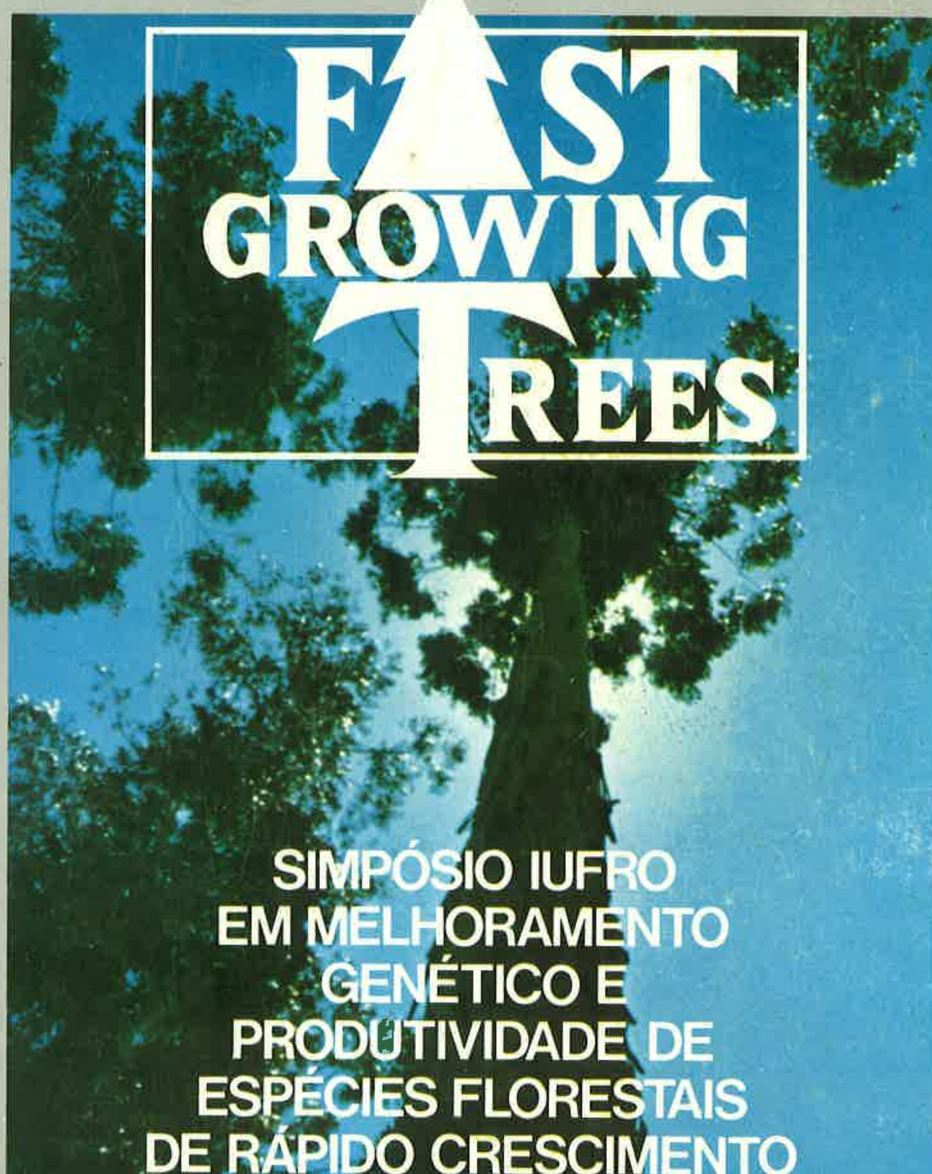
SILVICULTURA

ANO VIII MARÇO/ABRIL 1983 N.° 29

IUFRO
International Union of Forestry Research Organizations

SBS



ANAIS

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

Pás-Carregadeiras 930 e 966C.

