz Antonio.

Os dados climáticos e a localização das procedências das sementes constam do Quadro 1 e os dados dos locais de instalação constam do Quadro 2. (Ventura et alii, 1965/66)

Quadro 1 - Dados das procedências das sementes

Local	Precipitação (mm)	Latitude (o ')	Longitude (o ')	Altitude (m)
África do Sul	1.123,3	23º 47' S	30º 08' E	755
Manduri	1.161,0	23º 00' S	49º 19' W	700

Quadro 2 - Locais de instalação dos testes de progênie

Local	Precipitação (mm)	Latitude (o ')	Longitude (o ')	Altitude (m)
Itapetininga	1.128,0	47º 57' S	23º 42' W	645
Luiz Antonio	1.280,0	41º 40' S	42º 49' W	550

As mudas, em Itapetininga e Luiz Antonio, foram plantadas sob delineamento de blocos ao acaso, segundo PIMENTEL GOMES (1976), com 12 tratamentos (origens A, B, C, D, E, F, G, H, I, J, K e L) e 9 repetições. As parcelas constituiram-se de 9 plantas, no espaçamento de 2,0 x 2,0 m.

As parcelas foram implantadas alternando-se sempre as origens de Manduri com as da África do Sul e não foram usadas bordaduras. Pretende-se assim, após a avaliação do material de Manduri comparado com o da África do Sul, proceder-se a um desbaste deixando apenas uma muda por parcela, e se for o caso, também a eliminação completa da família não desejável. O objetivo passará a ser a condução do "stand" para produção de sementes melhoradas e com uma base genética mais ampla.

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[*] Os números referentes aos códigos A à F correspondem aos números de registro das árvores "plus" na Companhia Paulista, enquanto os números que correspondem aos códigos G à L são os de registro na África do Sul.

Resultados

A primeira dendrometria efetuada 18 meses após a instalação do teste de progênie, revelou pela análise de variância,que houve diferença estatística entre os dados de altura das 12 famílias, tanto em Itapetininga como em Luiz Antonio, com coeficientes de variação de respectivamente, 21,4 % e 7,57 %.

Os Quadros 3 e 4 apresentam as médias dos 12 lotes estudados, assim como a comparação dos mesmos, de acordo com o teste de Tukey.

As médias gerais (altura em m) das procedências de Manduri, em Luiz Antonio e Itapetininga foram respectivamente de 8,63 m e 3,66 m. As procedências da África do Sul mostraram para altura, as médias: Luiz Antonio 8,43 m e Itapetininga 3,80 m.

Quadro 3 - Comparação de altura (m), das diversas famílias das duas procedências de *Eucalyptus saligna* Sm, plantadas em Itapetininga, após 18 meses de plantios.

Procedências	Famílias	Média Geral (m)	Comparação das Famílias
1. Manduri	A	4,05	A > B, I
	B	2,87	
	C	2,92	C > B, I
	D	3,46	D > L
	E	3,73	E > I
	F	3,91	F > B, I
2. África do Sul	G	3,40	
	H	3,91	H > B, I
	I	2,72	
	J	4,09	J > B, I
	K	4,89	K > B, D, E, G, I, J
	L	3,77	L > I

Quadro 4 - Comparação de alturas (m), das diversas famílias das procedências de *Eucalyptus saligna* Sm, plantadas em Luiz Antonio, após 18 meses de plantio.

Procedências	Famílias	Média Geral (m)	Comparação das Famílias
1. Manduri	A	9,04	A > B, C, F, G, I, J, L
	B	8,00	
	C	8,49	C > B, G, I, J
	D	8,86	D > B, C, G, I, J, L
	E	8,76	E > B, G, I, J
	F	8,86	F > B, G, I, J
2. África do Sul	G	7,93	
	H	8,98	H > C, G, I, J, L
	I	7,93	
	J	8,10	J > B, I
	K	9,18	K > B, D, E, G, I, L
	L	8,45	L > I

A análise das características fenotípicas do material existente em Luiz Antonio estão evidenciadas no Quadro 5.

Quadro 5 - Características fenotípicas do ensaio instalado em Luiz Antonio (em porcentagem).

Classificação das plantas no campo	Procedências	
	Manduri	África do Sul
Retilíneas	8,02	12,14
Tortuosas	84,15	70,16
Bifurcadas	2,47	9,67

As porcentagens de falhas foram respectivamente para Manduri e África do Sul: 5,3 % e 7,8 %.

Discussão

A medida que as florestas nativas diminuem, aumenta a procura de eucaliptos, especialmente para finalidades que não exigem um produto final uniforme e muito específico, como por exemplo o caso de lenha doméstica, que hoje é o destino de cerca da metade da madeira cortada no mundo. Segundo Eldridge (1978), a madeira do eucalipto contribue para uma significativa proporção da energia usada em países em desenvolvimento, nas partes mais quentes da terra, situadas em faixas ao norte e ao sul do Equador, até latitudes de 40°.

Outros autores tem usado sementes provenientes de polinização livre de fenótipos superiores para formação de seus pomares. Franklin e Meskimen (1974) descrevem um programa de melhoramento de eucaliptos das espécies *E. grandis*, *E. robusta*, *E. camaldulensis* e *E. tereticornis*, em andamento na Flórida. Eldridge (1978) comentando esse trabalho opina que o método embora barato é bastante promissor e deve ser considerado em programas de melhoramento.

Jacobs (1973) afirma que os atuais plantios brasileiros originários do material introduzido por Navarro de Andrade, desde que devidamente manejados, podem fornecer sementes de boa qualidade e bem semelhantes às espécies nominais. O mesmo autor afirma que, sendo o suprimento de sementes da Austrália bastante limitado, o Brasil deve produzir a maioria de suas sementes das melhores fontes disponíveis, a despeito do problema de híbridos.

Os dados de crescimento do material procedente de Manduri, quando comparados com o material da África do Sul, embora com apenas 18 meses de idade, revela-se bastante promissor para plantios que se destinam a usos gerais, sem exigências de qualidades específicas.

Examinando-se os valores das alturas totais médias das diversas famílias verifica-se que existem diferenças significativas ao nível de 5 %, alternando-se os valores das progênies procedentes da África do Sul e de Manduri. As médias gerais das procedências de Manduri e África do Sul, tanto em Itapetininga como em Luiz Antonio foram bastante semelhantes. A média geral encontrada em Luiz Antonio foi significativamente superior à de Itapetininga, devido a condições edafoclimáticas mais favoráveis.

A análise fenotípica efetuada em Luiz Antonio revela que em geral as mudas da África do Sul estão bem melhores que as de Manduri em relação à retidão do fuste. Em relação ao número de plantas bifurcadas está havendo maior incidência na procedência da África do Sul.

Em relação às falhas, as procedências da África do Sul estão apresentando maior número que as de Manduri.

As famílias B, de Manduri; G e I da África do Sul são as que estão apresentando os menores índices de crescimento nas duas localidades, tanto em Itapetininga como em Luiz Antonio.

Conclusões

Comparando-se o desenvolvimento das plantas produzidas por sementes procedentes de Manduri, SP, com as provenientes de um pomar clonal, estabelecido na África do Sul, conclui-se que:

1. As médias gerais das duas procedências foram semelhantes.
2. As menores médias foram apresentadas pelas procedências I (Manduri) e G (África do Sul).
3. Quanto a locais de instalação, as médias das plantas de Luiz Antonio foram superiores às de Itapetininga.
4. No que se refere às características fenotípicas, a maior porcentagem de plantas retilíneas e bifurcadas está ocorrendo em material procedente da África do Sul. A maior porcentagem de plantas tortuosas foi do material procedente de Manduri.
5. Quanto à taxa de sobrevivência, Manduri vem apresentando valores superiores aos da África do Sul.

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CAPACIDADE DE SOBREVIVÊNCIA E INCIDÊNCIA NATURAL DE CANCRO EM ESPÉCIES E PROCEDÊNCIAS DE *EUCALYPTUS* NO NORDESTE DO ESTADO DO ESPÍRITO SANTO.

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Resumo

Uma pesquisa foi feita nos experimentos de introdução de espécies e procedências de *Eucalyptus spp*, instalados nas áreas de atuação da Floresta Rio Doce S/A, no Nordeste do Estado do Espírito Santo. As características observadas nas plantações na idade de nove anos foram capacidade de sobrevivência e ocorrência natural de Cancro em função das procedências em estudo. Observando-se em cada experimento, em duas das suas repetições, as parcelas, anotando-se as árvores infectadas, as árvores mortas pelo Cancro, falhas, morte por causas desconhecidas e, também, o D.A.P. e altura das árvores.

Summary

In order to observe the survival capacity and the natural incidence of canker on several provenances of *Eucalyptus* spp, at five to nine years old, a survey was carried out in the Northeast of Espirito Santo state .

For each experiment of species trial at least two of its replications were surveyed based on natural infections and deaths of trees caused by *Diaporthe cubensis* Bruner, failures, death of trees by unknown causes, as well the diameter (DBA) and height (H) .

1. INTRODUÇÃO

Em 1977, realizou-se um levantamento em ensaios de Introdução e Competição de espécies e procedências de eucaliptos, instalados em áreas da Florestas Rio Doce S/A, no Nordeste do Estado do Espírito Santo, com o objetivo de observar a incidência natural do cancro nas diversas procedências introduzidas. Naquela época, as procedências tinham de 2 a 5 anos, oferecendo, portanto, apenas informações preliminares (1) .

Em julho de 1979, novo levantamento foi realizado, estando as procedências com idade entre 5 a 9 anos, com objetivos mais abrangentes, quais sejam: observar a capacidade de sobrevivência e incidência natural da enfermidade cancro do eucalipto, causada por *Diaporthe cubensis* Bruner, nas diversas procedências introduzidas .

2. MATERIAL E MÉTODOS

Para cada experimento levantaram-se, no mínimo, duas de suas repetições. Observações detalhadas foram feitas em cada parcela, anotando-se infecções e mortes de árvores causadas por *Diaporthe cubensis*, falhas e mortes de árvores originárias de causa indeterminada, diâmetro (DAP) e altura (H) das árvores. De posse desses dados, calcularam-se percentuais de incidência de cancro e de perdas de acordo com FERREIRA et alii (1) .

3. RESULTADOS

Os resultados do levantamento foram agrupados em três grupos de idade por espécies e procedência, ou seja, 5, 7 e 9 anos. Os percentuais de incidência natural de cancro e perdas ocasionadas por mortes naturais, mortes por cancro e falhas, estão relacionados nas figuras I, II e III .

4. CONCLUSÕES

As procedências que se mostraram inadequadas à região, por terem apresentado baixa capacidade de sobrevivência, mesmo sendo algumas resistentes ao cancro (R), foram as seguintes : *E. andrewsii* NA 10040 e 10274, *E. acmenioides* NA 10008 (R), *E. benthamii* NA 5709, *E. camaldulensis* da África do Sul (A.S.) (R), *E. crebra* NA 8834, *E. deanei* NA 10340 *E. deglupta* 289 (R), *E. diversicolor* A.S., *E. ficifolia* A.S., *E. gamphocephala* A.S., *E. meliodora* A.S., *E. molucana* NA 9250, *E. nitens* NA 8445, *E. nova anglica* NA 9439 , *E. pilularis* NA 9492 (R), *E. trachyphloia* NA 9549 e *E.urophylla* NA 10135.

As procedências com capacidade de sobrevivência satisfatória e baixa incidência de cancro foram: *E. citriodora* A.S.e NA 10268, *E. cloeziana* A.S. e NA 9771, *E. deglupta* NA 559 , *E. dunnii* NA 9245 e 9370, *E. exerta* NA 8968, *E. microcorys* A.S. e NA 9717, *E. nesophylla* NA 6675, *E. paniculata* A.S. , *E. pellita* NA 10955, *E. phaeotricha* NA 9782, *E. pilularis* NA 9491, *E. quadrangulata* NA 8706, *E.robusta* A.S. , *E. siderophloia* NA 8826, *E. tereticornis* NA + 29, *E.torelliana* NA + 4, 8458 e 9798 e *E. urophylla* NA 9008, 9016, 10140 e 10145. Desse grupo, as espécies de *E. citriodora*, *E.cloeziana* *E. dunnii*, *E. microcorys*, *E. paniculata*, *E. pellita*, *E. pilularis*, *E. robusta*, *E. torelliana* e *E. urophylla*,deverão receber mais atenção dos silvicultores da região,porque são possuidoras de procedências cuja resistência ao cancro tem sido experimentalmente comprovada (1,2, 3) e têm crescimento satisfatório .

As procedências com elevada incidência de cancro foram: *E. grandis* A.S. V. Walt e Pretoria, NA + 48, 7244, 9535, 9753 e 10696, *E. maculata* A.S. e NA 10611, *E. propinqua* NA 8717, E. saligna NA 7786, 7808 e 10896. Com exceção de *E.maculata* e *E. propinqua* , as espécies desse grupo são importantes para a produção de celulose, razão pela qual vem-se desenvolvendo na Região, trabalhos de melhoramento florestal, visando resistência ao cancro e maior desenvolvimento volumétrico .

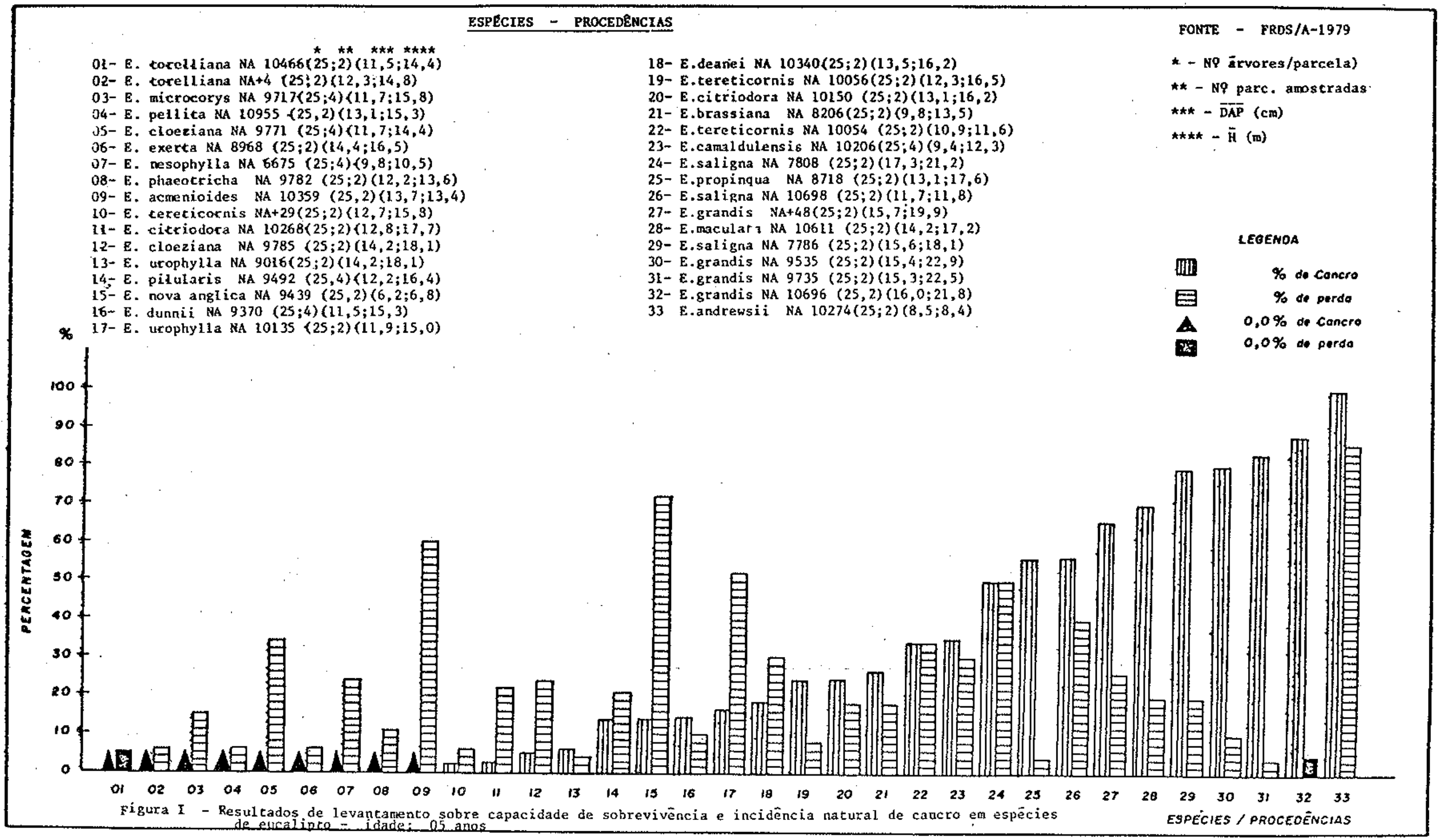

Figura I - Resultados de levantamento sobre capacidade de sobrevivência e incidência natural de caucro em espécies de eucalipto - idade: 05 anos

FONTE - FRDS/A -1979

ESPÉCIES - PROCEDÊNCIAS

* ** *** ****
01- E. torelliana NA-9798 (11;2)(13,1;17,4)
02- E. torelliana NA-8458 (100;2)(13,0;17,3)
03- E. cloeziana NA - 9771 (100;2)(15,6;19,7)
04- E. phaeotricha NA - 9782 (100;2)(15,3;18,6)
05- E. deglupta NA- 559 (100;2)(13,3;16,4)
06- E. deglupta NA - 289(100;2)(14,7;18,4)
07- E. nesophylla NA- 6675 (100;2)(12,4;13,8)
08- E. tesselaria NA- 7493 (100;2)(13,0;14,4)
09- E. exerta NA- 8968 (100;2)(14,1;18,6)
10- E. pilularis NA- 9491 (100;2)(17,1;22,8)
11- E. quadrangulata NA - 8706(100;2)(13,1;15,8)
12- E. dunnii NA - 9245 (100;2)(13,4;19,2)
13- E. acmenioides NA- 10008 (100;2(15,0;16,9)
14- E. siderophloia NA- 8826 (100;2)(11,2;12,8)
15- E. benthamii NA- 5709 (100;2)(20,1;18,3)
16- E. tereticornis NA 10006 (100;2)(13,4;17,3)
17- E. proprinqua NA - 9460 (100;2)(14,1;20,1)
18- E. deanei NA-9760 (100;2)(14,3;19,2)
19- E. resinifera NA-10113 (100;2(14,6;17,7)
20- E. deanei NA-7785-(100;2)(16,2;19,4)
21- E. camaldulensis NA-9728 (100;2)(9,4;10,8)
22- E. urophylla NA - 10135 (100;2)(14,4;15,8)
23- E. urophylla NA 9003 (100;2)(15,3 18,5)
24- E. propinqua NA - 8718 (100;2)(14,7,20,7)
25- E. saligna NA - 9789 (100;2)(14,6;19,4)
26- E. saligna NA- 9819 (100;2)(13,9;18,8)
27- E. andrewsii NA- 10040 (100;2)
28- E. trachyphloia NA-9549 (100;2)
29- E. crebra NA- 8634 (100;2)
30- E. nitens NA - 8445 (100;2)
31- E. molucana NA9250 (100;2)
32- E. lavopinea E. Rylestone N.S.W. (100;2)

LEGENDA

▥ *% de Cancro*
▤ *% de perda*
▲ *0,0% de Cancro*

* - Nº árv./parcela
** - Nº parc. amostradas.
*** - $\overline{DAP}$ (cm)
**** - $\bar{H}$ (m)

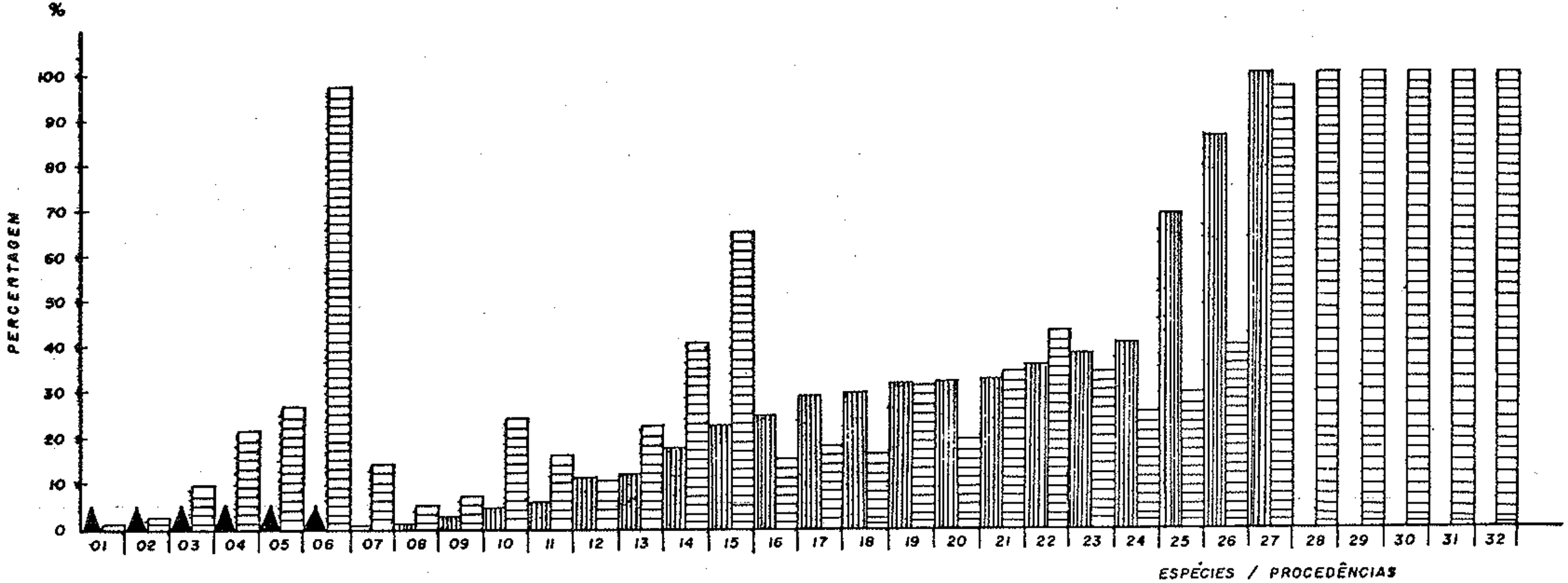

Figura II - Resultados de levantamentos sobre capacidade de sobrevivência e incidência natural de cancro em espécies de eucalipto - idade: 07 anos.

