FAST GROWING TREES

PROGRAMA COM *EUCALYPTUS GRANDIS* NA CHAMPION PAPEL E CELULOSE S.A.

Manoel de Freitas
Adalberto Plínio Silva
Antonio Sergio Diniz
. Champion Papel e Celulose S.A.
Paulo Yoshio Kageyama
Mário Ferreira
. Escola Superior de Agricultura Luiz de Queiroz
Brasil.

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. 22° 20' and Long. 46° 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	55,49
E. saligna	262,22	35,77
E. robusta	278,10	37,95
E. resinifera	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, apparantly, 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 occours 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 grom. 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	NOVEMBER
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.

8. Bibliography

AGUIAR, I.B. and KAGEYAMA, P.Y. - Estudos sobre Florescimento e Frutificação em Eucalyptus grandis - (em preparo), 1980.

BRIGATTI, R.A. and FERREIRA, M. - Estudos de Florescimento e Polinização Controlada em Eucalyptus - Relatório anual apresentado à CHAMPION PAPEL E CELULOSE S.A. (não publicado), 1980.

DEPARTAMENTO FLORESTAL DA CHAMPION PAPEL E CELULOSE S.A. - Aspectos Gerais dos Benefícios da Pesquisa Florestal para uma empresa - Comunicação Técnica, PRODEPEF, Brasília, 9:1-6, 1977.

DEPARTAMENTO FLORESTAL DA CHAMPION PAPEL E CELULOSE S.A. - Relatório de Inventário Florestal de 1979 (não publicado), 1979.

I.P.E.F. - INSTITUTO DE PESQUISAS E ESTUDOS FLORESTAIS - Relatório de Colheita de Sementes de Eucalyptus grandis na CHAMPION PAPEL E CELULOSE S.A.(não publicado), 1979.

I.P.E.F. - INSTITUTO DE PESQUISAS E ESTUDOS FLORESTAIS - Relatório de Colheita de Sementes de Eucalyptus grandis na CHAMPION PAPEL E CELULOSE S.A.(não publicado), 1980.

KAGEYAMA, P.Y., BALLONI, E.A. and JACOB, W.S. - Teste de Progênie de E.grandis - Resultados Preliminares - Boletim Informativo, IPEF, Piracicaba, 19 (6): 43-51, 1978.

KAGEYAMA, P.Y. and SILVA, A.P. - Um Novo Método de Melhoramento em Eucalipto: "Área de Produção de Sementes Especial" - (em preparo), 1980.

MORA, A.L. and FERREIRA, M. - Estudo do Florescimento de Eucalyptus urophylla Boletim Informativo, IPEF, Piracicaba, 19 (6) : 23-39, 1980.

MORA, A.L., VALERI, S.V., FERREIRA, M. and KAGEYAMA, P.Y. - Bases para Melhoramento Genético da Densidade Básica da Madeira de Eucalyptus grandis Hill ex-maiden - Boletim Informativo, IPEF, Piracicaba, 19 (6):53-61, 1978.

PACHECO, I.A. et alii - Dispersão de Pólen de Eucalyptus por Apis mellifera L., 1958 (Hymenoptera - Apidae) - (em preparo), 1980.

FAST GROWING TREES

UM NOVO MÉTODO DE MELHORAMENTO EM EUCALIPTO: "Área de Produção de Sementes Especial".

Paulo Y. Kageyama
. Departamento de Silvicultura, Escola Superior de Agricultura Luiz de Queiroz
Adalberto P. Silva
. Champion Papel e Celulose S.A.
Brasil

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 surrounded 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.