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

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

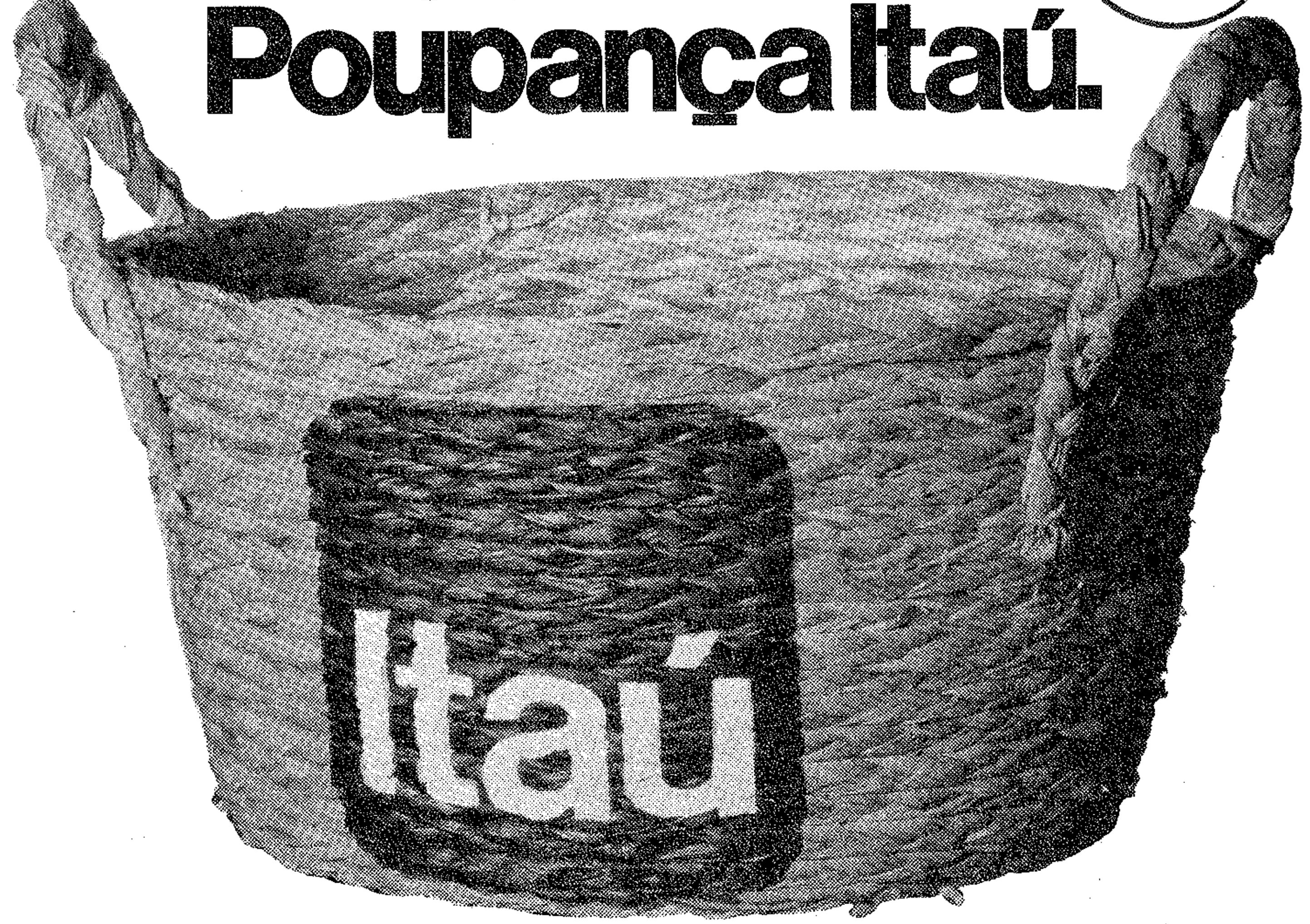
Há certas coisas que você só consegue com máquinas Caterpillar, como, por exemplo, contar com o Atendimento CAT PLUS, disponível através dos Revendedores Caterpillar e que começa a resolver os seus problemas mesmo antes da compra da máquina.

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

CATERPILLAR

SEMPRE A MELHOR SOLUÇÃO

Cesta de Poupança Itaú.



O lucro é batata.

Quem quer economizar com segurança total e garantia de lucro aplica na Cesta de Poupança Itaú. A Cesta de Poupança Itaú tem as melhores alternativas para você aplicar sempre com segurança e rentabilidade, e ainda escolher o tipo de renda: mensal, trimestral ou final. Ou fazer aplicações em títulos nominativos ou ao portador.