FONTE-FRDS/A-1979

ESPÉCIES/PROCEDÊNCIAS

```
                          * **  ***   ****
01- E. cloesiana A.Sul(50;5)(15,3;20,4)      10- E. grandis A.Sul V. Walt(15,7)(14,2;19,0)
02- E. microcorys A.Sul(50;3)(14,5;19,2)     11- E. grandis A.Sul Pretoria (50;7)(15,2;19,9)
03- E. robusta A.Sul (50;3)(12,5;14,2)       12- E. maculata A.Sul(50;7)(15,3;18,6)
04- E. citriodora A.Sul(50;3)(13,6;17,6)     13- E. gamphoceplala A.Sul (50;1)
05- E. paniculata A.Sul (50;7)(12,8;17,2)    14- E. meliodora A.Sul (50;7)
06- E. resinifera A.Sul (50;7)(11,6;12,5)    15- E. viminalis A.Sul (50,9)
07- E. maidenii A.Sul (50;7)(9,2;11,2)       16- E. ficifolia A.Sul (50;3)
08- E. pilularis A.Sul (50;2)(17,7;17,0)     17- E. diversicolor A.Sul (50;2)
09- E. camaldulensis A.Sul (50;2)(10,3;10,4)
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*- Nº árvores/parcela

**- Nº parc. amostradas

***- $\overline{DAP}$ (cm)

****- $\overline{H}$ (m)

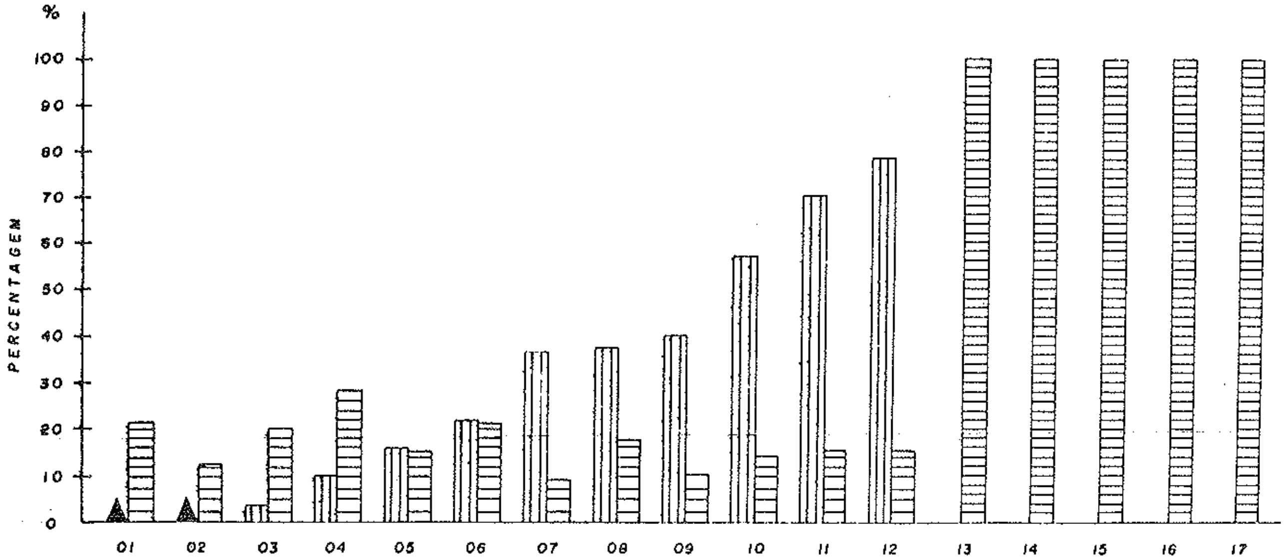

Figura III- Resultados de levantamento sobre capacidade de sobrevivência e incidência natural ao cancro - idade: 09 anos.

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PROGRAMA DE MELHORAMENTO DE *EUCALYPTUS GRANDIS*, COM PROCEDÊNCIA DE COFFS HARBOUR, PARA PRODUTIVIDADE E RESISTÊNCIA AO CANCRO CAUSADO POR *DIAPORTHE CUBENSIS*.

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Resumo

As procedências de *Eucalyptus grandis*, de Coffs Harbow (Australia) são consideradas altamente produtivas para as condições do Grupo Florestal Duratex, em São Paulo (Brasil).

Através dos estudos e pesquisas, os autores concluíram que o cancro é um fator limitante para esta espécie. Um programa de melhoramento tem sido conduzido com alguns resultados já obtidos e indicando que o programa deve ser continuado.

Summary

It is established that the Eucalyptus grandis from Coff's Harbour, Austrália, is highly productive for the Duratex Forest Group conditions, in São Paulo, Brasil.

However, the authors concluded, through researches and studies, that the canker is a limitant factor to this specie.

So, an improvement programme has been conducted, and it has already obtained some results.

These results have been indicated that the programme must be continued.

1 - Considerações Gerais

A Duraflora, Silvicultura e Comércio Ltda, é a empresa do grupo florestal Duratex responsável pela formação e manutenção de suas florestas.

Essa empresa tem, sob seu controle técnico, em torno de 23.000 ha de Eucalyptus spp plantados no Estado de São Paulo, principalmente no município de Lençóis Paulista.

As florestas, formadas basicamente a partir de 1970, têm o objetivo de abastecer as fábricas de chapas localizadas nos municípios de Jundiaí e Botucatu.

As espécies plantadas são predominantemente E.grandis e E.saligna, embora se tenha um grande número de outras, mais a nível experimental.

Essa predominância de E.grandis e E.saligna deve-se fundamentalmente, a três fatores principais:-

a) Bom desenvolvimento para nossa região.
b) Boa performance industrial.
c) Dificuldade de obtenção de sementes de outras espécies potenciais.

A preocupação constante do grupo, contudo, em melhorar sempre a sua produção de matéria-prima por unidade de área faz com que, incessantemente, novas espécies ou procedências sejam testadas e que trabalhos de melhoramento sejam especificamente conduzidos para determinados casos.

Daí o porquê, por exemplo, de se trabalhar com E.grandis de Coff's Harbour.

Essa procedência mostrou-se, quantitativamente e qualitativamente, uma das mais produtivas para as nossas condições, razão pela qual todo um programa de melhoramento a ela está voltado, procurando incrementar sua produtividade e eliminar, ou mesmo amenizar os problemas do cancro causado por Diaporthe cubensis, significativo em nossa região.

Quadro A - Alguns dados de produtividade das florestas do grupo, em São Paulo.

Espécies	Procedência-Origem	Idade	DAP (cm)	H (m)
E.grandis	Salto(SP)/Coff's Harbour	2	9,1	12,8
E.grandis	África do Sul	2	9,1	11,1
E.grandis	Coff's Harbour/Austrália	2	8,3	11,0
E.saligna	Bela Vista(SP)	2	7,8	8,8
E.saligna	Coff's Harbour Austrália	2	8,0	9,1
E.urophylla	Timor	2	8,2	10,6
E.pilularis	Walingat/Austrália	2	7,3	7,7
E.pilularis	Bulahdelah/Austrália	2	7,3	7,6
E.grandis	África do Sul	4	12,3	17,6
E.grandis	Coff's Harbour/Austrália	4	12,7	18,9
E.saligna	Bela Vista(SP)	4	11,4	15,6
E.grandis	África do Sul	5	13,7	19,5
E.grandis	Coff's Harbour/Austrália	5	14,1	23,3
E.saligna	Mairinque(SP)	5	13,1	18,7
E.saligna	Itatinga(SP)	5	13,2	19,6

DAP- Diametro medio a altura do peito
H - Altura média

2 - População base do programa

A população escolhida para desenvolvimento do programa foi plantada em 1970, no Horto Santa Maria, município de Salto -SP, com sementes vindas de Coff's Harbour, Austrália.

Plantada inicialmente ao espaçamento de 3,0 x 1,5m, essa população ocupa uma área de 170ha e apresenta volume cilíndrico médio com casca, aos 10 anos, de 900m^3 por hectare. Tem em torno de 60% de seus indivíduos originais atacados pelo Diaporthe cubensis.

São as seguintes as condições ecológicas da área:

latitude..............................	23° 02' S
longitude.............................	47° 09' W
altitude..............................	640m
t média máx...........................	27° C
t média min...........................	16° C
t média anual.........................	22° C
precipitação média anual..............	1300mm
clima.................................	CWa (Koppen)
solo..................................	latossol vermelho amarelo,orto.

3 - Desenvolvimento do programa

3.1 - Quantificação da doença (cancro) na população

Levantou-se, através de amostragem (parcelas permanentes) representativa da área, o número de indivíduos atacados pelo fungo, em dois anos consecutivos.

Procurou-se analisar, separadamente, as áreas de baixada ou solo mais úmido, daqueles de elevação ou solo mais seco, identificando-se os níveis da infecção.

Os resultados assim se apresentaram, aos 8 e 9 anos de idade:

Quadro B - resultados médios(%), em condições de solo úmido.

	LA	MA	BA	LA+MA+BA	AM	AQ	LA+MA+BA+AM+AQ	AS	F
Fev/78	9,3	10,5	16,0	35,8	8,8	3,7	48,3	33,7	18,0
Março/79	20,8	8,5	17,5	46,8	12,8	3,5	63,1	18,9	18,0
Variaçao	11,5	-2,0	1,5	11,0	4,0	-0,2	14,8	-14,8	0
Evoluçao	123,7	-19,0	9,4	30,7	45,5	-5,4	30,6	-43,9	0

Quadro C - resultados médios(%), em condiçoes de solo seco

	LA	MA	BA	LA+MA+BA	AM	AQ	LA+MA+BA+AM+AQ	AS	F
Fev/78	15,5	8,7	7,9	32,1	8,2	0,5	40,8	47,9	11,3
Março/79	31,2	9,5	9,2	49,9	10,7	0,5	61,1	27,6	11,3
Variaçao	15,7	0,8	1,3	17,8	2,5	0	20,3	-20,3	0
Evoluçao	101,3	9,2	16,5	55,5	30,5	0	49,8	-42,4	0

LA- árvores levemente atacada - início de fendilhamento da casca e exudação de goma.
MA- árvore mediamente atacada - fendilhamento acentuado da casca, porém sem exposição do lenho.
BA- árvore bastante atacada - cancro típico, com exposição do lenho.
AM - árvore morta*
AQ - árvore quebrada*
AS - árvore sadia
F - pontos de falha

Como se pode observar, os quadros são conclusivos. Note-se que, em condições de solo úmido, temos índice menor de LA que em solo seco. Quando se observam os níveis mais severos, MA e BA, contudo, e também AM e AQ, as condições de solo úmido são mais drásticas. Isso mostra que a doença, nessas condições, evolui realmente mais rápido.

Observe-se que, além da evolução da doença, nesse estágio, ser bastante significativa num único ano, a segunda rotação da floresta deverá estar bastante prejudicada, visto que o número de árvores sadias existentes está já num nível muito baixo.

Atente-se para o fato de que o número dessas árvores sadias diminuiu mais de 40% nesse único ano.

Deve-se ressaltar também que a madeira das árvores com níveis severos da doença, encontra-se bastante prejudicada para determinados fins.

3.2- Determinação da influência da doença na regeneração da população:

Locaram-se, dentro da população infestada, três parcelas de 225 pontos de árvores cada.

Esses pontos foram identificados individualmente e procedeu-se a dois levantamentos da doença nas parcelas: imediatamente antes e imediatamente após o corte das árvores, aos 9 anos, à altura de 5cm do solo.

Aos 6 meses após o corte analisou-se a brotação.

Quadro D - resultados com levantamento de cancro antes do corte

	Árvores Amostradas		Touças sem brotação		Touças c/brot. anormal*		Nºbrotos/ touça	Nº gemas/ touça	$\bar{H}$(m) 2 brotos domin	CV (%) p/ $\bar{H}$(m)	Nºbrotos tombados/ touça
	Nº	%	Nº	%	Nº	%					
LA	96	14,2	06	6,25	13	13,54	5,65	3,44	2,26	31,66	0,24
MA	37	5,5	01	2,70	08	21,62	5,33	3,16	2,20	32,36	0,31
BA	154	22,8	19	12,33	22	14,29	5,26	3,15	2,22	33,42	0,33
SADIAS	264	39,1	27	10,23	20	7,58	6,13	3,68	2,35	28,28	0,16
MORTAS	54	8,0	54	100,00							
FALHAS	70	10,4	70	100,00							
TOTAL	675	100,00									

LA - Início de fendilhamento da casca e exudação de goma.
MA - Fendilhamento mais acentuado, porém, sem exposição do lenho.
BA - Cancro típico com exposição do lenho e protuberância dos tecidos.
* - Touças com menos de três brotos.
CV - Coeficiente de variação.

---

* - Todas as árvores quebradas são consequência do cancro.

* - Em grande número das árvores mortas encontram-se picnídios e peritécios do fungo.

Quadro E - resultados com levantamento do cancro após o corte

	Árvores Amostradas		Touças sem brotação		Touças c/brot. anormal *		Nºbrotos/ touça	Nºgemas/ touça	$\bar{H}$(m) 2 brotos domin.	CV(%) p/ $\bar{H}$(m)	Nº brotos tombados/ touça
	Nº	%	Nº	%	Nº	%					
LA	174	25,8	21	12,07	15	8,62	5,73	3,61	2,33	32,67	0,21
MA	53	7,9	04	7,55	09	16,98	5,20	3,39	2,20	33,04	0,25
BA	68	10,0	16	23,53	16	23,53	4,73	3,13	2,20	34,87	0,30
SADIAS	256	37,9	12	4,69	11	4,30	5,84	3,75	2,33	30,88	0,14
MORTAS	54	8,0	54	100,00							
FALHAS	70	10,4	70	100,00							
TOTAL	675	100,0									

LA - Menos de 25% do círculo da touça afetado pelo fungo.
MA - 25% a 50% do círculo da touça afetado pelo fungo.
BA - Mais de 50% do círculo da touça afetado pelo fungo.
* - Touças c/menos de três brotos.

Como se pode ver os dois quadros, D e E, evidenciam bem a influência maléfica do Diaporthe cubensis na regeneração do Eucalyptus grandis.

O quadro D, análise da doença através do sintoma externo na árvore, não mostrou diferença significativa de falhas de brotação entre árvores sadias e doentes.

Quando se analisam, todavia, outros danos, há uma diferença bastante significativa entre árvores doentes e sadias. Observe-se, por exemplo, que as touças com brotação anormal e a queda de brotos aparecem nas árvores doentes com frequência em torno de 100% maior que nas árvores sadias.

O quadro E, análise da doença através do sintoma interno ne árvore, devido a maior precisão do método, evidencia mais claramente as consequências do fungo na regeneração das árvores.

Tanto as falhas de brotação como a brotação anormal das árvores doentes apresentam-se com frequência em torno de 180% maior que aquela apresentada pelas árvores sadias.

Note-se que as árvores com BA apresentam-se com 23,5% de touças não brotadas mais 23,5% de touças com brotação anormal, enquanto as árvores sadias mostram somente em torno de 4,5% para ambos os casos.

Isso implica que as árvores com esse nível mais severo da doença brotam 422% menos que as sadias e apresentam 422% a mais de brotação anormal.

Note-se que, até aos seis meses, o nº de brotos tombados por touça é também em torno de 100% maior para as árvores doentes.

Observe-se, em ambos os quadros, que o nº de brotos e gemas por touça brotada decresce, à medida que aumenta a severidade da doença. A altura média dos dois brotos dominantes das touças também diminui com os níveis maiores da doença, enquanto o coeficiente de variação dessa altura aumenta.

Pode-se afirmar, com base nos dados apresentados, que, também na brotação do Eucalyptus grandis, a influência do Diaporthe cubensis é altamente maléfica.

3.3- Melhoramento

3.3.1- Seleção de árvores superiores

Na população infestada, elegeram-se árvores superiores ao índice de seleção igual a 1:1600.

À árvore selecionada inicialmente juntaram-se cinco árvores dominantes adjacentes, para dendrometria comparativa. Posteriormente, mais cinco foram identificadas, sendo avaliado o cancro em todas as dez árvores adjacentes representativas da população.

Esses dados de cancro na população, ao redor da árvore superior, deverão ser usados para auxiliar a avaliação da progênie dessa árvore, desde que será meio-irmã da população.

As seguintes variáveis foram analisadas, subjetivamente de início, para que a árvore fosse eleita superior.

Vigor - Diâmetro e altura superiores à média das dominantes adjacentes.
Forma do fuste - Mais de 2/3 de retidão do fuste.
Ramificaçao:
Angulo dos ramos - Igual ou maior que à média das dominantes adjacentes.
Espessura dos ramos - Menor ou igual a média das dominantes adjacentes.
Persistência dos ramos - Menor ou igual à média das dominantes adjacentes.
Conicidade - Menor ou igual a média das dominantes adjacentes.
Comprimento de internódios - Maior ou igual à média das dominantes adjacentes.
Tamanho da copa:
Comprimento e largura - Menor ou igual à média das dominantes adjacentes.
Densidade - Maior ou igual à média das dominantes adjacentes.
Cancro - (Diaporthe cubensis) - ausência total.

Após eleiçao e identificação da árvore superior, procedeu-se a sua avaliação e cadastramento, segundo ficha anexa (anexo I).

O manuseio da ficha é auto-explicativo, exceção feita aos pontos atribuidos ao vigor da árvore, que é calculado segundo a superioridade relativa da árvore.

Quadro F - exemplo

Idade	6 ANOS		9 ANOS	
Variavel	DAP(cm)	H(m)	DAP(cm)	H(m)
Árvore superior	25	28	34	35
Árvores dominantes	21	26	30	33
Sup. absoluta	04	02	04	02
Sup. relativa	19,05%	7,69%	13,33	6,06

Para atribuição de pontos para DAP(diâmetro) e H(altura) da árvore superior, procedeu-se da seguinte forma:

a) Calculou-se a superioridade relativa de todas as árvores plus.

b) Calculou-se a média dessa superioridade e o seu desvio padrão.

x = Superioridade relativa média
σ = Desvio padrão
y = Superioridade relativa.

c) Distribuídas as superioridades na curva, os pontos foram atribuídos, como se segue:

Intervalo da curva	Pontos
$y < 0$	00
$\bar{x} - \sigma \geqslant y > 0$	05
$\bar{x} \geqslant y > \bar{x} - \sigma$	10
$\bar{x} + \sigma \geqslant y > \bar{x}$	15
$y > \bar{x} + \sigma$	20

Entre outras, 138 árvores selecionadas em março/78, foram avaliadas inicialmente e cadastradas e vêm sofrendo vistorias trimestrais para avaliação do cancro.

A primeira vistoria, em 7/78, mostrou algumas árvores com sintomas iniciais da doença, sem contudo apresentar nenhuma evolução significativa nos dois anos analisados.

Quadro G - Percentual (%) das árvores superiores com cancro:

Vistoria / Sintoma	7/78	10/78	1/79	5/79	11/79	1/80	6/80
LA	11,594	11.594	14,492	14,492	16,667	15,942	12,319
MA	0,724	0,724	0,724	0,724	0,724	0,724	0,724
BA	0,000	0,000	0,000	0,000	0,000	0,000	0,000

Convém ressaltar que as árvores atacadas não são sempre as mesmas, nas vistorias. Tem-se observado que as árvores mostram, numa vistoria, um sintoma inicial (LA) que, em vistorias posteriores, desaparecem. Isso vem comprovar a possível resistência da árvore à severidade da doença.

3.3.2-Propagação das Árvores Superiores

Enxertia

Todas as árvores selecionadas foram propagadas através de enxertia pelo método de garfagem ou fenda de topo.

Utilizou-se o sistema que se chamou "auto-enxertia", isto é, o porta-enxerto era produzido com sementes da árvore superior que doaria o ramo para a enxertia.

Realizou-se a enxertia no Município de Salto, em viveiro, com as mudas a altura média de 1 m, sob 50% de incidência solar direta, inicialmente, em período de verão (NOV/79).

nº de clones enxertados: 136
nº de enxertos produzidos: 4938

Quadro H - Resultados aos 90 dias após enxertia*

E.B.		E.V.		E.M.		TOTAL	
Nº	%	Nº	%	Nº	%	Nº	%
3.442	69,70	541	10,96	955	19,34	4.438	100

E.B. = Enxerto brotado
E.V. = Enxerto vivo sem brotação
E.M. = Enxerto morto
* Esses dados foram colhidos, 20 dias após os recipientes dos enxertos terem sido removidos para rustificação, antes do plantio no campo.

Bancos Clonais

Com os enxertos produzidos, instalaram-se bancos clonais nos municípios de Botucatu e Lençóis Paulista, nas seguintes condições:-

. LENÇÓIS - Faz. Piracema -
- Data : 02/79
- Nº de clones: 100
- Nº de repetições: 10
- Nº de enxertos plantados: 1000
- Delineamento: blocos ao acaso
- Espaçamento de plantio: 5,0x2,5m

. BOTUCATU - Faz. Morro do Ouro -
- Data: 03/79
- Nº de clones: 130
- Nº de repetições: variado
- Nº de enxertos plantados: 2035
- Delineamento: blocos ao acaso
- Espaçamento de plantio: 5,0 x 2,5 m

Os bancos foram instalados com os seguintes objetivos:-

. Estudos da variabilidade para incompatibilidade entre enxertos e porta-enxertos e para florescimento e frutificação.
. Reserva de material genético.
. Estudos de polinização controlada.
. Instalação de pomar de sementes de alta produtividade e resistência ao cancro*.

* Pretende-se, à medida que os testes de progênie apresentem resultados conclusivos, desbastar os bancos de forma que só permaneçam aqueles clones resistentes à doença. Os clones serão então remanejados para implatanção de pomar clonal de sementes.

Os dois bancos, após sua implantação, sofreram alguns danos consequentes de geadas. Tendo sido replantados, apresentam-se, aos 12 meses, nas seguintes condições:-

-LENÇÓIS
Enxertos vivos: 86,3%
Falhas: 13,7%
Rejeição: 4,0%
Frutificação: 9,5%
Altura: bastante variada devido plantios recentes

-BOTUCATU
Enxertos vivos: 90,4%
Falhas: 9,6%
Rejeição: 7,1%
Frutificação: 3,2%
Altura: bastante variada devido plantios recentes.

3.3.3-Avaliação da Descendência das Árvores Superiores

Para que a descendência das árvores superiores fosse avaliada, instalaram-se dois testes de progênie de meio irmãos, de todas as árvores colocadas em banco, nas seguintes condições:

Teste A

Delineamento em Láttice com 100 tratamentos e 9 repetições, sendo 97 árvores superiores e 3 testemunhas, assim caracterizadas:

	Espécie	Procedência	Origem
T_1	E.grandis	Itabira(MG)	Rodesia
T_2	E.grandis	Salto(SP)	Coff's Harbour(Austrália)
T_3	E.grandis	Salto(SP)	Coff's Harbour(Austrália)

As testemunhas T_1 e T_3 são de sementes de área comercial, sem rigor de seleção prévia.

A testemunha T_2 é de área de produção de sementes que passou por rigorosa seleção, e cuja lotação é apenas 160 árvores/ha.

Local de instalação: Horto Santa Maria, Salto, SP.
Data de instalação: Maio/79
Espaçamento de plantio: 3,0 x 1,5 m
Site*=área de latossol vermelho amarelo orto, após retirada de floresta de Eucalyptus, com 9 anos de idade, da mesma espécie e origem do teste. Solo de baixada sem preparo prévio (plantio entre linhas de tocos).
Adubação: 100 g de N-P-K 10-28-6 por árvore, distribuidos 50 g por cova, no ato do plantio e 50 g em cobertura, 30 dias após plantio.

Teste B

Delineamento e Láttice com 100 tratamentos e 6 repetições, sendo 97 árvores superiores e 3 testemunhas assim caracterizadas:

	Espécie	Procedência	Origem
T_1	E.grandis	Salto(SP)	Coff's Harbour(Austrália)
T_2	E.grandis	Salto(SP)	Coff's Harbour(Austrália)
T_3	E.grandis	Salto(SP)	Coff's Harbour(Austrália)

A testemunha T_1 é de sementes de área comercial, sem rigor de seleção prévia.

As testemunhas T_2 e T_3 são de área de produção de sementes que passaram por rigorosa seleção, e cujas lotações são, respectivamente, 160 e 200 árvores/ha.

Local de instalação: Fazenda Piracema, Lençóis Paulista, SP.
Data de instalação: Março/79.
Espaçamento de plantio: 3,0 x 1,5 m
Site = área de latossol vermelho amarelo fase arenosa cuja vegetação anterior era cerrado. Solo de elevação com uma gradagem pesada e duas leves, antes do plantio.
Adubação: 150 g de N-P-K 10-28-6 por árvore, distribuidos em sulco, 30 dias após plantio.

Analisando-se o quadro H pode-se ver que o crescimento das progênies, num ano, é magnífico. Note-se que as árvores cresceram, em média, mais de 70 cm por mês.

Deve-se atentar para o fato de oue, aos seis meses de idade, 85,6% das progênies apresentaram altura entre as classes de 4,0 m a 5,4 m enquanto a testemunha de Itabira situou-se entre 3,0 m e 3,4 m.

Destaque-se a performance excelente da testemunha número 2, sem contudo esquecer-se que se trata de semente melhorada de área de produção, da mesma procedência das árvores testadas cujas progênies são de meio irmãos.

Aos doze meses, praticamente 90% das progênies estão nas classes de altura entre 8,0m e 9,9 m, enquanto 33%, nas classes superiores a 9,0 m.

A testemunha número 2 mantém aos 12 meses seu estupendo desenvolvimento, enquanto a de número 3, também muito boa, situa-se na mesma classe da média das progênies (8,5 m a 8,9 m).

Voltando-se para o cancro pode-se notar que os seus sintomas já se manifestaram em 16,5% das progênies aos seis meses, evoluindo para 43,3% aos doze meses, distribuidos nas diversas classes de altura.

Convém ressaltar que esses sintomas não atingem a 5% das árvores dentro de cada progênie atacada e variam desde bronzeamento da copa, rachadura e anelamento do colo até morte da árvore.

Deve-se frisar mais uma vez que grande parte desses sintomas podem ser consequências da população e não da árvore superior, uma vez que, como já explicado, são progênies de meio irmãos dessa população infestada.

Deverá ser feita ainda uma análise procurando-se correlacionar os dados da doença na população ao redor de cada árvore superior, com a respectiva progênie.

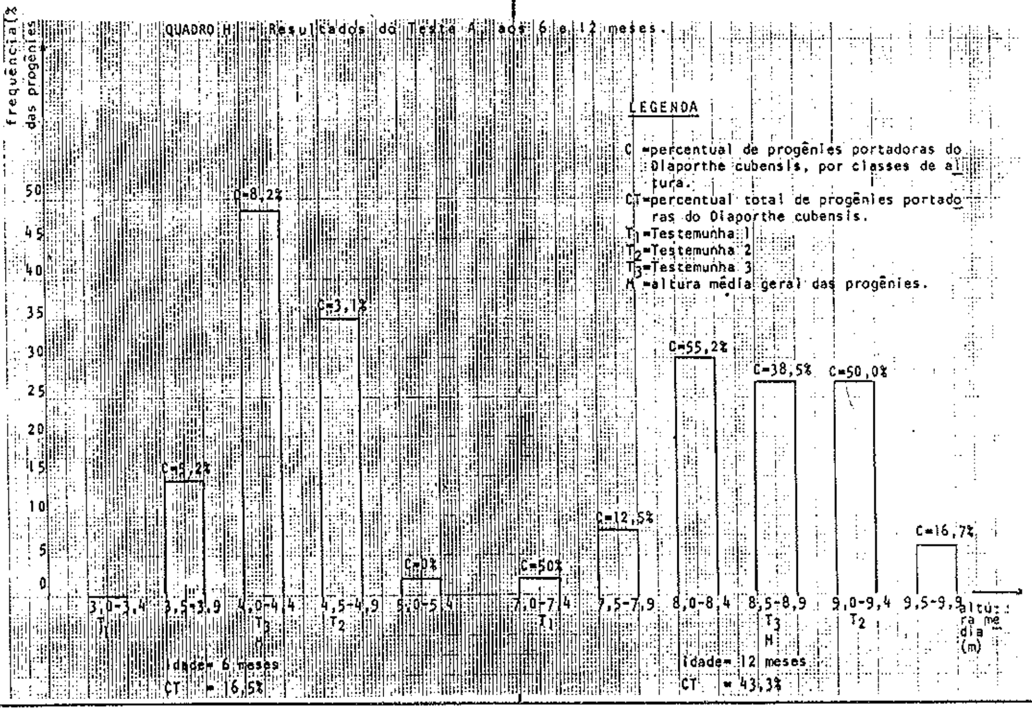
Essa e outras análises deverão ser feitas à medida que os testes evoluam e mais subsídios sejam conseguidos.

O quadro I, resultados do teste B aos 12 meses, mostra-se um pouco diferente, embora com as mesmas tendências, como se pode observar.

Note-se que a altura média das progênies desse teste está praticamente 100% inferior àquela do Teste A.

Isso explica-se devido aos seguintes fatores: Diferenças marcantes de site - Sistemas diferentes de plantio e adubação -

QUADRO H - Resultados do Teste A aos 6 e 12 meses.



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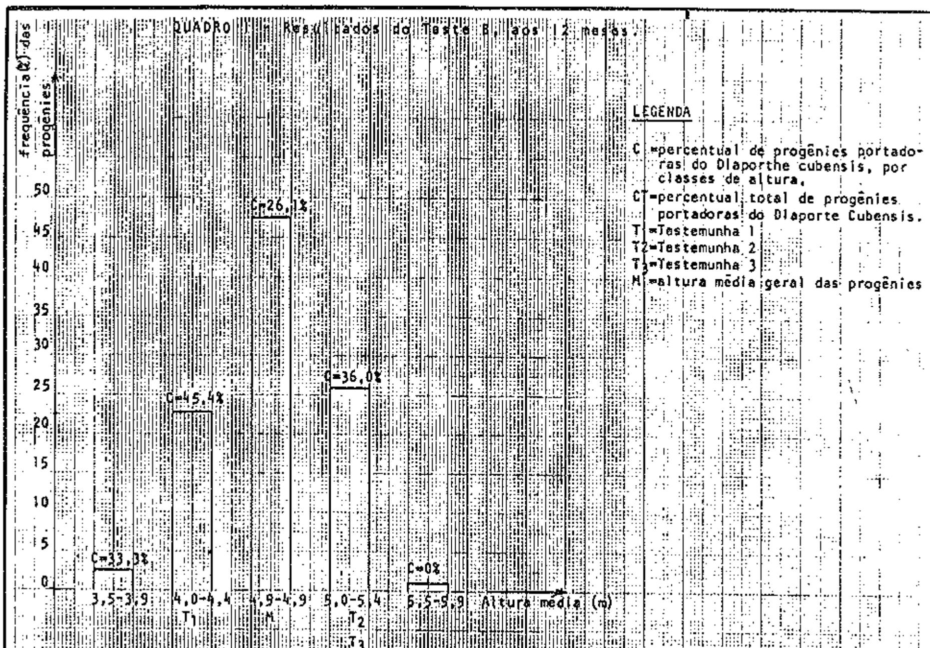
*A floresta erredicada tinha 60% de seus indivíduos severamente atacados pelo cancro.

QUADRO 1 - Resultados do Teste B, aos 12 meses.



-FICHA DE AVALIAÇÃO DE ÁRVORE SUPERIOR-

(ANEXO I)

ESPÉCIE	ÁRVORE Nº
PROCEDÊNCIA	TALHÃO
ORIGEM	FAZENDA
IDADE	MUNICÍPIO
ALTURA (m)	ESTADO
DAP(cm)	CIA
DATA	RESPONSÁVEL

CARACTERÍSTICAS ANALISADAS (PONTOS MÁXIMOS)	Pontos	
	Sub-Total	Total
1. Vigor (40 pontos) - Diâmetro(20) e Altura (20) a) Altura __________ b) Diâmetro __________		
Forma de tronco (30 pontos) a) Tronco perfeitamente reto (30) b) Tronco com tortuosidade -No terço inferior - Subtrair até 10 pontos Pequena (4) Média (7) Grande (10) -No terço médio - Subtrair até 7 pontos Pequena (3) Média (5) Grande (7) -No terço superior - Subtrair até 4 pontos Pequena (2) Média (3) Grande (4) -Tortuosidade Geral - Subtrair até 3 pontos Num só plano (0) Nos dois planos (3) c) Espiralização - Subtrair até 2 pontos Nenhum (0) Leve (2) d) Inclinação da árvore - Subtrair até 4 pontos Nenhum (0) Leve (4)		
Ramificação (13 pontos) a)Angulo dos ramos(05 pontos)-Aberto(5) Médio(2,5) Fechado(0) b)Espessura dos ramos(05 pontos)-Fino(5) Médio(2,5) Grosso (0) c)Persistência de ramos(03 pontos)-Pouca(3) Média(1,5) Intensa(0)		
4. Conicidade (05 pontos] - Pequena (5) Média (2,5) Grande (0)		
5. Comprimento do internódio (03 pontos)-Pequeno(0)Medio(1,5) Longo(3)		
6. Tamanho da Copa (04 pontos) a) Comprimento Grande(0) Médio(1) Pequeno(1,5) b) Largura Ampla (0) Média(1) Estreita(1,5) c) Densidade Densa (0) Média(0,5) Rala(1,0)		
7. Porcentagem de cancro ao redor (05 pontos) Abaixo de 30% (1) De 30-60%(3) Acima 60% (5)		
8. Frutificação - Nenhuma ( ) Fraca ( ) Média ( ) Intensa ( )		
TOTAL GERAL		

VIGOR

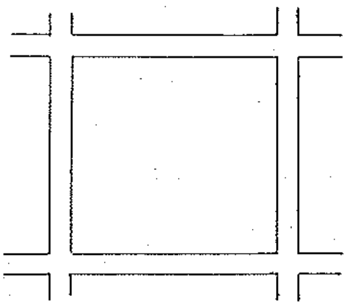
ÁRVORE	H (m)	DAP (cm)	DENSIDADE (d) g/cm³
01			
02			
03			
04			
05			
MÉDIA			
ÁRVORE SUPERIOR			

CARACTERISTICA	SUPERIORIDADE ABSOLUTA	SUPERIORIDADE RELATIVA
H		
DAP		
d		

% DE CANCRO AO REDOR DA ÁRVORE SUPERIOR

	SADIA	LA	MA	BA
ÁRVORES	(%)	(%)	(%)	(%)
01				
02				
03				
04				
05				
06				
07				
08				
09				
10				
TOTAL				

-CROQUI DE LOCALIZAÇÃO DA ÁRVORE-



O Teste B foi, logo após o plantio, severamente castigado por geadas.

Deve-se lembrar que todas as três testemunhas aqui são da mesma procedência do teste. T_2 e T_3 são de sementes melhoradas e T_1, não. (Ver dados de instalação).

O percentual de cancro para esse teste é ainda inferior àquele do Teste A. Isso era esperado devido ao maior potencial de fonte de inóculo do primeiro.

Resumindo-se as considerações, pode-se afirmar, analisando-se as classes de alturas que:-

Teste A, aos doze meses

2,1% das progênies não apresentam superioridade sobre T_1
8,2% das progênies têm 7,1% de superioridade sobre T_1
29,9% das progênies têm 14,3% de superioridade sobre T_1
26,8% das progênies têm 21,4% de superioridade sobre T_1
26,8% das progênies têm 28,6% de superioridade sobre T_1
6,2% das progênies têm 35,7% de superioridade sobre T_1
40,2% das progênies são inferiores a T_3
26,8% das progênies não apresentam superioridade sobre T_3
26,8% das progênies têm 5,9% de superioridade sobre T_3
6,2% das progênies têm 11,8% de superioridade sobre T_3

Teste B, aos doze meses

3,1% das progênies são inferiores a T_1
22,7% das progênies não apresentam superioridade sobre T_1
47,4% das progênies tem 12,5% de superioridade sobre T_1
25,8% das progênies tem 25,0% de superioridade sobre T_1
1,0% das progênies tem 37,5% de superioridade sobre T_1

Como se pode observar, existem boas perspectivas para continuidade dos trabalhos de melhoramento, pois as progênies mostram ganho considerável sobre o material comercial, já aos 12 meses de idade.

Em termos de doença, embora exista grande variação entre e dentro das progênies testadas, é cedo ainda para se afirmar qualquer coisa devendo-se dar continuidade às análises.

Todas as testemunhas apresentam sintomas de cancro aos doze meses.

4 - Consideração Final

Como se observou, o presente trabalho procurou mostrar como vem se desenvolvendo, dentro do grupo, o programa de melhoramento específico de Eucalyptus grandis procedente de Coff's Harbour.

Mostrou-se que, embora com alta produtividade para as nossas condições, a espécie é bastante prejudicada pelo Diaporthe cubensis.

Os danos são bastante significativos tanto para a primeira como segunda rotação.

Como base nisso, além de se procurar em forma de manejo que possibilite uma redução na disseminação e severidade da doença, na população já implantada, deu-se início ao trabalho de melhoramento aqui descrito e parcialmente analisado.

As árvores superiores selecionadas no meio da população infestada, não mostraram, em dois anos de acompanhamento, evolução na doença. Isso nos leva a crer que a sua possível resistência não é devida ao acaso.

Os bancos clonais instalados, embora sofridos de geadas, mostram bom desenvolvimento apresentado já um pouco de florescimento e frutificação.

Os testes de progênie, aos 12 meses também, apresentam excelente crescimento com muito boas perspectivas para continuidade do programa visando à produtividade.

Em relação à doença, não se pode, ainda, concluir através das progênies.

Acreditamos que com a evolução dos testes e aprimoramento das análises em andamento os objetivos serão alcançados.

Em síntese, esses trabalhos até aqui conduzidos nos mostraram que:-

a) Deve-se direcionar o manejo da floresta implantada, de forma a minimizar a disseminação e severidade da doença nas populações. Uma das alternativas seria cortar a floresta em idade mais jovem possível, antes que a doença atinja níveis elevados como aqueles aqui levantados.

b) As florestas a serem ainda implantadas com E.grandis, deverão nascer de sementes melhoradas da população base do presente trabalho, uma vez que os testes de meio irmãos já mostram ganhos significativos de produtividade sobre as populações comerciais.

c) Embora as progênies estejam ainda indefinidas quanto à possível resistência à doença, a análise das árvores matrizes tem-se mostrado otimista, desde que, embora tenha havido grande evolução do mal na população, essas árvores permanecem num nível constante e baixo.

POMARES DE SEMENTES CLONAIS DE *EUCALYPTUS GRANDIS* NA ÁFRICA DO SUL.

G. Van Wyk
. Forest Research Station
L.M. Hodgson
. Republic of South Africa.

Resumo

A extensa ârea plantada com *E. grandis* na Repûblica Sul Africana foi o maior incentivo para se iniciar o programa de melhoramento. Ârvores "plus" com alta produção volumêtrica, forma desejâvel da copa e do tronco, e ausência de rachamento basal das toras apôs a derrubada, foram incorporadas em pomares de sementes clonais. Esses pomares clonais foram submetidos a vârias têcnicas de manejo que tiveram influência significativa no rendimento de sementes. Um simples ramete pode render 2,9 kg de sementes na idade de 8 anos.

Os resultados de alguns testes de progênie indicam que pode haver ganho genêtico considerâvel nas descendências do pomar para a redução do rachamento na base das toras, acrêscimo da produção volumêtrica e melhoria da forma do tronco. Algumas idêias são tambêm apresentadas para orientar como utilizar a informação genêtica dos testes de progênie no delineamento de pomares de sementes.

CONAL SEED ORCHARDS OF *EUCALYPTUS GRANDIS* IN SOUTH AFRICA.

Summary

The large area of land planted to E.grandis in the Republic of South Africa was a great incentive for starting a breeding programme. Plus trees with high volume production, desirable stem and crown form and lack of log-end splitting upon felling were incorporated in clonal seed orchards. These orchards were subject to various management techniques that had a significant influence on seed yield. Figures are presented on actual and potential seed yield. A single ramet may yield as much as 2,9 kg seed at the age of eight years.

Results from some progeny tests indicate that there can be considerable genetic gain in seed orchard offspring in reduction of splitting, increasing volume production and improving stem form. Some ideas are also presented on how to utilise genetic information from progeny tests in seed orchard design.

INTRODUCTION

Eucalyptus grandis is the most important hardwood species planted in the Republic of South Africa and by 1977 294 000 hectares were planted to this species. It is predicted that by the end of the century some 20% of the total demand will be used for sawtimber, lamination, construction, flooring and furniture (Anon. 1971), the remainder being required for pulpwood and mining timber.

The initial breeding programme was undertaken with sawtimber production in mind, for which purpose valid assessments of timber qualities could not be made before the age of 8 to 10 years. This breeding programme was later adapted to include breeding for short rotation pulpwood and mining timber crops, using seedling seed orchards. In this case screening is feasible at an early age and on a large number of families.

For both of the above purposes selected trees are assessed for volume production, stem straightness, desirable crown characteristics and freedom from log-end splitting upon clearfelling and cross cutting. Generally the latter does not occur in young trees. Hence, on the assumption that this phenomenon may be genetically controlled, parent trees were selected in even-aged stands, 18 years of age and older, managed for sawtimber production. Initial assessment of end-splitting is done in the field 72 hours after felling. The bottom log and second log from each tree were initially railed to the South African Forestry Research Institute for a complete yield study. The latter practice was later abandoned because a sufficiently high correlation was found between the field assessment and the yield of graded timber. Yield studies are also very costly and time consuming causing a bottle-neck in the rate of plus tree acceptance.

Initially, selection intensity was very high, with only one tree in 40 to 50 ha being accepted. This paid off because only very high quality parents were included in the first seed orchards. Now a dual purpose selection programme with somewhat lowered selection intensities yields more and more younger plus trees. However, sawtimber seed orchard standards do not necessarily drop because short rotation selections virtually go through one phase of screening on volume production and stem form before being included in the sawtimber programme.

THE OPERATIONAL SEED ORCHARD

a. Planning and establishment

Vegetative propagation:

Although success with rooting of cuttings has been achieved in Brazil and the Congo, the attempts with E.grandis cuttings in South Africa were not very promising. Even though some strikes were obtained with cuttings from coppice shoots, lack of facilities and other practical considerations made it necessary to look at various grafting techniques.

After trial of several grafting techniques (Van Wyk, 1977) the procedure finally adopted was a method similar to the rind graft described by Garner (1968). By this method an initial "take" of more than 90% can be obtained, but thereafter incompatibility may set in and this is liable to reduce success to as low as 50% with some clones.

Stock plants should be raised specifically for grafting. In an investigation on scion-rootstock relationships Van Wyk and Hodgson (1972) found that it is highly advantageous to use seed (for growing rootstocks) from the same ortet from which scions are to be taken for grafting. There was even some indication that selfed rootstocks may give better results with related scions, but this was not investigated in depth.

Raising rootstocks needs a fair amount of planning because seed from selected ortets must be harvested well in advance of the grafting season. In South Africa, grafting is usually done when the rootstocks are 10 months old. Grafting is done through the year but best results are obtained in spring. This work is done mainly in Northern Transvaal where temperatures range from 15 °C to 25 °C. Large deviations from these will probably dictate more exact grafting seasons.

Rootstocks are normally grown in plastic containers with 4,5 to 6,5 litre capacity. After grafting, the plants are usually kept in partial shade in the nursery for several weeks before planting. The large containers require large amounts of nursery soil, causing increased expenses. Hence, a preliminary test, in which 129 grafts were done at two sites, was planned to investigate in situ grafting. There was no nursery control, but the 88% success obtained after three months was comparable with nursery grafting, indicating that in situ grafting could be used in future (Hodgson, 1977b).

Seed orchard site;

E.grandis is a heavy seed producer and it seems a simple matter to select a site suitable for seed production. However, comparison of seed yields of clones grafted at two sites showed that the drier and warmer low altitude site produced better seed crops.

Little is known about the extent of isolation required to guard against contamination from unwanted pollen of the same species. The first seed orchard in South Africa was established in pine stands to obtain proper isolation. However, topographically this site was undesirable for further expansion. Seed from this orchard was used to raise trees for planting a "screen" 90 m wide to separate a second seed orchard from an existing plantation. This may not be as effective as one would wish, but considering the localised foraging behaviour of the honey bee (Free, 1970) which has been shown to be an active pollen vector, considerable protection should be obtained from such a screen.

Beehives have been introduced into the orchard, although it is not known how many of these should be kept per unit area. Presumably the ideal would be to arrange that the bees in the hives need not go elsewhere for eucalypt nectar and pollen, but this still leaves the question of bees entering the area from outside. In fruit orchards 2 1/2 bee colonies per hectare are considered to be enough for sufficient fruit (Free, 1970). Since older eucalypt trees flower profusely, possibly three colonies per hectare will be more efficient. Bees from different colonies in competition "wander" more often than bees in single colonies which normally forage constantly on small areas. This "wanderlust", however, would be beneficial for the promotion of cross-pollination, because non-competing bees may tend to work too much on a single ramet. The question of the use of pollen traps in the hives to promote cross pollination has not been investigated. Obviously there is much scope for investigation in these matters.

As regards inter-specific pollination, the best guide available for deciding whether neighbouring plantations could be a source of contamination is the relationship between the species concerned. To consider this, reference should be made to the grouping of species within the genus into eight subgenera, which are regarded as corresponding to fertility groups, these being largely or completely reproductively isolated from one another (Pryor and Johnson, 1971).

Espacement and design

An espacement of 8,2 x 8,2 m (27' x 27') was adopted for seed orchards.

This espacement facilitates mechanical maintenance of grass swards in the orchards but may be too wide for efficient cross-pollination. Grouping of clones based on the breeding value of parents is at present being considered.

b. Management and harvesting

Originally the branches of ramets were tied down or weighted down in an effort to keep seed-producing capsules within reach. Trees were also pollarded to encourage growth of side branches. Although this practice was effective, it proved to be very expensive and resulted in a great loss of seed. With this practice tree crowns did expand fast in diameter and it was found that an 8,2 m x 8,2 m espacement was too close for ramets of five to six years of age.

The strong apical growth of E.grandis required investigation into some means of crown control. Four treatments were applied by Hodgson (1977a), one of these being to allow growth to continue for six seasons after grafting, followed by felling when trees were about 15 m high. The intention was that after felling, coppice shoots should be allowed to grow with a view to rotational felling thereafter. The other three treatments involved pollarding at various heights and treating the resulting coppice by either tying them down so that seed collection could be done from ground level, or cutting them back at the most appropriate stage.

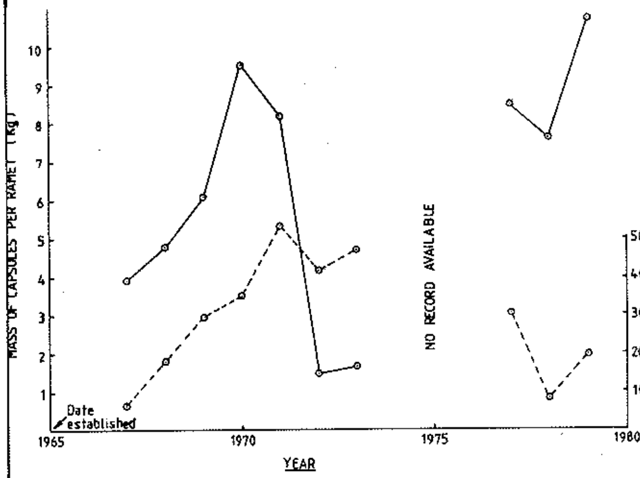


Fig 1 : Mass of green capsules produced per ramet (o——o) and number of ramets (o---o) harvested annually in Seed Orchard NO 1.

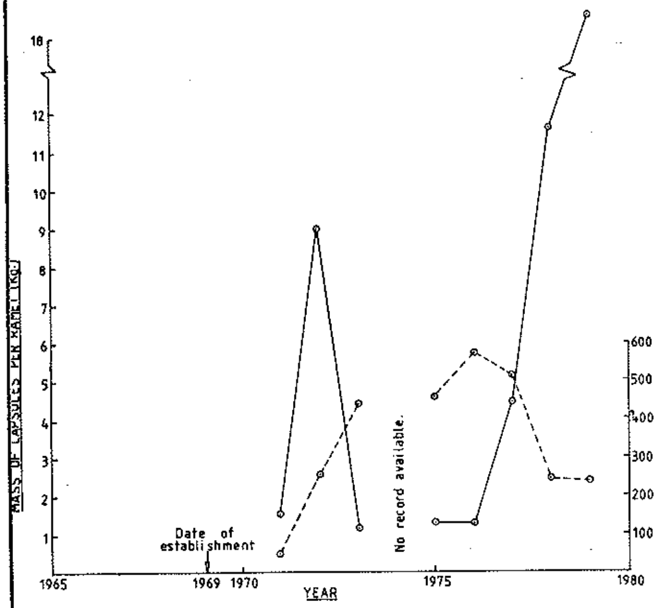


Fig 2 : Mass of green capsules produced per ramet (o——o) and number of ramets (o---o) harvested annually in Seed Orchard NO 2.

The treatment in which ramets were allowed to grow freely for a number of seasons and capsules were then harvested by felling the tree proved to be very efficient in labour requirements and yielded by far the best seed production. Because only part of the orchard is harvested every three or four years it was thought that much more land would be required. However, the seed yield is increased to such an extent that a much smaller area can be harvested to give the required seed crop.

A feature which makes this treatment feasible is that E.grandis capsules remain unopened for long periods, as long as the branch remains alive. Considering all this, it was found that a rotation of four years should be adopted. Some lower branches may die off in this period, but these can usually be reached with pruning shears on long poles to harvest capsules on such branches.

c. Seed yield

It was found that the time required for capsules and seed to ripen varies with sites (Hodgson, 1975). At the wetter, cooler site the optimum ripening time seems to be between five and seven months after anthesis compared to four to six months at the warmer site.

Grafted trees usually flower within two years after grafting if scions are taken from trees that have flowered before, but scions taken from young coppice shoots will not typically flower one to two years after grafting.

In South Africa, the first seed orchard was established in 1965. Although 8 ha was set aside, the area was almost never fully stocked because of slow rate of establishment, incompatability problems and reconstitution of clonal composition. Therefore, to calculate potential seed production per unit area average figures per ramet should be translated to an area basis (148 ramets = 1 ha). The first seed orchard now contains 1 184 ramets from 74 clones and the second orchard, established in 1969, 1 313 ramets from 78 clones.

Seed production of E.grandis is very good, especially if tree crowns can develop relatively freely. The green mass of capsules produced per ramet and the number of ramets harvested annually are shown in Fig. 1 and 2. From the graphs it is clear that from 1977 seed production increased even though the number of ramets dropped because of the new management technique.

A closer look at the graphs reveals some of the management effects. At first glance it seems as if seed orchard no. 1 is a better producer than no. 2. However, our opinion is that the higher production is due to the fact that tree crowns were allowed to develop more freely in no. 1 than in no. 2. This was not done on purpose, but since seed orchard no. 1 was 11 km away and no. 2 was at the research station, tying, pruning and cutting was done much more regularly in the latter orchard.

The treatments had a significant influence on crown development. This is well illustrated by the graph of seed orchard no. 2. For the first three years the trees were almost free growing because they were still small and harvesting could be done easily. In 1972, harvesting was done by felling the trees. Thereafter the tree crowns were controlled by topping and bending of branches. In 1976 it was decided to divide the seed orchard into three blocks and to harvest by felling the fully-established grafted trees on a rotation of three years. Ramets in the blocks were then allowed to coppice and grow freely. The first block was felled in 1977. Naturally the 1978 and 1979 production was high because crowns had more time to grow. Unfortunately we are not yet back to the first block to get an idea of the constant yield on a three year rotation. The highest recorded yield of capsules for a single ramet was 40 kg at the age of eight years. In 1979, 14 ramets of this clone, G 15, produced an average of 18,15 kg capsules per ramet at nine years.

A considerable amount of chaff and small seed is also produced. The average ratio of green mass of capsules to mass of seed and chaff over seven years at seed orchard no. 2 was 13,7 : 1. Seed can be cleaned relatively well by sieving. Hodgson (1976) has shown that the mass of seed and chaff can be reduced by more than 50% by using a 0,5 mm sieve, while 84% of the viable seed mass will be retained. It was also shown that the 16% of seed discarded will be low in germination rate and will give seedlings with poor survival and initial height growth.

GENETIC IMPROVEMENT

Unfortunately no large progeny tests were planted at the time of seed orchard establishment and only two small trials, one with five full-sib families and the other with nine open-pollinated families were available for assessing log-end splitting by Malan (1979). He demonstrated significant family variation with heritability in the order of 0,20. At the very high selection intensity of only one tree in 40 ha at the beginning of the programme this means a predicted gain of up to 30% in reduction of splitting from seed orchard offspring alone.

A larger partial diallel trial was assessed recently at three years of age. Large family variation for volume production and stem form was found, with heritability estimates of 0,16 and 0,45, respectively. This gives a predicted gain of 26% and 62%, respectively, at a selection intensity of 3,75. The overall mean volume of the trial was 39% better than a commercial control and stem form was 16% better.

A very significant feature in this trial was that much non-additive variance was found for volume production but not for stem form. This is in agreement with what Van Wyk (1975) has found testing many of the same parents in Florida, U.S.A. Outstanding specific combinations were identified for volume production, stem form and crown form. This information should be utilised in further breeding work.