Na Cesta de Poupança Itaú você encontra estes papéis:

Letra Itaú - renda prefixada. Você aplica hoje e sabe exatamente quanto vai ganhar. Além disso, precisando de dinheiro a qualquer momento, é só procurar qualquer agência do Banco Itaú.

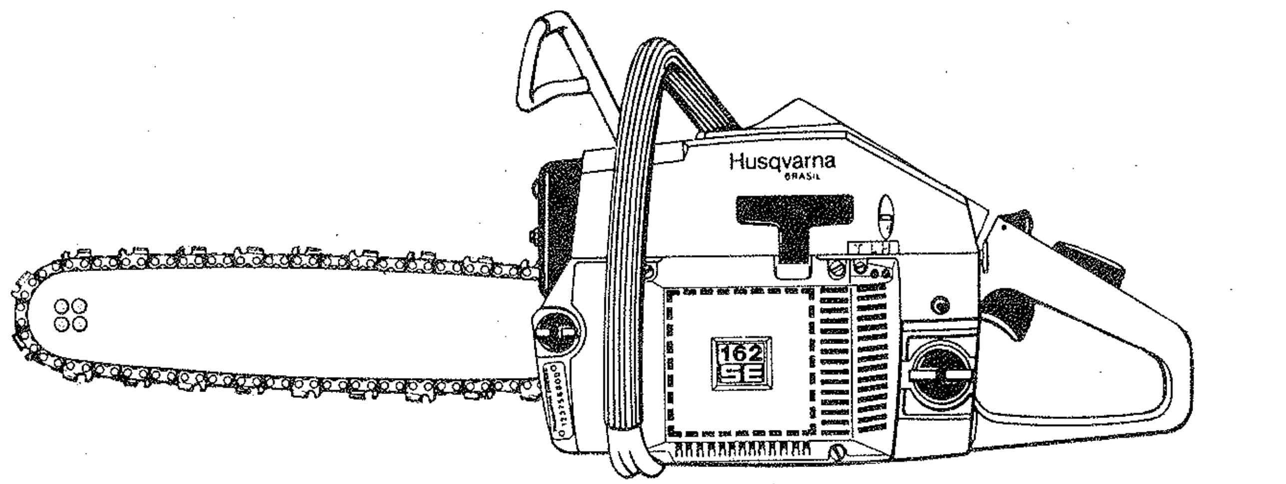
Super Poupança Itaú - rende juros e correção monetária. Você pode aplicar em qualquer dia do ano, por prazos de 6 a 12 meses, e a renda pode ser trimestral ou final.

Renda Mensal Itaú - renda prefixada. Você aplica em qualquer dia e fica sabendo na hora quanto vai ganhar. Para maior comodidade, a renda é creditada mensalmente em sua conta corrente, no mesmo dia do mês em que você fez a aplicação.

Aplique na Cesta de Poupança Itaú. Ela tem sempre o investimento do tamanho das suas economias.
E o lucro é batata.

Itaú
Eletrônica Global

Husqvarna
a mais profissional



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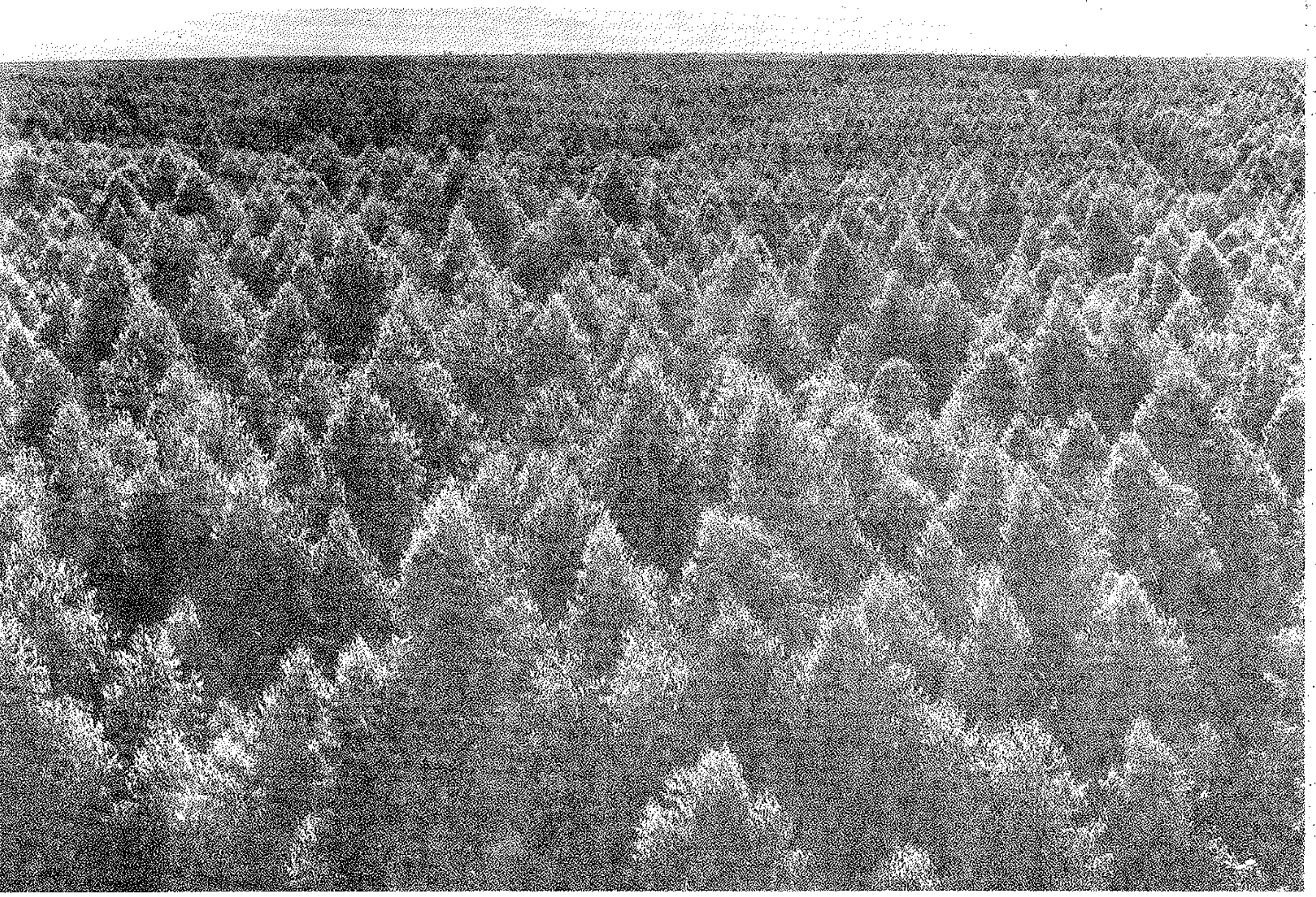
Os especialistas em Moto-Serra

A Aracruz planta árvores e o Brasil colhe divisas.



A Aracruz já plantou mais de 100 milhões de árvores no norte do Espírito Santo. E o resultado disto, é que o Brasil tem colhido milhões de dólares em divisas com a exportação de celulose por ela produzida. Só no ano passado, isto representou 145 milhões de dólares, o que colocou a Aracruz entre os 20 maiores exportadores brasileiros.

Mas, além de divisas, o Brasil tem colhido outros benefícios com o trabalho da Aracruz. Por exemplo: mais de 5.000 empregos diretos gerados pelo empreendimento, composto pelas áreas de plantação, fábrica de celulose, unidades químicas, e um bairro – o Coqueiral. Direta e indiretamente, isso beneficia milhares de famílias e a região, que passou a contar com novos atrativos para que outras empresas se instalem ali, graças à infra-estrutura montada para a Aracruz.

Além dos eucaliptos que abastecem a sua fábrica, para a produção anual de 400 mil toneladas de celulose, a Aracruz já plantou mais de 1 milhão e 600 mil árvores nativas, como jacarandá, peroba, pau-brasil, e 60 mil frutíferas para aumentar a oferta de alimentação da fauna. Na floresta, as pragas e os insetos daninhos são combatidos através de seus próprios inimigos naturais, evitando-se assim, o emprego de produtos químicos.

Tudo isso com a preocupação de proteger a terra, a fauna e a flora da região. Pois, a Aracruz sabe que só consegue colher bons frutos, quem trabalha em harmonia com a natureza.

ARACRUZ CELULOSE S.A.
Raízes brasileiras do progresso.