FUTURE PLANS

Taking cognizance of outstanding combinations the seed orchard layout can be altered to increase the frequency of offspring from these good combinations. Ideally, maximum gains can be achieved by establishing two-clone orchards. However, until the effect of inbreeding is better known, multiclonal seed orchards are still preferred.

The effect of selfing on seed set was demonstrated by Hodgson (1976b), who showed that the relative seed yield from selfed flowers could vary from 2% to 47% of that of cross-pollinated flowers. As mentioned before, the foraging behaviour of the honey bee appears to promote self-pollination, although self-fertilisation does not ensue to the extent that might be expected from observation of the foraging habits of bees. This is because the bee visits are concentrated during the first two days after anthesis, at which time self-pollination rarely results in self-fertilisation. Since Hodgson showed that most E.grandis parents are self-fertile, wide espacement of single ramets in the seed orchard is not desirable.

In South Africa, the results from the progeny test were studied carefully and the information was used to group clones in clusters of three to four ramets from different clones. These clusters are planted in a square pattern, but are further apart than the usual 8,2 m distance. A cluster distance of 14 m was adopted to exploit the localised foraging behaviour of the honey bee. Ramets are planted at 2,5 m espacement within clusters and most clusters consist of three ramets, each from a different clone. This layout will not necessarily mean more land requirement than the traditional espacement. The total crown width of each cluster should be increased in about the same proportion as the "loss" in density of clusters.

An alternative would be to plant broken biclonal "hedges" of say 20 m length and maybe 15 m between hedges. Hodgson (1975) has shown that selective fertilisation occurs in favour of cross pollen when self and cross pollens are used in mixture. If such clones with preferential fertilisation could be identified readily, this phenomenon could be utilised efficiently in planning bi-clonal hedge rows. Knowledge of synchronisation of flowering periods of the two relevant clones will aid in selecting pairs of clones with outstanding combining ability for planting within each hedge.

Asexual propagation of outstanding individuals is another aspect that should be considered. Utilisation of the high degree of non-additive variance is indeed challenging for E.grandis. Propagation of outstanding individuals from outstanding full-sib families in a combined sexual and asexual programme would mean a significant step towards maximum gain.

Appendix Table 1: Physiographical features of two E.grandis seed orchards

Seed orchard number	Lat.	Long.	Alt. (m)	Mean annual rainfall	Area (ha)
1	23°49'S	30°01'E	760	1730	8,0
2	23°47'S	30°06'E	1300	930	8,8

Appendix Table 2: Annual capsule yield * from two E.grandis seed orchards

Year	S.O. no. 1		S.O. no. 2	
	No. of ramets harvested	Mass of capsules (kg)	No. of ramets harvested	Mass of capsules (kg)
1967	66	258	-	-
1968	180	858	-	-
1969	293	1773	-	-
1970	349	3309	-	-
1971	527	4292	51	81
1972	412	601	253	2266
1973	467	759	434	504
1974	-	-	-	-
1975	-	-	459	577
1976	-	-	578	683
1977	300	2535	517	2282
1978	83	627	243	2837
1979	194	2073	232.	4300

* Ratio green capsule mass : seed and chaff mass is 13,7 : 1

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EFEITOS DA ENDOGAMIA EM FAMÍLIAS DE *E. grandis* COM DIFERENTES GRAUS DE PARENTESCO.

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Resumo

As análises introdutorias referem-se aos efeitos detrimentais da autofecundação em *E. grandis*. Como se comportam os outros tipos de endogamia, tais como o acasalamento de meios irmãos ou irmãos germanos, quando comparados com o material de polinização cruzada? São apresentados os resultados de dois ensaios comparando o crescimento de famílias, oriundas de autofecundação, meios irmãos, irmãos germanos, mistura de pólen, polinização livre e testemunha. Embora as árvores sejam muito jovens e o tamanho das amostras muito pequeno, é evidente que a autofecundação e o acasalamento de irmãos germanos não são desejáveis. A diferença entre acasalamento de meios irmãos e as famílias supostamente de polinização livre é evidente, sugerindo que um estudo mais profundo deve ser efetuado para se avaliar essas comparações.

INBREEDING EFFECTS ON *E. grandis* FAMILIES WITH DIFFERENT DEGREES OF RELATEDNESS.

Summary

Introductory remarks refer to the detrimental effects of selfing in E.grandis. How do other types of inbreeding such as the mating of half-sibs or full-sibs compare with out-crossed material? Results from two trials are presented comparing growth performance of selfed, half-sib, full-sib, polymix, open-pollinated and control families with each other. Even though the trees are still young and sample sizes may be too small, it is evident that selfing and full-sib mating are not desirable. The difference between half-sib mating and supposedly out-crossed families is less evident, suggesting that more in-depth study may be required for these comparisons.

INTRODUCTION : SELFING

Inbreeding depression is the phenomenon whereby the mean level of characters closely connected to fitness in animals or naturally out-breeding plants is reduced and consequently leads to loss of general vigour and fertility (Falconer, 1960). Self-fertilisation is the most severe form of inbreeding. Any literature review on the subject includes statements with regard to the detrimental effects of selfing in naturally out-crossing plants (Hodgson, 1975).

In comparing self-pollinated families with mix-pollinated or open-pollinated families Hodgson (1976a) invariably found that self-fertilisation and self-pollination treatments adversely affect most characteristics, e.g. seed yield, growth performance and stem form in Eucalyptus grandis. The reduction in seed yield following self-pollination, compared with cross-pollination, varied from 53% to 98% for 11 clones tested. Hodgson (1976b) used this as a quick indication of the "self-ability" of a clone. He identified 15 different types of abnormality and pointed out that selfing led to a depression in height growth of 8% to 49%, compared with open-pollinated offspring. From this and other observations Hodgson concluded that the product from a seed orchard is subject to a certain degree of degrade as a result of the amount of selfing taking place which has been estimated as commonly amounting to some 30%.

OTHER DEGREES OF INBREEDING

While it is evident that selfing should be avoided in naturally out-crossing plants, the question arises "What about crossing other types of relatives?". Repeated crossing among individuals in a small population will inevitably lead to inbreeding. The inbreeding coefficient after one generation is 0,500; 0,250 and 0,125 for selfing, full-sib and half-sib mating respectively (Falconer, 1960). How well are these values reflected in practice?

Often one is tempted to include half-sibs in an advanced generation seed orchard because outstanding families in progeny tests frequently have one parent in common. Such half-sibs are then normally spaced far apart in the seed orchard, but how serious an effect will it have if they do cross? In an attempt to investigate these questions the following two trials were laid out.

MATERIALS AND METHODS

In the first trial, controlled crosses were made on F_1 trees to obtain four selfed (S) families, five half-sib (HS) families and seven families from mixture pollinations. Pollen mixtures (M) contained pollen from five parents not related to any of the female parents.

In 1977 the trial was planted in five-tree row plots with three to five replications because not enough plants were available to plant five replications for all families. Height growth, stem form and diameter at breast height were assessed at two years and three years of age.

The second trial includes two selfed, four full-sib (FS) and eight half-sib families from crosses among F_1 parents. The nine open-pollinated (OP) and nine mixture-pollinated families in the trial resulted from back-crosses to the parent population, P_o. Also, included were two seed orchard (SO) families, one open-pollinated commercial control (CC) and one controlled-pollinated (CC) family, all from P_o parents.

Ten-tree row plots in a 6 x 6 lattice design with four replications were planted for the latter trial in 1979. Height growth was measured at the age of one year.

All data were analysed using the general linear models procedure from the Statistical Analysis System (Helwig et al., 1979)

RESULTS

It is clear that the number of comparison combinations increases rapidly with an increase in the number of parents involved. The families included in the two trials are only a sample of all possible combinations, but the objective was to determine whether a definite segregation of different degrees of relatives could be found.

The results from trial one (Table 1) indicate that generally half-sib and polymix families are significantly less depressed in growth than self-pollinated families. However, there is no clear-cut difference between the group of half-sib families and the group of polymix families. In fact, at both ages the mean volume of the group of half-sib families was higher than the mean of the group of polymix families, though not significantly so (the mean of half-sibs at three years was 0,0457 m³ as against a mean of polymix families of 0,0420 m³).

Comparison of subsamples of families also reveals interesting results:

(17 x 15) x (17 x 19)
(17 x 19) x M
(17 x 15) x M
(15 x 17) x (15 x 19)

(19 x 17) x (19 x 6)
(19 x 6) x M
(19 x 17) x M

In these two comparisons of family mean volume at three years the inbred families (half-sib) do not seem to be inferior to out-crossed families. The lines depict no significant difference at the 5% level of significance.

Family mean heights of trial two at one year are shown in Fig. 1. Analysis of variance showed significant replication by family interaction for a randomised complete block analysis. Therefore least square analysis for

Table 1. Volume and stem form of selfed, half-sib and polymix families at two years and three years of age. Significance of difference indicated by Duncan's NMRT at the 5% level.

Family	Type[1/]	Volume at		Stem form at	
		2 years ($m^3 \times 10^{-4}$)	3 years ($m^3 \times 10^{-4}$)	2 years	3 years
(17x15)x(17x19)	HS	201,1 a[2/]	537,2 a	4,00 ab	4,20 ab
(17x19)xM	M	179,8 ab	502,9 ab	4,35 a	4,13 abc
(15x17)x(19x17)	HS	164,4 abc	459,0 abc	3,88 a	3,56 bcd
(19x17)x(19x 6)	HS	162,5 abc	458,3 abc	4,16 a	3,56 bcd
(17x15)xM	M	157,1 bc	452,7 abc	3,85 ab	4,17 abc
(15x17)xM	M	152,8 bc	432,0 abc	4,00 a	3,92 abcd
(17x19)x(6x19)	HS	147,3 bc	374,1 cd	3,38 b	3,36 de
(19x 6)xM	M	144,8 bc	444,6 abc	3,96 ab	4,20 ab
(15x17)x(15x19)	HS	141,9 bc	455,8 abc	4,32 a	4,28 a
(19x17)xM	M	141,6 bc	399,5 bcd	3,88 ab	3,56 bcd
(15x19)xM	M	140,0 bc	412,4 abcd	4,05 ab	3,35 de
(6x19)xM	M	111,3 cd	296,6 cde	3,30 b	3,10 de
(19x17)xS	S	83,2 de	151,0 e	3,31 b	2,64 e
(15x17)xS	S	80,1 de	194,4 e	3,48 b	3,43 cde
(19x 6)xS	S	68,2 de	245,7 de	4,00 ab	3,44 bcde
(15x19)xS	S	38,7 e	128,1 e	3,44 b	2,44 e

1/ Refer to text for identification code of inbred type.
2/ Values connected with the same letter are not significantly different from each other.

Table 2. Least squares means for family heights of various types of related families and summary of mean height by type group

Family		Type 1/	LS Mean Height (m)
Code	Cross		
25	(58 x 17) x M	M	5,030
12	(58 x 17) x OP	OP	4,968
10	(17 x 15) x OP	OP	4,913
7	(6 x 17) x OP	OP	4,809
36	101 x 37	GC	4,795
31	(58 x 19) x (58 x 17)	HS	4,762
21	(10 x 15) x M	M	4,592
8	(10 x 17) x (10 x 15)	HS	4,579
34	S.N. 29153	SO	4,503
24	(19 x 6) x (19 x 17)	HS	4,462
28	(47 x 17) x M	M	4,455
13	(10 x 17) x M	M	4,393
27	(19 x 6) x OP	OP	4,381
23	(10 x 17) x OP	OP	4,317
5	(47 x 17) x (47 x 19)	HS	4,284
20	(19 x 6) x M	M	4,121
18	(58 x 17) x (47 x 17)	HS	4,099
16	(58 x 17) x OP	OP	4,057
19	(6 x 17) x M	M	4,042
32	(10 x 17)$_1$ x (10 x 17)$_2$	FS	4,028
17	(17 x 15) x M	M	3,995
35	S.N. 29197	SO	3,984
14	(35 x 17) x (35 x 19)	HS	3,983
30	(47 x 17) x OP	OP	3,952
4	(10 x 15) x OP	OP	3,844
11	(58 x 19) x M	M	3,822
33	S.N. 29154	CC	3,799
15	(15 x 19) x (15 x 17)	HS	3,796
9	(35 x 17) x M	M	3,787
22	(35 x 17) x OP	OP	3,718
26	(58 x 19)$_1$ x (58 x 19)$_2$	FS	3,570
2	(47 x 17) x (47 x 17)	S	3,552
6	(17 x 15)$_1$ x (17 x 15)$_2$	FS	3,426
29	(35 x 17)$_1$ x (35 x 17)$_2$	FS	3,315
3	(17 x 19) x (17 x 15)	HS	2,698
1	(10 x 15) x (10 x 15)	S	2,561
		M	4,25
		GC	4,80
		SO	4,24
		CC	3,80
		OP	4,33
		HS	4,08
		FS	3,58
		S	3,06

1/ Refer to text for identification code of inbred types.

the lattice design was performed to obtain least squares means for comparison (Table 2).

DISCUSSION

The objective of the trials was mainly to see if the different degrees of inbreeding, especially full-sib and half-sib mating, and selfing are so serious that these groups will segregate clearly from outbred offspring. Here it is admitted that the sample of families in each group is probably too small to obtain a distinct result. However, the polymix families are completely outbred (barring possible remote co-ancestry from previous generations) and open-pollinated families should have a relatively low degree of inbreeding, presumably with $F < 0,05$. Hence, one would expect more distinct segregation between the groups.

Both trials confirm that selfing is very detrimental to growth performance. Also, except for one family in trial two it seems that full-sib mating is not desirable. Even though the second trial is still very young, one would expect the polymix families to be far superior to half-sib families, with the open-pollinated families intermediate. Therefore the performance of the half-sib families as a group is rather surprising. Except for one very poor half-sib family in the second trial, the results tend to indicate that half-sib mating is not worse than other supposedly outbred matings. However, at this stage one could not risk recommending that half-sibs should be allowed to be established in the seed orchard, especially bearing in mind the possibility of co-ancestry among the trees selected. The trees may still be too young for inbreeding effects to set in because Hodgson found that even selfed families compete well during

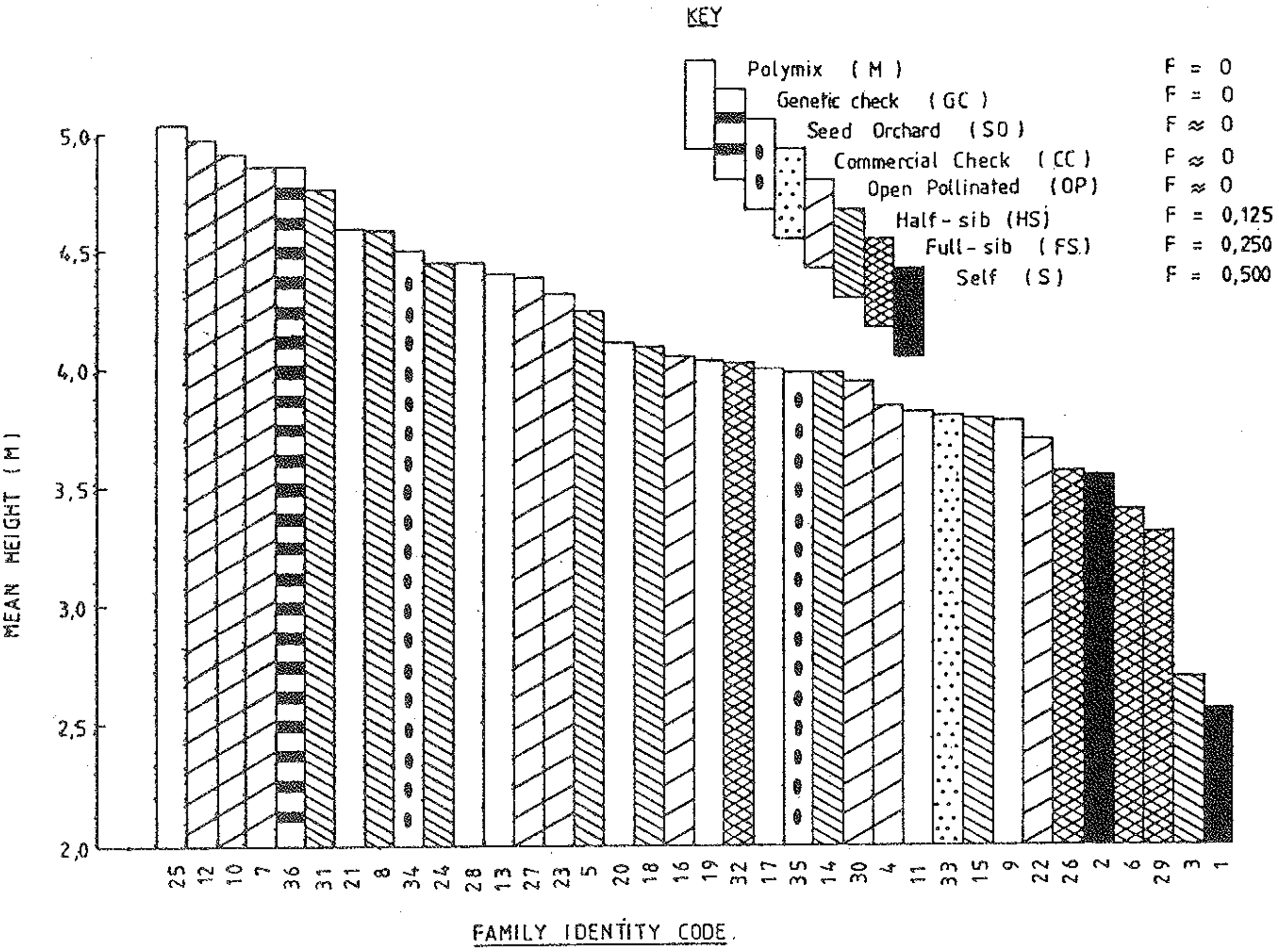

Fig. 1 : Mean height of families with different degrees of inbreeding.

the first growth season before they start lagging behind out-crossed families (personal communication). However, this was correlated with number of seeds per capsule.

Comparison of pairs of OP and M families (Table 2) in most cases indicates that the latter families are superior to the open-pollinated families. This is in agreement with the results of Hodgson (1975) who concluded that the degrade is due to the amount of natural selfing occurring after open-pollination.

The poorer performance of the two seed orchard families may be due to the fact that they belong to the parent population (P_o) while the other open-pollinated and polymix families are F_1 offspring back-crossed to P_o). The results from these trials should be scrutinised in greater depth, taking cognisance of the performance of the F_1 parents, possible specific combination effects and other factors that may play a role. Therefore, even though results indicate that some degree of half-sibbing could be tolerated, further trials are required before making more definite conclusions. At this stage it can be stated that self-pollination and the mating of full-sibs are undesirable.

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RESULTADOS DE MELHORAMENTO DE DOIS TESTES DE PROGÊNIE DE *Eucalytus grandis* NA IDADE JUVENIL.

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Resumo

Neste trabalho são descritos resultados do teste de progênie de *E. grandis* aos 2 e 3 anos de idade. O primeiro ensaio, um dialélico parcial, foi implantado para avaliar o comportamento dos progenitores durante rotação longa para produção de madeira para serraria. O objetivo do outro ensaio, um pomar de semente por mudas plantado como uma repetição do teste de famílias de polinização aberta, ê avaliar o comportamento das famílias de rotação curta, tendo como objetivo a produção de madeira para mineração e polpa.

Através do teste dialélico ficou claro que existe variância aditiva e não aditiva e sua grandeza ê significativa em populações de *E. grandis*.

Ganhos de 26% e 62% na produção volumétrica e na forma de tronco, respectivamente, poderiam ser obtidos através de sementes de pomares.

Utilizando-se a variância não aditiva os ganhos em volume poderiam ser da ordem de 51% em uma única geração.

Igualmente variações significativas ao nível de famílias foram obtidas em pomares de sementes por mudas. A seleção das melhores famílias e das melhores árvores dentro das melhores famílias, poderia originar ganhos de mais de 30% tanto para forma do tronco como para produção volumétrica.

BREEDING RESULTS FROM TWO YOUNG *Eucalyptus grandis* PROGENY TESTS.

Summary

Results from two, three-years old Eucalyptus grandis progeny tests are described. The first trial, a partial diallel, was established for evaluating parental performance over a long rotation such as sawtimber production. The objective of the other trial, a seedling seed orchard planted as a replicated open-pollinated family trial, is to assess family performance over the short term in view of growing short rotation products like mining timber and pulpwood.

From the diallel trial it is clear that large amounts of additive as well as non-additive variance is present in the E. grandis population. Gains of 26% and 62% in volume production and stem form respectively, should be obtained from seed orchard seed. Utilising non-additive variance, gain in volume could be increased to 51% in one generation of breeding work.

Equally large amounts of family variation were obtained from the seedling seed orchard. Purposeful selection of the best families and the best trees within the best families should give gains of more than 30% for both stem form and volume production.

INTRODUCTION

The Eucalyptus grandis tree improvement programme in South Africa was initiated with the production of sawtimber in mind. Therefore much emphasis was placed in the selection programme on volume production, stem straightness and branch size, but especially on lack of log-end splitting after felling and cross-cutting of a tree. The latter was included on the assumption that splitting may be under genetic control. Recently, the first indications were obtained that this may indeed be so (Malan, 1979).

The sawtimber breeding programme involves the traditional selection of plus trees, the establishment of grafted seed orchards and the planting of progeny tests to be assessed over a period of 10 to 15 years. Sawtimber rotation is 22 to 26 years.

In 1971, it was predicted (Anon.) that sawtimber will account for only 20 % of the total hardwood timber demand, and it was decided that a breeding programme for short rotation products (pulpwood and mining timbers) should be started. For this a series of seedling seed orchards, to be assessed over short term, was established. They are planned as progeny tests and converted to seed orchards at the age of three years.

In this paper results are given for a partial diallel trial (sawtimber breeding) and a seedling seed orchard (short rotation breeding) at three years of age.

MATERIALS AND METHODS

The diallel trial includes one open-pollinated commercial control family plus 71 full-sib crosses (Fig. 1) made among 20 selected parents.

MALE

FEMALE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	P	Q	R	S	T
A		x		x										x	x				
B	x					x									x				
C		x							x							x	x	x	x
D		x										x		x		x		x	
E												x			x		x		
G										x					x	x		x	
H	x			x						x									
I		x				x				x	x			x					
J	x											x							
K																			x
L	x	x		x			x	x		x						x			
M				x			x					x			x		x		x
O	x		x			x	x					x							x
P	x				x									x					
Q						x													
R		x												x	x	x			
S						x								x					
T	x				x	x				x	x		x						

Fig. 1. Mating design of the diallel trial.

The trial was planted as 10-tree rowplots in an 8 x 9 lattice design with three replications at the normal espacement of 2,7 x 2,7 m. The seedling seed orchard (S.S.O.) has 99 families raised from open pollinated seed collected from selected parents. The families were planted in plots 2 x 2 trees square over nine replications at 2,1 x 2,1 m espacement. The trial is thinned at the age of two years, when 50 % of each plot is removed, and 50 % of the remainder is thinned at three years of age. Also, the worst families are culled during the second thinning to convert the trial into a seedling seed orchard with only one tree per plot left for the best families in each replication in the fourth year.

Height was measured in the diallel trial at five months. In the S.S.O. diameter at breast height, height growth, crown form and stem form were assessed at two years and in both trials at the age of three years.

Data was analysed using the DIALL programme (Schaffer et al, 1969) and the SAS package (Helwig et al, 1979).

Heritabilities were estimated by the formulae:

$$h^2 = \frac{4\sigma^2_{gca}}{2\sigma^2_{gca} + \sigma^2_{sca} + \sigma^2_p + \sigma^2_w} \quad \text{and} \quad h^2 = \frac{4\sigma^2_f}{\sigma^2_f + \sigma^2_{rf} + \sigma^2_w}$$

in the diallel and S.S.O. respectively. Refer to Table 1 and 2 for identification of the variance components.

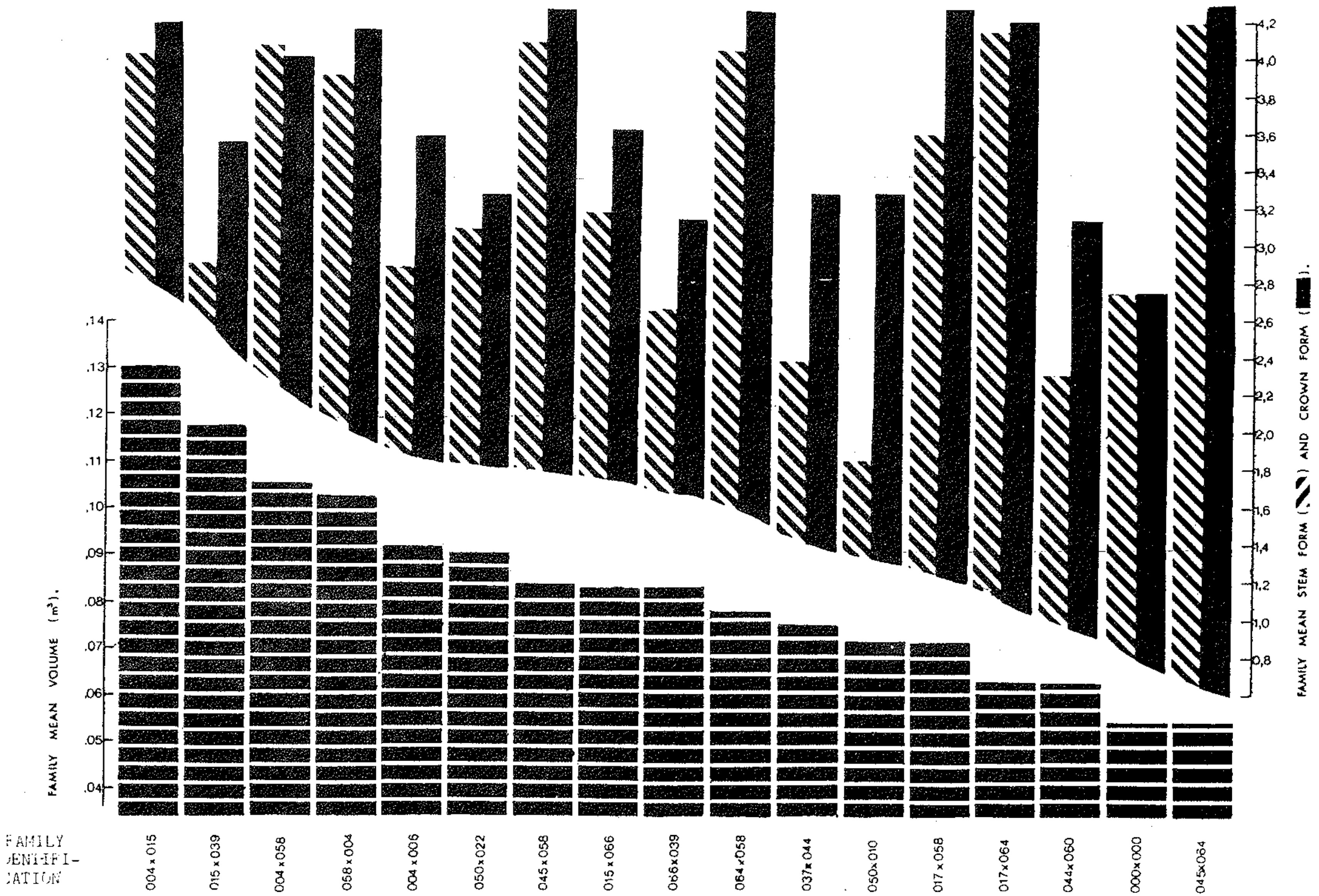

Fig. 2. FAMILY MEAN VALUES FOR VOLUME PRODUCTION, STEM FORM & CROWN FORM OF A SAMPLE OF *E.GRANDIS* FULL SIB FAMILIES AT 3 YEARS

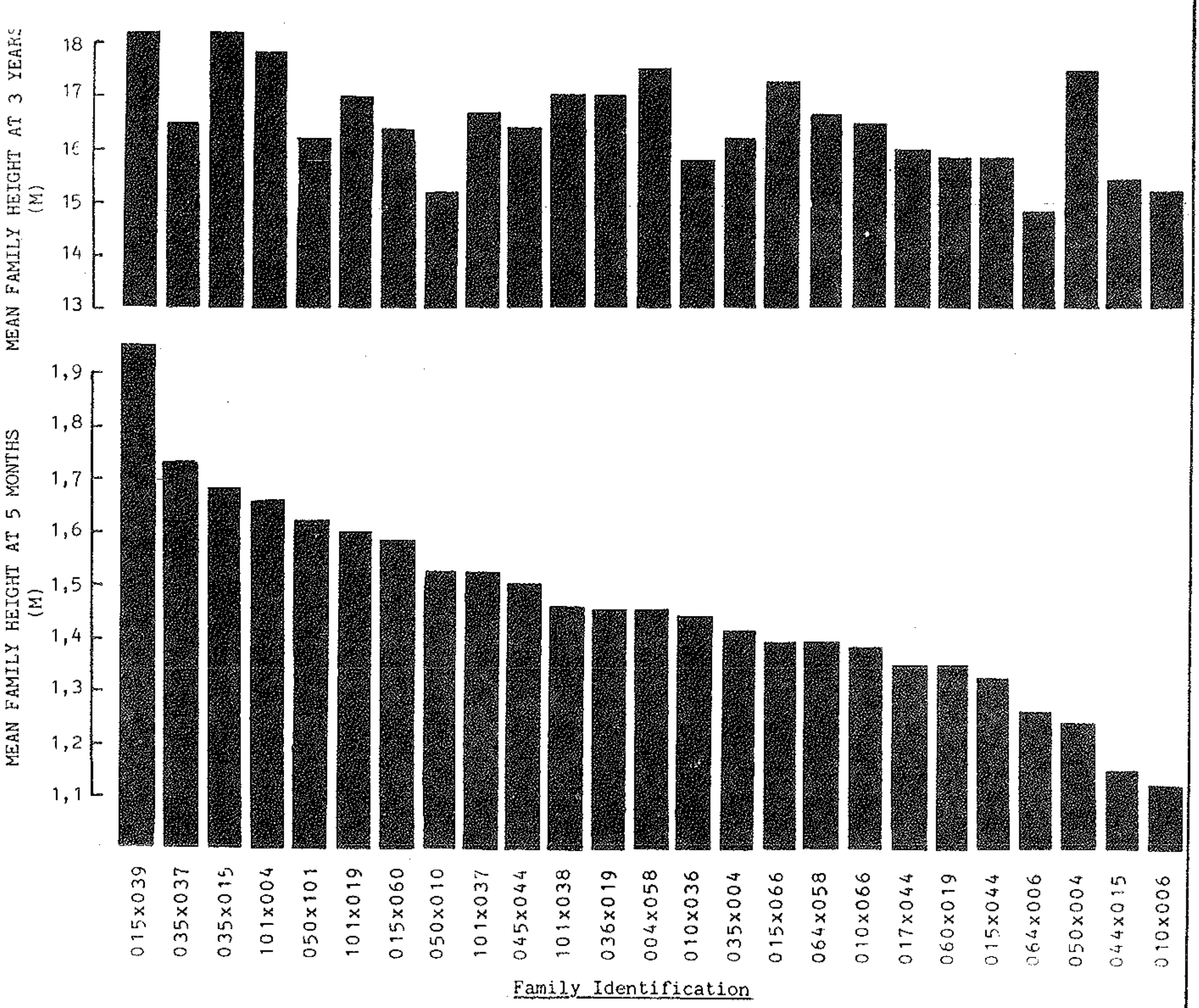

FIG 3 : Family mean heights of a sample of *E.grandis* full sib families at 5 months & at 3 years.

RESULTS AND DISCUSSION

The diallel trial

Family variation and volume production

Large family variation of volume production, crown form and stem form was observed (Fig. 2 and Table 1). Mean family volume varied from 0,043 m³ per tree to 0,131 m³ at age three years. From Fig. 2 it is also clear that the families with the best volume production are not always the ones with the best crown form and stem form. In this case a selection index will aid considerably in selecting parents for advanced generations.

At age three years the total standing volume of the trial was 101 m³/ha giving a mean annual increment of 33,7 m³/ha/a.

Heritability and gain

Heritability estimates for volume production and crown form are moderate, i.e. 0,16 and 0,26 respectively. For stem form the estimate is relatively high ($h^2 = 0,45$). The large amount of non-additive variance for volume production must be noted. This is in agreement with previous work by the author (Van Wyk, 1975) where it was suggested that the large amount of non-additive variation may be caused by allelic and/or linkage disequilibrium. It is also interesting to note that stem form and crown form seem to be mainly under additive genetic control (Table 1).

Selection from the parent population was strict and a selection intensity of 3,75 will not be unrealistic. At this intensity, a gain of 26 % in volume production and of 62 % in stem form over the trial mean is predicted from seed orchard seed at three years of age.

The existing trial is somewhat restricted as regards number of families for subsequent selection, if inbreeding is to be avoided. However, if the eight best full-sib families could be selected to utilise specific combining ability (Shelbourne, 1969) a gain of 51 % in volume production is predicted at age three years of age.

Reciprocals

The trial included seven reciprocal crosses. These were analysed for volume production and stem form, and for both characteristics no significant differences could be found. This suggests that the male and female gametes contribute equally to the zygote and that mating designs need not include reciprocal crosses.

Correlations

Genetic correlations indicate that stem form and crown form are highly correlated (0,96) but that stem form and volume production are poorly correlated (0,23). No relationship seems to exist between crown form and volume production ($r_G = -0,02$).

Fig.3 also indicates the poor phenotypic correlation between early height measurements (five months) and later measurements at three years. This confirms previous observations (Van Wyk, 1975) that early selection, i.e. before the age of one year, will have no beneficial value in *E.grandis*.

Table 1. Mean squares, estimates of variance components and heritabilities (h^2) of some characteristics in a diallel trial of *E.grandis* at 3 years.

Source $^{a/}$ of variation	D F	Mean squares		Variance components for		
		Volume	Stem form	Volume (x10^{-2}	Stem form	Crown form
GCA	19	0,0130***	29,33***	0,047	0,151	0,112
SCA	44	0,0043^{NS}	2,32^{NS}	0,121	0,050	0,066
Plot	126	0,0032	3,20	0,252	0,245	0,331
W/in Plot	1905	0,0007	0,75	0,705	0,751	1,084
h^2	-	-	-	0,16	0,45	0,26

a/ GCA : General combining ability; σ^2_{gca} = variance component for GCA.

SCA : Specific combining ability; σ^2_{sca} = " " " SCA

σ^2_p = variance component due to plot variation

σ^2_w = variance component due to within plot variation

The seedling seed orchard

Family variation and volume production

Significant family variation for volume production and stem form was obtained at ages two and three years. At the latter age the mean family volume per tree varied from 0,033 m³ to 0,071 m³. Significant interaction between replication and family was also found but was not studied in detail. The family component of variance was about half that of the interaction component of variance. Interpretation of family mean performance therefore requires some caution.

The mean annual increment was 25,78 m³/ha/a over three years. This is much lower that that of the diallel trial but may be ascribed to
a) the fact that only one parent was selected and
b) a possible delay in complete utilisation of the site after the first thinning.

From the first to the second thinning (a 10-month period) the volume increment was 36,22 m³/ha. This period (February to November) did not include the peak of the growth season namely December and January.

Heritability and gain

Estimates of variance components (Table 2) reveal that the within-plot variation decreased from the first to the second thinning, causing the heritability estimate to increase substantially. The estimates for volume production (h^2 = 0,33) and stem form (h^2 = 0,38) imply that large gains will be possible in an intensive selection programme.

Sixty-two families out of 99, and nine out of 36 trees per family (one in each replication), were retained as seed trees. For the genetic gain prediction, the dominance variance estimates obtained in the diallel trial were assumed for the S.S.O., i.e. $\sigma^2_D = 2\sigma^2_A$ for volume production, and $\sigma^2_D = 1/3\ \sigma^2_A$ for stem form, where σ^2_D = dominance variance and σ^2_A = additive variance.

With these assumptions it is predicted that the gain in volume production at three years should be 36 % compared to the trial mean, and gain in stem form should be 41 %. If the mean of the trial is only 5 % better than the mean of the parent population, it should be appreciated that the offspring from the seedling seed orchard will be substantially better than the previous generation.

Table 2. Estimates of variance components and heritability for volume production and stem form in an *E.grandis* seedling seed orchard at two and three years of age.

Variance component$^{a/}$	Two years		Three years	
	Volume	Stem form	Volume	Stem form
σ^2_f	565,4	0,061	3335,3	0,091
σ^2_{rf}	1150,7	0	6968,7	0,110
σ^2_w	8327,3	2,641	29878,9	0,766
h^2	0,23	0,09	0,33	0,38

a/ σ^2_f = Variance component due to family variation.
σ^2_{rf} = " " " " family x replication variation
σ^2_w = " " " " within plot variation
h^2 = narrow sense heritability

CONCLUSIONS

The results from these two trials demonstrate clearly that large amounts of genetic variation exist in the local *E.grandis* population. Additive genetic variance is large enough to obtain significant gains in a recurrent selection programme. The magnitude of non-additive variance, especially for volume production, is indeed challenging. If mass vegetative propagation techniques could be developed successfully it may not be presumptuous to talk about 100 % gain in the first cycle of *E.grandis* breeding.

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VARIABILIDADE GENÉTICA E CORRELAÇÃO DE CARACTERÍSTICAS MORFO-FISIOLÓGICAS EM MUDAS DE *Eucalyptus.*

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Resumo

Diferenças significativas nas características morfo-fisiológicas foram evidenciadas entre mudas de seis espécies de eucalipto. A possibilidade de uso da relação largura/comprimento da folha é sugerida como um parâmetro para diagnose. Com excessão de *E. citriodora* e *E. exserta,* a produção de matéria seca (MSP) foi máxima nas outras 4 espécies *(E. tereticornis, E. alba, E. torelliana* e *E. intertexta).* Contudo, a MSP mostrou correlação positiva com área foliar, peso específico da folha, altura da muda, diâmetro no colo e comprimento da folha, sua máxima associação foi com o diâmetro do colo. O comprimento da folha e a relação comprimento/largura registraram as estimativas máximas para herdabilidade e ganho genético. O diâmetro do colo possuia alto h^2 e e satisfatoriamente alta GA, e esta característica pode ser usada como índice de seleção.

INTRODUCTION

A plethora of reports is available on the existence of a close parallel between juvenile vigour and adult growth in tree crops (Ellertsen, 1955; Zobel, 1961; Barber and van Haverbeke, 1961; Bengtson, 1963; Zarger, 1965; Snyder, 1969; Pawsey, 1972; Squillace and Gansel, 1974; Olembo and Dyson, 1976; Overton and Kim Ching, 1978; Robinson and van Buijtenen, 1979). Early seedling dry weight had a distinct correlation with later height in *Eucalyptus grandis* (Wyk, 1977). Dry matter production being a complex trait governed by a multitude of ancillary characters, direct selection for this attribute may often be misleading and, hence indirect methods like determining its association with less variable growth components may be rewarding. Studies on the nature and magnitude of heritable components of overall variability is a little investigated area in *Eucalyptus*. A study was therefore designed to determine the relationship of physiological and morphological attributes with dry matter production and their genetic parameters with a view to assess their utility as selection indices. The results are reported herein.

MATERIALS AND METHODS.

The study was conducted at the Forestry Research Station, Mettupalayam during the monsoon season of 1978. Seeds of six eucalypt species viz., *tereticornis*, *citriodora*, *alba*, *exserta* *torelliana* and *intertexta* were sown in polythene containers measuring 20 x 15 cm and holding uniform quantity of a mixture of soil, sand and farmyard manure in the proportion, 4:1:1. Three weeks after sowing, seedlings were thinned to one per container.

In each species four replicates of five containers each were maintained. When seedlings were 150 days old, they were assessed for the following attributes: 1. Dry matter production (DMP), 2. Leaf area/plant (LA) 3. Specific leaf weight (SLW) 4. Leaf area ratio (LAR) 5. Leaf, stem and root weight ratios (LWR, SWR, RWR) 6. Seedling height 7. Diameter at base 8. Leaf number/plant 9. Leaf size and 10. Leaf length to breadth ratio (l/b ratio).

After resolution of the plant samples into the respective components and count of leaf number, the shoot length and leaf dimensions were measured. Leaf area was derived at gravimetrically from the dry weight of leaf discs of known area obtained by a cork-borer. The leaf discs and plant components were oven-dried to constant weight at 80°C and their dry weights recorded. Dry matter production is the weight of the dried plant expressed in mg. The leaf, stem and root weight ratios were expressed as the per cent dry weight of each part over the total dry weight of the plant (Eze, 1973). Specific leaf weight is the dry weight per unit leaf area and expressed in mg/dm^2 (Tanaka *et al.*, 1966). Leaf area ratio given in cm^2/mg is the ratio of total leaf area to total plant weight (Warren Wilson, 1967).

Correlation coefficients between the different variables were worked out following Al-Jibouri *et al.*(1958). Genotypic coefficient of variation (GCV), percentage of heritability(h^2) and genetic advance (GA) of the growth attributes were extracted following respectively Burton (1952), Hanson *et al.*(1956) and Johnson *et al.*(1955).

RESULTS AND DISCUSSION

1. Variations in Physiological and Morphological Attributes Among the six Species of Eucalyptus.

Data on the various physiological and morphological attributes are given in Table 1. There were significant differences among the six species in respect of all the characters evaluated. *E.citriodora* recorded the least DMP; Barring this species and *E.exserta*, all other species were comparable from the standpoint of this attribute. The DMP in *E.exserta* was more than that of *E.citriodora*, but inferior to that of other species. An analysis of the distribution of the DMP over the plant parts revealed that, in general, about 60 per cent of the dry matter was relegated to the leaf and the remaining apportioned equally between the stem and root. Leaf area was maximum in *E. tereticornis* and *E.torelliana* and minimum in *E.citriodora*. Leaf dry weight per unit leaf area (SLW) was distinctly high in *E.intertexta*, but leaf area per unit plant weight (LAR) was maximum in *E.citriodora* and *E.torelliana*. Pronounced differences were discernible between the species with reference to l/b ratio. The leaves, invariably, were longer than broader; in *E.exserta* the l/b ratio was more than sixteen whereas in *E.intertexta* it was more than 5. Since morphological variations in mature plants as between *E.viminalis* and *E.dalrympleana* ~~are~~ are not as marked as in seedlings, seedling characteristics, especially, those of the foliage can be utilised for diagnostic purpose (Turnbull, 1978). Length to breadth ratio of juvenile foliage may therefore be used to characterise the species studied.

2. Correlation between the Various Physiological and Morphological Attributes.

The total correlation coefficients between DMP and the other growth components and also among the latter *inter se* are presented in Table 2. DMP was positively correlated with LA, SLW, seedling height, base diameter and leaf length, and, of these, base diameter ~~and leaf~~ bore the strongest association. DMP, however, exhibited negative relationship with LAR. Gross plant photosynthesis is the integral of total leaf area and photosynthetic rate per unit leaf area. This explains the positive association between DMP and LA. Specific leaf weight which also connotes leaf thickness has been implicated in many physiological processes of plant, especially, photosynthetic rate since a high SLW should permit less of incident radiation to pass through a leaf without interception(Tsunoda,1964 ; Peace *et al.*, 1969; Dornhoff and Shibles, 1970; Criswell and Shibles, 1971; Rai and Murty, 1979). A thinner lamina has also been shown by Turrell (1936, 1944) to indicate a lower internal surface area and to accompany lower rates of photosynthesis. The positive association between DMP and SLW observed in the present investigation suggests that a high SLW contributes to high photosynthetic efficiency in eucalypts also. This, however, needs further elucidation since Cameron (1970) has reported photosynthesis to be more in the thinner intermediate leaves than in the thicker juvenile leaves of *Eucalyptus fastigata*, implying absence of any such association. Among the auxilliary characters, LA displayed a positive association with both seedling height and base diameter. Both leaf length and leaf breadth had a positive bearing on base diameter. SLW and LAR possessed a negative relationship.

3. Genetic Parameters of the Various Physioligical and Morphological attributes.

Data on genetic parameters of the various growth components are depicted in Table 3. The high GCV exhibited by leaf size and l/b ratio indicates that these traits are genotypically more predominant and it is possible to effect further improvement in them. Characters like seedling height and base diameter recorded low estimates of GCV, indicating their vulnerability to environmental fluctuations. But, Burton(1952) has suggested that GCV in conjunction with heritability estimates would give a clear picture of the extent of advance to be expected by selection. Even from this standpoint, leaf size and l/b ratio excelled other attributes. Heritability, however, indicates only the effectiveness with which selection of genotype can be based on the phenotypic performance but fails to show the genetic progress; high herita-

Table 1: Variations in Physiological and Morphological attributes among 150 day seedlings of six species of *Eucalyptus*.

	DMP/ plant (mg)	LA/ plant (cm^2)	SLW (mg/ dm^2)	LAR (cm^2/ mg)	Seedling height (cm)	Base dia. (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf breadth (cm)	1/b ratio	LWR (%)	SWR (")	RWR (%)
E. tereticornis	1404	457	161	0.32	29.1	0.24	16.0	6.00	1.65	3.62	52.5	22.3	24.9
E. citriodora	439	219	122	0.49	17.1	0.13	13.9	3.21	1.34	2.39	60.6	22.3	16.8
E. alba	1098	403	169	0.37	24.7	0.20	15.8	4.40	1.91	2.29	62.4	19.3	18.0
E. exserta	773	320	154	0.41	27.5	0.17	31.2	6.82	0.41	16.42	63.2	22.3	22.3
E. torelliana	1100	504	128	0.46	24.2	0.21	11.1	4.96	3.05	1.62	59.1	23.1	17.5
E. intertexta	1214	328	246	0.27	22.1	0.19	20.7	5.08	0.91	5.63	66.7	16.3	16.7
CD 5%	316	85	21	0.06	3.7	0.02	3.7	0.74	0.24	1.04	3.9	3.1	5.7

Table 2: Total correlation coefficients between the different variables.

	LA	SLW	LAR	Seedling height	Base Dia.	No.of leaves	Leaf length	Leaf breadth	1/b ratio
DMP	0.782**	0.518**	-0.721**	0.591**	0.923**	-0.093	0.441*	0.298	-0.187
LA		-0.028	-0.166	0.646**	0.833**	-0.272	0.378	0.263	-0.261
SLW			-0.887**	0.056	0.292	0.285	0.229	-0.385	0.123
LAR				-0.291	-0.588**	-0.236	-0.368	0.283	-0.080
Seedling height					0.605**	0.358	0.783**	0.193	0.360
Base Dia.						-0.212	0.447*	0.436*	-0.243
No.of leaves							0.564**	-0.793**	0.929**
Leaf length								-0.274	0.685*
Leaf breadth									-0.731**

bility *per se* is no index of greater genetic gain (Johnson *et al.*, 1955). Heritability estimates in broad sense will be reliable if accompanied by a high GA(Swarup and Chaugale, 1962; Ramanujam and Thirumalachar, 1967). Measured by this yardstick, leaf size, 1/b ratio and SLW had high heritability coupled with high GA, indicating that their high heritability was the outcome of additive gene effects (Panse, 1957). Number of leaves/plant and LWR exhibited high heritability but low GA, suggesting that their high heritability was a reflection of non-additive (dominance and epistasis) gene effects (Panse, 1957). Low estimates of GCV, h^2 and GA manifested by RWR imply that this character should not be relied upon for purpose of selection. Base diameter which showed the strongest positive association with DMP was characterised by high heritability and fairly high GA. This growth component may therefore be used as a selection index.

SUMMARY.

Significant differences in physiological and morphological traits were evident among the seedlings of six eucalypt species. The possibility of using 1/b ratio of leaf as a key for diagnosis is suggested. Barring *E.citriodora* and *E.exserta*, DMP was maximum in the other four species viz., *tereticornis*, *alba*, *torelliana* and *intertexta*. Though DMP exhibited positive correlation with LA, SLW, seedling height, base diameter and leaf length, its strongest association was with base diameter. Leaf length and 1/b ratio recorded maximum estimates for heritability and genetic gain. Base diameter possessed high h^2 and fairly high GA and this attribute can be used as a selection index.

Table 3: Genetic Parameters of Physiological and Morphological attributes.

	Mean	PCV	GCV	h^2(%)	GA	GA as % of Mean
DMP/plant (mg)	1004	38.7	32.6	70.9	570	56.7
LA/Plant (cm^2)	371	30.8	26.8	75.7	178	48.0
SLW (mg/dm^2)	163	28.1	26.8	90.8	86	52.6
LAR (cm^2/mg)	0.39	23.6	20.6	76.1	0.14	37.0
Seedling ht.(cm)	24.1	19.7	16.7	72.3	7. 1	29.4
Base Dia.(cm)	0.19	19.4	17.9	85.7	0.06	34.2
Leaves/plant	18.1	41.0	38.6	88.4	1.3	7.4
Leaf length (cm)	5.08	26.0	24.1	86.1	2.3	46.1
Leaf breadth (cm)	1.55	59.4	58.4	96.7	1.83	118.4
1/b ratio	5.33	105.9	103.1	98.4	11.45	214.9
LWR (%)	60.8	15.7	15.1	92.4	18.2	30.0
SWR (%)	20.9	15.1	11.4	57.4	3.7	17.8
RWR (%)	19.4	24.5	14.5	35.0	3.4	17.6

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MELHORAMENTO GENÉTICO DE *Eucalyptus saligna sm.* NA NOVA ZELÂNDIA.

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Resumo

O *Eucalyptus saligna* Sm. é plantado em pequena escala no Norte da Nova Zelândia e principalmente devido às características decorativas de sua madeira. Cresce mais rapidamente e é menos problemático que espécies relacionadas, *E grandis* Hill ex Maid e *E. deanei* Maiden, com o besouro tartaruga (Paropsis charybdis Stal) na região (latitude 35°38'S).

Na Nova Zelândia, as procedências de maior crescimento são as do extremo Sul da ocorrência da espécie na Nova Gales do Sul (N.S.W.) (por ex., Kangaroo Valley e Batemans Bay). Nos testes de progênies de polinização cruzada originárias de Nova Gales do Sul e introduzidas na Nova Zelândia, algumas das progênies locais de origem australiana desconhecida têm crescimento semelhante aos das melhores procedências australianas.

Pomares clonais de sementes foi estabelecido a partir de enxertos de árvores plus selecionadas fenotipicamente para crescimento em diâmetro, retidão do fuste, evidência de auto-desbaste e espessura dos ramos. Nos pomares, os clones inferiores são eliminados e substituídos por superiores usando os resultados de testes de progênie aos 3 anos de idade. As primeiras colheitas comerciais de semente estão programadas para janeito de 1981, 3 1/2 anos após o estabelecimento dos pomares.

GENETIC IMPROVEMENT OF *Eucalyptus saligna sm.* IN NEW ZEALAND.

Summary

Eucalyptus saligna Sm. is grown on a small scale in northern New Zealand, mainly for its decorative timber. It grows faster and is far less troubled by the Eucalyptus tortoise beetle (Paropsis charybdis Stål) in this region (latitude 35°-38°S) than the related eastern blue gums, Eucalyptus grandis Hill ex Maid. and Eucalyptus deanei Maiden.

The fastest-growing provenances of E. saligna on New Zealand sites are those from the southern end of the species' range in New South Wales (e.g., Kangaroo Valley, and Batemans Bay). In tests of native New South Wales and exotic New Zealand open-pollinated families, some local families of unknown Australian origin have grown as fast as families of the best native provenances.

Clonal seed orchards have been established from grafts of local plus trees phenotypically selected for fast diameter growth, straightness of stem, evidence of good natural pruning, and fineness of branching. Orchards have been rogued of poorer clones and reconstituted with better ones using 3-year growth results from progeny tests. First commercial harvests of seed are expected in January 1981, 3¼ years after the orchards were planted.

INTRODUCTION

Eucalyptus saligna Sm. is the main eucalypt planted in the northern part of the North Island of New Zealand (latitude 35°-38°S). An area of about 50 ha per year is currently planted in State forests, the intended primary end-use being decorative timber. Although E. saligna is prone to wind damage in exposed situations (presumably because the juvenile wood is very brittle), no other eucalypts are as dependable as E. saligna on these warm, northern sites with comparatively high rainfalls (1500-2000 mm per year). The nearest rival is perhaps Eucalyptus botryoides Smith. The three other eastern blue gums, Eucalyptus grandis Hill ex Maid., Eucalyptus deanei Maid., and Eucalyptus robusta Sm., do not grow well in New Zealand, partly because their leaves are highly palatable to the Eucalyptus tortoise beetle, Paropsis charybdis Stål.

Seed sources of most plantings of E. saligna in New Zealand over the last 20 years have been various local New Zealand stands of unknown Australian origin. Only two major seed importations from Australia have been made by the New Zealand Forest Service in recent years - from Pine Creek State Forest just south of Coffs Harbour in the Wauchope Forestry District on the north coast of New South Wales, and from Kangaroo Valley, between Nowra and Robertson, south of Sydney.

A genetic improvement programme was initiated in New Zealand in 1975 with the objective of identifying the best native provenances and local exotic populations of E. saligna, and of creating seed orchards to supply all future local seed requirements. In this paper are outlined the steps being taken in the programme, and the main results achieved so far.

PROVENANCE SELECTION

Provenance tests of 18 seedlots of E. saligna, together with lots of E. botryoides (1), E. grandis (3), E. deanei (2), and Eucalyptus dunnii Maid. (1) were planted on four sites in 1976 (Figs. 1 and 2). This was the first known introduction of E. dunnii to New Zealand.

At the northernmost site of Aupouri, on coastal sand, all species grew poorly, and no reliable comparisons of seedlots could be made there. The trees grew well at the other sites (clays and clay-loams) and results from these at age 3 years from seed sowing are summarised in Table 1. Particularly fast growth at all sites was shown by the E. saligna seedlots from Kangaroo Valley and Batemans Bay, New South Wales. Several New Zealand exotic seedlots, notably those from Rotoehu Forest (second-generation "Bartlett's" strain[1]) and Kauaeranga (an orchard of nine grafts planted in 1965) grew well, with the Rotoehu seedlots being among the very best in stem straightness, freedom from forking, and fineness of branching. Progeny from a seed orchard in South Africa grew slowly and had surprisingly poor stem form, including a high frequency of forking.

Eucalyptus grandis did not generally grow as well in these trials as the best E. saligna, though lots from South Africa and Coffs Harbour grew well at the Waitangi site. The Eucalyptus tortoise beetle severely defoliated E. grandis at Mahurangi greatly curtailing its growth. Eucalyptus deanei (cf. Bain, 1977) and E. dunnii suffered very heavy beetle attack, and grew comparatively slowly, on all sites. The E. botryoides lot did not grow especially fast on any site, but, like E. saligna, was very resistant to the tortoise beetle.

Six of the seedlots studied in New Zealand have also been tested in the State of Espirito Santo, Brazil (Campinhos and Ikemori, 1978). Comparison of mean diameters of these in the two countries (Table 2) shows that E. grandis grows faster than E. saligna in Espirito Santo - the reverse of the situation in New Zealand. It is notable that E. saligna lot S. 7730 from Kangaroo Valley was the fastest-growing provenance of this species in both countries. Only very sketchy information has been published about E. saligna provenances in other countries (Marsh and Haigh, 1963; Mullin and Barnes, 1977).

Though admittedly preliminary, these provenance trial results have been used in New Zealand as follows:

- New commercial importations of seed were made from Kangaroo Valley and Batemans Bay;
- Plantings have been located of earlier importations of seed from Kangaroo Valley and Batemans Bay, and set aside for seed production;
- Seed collection has been diverted from the previously preferred "Bartlett's" strain at Silverdale to second-generation stands of the same strain at Rotoehu Forest.

CLONAL SEED ORCHARDS

Breeding of E. saligna started in New Zealand in 1965 with the selection of some plus trees and the establishment of a small experimental grafted seed orchard. Progeny from this 6-clone orchard at Kauaeranga grew very well in the provenance tests (Table 1). A fresh start was made with a breeding programme in 1975, with the objective of developing seed orchards capable of producing 5-10 kg seed per year.

Plus Tree Selection

Seventy-eight plus trees were selected in 18 New Zealand plantations in 1975-76 (Fig. 2). Stands varied from small farm plantings or experimental plots of 20-100 trees to extensive plantations of several hectares. Trees were aged 17-48 years. The policy of selecting only a few trees per stand, but from numerous stands, was deliberate since the Australian origins of the stands were not known, and eight of the stands sampled were derived from seedlots known to have been collected from just a very few trees in old arboreta or woodlots.

Trees were selected for presence of seed, straight stems, evidence of good natural pruning, and fast growth. It was impracticable to initially select for important wood properties such as freedom from end-splitting in logs (Barr, 1980), but it is hoped attention can be given to these at a later stage. Since the species is being grown primarily for timber, it may be prudent to concentrate on milling and seasoning qualities in future selection programmes, if the necessary screening techniques can be developed.

Within stands, selection rate varied from as low as 1 tree in 5 in the smaller stands to as high as 1 in 50 in the larger plantations such as Athenree.

Grafting

Scions were collected from 44 of the plus trees by shooting (0.22 rifle) or climbing in either late December 1975 or early March 1976, and cleft-grafted on to 3-month-old seedling root stock of a routine seedlot. The grafts made in December grew fastest.

Orchard Management

Healthy, vigorous grafts were obtained from 40 of the 44 plus trees, and an orchard was established at Rotorua at 6 x 6 m spacing in September 1976. A few grafts died and were replaced in 1977, to give a fully stocked orchard of 120 grafts (three per clone, randomised). Further orchards of several of these clones were established at Kauaeranga (45 grafts) and Tairua (47 grafts) in 1977, the latter as a row of grafts planted 4 m apart.

The planted grafts were kept free of weeds, and were side-dressed liberally with N-P-K fertiliser in spring and autumn each year for the first 2 years. After the first year, grafts were regularly lopped (i.e., top-pruned) to a height of 2-3 metres to encourage development of a broad crown with heavy lower limbs. It was hoped that this procedure would encourage early seed production and facilitate seed collection.

Sporadic flowering occurred in the Rotorua orchard in February-March 1979, but the first general flowering occurred in February-March 1980, 2¼ years after the grafts were planted. The first crop of seed, from about 25 grafts, is expected to be picked in February 1981. The orchard at flowering time supports a large number of honey-bees and assorted flies that appear to effectively cross-pollinate the flowers. One clone flowers in May, placing it out of phase with the others.

Despite a 30% loss of grafts from incompatibility, and some troublesome wind breakage of heavy limbs (often laden with developing fruits), the grafted orchard concept still appears a promising and convenient method of seed production in E. saligna.

Improved Clonal Orchards Using Progeny Test Results

Most plus trees were represented in open-pollinated family tests planted on two sites in 1976. Results in 1979 showed large differences among families in early growth rate, and were used, together with an assessment of graft health in the seed orchards, to select a superior group of 25 clones as follows:

- 11 clones in 1976-77 orchards that grew very well as grafts and whose progeny grew well in progeny tests;
- 14 clones not originally grafted in 1975-76 but whose progeny grew well in progeny tests.

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[1] The so-called "Bartlett's" strain from Silverdale near Auckland has a good local reputation with sawmillers. End-splitting of logs is rarely severe, distortion (spring and bow) in freshly sawn timber is not excessive, and boards remain stable after drying. The timber often possesses a decorative wavy grain.

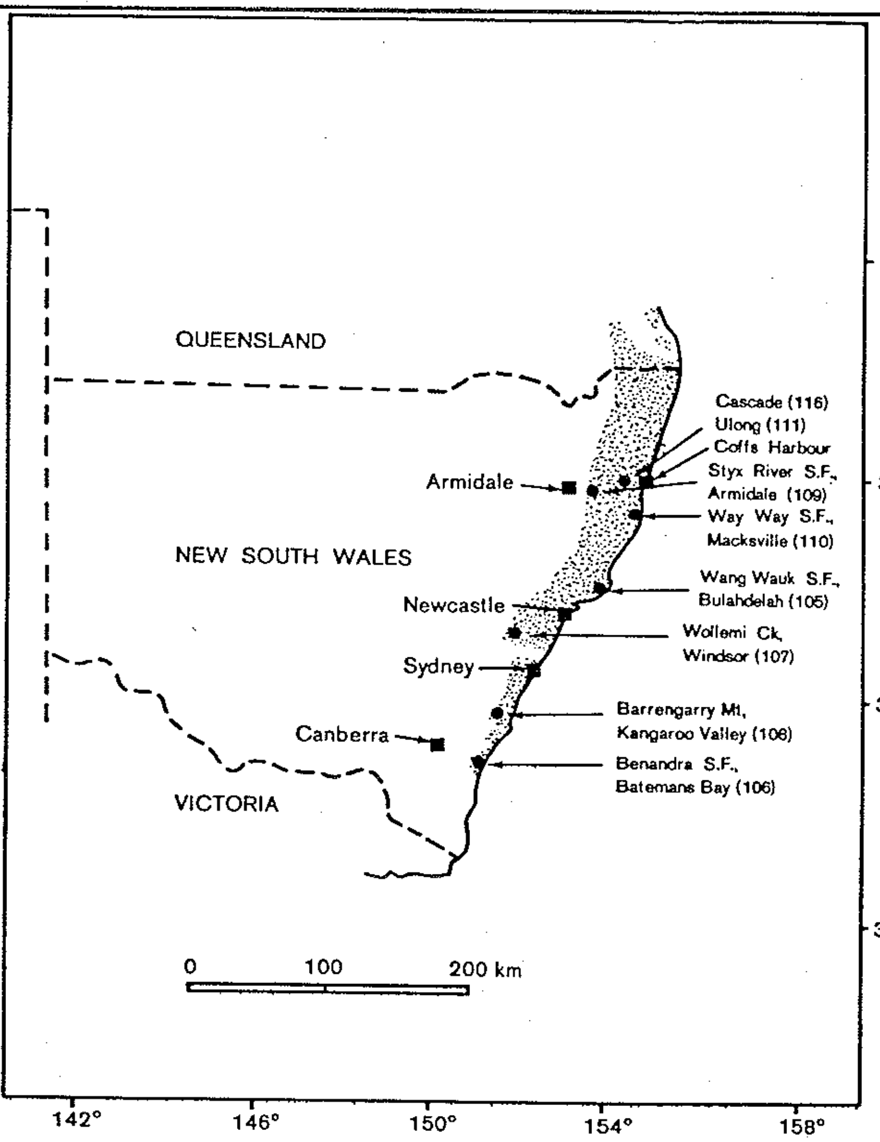

FIG. 1 NATURAL DISTRIBUTION OF E SALIGNA AND LOCATION OF NATIVE PROVENANCES UNDER TEST IN NEW ZEALAND

Grafts were made of all 25 clones in February 1980, and a new seed orchard will be planted in September 1980. Meanwhile, clones that produced especially slow-growing progeny or that showed serious graft incompatibility have been removed from the 1976-77 orchards. Seedling root stocks for the 1980 grafts were open-pollinated progeny from seed collected off the six plus trees showing the healthiest growth as grafts. It is hoped that resulting orchards will show a much lower level of graft incompatibility than experienced with grafts made on a random sample of seedlings as root stocks.

Genetic Gain

What level of genetic improvement can be expected from the clonal seed orchards? Progeny test results at age 3 years at the main test site at Mahurangi are summarised in Table 3. They show that improvement can be made from provenance selection, plus tree selection, and progeny testing, but give no direct measure of the likely improvement from the orchard itself.

Progeny of the top 25 New Zealand plus trees (i.e., those propagated in the new seed orchards) grew somewhat slower, on average, than families of the native Kangaroo Valley provenance, although considerably faster than most families of other native provenances. The 10-15 fastest-growing New Zealand families, however, were fully as vigorous as the Kangaroo Valley families. Families from New Zealand trees generally had slightly better stem quality than their Australian counterparts from mainly random seed trees in native stands, suggesting that the rather mild phenotypic selection in New Zealand stands may have been effective.

The following estimates of variance components ($\pm$ S.E.) and repeatabilities of family means were obtained from the 100 open-pollinated families at Mahurangi at age 3 years:

	Diameter (cm)	Stem Quality (1-9)
Families variance component ($\hat{\sigma}_f^2$)	0.49 $\pm$ 0.17	0.04 $\pm$ 0.04
Replicates variance component ($\hat{\sigma}_r^2$)	1.52 $\pm$ 0.48	0.23 $\pm$ 0.09
Error variance compenent ($\hat{\sigma}_e^2$)	2.81 $\pm$ 0.17	2.71 $\pm$ 0.16
Repeatability ($\frac{\hat{\sigma}_f^2}{\hat{\sigma}_f^2 + \hat{\sigma}_e^2/23.6}$)	0.80**	0.35 n.s.

Genetic variation among families in stem quality was largely obscured by severe wind damage to the trees.

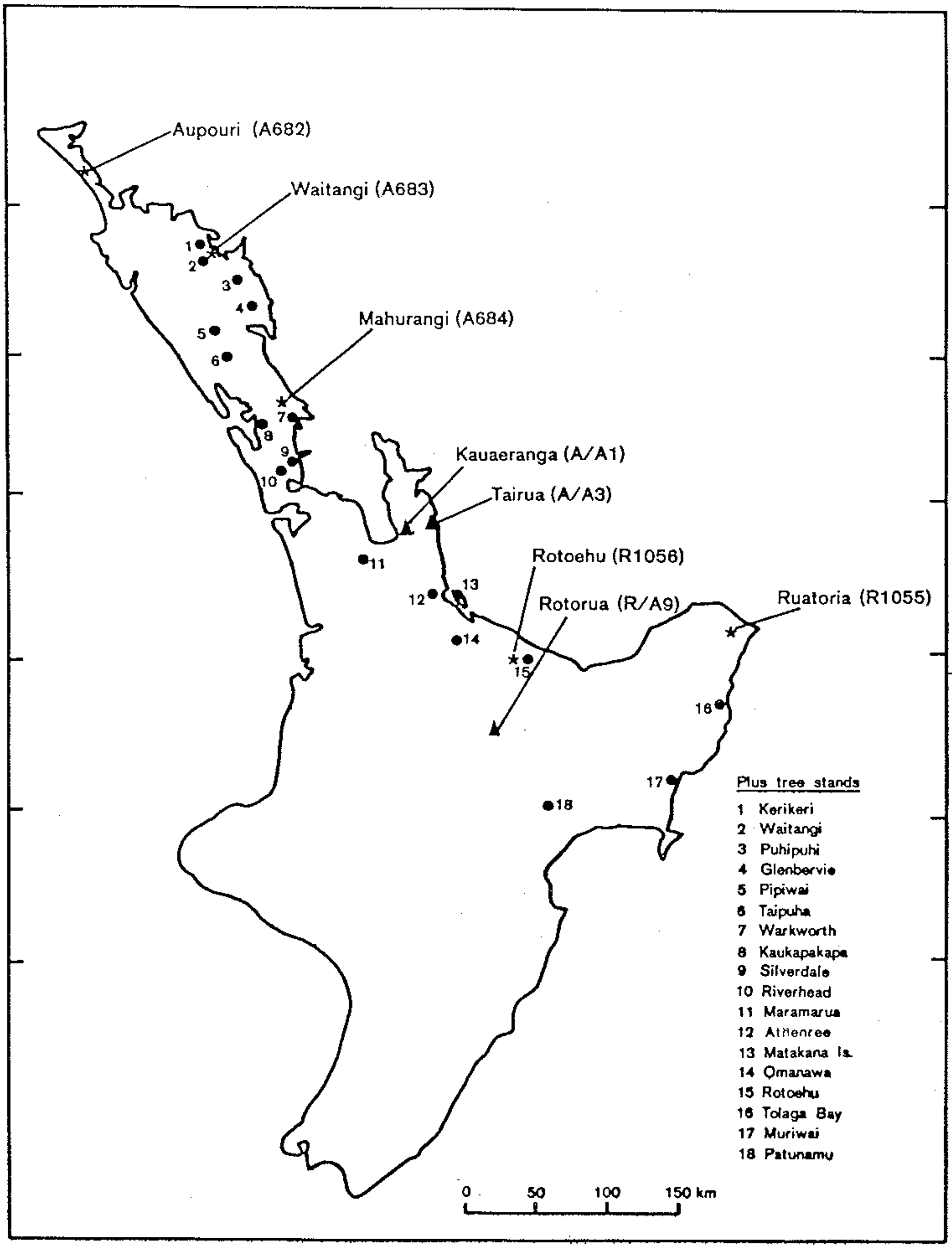

FIG. 2 LOCATION OF E. SALIGNA TEST PLANTATIONS (★), CLONAL SEED ORCHARDS (▲) AND PLUS TREE STANDS (●)

Table 1 - Performance of E. saligna provenances and four other species at three sites in the North Island, New Zealand at age 3 years from seed sowing - assessed July/August 1979

Rank[1]	NZ Code No.	Origin	Diameter[2] (cm)	Height[3] (m)	Diameter rank by site			Stem[4] quality (1-9)
					Waitangi	Mahurangi	Ruatoria	
1	108	Kangaroo Valley, N.S.W., Alt. 610 m S. 7730 (10 trees, Barrengarry Mt)	7.2	5.1	1	1	1	6.3
2	106	Batemans Bay, N.S.W., Alt. 30 m S. 7508 (11 trees, Benandra S.F.)	6.8	5.0	3	2	5	6.1
3	111	Coffs Harbour, N.S.W., Alt. 530 m N.S.W. C 900 (Ulong)	6.8	5.4	2	4	11	7.0
4	145	Kauaeranga Seed Orchard, NZ (6 clones). FRI 76/2018	6.8	4.6	9	3	3	6.2
5	46	Rotoehu Forest, NZ R 72/945, Compt. 52e	6.7	4.7	7	7	2	6.7
6	57	Rotoehu Forest, NZ RO/O/75/22. Compt. 83. (20 trees)	6.7	4.7	12	6	10	6.8
7	109	Styx River S.F., Armidale N.S.W. 915 m; N.S.W. C 792	6.5	4.4	15	12	16	6.3
8	146	E. grandis, J.D.M. Keet Seed Orchard, South Africa (50 clones)	6.4	4.6	5	15	6	6.2
9	107	Windsor, N.S.W. Alt. 300 m S. 7786 (11 trees, Wollemi Ck)	6.4	4.4	6	5	19	6.7
10	128	Waitangi Forest, NZ, Compt. 30 FRI 76/2017, (8 random trees)	6.4	4.7	8	14	7	5.9
11	116	Coffs Harbour, N.S.W. (Cascade)	6.4	4.5	16	9	14	6.3
12	58	Athenree Forest, NZ AK/0/75/16, Compt. 16 (6 trees)	6.3	4.6	13	13	4	6.2
13	55	Silverdale, NZ, FRI 76/2012 (Bartletts strain, random trees)	6.3	4.3	10	11	18	6.5
14	149	Patunamu Forest, NZ FRI 76/2049, Compt. 8 (3 trees)	6.2	4.6	20	10	12	6.7
15	148	E. botryoides, Woodhill Forest, NZ, AK 74/1058	6.2	4.5	21	8	8	6.0
16	158	E. grandis, Coffs Harbour, N.S.W. Alt. 18 m. S. 7823	6.1	4.7	4	20	17	6.7
17	105	Bulahdelah, N.S.W., Alt. 230 m S. 7808 (8 trees, Wang Wauk S.F.)	6.1	4.6	14	19	9	6.3
18	75	E. grandis, Kenya	5.9	4.2	11	18	21	6.2
19	74	Riverhead Forest, NZ AK/C/75/54 (2 trees)	5.8	4.3	17	23	13	5.5
20	110	Macksville, N.S.W., Alt. 305 m N.S.W. C 602, Way Way S.F.	5.6	4.4	18	17	15	6.3
21	150	E. deanei, Glen Innes, N.S.W. Alt. 760 m. S. 7822	5.5	3.8	23	16	23	6.3
22	166	Silverdale, NZ (Bartletts strain, 2 selected trees)	5.4	4.1	19	21	22	6.3
23	147	J.D.M. Keet Seed Orchard, South Africa (10 clones)	5.2	4.1	22	24	20	5.8
24	151	E. deanei, Wollemi Ck, N.S.W. Alt. 300 m. S. 7875	5.1	3.6	25	22	24	6.5
25	157	E. dunnii, Coffs Harbour, N.S.W. Alt. 300 m. S. 11786 (23 trees, Kangaroo River S.F.)	4.9	3.6	24	25	25	5.6
		SITE MEAN DIAMETER (CM)			5.2	8.3	5.2	

[1] By mean diameter averaged over three sites

[2] Averaged over three sites. LSD = 0.8 cm. F-test (seedlots) = 4.47**; F-test (seedlots x sites) = 2.71**

[3] Averaged over Waitangi and Ruatoria only

[4] Higher the score, the better the stem quality (straightness, malformation, branching). LSD = 0.6. F-test (seedlots) = 2.97**; F-test (seedlots x sites) = 1.65**

It is planned to upgrade the seed orchards again, by removing the poorer clones as judged by an assessment of the progeny tests at age 8 years.

FUTURE POSSIBILITIES

Family Tests

In addition to the provenance tests, 100 open-pollinated families of E. saligna have been established in tests using single-tree plot field designs with 36 trees per family. Represented are 43 native families (mainly of CSIRO provenances S. 7730, S. 7508, S. 7786 and S. 7808 listed in Table 1), 55 New Zealand families, and 2 American (Hawaii and Brazil) families.

The use of these tests as progeny tests of seed orchard clones has already been described. Other intended applications are for second-generation plus tree selection, for estimating genetic parameters, and as seedling seed orchards if needed, once heavy thinning has been done to remove the worst trees.

Hybridisation

"Half-barked" trees suggestive of E. saligna x E. botryoides hybrids are common in New Zealand woodlots and are often among the best trees in the stand. Furthermore, it is suspected that the Kangaroo Valley provenance of E. saligna may partly owe its outstanding vigour to natural hybridisation with E. botryoides. There is some intermediacy in bark characteristics in the Kangaroo Valley population to support this contention (see also Pryor and Johnson, 1971). A hybrid breeding programme is thus a possibility for the future.

ACKNOWLEDGEMENTS

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The co-operation and assistance of NZ Forest Products Ltd with the provenance and family tests at Mahurangi Forest is greatly appreciated.

Table 2 - Comparison of mean diameter growth of six CSIRO seedlots common to tests in Brazil and New Zealand

CSIRO Seedlot	Origin	Mean diameter (cm) Brazil [1] (2 yrs)	Mean diameter (cm) New Zealand [2] (3 yrs)
E. saligna			
S. 7730	Kangaroo Valley	10.2	7.2
S. 7508	Batemans Bay	8.9	6.8
S. 7786	Windsor	10.0	6.4
S. 7808	Bulahdelah	9.3	6.1
E. grandis			
S. 7823	Coffs Harbour	11.4	6.1
E. deanei			
S. 7822	Glen Innes	9.0	5.5

1 Aracruz, Espirito Santo (Campinhos and Ikemori, 1978).

2 Averaged over three sites - Waitangi, Mahurangi,'Ruatoria

Table 3 - Comparison of New Zealand and New South Wales E. saligna families at Mahurangi at age 3 years from seed sowing

Group	Number of families	Mean [1] diameter (cm)	Mean stem quality score (1-9)
A. Best New Zealand plus tree families	25	9.1 b	6.4 a
B. Other New Zealand plus tree families	32	8.7 c	6.3 ab
C. Kangaroo Valley families (S. 7730/1-9), New South Wales	9	9.4 a	6.2 b
D. Families of other native New South Wales provenances	34	8.0 d	6.2 b

1 Groups not followed by at least one common letter differ significantly at 95% level (group LSD test).

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sessão II
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ALGUNS EFEITOS DA DESRAMA SOBRE O CRESCIMENTO DAS ÁRVORES E A QUALIDADE DA MADEIRA DE *Eucalyptus grandis* NA ZULULÂNDIA.

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Resumo

Em um ensaio de desrama conduzido em plantações de *E. grandis*, 6 regimes de desrama aplicados mostraram efeitos desprezíveis sobre a taxa de crescimento em comparação com a testemunha. A recuperação das árvores que tiveram até 50% de suas copas removidas foi rápida. Os ganhos verificados em termos de madeira sem nós foram insignificantes, enquanto que a degradação da madeira devido a estresses induzidos por uma desrama severa não foi significativa. Uma desrama corretiva e limpezas para facilitar o acesso são as medidas que seriam justificáveis no caso.

SOME EFFECTS OF PRUNING ON THE GROWTH AND TIMBER QUALITY OF *Eucalyptus grandis* IN ZULULAND.

Summary

A pruning trial in Eucalyptus grandis with six pruning regimes and a control displayed negligible effects on growth rates. Recovery after removal of up to 50 % of the live crown was rapid. Gains in knot-free timber were insignificantly small while degrade due to stresses induced by severe pruning was not significant. Corrective pruning and brashing for access only is advocated.

INTRODUCTION

During the period April 1977 to March 1978 a total of 232 260 m^3 of Eucalyptus grandis sawlogs was delivered to primary processors in the Republic of South Africa (Anon. 1978). This represents 8,6 % of the total sawlog production of South Africa and demonstrates the importance of the species to the country. The historical development of the hardwood section of the timber industry has been thoroughly described by Maree (1979), Lückhoff (1967) and Nicholson (1963).

As early as 1940 Maree (ibid) described the concern expressed about the timber lost because of knots. As a result a pruning policy similar to that for conifers was introduced. This resulted in the development of excessive growth stresses within the timber, and the light, frequent prunings were difficult to apply in practice. An experiment designed to assess the effect of various live pruning regimes on the growth and timber qualities of the species was established at Langepan in 1952.

Langepan (now part of the KwaMbonambi State Forest) lies on the coastal plain of Zululand and the experiment is situated at approximately 32° 12' E and 28° 40' S. This is in close proximity to the C.C.T. spacing trial for which the climate has been comprehensively described by Bredenkamp (1977). Essentially the area is on the boundary of the humid and subhumid climatic zones with a mean annual temperature of 21,8° C, a mean annual rainfall of 1 400 mm and without marked differentiation between wet and dry seasons. Zululand has only 12,4 % of the country's Eucalyptus grandis plantations by area but produces 35,2 % of the sawtimber from the species (Anon. 1978).

The experiment described hereafter was initiated and first analysed by Lückhoff (ibid) who used data collected when the trees were 12 years old. He concluded that:

> "In all treatments pruning of living branches had a greater effect on diameter than on height growth, although in Treatment (vii) (the most severe pruning) height growth was significantly depressed a few months earlier than diameter growth ..." and "... the removal of 40 per cent or more of the length of living crown causes a highly significant drop in diameter increment and mean diameter, and generally a significant drop in height increment and mean height, in the growing season following pruning. The removal of a third, or less, of the length of living crown has no significant effect on either diameter or height growth. Where the initial pruning removes 40 per cent or more of the length of living crown, and is followed by a second pruning which removes a third of the length of living crown, there is no further depressive effect on increment but mean diameter remains significantly depressed and recovery is delayed for about a year. All treatments recovered completely from the effects of pruning, even in the case of the severest treatments, two years or less after the completion of the final pruning treatment."

The calculations on which the above conclusions were based are available on the experimental record. It is apparent that although standard analyses of variance showed non-significant F-values all treatments were nevertheless compared by means of the least significant difference test.

Although no reference is made to the level of significance used for the test criterion, these comparisons must be considered as non-independent and the true probability level probably far exceeded that which was used. Steel and Torrie (1960) claim that with six treatments the observed value of t for the greatest difference will exceed the tabulated 5 % level about 40 % of the time even when no effect is present. With seven treatments the error level will be even higher. Snedecor and Cochran (1976) quote R.A. Fisher as follows: "When the z-test (i.e., the F-test) does not demonstrate significance, much caution should be used before claiming significance for special comparisons." The use of the terms significant and highly significant in the conclusions quoted above should be interpreted with circumspection.

Schönau (1974) found that removal of 50 % of the live crown reduced the mean height significantly and the DBH highly significantly when E. grandis was planted on a poor site.

In his study of the timber yields at 12 years of age Lückhoff (ibid) concluded that "... although early live pruning reduces the incidence of knots in sawn boards it also results in serious degrade due to stresses being set up in the wood which give rise to spring. The extent of this degrade appears to be directly proportional to the severity of pruning. Pruning of live branches has not, therefore, had the effect which was hoped for. There is only a small increase in the production of grade I timber while the percentage of reject timber has remained practically unchanged or even increased in severe pruning treatments, due to the high incidence of spring in the sawn product". No statistical testing of results regarding timber quality were carried out.

Experimental method

The experiment was a randomised complete block with four replications. All the treatments except the control were based on three lifts to final pruning height of 6,7 m as this was the normal maximum pruning height for all species in South Africa.

The treatments applied were as follows:

(i) Control - no pruning except for brashing of dead branches for access.

(ii) Prune all stems 2,4 m at a mean height of 6,1 m at 12,2 m.

(iii) Prune all stems to half height at a mean height of 4,6 m to 4,6 m at 7,6 m and to 6,7 m at 11,0 m.

(iv) Prune as for treatment (ii) but at mean heights of 6,1 m, 7,6 m and 10,7 m.

(v) Prune all stems to one third height at a mean predominant height of 6,1 m to half height at 9,1 m and 6,7 m at 12,2 - 13,7 m.

(vi) As for (v) but only 121 stems/ha pruned in the second and third lifts.

(vii) Prune all stems to half height at a mean height of 3,7 m to 3,7 m at 6,1 m and to 6,7 m at 10,7 m.

The experimental area was ploughed in March 1952, disc harrowed four months later and then planted at an espacement of 2,74 m in September of the same year. The first pruning treatments were applied when the trees were 18 months old and were finalised in October 1955 when the trees were just over three years of age. During this period there were complete enumerations whenever a treatment was applied. There were also annual enumerations in the four subsequent years resulting in 13 data sets.

When the trees were 12 years old the earlier growth data was analysed and the stand was thinned to 741 stems/ha. Logs from three of the largest thinned trees in each treatment were sawn and the boards graded. Further thinnings were at 15 years to 494 stems/ha and at 18 years to 247 stems/ha. The final assessment of the experiment was carried out in September 1977 when the trees were 25 years old. As a result of Lückhoff's (ibid) findings only treatments (i), (ii), (iv) and (vii) were sampled by selecting five trees at random from each plot. After measurement of DBH the trees were felled and debarked.

The following measurements were taken:

Height to top (m)
Height to first living branch (m)
Underbark diameter of 3,3 m logs at both ends (cm).

The bottom three logs of each tree were sawn through and through into 29 mm thick boards, edged to standard board widths and seasoned under cover until the equilibrium moisture content was reached. The seasoned boards from all logs were graded in accordance with S.A.B.S. Hardwood Furniture Specification 1099 - 1976, taking into account all the defects. As there were enumerations of the experiment at various times of the year, they are not directly comparable in terms of stage of development during the growing cycle. Age, the independent variable for analysis of the DBH and height data, was thus weighted with the expected monthly growth expressed as a percentage of a full year as established by Van Laar (1973) and modified for Zululand by Bredenkamp (ibid).

Results

A. The effect on DBH growth

In respect of mean DBH (root mean squared breast height diameter, over bark) analyses of variance were computed for each of the first 12 enumerations. The results are presented in Table 1.

There were highly significant differences between replications during the early stages of the experiment. Such a situation occurs frequently in Zululand which has essentially a very flat topography coupled with a high water table. The slightest undulation often results in quite remarkable site differences. However these differences disappeared shortly after the trees were three years old. At no stage was there any indication of statistically significant differences in DBH which could be attributed to treatment effects. The DBH development is shown in Figure 1 and can be described by the equation

$$\text{DBH} = 21{,}106 - 33{,}8599 \times 0{,}6497^{\text{Age}} \quad \ldots\ldots\ldots\ldots\ldots \text{ eq. } 1$$

where $S_{y.x} = 0{,}510$ and the sum of squared deviations from the mean is 11,70.

As the experiment was completely enumerated whenever a treatment was applied, it was possible to test the assumption that recovery of Eucalyptus grandis is so rapid that any treatment effects on DBH increment had disappeared and thus show non-significance in Table 1.

The increment (mm/day) was calculated for the interval between measurements immediately following a treatment. The comparable interval for the control was obtained by use of the mean age of application in respect of all other treatments. As treatment (vi) was only applied to some stems it was excluded from the analysis. No significant differences were discerned.

The DBH increment was similarly calculated for the interval between the two measurements immediately preceding the first pruning. The difference between DBH increment before and after the pruning was compared by a test of paired observations. Treatments (i) and (vi) were excluded from the analysis. Again no significant difference was detected.

B. The effect on height growth

In respect of mean plot heights, analyses of variance were computed for each of the 13 enumerations. Mean height (Ht) was described as the regression height of the tree with the root mean squared diameter from the quadratic function

$$\text{Ht} = B_0 + b_1 \text{ (DBH)} + b_2 \text{ (DBH)}^2$$

with the exception of the first measurement at 0,92 years of age when the arithmetic mean height was used. The results are presented in Table 2.

As with the DBH analyses, highly significant differences were found in respect of replications which subsequently disappeared. No differences in respect of treatment effects were found to be significant except that for August 1958, three years after application of the last treatment. This is anomolous and no explanation can be offered.

The height development is shown in Figure 1 and can be described by the equation:

$$\text{Height} = (5{,}1120 - 5{,}8724 \times 0{,}6788^{\text{Age}})^{2{,}062} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{ eq. } 2$$

where $S_{y.x} = 0{,}093$ ant the sum of squared deviations is 12,470.

The height increment (i_{Ht}) per lift (mm/day), expressed as the increase in height from the time of application of the treatment until the subsequant enumeration, was computed from plot regression equations similar to eq 2. Variables for the control treatment were obtained as described for the analysis of DBH increment, treatment (vi) was again excluded.

Analyses of variance showed a treatment difference at the 5 % level of significance in respect of height increment after the first lift and no differences for the subsequent lifts. Investigation of the first lift by means of the Student-Newman-Keuls' test (Steel and Torrie, 1960) revealed that the height increment after the heaviest pruning (treatment (vii)) had been significantly depressed (p = 0,05) and there was no significant difference between the other treatments.

Treatment	(vii)	(iii)	(v)	(iv)	(ii)	(i)	
Mean i_{Ht}	12,23	13,33	15,38	16,20	16,43	16,73	(mm/day)

The length of the unpruned crown (CL) after the first lift was defined as the difference between mean plot height (Ht) and the specified pruning height. The data was fitted to the function

$$i_{Ht} = b_0 + b_1 \ Ht + b_2 \ Ht^2 + b_3 \ CL.$$

The analysis of regression is shown in Table 3.

As mean plot height is insignificant in the response, a polynomial equation with i_{Ht} as a function of CL was fitted. The analysis of regression showed both the linear and quadratic terms to be highly significant. The prediction equation is:

$$i_{Ht} = 1{,}417 + 0{,}099 \ CL - 0{,}023 \ CL^2 \ \ldots\ldots\ldots\ldots\ldots\ldots \quad \text{eq. 3}$$

Solution of the first derivative of the equation shows that 2,15 m is the optimum length of live crown to be left after the first pruning to maximise height increment.

C. The effect on crown length and taper

Analysis of the final enumeration data showed no significant differences between treatments or replications in respect of DBH, mean height or height to the first live branch. The relationship between crown length and height is linear.

As the sample logs were prepared in 3,3 m lengths the juncture of the second and third logs coincided with the maximum pruning height (2 x 3,3 m + stump = 6,7 m). Analyses of variance for these logs were calculated in respect of taper expressed as mm/m and the results showed that the pruning treatments applied did not affect the taper of the logs immediately above or below the maximum pruning height. However, an investigation by means of paired observations showed that the taper of the third log is significantly greater than that of the second log.

D. The effect on timber quality (25 years)

The grading results of the boards from the bottom three logs are presented in Table 4. As only the bottom two logs represented the pruned portion of the stem the grading results of boards from these logs are presented separately in Table 5.

In all cases an analysis of variance was carried out to test the difference between the treatment means. An analysis of covariance showed that the variation in tree size (DBH) between treatments was small enough not to have had any significant effect on sawn yields.

The four pruning treatments had no significant effect on the total yield of graded timber. There were also no indications that pruning intensity significantly affected timber losses due to any defect. Although not significant, treatment (ii) produced the highest percentage of clear grade timber and total graded timber. This treatment also produced the lowest percentage of timber rejected because of excessive knots and knot defects as well as the lowest percentage of timber rejected for all defects. Only in the case of Knotty Grade timber did pruning intensity appear to have had a significant effect. Both pruning treatments (i) and (ii) differed significantly from treatments (iv) and (vii) at a 1 % level of significance.

The results of the analyses of the grading data from the lower two logs did not differ much from the results obtained from material of the lower three logs.

The control produced a relatively high percentage of timber rejected because of excessive knots and associated defects. Treatment (vii), which is the severest degree of pruning, resulted in an unexpectedly high percentage of timber rejected owing to this defect. These differences were not significant. Similarly a non-significant increase in degrade due to warp appeared to be directly proportional to pruning intensity.

CONCLUSIONS

1. Recovery of Eucalyptus grandis after pruning is extremely rapid. Severe pruning of 50 % of the live crown significantly retards height increment but only for a very short period. The rate of recovery is such that no significant effects of pruning are reflected in DBH and height growth.

2. Height increment is significantly correlated with the length of the live crown while total tree height is relatively unimportant. The relationship between height increment and crown length is quadratic.

3. Pruning does not affect subsequent self-pruning above the maximum pruned height.

4. Pruning does not affect log taper within or above the pruned zone.

5. The taper of the log immediately above the maximum pruning height is significantly greater than that of the heighest pruned log. It is unlikely that this is a result of the pruning.

6. The pruning treatments applied had no significant effect on the total yield of graded timber. Similarly there were no timber losses due to defects which could be attributed to pruning.

7. Significant differences in yields of knotty grade timber owing to pruning treatment represented only a small proportion of the volume at 25 years of age, thus supporting Lückhoff's (ibid) findings on the quality of 12 year old timber.

DISCUSSION

Height growth of Eucalyptus grandis under typical Zululand conditions is in the order of 4 m per annum (12 mm/day) during the first four years. The treatments in this trial required three lifts and the interval between subsequent pruning operations varied from 89 to 306 days. Such regimes are not feasible in practice and the decision by the Department of Forestry (Anon, 1977) to reduce prunings from three lifts to one was logical.

A current work study report is based on live pruning in three lifts to 7,5 m and specifies 11,9 labour units/ha. The single pruning is essentially a brashing of dead branches where the weight of the saw alone is sufficient to remove the branch and the labour component of the cost could be considerably reduced. The single pruning must however be carried out in three (possibly two) consecutive operations owing to the difficulties of pruning lower branches with long-handled saws in densely stocked stands. Workstudy officer P. Ramsay (pers. comm.) estimates the current requirements to be 5,2 units/ha. Further savings in respect of transport of labour to the field and supervision are envisaged. Nevertheless these components plus the supply and maintenance of saws result in substantial expenditure early in the rotation which should be curtailed.

De Villiers (1968) found a steeper radial density gradient, after lower initial density, in stems of E. grandis grown in Zululand compared to those grown in less tropical climates. It is also well known that the core of the species becomes progressively more discoloured and brittle with age. Mill manager J.L. van der Walt (pers. comm.) has found that from the age of 20 years onwards this material is so brittle that it cannot be chipped properly and can therefore not even be used for fibre production. Maree (ibid) reported that boards from this material are used solely for underground work where quality is of no consequence. Most of the core wood produced in Zululand from older trees is utilised for the production of wedges for underground use. The specifications are extremely lax, the prices are low and all material from a core ranging from 150 to 200 mm is utilised in this manner. Restriction of the size of the knotty core by early live pruning is thus producing knot-free waste timber.

Lückhoff (1967) has outlined the practical problems associated with live pruning of the species and shown that increased severity of pruning results in increased degrade of yields due to spring. The latest timber quality assessment confirms this although the effects are not significant.

Van Laar (1961) investigated branch shedding and found that physiological factors were not the only factors involved. This experiment did not disclose any effect of pruning on subsequent branch shedding but as three thinnings were done an additional source of variation had been introduced.

Van Laar and Bredenkamp (1979) investigated the relationship between crown length and DBH over a wide range of stocking intensities for the same species at nearly the same age, and found the relationship to be linear. In this study multiple regression analysis showed height to be the more important predictor variable. Only the linear effect was significant.

The findings of this study are applicable to good sites as the experiment is situated on one of the best E. grandis sites in the country. The converse is true on poor sites as has been shown by Schönau (ibid).

This study shows that pruning does not adversely affect growth parameters nor does it result in marked improvement of clear timber yields.

RECOMMENDATIONS

It appears fruitless to practice live pruning of Eucalyptus grandis and the expense of even merely brashing dead branches to 7 m cannot be justified. A corrective pruning with secateurs when the trees are 3 to 4 m high to discourage the formation of forks may be required on poorer sites but a brashing for access is all that is required for the majority of stands.

On wetter Zululand sites self-pruning does not appear to be as effective as on average sites. Branches remain alive down to ground level for much longer periods of time. Further investigation is required but on such sites an earlier live pruning to 2 or 3 m may be required.

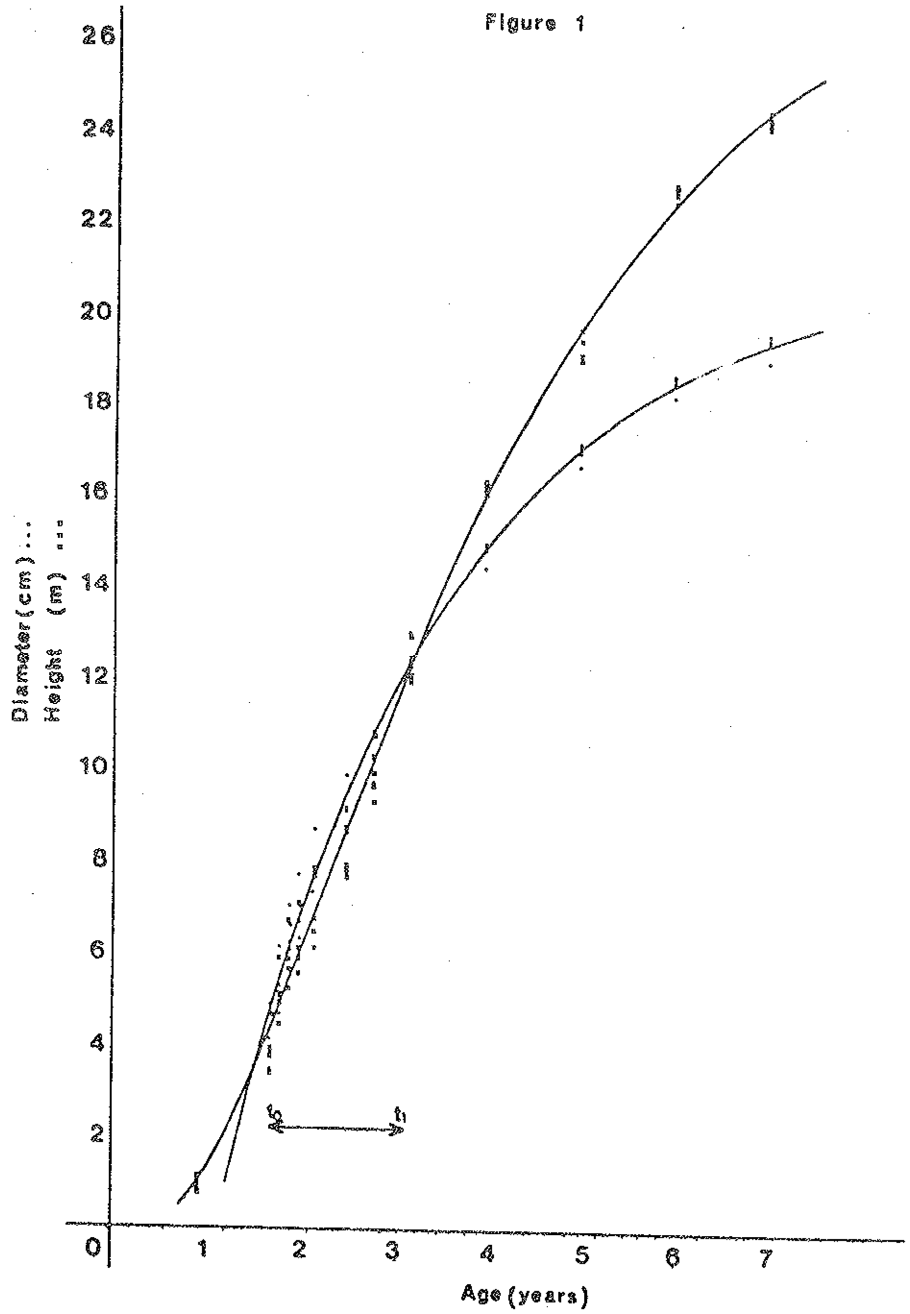

Figure 1 : DBH and height growth (means of all replications) during first seven years. ($t_o \leftrightarrow t_1$ denotes interval during which will treatments were applied.)

Table 1 Results of analyses of variance in respect of DBH

Age (years)	Mean square			F	
	Replications	Treatments	Error	Replications	Treatments
1,67	2,430	0,046	0,210	11,57**	<1 n.s.
1,78	2,743	0,180	0,273	10,05**	<1 n.s.
1,86	2,647	0,172	0,286	9,26**	<1 n.s.
1,96	2,321	0,252	0,329	7,05**	<1 n.s.
2,11	2,223	0,305	0,245	8,75**	1,20 n.s.
2,46	1,790	0,275	0,287	6,24**	<1 n.s.
2,74	1,221	0,339	0,211	5,79**	1,61 n.s.
3,11	1,166	0,318	0,217	5,37**	1,46 n.s.
3,92	0,397	0,409	0,163	2,44 n.s.	2,51 n.s.
4,92	0,298	0,335	0,178	1,67 n.s.	1,88 n.s.
5,92	0,298	0,315	0,197	1,51 n.s.	1,60 n.s.
6,92	0,504	0,389	0,173	2,91 n.s.	2,24 n.s.

Probability levels : Replications : $F_{0,05}$ (3,18 d.f.) = 3,16
$F_{0,01}$ (3,18 d.f.) = 5,09
Treatments : $F_{0,05}$ (6,18 d.f.) = 2,66
$F_{0,01}$ (6,18 d.f.) = 4,01

Table 2 Results of analyses of variance in respect of mean height

Age (years)	Mean square			F	
	Replications	Treatments	Error	Replications	Treatments
0,92	0,127	0,007	0,018	7,06**	<1 n.s.
1,67	1,853	0,067	0,159	11,65**	<1 n.s.
1,78	2,580	0,301	0,505	ø 5,12*	ø <1 n.s.
1,86	2,818	0,300	0,269	10,48**	1,12 n.s.
1,96	2,628	0,324	0,250	10,51**	1,37 n.s.
2,11	2,667	0,352	0,237	11,25**	1,48 n.s.
2,46	1,616	0,260	0,306	5,28**	<1 n.s.
2,74	2,508	0,417	0,313	8,01**	1,33 n.s.
3,11	1,303	0,223	0,298	4,37*	<1 n.s.
3,92	2,451	3,229	3,040	ø<1 n.s.	ø1,06 n.s.
4,92	0,413	0,272	0,239	1,73 n.s.	1,14 n.s.
5,92	0,099	0,408	0,070	1,41 n.s.	5,82 **
6,92	0,022	0,236	0,102	<1 n.s.	2,31 n.s.

Probability levels : Replications : $F_{0,05}$ (3,18 d.f.) = 3,16
$F_{0,01}$ (3,18 d.f.) = 5,09
Treatments : $F_{0,05}$ (6,18 d.f.) = 2,66
$F_{0,01}$ (6,18 d.f.) = 4,01
ø : Assessed with 17 d.f. for error term.

Table 3 Analysis of variance for regression $i_{Ht} = b_0 + b_1 Ht + b_2 Ht^2 + b_3 CL$

Source	SS	df	MS	F
Total	1,135	23		
Regr x_1	0,017	1	0,017	<1 n.s.
Regr x_2	0,077	1	0,077	2,05 n.s.
Regr x_3	0,294	1	0,294	7,86 *
Error	0,748	20	0,037	

Table 4 Results of the grading studies carried out on all three logs at age 25 years. (All volumes are expressed as a percentage of the total sawn yield.)

Treatment No.	Mean DBH (mm)	Graded timber (%)				Rejected timber (%)					
		Clear grade	Semi-clear timber	Knotty grade	Total	Knots	Warp	Splits and checks	Wane	Other defects	Total
(i)	394	36,08	36,97	2,11	75,16	15,24	1,87	0,52	0,51	6,79	24,84
(ii)	386	51,52	27,42	2,55	81,49	8,15	2,90	1,63	1,02	4,81	18,51
(iv)	366	43,69	25,80	4,66	74,15	11,88	6,78	1,14	0,78	5,27	25,85
(vii)	352	38,44	26,61	6,19	71,24	14,82	5,75	1,59	0,86	5,74	28,76

Table 5 Results of the grading studies carried out on the lower two logs at age 25 years. (All volumes are expressed as a percentage of the total sawn yield.)

Treatments No.	Mean DBH (MM)	Graded timber (%)				Rejected timber (%)					
		Clear grade	Semi-clear timber	Knotty grade	Total	Knots	Warp	Splits and checks	Wane	Other defects	Total
(i)	394	34,42	33,20	2,06	69,68	21,21	1,97	0,62	0,42	6,10	30,32
(ii)	386	58,87	22,43	1,63	82,93	4,65	3,89	1,05	1,05	6,43	17,07
(iv)	366	37,16	30,33	4,71	72,10	7,62	10,27	1,04	1,38	7,59	27,90
(vii)	352	42,07	23,27	5,12	70,46	11,45	6,51	0,93	2,91	7,74	29,54

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INFLUÊNCIA DO ESPAÇAMENTO DE PLANTIO NA PRODUTIVIDADE FLORESTAL.

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Resumo

O presente trabalho procura avaliar do ponto de vista técnico os reflexos do espaçamento de plantio sobre o desenvolvimento de florestas econômicas. Essa avaliação crítica visa orientar o silvicultor para que o mesmo selecione seu espaçamento de plantio, dentro de limites aceitáveis, minimizando seus riscos de insucesso.

Os reflexos do espaçamento de plantio sobre o volume de madeira e práticas silviculturais, bem como as suas interações com a qualidade do "site", idade de corte e espécie a ser implantada, foram os principais fotores discutidos neste trabalho.

O comportamento diferencial do E. *saligna* em relação ao E. *grandis*, em espaçamentos mais fechados, ficou evidenciado por um maior auto-desbaste do primeiro quando implantado em espaçamentos inferiores a 7,5 m^2/planta. Esta fato demonstra que deve ser feita uma revisão de conceitos sobre as técnicas de implantação do E. *saligna*.

Considerando-se as limitações ambientais de grande parte das regiões dos cerrados brasileiros, bem como as características silviculturais das espécies de *Eucalyptus* atualmente disponíveis para plantio, sugeriu-se evitar plantios de extensas áreas de florestas de *Eucalyptus*, com espaçamentos inferiores a 3 m^2/planta.

SPACING INFLUENCES OVER *Eucalyptus* FOREST PRODUCTIVITY.

Summary

This work aims the evaluation from the technical point of view of the planting spacement effects on the economic forest development to guide the planting spacement choice by the forester, within acceptable limits, minimizing the risk.

The planting spacement effects on the wood volumetric yield and in silvicultural practices, as will their interation with the site quality, exploration age and species were the main factors discussed in this work.

The results indicate that when E. *saligna* is planted in small spacing (less than 7.5 m^2/tree) it shows a higher self-thinning potential than E. *grandis*. This fact suggest that a complet review of E. *saligna* establishment and management techniques must be done as soon as possible.

Considering the environmental limitations of brazilian savanna regions, and silvicultural characteristics of *Eucalyptus* species available to be planted in those areas, it seems a wise procedure to avoid using spacing less than 3.0 m2/tree.

2. INTRODUÇÃO

O objetivo básico da silvicultura moderna não é simplesmente produzir um alto volume de madeira. É necessário que este alto volume seja de um material adequado à cada uso e que proporcione um máximo retorno do investimento aplicado.

A silvicultura brasileira tem hoje dois grandes desafios que, quando solucionados, trarão sem dúvida uma considerável economia de divisas ao país. O primeiro, de solução possível a médio e longo prazo, seria equacionar os problemas silviculturais da Floresta Amazônica. O segundo seria procurar atender a curto prazo, a crescente demanda de madeira industrial e ainda suprir parte das necessidades energéticas do país.