Com os produtos Eucatex você vê quantas voltas pra frente dá este país.

Todos os dias os produtos da Eucatex estão completando uma volta ao mundo. Ou iniciando outra. E quem chega à frente todas as vezes é este país. Com as cores do Brasil, a Eucatex abriu mercado em mais de 55 países: E.U.A., Canadá, Alemanha, França, Bélgica, Holanda, Inglaterra, Peru, Chile, Argentina, México, Venezuela; mais países da África; países do Oriente Médio. Importante é que a cada volta que os produtos Eucatex dão ao mundo, voltam mais divisas para o Brasil e mais oportunidades de trabalho. O crescimento da Eucatex reflete o próprio crescimento do País onde nasceu há 30 anos. Crescendo junto, a Eucatex desenvolveu novos produtos, não pára suas atividades de pesquisas, é incansável na descoberta de novas maneiras de levar mais conforto ao homem. Ela começou com chapas de fibra de madeira, criou forros e revestimentos, passou para outros tipos de matéria-prima - o aço, o alumínio, o plástico, a fibra de vidro - evoluiu, revolucionou. Hoje é uma empresa com uma versátil linha de forros, divisórias, portas, batentes, revestimentos. E descobriu a Vermiculita, um mineral que revolucionou as técnicas para melhorar a agricultura, com largo emprego na construção civil e na indústria. Esse novo investimento da Eucatex não é um simples acaso: é conseqüência natural de uma empresa que todos os dias dá uma volta para a frente em tecnologia.

eucatex

Av. Francisco Matarazzo, 584/612
Tel.: 825-2233 - PABX - SP.

EDITORIAL

A Sociedade Brasileira de Silvicultura lavra mais um tento, publicando neste número da Revista a primeira parte do Simpósio sobre Melhoramento Genético e Produtividade de Espécies Florestais de Rápido Crescimento, promovido pela SBS e patrocinado pela IUFRO (INTERNATIONAL UNION OF FORESTRY RESEARCH ORGANIZATIONS), com realização ocorrida em Águas de São Pedro, no Estado de São Paulo, em agosto de 1980.

Baldados os esforços para a publicação em separado dos Anais, pela inexistência de verbas a isso especialmente destinadas, a Presidência não vacilou em autorizar a inclusão desse trabalho na série normal de tiragens da Revista Silvicultura, onde os custos editoriais e gráficos, diminuidos pelos ganhos com a inserção de publicidade, puderam ser atendidos, com algum sacrifício, pelas exíguas verbas normais da própria SBS.

Com isso, a Sociedade Brasileira de Silvicultura desincumbe-se de encargo antigo, cumprindo de forma integral e plena, compromissos assumidos há tres anos com o seu quadro social e com a comunidade internacional de pesquisa florestal.

O atraso, involuntário e penoso, não desmerece o valor dos trabalhos publicados, sendo de se lhe atribuir, quando muito, o demérito de não trazer até a data de hoje, os dados que foram ordenados por séries cronológicas.

Finalizando, cabe reconhecer que nessa publicação, ao trabalho da SBS somaram-se os esforços da equipe técnica do Departamento de Silvicultura da ESALQ–USP e os incentivos de todos aqueles que vindos do exterior ombrearam conosco nesse importante evento.

Laerte Setubal Filho
Presidente

INTRODUÇÃO

O Simpósio IUFRO em Melhoramento Genético e Produtividade de Espécies Florestais de Rápido Crescimento, realizado em Águas de São Pedro, São Paulo, Brasil, no período de 25 a 30 de agôsto de 1980, teve seu êxito plenamente garantido por três fatores importantes: Número e nível técnico dos participantes – 347 técnicos de 27 países –número e qualidade das contribuições técnicas – 297 trabalhos de 734 autores – e, finalmente, rigoroso cumprimento da programação estabelecida, graças ao perfeito entendimento entre participantes e promotores.

O estabelecimento das condições que possibilitaram este êxito, só foi possível pela colaboração inestimável prestada por organizações brasileiras e estrangeiras, cujos nomes acham-se consignados nestas atas.