A evolução atual pela qual vem passando os nossos conhecimentos, com relação às florestas implantadas, certamente permitirá que se atinjam os propósitos deste segundo desafio.

Dentro deste contexto, o conhecimento sobre as possíveis implicações ecológicas e silviculturais do espaçamento de plantio assume uma importância fundamental no sentido de se evitar exageros na adoção dos espaçamentos.

O assunto abordado por este trabalho visa levantar alguns problemas, discutí-los e, quando possível, trazer algumas sugestões de forma que se possa nortear de maneira mais equilibrada a adoção de espaçamentos de plantio.

3. ESCOLHA DO ESPAÇAMENTO DE PLANTIO

A escolha do espaçamento de plantio, na maioria dos planejamentos florestais, tem se fundamentado simplesmente no uso final da madeira, negligenciando-se outros envolvimentos ecológicos/silviculturais de suma importância.

O espaçamento tem uma série de implicações do ponto de vista silvicultural, tecnológico e econômico. Ele afeta as taxas de crescimento das plantas, qualidade da madeira, idade de corte, bem como as práticas de exploração e manejo florestal e, consequentemente, os custos de produção.

Em nossas condições, a maioria dos plantios comerciais tem sido implantados em função de estudos desenvolvidos com vistas a produção de madeira para celulose e/ou chapas de fibras. Considerando-se a diversidade de comportamento das espécies florestais e as diferentes qualidades de madeira exigidas para cada uso, espera-se que o espaçamento ideal para celulose não seja o mesmo indicado para produção de lenha, carvão ou madeira para energia. A diferenciação entre espaçamentos também pode ocorrer ao nível de espécies, ou seja, espécies diferentes podem apresentar comportamentos diferentes dentro de um mesmo espaçamento de plantio.

Em função dos diferentes aspectos silviculturais correlacionados ou alteráveis pela escolha do espaçamento, considerou-se como importantes a serem abordados:

a. Espaçamento x volume de madeira;
b. Espaçamento x idade de corte;
c. Espaçamento x qualidade do "site";
d. Espaçamento x espécie;
e. Espaçamento x práticas silviculturais;

Ressalta-se ainda que o espaçamento também pode afetar a qualidade da madeira. Entretanto, este aspecto não será discutido no presente trabalho.

a. Espaçamento x Volume de madeira

Altura, DAP, sobrevivência e conicidade do fuste são características passíveis de alteração pelo espaçamento de plantio e que interferem tanto no volume total de madeira como no volume útil produzido pela floresta.

a.1. DAP e Altura

Em média, segundo preceitos teóricos silviculturais, o espaçamento tem uma influência maior no desenvolvimento do DAP do que no desenvolvimento em altura das árvores. O aumento do DAP através do aumento do espaçamento entre árvores foi comprovado por centenas de trabalhos experimentais desenvolvidos nas mais diversas regiões do mundo. Entretanto, existe alguma controvérsia com relação aos reflexos do espaçamento sobre o crescimento em altura das árvores. Existem casos onde a altura média aumenta com o espaçamento e outros onde o resultado é o inverso *(EVERT, 1971)*.

Em um experimento conduzido pelo IPEF, verificou-se uma tendência em diminuir a altura média das árvores à medida que se diminuía o espaçamento. Entretanto, conforme se observa na tabela 1, a altura média de 15% das árvores dominantes das parcelas não sofreu alterações significativas para ambas as espécies estudadas, aos 74 meses de idade.

TABELA 1. Altura média total e altura média de 15% das maiores árvores da parcela de *E. grandis* e *E. saligna*, aos 74 meses de idade, sob diferentes espaçamentos.

Espaçamento	*E. grandis*			*E. saligna*		
	$\bar{H}$ (m)	CV%	*$\bar{H}$ dom. (m)	$\bar{H}$ (m)	CV%	*$\bar{H}$ dom. (m)
3,0 x 1,50	20,4	23	26,7	16,9	32	24,6
3,0 x 2,00	21,4	17	26,6	18,3	31	24,3
3,0 x 2,50	21,2	20	26,0	19,2	23	24,8
3,0 x 3,75	22,8	23	27,2	19,4	26	24,7

Fonte: *BALLONI et alii (1980)*

* Altura média das maiores árvores da parcela (15% do total).

A explicação para tal fato é de certa forma simples, pois a diminuição do espaçamento dentro de certos limites tende, para muitas espécies, a aumentar o número de árvores dominadas as quais contribuem efetivamente para diminuição da altura média do povoamento. O aumento do coeficiente de variação da altura, no caso do *E. saligna*, sob espaçamentos mais apertados reforça a citada explicação.

É bastante conhecido o fato de que povoamentos mais densos produzem maior volume total de madeira que aqueles menos densos. Por outro lado, os espaçamentos maiores produzem um número mais elevado de árvores com maior volume individual. Entretanto, apesar da produção volumétrica total de madeira ser mais elevada em povoamentos com maior número de árvores, o volume útil pode não sofrer alterações, conforme se observa nas tabelas 2 e 3. Nota-se que o volume útil se mantém e a produção de lenha fina aumenta, quando se aumenta o número de árvores por área.

Estes dados sugerem que as indústrias de celulose e chapas de fibras devem estudar as possibilidades de redução dos espaçamentos de plantio, no sentido de se aumentar a produção de lenha fina para energia sem, entretanto, afetar o volume de madeira para celulose ou chapas.

Por outro lado, existem casos, para certas espécies, onde o volume útil chega a aumentar quando se aumenta o espaçamento, apesar do volume total diminuir. Estes casos tornam-se mais viáveis à medida que se exigem madeiras de bitolas mais largas.

TABELA 2. Crescimento médio em diâmetro, altura e volume por classes de diâmetro útil, em povoamento de *E. grandis*, com 10 anos e 4 meses de idade, sob diferentes espaçamentos.

Espaçamento* inicial (m)	Altura (m)	DAP (cm)	Volume (m^3/ha)		
			Ø > 5 cm	Ø > 7,5 cm	Ø > 12,5 cm
3,0 x 2,8	17,6	15,0	118	109	62
2,8 x 2,8	17,7	14,7	127	117	62
2,4 x 2,8	17,3	14,2	138	127	62
2,1 x 2,8	17,9	13,8	152	139	61

Fonte: *SCHONAU (1974)*

* Estimado em função da escala original (pes^2/acre).

TABELA 3. Crescimento médio em diâmetro, altura e volume para todas as árvores e para árvores com DAP maior que 10,24 cm, em povoamentos de *E. grandis*, com 7 anos e 3 meses de idade, sob diferentes espaçamentos.

Espaçamento* inicial (m)	Altura (m)	DAP (cm)		Volume m^3/s/casca ha		Altura DAP > 10,24 cm	
	Média	Médio	DAP > 10,24 cm	Médio	DAP > 10,24 cm	Árv/ha Nº	
1,2 x 2,5	11,7	8,1	12,2	90 a	54 a	828	29
2,5 x 2,5	12,0	10,2	14,2	72 ab	62 a	684	45
3,6 x 2,5	11,6	10,4	14,0	53 b	45 a	541	52
4,9 x 2,5	12,6	12,7	14,7	54 b	52 a	561	72

Fonte: *MESKIMEN & FRANKLIN (1978)*

* Estimados em função da escala original (pes^2/acre).

Conforme observado por *VAN LAAR (1961)*, o volume útil (até 7,6 cm) das árvores dominadas (9 a 12 m de altura) diminuiu com o acréscimo de árvores por hectare, enquanto que o volume útil das classes de árvores com 12 a 15 m de altura não foi alterado. Por outro lado, o volume útil das árvores dominantes (20 a 30 m de altura) aumentou com a diminuição do espaçamento de plantio, dentro dos limites e espécie (*E.saligna*) usados pelo autor.

Estes dados mostram que a adoção de espaçamentos não adequados para uma certa espécie pode resultar em um número excessivo de árvores dominadas as quais influem negativamente no volume útil e possivelmente no volume total.

Os dados apresentados na tabela 4 dão uma idéia da magnitude da redução do volume útil, quando o número de árvores dominadas no povoamento é excessivamente grande, já que o volume de lenha fina tem maior representatividade nas classes menores de DAP.

TABELA 4. Porcentagem de lenha fina (diâmetro menor que 8 cm) para diferentes classes de DAP.

DAP (cm)	Lenha fina
10,0	45
12,5	25
15,0	15
17,5	9
20,0	5

Adaptado de *GOES (1977)*

a.2. Sobrevivência

A sobrevivência das plantas por ocasião do corte é altamente importante para os regimes de talhadia e reflete diretamente sobre o volume total de madeira produzida.

EVERT (1971), através de uma revisão de literatura, observou que a sobrevivência foi influenciada por espaçamentos até 3,5 m^2/planta. Além deste valor, as causas, segundo o autor, seriam outras que não o efeito da competição entre plantas

Os estudos efetuados por *GUIMARÃES (1960)* mostraram que a sobrevivência do *E. saligna*, aos 8 anos de idade, foi afetada pelo espaçamento. Enquanto que nos espaçamentos inferiores a 2 m^2/planta a sobrevivência foi da ordem de 38%, nos maiores que 4,5 m^2/planta ela foi aproximadamente 56%.

É bem verdade que para a maioria das espécies, os espaçamentos mais apertados, mesmo com maior percentual de falhas e árvores dominadas, permitirão que se tenha um maior volume total de madeira, além de um maior número de árvores para segunda rotação, o que é desejável nos regimes de talhadia. Entretanto, este aspecto carece de maiores informações, principalmente aquelas de caráter econômico.

a.3. Fator de Forma

A conicidade do fuste representada pelo fator de forma é outra característica que pode ser influenciada pelo espaçamento e que tem reflexos na produção real de madeira.

EVERT (1971) levanta a possibilidade das relações entre o fator de forma e o espaçamento serem puramente um reflexo do efeito do espaçamento no DAP e, portanto, não seria necessário estudar o efeito residual do espaçamento no fator de forma. Talvez *EVERT* tenha razão, entretanto, mesmo que as interferências no fator de forma sejam produto do reflexo do espaçamento no DAP, estas interferências alteram o volume real final e, assim, deverão ser consideradas.

VAN LAAR (1978), trabalhando com *P. patula*, para um dado DAP (35,1 cm) e altura (28,6 m), verificou que o fator de forma diminuiu com o aumento do espaçamento, sendo 0,477 quando haviam 902 plantas/ha e 0,437 para 124 plantas/ha. Essa alteração pode significar um acréscimo de quase 10% no volume real, evidenciando a importância da avaliação de tal característica nos estudos de espaçamentos. Os dados apresentados por *MONTAGNA et alii (1973)* também mostram alguma tendência de aumento da conicidade com o aumento do espaçamento, a partir de um certo número de plantas por hectare.

b. Espaçamento x Espécie

Durante o crescimento inicial da floresta, o principal fator de competição é a erva daninha cujo controle é normalmente feito pelos tratos culturais. Alguns anos após, inicia-se a competição entre árvores por luz, água e nutrientes. Nos anos subsequentes os fatores limitantes do crescimento, presentes em quantidades marginais, começam a escassear e consequentemente a selecionar as plantas do povoamento, entrando o mesmo em estagnação e aumentando o número de árvores dominadas.

A maioria das espécies de *Eucalyptus* de rápido crescimento é intolerante à competição *(HILLIS & BROWN, 1978)*, ocorrendo uma rápida segregação do talhão em estratos (dominantes, codominante e dominado). O tempo para definição dos estratos será maior ou menor dependendo do espaçamento, da espécie, da qualidade do "site" e de uma interação entre estes fatores. Esta estratificação é produto da habilidade competitiva das árvores, cuja variação ocorre tanto entre espécies como entre árvores dentro de uma mesma espécie.

Existem espécies mais tolerantes à competição, ou seja, que possuem uma baixa taxa de autodesbaste, mesmo em talhões homogêneos. *HILLIS*

TABELA 5. Proporção de árvores dominadas, falhas e mortas em parcelas experimentais de *E. grandis* e *E. saligna*, aos 6 anos e 2 meses de idade, sob diferentes espaçamentos.

Espaçamento	*E. grandis*		*E. saligna*	
	% Falhas e mortas	% Dominadas*	% Falhas e mortas	% Dominadas*
3,0 x 1,50	16	15	21	30
3,0 x 2,00	18	6	21	20
3,0 x 2,50	15	9	11	12
3,0 x 3,75	19	12	11	16

Fonte: *BALLONI et alii (1980)*

* Dominada 1/2 da altura das maiores árvores da parcela (15% do total).

& BROWN, 1978), citam o *E. camaldulensis* e *E. maculata* como espécies mais tolerantes à autocompetição. O *E. pilularis* seria tolerante e o *E. regnans* intolerante segundo os mesmos autores.

Para os povoamentos implantados, o grau de autodesbaste ou a porcentagem de árvores dominadas no talhão pode também ser produto do grau de melhoramento genético em que se encontra a espécie. Os dados da tabela 5 mostram, para os espaçamentos mais apertados, que o *E. saligna* apresenta um maior número de plantas dominadas, falhas e mortas do que o *E. grandis*, sendo que ambas as espécies originaram-se de sementes colhidas em povoamentos naturais em Coff's Harbour, na Austrália. No caso dos espaçamentos mais abertos, as diferenças entre as espécies praticamente desaparecem no que tange as características avaliadas.

Estes dados, apesar de não serem conclusivos, mostram claramente que o plantio de *E. saligna*, em espaçamentos inferiores a 3,0 x 2,0 m, deve ser encarado com cautela para rotações convencionais, ou seja, corte com 6 a 7 anos de idade.

c. Espaçamento x Idade de corte

O espaçamento e a idade de corte encontram-se intimamente relacionados, ou seja, os plantios sob espaçamentos menores normalmente exigem desbastes ou ciclos mais curtos de cortes, pois a competição entre plantas ocorre mais precocemente, antecipando a estagnação do crescimento do povoamento.

Em função das relações entre as referidas características e por não justificar discussões isoladas de cada uma, elas serão abordadas conjuntamente.

A idade de corte tem sido definida em função do rítmo de crescimento, espaçamento, finalidade da madeira e de algumas interações entre os citados fatores. Pouca ênfase tem sido dada as suas interações com a espécie, conforme já ressaltado anteriormente.

A porcentagem de árvores dominadas e mortas cresce com o avanço da idade, causando consequentemente um aumento da porcentagem de falhas. Este fato ocorre com maior intensidade e mais precocemente nos espaçamentos mais apertados.

A tabela 6 mostra alguns dados sobre a evolução da mortalidade em função da idade, enquanto que a tabela 7 mostra a evolução da porcentagem de árvores dominadas em função da idade e do espaçamento.

TABELA 6. Volume de madeira e mortalidade de *E. grandis* em diferentes idades.

Idade		Mortalidade	Vol. (m^3/ha)*
anos	meses	%	
2	3	1,9	4,4
2	9	1,9	8,1
4	4	2,6	22,7
5	5	3,6	39,9
6	6	5,6	57,2
**7	6	13,4	70,1
9	1	19,6	94,7
10	4	25,0	109,8

Fonte: *SCHONAU (1974)*

* Volume até 5 cm de diâmetro no espaçamento 2,8 x 2,8 m.

** Ocorrência de um período anormal de estiagem.

TABELA 7. Porcentagem de árvores dominadas de *E. saligna*, em função do espaçamento e da idade.

Espaçamento	Idades (anos)		
(m)	4	6	9
3,0 x 1,50	31%	45%	57%
3,0 x 2,0	31%	37%	43%
3,0 x 2,50	13%	22%	38%
3,0 x 3,75	21%	25%	35%

Adaptado de *BALLONI et alii (1980)*

É evidente que uma mortalidade mais acentuada e/ou um maior número de árvores dominadas pode refletir negativamente no volume de madeira, estabilizando e até reduzindo o incremento médio anual.

Os resultados obtidos por *MELLO et alii (1976)* mostram que a idade de corte varia em função da espécie e do espaçamento adotado.

A manutenção da floresta com o crescimento estagnado não é desejável, devendo-se para evitar tal problema, fazer o corte ou desbastes, em idades mais jovens. Todavia, dependendo do espaçamento de plantio e do ritmo de crescimento, os cortes tornar-se-iam necessários em fases muito jovens do crescimento, o que poderia exportar quantidades excessivas de nutrientes do solo, diminuindo sua fertilidade e podendo comprometer o sucesso das rotações futuras, além de produzir madeira de qualidade inferior. Portanto, dependendo da espécie a ser implantada, não seria conveniente a adoção de espaçamentos extremamente apertados para se antecipar sua rotação.

Os incrementos gravimétricos anuais obtidos por *BELOTTE (1980)* (tabela 8) sugerem para o espaçamento estudado (3,0 x 2,0 m), que o corte do *E. grandis* à idades inferiores à 4 anos não seria compensador, já que a curva de crescimento em peso sofre uma grande inclinação positiva a partir do 4º ano. Esses acréscimos do crescimento gravimétrico podem ser parcialmente explicados devido a um provável aumento na densidade da madeira à partir do 5º ano, além evidentemente do crescimento volumétrico. Os dados obtidos por esse autor mostram a importância de se fazer um inventário florestal criterioso de forma à acompanhar o crescimento da floresta não só do ponto de vista dendrométrico mas também quanto ao crescimento gravimétrico.

TABELA 8. Peso total da materia seca da parte aérea de *E. grandis* em função da idade.

Idade ano	Peso* (Ton/ha)	IMA (Ton/ha/ano)
1	12,1	12,1
2	39,4	19,7
3	64,3	21,4
4	108,4	27,1
5	149,1	29,8
6	289,6	48,3
7	224,2	32,0

Adaptado de *Belotte (1980)*

* Peso dos ramos, folhas e caule de 1.500 árvores/ha.

IMA - Incremento médio anual, em peso.

d. Espaçamento x "Site"

Conforme já salientado, após alguns anos de crescimento da floresta, as plantas entram em competição por água, luz e nutrientes. Portanto, é esperado que os fatores abióticos do "site" (climáticos, edáficos e fisiográficos) devam ter suas influências na escolha do espaçamento. Locais mais secos e/ou com solos de mais baixa fertilidade apresentam tendências a suportar um número menor de plantas por área do que locais mais úmidos e férteis, ou seja, existe uma área basal máxima para cada "site".

Sobre este aspecto, *BARRET et alii (1975)* afirmam que plantios de *Eucalyptus* em espaçamentos menores que 2 m^2/planta somente seriam indicados para os melhores "sites". Em "sites" pobres, os espaçamentos deveriam ser superiores a 3 m^2/planta.

Já o *WATLLE RESEARCH INSTITUT (1970)* recomenda, para os sites mais pobres, o plantio de *Eucalyptus* sob espaçamentos mais amplos caso contrário a indicação daquela Instituição seria o plantio de *Pinus*.

Os resultados obtidos por *VAN LAAR (1961)*, para *Eucalyptus saligna*, não confirmaram, para os sites estudados, a necessidade de se abrir os espaçamentos em sites mais pobres. Afirma o autor que o problema é bastante complexo, pois o crescimento do talhão não só depende do consumo de água pelas árvores, mas também da água consumida pela vegetação competidora. Desta forma, a maior competição das ervas daninhas nos espaçamentos mais amplos poderia influir nos resultados.

O plantio em espaçamentos apertados e em "sites" mais ricos pode também depender da existência de mercado para a madeira fina pois, caso contrário os desbastes serão considerados como operações culturais necessárias, sem retorno econômico. Segundo essa última afirmativa feita por *ASSMANN (1970)*, depreende-se que a escolha do espaçamento de plantio, mesmo em "sites" pobres, estaria ligada à existência de mercado para o produto final da floresta.

e. Espaçamento x Práticas silviculturais

Conforme salientado nos itens anteriores, a densidade do povoamento pode influir significativamente no crescimento das árvores.

Dependendo da espécie e das características ambientais, quanto maior o número de árvores por unidade de área, dentro de certos limites, maior o volume total de madeira produzida. Por outro lado, o aumento da densidade do talhão implica no aumento dos custos de implantação e exploração, sendo necessário balancear os aumentos das produções com os aumentos dos custos.

Maior consumo de mudas e fertilizantes bem como uma possível dificuldade de exploração, acesso para os tratos culturais e produção de madeira de pequenas dimensões nos desbastes, são as principais consequências negativas, sob o ponto de vista técnico e econômico, dos espaçamentos mais apertados. Por outro lado, além do maior volume total de madeira produzida, os plantios sob espaçamentos mais apertados certamente exigirão menor número de tratos culturais, devido a uma ocupação mais rápida do terreno, abafando de forma mais efetiva o crescimento das ervas daninhas.

Outro aspecto a ser considerado como favorecido pelos espaçamentos mais apertados é uma maior possibilidade de se ter uma produção mais favorável, também na 2a. rotação, quando a regeneração for por talhadia. Este detalhe deve ser considerado principalmente para as espécies com problemas de baixa sobrevivência das touças, muito embora a *WATTLE RESEARCH INSTITUT (1970)* considere que a mortalidade das touças é aumentada em função do aumento da densidade do talhão.

A desrama natural também ocorrerá de maneira mais rápida nos espaçamentos mais apertados, devido a competição mais intensa por luz e, consequentemente, uma morte mais precoce dos ramos inferiores.

Não só a densidade de plantio mas também a retangularidade do espaçamento, ou seja, a relação entre a distância entre linhas e a distância dentro da linha, pode influenciar significativamente os rendimentos de plantio. Teoricamente os espaçamentos retangulares proporcionam, para uma mesma densidade de plantas, maiores rendimentos de plantio que espaçamentos quadrados.

WIANT JR. (1973), através de modêlos teóricos, constatou através da da tabela 9 que da densidade de plantas, a sistemática de distribuição na área pode influenciar o crescimento.

Sandrasegaran (1966), citado por *EVERT (1973)*, também verificou, para um mesmo número de árvores por área, que os espaçamentos triangulares levavam certa vantagem sobre os quadrados, já que os primeiros utilizavam 90,69% do espaço desponível, e os últimos apenas 78,54%.

TABELA 9. Porcentagem teórica de recobrimento do solo em função da forma de disposição das plantas no terreno.

Espaçamentos	Porcentagem teórica de recobrimento
Retangular	< 78%
Quadrado	78%
Triângulo Equilatero	91%

Adaptado de *WIANT JR. (1973)*

Segundo *ASSMANN (1970)*, considerando-se o melhor e mais uniforme aproveitamento do espaço para crescimento, obtido pelo espaçamento triangular, o mesmo deve ser adotado desde que as condições locais e técnicas permitam.

4. CONSIDERAÇÕES FINAIS

Em função do que foi discutido nos itens anteriores, observa-se que alguns conceitos tidos como imutáveis dentro da Silvicultura Brasileira merecem ser revistos e reestudados. Buscando dar uma contribuição a essa revisão de conceitos e evitar insucessos nos futuros plantios são apresentadas abaixo, algumas sugestões:

- Instalação imediata de experimentos buscando informações quanto às interações entre espécies, espaçamentos e idades de corte com as espécies/procedências já definidas como potenciais para as diferentes regiões do país.

- Avaliar, nos experimentos de espaçamento e idades de corte, além dos parâmetros convencionais (DAP, altura e % de falhas), o volume útil, fator de forma, qualidade da madeira, porcentagem de árvores mortas e dominadas, e de maneira especial, no caso de madeira para energia, os incrementos gravimétricos.

- Evitar a extrapolação de resultados de estudos de espaçamentos feitos com outras espécies e em outras situações de solo e clima, para espécies e/ou condições ambientais particulares.

- Finalmente como medida de precaução e considerando-se as limitações ambientais de grande parte da região dos cerrados, bem como as características silviculturais das espécies de *Eucalyptus* atualmente disponíveis para plantio, evitar o plantio de grandes áreas de florestas de *Eucalyptus* com espaçamentos inferiores a 3 m^2/planta , até que as pesquisas em andamento mostrem suas reais possibilidades.

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PRÁTICAS CULTURAIS PARA A OTIMIZAÇÃO DA PRODUTIVIDADE DE EUCALIPTOS PARA FIBRAS E ENERGIA.

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Resumo

As plantações de folhosas totalizaram nos Trópicos 3.080.000 ha em 1975 e espera-se que no ano 2.000 essa área aumente para 4.535.000 ha na América Tropical, 1.050.000 ha na África Tropical e 4.325.000 ha na Ásia Tropical. A maioria destas plantações serão de Eucaliptos, que deverão ser manejadas através da talhadia, envolvendo rotações inferiores a 8 ou 12 anos.

Rendimento de 100 m^3/ha são esperados, para rotações de 4 anos, na produção de biomassa. Para atingir esses rendimentos esperados deve-se tomar cuidado na seleção das espécies para os locais, na utilização de mudas geneticamente melhoradas, no preparo intensivo do solo, nos tratos culturais e adubação. Propágulos vegetativos serão normalmente utilizados em função da viabilidade de obtenção do material genético melhorado; considera-se que os benefícios dessa prática serão maiores que os riscos potenciais da monocultura.

O estudo econômico da talhadia em folhosas, visando a produção de fibras e energia, pode ser elaborado através dos objetivos estabelecidos pela organização.

No Sudeste do U.S.A. no período de 1979-80 o custo de implantação girou em torno de U.S.$750 por ha, incluindo-se tratos culturais durante um ano e excluindo-se o custo da terra. Embora esse custo seja relativamente alto, nas próximas duas décadas será dada maior atenção para talhadia em folhosas de fibra curta do que para as coníferas relativamente raras.

Cultural Practices for Optimizing Productivity of Eucalypts for Fiber and Energy.

Summary

Hardwood plantations in the Tropics totalled 3,080,000 hectares by 1975 and the total is expected to increase to 4,535,000 hectares in tropical America, 1,050,000 in tropical Africa, and 4,325,000 hectares in tropical Asia by the year 2000. The majority of these plantations will be Eucalyptus, which will be managed on coppice rotations less than 8 to 12 years.

Yields of 100 m3/ha are projected for biomass rotations of 4 years. To achieve the yield projections, care must be exercised to match species to site and to use genetically improved planting stock, intensive site preparation, cultivation and fertilization. Vegetative propagules will be commonly used as genetically improved plant material becomes available, the benefits of which will outweigh the potential dangers of monoculture.

The economics of coppicing hardwoods for fiber and energy can be determined only by objectives set by the participating organization. Plantation establishment cost of about U. S. $750 per hectare, inclusive of cultivation for one year but exclusive of land cost, were encountered in southern USA in 1979-80. Despite the relatively high costs, emphasis in the next two decades will be greater for the short-fibered coppicing hardwoods than for the relatively scarce long-fibered conifers.

INTRODUCTION

Eucalyptus spp., indigenous to Australia and the islands of Micronesia, have been planted for industrial use for more than a century. Greatest activity has occurred in the Tropics of South America, Africa and Asia, but commercial plantings extend into the Temperate Zone in areas of mild climate as far as 60°N latitude in Denmark and the Georgian state of Russia, and as far as 45°S latitude in Chile, Argentina and New Zealand. By 1975, 3,080,000 hectares of hardwood plantations, the majority of which is Eucalyptus, had been planted in the Tropics and the total is expected to increase to 4,535,000 hectares in tropical America, 1,050,000 hectares in tropical Africa, and 4,325,000 hectares in tropical Asia by the year 2000 (Lanly and Clement, 1979).

Major products from Eucalyptus plantations are pulpwood, charcoal wood, mining timber, rough building and fencing material, and fuel from rotations of 10 years or less, railroad ties, transmission poles and small sawlogs from rotations of 10 to 15 years, and saw and veneer logs from rotations of 25 to 30 years. Silvicultural practices for optimizing production for fiber and energy will be highlighted in this paper. Emphasis will be restricted to the Tropics and Subtropics because species selection is still the major objective in temperate zones where Eucalyptus is being evaluated.

Plantation Establishment

It is assumed that genetically improved plant material of the most adapted species and provenance of either seedling or vegetative origin is available for plantation establishment. Methods of producing genetically improved plants are the subject of other papers at this symposium and will not be discussed here. Likewise, production of planting stock will be left to the development of other program participants except for general comments on the type of plant needed for successful plantation establishment.

Containerized Seedlings

Containerized seedlings for plantation establishment have been preferred for the arid climate in most countries where Eucalyptus has been planted. Greater flexibility is achieved in planting such seedlings over bare-root planting stock because of the ability to schedule planting with the wet season.

Sturdy seedlings 25 to 40 cm tall are desired from container operations for outplanting. Smaller seedlings are difficult to plant and tend, and survival and growth of small plants is generally inferior to performance of optimal-sized plants. Seedlings taller than about 40 cm cannot be readily grown in tube containers smaller than 2.5 cm x 12.5 cm or in box containers smaller than 5 cm x 5 cm x 7.5 cm because of restricted rooting capacity. Containers larger than those specified become cost-prohibitive because of a geometrical increase in cost of the pot and the reduced number of seedlings that can be maintained per unit area of bed space in available greenhouses, shadehouses and nurseries. Cost of 30 cm-tall seedlings in southern USA in 1980 averaged about U.S. $90/1000.

Production of bare-root Eucalyptus seedlings has received little attention except in New Zealand and more recently in USA. Compared to containerized plants, flexibility is lost in season of planting, but larger seedlings of improved condition for harsh planting sites can be produced more economically as bare-root stock. Characteristics of Eucalyptus which make them difficult to transplant are naked buds, large leaves and a deep carrotlike root system which is specifically common to species most suited to arid conditions. Nursery practices to reduce the effect of these traits for successful transplanting include restricted use of irrigation and fertilizers after mid-growing season when the seedlings are 25 to 30 cm tall. Root-wrenching is begun at this stage and is continued at about fortnightly intervals until the desired root system is obtained (Bunn and van Dorsser, 1969). The taproot is first severed about 8 cm below soil surface. Each subsequent pass of the wrenching blade is at a slightly deeper depth. Paramount to success of wrenching is a friable soil which will allow aeration of the root system while holding height growth in check. The ultimate objective is production of seedlings with a compact, fibrous root system and a sturdy aerial portion of 30 to 50 cm tall with leathery leaves. Experience has shown that flimsy seedlings of inferior height and stem caliper, regardless of containerized or bare-root origin, should be discarded.

Methods alternative to wrenching for production of bare-root planting stock are being evaluated in USA. Seedlings of E. viminalis from seed planted in April, 1978 were lifted and treated for outplanting in March, 1979. Most large seedlings were top-clipped to 50 cm. Treatments included (1) foliage sprayed with antitranspirant, (2) roots dipped in kaolin slurry, (3) foliage sprayed with antitranspirant and roots dipped in kaolin slurry, and (4) control. The machine-planted seedlings were evaluated in March, April, May and July for survival and condition (Table 1). Many seedlings appeared dead two weeks after planting, but subsequent evaluations showed that they had died back only to sprout at or near root collar. Greatest dieback and mortality occurred to large seedlings that had not been top-clipped. Best success was achieved from spraying foliage and dipping roots, but that treatment was only slightly superior to root-dipping alone. Survival and condition of seedlings receiving only foliar spray was inferior to the control. Conclusions from this and other trials in southern USA show that planting bare-root is a viable option to planting containerized stock. Best success is achieved from planting one month to either side of winter solstice.

Table 1. Effect of foliar antitranspirant and root slurry on survival and condition of bare-root-planted 1/0 E. viminalis seedlings in southern USA

	Survival (%)				Condition Score[2]			
Date	S[1]	K	StK	C	S	K	StK	C
21 March	44	80	92	92	19	34	36	32
19 April	92	96	96	92	36	45	48	39
5 May	68	96	96	88	32	47	48	42
7 July	64	92	96	88	32	44	48	43

[1] Treatments:
S = foliage sprayed with antitranspirant
K = roots dipped in kaolin slurry
S+K = foliage sprayed with antitranspirant and roots dipped in kaolin slurry
C = control

[2] Condition score. Cumulative total of plant condition within a treatment. A plant in good health and vigor was scored 2, one in poor health and vigor scored 1, and a dead plant was scored 0.

Rooted Cuttings

Great progress has been made in recent years in vegetatively propagating Eucalyptus, especially by rooting cuttings. This procedure allows for capture of total genetic variance as opposed to capture only of the additive portion of genetic variance from a breeding program utilizing sexual recombination. The most notable achievement from use of asexually propagated plants is uniformity in tree form and growth; on a given site, every tree resembles every other tree. This feature imparts many economic advantages, including increased production per unit time, especially for short-rotation crops, decreased harvesting and processing costs, and improved utilization. Some concern has to be expressed about the susceptibility of the monoculture to catastrophe, but values far outweigh limitations for operations kept on a reasonable scale.

Most notable success with rooting cuttings of Eucalyptus has been achieved by Aracruz Florestal in Espírito Santo. Tendencies for other organizations to immediately mimic success of Aracruz Florestal is unwise. Few organizations have the proven genetic material possessed by the Espírito Santo company, and until such material is available, use of asexual reproduction for operational plantings is a gamble. Selections for propagation should come from trees approaching rotation age from second or third generations of proven land races. Odds for selecting the best genotype from species and provenance introduction trials for rooting are extremely remote.

Precaution is also advised on translating rooting success from one environment to another. A case in point is interpretation that the heavy clay rooting medium used successfully by Aracruz Florestal is key to successful rooting elsewhere. Comparable results to those obtained in Espírito Santo have been obtained in France by Association Forêt-Cellulose (AFOCEL) and to some degree in southern USA by U. S. Forest Service from combinations of vermiculite, perlite and peat media. The lesson learned is that the rooting medium as well as all other variables of rooting must be matched to the local environment.

Site Selection

Eucalyptus spp. have broad adaptability to soils of different texture, fertility and moisture-holding capacity. Like most tree species, best growth occurs on the best sites but the majority of plantations in tropical America, Africa and Asia have been established on land devoid of high forests such as savannas, llanos, pampas, palmetto prairies, and dune sands. Among the reasons for favoring open forest and grassland for plantations are minimal cost for site preparation, relative freedom from soil pathogens associated with high forests, reduced weed competition compared to those soils with superior water-holding capacity, and freedom from competition with indigenous high forests of higher end value. In southern USA, for example, Eucalyptus forests are planned for the palmetto prairies of central Florida and the well-drained sandy soils of north Florida, and the southern portions of Georgia, Alabama, Mississippi, Louisiana and Texas. Those niches are poorly occupied by forest trees of acceptable performance and weed competition is relatively easier to control than on adjacent land supporting high forests.

Site Preparation

Complete site preparation is prerequisite for successful tree establishment and performance. In areas where machinery is available, residual trees are best controlled by shearing and rootraking, followed by burning of windrows. Single or double-disking with a bush and bog disk precedes planting. Common practice in arid climates is to till the strip in which the trees will be planted while leaving unmolested a strip of equal width between rows. Tall grass in the leave strips gives protection from arid winds to the newly planted seedlings. Subsoiling or ripping to 60 cm to 75 cm is a desired practice on abandoned agriculture land where a plowpan has developed, and on savannas and prairies where impervious layers of sand and organic layers have developed. Soils with imperfect drainage which are often free of high or low forest are commonly site-prepared by single- or double-disking followed by bedding. Trees are planted on the ridge to keep the root system above the water table until plant establishment occurs. Fertilization, if needed, is commonly incorporated within the bed. Incorporation of 0.5 to 1.0 tonnes/ha of ground rock phosphate is common practice on the deficient Immokalee soils of central Florida's palmetto prairies. Similar corrections in nutrient deficiencies as determined by soil analysis are or should be rectified in other parts of the world where Eucalyptus plantations are being established. Where heavy equipment is unavailable, site preparation is by hand. The planting spot is thoroughly tilled to a depth of 25 cm to 50 cm and to a variable radius of 25 cm to 100 cm, depending upon anticipated competition. Deficiencies in soil fertility are corrected at time of planting.

Planting

The number of trees planted per unit area is subject to site quality and objective. Fewer trees are planted on sites of low quality, as opposed to high quality. Similarly, fewer trees are planted for pulpwood rotations of about 10 years (2.5 x 2.5 m = 1600 trees/ha) than for biomass rotations of 4 years or less (2.0 x 2.0 = 2500 trees/ha).

Planting is by hand or machine, depending upon circumstances, but machine planting is preferred because of increased survival and growth resulting from the tilling effect of the planter foot. A delay of 20 days is recommended between machine site preparation and planting, to allow the soil to firm; the delay should not exceed 60 days because of invading weeds.

Best success in survival and growth is achieved when the seedlings are planted immediately upon receipt from the nursery. Transport vans with controlled temperatures of 18° to 24° C. are desired for delivering and temporarily storing seedlings Care has to be exercised to avoid root disturbance in transport and planting of containerized seedlings, and roots of bare-root seedlings must be kept moist from time of lifting until planting. High soil moisture is required at time of planting, either from rain or irrigation. Conditions for optimum planting are during misting rain.

Cultural Practices

Cultivation at least twice for the first year is required for successful development of most eucalypt plantations. Hoeing is accepted practice for seedlings planted in individually site-prepared hills. Control of unwanted herbaceous and woody vegetation remaining between and within rows is by herbicides, disking, mowing or chopping. Disk cultivation is practiced on suitable terrain where competition is severe. Single or double gang disks are especially modified to cast soil onto the row, smothering weeds and vines around the base of the seedlings. One-way cultivation is satisfactory for controlling competition on all but the most fertile sites. Cross-cultivation, hoeing or other individual hill treatment is required where weed competition is severe. Aeration in addition to competition control is imparted by disk cultivation and results in added tree growth as opposed to other competition control systems (Malac and Heeren, 1979).

Response in growth from application of inorganic nitrogen fertilizers occurs almost invariably, regardless of site quality, and good responses have been obtained from application of other nutrients (Cromer, *et al.*, 1980; Jacobs, M. R., 1976; W.R.I., 1972). Best results from nitrogen are obtained from applications made in the first year after planting after the root system has become firmly established, whereas phosphorus, calcium and magnesium deficiencies should be corrected by soil incorporation before planting. Impaired survival and growth from soil deficiencies of potassium, manganese, sulphur and the minor elements have not been reported. Estimated nutrient levels for optimum growth of intensively managed hardwood plantations inclusive of Eucalyptus in southern USA, as determined by the N. C. State double acid extraction method, (Davey, 1973) are:

Soil Variable	Desired Level
Phosphorus	> 20 kg/ha
Potassium	> 100 kg/ha
Calcium	> 400 kg/ha
Magnesium	> 50 kg/ha
Manganese	> 10 kg/ha
pH	5.5 - 7.0

Responses from application of nitrogen increase with rate over the ranges evaluated. For example, compared to the control, increases in stemwood volume of E. globulus 9.5 years after treatment with 168, 565 and 1130 kg/ha of 18%N, 8%P fertilizer were 120%, 178% and 183%, respectively (Cromer, 1980). Among four kinds of nitrogen evaluated, ammonium nitrate at 200 kg/ha was superior for effecting growth of E. grandis in greenhouse and plantation trials on spodosal soils in southern USA (Barros and Pritchett, 1979). Similar results have been found elsewhere where competition control accompanies nitrogen fertilization.

Limited fertilizer trials have been conducted in established stands but application of nitrogen in conjunction with thinning will likely give responses similar to those obtained in thinned coniferous stands (NCSU, 1980). Application of fertilizers in combination with cultivation just before or after harvest will likely become standard practice for stimulating coppice reproduction.

Responses from irrigating Eucalyptus plantations after establishment would almost surely be significant. However, scarcity of water in arid areas where most plantations exist will prohibit irrigation except for the most intensively managed crops.

Thinning

Thinning is not anticipated for coppice crops managed at rotations less than about 10 years. For rotations of 12 to 15 years, one thinning at 8 to 9 years may be anticipated (Jacobs, 1976).

Yields

Yields from 9 to 50 cubic meters per hectare per annum have been reported from E. grandis/E. saligna plantations at 8- to 12-year rotations in Angola and Argentina respectively (Jacobs, 1976). E. globulus plantations in Portugal yield from 4 to 40 m^3/ha/annum at 10 years, with 15 to 30 m^3 being reasonably expected on the better ecological sites. Similar yields can be expected in other areas of the Tropics and Subtropics from adapted provenances planted on Site Quality I and II soils which receive good management. Experience has shown that yields of many plantations could easily be doubled by using proven silvicultural practices. Projections have been made to show that 100 m^3/ha/annum could be realized from rotations of 4 years when the objective is biomass production of aboveground portions of the trees (Kalish, 1979). Requirements for such yields include species-site adaptability, clonally reproduced genetically improved planting stock, and intense management including the use of fertilizers.

Economics

The economics of managing for short-rotation, intensive-culture tree crops can only be determined when the objectives are firmly established. Those objectives will vary within and among countries and include product desired, rotation length, available capital, interest rate and a host of sociological factors: Exclusive of land cost but inclusive of site preparation, planting and cultivation costs through year one, the price for establishing short-rotation intensively cultured crops in southern USA in 1979-80 is U. S. $750 per hectare. Yields of 15 m^3/ha/annum are expected from these plantations at rotations of 10 to 15 years. Two coppice rotations are anticipated in addition to the seedling rotation with comparable yields expected from each of the three rotations. However, it is uncertain whether the coppice rotations will be realized. If material of sufficiently improved genetic quality is available, the coppice stands will be sacrificed. Site preparation for the new crop will be relatively inexpensive; it will entail bedding or ridging of soil over the residual stumps to prevent sprouting, followed by planting on the ridge. Economics of the new seedling crop is expected to equal or exceed returns from the sacrificed coppice crop.

CONCLUSION

Short-rotation intensive-culture tree crops are receiving increased attention because of their potential value for fuel. This objective, in addition to rotations of 10 to 15 years for pulpwood, charcoal wood and small sawlogs, has increased interest in Eucalyptus and other coppicing species. Despite an abundance of short-fibered hardwood species and the general paucity of long-fibered coniferous species throughout the world, greatest emphasis in the next two decades will be on establishment of coppicing species. Major reasons for this phenomenon are all energy related:

1. Fast-growing coppicing species will yield more fiber per unit area per unit time than conifers.
2. The wood-using industry is establishing a strong trend to concentrate their wood supply close to the processing plant, the benefit from which will be reduced transportation costs at a future time when the mode and economics of transportation are unknown. Coppicing plantations are envisioned as a way to offset the high cost of land and wood concentration.
3. Genetic gains can be made more quickly with fast-growing coppicing hardwoods common to the Tropics than with conifers because they reach sexual maturity more quickly and because they can be vegetatively propagated more easily. Hardwood seedlings and propagules also respond more readily to intensive culture than conifers. The conclusion is that genetics and silviculture of coppicing tropical hardwoods will advance much more rapidly than they have in the past.

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SILVICULTURA INTENSIVA PARA MATERIAL VEGETAL MELHORADO.

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Resumo

Em 1978 a República do Congo iniciou um grande programa de reflorestamento utilizando ramos enraizados de espécies selecionadas de eucaliptos. Desenvolveu-se um novo sistema de silvicultura intensiva para esta nova e produtiva floresta.

SYLVICULTURE INTENSIVE POUR MATERIAL VEGETAL AMELIORE.

Resumé

In 1978, People's République of Congo started a large scale afforestation programm with rooted cuttings of selected Eucalyptus. A system of intensive sylviculture has been invented for this new, high productive forest.

2 - INTRODUCTION

Dans le but d'assurer le ravitaillement d'une usine de pâte cellulosique devant produire 250 000 tonnes de pâte par an, le Congo a créé en 1978 l'UNITE D'AFFORESTATION INDUSTRIELLE DU CONGO (U.A.I.C) afin de réaliser la première tranche d'un programme de 30 000 hectares de plantations clonales d'Eucalyptus dans la région de Pointe Noire.

Grâce à la production de ses deux pépinières industrielles de bouturage l'U.A.I.C. dont le C.T.F.T. assure la gérance a déja planté 600 ha en 1978 et 3000ha en 1979.

Les performances remarquables du matériel végétal utilisé ainsi que les caractéristiques propes aux peuplements clonaux ont amené à mettre au point un nouveau type de sylviculture adapté à des conditions de milieu très favorables à une production forestière intensive.

3 - LE MILIEU

3 - 1 Le climat

La région de Pointe Noire est située à environ 5° de latitude Sud. Le climat chaud (moyenne annuelle 24°C.) est caractérisé par l'alternance d'une saison humide (de Novembre à Mai) chaude et ensoleillée et d'une saison dite sèche (de Mai à Octobre) plus fraîche, nuageuse et à forte hygrométrie .

La pluviosité annuelle moyenne est de 1.250 mm.

3 - 2 Le sol et la végétation naturelle

L'essentiel de la zone intéressée par le projet (environ 50 000 ha) est située sur des sols sableux, assez pauvres, à profil peu différencié et homogènes sur de grandes surfaces.

Le relief est atténué et il existe de vastes étendues pratiquement plates.

La végétation naturelle est une savane faiblement arbustive.

3 - 3 Conclusion

Le milieu de la région de Pointe Noire réunit des conditions très intéressantes pour envisager une culture intensive d'arbres forestiers :

- Le climat offre de fortes potentialités de photosynthèse
- La topographie et la nature de la végétation naturelle permettent une mécanisation aisée des travaux.
- Les sols sableux et pauvres ont une vocation forestière réelle et leur fertilité peut-être améliorée par des apports d'engrais appropriés.

4 - LE MATERIEL VEGETAL

4 - 1 Hybrides et clones sélectionnés

Les plantations de l'U.A.I.C. sont actuellement réalisées avec deux hybrides naturels, à fort hétérosis, E.PF$_1$ et E. 12 ABL x Saligna*.

Certaines combinaisons de ces deux hybrides se sont révélées particulièrement performantes et on dispose aujourd'hui de plusieurs dizaines de clones sélectionnés qui permettent d'atteindre une production de l'ordre de 40 m^3/ha/an à l'âge de 6 ans, terme prévu de la rotation.

Ces clones sont installés en parcelles monoclonales juxtaposées de 50 hectares. Il est important de noter que la composition de cette variété multiclonale industrielle évolue dans le temps en fonction des résultats des tests clonaux et de la synthèse de nouveaux hybrides programmés annuellement par la Recherche. La variabilité génétique des plantations devrait pouvoir être ainsi maintenue à un niveau satisfaisant, dans l'espace et dans le temps.

4 - 2 Particularités des peuplements clonaux

Le gain considérable enregistré grâce au clonage qui se traduit par un gain sur tous les critères intéressant la production (croissance en hauteur, circonférence, densité etc...) se fait également sentir au niveau du peuplement qui devient parfaitement homogène et sans emplacement improductif.

Cette homogénéité tout à fait remarquable comparée à une plantation classique issue de semis permet d'aborder d'une manière rationnelle la plupart des problèmes liés à la culture de peuplements forestiers à courte rotation : choix de l'espacement, fertilisation, entretien de la plantation.

5 - LA SYLVICULTURE DES PLANTATIONS CLONALES D'EUCALYPTUS

5 - 1 Orientation générale

La sylviculture doit tenir compte de l'objectif du projet, du tempérament et des exigences de l'espèce utilisée dans les conditions du milieu.

Au Congo, dans le cadre du projet étudié, l'objectif est de produire du bois à pâte le plus massivement et le plus rapidement possible.

On sait d'autre part que les Eucalyptus sont des espèces de pleine lumière qui supportent mal un ombrage latéral. En peuplement, ils sont très sensibles à la concurrence exercée par leurs voisins et à celle de la végétation adventice.

Cette tendance semble fortement accentuée dans le cas des clones hybrides à haute productivité selectionnés au Congo. La compétition inter-arbres dans une plantation clonale s'exerce en particulier très tôt (vers l'âge de 6 mois environ) même à grands écartements.

Enfin, on a montré que dans la zone étudiée les Eucalyptus réagissaient bien à une fertilisation minérale.

La sylviculture de l'Eucalyptus pratiquée au Congo consiste donc à installer un petit nombre de boutures de sujets d'élite à l'hectare sur un sol travaillé et fertilisé à l'avance, puis à soutenir un rythme intensif d'entretiens jusqu'à ce que le peuplement soit fermé.

L'organisation des travaux dépend étroitement du régime climatique local.

5 - 2 La préparation des terrains

Elle est réalisée entièrement au cours de la saison sèche et comporte les travaux suivants

- Dessouchage
- Labour
- Piquetage
- Préparation des trous
- Fertilisation

Le dessouchage associé à un brûlis, consiste à extirper le plus souvent à la main les végétaux ligneux présents sur la zone à planter (buissons d'Annona arenaria essentiellement.)

Le labour est effectué en plein, au cover-crop, entre Juillet et Septembre. Il s'agit en fait d'une façon superficielle et non d'un véritable labour, qui permet un ameublissement du sol tout en maintenant la mince couche humifère dans les horizons de surface.

Le piquetage est réalisé à un espacement de 5m x 5m (400 plants/ha)

La préparation des trous Les trous sont préparés à la bêche, à la suite du piquetage, sur un terrain encore très meuble et parfaitement propre.

La fertilisation consiste en un épandage mécanisé en plein de chlorure de potassium (150 kg KCL/ha) un mois avant la plantation.

5 - 3 La plantation

Elle a lieu dès que la saison des pluies est bien installée (Novembre-Décembre) et dure en général 3 semaines à un mois.

Les boutures élevées en sachet plastique sont mises en place manuellement, après enlèvement du sac.

En 1979, 2 700 hectares ont été plantés entre le 4 et le 23 Décembre, en 18 jours.

5 - 4 Les entretiens

Le maintien de la propreté du sol est une condition essentielle de la réussite et du développement ultérieur des plantations.

Les entretiens sont donc menés de manière très intensive et selon un calendrier impératif :

Décembre-Janvier : 1ère intervention comportant :
- Un entretien manuel autour des plants
- Un entretien mécanisé au cover-crop entre les lignes de plants.

Février-Mars : 2ème intervention comportant :
- Un entretien mécanisé au pulvériseur à disques entre les lignes de plants
- Un entretien manuel autour des plants.

Mai-Juin : 3ème intervention comportant :
- Un entretien mécanisé au pulvériseur à disques entre les lignes de plants
- Un entretien manuel autour des plants.

Pendant la saison sèche le sol restera naturellement propre.

La 4ème intervention à lieu au début de la saison des pluies suivante (Décembre-Janvier) dans un peuplement agé de 13 à 15 mois. Il s'agit d'un entretien mécanisé au cover-crop entre les lignes de plants.

A 18 mois, les arbres mesurent de 12 à 15 m de haut et exercent une concurrence suffisante par leur couvert et les racines pour éliminer tout recru.

Le forestier n'interviendra plus dans ce peuplement jusqu'à l'exploitation vers l'âge de six ans.

Les clones plantés rejetant particulièrement bien de souche, il est en suite prévu 2 ou 3 rotations de taillis sans que l'on puisse craindre une diminution de production.

6 - PERSPECTIVES D'AVENIR

Lorsque les 30 000 ha seront réalisés, la production dépassera 1 million de m^3 de bois fort par an avec une rotation de 6 ans.

Sur la base des réalisations actuelles, le prix de l'hectare d'afforestation en boutures est d'environ 140 000 F CFA (1980) soit environ 550 Dollars l'hectare.

Ce prix est sensiblement inférieur au prix de revient d'une plantation issue de semis du fait notamment de la diminution très considérable du nombre de plants utilisés et du rendement accru des interventions mécanisées que permet le grand écartement.

Le gain définitif sera d'autant plus net que la multiplication végétative a permis de passer d'une production de 20 à 25 m^3/ha/an pour les plantations issues de graines sélectionnées à 40 m^3/ha/an avec les meilleurs clones actuels.

Il semble encore possible d'améliorer ces chiffres en intervenant sur deux éléments :

- Le sol : dont la pauvreté constitue le principal facteur limitant. De nouvelles formules de fertilisation sont actuellement à l'étude, ainsi que la possibilité d'introduire certaines mycorhizes de l'Eucalyptus qui n'existent pas actuellement au Congo.

- Le matériel végétal grâce à de nouveaux clones et surtout de nouveaux hybrides artificiels que devrait fournir la Recherche dans les prochaines années.

7 - CONCLUSION

La maîtrise de la méthode du bouturage de l'Eucalyptus au Congo a permis d'exploiter pleinement le très fort hétérosis de ces espèces.

L'application de la méthode sur une échelle industrielle est à l'origine de peuplements à très haute productivité, d'un nouveau type pour lesquels a été mise au point, dans un objectif précis, une sylviculture appropriée très intensive.

C'est là un exemple particulièrement significatif de l'efficacité d'une bonne intégration de l'écologie, de la réflexion génétique, et de la sylviculture.

INFLUÊNCIA DA LIMPEZA DAS CEPAS NO VIGOR DAS BROTAÇÕES DE *EUCALYPTUS SPP.*

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Resumo

O experimento foi desenvolvido em plantações da região do Vale do Rio Doce, em Minas Gerais, e teve o objetivo de determinar o efeito da limpeza das cepas no crescimento e vigor das brotações.

Não foi observada diferença significativa no crescimento da brotação devido à limpeza das cepas. Todavia, esta limpeza deveria ser realizada nas cepas, como medida silvicultural, aos 300 dias após o corte das árvores.

A limpeza é necessária para permitir os brotos novos desenvolverem-se rápida e livremente em seus estágios iniciais. O uso do fogo não mostrou nenhum efeito significativo no desenvolvimento e no vigor das brotações, e não se constitui prática comum na silvicultura brasileira.

Summary

Experiments were carried out in plantations in the Vale do Rio Doce region, Minas Gerais, to determine the effect of cleaning stumps on the growth and vigor of the subsequent coppice.

Among the treatments studied, there was no significant difference in coppice growth due to cleaning. However, cleaning should be carried out about the stumps as a general silvicultural practice 300 days after the harvest cut.

Cleaning is necessary to allow young shoots to develop rapidly and free of any impediment which may damage them in their early stages. The use of fire has not shown any significant effect on the development and vigor of coppice growth, and is not an adapted practice in Brazilian forestry.

2. Introdução

As operações de limpeza ao redor das cepas geralmente não são efetuadas. Entretanto, em áreas onde há poucos galhos e cascas, as brotações surgem mais vigorosas, aumentando a produtividade do povoamento na idade de corte. Essas observações motivaram a realização deste trabalho, que teve o objetivo de estudar a influência da limpeza das cepas, inclusive com o uso do fogo, no desenvolvimento de brotações de *Eucalyptus* spp, levando em consideração os custos operacionais da limpeza e queima dos resíduos da exploração florestal.

UPPIN (1966) enfatiza que a produção volumétrica de madeira de eucalipto, na Índia, na segunda rotação, é sempre cerca de 10 a 20% maior, caindo gradualmente na 3ª e 4ª rotações. A razão dessa queda de produção está no fato de que muitas cepas morrem após cada corte.

BRIQUELOT (1971) verificou que as operações de limpeza das cepas e a pré-desbrota, nas condições de campo, não exercem influência no percentual de morte das cepas e no desenvolvimento das brotações, quer em diâmetro, quer em altura.

REZENDE (1980) comenta que, quando se faz o coroamento das cepas, limpando um círculo de 1 m de diâmetro em torno delas, o desenvolvimento da brotação não é prejudicado. Entretanto, o enleiramento do material proveniente da exploração prejudica um pouco o desenvolvimento dos brotos. O uso do fogo para eliminação dos resíduos da exploração prejudica a brotação, ocorrendo o mesmo quando se usa o fogo antes da exploração, quando há pequenas quantidades de material combustível, indicando que o fogo é prática indesejável para estimular o desenvolvimento das brotações de *Eucalyptus* spp.

3. Metodologia

O experimento foi instalado em áreas pertencentes à Cia. Siderúrgica Belgo-Mineira e administradas pela Cia. Agrícola e Florestal Santa Bárbara, no município de Dionísio, MG.

A espécie utilizada foi o *Eucalyptus urophylla* (Rio Claro), cortado aos 7 anos de idade. As mudas foram produzidas em torrão paulista e, posteriormente, levadas para o campo, sem receber adubação. Foi empregado o espaçamento de 2 x 2 m, com 2.500 plantas/ha. A exploração foi feita com motosserras, utilizando-se muares para levar a lenha do povoamento florestal até os carreadores. A desbrota foi feita aos 10 meses, deixando-se as brotações mais vigorosas, de acordo com o diâmetro da cepa.

O delineamento estatístico utilizado foi o de blocos ao acaso, com 3 repetições e 8 tratamentos, perfazendo um total de 24 parcelas, sendo que a área de cada parcela foi de 288 m^2.

Os tratamentos estudados foram os seguintes:

A - Testemunha - sem limpeza das cepas

B - Limpeza em torno das cepas (0,5 m de raio)

C - Limpeza total dos resíduos da exploração florestal

D - Limpeza parcial dos resíduos, fazendo-se leiras entre as cepas

E - Limpeza com o uso do fogo antes da exploração florestal

F - Limpeza com o uso do fogo, exterminando totalmente os resíduos da exploração florestal, sem proteger as cepas.

G - Limpeza com o uso do fogo, com proteção das cepas, limpando-se ao seu redor (0,5 m de raio)

H - Limpeza com o uso do fogo diretamente nas leiras.

Os resultados foram avaliados por meio da análise de variância, e as médias foram comparadas pelo teste de Tukey, ao nível de 5% de probabilidade.

QUADRO 1 - Médias de altura, DAP e área basal das brotações de *Eucalyptus* spp, aos 10 e 18 meses de idade.

Trat.	Altura (m)		DAP (cm)		Área Basal (m^2/ha)	
	10 meses	18 meses	10 meses	18 meses	10 meses	18 meses
A	4,94 a	8,26 a b	3,16 a	6,06 a	1,99 a	6,20 a b
B	5,02 a	8,36 a	3,26 a	6,36 a	2,23 a	7,48 a
C	4,76 a	7,86 a b	3,18 a	6,00 a	1,69 a	4,71 a b
D	4,88 a	7,96 a b	3,19 a	6,33 a	1,51 a	5,47 a b
E	4,62 a	7,96 a b	3,14 a	6,43 a	1,05 a	4,53 a b
F	3,77 a	6,83 b	2,62 a	5,66 a	0,74 a	2,52 b
G	3,84 a	8,26 a b	3,04 a	6,20 a	1,88 a	6,14 a b
H	4,71 a	7,56 a b	3,14 a	6,10 a	1,45 a	4,94 a b

* Médias seguidas da mesma letra, nas colunas, não diferem entre si, pelo teste de Tukey, ao nível de 5% de probabilidade.

4. Resultados e Discussão

Vêem-se no Quadro 1 os resultados das médias das medições de altura de brotos, DAP e área basal efetuadas aos 10 e 18 meses depois do corte da floresta. Observa-se que a limpeza das cepas não influenciou o crescimento em altura aos 10 meses de idade; entretanto, aos 18 meses esse crescimento foi influenciado.

O uso do fogo para eliminação dos resíduos da exploração florestal influenciou negativamente o desenvolvimento em altura das brotações aos 10 e 18 meses. Entretanto, limpando-se ao redor das cepas, não houve prejuízo para o desenvolvimento em altura da brotação. A limpeza total dos resíduos da exploração florestal não se mostrou eficiente para o desenvolvimento em altura, além de serem consideráveis os gastos com a mão-de-obra necessária para realizar essa operação.

A limpeza das cepas não influenciou o desenvolvimento do DAP das brotações, aos 10 e 18 meses de idade, embora o tratamento B tenha apresentado diâmetro maior, juntamente com o E. O uso do fogo também prejudicou o crescimento em diâmetro.

A limpeza das cepas não influenciou a área basal aos 10 meses de idade; isso, porém, ocorreu aos 18 meses. Verifica-se que o tratamento B - limpeza somente ao redor das cepas - apresentou médias de área basal, 7,48 m^2/ha, 20% maiores quando comparado com a testemunha. Observa-se, ainda, que o uso do fogo diretamente nas cepas, para eliminação total dos resíduos da exploração florestal, foi prejudicial, resultando nas menores médias de área basal, 2,52 m^2/ha, isto é, 146% a menos que a testemunha.

Para todos os parâmetros avaliados, o tratamento B foi o mais eficiente, embora a testemunha também tenha apresentado resultados satisfatórios. Todavia, é indispensável que se faça uma análise dos gastos relativos às operações de limpeza dos resíduos, para que se possa tomar uma decisão mais correta.

No Quadro 2 são apresentados os custos/ha e os gastos com as operações de limpeza das cepas. Observa-se que os custos não foram baixos, pois essas operações foram realizadas manualmente. Se o crescimento da área basal for mantido neste ritmo, admite-se que, na idade de corte, o tratamento B deverá proporcionar um volume superior ao da testemunha, aproximadamente 20%, o que equivale a dizer que essa diferença de volume poderá resultar na produção de cerca de 15 metros cúbicos a mais de carvão vegetal, o que compensaria o gasto com a limpeza em torno da cepa, num raio aproximado de 0,5 m, ocasião em que seriam gastos 13,83 horas/homem na limpeza de 1,00 ha, com aproximadamente 1000 cepas, ou seja, em torno de 1 minuto para limpeza de cada cepa.

Quando não se efetuou a limpeza das cepas, o desenvolvimento em altura foi levemente prejudicado, mostrando ser necessário, pelo menos, desabafar as cepas, retirando os galhos que ficam sobre elas.

QUADRO 2 - Custos/ha, gastos com as operações de limpeza das cepas, na região do Vale do Rio Doce, MG, em terrenos com topografia ligeiramente acidentada.

Trát.	Operações	Hh/ha	Custos (Cr$/ha)
A	-	-	-
B	Limpeza	13,83	358,59
C	Limpeza	28,90	749,56
D	Limpeza	23,98	621,94
E	Limpeza	4,15	107,70
	Queima	1,68	43,58
F	Limpeza	12,65	328,08
	Queima	1,73	44,82
G	Limpeza	35,04	908,94
	Queima	1,92	49,77
H	Limpeza	38,14	989,35
	Queima	1,80	46,69

OBS: Homem/hora = Cr$25,94

Os tratamentos retirados totalmente os resíduos da exploração não se mostraram eficientes e apresentaram custos muito elevados. Cita-se como exemplo o tratamento C, onde foram gastos cerca de Cr$749,56 com a limpeza de 1,0 hectare, o que indica não ser econômica a realização dessa operação.

A limpeza das cepas com o uso do fogo influenciou negativamente o desenvolvimento das brotações, sendo que o tratamento F apresentou as menores médias de altura e diâmetro. Esse tratamento, além de não ser recomendável tecnicamente, mostrou-se também com custos elevados. Entretanto, o tratamento E, fogo antes da exploração florestal, apresentou custos baixos, cerca de Cr$151,28 por hectare, além de não prejudicar o desenvolvimento das brotações de Eucalyptus spp.

5. Resumo e Conclusões

Este trabalho foi instalado na região de Dionísio, MG, em áreas pertencentes à Cia. Siderúrgica Belgo-Mineira e administradas pela Cia. Agrícola e Florestal Santa Bárbara. O objetivo foi verificar a influência da limpeza das cepas no desenvolvimento de brotações de Eucalyptus spp, levando em consideração os custos operacionais dessa limpeza.

De acordo com os resultados obtidos aos 10 e 18 meses de idade, pode-se concluir que a limpeza em torno das cepas, num raio de aproximadamente 0,5 m, mostrou-se mais eficiente para todos os parâmetros estudados, altura, DAP e área basal, obtendo-se aos 18 meses, um ganho, em área basal, em relação à testemunha, de aproximadamente 20%.

Uma desvantagem desse tratamento são os custos operacionais da limpeza das cepas (Cr$358,59/ha).

O uso do fogo para limpeza das cepas prejudicou o desenvolvimento da brotação, quando aplicado após o corte, diretamente sobre as cepas. Entretanto, feita antes do corte da floresta, essa prática não prejudicou o crescimento das brotações, apresentando, porém, o inconveniente dos custos operacionais.

A limpeza das cepas é prática recomendável, entretanto, as limitações são os custos operacionais elevados. Sendo assim, o mais vantajoso é fazer apenas a limpeza em torno das cepas, retirando a galhada e as cascas que ficam sobre as cepas, abafando os brotos.

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EFEITO DO DIÂMETRO DAS CEPAS NO DESENVOLVIMENTO DE BROTAÇÕES DE *EUCALYPTUS SPP.*

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Resumo

Trabalho desenvolvido na região do Vale do Rio Doce, em Minas Gerais, com o objetivo de determinar o comportamento das brotações em função do diâmetro das cepas, em *Eucalyptus urophylla* (híbrido de Rio Claro).

Foi utilizada análise de regressão para estudar o efeito do diâmetro das cepas, altura das brotações, circunferência à altura do peito, e o número de brotações por cepa, à idade de 6 e 24 meses.

O número de brotações por cepa aumentou com o aumento da idade. Numa mesma idade, as cepas com os diâmetros menores e as com os diâmetros maiores suportaram um menor número de brotos. Para todas as idades estudadas, as cepas com diâmetro de 17,9 cm mostraram maior número de brotos por cepa.

A análise mostrou ainda que à medida que o diâmetro das cepas aumenta, o vigor das brotações também aumenta.

Summary

This research was conducted in the region of "Vale do Rio Doce, MG". With objetive of studing the sprouting behavior in relation to the diameter of the stumps, for Eucalyptus urophylla (hibrid of Rio Claro).

A regression analysis was used to study the effect of stump diameters, sprout height and breast height circunference, and the number of sprout by stump, at ages of 6 and 24 months.

The number of sprouts by stump increased with increase in age. Within same age stumps with smaller and larger diameters provided a smaller number of sprouts by stump. For all ages analyzed the stumps with a diameter of 17.9 cm showed larger number of sprouts by stump.

The analysis also showed that as the diameter of the stumps increased the healthy of the sprouts increased.

2. Introdução

As espécies do gênero *Eucalyptus* têm condições de brotação depois de cada corte realizado na floresta. Durante as operações de desbrota deve-se selecionar os brotos tidos como os mais vigorosos e que tenham melhor distribuição nas cepas, para que se obtenha aumento de produtividade nos cortes subseqüentes.

Geralmente, fazem-se três cortes durante a rotação das florestas de eucaliptos, cortes estes feitos de 7 em 7 anos. O número de brotos/cepa varia muito, dependendo da utilização da matéria-prima ou das normas internas das empresas florestais. Algumas empresas dispõem de tabelas para determinar o número de brotos que devem ser deixados em cada cepa, de acordo com o diâmetro das cepas; entretanto, observa-se que cepas com pequenos diâmetros têm número reduzido de brotos; o mesmo acontece com as cepas de diâmetros grandes.

Este trabalho teve como objetivo estudar o número de brotos das cepas e a correlação do diâmetro da cepa com o vigor das brotações de *Eucalyptus* spp.

ANDRADE (1961), estudando brotação de *Eucalyptus saligna*, observou que, aos 16 anos de idade, os maiores diâmetros médios foram obtidos quando as cepas foram conduzidas com um só broto, em relação às que foram conduzidas com dois ou três.

WICK e WHITESELL (1969) estudaram os efeitos dos diâmetros das cepas no desenvolvimento de "Tropical Ash" e concluíram que há uma correlação entre o tamanho da cepa e o vigor das brotações: cepas com maiores diâmetros produzem brotações mais vigorosas, isto é, brotos com maiores diâmetros e altura. O número de brotos aumenta de acordo com o diâmetro da cepa até certa classe de diâmetro; a partir daí, esse número decresce, sendo que há uma classe de diâmetro ótima, que proporciona grande número de brotos/cepa.

BRIQUELOT (1973), trabalhando com brotações de *Eucalyptus paniculata* na região do Vale do Rio Doce, MG, enfatizou que a distribuição do número de brotos/cepa é superior para as cepas de árvores dominantes, sendo maior a ocorrência de 2 a 3 brotos/cepa; para as cepas de árvores dominadas, é maior a ocorrência de 1 e 2 brotos/cepa.

3. Metodologia

Este trabalho foi conduzido em áreas com *Eucalyptus urophylla* (híbrido de Rio Claro) pertencentes à Cia Ferro Brasileiro e administradas pela A-Rural Mineira S.A., no Vale do Rio Doce, MG. Os povoamentos estudados estavam com 6, 8 e 10 anos de idade quando foi feito o 1º corte dos povoamentos. Fez-se o corte com motosserras, e a madeira foi levada por meio de muares, até os carreadores. Para a realização deste estudo, foram avaliados os diâmetros das cepas, o número de brotos/cepa, a altura e o diâmetro dos brotos.

Cada unidade experimental tinha 200 m^2 (10 x 20 m). Para facilitar a análise dos resultados foram adotadas classes de diâmetro médio das cepas; para isso, foram utilizados dados médios de nº de brotos/cepa para cada idade estudada. O número de brotos/cepa foi transformado em raiz quadrada, para obter as equações de regressão.

A 1ª medição foi feita aos 6 meses de idade, contando o nº de touças/cepa, com os respectivos diâmetros. Aos 2 anos de idade, foram avaliadas as mesmas parcelas, medindo-se os diâmetros das cepas, a altura e o diâmetro do maior broto. A desbrota foi realizada aos 15 meses de idade, deixando-se em cada cepa os 4 brotos tidos como mais vigorosos e de melhor distribuição nas cepas.

Os efeitos da idade e do diâmetro das cepas sobre o número de brotos, o CAP e a altura de plantas foram testados por meio da análise de variância da regressão.

O modelo estatístico utilizado foi o seguinte:

$$Y_i = b_0 + b_1 D_i + b_2 I_i + b_3 D_i^2 + b_4 I_i^2 + b_5 D_i I_i + e_i$$

em que:

Y_i = características estudadas

D_i = diâmetro das cepas (ponto médio da classe cm)

I_i = idade (anos)

b_0 = constante de regressão

b_j = coeficiente de regressão

e_i = erro aleatário, considerado normal e independentemente distribuído, com média zero e variância

O grau de ajustamento dos modelos aos dados foi avaliado pelos coeficientes de determinação (R^2), pela significância dos coeficientes de regressão, avaliados pelo teste "t", e pela significância da regressão, avaliada pelo teste "F", adotando-se um nível de até 5% de probabilidade.

4. Resultados e Discussão

4.1 - Número de brotos/cepa

Ajustou-se uma equação de regressão (Figura 1) para o número de brotos/cepa, de acordo com o diâmetro das cepas e as idades dos povoamentos. De acordo com o valor do coeficiente de determinação (R^2), verifica-se que as variáveis independentes explicaram 73,6% da variação total na variável dependente.

Por meio da superfície de resposta (Figura 1), visualiza-se o efeito quadrático do diâmetro das cepas.

Verifica-se, de acordo com o exame da equação de regressão (Figuras 1 e 2), que, para os diâmetros estudados, a função estimada para número de brotos apresentou valor máximo para 17,9 cm de diâmetro para todas as idades estudadas. Observou-se, ainda, que, para maiores idades, tem-se maior número de brotos/cepa.

4.2 - CAP - circunferência à altura do peito dos brotos

Ajustou-se uma equação de regressão (Figura 3) para a CAP, de acordo com o diâmetro das cepas e a as idades dos povoamentos. De acordo com o valor do coeficiente de determinação (R^2), verifica-se que as variáveis independentes explicaram 96,4% da variação total observada na CAP.

Por meio da superfície de resposta (Figura 3), visualiza-se o efeito quadrático, tanto para o diâmetro quanto para a idade.

Para todas as idades, verificam-se maiores valores de CAP dos brotos à medida que aumenta o diâmetro das cepas (Figura 4).

A função estimada para CAP dos brotos apresentou valor máximo para 43,3 cm de diâmetro, para todas as idades, valor este que não consta no intervalo estudado.

4.3 - Altura das brotações

Ajustou-se uma equação de regressão (Figura 5) para altura de brotos, com relação ao diâmetro das cepas e às idades. Pelo valor do coeficiente de determinação (R^2) verifica-se que as variáveis independentes explicaram 92,4% da variação total observada na altura de plantas.

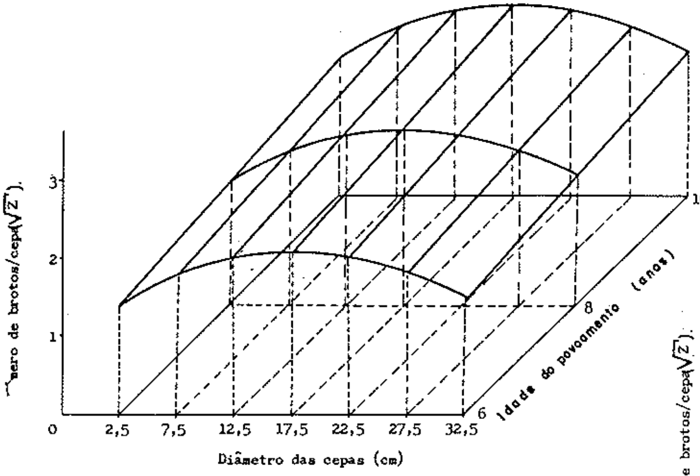

FIGURA 1 - Visão em perspectiva da superfície de resposta do número de brotos (médias da raiz quadrada)

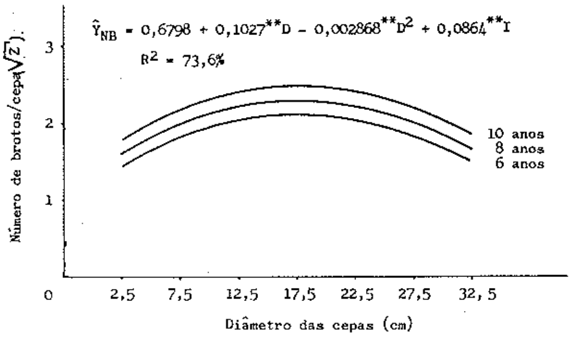

FIGURA 2 - Médias da raiz quadrada do número de brotos ($\hat{Y}_{NB}$), em função do diâmetro das cepas (D) e da idade (I).
** Significativo ao nível de 1% de probabilidade pelo teste "t"

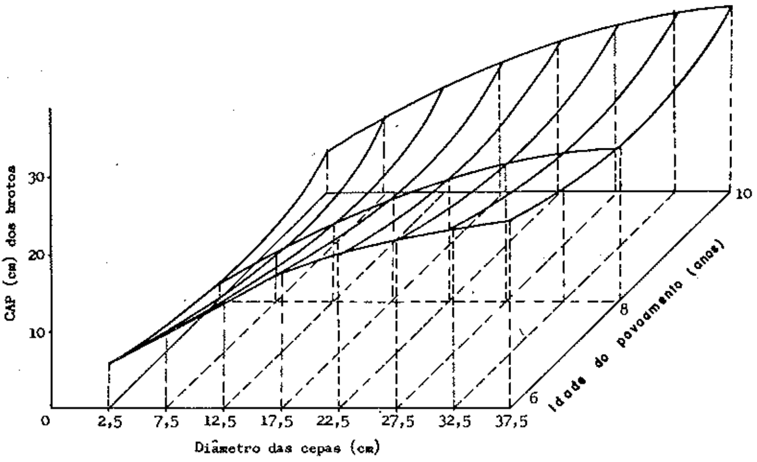

FIGURA 3 - Visão em perspectiva da superfície de resposta da CAP dos brotos.

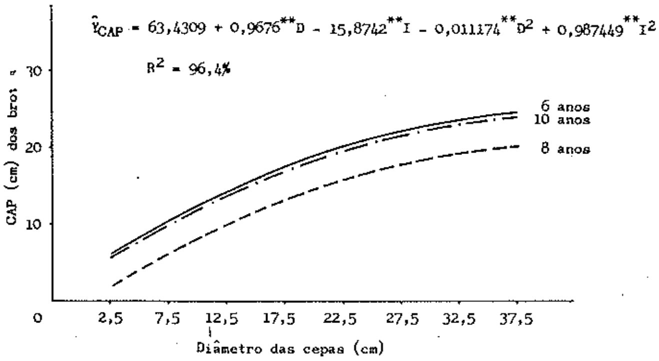

FIGURA 4 - Circunferência à altura do peito ($\hat{Y}_{CAP}$), em função do diâmetro das cepas (D) e da idade (I).
** Significativo ao nível de 1% de probabilidade pelo teste "t"

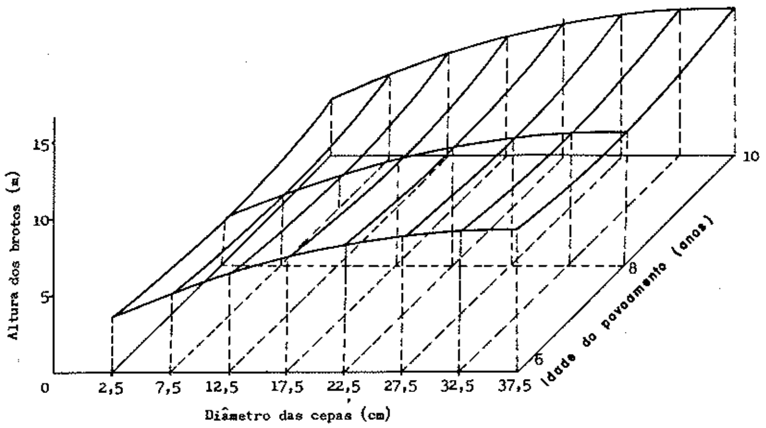

FIGURA 5 - Visão em perspectiva da superfície de resposta da altura dos brotos

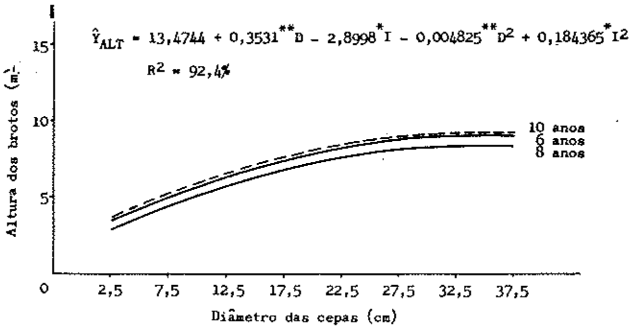

FIGURA 6 - Altura dos brotos ($\hat{Y}_{ALT}$), em função do diâmetro das cepas (D) e da idade (I).

**,* Significativo aos níveis de 1 e 5% de probabilidade, respectivamente pelo teste "t"

Por meio da superfície de resposta (Figura 5), visualiza-se o efeito quadrático, tanto para o diâmetro como para a idade.

A função estimada para altura das brotações apresentou valor máximo para 36,6 cm de diâmetro, para todas as idades (Figura 6). De acordo com a Figura 6, observa-se que, para as três idades estudadas, quanto maior o diâmetro da cepa, maiores as alturas médias das brotações, até 36,6 cm.

5. Resumo e Conclusões

Este trabalho, realizado na região do Vale do Rio Doce, MG, teve como objetivo estudar o comportamento do número de brotos, em relação ao diâmetro das cepas, para <u>Eucalyptus</u> <u>urophylla</u> (híbrido de Rio Claro).

Os resultados obtidos aos 6 e 24 meses de idade foram avaliados por meio da análise de regressão. Os parâmetros estudados foram: diâmetros das cepas, altura e CAP dos brotos e número de brotos/cepa. De acordo com os resultados obtidos, conclui-se que o número de brotos/cepa aumenta com o aumento da idade e que, para uma mesma idade, as cepas com menores diâmetros proporcionam números reduzidos de brotos/cepa, o mesmo acontecendo nas cepas de grandes diâmetros. Para todas as idades estudadas, para o diâmetro de 17,9 cm verificou-se maior número de brotos/cepa. Observou-se também que, quanto maior o diâmetro das cepas, mais vigorosos eram os brotos, isto é, com maiores alturas e CAP.

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OS TRATAMENTOS SILVICULTURAIS DAS PLANTAÇÕES DE *EUCALYPTUS* NO SUL DA ÁFRICA.

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Resumo

Aproximadamente 500 000 hectares já foram reflorestados com *Eucalyptus* spp no sul da África principalmente com *E. grandis*, para a produção de vigas de madeira para a mineração, produção de celulose, material bruto de construção e de cercas, assim como para queima, em rotações curtas de 6 a 10 anos para a obtenção de postes, numa rotação média de 10 a 14 anos, e para serraria, laminação e pilares, numa rotação moderadamente longa de 14 a 30 anos. As florestas de rotação curta são plantadas em espaçamentos de 2,1 x 2,1 até 2,7 x 2,7 metros, e são manejadas em regime de talhadia, sendo que normalmente são realizados de 2 a 4 cortes antes da reforma do povoamento. A limpeza, deixando 1, 2 ou 3 brotos por cepa é normalmente realizada dentro de 1 a 2 anos após o corte, mas não se pratica desrama nem desgalhamento. As rotações médias e longas são estabelecidas em espaçamento de 2,7 x 2,7 metros, e são desbastadas desde idade jovem. O desgalhamento é realizado normalmente, mas a desrama dos ramos ainda vivos não mostrou ser benéfica, a menos que seja feita próxima à época em que os ramos morrem. Após o corte raso, normalmente é feito o replantio.

THE SILVICULTURAL TREATMENT OF EUCALYPT PLANTATIONS IN SOUTHERN AFRICA.

Summary

Approximately 500 000 ha has been afforested in Southern Africa with Eucalyptus spp., principally E. grandis, for the production of mining timber, pulpwood, rough building and fencing materials and fuel on a short rotation of 6 to 10 years, for telegraph and transmission poles on a medium-length rotation of 10 to 14 years and for saw- and veneer-logs and piles on a moderately long rotation of 14 to 30 years. Short rotation crops are planted at an espacement of 2,1 x 2,1 to 2,7 x 2,7 m and managed under the coppice clearfelling system, from 2 to 4 crops usually being harvested before replanting becomes necessary. Cleaning to 1, 2 or 3 shoots per stool is usually undertaken within 1 to 2 years of coppicing, but no pruning or brashing up is done. Medium-length and long rotation crops are established at 2,7 x 2,7 m and thinned from an early age. Brashing up is common practice, but live pruning has not proved to be altogether beneficial unless carried out just before the branches die. After clearfelling the site is usually replanted.

INTRODUCTION

Recent estimates of the areas afforested with Eucalyptus spp. in the more important timber-growing territories of Southern Africa (Jacobs, 1976) indicate that the total extent of commercial plantations in the region as a whole probably now exceeds 500 000 ha. Afforestation may be said to have commenced towards the close of the nineteenth century (Poynton, 1979), and the rate of planting increased progressively up to the period following the Second World War.

Eucalypts are grown in Southern Africa on a short rotation of approximately 6 to 10 years for mining timber, pulpwood, building poles, fencing materials and fuel, on a short to medium-length rotation of 10 to 14 years for telegraph and transmission poles and on a medium-length to long rotation of 14 to 30 years for saw- and veneer-logs and harbour piles. As a general rule they are managed as pure, even-aged stands. Short-rotation crops are regenerated as far as possible by means of coppice, but stands grown on a medium-length to long rotation are generally replanted as this results in a fuller stocking, more uniform growth and superior stem form.

Research on the silvicultural treatment of eucalypts has been in progress for more than 60 years. Most of the experimental work undertaken thus far has been done on E. grandis, but some attention has been given to the thinning of E. botryoides, E. cladocalyx, E. cloeziana, E. dives, E. fraxinoides, E. globulus, E. maculata, E. maidenii, E. microcorys, E. nitens, E. paniculata, E. polyanthemos, E. punctata, E. resinifera, E. saligna and E. sideroxylon.

SHORT ROTATION CROPS

Short rotation eucalypt crops are generally established at an espacement of (or equivalent to) 2,1 x 2,1 to 2,7 x 2,7 m, depending on the class of material which it is intended to produce, and managed under the coppice clearfelling system (Poynton, 1979). No thinning save for a reduction in the number of coppice shoots per stool early in the second and subsequent rotations is undertaken, neither is any pruning or brashing up of dead branches normally carried out.

A moderately high initial stocking density has been shown to increase profitability if the objective is to grow the maximum volume of timber without regard for the size and quality of the material produced (Schönau, 1970, 1974). It also serves to provide in some measure against the loss of a certain proportion (usually about 5 per cent) of the stools every time that the stand is coppiced. Moreover, through the quicker suppression of weed growth it leads to more efficient site utilisation as well as to a reduction in the fire hazard. On the other hand, close espacements depress diameter increment and increase the diameter range of the trees in the stand owing to the weaker individuals becoming suppressed by the more vigorous - thereby complicating management (W.R.I., 1972).

With regard to the number of coppice shoots left to develop on each stool and the stage at which coppice reduction is undertaken, the practice in Southern Africa varies considerably. Experimental evidence proves conclusively that diameter increment (though not height growth) becomes significantly depressed if coppice reduction is not undertaken early in the rotation (Poynton, 1965). Total volume production is, however, increased - initially at least - although on a rotation of 10 years or more the gain is insignificant. While some growers favour cleaning to a single shoot per stool within about a year of coppicing (particularly in areas of comparatively low rainfall and on shallow soils), others, attracted by the larger volume of mining timber or pulpwood that can ostensibly be obtained, allow as many as 3 shoots to develop on every stool to the end of the rotation. Barrett, Carter and Seward (1975) suggest that a generally applicable routine might be to reduce the number of shoots to 2 or 3 per stool when the crop is about 4 m tall and to clean again a year later to 1 or 2 shoots, favouring a single stem for the better grades of pole and 2 stems for other classes of material. They further advocate that the eventual number of stems that remain after cleaning should be not less than the number of seedling trees originally planted, sufficient extra stems being left when cleaning to a nominal 1 shoot per stool to make up for the stumps which have died. Stubbings and Schönau (1979) recommended that coppice reduction in E. grandis should start when the dominant height is between 3 and 4 m and that it should be carried out in not less than two stages, the first cleaning being to 2 or 3 shoots per stool (depending on the object of management) and the second - when the dominant height is between 7 and 8 m - to 1 or 2 per stool.

The number of coppice crops that can be harvested from the same stools before re-planting becomes economically desirable has been the subject of long debate and a certain amount of experimentation in Southern Africa, but no definite guidelines can be laid down as yet. It is generally agreed that repeated coppicing leads to gradually diminishing yields, but this would seem to be attributable to depletion of the growing stock through stump mortality rather than to exhaustion of the stools or to soil impoverishment. In E.grandis, according to van Laar (1961), height growth (and hence site class) does not show any progressive change with repeated coppicing. On average sites, at least 2 coppice crops can normally be counted on before interplanting or replanting becomes necessary provided that the age of the trees when felled does not exceed 10 to 12 years (W.R.I., ibid.). The number of coppice crops harvested can be expected to vary with circumstances (Barrett, Carter and Seward, ibid.), however, and under favourable conditions the surviving stools may still be vigorous after 4 coppice rotations (Poynton, 1960).

E. grandis coppice in Zululand usually grows more rapidly than seedling stock up to the age of 10 years on first quality sites, while on second and third quality sites it generally maintains its lead for 11 and 13 years respectively (Lückhoff, 1955). Similarly, in the northern Transvaal the mean diameter of single-stemmed first-rotation coppice was observed to be somewhat more than that of the replanted controls after nearly 12 years in a replicated experiment established on a second quality site - although the total standing volume of the control was greater than that of the coppiced plots owing to the failure of some of the stumps to regenerate and because of subsequent losses from drought.

MEDIUM-LENGTH ROTATION CROPS

Stands managed on a medium-length rotation for the production of telephone and transmission poles in Southern Africa are, with rare exceptions, planted at an espacement of 2,7 x 2,7 m and felled at the age of 10 to 16 years, depending on species and site quality. Thinning is undertaken from the age of 4 or 5 years in order to improve the growth of the best stems, and upon the final crop being harvested the site is usually (but not invariably) replanted. Pruning, when carried out, is limited to brashing up (i.e. knocking off the dead branches with a heavy stick), its object being to eliminate dead knots in the peripheral layers of the poles and to improve access to the interior of the stand.

In South Africa, where substantial areas have been allocated to pole production, the eucalypt species now most favoured is *E. cloeziana*. However, *E. grandis* is also grown fairly extensively for telephone poles, while *E. paniculata* was at one time much planted not only for telephone but also for telegraph and smelter poles.

The following thinning prescriptions for stands of *E. cloeziana* managed on a medium-length rotation for the production of telephone and transmission poles have been approved for use in State plantations by the South African Department of Forestry:

THINNING SCHEDULES FOR *E. CLOEZIANA* PLANTED ON FIRST AND SECOND QUALITY SITES FOR THE PRODUCTION OF TELEPHONE AND TRANSMISSION POLES IN SOUTH AFRICA

Age	Stems per ha	
	Site quality I	Site quality II
0................	1 680	1 680
4................	1 000	750
6................	750	425
10................	0	-
13................	-	0

In Zimbabwe, stands of *E. grandis* are sometimes managed on a medium-length rotation under the coppice with standards system by the Forestry Commission. About 50 trees/ha are retained when the rest of the crop is felled, and these are subsequently exploited between the ages of 7 and 12 years for telephone and transmission poles. Stands of *E. cloeziana* established by private growers for pole production are thinned more-or-less according to the following schedule:

THINNING REGIME APPLIED TO *E. CLOEZIANA* STANDS MANAGED FOR POLE PRODUCTION IN ZIMBABWE

Age	Stems/ha
0....................	1 370
4-5....................	700
6-7....................	450
9-10....................	0

In Malaŵi, stands of *E. grandis* and other eucalypt species are again frequently managed under the coppice with standards system for the supply of transmission and building poles, posts and fuelwood (Hardcastle, 1975). Thinning is undertaken at the age of 5 years, when about 200 selected trees/ha are marked for retention as standards and thereafter culled on demand over the next 7 years. Two crops of small diameter wood, over and above the standards, are harvested during the course of the 12-year rotation.

MEDIUM-LENGTH TO LONG ROTATION CROPS