Na publicação dos Anais do Simpósio, adotou-se o critério da impressão direta, a partir dos originais dos trabalhos técnicos apresentados pelos autores. Êsse processo, adotado por razões de facilidade e economia, apresentou pequenas imperfeições técnicas na impressão dos trabalhos que não seguiram as normas estabelecidas antecipadamente, sem que isso, contudo, represente prejuízo maior à obra.

Finalmente, o atraso ocorrido na publicação destes Anais é atribuível, com exclusividade, à absoluta excassez de recursos financeiros. Esse óbice, que retardou a apresentação física da obra, em momento algum arrefeceu o entusiasmo dos responsáveis por sua publicação e o interesse da comunidade florestal mundial.

INTRODUCTION

The success of the IUFRO SYMPOSIUM ON BREEDING AND YIELD OF FAST GROWING TREES held in Águas de São Pedro (SP), Brazil, from 25 to 30 of August, 1980, was assured by three important factors: The number and the technical level of the participants (347 technicians from 27 countries); the number and the quality of the papers presented (297 papers from 734 authors); and finally the fact that the program established was strictly abided to which may be attributed to a perfect understanding between participants and promotors.

This success was only possible through the valuable collaboration offered by Brazilian and foreign organizations whose names are listed in these Proceedings.

The Proceedings were published using a direct printing process from original copies of the technical papers presented by the authors. This process which was adopted for economical and facility purposes, presented small technical imperfections in the printing of papers where the pre-established requirements were not followed. However, no large damages were caused by this inconvenience.

Finally, the dealy in the publication of these Proceedings is attributed exclusively to the absolute lack of financial resources. This obstacle, which delayed the physical presentation of the work, at no time hindered the enthusiasm of those responsible for its publication and the interest of the world's forest community.

INTRODUCTION

Le Symposium IUFRO sur l'Amélioration Génétique et la Productivité d'Espèces Forestières à Croissance Rapide, qui s'est tenu à Águas de São Pedro, São Paulo, Brésil, du 25 au 30 Août 1980 a atteint pleinement son but grâce à trois facteurs importants: Nombre et niveau technique des participants – 347 techniciens de 27 pays – nombre et qualité des conférences techniques – 297 travaux de 734 auteurs – et, finalement, éxecution rigoureuse du programme établi, grâce à l'entente parfaite entre les participants et les promoteurs.

L'établissement des conditions qui ont permis ce succès n'a été possible qu'avec la collaboration inéstimable des organisations brésiliennes et étrangères, dont les noms se trouvent cités dans ces comptesrendus.

Pour la publication des Annales du Symposium, il a été adopté le critère de l'impression directe, à partir des travaux que n'ont pas suivi les normes établies à l'avance, sans que pour cela amène aucun préjudice majeur à l'oeuvre.

Finalement, le retard survenu dans la publication des ces Annales est attribué exclusivement au manque absolu de recours financiers. Cet obstacle, qui a retardé la publication physique de l'oeuvre, n'cependant pas diminué l'enthousiasme des responsables pour sa publication ni l'intérêt de la communauté forestière mondiale.

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PATROCÍNIO

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Min. da Indústria e Comércio

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Embrapa – Empresa Brasileira de Pesquisas Agropecuárias

Finep – Financiadora de Estudos e Projetos

CNPq – Conselho Nacional de Desenvolvimento Científico e Tecnológico,

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Consider – Conselho de Não-Ferrosos e de Siderurgia

Fapesp – Fundação de Amparo à Pesquisa do Estado de São Paulo

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Secretaria da Indústria, Comércio, Ciência e Tecnologia do Estado de São Paulo,

IPEF – Instituto de Pesquisas Florestais

Instituto Florestal do Estado de São Paulo

Associação Nacional dos Fabricantes de Papel e Celulose

Federação do Comércio do Estado de São Paulo

FAO – Food and Agricultural Organization

Abecel – Associação Brasileira dos Exportadores de Celulose

Banco Itaú S.A.

Eucatex S.A. Indústria e Comércio

Olinkraft Celulose e Papel Ltda.

Klabin do Paraná

Agro-Florestal S.A.