Eucalypt stands managed on a medium-length to long rotation for the production of saw- and veneer-logs, bolts for tool handle manufacture and harbour piles are planted at an espacement of 2,7 x 2,7 m and thinned periodically at short intervals from an early age. Brashing up and in some cases live pruning is undertaken when producing the better grades of timber.

In South Africa, research on the thinning of eucalypt stands has been conducted over many years, while recently the relationship between stand density and the growth of *E. grandis* was investigated by Bredenkamp (1977) using data derived from the Correlated Curve Trend (C.C.T.) experiments.

Marsh and Burgers (1967), also basing their calculations on C.C.T. data, critically reviewed the several thinning regimes applied by the State and by various private timber growers to stands of *E. grandis*, having due consideration for the probable effects of the different treatments upon wood properties and soil expectation values. A regime which they tentatively put forward and showed to compare well with others examined by them in terms of profitability is as follows:

THINNING REGIME PROPOSED BY MARSH AND BURGERS (1967) FOR *E. GRANDIS* GROWN IN SOUTH AFRICA FOR SAWTIMBER PRODUCTION

Age	Stems/ha
0................	1 310
7................	1 000
10................	750
13................	500
16................	250
19................	150
30................	0

The above thinning regime has, as far as is known, never been applied in practice. The same is true also of regimes suggested previously by Lane-Poole (1936) and van Laar (1961).

In 1968, 1974 and again in 1979 revised thinning schedules for *E. grandis* were introduced by the Department of Forestry for use in State plantations. The last two, particularly, called for considerably earlier and heavier thinnings than those advocated by Marsh and Burgers (*ibid.*), experience having shown that severe wind damage may occur in stands which have not been opened up sufficiently to prevent the trees from becoming whippy. The currently applied thinning regime for *E. grandis* is as follows:

CURRENT (1979) THINNING SCHEDULE FOR *E. GRANDIS* GROWN IN SOUTH AFRICA FOR SAWTIMBER IN STATE PLANTATIONS

Age	Stems per ha
0.............	1 370
3-5.............	750
7-9.............	500
11-13.............	300
25-30.............	0

Stands of *E. citriodora*, *E. microcorys*, *E. resinifera* and other species grown by the State for sawtimber in South Africa are thinned according to the following schedule:

THINNING SCHEDULE FOR SPECIES OTHER THAN *E. GRANDIS* PLANTED IN SOUTH AFRICA BY THE STATE FOR SAWTIMBER

Age	Stems per ha
	I
0..................	1 310
7..................	750
11..................	500
15..................	300
30..................	0

In the southern Cape, stands of *E. diversicolor* managed for the supply of quality logs to the tool handle manufacturing industry are thinned as follows:

THINNING SCHEDULE FOR *E. DIVERSICOLOR* PLANTED BY THE STATE IN SOUTH AFRICA

Age	Stems per ha
0..............	1 370
6..............	625
12..............	375
15..............	225
18..............	175
30..............	0

In Zimbabwe early attention to thinning is considered essential when eucalypts are grown on a long rotation for timber. The following regime gives an indication of the treatment applied by the major timber-growing companies to such stands:

THINNING SCHEDULE COMMONLY APPLIED TO LONG-ROTATION EUCALYPT CROPS IN ZIMBABWE

Age	Stems per ha
0...............	1 370
4-5..............	700
6-7..............	450
9-10.............	250
20...............	0

Eucalypts are not grown for sawtimber to any extent in Malaŵi, but where local industry can absorb timber of sawlog or transmission pole size the following prescriptions serve as a basis for thinning:

THINNING SCHEDULE FOR SAWLOG AND TRANSMISSION POLE PRODUCTION IN MALAŴI

Age	Stems per ha
0................	1 330
3................	740
5................	500
10...............	370
15-20............	0

The desirability or otherwise of live pruning in stands of *E. grandis* managed on a medium-length to long rotation has been investigated in South Africa.

Analysing the results of a pruning experiment conducted in Zululand, Lückhoff (1967) concluded that heavy live pruning was not desirable and that branches should only be removed shortly before they die, the object being to eliminate loose or decayed knots and to restrict the knotty core to a diameter of between 80 and 130 mm. With this in mind he recommended that all stems should be pruned to a height of 2,4, 4,6 and 6,7 m when the mean height of the stand reached 6, 9 and 12 m respectively, with a possible further thinning at a later stage. Bredenkamp, Malan and Conradie (1980), assessing the results of the same experiment from the time of its inception until its termination 25 years later, disagreed in certain respects with Lückhoff's statistical interpretation of the results but endorsed his main conclusions. The effect of live pruning on the growth rate and yield of *E. grandis* established on a low quality (class VIII) site had meanwhile been investigated by Schönau (1970, 1974), who formed the opinion that the operation could not be justified in these circumstances.

In South Africa, no clearly defined State policy in respect of pruning eucalypt stands existed before 1965 (Maree, 1979; Poynton, 1979). However, in that year prescriptions were laid down by the Department of Forestry with the object of limiting the occurrence of small, loose knots in sawlogs. Separate schedules were prepared for fast-growing species such as *E. grandis* and for slower-growing species, the intention being to restrict the diameter of the knotty core to 75 mm in the case of the former and to 100 mm in the case of the latter. These schedules were as follows:

1965 PRUNING SCHEDULES FOR FAST- AND MEDIUM-FAST GROWING EUCALYPTS RAISED FOR SAWTIMBER AND OTHER SPECIALISED PURPOSES IN SOUTH AFRICA

Growth rate	Predominant height of stand (m)	Height of pruning (m)	Number of Stems pruned per ha
Fast.......	6-7,5	Half-height	All
	9	5	500
	12	7,5	250
	15	10	250
Medium-Fast...	7,5	Half-height	All
	10,5	5	500
	13,5	7,5	250
	16,5	10	250

The above schedules still apply in so far as the slower-growing species are concerned. However, the prescriptions for fast-growing species proved to be too drastic and were consequently modified in 1969 to accord more closely with Lückhoff's proposals.

The express intention when prescribing the above treatments was to effect the removal of all branches before they died. A survey undertaken by the Department of Forestry during 1977 revealed, however, that in the case of *E. grandis* successive prunings did not always, for practical reasons, keep abreast of height growth, with the result that many branches were being removed only after they were dead. Moreover, it was found that the third pruning limited the diameter of the knotty core unnecessarily - not all of the clear wood put on being suitable for structural purposes owing to extreme juvenility. To rationalise management and to reduce costs it was decided to prune stands of this species in one operation from ground level to 7 m at the age of three to four years, ideally just after completing the first thinning. In practice it seemed likely that this would often amount to brashing up, as the branches could already be dead to that height.

In Zimbabwe live pruning is seldom undertaken in eucalypt stands, though brashing up may sometimes be carried out with the object of improving access (Barrett, Carter and Seward, *ibid.*)

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MANEJO DOS EUCALIPTOS PARA PRODUÇÃO DE TORAS PARA SERRARIA NA NOVA ZELÂNDIA.

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Resumo

Estudos no desdobramento e secagem da madeira de Eucaliptos demonstraram que a recuperação, a nível aceitável (maior que 50%), constituída por madeira de bom padrão, pode ser conseguida de plantações de Eucaliptos na Nova Zelandia. As madeiras demonstraram ser adequadas para lâminas, mobília, acabamentos interiores, marcenaria, molduras e assoalhos. A necessidade básica em relação às toras é que tenham diâmetro médio superior a 500 mm, visando reduzir a influência das tensões de crescimento e, como consequência, obter madeira livre de defeitos no limite exterior da tora e, ao mesmo tempo, obter tábuas aparelhadas com largura razoável. O desdobro e aparelhamento é indicado como método para reduzir perdas na secagem e facilitar o recondicionamento das peças.

Como consequência a silvicultura para serraria terá como objetivo final fornecer toras com DAP compreendido entre 700 a 750 mm em plantações com densidade final de 100 árvores/ha.

MANAGEMENT OF *EUCALYPTS* FOR SAWLOG PRODUCTION IN NEW ZEALAND.

Summary

Sawing and drying studies have demonstrated that acceptable recoveries (greater than 50%) of high-grade timber can be obtained from plantation-grown eucalypt species in New Zealand. The timbers have proved suitable for veneers, furniture, interior finishings, joinery, mouldings, and flooring. The primary requirement is for logs with mid diameter greater than 500 mm to reduce the influence of growth stress, to obtain wood free of defect outside the core, and to quarter-saw boards of reasonable width. Quarter sawing is advocated to minimise drying degrade and obtain the advantages of reconditioning.

As a consequence, silviculture for sawlogs will aim to produce final-crop trees of 700 to 750 mm breast height diameter at a stocking of 100 stems/ha.

INTRODUCTION

New Zealand is now heavily dependent on exotic conifers grown in plantations for the bulk of timber supply for both domestic use and export. The timber of Pinus radiata D. Don and other pines provides adequately for most purposes but is considered unsuitable for some specialised uses. Indigenous and imported timbers which are currently used for furniture, interior joinery, and other end-products requiring a high-grade, clear timber is scarce, and it is essential that suitable substitutes be found. Of the various exotic species planted over the years some eucalypts have grown very rapidly and shown an adaptation to particular climates. Eucalypt timber in Australia serves a wide range of uses including those referred to above. Attempts to use New Zealand-grown wood similarly have been disappointing but some species showed sufficient promise to warrant more intensive investigation.

A number of studies (Kininmonth et al. 1974) have been conducted by the Forest Research Institute on the sawing and seasoning of the most promising eucalypt species. The results of these and other unreported studies, supported by the experiences of sawmillers and farm foresters (Barr 1980), have lead to the following conclusions on the most appropriate species, conversion techniques, and silviculture for the production of high-grade eucalypt timber in New Zealand.

CHOICE OF SPECIES

The major concern has been to select a small number of species that between them show enough adaptation for all the major sites for afforestation. The species of greatest potential fall into two groups:

(a) Eucalyptus regnans F. Muell., E. fastigata Deane et Maid., and E. delegatensis R.T. Bak. of the ash group, with timbers of a pale colour and an air-dry density (12% m.c.) in the range 520 to 630 kg/m^3.

(b) E. saligna Sm. and E. botryoides Sm., with timbers reddish in colour and an air-dry density around 700 kg/m^3.

The end-uses for which the wood from these species is suited includes sliced veneer, furniture, interior finishings, joinery, and turnery; the poorer grades can be used in general building, lamination, and pallet production. The slabs, offcuts, and logs too small for sawing can be chipped and used as fuel or in the manufacture of reconstituted boards or short-fibred pulp.

SAWING AND DRYING

The major factor leading to difficulties in conversion of eucalypt logs to sawn timber is the presence of growth stresses within the tree. Relief of these stresses results in end-splitting of logs and the distortion of boards on sawing. As reported by Kininmonth et al (1974) the conversion from log to sawn volume for E. saligna, after docking for end-splits, was 40.9% on flat-sawn boards and 45.3% for quarter-sawn material.

Log size has a marked effect on conversion factor and grade recovery. The impact of growth stresses is less pronounced as log size increases. Logs with a mid diameter greater than 500 mm yield, on average, above 50% recovery; this reduces, along with the proportion of clear and dressing grades, as diameter decreases, to the extent that logs with a mid diameter less than 400 mm are not considered worth sawing.

In summarising the influence of log size, Kininmonth et al. (1974) state "Nonetheless the conclusion reached from these studies is that the largest trees of any age should be at least equal to the smallest in terms of sawn recovery, should suffer less from growth stesses and should yield a higher proportion of superior grades. It remains to be seen whether this applies to trees grown very rapidly to produce sawlogs on short rotations. A more certain merit of fast growth and short rotation, particularly in the denser groups, including E. saligna, is that wood of lower density, which is more acceptable for machining will be produced".

As a consequence of the above studies it was recommended (N.Z. Forest Service 1976) that, if eucalypt species were to be grown for saw or veneer logs, a minimum breast height diameter of 750 mm at time of felling was to be aimed for. This would yield three to four 5-m logs/tree within the limit of 400 mm SED which appeared to be the minimum for a satisfactory recovery of the grade of timber sought for the particular end users of eucalypt timber being considered. The studies also demonstrated the need to reduce degrade from knots through encouraging natural branch shedding; this could be done by maintaining a high stocking, by pruning, or by a combination of the two. It also appeared wise to grow the trees as fast as possible for as long as possible to minimise the effects of growth stresses.

These recommendations are in agreement with those of Page (1978) who, in examining the production of sawn timber from fast-grown eucalypts in Australia, reported that in existing mills the economics of milling deteriorate rapidly when log diameter is less than 500 mm. In mills specifically designed to handle small logs there is a rapid fall-off in profit below 300 mm, but to avoid the defects of brittle heart, pith, and spring a log size possibly as large as 500 mm mid diameter may be desirable. He concludes that "from the point of view of utilisation, the problems of converting young eucalypt forests are best alleviated by delaying harvesting until a diameter overbark at breast height of about 700 mm is attained".

All species studied can be satisfactorily dried if reasonable care is taken. Initial air drying to 30% moisture content or less can be followed by kiln drying at the recommended schedule (see Kininmonth et al. 1974). Quarter-sawing is preferred as surface checking is reduced, the dried boards are more stable, and where collapse on drying occurs this can be readily recovered by reconditioning. In flat-sawn boards collapse leads to surface checking, which is most severe around knots, and such checking is accentuated by reconditioning. Collapse is unavoidable in the ash group of eucalypts and the aim should be to limit the severity and to recondition routinely. Collapse-induced internal checking was a major defect in E. delegatensis and, although reconditioning will close these checks, the discontinuity remains. Degrade during air drying is insignificant for E. saligna and E. botryoides, with only slight collapse in the lower density material. Reconditioning of these higher density species is not recommended.

SILVICULTURE

The aim of silviculture for sawlog production will be to produce trees of the dimensions previously mentioned. This can be achieved by adopting one of the following systems.

Pure Plantations

An initial stocking of 1200 stems/ha is reduced progressively by thinning to a final stocking of about 100 stems/ha. The thinning to final stocking is done once natural branch shedding has occurred up to the fourth log, which corresponds to a top height of between 25 and 30 m.

The final-crop stocking of 100 stems/ha is based on observations of the number of dominant trees in older untended stands, the growing space required by trees of the diameter (750 mm) desired at clearfelling, and the number of trees with this mean diameter that can be carried in a stand with the basal area of between 45 and 55 m^2/ha assessed in older untended plantations.

The reduction of stocking to a figure which is low in comparison with pine, is also to encourage the development of a broad well-balanced crown and to concentrate diameter growth on three or possibly four 5 m logs. As the top logs (above 20 m) will not produce sawn timber, the form in this part of the tree is of little consequence.

Rotation length is governed by the achievement of the desired mean diameter, which results to date indicate will probably be in the range of 30 to 35 years for the better sites.

At present the outlets for eucalypt thinnings are limited and alternative systems are being tried to reduce what could be a considerable waste of small-diameter wood.

Pine/Eucalypt Mixtures

Eucalypts initially planted in rows 8 to 10 m apart, with a distance between trees of 2 to 2.5 m, are separated by two or three rows of *P. radiata*. The main function of the pines is to provide the competition needed to keep the branch size on the eucalypts small and to promote branch shedding.

Mixture with pine allows a lower number of eucalypts to be planted per hectare, as availability of stock is limiting the extent of pure planting in many places. Outlets already exist for pine thinnings and there is no problem with coppice growth. A mixed crop can be carried with a possible increase in overall volume production and greater flexibility in selection.

If the performance of the eucalypts is up to expectations, then the pines can be eliminated by a series of thinnings and the eucalypts reduced to 100 stems/ha.

If the performance of the eucalypts is less satisfactory, then a proportion of the pines can be pruned and retained along with the eucalypts and either removed as a sawlog thinning at age 25-30 years or carried through with the eucalypts as a mixed crop until clearfelling at age 35-40 years.

To illustrate the comparative growth of the different species, in a 9-year-old stand of mixed *E. saligna* thinned to 100 stems/ha and *P. radiata* thinned to 250 stems/ha, mean height and diameter of the eucalypts were 19.8 m and 232 mm respectively, and of the pines 18.4 m and 225 mm.

Animal Grazing and Timber Production Combined

The two systems outlined so far rely on between-tree competition to induce natural branch shedding. If mechanical pruning is adopted thinnings can be heavier and earlier, with a smaller volume wasted if no markets exist for thinnings. Some farm foresters (*see* Barr 1980) have either introduced grazing animals into these heavily thinned young stands or planted eucalypts at stockings around 700 stems/ha on existing pasture. The low final-crop stocking advocated for eucalypt sawlogs and the associated under-utilisation of the site for part of the rotation may be compensated for by the returns from grazing.

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IMPLANTAÇÃO DE FLORESTAS DE EUCALIPTOS EM NOVA ZELÂNDIA USANDO MUDAS DE RAIZ NUA.

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Resumo

Acima de 1500 ha de plantações de eucalipto estão sendo implantadas anualmente na Nova Zelândia usando mudas de raíz nua. As técnicas de produção de mudas são similares àquelas utilizadas para a maioria das plantações de *P. radiata* D. Don.

A semeadura é feita mecanicamente nos canteiros e mudas vigorosas de um ano de idade, com sistema radicular bem desenvolvido e fibroso, são produzidas através de um programa intensivo de controle de ervas daninhas, adubação, desbaste, corte basal e lateral das raízes e arrancamento. Desde que essas mudas sejam manuseadas com cuidado e a plantação seja efetuada durante o inverno e início da primavera, a sobrevivência pode ser superior a 90%.

A produção de mudas em embalagens também demonstra ser altamente potencial, mas tais métodos caros não oferecem vantagens quando comparados com o de raiz nua na implantação de florestas comerciais.

EUCALYPT PLANTATION ESTABLISHMENT IN NEW ZEALAND USING BARE-ROOTED SEEDLINGS.

Summary

Over 1500 ha of eucalypt plantations are being established annually in New Zealand using bare-rooted seedlings. Production techniques are similar to those used for the major plantation species, *Pinus radiata* D. Don. Seed is drill-sown into the beds and a robust *1-year-old* seedling with a well-developed fibrous root system is produced by an intensive programme of weed-control, fertilising, thinning, undercutting, lateral root pruning, and wrenching. Provided these seedlings are handled with reasonable care, planting during winter and early spring normally gives survivals over 90%.

The raising of seedlings in various types of containers has also proved highly successful, but such costly methods offer no advantage over bare-rooted stock for the bulk of planting.

INTRODUCTION

The use of bare-rooted seedlings is a well-established practice in the establishment of conifer plantations in New Zealand. Similar techniques are now used for the raising and planting of about 1500 ha of eucalypts annually. The species grown are principally *Eucalyptus regnans* F. Muell., *E. saligna* Sm., *E. delegatensis* R.T. Bak., and *E. fastigata* Deane et Maid. Compared with the methods adopted for the raising of the major plantation species, *Pinus radiata* D. Don, eucalypts require more intensive conditioning to develop a plant capable of surviving and growing rapidly after planting. The following account outlines methods for raising bare-rooted seedlings currently practised at the Forest Research Institute (F.R.I.) nursery; these procedures are generally followed by other eucalypt growers.

NURSERY PRACTICE

The objective in raising bare-rooted eucalypts is to produce lightly branched seedlings, 45-60 cm in height, with a root collar diameter of 8-15 mm by mid-winter. Top growth is restricted, and the development of a vigorous fibrous root system is encouraged by a long period of conditioning before lifting.

Eucalypts need extremely fertile nursery soil and in the light soil at Rotorua two slow-release nitrogenous fertilisers, "Magamp" (containing magnesium ammonium potassium phosphate) at 250 kg/ha and isobutylidene-diurea (IBDU) at 500 kg/ha, are incorporated into the seedbed prior to sowing. Results of recent trials suggest that it may be possible to substitute 30% potassic serpentine superphosphate (at 1500 kg/ha) for these two fertilisers and to satisfy the nitrogen requirements with foliar and inter-row applications of urea.

Preparation of seed for sowing entails stratification for those species from naturally colder climates, with E. delegatensis requiring 12 weeks treatment and E. regnans 4 weeks. Eucalyptus saligna is not stratified.

To facilitate the mechanisation of subsequent operations, seed is drill sown. In the absence of satisfactory cleaning and pelleting techniques, the larger-seeded species such as E. delegatensis and E. regnans can be dribbled through an agricultural sower but the smaller-seeded species such as E. saligna are sown by hand at 40 viable seeds per metre of drill. The seed is mixed with fine sand or soil and very lightly covered with sandy soil. Four people can sow 400 metres of drill per hour, equivalent to 6000 final-crop trees

Nitrofen at 7 kg active ingredient (a.i.)*/ha applied within 2 days of sowing ("post sowing" treatment), gives approximately 6 weeks control of broadleaved weeds and grasses. When nitrofen has lost its effectiveness, hand weeding is necessary until seedlings develop large spreading leaves.

On heavy soils linuron is used, also as a post-sowing application, at rates of 0.5–0.75 kg a.i./ha. To obtain the best weed control without crop injury post-sowing applications are made to moist seedbeds. Linuron, in particular, must be applied within 2 days of sowing as delayed applications are likely to cause crop injury.

Chlorthal can be applied to eucalypt seedlings that are in the fully developed four-leaf stage, at 6 kg a.i./ha. Recent trials have shown that applications of propazine at 0.6 kg a.i. plus chlorthal at 7 kg a.i. in 450-500 litres water/ha may be made with safety when seedlings are a minimum of 15 cm tall. Light irrigation to wash weedicide deposits off the leaves and on to the soil follows this treatment. Such applications, made after hand weeding, have given completely clean seedbeds for the remainder of the season.

Seedling spacing is important; eucalypts need ample room to develop because if crowded they become spindly and tend to stagnate. For bare-rooted stock a compromise has to be reached between a wide spacing that allows maximum stem diameter growth in relation to height, and a narrow spacing aimed at suppression of branch size, as clean-stemmed seedlings are easier to handle and plant than heavily branched ones.

The first thinning, when seedlings are 8 to 10 cm tall, is aimed at removing any bent, malformed, and suppressed seedlings. During the second thinning, when seedlings are 15 to 20 cm tall, the stocking is reduced to approximately 15 seedlings per metre of drill. This second thinning takes place as soon as the seedlings have recovered from undercutting shock.

To minimise transplanting shock, seedlings are subjected to very intensive conditioning. The treatment starts with an undercut aimed at severing the taproot at 6-8 cm when trees are 15-20 cm tall, using a razor-sharp reciprocating blade 20 mm wide and 2 mm thick. To obtain a clean cut, blade speed should be at least 3.5 times that of tractor forward speed.

Prior to undercutting, the soil should be moist, and for the next 3 days frequent light overhead irrigation is often required to prevent wilting and avoid mortality.

Lateral root pruning at frequent intervals is necessary initially to stop the development of strong woody lateral roots and later to encourage fibrous root development. The first lateral pruning is done as soon as the trees have recovered from undercutting (normally after 10 days) and subsequently at 3- to 4-week intervals.

Two weeks after the first lateral pruning, trees are wrenched for the first time. This is done with a reciprocating blade at a depth of 8 to 10 cm with further wrenching at 1- to 3-week intervals depending on growth of trees and soil conditions. The aim is to keep the soil loose and aerated. No watering is necessary before or after wrenching.

FIELD PROCEDURES

To obtain good survival and growth with bare-rooted seedlings good nursery practice must be matched by subsequent care in handling, transport, and planting. Consistently good results have been reported by Poole and Fry (1980) when seedlings are lifted into cardboard cartons and planted the following day.

The general observation worldwide that the growth of newly planted eucalypts is encouraged by cultivation, weed control, and fertiliser application applies also to the establishment of bare-rooted seedlings in New Zealand. However, cultivation is often impossible because of steepness of slope or the presence of large stumps on pine cutovers.

Before planting, weed competition is reduced as much as possible by burning, cultivation, the use of herbicides, or a combination of these methods. The only chemicals applied over planted eucalypt seedlings are a few of the triazines, simazine, atrazine, and terbuthylazine plus terbumeton, and even these must be used with discretion.

Eucalypts usually respond to the liberal application of nitrogenous fertiliser soon after planting. Experiments with different fertilisers and rates on mainly pumice soils have led to the current recommendation that 60 g of urea be applied in a spade slit 15-20 cm from the tree at or soon after planting. For some sites and some species this rate could be reduced to 30 g.

RESULTS

Various trials by the F.R.I. over many years have demonstrated high survivals (in excess of 90%) for a range of species planted as bare-rooted seedlings during the months of May, June, July, and August. By using techniques similar to those outlined, Poole and Fry (1980) report survivals of 85-90% and mean heights up to 2 m after the first season's growth. This is in an 800-ha annual planting programme of predominantly E. regnans.

The planting of container-grown stock has also been well tried, with excellent results in terms of survival and growth. However, the additional production cost of these seedlings (Albert et al. 1980) in comparison to bare-rooted means that their only likely use in large-scale programmes would be to extend the planting period up to December. With the present scale of planting this is not necessary.

While recognising that the climate, soils, and labour availability in New Zealand differ from those of other countries, it could well be that our experiences in raising bare-rooted stock could be of value elsewhere. The unsatisfactory experiences of others in the past may well be reversed by intensive seedling conditioning as practised in New Zealand.

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RELATÓRIO SOBRE A REGENERAÇÃO DE *EUCALYPTUS CAMALDULENSIS* DEHNH. ATRAVÉS DE REPLANTIO DE CEPAS.

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Resumo

O *E. camaldulensis*, apresenta grande possibilidade de sucesso quando regenerado através das cepas. O padrão das brotações e regeneração das raízes das cepas demonstram que as brotações se desenvolvem mais cedo do que as raízes. A presença das folhas nas brotações desempenha papel significativo para o desenvolvimento ativo das raízes durante o período de 4 a 6 semanas após a replantio.

REPORT ON REGENERATION OF *EUCALYPTUS CAMALDULENSIS* DEHNH. BY STUMP REPLANTING.

Summary

E.camaldulensis shows a high degree of success when regenerated by means of stumps. The pattern of sprouts and root regeneration of stumps reveals that sprouts develop earlier than roots. The presence of leaves of sprouts plays a significant role for active root development particularly during the period of 4-6 weeks after replanting.

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* Equivalent to 29.2 litres of the 24% emulsifiable concentrate in 500 litres water/ha.

INTRODUCTION

E.camaldulensis Dehnh. synonym *E.rostrata* Schlecht., common name River Red Gum or Murray Red Gum, is a native species of Australia. It is found in all states of Australia except Tasmania, the southern part of Western Australia and the coastal fringes of Victoria, New South Wales and eastern Queensland (Figure 1).

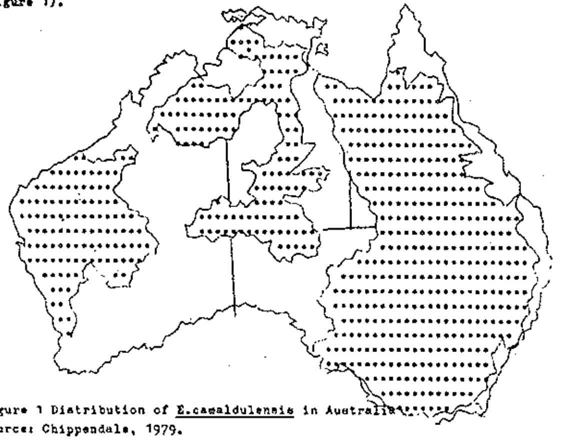

Figure 1 Distribution of *E.camaldulensis* in Australia
Source: Chippendale, 1979.

E.camaldulensis is one of the most important eucalypt species, widely distributed, between latitudes 14°S to 38°S, growing over a wide range and in a wide range of climatic conditions in Australia, though mainly in areas of high summer temperatures and low rainfall where underground water is available. The altitude of the principal areas where *E.camaldulensis* occurs varies between 30-230 m but in some places in the interior it extends to higher altitudes, up to 610 m, such as in the Mt Lofty Ranges, in the Flinders Ranges of South Australia or at Alice Springs, Northern Territory(Hall, Johnston and Chippendale 1970). Temperatures may vary from a minimum of -6°C to a maximum of 54°C with a diurnal range of up to 21°C, but its distribution is limited when the temperature is lower than -7°C(Turnbull, 1973). The annual rainfall is mainly 225-650 mm and may reach 1000 mm in limited areas. Soils where *E.camaldulensis* occurs vary from sandy, in the north of Australia, to heavy clay soils over limestone. *E.camaldulensis* is one of the most drought tolerant eucalypts and can exist in areas with very low and unreliable rainfall.

E.camaldulensis can regenerate in several ways, including seedling, coppicing and stump-replanting. Anon.(1929) and Kermode(1964) reported that artificial regeneration of forest tree species by means of the stump planting method has long been a standard practice in a number of countries. Champion and Pant(1932) and FAO(1956) found the method was used in Burma in about 1920 and the species was teak(*Tectona grandis*). Since then it has been used increasingly with success with many species in Asia and Africa including *Acacia arabica*, *A.catechu*, *Cassia fistula*, *Dalbergia sissoo*, *Gmelina arborea* and *Terminalia tomentosa*(Champion and Pant, 1932, FAO, 1956, 1959, Jacobs, 1955, Troup, 1921).

Regeneration of *Eucalyptus* species by means of stump-replanting was studied about 50 years ago but is not well known. Jacobs(1955) noted that the technique is successful with a number of species, including *E.camaldulensis*, *E.rudis* and *E.melliodora*. However, no details of stump planting with the eucalypts were given by this author.

Karschon(1963) compared regeneration of *E.camaldulensis* by means of stump-replanting with seedling in the field of Illanoth in Israel. He grew and stumped 4 seedlings in each of 4 replications and assessed survival per cent and height growth at age 10 and 20 months after planting. Karschon found the survival per cent was 82 and 100 for stump-replanting and seedlings respectively. The height growth of seedlings was taller than that of stump-replanting. Karschon concluded that the technique of stump-replanting should not be introduced to the studied area due to lower survival and height growth.

The author's openion suggests that this conclusion by Karschon may be questioned in terms of height growth in long term assessment due to root system.

Chinamani and Gupte(1966) also studied stump-replanting of *E.citriodora*, *E.globulus* and *E.tereticornis* in India and found that survival per cent of *E.globulus* was very low, 10-20 %, while survival per cent of the other two species was relatively high. Length of the stem section, in addition, was found to be affecting survival.

Stump planting is a silvicultural technique and has several advantages over seedling planting. FAO(1963) stated that stumps have a fast initial growth rate, are very easy to transport and transplant, are vigorous and hardy, and can withstand droughts and attacks by ants.

Due to the several advantages which may be obtained as mentioned above, and at the same time the apparent lack of details of this technique, it was considered important to undertake a formal investigation. A study was set up using a number of provenances of *E.camaldulensis* to investigate and to observe factors which may affect the growth of stumps.

MATERIALS AND METHODS

The experiment was conducted in the glasshouse of Forestry Department, The Australian National University, Canberra, Australia as part of the author's graduate study work. The experiment was composed of three parts i.e. the initial experiment, the pattern of regeneration of roots and sprouts from stumps and the effect of sprouts on root development.

One-year-old of seedlings of *E.camaldulensis* were used in the experiment. Details of seed source of the seedlings and provenances used for each study are given in Table 1.

Table 1
Seed source of *E.camaldulensis* used for this study. Seed supplied by the CSIRO Division of Forest Research, Canberra, Australia.

Seed lot No.	Locality	Latitude °S		Longitude °E		Altitude (m)	Soils
		°	'	°	'		
10483	NW William Ck. SA	28	43	135	55	240	rocky loam
10533	Victoria River NT	15	06	131	07	30	sandy loam
10666	Lake Albacutya VIC.	35	44	142	02	60	grey clay
10912	N Chillagoe QLD.	17	03	144	32	335	sandy
10923	Gilbert River QLD.	17	10	141	45	30	pH 6.5-7

The seedlings were grown in a heated glasshouse with no special treatment. Supplementary light in the open glasshouse was used to provide a 16 hour photoperiod. Seeds of each provenance were sown separately in pots containing equal parts of a mixture of perlite and vermiculite. When the seedlings were about 3-5 cm high they were pricked out and transplanted to 15 cm diameter pots. Three seedlings were planted into each pot and after two months only the best was kept for the study.

The method used to prepare stumps of *E.camaldulensis* for the experiment was similar to that used for teak(*Tectona grandis*). The sequence of operations for the preparation of stumps of *E.camaldulensis* can be described as follows:

Seedlings were lifted out of the pots, the shoot was cut at a point about 2-3 cm above the root collar. All side or lateral roots were pruned off cleanly where they join the main root. The tap-root was pruned down to 10-16 cm with one clean slanting cut. Some of the seedlings had multiple-branched roots. These were used although it is usually preferable to reject all plants with multiple-branched roots for stump planting(FAO, 1956, 1959, Kermode, 1964).

Plastic pots of 17 cm diameter were used for the experiment. A mixture of equal parts of perlite and vermiculite was used as a growth medium for planting.

As with teak stump planting a hole was made using a stick at the center of the pot. The diameter of the hole was about 1-2 cm wider than the stump diameter and about the length of the root deep. A stump was planted with its root collar level with the ground surface. The mixture of perlite and vermiculite was compacted around the stump leaving no air spaces. A randomized complete block design with provenances and replications was used for the experiment except in Study II. Number of seedlings, provenances, treatments and replications used for Study I and III is shown below:

	seedlings	provenances	treatments	replications
Study I	10	3	-	4
Study III	5	3	7	5

The pots were watered twice a day using a hose fitted with a fine rose. Each pot stood in a saucer and the saucer was kept full of water throughout the period of the observations. This then constituted a shallow watertable effect in each pot.

Fertilization was applied 3 weeks after replanting. A crystalline soluble mixed fertilizer 'Aquasol' was used once a week. The concentration of the fertilizer used was 1 teaspoon per 20 litres of water. In the first period 250 ml of fertilizer solution was poured carefully round the stumps so as to avoid the buds or sprouts which were appearing, as these could be damaged by the fertilizer. Once the sprouts were about two months old fertilizer was applied by overhead methods.

Observations of the three studies are as follows:

Study I *Initial experiment*. Observations were made on *survival* and *height growth* of sprouts at age 8 weeks and with 15 days interval until 75 days after stump-replanting. In this study excess sprouts were trimmed off after 4 weeks and only one was kept for study.

Study II *Pattern of regeneration of roots and sprouts from stumps*. Observations were made for eight weeks following replanting. Two stumps, one of each provenance, were lifted each week from the pots and washed carefully to expose the root systems. *Development of sprouts and roots* were studied and recorded. Then all new sprouts and roots were harvested and dried in an oven set at 65°C for one week and the *dry weight* was recorded.

Study III *Effect of sprouts on root development*. The study consisted of 7 treatments as below:

Treatment 1. Control. Sprouts were allowed to grow throughout the duration of the experiment;

Treatment 2, 3, 4 and 5. Sprouts on the stem were removed at the end of two, four, six and eight weeks respectively after stump-replanting. Regrowth sprouts were allowed to grow throughout remainder of the experiment;

Treatment 6. During the experiment sprouts were removed twice, at the end of two weeks and once again at the end of four weeks after stump-replanting;

Treatment 7. Sprouts were removed three times during the experiment, at the end of two, four and six weeks after stump-replanting.

A final harvest was made ten weeks from stump-replanting. The roots were washed and *lateral roots* were separated from the stump, *dried* at 65°C for three days and *weighed*.

RESULTS AND DISCUSSION

Study I. *Initial experiment*.

(NW William Ck. SA, Lake Albacutya VIC., Gilbert River QLD.)

Planting *E.camaldulensis* by stumps in the present study showed a high degree of success. Survival per cent of the individual provenances at age 8 weeks after stump-replanting varied between 86-96 per cent, the differences being statistically non-significant(Table 2)

Table 2

Survival of E.camaldulensis planted as stumps. Assessment at age 8 weeks after stump-replanting.

Provenances	Survival per cent	Significant differences
NW William Ck. SA.	96.7	
Lake Albacutya VIC.	93.3	NS
Gilbert River QLD.	86.7	

This result is in agreement with Champion and Pant(1932) who reported on E.camaldulensis planted on irrigated areas of the Punjab and in Burma many years ago, and with Jacobs(1955).

The sprouts developed quite slowly during the first 45 days after stump-replanting but subsequently they grew very quickly(Figure 2). This appeared to be related to the development of a new root system and this aspect is observed further in Study II.

In the initial period the sprouts of all three provenances developed at comparable rate but at the end of the 75th day observation period the Gilert River and Lake Albacutya provenances were apparently superior, but the differences were not statistically significant. The differences may have been due to differences in the stored reserves in the stumps. This result may be confirmed in some ways by the work of Grunwald and Kerschon(1974) who studied coppice regeneration of E.camaldulensis in Israel and found that the shoot development was related to the size of the tree before cutting.

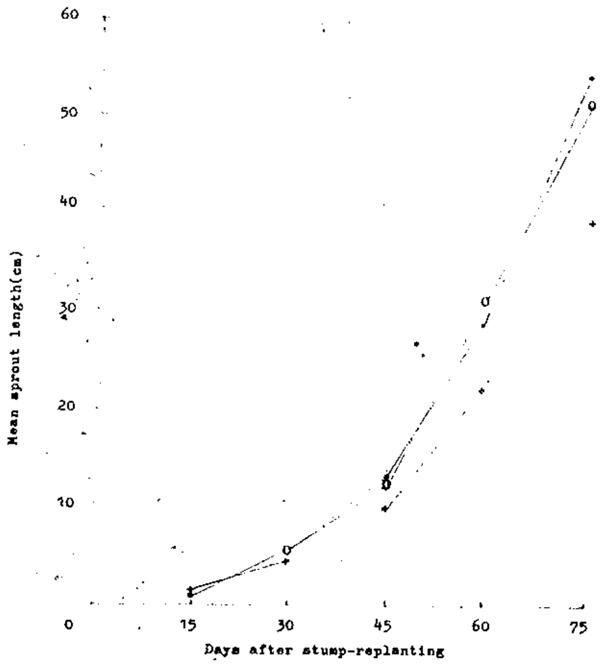

Figure 2 Sprout development of E.camaldulemsis planted by stumps.
*-Gilbert River, +-NW William Ck., O-Lake Albacutya.

Study II. Pattern of regeneration of roots and sprouts from stumps.

(Victoria River NT., N Chillagoe QLD.)

The pattern of regeneration of roots and sprouts from stumps of each stage is described as follows;

One week from stumping and replanting adventitious buds developed and emerged from the bark on stumps of both provenances. These were first seen as naked buds, red in colour. There was no sign of new roots at this age.

At two weeks the bud became sprouts, leaves unfolded and turned gradually from red colour to green.

Two small new roots were found only on the stump of the Victoria River provenance. The roots appeared as one behind the cut tip of the stump and one near the root collar.

After three weeks several sprouts had appeared and developed rapidly.

The roots developed rather slowly. These roots originated at different points on the root stump section.

At the end of the fourth week sprouts were developing very fast, were vigorous and healthy. Naked buds were still to be found at this age.

Roots were found only on the uprooted stump of the Victoria River provenance and most roots were thin. Careful inspection of stumps of both provenances revealed a region which looked like a group of buds as 'callus', formed as two rows around the cut tip. This callus had a round surface, rather soft, appeared very active in development and presumably roots would develop from this region. Wright(1962) stated that callus is a mass of unoriented tissue which develops near the lower end of a cutting and probably helps in water absorption. Kozlowski(1971) studied rooting of cuttings and confirmed that callus played an important role in the rooting process.

At age five weeks sprouts of both provenances continued to grow vigorously.

Roots had developed further and callus was still found to be forming around the tip.

During the final three weeks sprouts of both provenances were healthy and continued to develop vigorously.

Roots and callus were found together up to the age six weeks. Root development on the stumps continued to be vigorous, healthy and with the development of branched roots.

Where dry weight of sprouts and roots of the two provenances are considered sprout dry weight of the two provenances during the first 6 weeks after replanting is comparable but at the end of 8 weeks sprout dry weight of the Victoria River provenance was greater than that for N Chillagoe provenance.

The Victoria River provenance developed roots earlier and greater amount than the N Chillagoe provenance(Figure 3).

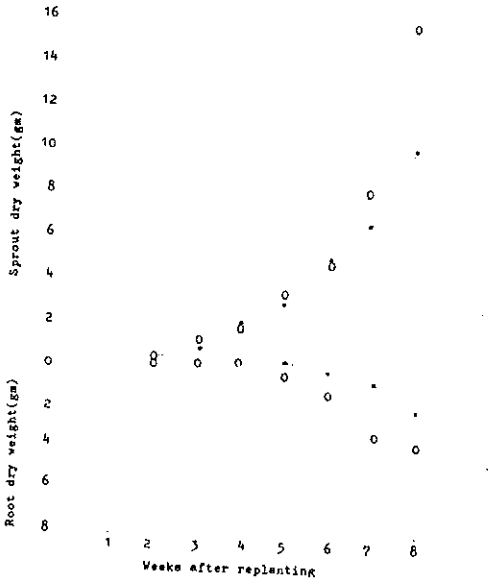

Figure 3 Sprout and root dry weight of E.camaldulensis planted as stumps.
*_ N Chillagoe, O - Victoria River.

The presence study indicates sprouts developed earlier than roots suggesting that the presence of sprouts on the stem influenced root regeneration. Further observations of this evidence was made in Study III.

Study III. Effect of leaves of sprouts on root development.

(Lake Albacutya VIC., May River WA., Victoria River NT.)

The present study shows highly significant differences in root production between treatments but no significant difference between provenances and with no significant interaction between provenances and treatments(Table 3).

Table 3

Summary of significant differences in root production between treatments, provenances and its interaction. Assessment at age 10 weeks after stump-replanting.

	Treatments	Provenances	Interaction
Significant differences	**	NS	NS

Stumps of the control treatment produced significantly more root dry weight than all the other treatments. Stumps of treatment 2 produced more root than all the remaining treatments. Treatment 5 in turn produced marginally more root than treatment 3, 4, 6 and 7, all of which produced very little root, with no significant difference between them(Table 4).

Table 4

Root dry weight from different treatments and provenances of E.camaldulensis 10 weeks after stump-replanting.

Provenance	Mean root dry weight by treatments(gm)							L.S.D.	
	1	2	5	3	4	6	7	.05	.01
Lake Albacutya	1.25	0.56	0.21	0.08	0.07	0.07	0.04		
May River	0.92	0.91	0.24	0.09	0.11	0.05	0.01	0.33	0.43
Victoria River	0.96	0.58	0.39	0.11	0.10	0.09	0.02		
Total mean	1.04	0.68	0.28	0.09	0.09	0.07	0.02	0.19	0.25

The influence of sprouts on root production appears from the experiment to be most critical during the period of 4 to 6 weeks from stumping. Root dry weight where leaves were removed during this period, i.e. treatments 3, 4, 6 and 7, was very small. In Study II it was observed that this was a period of callus formation before the development of new roots. The treatments must then have limited the development of callus and subsequent root formation.

The results of this experiment confirm that the presence of leafy sprouts plays a significant role in root production of stumps. Presumably both carbohydrates and auxins produced in the leaves and translocated to the roots were partly responsible for the observed response(Richardson, 1957, Hartmann and Kester, 1975). A similar study of the effect of leaves on cutting of *Acer rubrum* and *E.camaldulensis* which was carried out by Bachelard and Stowe (1963) confirmed that auxin and leaves were essential for optimal rooting.

The present results indicate that the continued presence of the leaves formed during the regeneration period is necessary for root development or root initiation of stumps. The results suggest that the benifits of stump replanting could very quickly be lost if the new sprouts were browsed or defoliated by insects.

CONCLUSION

The observations on stump regeneration in this study prove of considerable practical benefit as this is a very useful technique which could be employed in plantation establishment. This method would help with rapid and extensive afforestation, or reforestation at lower costs. Similer to a coppice regeneration system, which is very widely used in eucalypt plantations in many countries in the world, this method would achieve higher productivity because of more than one shoot on the stem, thus improving the economics of production.

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CRESCIMENTO E PRODUÇÃO DE MADEIRA DE EUCALIPTO.

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Resumo

Um experimento objetivando o estudo da produção de madeira para o suprimento de indústria de chapas duras foi instalado em Itupeva, Estado de São Paulo, Brasil.

O clima do local é do tipo Cfa, e o solo é Podzólico com cascalho, ácido e pobre. A topografia é ondulada. A precipitação média é de 1300 mm por ano, com verão chuvoso e inverno seco.

O delineamento estatístico utilizado consistiu de fatorial em blocos casualizados, com 4 repetições, de 224 plantas por parcela, incluindo a bordadura.

O solo foi bem preparado através de aração e gradagem, sendo que no plantio foi feita adubação de 100 g de NPK 9:10:9 por planta.

As espécies utilizadas no ensaio foram: *E. saligna*, *E. grandis*, *E. urophylla* e *E. propinqua*. As mudas foram produzidas no local, tendo sido utilizadas as melhores sementes disponíveis na época.

Os espaçamentos usados foram de 3,0 x 1,5 m e de 3,0 x 2,0 m.

As árvores foram cortadas em corte raso aos 5, 7, 9 e 11 anos de idade.

O crescimento foi acompanhado por medições anuais da altura total, DAP e número de falhas. A produção de madeira foi medida após a derrubada das árvores, nas idades preestabelecidas.

Os volumes obtidos referem-se ao total de madeira empilhada com casca. O peso da madeira foi estimado através da densidade básica. Os aspectos econômicos deste estudo serão abordados em outro trabalho.

Todos os resultados foram analisados estatisticamente e as seguintes conclusões podem ser resumidas:

1. A altura total das árvores variou com as espécies e com os espaçamentos, aumentando com a idade da árvore. A altura máxima verificada foi para o E. grandis no espaçamento de 3 x 2 m e à idade de 11 anos. Neste tratamento, a altura máxima média atingida foi de 25,57 metros.
2. O crescimento em diâmetro (DAP) de *E. grandis* e do *E. urophylla* foi maior do que o verificado para *E. propinqua* e *E. saligna*. O diâmetro aumentou com a idade, e foi superior no espaçamento de 3 x 2 m. O DAP médio verificadc foi para *E. urophylla*, à idade de 11 anos, tendo atingido 17,23 cm.
3. A porcentagem de falhas variou entre as espécies de acordo com a seguinte ordem crescente: *E. propinqua*, *E. saligna*, *E. grandis* e *E. urophylla*, de 3% a 22%. A porcentagem de falhas cresceu com a idade e foi menor no espaçamento de 3 x 2 metros.
4. A produção volumétrica com casca foi diferente entre as espécies. O E. grandis, com 457,60 esteres por hectare, foi superior aos demais. Em segundo lugar ficou o E. urophylla, com 426,87 st/ha, seguido por ambas as demais espécies E. saligna, com 362,89 st/ha, e E. propinqua, com 352,71 st/ha.
5. Os volumes totais obtidos às idades de 7 e 9 anos não foram diferentes. Ambos foram maiores do que o obtido à idade de 11 anos. A produção alcançada aos 5 anos ficou em último lugar.

6. Em relação à produção volumétrica total, o espaçamento de 3 x 1,5 m mostrou-se superior ao de 3 x 2 m, com 417,11 st/ha, contra 382,9 st/ha, respectivamente.

7. As produções volumétricas maiores foram obtidas por E. grandis e E. urophylla, no espaçamento de 3 x 1,5 m, às idades de 7 e 9 anos. A produção máxima verificada foi obtida por E. urophylla à idade de 9 anos, tendo atingido a 545,88 st/ha.

8. O incremento anual médio em termos de volume total para E. grandis, com 60,60 st/ha de madeira com casca, foi superior ao das demais espécies. Em segundo lugar ficou o E. urophylla, com 55,78 st/ha, seguido pelo E. saligna, com 48,64 st/ha, e o E. propinqua, com 46,86 st/ha.

9. Em relação à idade de corte das árvores, maiores incrementos foram obtidos à idade de 7 anos, com 63,19 st/ha/ano, e à idade de 5 anos, com 62,74 st/ha/ano. Em seguida vem a idade de 9 anos, com 50,76 st/ha/ano. A idade de 11 anos ficou em último lugar, com 35,20 st/ha/ano.

10. Comparando os incrementos por espaçamentos, verificou-se que o espaçamento de 3 x 1,5 m, com 55,27 st/ha/ano, foi estatisticamente superior ao de 3 x 2,0 m que apresentou 50,67 st/ha/ano.

11. A máxima produtividade foi alcançada por E. grandis, no espaçamento de 3 x 1,5 m, à idade de 7 anos, com 77,20 st/ha/ano, e à idade de 5 anos, com 73,68 st/ha/ano de volume total de madeira com casca empilhada.

12. A produção média em termos de peso de madeira seca variou entre as espécies, sendo que o E. urophylla foi o mais produtivo, com 156,25 ton/ha. Em segundo lugar ficou o E. grandis, com 139,10 ton/ha, seguido pela E. propinqua, com 130,94 ton/ha, e o E. saligna, com 118,16 ton/ha.

13. Em relação à idade de corte, as produções observadas à idade de 11 anos, com 151,53 ton/ha, foi similar à de 9 anos, com 149,90 ton/ha, e à de 7 anos, com 143,58 ton/ha de madeira seca. Em segundo lugar ficou a produção alcançada à idade de 5 anos, com apenas 99,42 ton/ha.

14. O espaçamento de 3 x 1,5 m apresentou a maior produção média em termos de madeira seca, com 140,17 ton/ha, quando comparada com a obtida no espaçamento de 3 x 2 m, com 132,05 ton/ha.

15. A produção máxima foi alcançada pela espécie E. urophylla, no espaçamento de 3 x 1,5 m, à idade de 7 anos, com 178,46 ton/ha, e aos 9 anos, com 195,34 ton/ha.

GROWTH AND WOOD PRODUCTION OF EUCALIPT.

Summary

An experiment aiming to study the wood production, destined for supplying hard loard industry, was established in Itupeva, State of São Paulo, Brazil.

The local climate is C f a type, and the soil is Podzolized with gravel, acid and poor. Relief is waved. Average rainfall is 1 300mm per year, with rainy summer and dry winter.

Statistical design used was a factorial, in randomized block, with 4 replications, of 224 plants' plots, including duble edge.

Terrain was well prepared through plowing and disking and, at planting time the holes received 100g of NPK 9:10:9 per plant.

Species choosed were: Eucalyptus saligna, E.grandis, E. urophylla and E.propinqua. Seedlings were produced locally with the best seed at that time.

Spacings used were 3,0 x 1,5m and 3,0 x 2,0m.

Clear cut were done at 5,7,9 and 11 years.

Growth was followed by annual mensuration of total height, DBH and failures. Wood productions were measured, after clear cut, at each age foreseen.

Obtained volumes refer to total piled wood, with bark. Wood weights were estimated through basic specific gravity.

The economic study of this production will be presented in a separate paper.

All results were statistically analised and the following conclusions can be drawn from discussion:

1 - Total height growth of the trees varied with species and with spacing, and grew with the age. They were higher : E.grandis, spacing 3 x 2,0m and the age 11 years. In this treatment the maximum average height was 25,57m.

2 - The diameter (DBH) tree growth of E.grandis and E.urophylla were higher than E.propinqua and E.saligna. Diameter grew with the age and was superior in spacing 3 x 2,0 m. The maximum average DBH was achieved by E.urophylla, at age 11, with 17,23 cm.

3 - Failures percentage varied among species according to the following increasing order: E.propinqua, E.saligna, E. grandis and E.urophylla, from 3% up to 22%. The failures % grew with the age and were lower in spacing 3 x 2,0 m.

4 - Total wood with bark volume production was different among species. The E.grandis, with 457,60 steres per hectare was superior to the others. In second place comes E.urophylla, with 426,87 st/ha and, in third are both, E.saligna with 362,89 st/ha and E.propinqua with 352,71 st/ha.

5 - The total volumes obtained at age 7 and 9 were not different. Both were higher than that at age 11. In last place is the production at 5 year old.

6 - The spacing 3 x 1,5m, with 417,11 st/ha showed superior than 3 x 2,0m, with 382,93 st/ha of total volume produced.

7 - Higher volumetric productions were obtained by E. grandis and E.urophylla, in spacing 3 x 1,5m, at ages 7 and 9 years. The highest was reached by E.urophylla at 9 year old, with 545,88 st/ha.

8 - The annual average increment of total volume of E. grandis, with 60,60 st/ha of wood with bark was superior than the other species. In second place comes E.urophylla with 55,78 st/ha and, at last, with similar productivities, are E.saligna with 48,64 st and E.propinqua with 46,86 st.

9 - Related to cut age of trees, higher increments were obtained at age 7, with 63,19 st/ha/year and at age 5, with 62,74 st. In second place comes the age 9, with 50,76 st. The last is age 11, with 35,20 st/ha/year.

10 - Comparing the increments by spacing it was verifyed that the 3 x 1,5m, with 55,27 st/ha/year was statistically superior than that of 3 x 2,0m, with 50,67 st.

11 - The highest productivities of all trees were achieved by E.grandis, in spacing 3 x 1,5m, at 7 years of age, with 77,20 st/ha/year, and at age 5, with 73,68 st/ha/year of total volume of piled wood with bark.

12 - The average production in terms of dry wood weight varied among species, being the E.urophylla the most productive, with 156,25 ton/ha. In second place appear E. grandis, with 139,10 ton/ha and E.propinqua, with 130,94 ton/ha. At last place is E.saligna, with 118,16 ton/ha.

13 - Related to cut age, productions at 11 year old, with 151,53 ton/ha was similar to the age 9, with 149,90 ton/ha and at 7, with 143,58 ton/ha of dry wood. In second and last place is the production at the age 5, with only 99,42 ton/ha.

14 - Spacing 3 x 1,5 m presented higher average production of total dry wood, with 140,17 ton/ha, when compared to 3 x 2,0m, with 132,05 ton/ha.

15 - The maximum productions were achieved by E.urophylla, in spacing 3 x 1,5m, at 7 years of age, with 178,46 ton/ha and at at 9 years, with 195,34 ton/ha.

I - Introdução -

Os eucaliptos constituem-se nas espécies florestais mais utilizadas nos reflorestamentos no Brasil.

Apesar da grande diversidade de utilizações de sua madeira, os reflorestamentos com eucalipto tem sido destinados basicamente ao abastecimento das indústrias de celulose e de chapas.

Recentemente essa madeira passou a ter muito maior expressão pela necessidade de sua utilização tambem para energia , fato que ampliou significativamente a demanda no mercado interno.

A importância da produção de madeira no Brasil pode ser avaliada através do quadro de demanda a seguir apresentado.

Demanda projetada para os principais setores dependentes da matéria prima madeira (milhões de m^3) Fonte: IBDF.

Anos	Madeira processada mecanicamente	Carvão e lenha	Papel e celulose	Demanda total
1975	17,31	141,7	11,20	170,21
1980	23,09	156,7	18,82	198,61
1985	29,44	157,6	29,05	216,09
1990	36,43	164,1	43,09	244,52
1995	44,15	173,1	63,31	280,56
2000	53,38	182,4	89,10	324,88

Observa-se pelo quadro acima uma demanda continuamente crescente e portanto cada vez mais dependente da produção atra vés dos reflorestamentos. Considerando-se que, nesse conjunto, os eucaliptos são majoritários, em quantidade, pode-se depreender daí a expressão de sua produção de madeira para atendimento do mercado brasileiro.

Outro aspecto a ser ressaltado é o valor que o reflorestamento, no atendimento da demanda do setor madeireiro, representa sobre a preservação das matas naturais do país.

Dessa forma, os eucaliptos passam a ter maior importância, na medida em que sejam destinados tambem como fonte de madeira grossa para o processamento mecânico.

O presente trabalho trata da apresentação dos resultados obtidos de um experimento de campo sobre o crescimento e produção de madeira de quatro espécies de eucalipto, cultivadas sob dois espaçamentos e exploradas em quatro idades distintas. Resultados preliminares foram apresentados por Coelho et alii 1970 e Mello et alii 1972.

Trabalhos comparativos tem sido desenvolvidos em várias partes do mundo, utilizando tanto eucalipto como outras espécies de rápido crescimento.

Guimarães (1956) trabalhando com *Eucalyptus saligna* comparou 11 combinações de espaçamentos entre plantas, desde 1,0 x 1,0m até 3,0 x 2,0m. Com os volumes de lenha obtidos aos 8 anos de idade concluiu:

1º Há estreita correlação entre os espaçamentos e a produção volumétrica de lenha. À medida que diminui o espaçamento de plantio, aumenta a produção de lenha, mas os aumentos são pequenos.

2º Sob o aspecto econômico, não é aconselhável a adoção de espaçamentos menores que 2,0 x 2,0m.

3º O espaçamento que forneceu maior lucro líquido foi 4,57 m^2 por árvore, que corresponde a 3,0 x 1,5m.

4º O espaçamento que apresentou maior renda do capital foi 7,60 m^2 ou seja 3,0 x 2,5m.

Esses espaçamentos são convenientes ainda, por permitirem o emprego de implementos mecanizados.

Pryor (1967), citado por Coelho et alii 1970, considera que o espaçamento tem grande efeito sobre o custo da matéria-prima produzida e sobre a contestura dos preços correntes pela restrita oportunidade de manipulação do produto obtido. Admitindo que por necessidade de caráter tecnológico e social o manejo dos povoamentos de eucalipto tenha por objetivo a produção de madeira industrial, de rápido crescimento, porém de baixa densidade, devendo ser alcançadas produções em rotações curtas, os espaçamentos mais amplos possíveis, sob determinadas condições, serão os mais apropriados. Conclue que decisões precisas, sobre espaçamentos e espécies não podem ser tornadas sempre sem um conhecimento mais acurado da influência dos mesmos nas qualidades dos produtos obtidos.

Trabalhando com Populus x Euramericana C.V. "I-154", Berhouet e col. (1973) compararam o rendimento em madeira em parcelas sob os seguintes espaçamentos: 2 x 2m, 3 x 2m, 3 x 3m, 4 x 4m, 5 x 5m e 6 x 6m. Constatou-se que o espaçamento 6 x 6m triplica o rendimento de madeira em m^3/ha/ano em relação ao espaçamento menor testado. No espaçamento 6 x 6m obteveram-se as maiores porcentagens de rendimento em madeira, sendo: para laminação 28,12%, serraria 32,81%, embalagem 23,46% e celulose e papel 15,49%. Somente o espaçamento 6 x 6m permite a comercialização de madeira para laminação.

Smith e col.(1977) estudando os seguintes espaçamentos de plantio de *Pinus elliottii* var. *elliottii*: 1,8 x 1,8m, 1,8 x 3,0m, 1,8 x 3,6m, 2,4 x 2,4m, 2,4 x 3,6m, 3,0 x 3,0m e 3,6 x 3,6m verificaram, aos 14 anos de idade, que:

a) o volume total a essa idade foi diretamente proporcional ao número de árvores plantadas por unidade de área.

b) a densidade da madeira não foi afetada pelo espaçamento.

c) quando a dispersão dos valores entre madeira para serraria e para celulose for estreita, o espaçamento ideal estará ao redor de 1,8 x 1,8m.

d) quando a madeira de serraria é altamente valorizada em relação a de celulose, o espaçamento ótimo financeiramente seria 3,6 x 3,6m.

e) considerados todos os fatores, incluindo os preços de mercado, indicam um espaçamento ótimo variando de 3 x 1,8m = 5,4m^2 a 3,6 x 1,8m = 6,48 m^2.

Analizando o efeito de 5 espaçamentos sobre o crescimento do *Eucalyptus "urophylla"*, de origem híbrida, Couto et alii (1977) concluiram que dentre os espaçamentos estudados, o 3,0 x 2,0m combinou todos os aspectos positivos necessários ao melhor aproveitamento da área para rotação de 8 anos.

Gomes et alii (1977) estudaram o comportamento de 57 espécies e procedências de eucalipto na região de Viçosa, Minas Gerais. Os autores concluiram, através de avaliação feita aos 28 meses de idade, considerando em conjunto todas as características de crescimento e forma das árvores, que apenas o *Eucalyptus grandis* e *E.saligna* destacaram-se estatísticamente superiores.

Estudos com *Eucalyptus grandis* no sul da Florida realizados por Meskimen e col. revelaram que o volume de árvores comercializáveis (DAP 10cm) foi quase o mesmo nos espaçamentos de 1,2 x 2,4m, 2,4 x 2,4m, 3,6 x 2,4m e 4,8 x 2,4m, em plantações com 7,4 anos de idade. O volume total em todas as árvores, entretanto, foi 1,7 vez maior no espaçamento mais fechado, do que nos dois espaçamentos mais amplos. Mas, no sistema convencional para madeira para celulose, podem ser obtidos rendimentos comerciais iguais àqueles, em espaçamentos mais abertos, a custos mais baixos de implantação e exploração. Nem a qualidade da madeira nem a altura das árvores foram afetados apreciavelmente pelos espaçamentos estudados.

O *Acer saccharinum* L., uma das espécies folhosas de rápido crescimento no Estado de Kansas, foi plantado sob os espaçamentos de 0,3 x 0,3m, 0,45 x 0,45m e 0,6 x 0,6m. Os resultados obtidos por Geyer (1978) em seu estudo da influência do espaçamento e do ciclo de corte em rotações curtas, mostraram que produtividades altas (10 ton/ha/ano) de material seco, podem ser obtidas de alto fuste e de várias talhadias dessa espécie. Mesmo após cinco ou seis cortes rasos em ciclos de 8 anos, a produtividade não diminui. Embora a produtividade em fibra tenha sido mais alta para espaçamentos mais apertados nos primeiros 2 anos, ela foi a mesma nos anos sucessivos. Foi produzida mais madeira, anualmente, em ciclos de corte longos que em ciclos curtos. Dentro dos parâmetros deste estudo, em solo bom, um ciclo de corte de 3 anos é, aparentemente, melhor. A densidade de fibra da árvore inteira foi razoavelmente alta (0,41) e as características do valor combustível foram altas (8,05 Btn).

2 - Material e métodos -

A área onde o experimento foi instalado situa-se a 23°09' de latitude sul e 47°03' de longitude oeste, a 700 m de altitude, em Itupeva, Estado de São Paulo, Brasil.

O solo é do tipo podzolizado (Comissão de Solos, 1960), moderadamente drenado, pouco profundo, com espessura efetiva de 1,5m, apresentando cascalho ao longo do perfil.

O relevo na região varia de forte ondulado a montanhoso. A cobertura vegetal primária era floresta latifoliada tropical semi-decídua.

A fertilidade do solo no geral é baixa, com teores médios em N e K mas, com acidez elevada. A análise do solo local revelou: pH = 4,8; matéria orgânica = 2,07%; N total = 0,11%; P = 0,05 e.mg/100g de terra; K = 0,13 e.mg/100g; Ca = 0,56 e.mg/100g e.Mg = 0,40 e.mg/100g.

O clima, de acordo com Godoy e Ortolani (sem data), é do tipo Cfa, com base no sistema de Köppen. É um clima mesotérmico úmido, sem estiagem, em que a temperatura média do mês mais quente é maior que 22°C e do mês mais frio é menor de 18°C. O total das chuvas do mês mais sêco é superior a 30mm e menor que 60mm. A precipitação anual varia de 1 100 a 1 700mm de chuva. Os meses mais chuvosos vão de outubro a março (verão) e os menos chuvosos vão de abril a setembro (inverno).

Preparo do solo - constou de aração e gradagem antes da instalação do experimento.

As espécies utilizadas foram: *Eucalyptus saligna* Sm; *E. grandis* Hill ex Maiden; *E.urophylla* Reinw e *E.propinqua* Deane & Maiden, com mudas selecionadas produzidas, com as melhores sementes disponíveis na época, em viveiro local.

Por ocasião do plantio, as mudas receberam adubação de 100g/cova de uma formula NPK 9:10:9 usando-se sulfato de amonio, superfosfato simples, fosforita de Olinda e cloreto de potassio.

No plano do experimento utilizou-se o esquema fatorial 4x4x2 para espécies, idades de corte e espaçamentos, com 4 repetições em blocos casualizados.

Cada parcela era composta de 224 plantas (14x16) sendo que apenas as 120 centrais foram usadas e mantida uma bordadura dupla.

O espaçamentos adotados foram 3,0 x 1,5m e 3,0 x 2,0m.

As idades de corte visando a utilização economica do material lenhoso total, para abastecimento de industria de chapas, foram programadas para 5,7,9 e 11 anos, de modo a permitir estudar ainda o rendimento industrial a cada idade e a natureza do produto final obtido.

Foi feito o acompanhamento do crescimento através de medições anuais de altura e DAP. Os volumes de madeira empilhada foram obtidos após corte raso. Os pesos de madeira foram estimados baseando-se em determinações da densidade básica feitas em laboratório. O estudo econômico dessa produção será apresentado em outro trabalho.

3 - Resultados e discussão -

Os dados de crescimento em altura são apresentados no quadro I a seguir:

QUADRO I - Crescimento em Altura (m)
Height growth (m)

idade (age)	5anos(years)		7 anos		9 anos		11 anos	
espaçamento (spacing) espécie (species)	3x1,5	3x2	3x1,5	3x2	3x1,5	3x2	3x1,5	3x2
E.urophylla	18,20	18,53	21,15	21,92	20,79	21,31	22,72	23,74
E.grandis	20,55	20,40	21,07	22,25	22,81	25,02	24,01	25,57
E.propinqua	18,23	17,97	18,05	20,28	19,67	18,31	19,96	21,72
E.saligna	19,27	18,93	19,45	19,89	20,49	21,38	21,10	21,58
Média(average)	19,06	18,96	19,93	21,08	20,94	21,51	21,95	23,15

Análise estatística dos dados de altura.

Teste F - significativo ao nível de 1% de probabilidade - para espécie e idade e, a 5% para espaçamento.

Teste de Duncan, ao nível de 5%, para os contrastes de altura:

espécie (species)	média (average)	grupo (group)
E.grandis	22,71	A
E.urophylla	21,05	B
E.saligna	20,26	B
E.propinqua	19,27	C

idade (age)	média (average)	grupo (group)
11anos	22,55	A
9anos	21,22	B
7anos	20,50	B
5anos	19,01	C

espaçamento (spacing)	média (average)	grupo (group)
3x2,0m	21,18	A
3x1,5m	20,47	B

Média geral = 20,82m
(General average)

C.V. = 8,17%

Pelos resultados da análise estatística dos dados de altura verifica-se uma superioridade do E.grandis sobre as demais espécies. O E.urophylla e E.saligna não diferiram entre si mas tambem foram superiores ao E.propinqua.

Quanto ao efeito das idades verifica-se que aos 7 e 9anos as alturas das árvores eram semelhantes, sendo ao mesmo tempo inferiores à altura aos 11 anos e superiores à aos 5 anos.

Da mesma forma no espaçamento 3x2m a altura média das árvores era superior que aquela no 3x1,5m.

A altura média de todas as árvores foi superior a 20m , sendo a média máxima, 25,57m, alcançada pelo E.grandis aos 11 anos, no espaçamento 3x2m e, a média mínima, 17,97cm, pelo E.propinqua aos 5 anos, tambem no 3x2m.

Os dados de crescimento em diâmetro são apresentados no quadro II.

QUADRO II - Crescimento em Diâmetro (DAP) - cm
Diameter (DBH) growth - cm

idade (age)	5anos(years)		7 anos		9 anos		11 anos	
espaçamento (spacing) / espécie (species)	3x1,5	3x2	3x1,5	3x2	3x1,5	3x2	3x1,5	3x2
E.urophylla	11,88	11,73	13,40	24,88	15,02	15,78	14,91	17,23
E.grandis	13,18	13,38	13,45	14,37	14,20	16,00	15,05	16,98
E.propinqua	10,45	11,28	11,62	13,23	12,70	14,43	10,55	14,55
E.saligna	11,63	11,65	11,68	12,83	12,44	13,84	12,62	14,26
Média(average)	11,78	12,01	12,54	13,83	13,59	15,01	13,28	15,75

Análise estatística dos dados de diâmetro.

Teste F - significativo ao nível de 1% de probabilidade - para espécie, idade, espaçamento e para as interações espécie x idade e espaçamento x idade.

Teste de Duncan, ao nível de 5%, para os contrastes de diâmetro.

espécie (species)	média (average)	grupo (group)
E.grandis	14,58	A
E.urophylla	14,36	A
E.propinqua	12,76	B
E.saligna	12,62	B

idade (age)	média (average)	grupo (group)
11 anos	14,83	A
9 anos	14,40	B
7 anos	13,19	C
5 anos	11,90	D

espaçamento (spacing)	média (average)	grupo (group)
3x2,0m	14,20	A
3x1,5m	12,96	B

Média geral = 13,58cm
(General average)

C.V. = 4,55%

A análise estatística dos dados de crescimento em diâmetro revelou um agrupamento das espécies, sendo que no grupo superior aparecem o E.grandis e o E.urophylla e, no inferior, o E.propinqua e E.saligna.

Quanto às idades, os diâmetros médios foram crescentes com a idade e significativamente diferentes entre si.

No espaçamento 3x2,0m os diâmetros foram superiores aos do 3x1,5m.

A média geral dos diâmetros foi 13,58cm, sendo que a média máxima, 17,23cm, foi alcançado pelo E.urophylla, no espaçamento 3x2m, aos 11 anos de idade e, a mínima, 10,45cm, pelo E.propinqua, no espaçamento 3x1,5m, aos 5 anos.

Houve ainda interação significativa para espécie x idade e espaçamento x idade. Verifica-se, pelo quadro II, que o E.propinqua aos 11 anos de idade, no espaçamento 3x1,5m, apresentou diâmetro médio menor que aos 9 anos. Da mesma forma o diâmetro médio das quatro espécie, no espaçamento 3x1,5m aos 11 anos foi inferior ao dos 9 anos. Isso pode ser explicado pela maior sensibilidade à competição entre as árvores, mostrada pelo E.propinqua e E.saligna.

Os percentuais de falha do experimento são apresentados - no quadro III.

QUADRO III - Falhas (Failures) - %

idade(age)	5anos(years)		7 anos		9 anos		11 anos	
espaçamento (spacing) / espécie (species)	3x1,5	3x2	3x1,5	3x2	3x1,5	3x2	3x1,5	3x2
E.urophylla	18,54	16,84	18,54	17,91	18,75	18,60	19,37	20,00
E.grandis	14,29	9,18	16,87	10,21	19,58	14,38	22,08	18,96
E.propinqua	3,06	3,96	3,96	5,21	4,58	4,37	5,00	5,00
E.saligna	5,10	4,59	7,92	6,04	8,12	6,04	10,21	6,87
Média (average)	10,25	8,64	11,82	9,84	12,76	10,94	14,16	12,71

Análise estatística dos dados de falhas.

Teste F - Significativo ao nível de 1% de probabilidade - para espécie, idade, espaçamento e para as interações espécie x idade e espécie x espaçamento.

Teste de Duncan ao nível de 5%, para os contrastes de falhas.

espécie (species)	média (average)	grupo (group)
E.urophylla	18,61	A
E.grandis	15,69	B
E.saligna	6,86	C
E.propinqua	4,24	D

idade (age)	média (average)	grupo)group)
11 anos	13,44	A
9 anos	11,85	B
7 anos	10,68	B C
5 anos	9,44	C

espaçamento (spacing)	média (average)	grupo (group)
3x1,5m	12,25	A
3x2,0m	10,45	B

Média geral = 11,35%
(General average)

C.V. = 23,21%

A ocorrência de falhas foi estatísticamente diferente entre todas as especies, cujos percentuais aparecem na seguinte ordem decrescente: E.urophylla, E.grandis, E.saligna e E.propinqua.

O percentual mais alto de falhas ocorrem aos 11 anos de idade. Em segundo lugar aparece aos 9 anos que embora não difira dos 7 anos, é maior que aos 5 anos.

Houve ainda diferença significativa de falhas entre os espaçamentos, tendo sido maior no 3x1,5m.

A média geral de falhas foi 11,35% para todo o experimento, porém a média máxima, 22,08%, ocorreu para o E.grandis, no espaçamento 3x1,5m, aos 11 anos de idade. A média mínima foi para o E.propinqua, no 3x1,5m, aos 5 anos de idade.

A interação espécie x idade é revelada pelo E.grandis que apresenta sistematicamente falhas menores que o E.urophylla , exceto no espaçamento 3x1,5m, que são maiores aos 9 e 11 anos. Da mesma forma as falhas do E.propinqua, no espaçamento 3x2m - aos 7 anos são maiores que aos 9 e 11 anos. Para a interação espécie x espaçamento observa-se que nas idades de 9 e 11 anos as falhas do E.grandis são maiores que as do E.saligna nos espaçamentos 3x1,5m e menores no 3x2,0m.

As produções em volume total de madeira empilhada, com casca, obtidas por corte raso, são apresentadas no quadro IV a seguir.

QUADRO IV - Volume total de madeira empilhada, com casca (estereo/ha)
Total piled wood volume, with bark (steres/ha)

idade (age)	5anos(years)		7 anos		9 anos		11 anos	
espaçamento (spacing) / espécie (species)	3x1,5	3x2	3x1,5	3x2	3x1,5	3x2	3x1,5	3x2
E.urophylla	321,85	283,57	500,59	452,64	545,88	457,18	438,04	415,22
E.grandis	368,42	344,72	540,41	471,88	531,72	539,21	444,84	419,56
E.propinqua	276,06	277,32	420,96	385,58	417,11	382,18	247,41	340,02
E.saligna	342,96	294,86	395,91	370,41	401,47	380,19	405,01	312,28
Média	327,32	300,12	464,47	420,13	474,05	439,69	383,83	371,77

Análise estatística dos dados de volume.

Teste F - Significativo ao nível de 1% de probabilidade - para espécie, idade e espaçamento.

Teste de Duncan, ao nível de 5%, para os contrastes de volume:

espécie (species)	média (average)	grupo (group)	idade (age)	média (average)	grupo (group)
E.grandis	457,60	A	9 anos	456,87	A
E.urophylla	426,87	B	7 anos	442,30	A
E.saligna	362,89	C	11 anos	387,17	B
E.propinqua	352,71	C	5 anos	313,72	C

espaçamento (spacing)	média (average)	grupo (group)
3x1,5m	417,11	A
3x2,0m	382,93	B

Média geral = 400,02 st/ha
(General average)

C.V. = 13,57%

As curvas de volume são apresentadas nas figuras 1 e 2 no apêndice.

Após a análise estatística, verifica-se a superioridade - do E.grandis, em termos de produção volumétrica de madeira. Em segundo lugar aparece o E.urophylla e em terceiro, com produções semelhantes aparecem o E.saligna e E.propinqua. Para volume útil sem casca, Mello et alii 1976 encontraram, aos 7 e 9 anos produções mais altas para E.urophylla e E.saligna.

Com relação às idades de corte, a produção de madeira aos 11 anos foi significativamente inferior às produções aos 7 e 9 anos, as quais não diferiram entre si. O volume mais baixo foi obtido aos 5 anos de idade. As produções volumétricas aparecem na seguinte ordem decrescente: 9 anos, 7 anos, 11 anos e 5 anos.

Quanto ao efeito do espaçamento sobre o volume total de madeira, observa-se uma supeioridade do espaçamento 3x1,5m sobre o 3x2,0m, o que concorda com Guimarães 1956.

Na produção de madeira sem casca para indústria de celulose, Mello et alii 1971 comparando essas mesmas espécies e espaçamentos, obtiveram, aos 5 anos, volumes comerciais maiores para E.saligna, a 3x2,0m.

A média geral de produção para todo o experimento alcançou 400 estereos/ha, enquanto a produção média máxima, 545,88 st/ha, for obtida pelo E.urophylla no espaçamento 3x1,5m, aos 9 anos de idade e, a mínima, 247,41 st/ha, pelo E.propinqua no espaçamento 3x1,5m aos 11 anos.

As produções mais altas estão concentradas no E.grandis e E.urophylla, no espaçamento 3x1,5m, aos 7 e 9 anos de idade.

No quadro V são apresentados os dados de incremento volumétrico de madeira empilhada, com casca, em cada um dos tratamentos.

QUADRO V - Incremento de Volume (stereo/ha/ano)
Volume increment (stere/ha/year)

idade (age)	5anos(years)		7 anos		9 anos		11 anos	
espaçamento (spacing) / espécie (species)	3x1,5	3x2	3x1,5	3x2	3x1,5	3x2	3x1,5	3x2
E.urophylla	64,37	56,71	71,51	64,66	60,65	50,79	39,82	37,75
E.grandis	73,68	68,94	77,20	67,41	59,08	59,91	40,44	38,14
E.propinqua	55,21	55,46	60,14	55,08	46,35	42,46	22,49	30,91
E.saligna	68,59	58,97	56,56	52,91	44,61	42,24	36,82	28,39
Média(average)	65,46	60,02	66,35	60,02	52,67	48,85	34,89	33,80

Análise estatística dos dados de incremento de volume.

Teste F - Significativo ao nível de 1% de probabilidade para espécie, idade e espaçamento e, a 5% para a interação espécie x idade.

Teste de Duncan, ao nível de 5%, para os contrastes de incremento de volume:

espécie (species)	média (average)	grupo (group)	idade (age)	média (average)	grupo (group)
E.grandis	60,60	A	7 anos	63,19	A
E.urophylla	55,78	B	5 anos	62,74	A
E.saligna	48,64	C	9 anos	50,76	B
E.propinqua	46,86	C	11 anos	35,20	C

espaçamento (spacing)	média (average)	grupo (group)
3x1,5m	55,27	A
3x2,0m	50,67	B

Incremento médio = 52,97st/ha/ano
(average increment)

C.V. = 11,78%

Verifica-se pela análise estatística, que o incremento - mais alto foi obtido pelo E.grandis. Em segundo lugar vem o E. urophylla. A mais baixa é do E.saligna e E.propinqua.

Quanto à idade de corte os incrementos mais altos foram obtidos aos 7 e 5 anos, que não diferem entre si. Em segundo lugar aparece o aos 9 anos e, por último, o dos 11 anos de idade, com diferenças significativas entre si.

O incremento médio no espaçamento 3x1,5m foi superior ao do 3x2,0m.

O incremento médio de volume total de madeira com casca, para todas as árvores do experimento, foi de 52,97 st/ha/ano. A média máxima foi alcançada pelo E.grandis, no espaçamento - 3x1,5m aos 7 anos de idade, enquanto que a mínima foi obtida pelo E.propinqua no espaçamento 3x1,5m aos 11 anos de idade.

A interação espécie x idade foi revelada pelo E.propinqua, que no espaçamento 3x1,5m é crescente até os 7 anos e decrescendo aos 11 anos de idade.

Observa-se que os incrementos volumétricos mais altos foram obtidos pelo E.grandis no espaçamento 3x1,5m aos 7 e aos 5 anos de idade.

O peso de madeira, estimado através da densidade básica, relativo ao volume total obtido em cada tratamento é apresentado no quadro VI a seguir.

QUADRO VI - Peso total de madeira (ton/ha).
Total wood weight.

idade (age)	5anos(years)		7 anos		9 anos		11 anos	
espaçamento (spacing) / espécie (species)	3x1,5	3x2	3x1,5	3x2	3x1,5	3x2	3x1,5	3x2
E.urophylla	105,30	103,27	178,46	159,12	195,34	161,71	178,02	168,78
E.grandis	106,62	107,75	149,10	139,84	150,73	155,04	153,81	149,91
E.propinqua	93,00	85,30	151,64	138,66	157,63	142,37	128,13	150,79
E.saligna	98,30	95,85	121,26	110,69	119,89	116,48	155,56	127,22
Média(average)	100,81	98,04	150,11	137,08	155,90	143,90	153,88	149,17

Análise estatística dos dados de peso de madeira.

Teste F - Significativo ao nível de 1% de probabilidade para espécie e idade e, a 5% para espaçamento.

Teste de Duncan ao nível de 5% para os contrastes de peso: e, a 5% para espaçamento.

espécie (species)	média (average)	grupo (group)	idade (age)	média (average)	grupo (group)
E.urophylla	156,25	A	11 anos	151,53	A
E.grandis	139,10	B	9 anos	149,90	A
E.propinqua	130,94	B	7 anos	143,58	A
E.saligna	118,16	C	5 anos	99,42	B

As curvas de peso de madeira são apresentadas nas figuras 3 e 4, no apêndice.

espaçamento (spacing)	média (average)	grupo (group)
3x1,5m	140,17	A
3x2,0m	132,05	B

Média geral = 136,11 ton/ha
(General average)

C.V. = 16,24%

A análise estatística das produções expressas em peso de madeira revela que o E.urophylla é o mais produtivo, aparecendo superior ao E.grandis e E.propinqua, com produções semelhantes entre si. A produção significativamente mais baixa é apresentada pelo E.saligna. A produção de madeira útil, sem casca, em solo de cerrado obtida por Mello et alii 1971, do E.propinqua, foi inferior às demais espécies.

Com relação às idades de corte, apenas a produção aos 5 anos foi inferior. Os cortes aos 7,9 e 11 anos apresentaram - produções de mesmo grupo de significâncias. Isso mostra que não há conveniência em deixar para explorar o eucalipto com idade superior aos 7 anos.

Quanto ao espaçamento o 3x1,5m foi superior ao 3x2,0m com significância ao nível de 5%.

Contrariamente, o peso de madeira útil para celulose, encontrado por Mello et alii 1971, foi superior no espaçamento - 3x2,0m. Entretanto, aos 7 e 9 anos, Mello 1976 não encontrou diferença entre os espaçamentos.

A média geral obtida em todo o experimento foi de 136,11 ton/ha. A média máxima, 195,34 ton/ha, foi alcançada pelo E. urophylla no espaçamento 3x1,5m, aos 9 anos de idade e, a mínima, 85,30 ton/ha, foi apresentada pelo E.propinqua no espaçamento 3x2,0m, aos 5 anos de idade.

As produções mais convenientes foram obtidas pelo E.urophylla, no espaçamento 3x1,5m, aos 7 anos de idade, com 178,46 ton/ha e aos 9 anos, com 195,34 ton/ha.

Essa inversão da produtividade entre E.grandis e E.urophylla quando se compara respectivamente, volume e peso de madeira, deve-se ao fator densidade básica média. Esta é mais alta no E.urophylla, com 0,57g/cm^3, se comparada com o E.grandis, com apenas 0,45g/cm^3.

4 - Resumo e conclusões -

Um experimento visando estudar a produção de madeira, destinada ao abastecimento de indústria de chapas duras, foi instalado em Itupeva, Estado de São Paulo, Brasil.

O clima local é do tipo Cfa, e o solo Podzolizado com cascalho, ácido e de baixa fertilidade. O relevo é ondulado. A precipitação média é de 1300mm de chuvas por ano, com verão - chuvoso e inverno seco.

Foi usado um delineamento fatorial, em blocos ao acaso, com 4 repetições, de parcelas de 224 plantas, incluida a bordadura dupla.

O solo foi bem preparado por meio de aração e gradagem , sendo que, no ato do plantio das mudas, foi feita uma adubação, na cova, de 100g de NPK 9:10:9 por planta.

As espécies escolhidas foram: Eucalyptus saligna, E.grandis, E.urophylla e E.propinqua, cujas mudas foram produzidas com as melhores sementes disponíveis.

Os espaçamentos adotados foram 3,0x1,5m e 3,0x2,0m.

As idades de corte previstas eram: 5,7,9 e 11 anos.

O crescimento foi acompanhado através de medições anuais de altura total e DAP e contagem de falhas. As produções foram medidas, após o corte raso, em cada uma das idades previstas.. Os volumes obtidos referem-se à madeira total, empilhada, com casca. Os pesos foram estimados através da densidade básica da madeira.

O estudo econômico dessa produção será apresentado em outro trabalho.

Todos os resultados foram analisados estatisticamente e, a discussão dos resultados permite as seguintes conclusões:

1- O crescimento em altura total das árvores variou com a espécie e com o espaçamento, tendo sido, ainda, crescente com a idade. Foram superiores o E.grandis, o espaçamento 3x2,0m e a idade de 11 anos. Nesse tratamento a altura média máxima foi 25,57m.

2- O crescimento em diâmetro das árvores de E.grandis e E.urophylla foram maiores que o de E.propinqua e E.saligna. O diâmetro foi crescente com a idade e foi superior no espaçamento - 3x2,0m. O DAP médio máximo foi alcançado pelo E.urophylla, aos 11 anos, com 17,23cm.

3 - A incidência de falhas variou entre as espécies na seguinte ordem crescente: E.propinqua, E.saligna, E.grandis e E.urophylla. O intervalo foi de 3% a 22%. Os percentuais de falhas cresceram ainda com a idade e foram menores no espaçamento - 3x2,0m.

4- A produção de madeira, com casca, expressa em volume total foi diferente entre espécies. O E.grandis, com 457,60 st/ha , foi superior às demais. Em segundo lugar está o E.urophylla , com 426,87 st/ha e, em terceiro, aparecem o E.saligna, com 362,89 st/ha e o E.propinqua, com 352,71 st/ha.

5- O volume total obtido aos 7 anos de idade não diferiu daquele aos 9 anos. Ambos foram superiores ao volume obtido aos 11 anos. Em último lugar está a produção aos 5 anos.

6- O espaçamento 3x1,5m, com 417,11 st/ha mostrou-se superior ao 3x2,0m, com 382,93 st/ha de volume total produzido.

7- As produções volumétricas mais altas foram alcançadas pelo E.grandis e E.urophylla, no espaçamento 3x1,5m, aos 7 e 9 anos de idade. A máxima foi obtida pelo E.urophylla aos 9 anos, com 545,88 st/ha.

8- O incremento anual médio de volume total de madeira, com casca, por hectare, do E.grandis, com 60,60 st, foi superior aos das demais espécies. Em segundo lugar vem o E.urophylla , com 55,78 st e, por último, com produtividades semelhantes, o E.saligna com 48,64 st e E.propinqua com 46,86 st.

9- Em relação à idade de corte das árvores os incrementos mais altos, de volume total de madeira com casca, foram alcançados aos 7 anos, com 63,19 st/ha/ano e aos 5 anos, com 62,74 st. Em segundo lugar vem aos 9 anos, com 50,76 st e por último, aos 11 anos, com 35,20 st.

10- Comparando os incrementos por espaçamento verificou-se que o 3x1,5m, com 55,27 st/ha/ano foi significativamente superior ao do 3x2,0m, com 50,67 st.

11- As produtividades mais altas, em todos os tratamentos, foram obtidas pelo E.grandis, no espaçamento 3x1,5m, aos 7 anos, com 77,20 st/ha/ano e aos 5 anos, com 73,68 st/ha/ano de volume total de madeira empilhada, com casca.

12- A produção média expressa em peso de madeira seca variou com a espécie. O E.urophylla foi o mais produtivo, com 156,25 ton/ha. Em segundo lugar apareceu o E.grandis, com 139,10 ton/ha e o E.propinqua, com 130,94 ton/ha. Por último vem o E.saligna com 118,16 ton/ha.

13- Quanto à idade de exploração as produções foram semelhantes entre 11 anos, com 151,53 ton/ha, aos 9 anos, com 149,90 - ton/ha e aos 7 anos, com 143,58 ton/ha de madeira seca. Em segundo lugar aparece a produção aos 5 anos com apenas 99,42ton/ha.

14- O espaçamento 3x1,5m apresentou produção média mais alta de madeira seca total, com 140,17 ton/ha, quando comparada ao espaçamento 3x2,0m, que produziu 132,05 ton/ha.

15- As produções máximas foram alcançadas pelo E.urophylla, no espaçamento 3x1,5m, aos 7 anos de idade, com 178,46 ton/ha e aos 9 anos, com 195,34 ton/ha.

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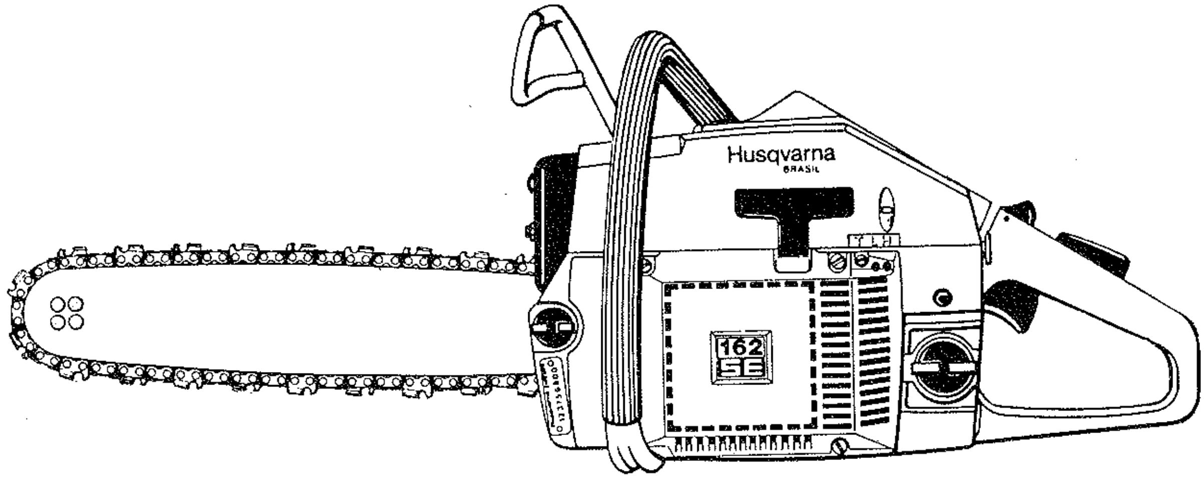
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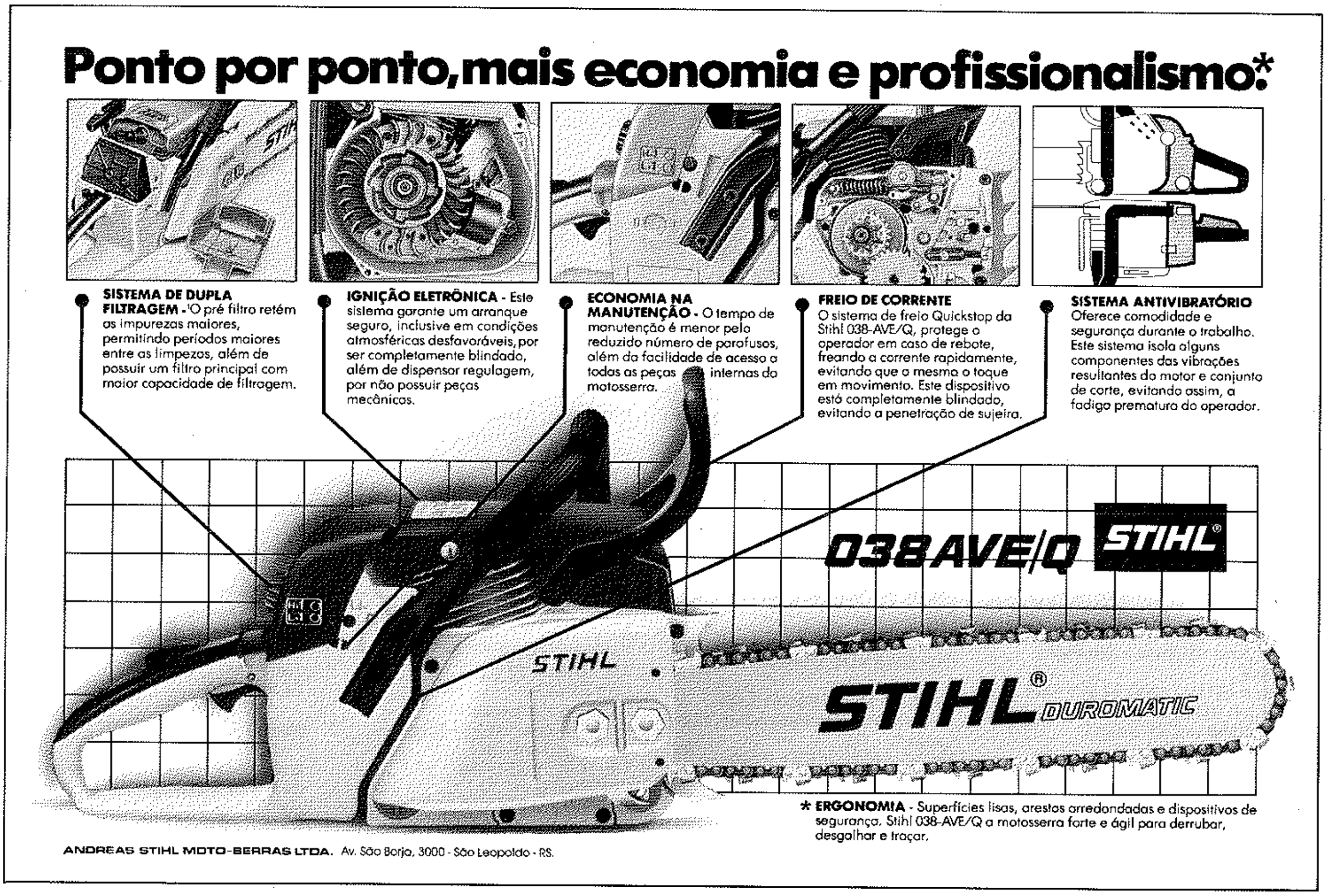

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SISTEMA DE DUPLA FILTRAGEM - O pré filtro retém as impurezas maiores, permitindo períodos maiores entre as limpezas, além de possuir um filtro principal com maior capacidade de filtragem.

IGNIÇÃO ELETRÔNICA - Este sistema garante um arranque seguro, inclusive em condições atmosféricas desfavoráveis, por ser completamente blindado, além de dispensar regulagem, por não possuir peças mecânicas.

ECONOMIA NA MANUTENÇÃO - O tempo de manutenção é menor pelo reduzido número de parafusos, além da facilidade de acesso a todas as peças internas da motosserra.

FREIO DE CORRENTE
O sistema de freio Quickstop da Stihl 038-AVE/Q, protege o operador em caso de rebote, freando a corrente rapidamente, evitando que a mesma o toque em movimento. Este dispositivo está completamente blindado, evitando a penetração de sujeira.

SISTEMA ANTIVIBRATÓRIO
Oferece comodidade e segurança durante o trabalho. Este sistema isola alguns componentes das vibrações resultantes do motor e conjunto de corte, evitando assim, a fadiga prematura do operador.

* **ERGONOMIA** - Superfícies lisas, arestas arredondadas e dispositivos de segurança. Stihl 038-AVE/Q a motosserra forte e ágil para derrubar, desgalhar e traçar.

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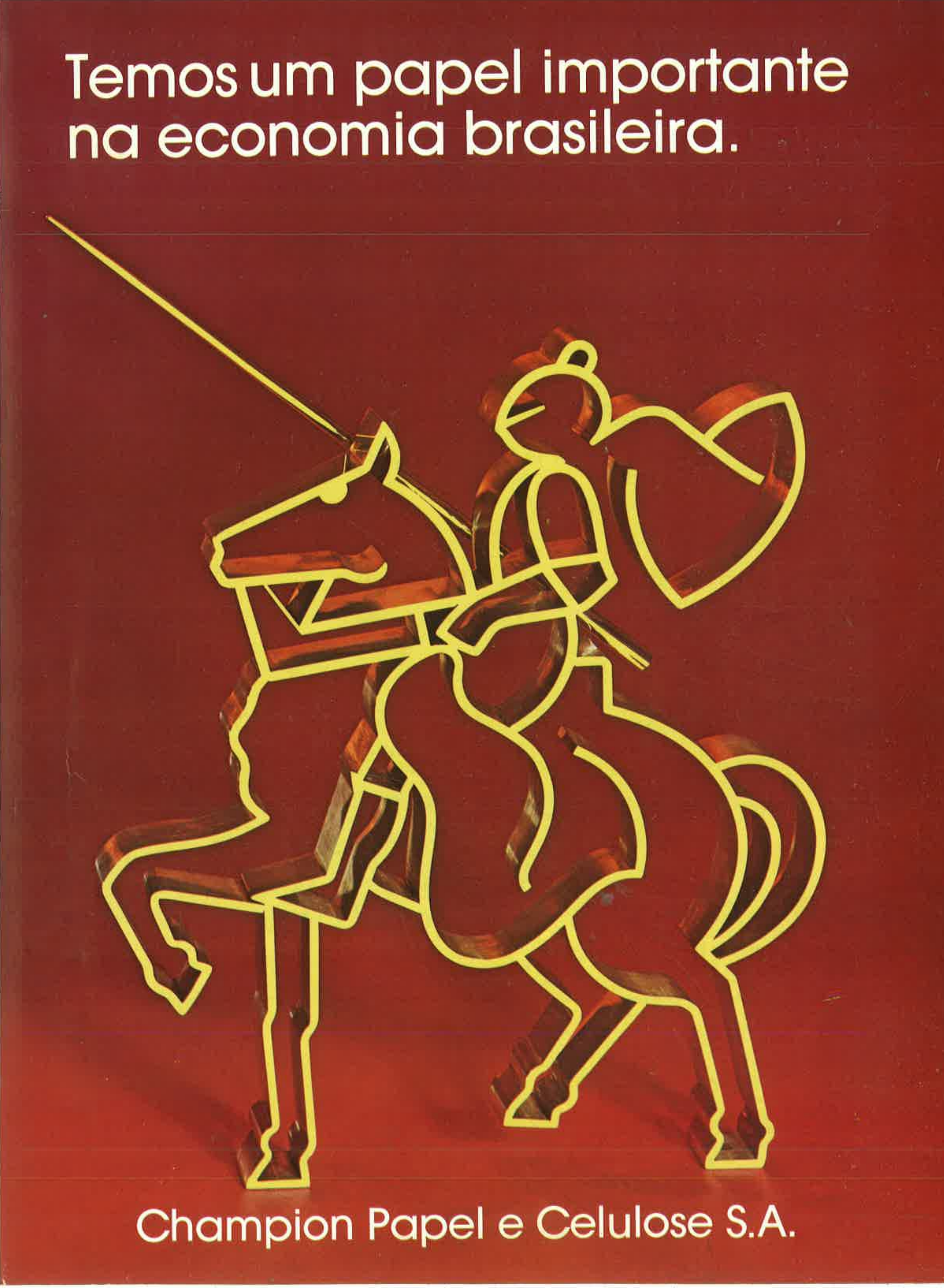
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