ENTIDADES ENVOLVIDAS

IPT – Instituto de Pesquisas Tecnológicas,
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Associação Brasileira de Empresas de Reflorestamento,
Associação Brasileira dos Produtores de Madeira,
Sindicato da Indústria de Serrarias, Carpintarias, Tanoarias, Madeiras Compensadas e Laminadas, Aglomerados e Chapas de Fibras de Madeira do Estado de São Paulo,
Associação Brasileira da Indústria de Compensados Especiais,
Sociedade Brasileira de Engenheiros Florestais,
Sociedade Nacional de Agricultura e Abima – Associação Brasileira das Indústrias de Madeira Aglomerada

A Sociedade Brasileira de Silvicultura agradece à Associação Nacional dos Fabricantes de Papel e Celulose, a cessão do papel desta edição.

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Alan Brown, Garth Nikles, Leon Pederick, Ken Eldridge e Hugh Waring.

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

CONTRIBUTIONS

Secretaria de Cultura do Estado de São Paulo – (São Paulo State Secretariat of Culture)
Secretaria da Agricultura do Estado de São Paulo – (São Paulo State Secretariat of Agriculture)
IPEF – Instituto de Pesquisas Florestais – (Institute for Forestry Research)
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Associação Nacional dos Fabricantes de Papel e Celulose (National Association of Paper and Cellulose Manufacturers)
Federação do Comércio do Estado de São Paulo – (São Paulo State Trade Federation)
FAO – Food and Agricultural Organization
Abecel – Associação Brasileira dos Exportadores de Celulose – (Brazilian Assocation of Cellulose Exporters)
Banco Itaú S.A.
Eucatex S.A. Indústria e Comércio
Olinkraft Celulose e Papel Ltda.
Klabin do Paraná
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Associação Brasileira dos Reflorestadores – (Brazilian Association of Reforesters)
Associação Brasileira dos Produtores de Madeira – (Brazilian Association of Wood Producers)
Sindicato da Indústria de Serrarias, Carpintarias, Tanoarias, Madeiras Compensadas e Laminadas, Aglomerados e Chapas de Fibras de Madeira do Estado de São Paulo – (The Industrial Union Syndicate of Sawmills, Carpentry, Cooperage, Sheet-and Plywoods, Pulp and Plates of Wood Fibers of the State of São Paulo)
Associação Brasileira da Indústria de Compensados Especiais – (The Brazilian Association of the Industry of Special Plywoods)
Sociedade Brasileira de Agricultura – (The Nacional Agriculture Society) and
Abima – Associação Brasileira das Indústrias de Madeira Aglomerada – (Brazilian Particle Board Plywood Industrial Association)

Programa Geral

DIA 25/8/80
Segunda Feira

8,00 horas: 18,00 — Registro e retirada de material pelos Participantes

CENTRO DE CONVENÇÕES
Secretaria Executiva

11,00 horas: **SESSÃO SOLENE DE ABERTURA DO SIMPÓSIO**

Pronunciamentos: **Sérgio Carlos Lupattelli**
Presidente do Simpósio e da SBS
Mauro Silva Reis
Presidente do Instituto Brasileiro
de Desenvolvimento Florestal e
Representante do Ministro Amaury Stabile, da Agricultura.

GRANDE AUDITÓRIO

12,00 horas — **ENCERRAMENTO**

14,30 horas 18,30 — **INSTALAÇÃO DOS TRABALHOS TÉCNICOS**
Presidente da Mesa: Newton Carneiro

APRESENTAÇÃO DOS TRABALHOS DE ABERTURA

1. "Programas em andamento e problemas básicos das florestas implantadas de eucaliptos". Com especial referência ao Brasil e América do Sul. — **Prof. Dr. João Walter Simões.**
2. "Florestas implantadas de pinheiros tropicais". Com especial referência à implantação, manejo e exploração de florestas de pinheiro tropicais. — **Dr. Francisco Bertolani.**
3. Silvicultura Intensiva em Melhoramento Genético de Eucalyptus spp. **Prof. Dr. Mário Ferreira.**
4. "Perspectivas de melhoramento de pinheiros tropicais no programa cooperativo do IPEF". **Prof. Paulo Yoshio Kageyama.**
5. "Testes internacionais de procedências de pinheiros tropicais". — **Dr. R. Barnes** (Inglaterra)
6. "Testes internacionais de procedências de eucaliptos". — **Engº B. Martin.** (França).
7. "Coordenação Nacional da Experimentação sobre procedências de eucaliptos no Brasil". **Prof. Dr. Antonio Paulo Mendes Galvão.**

GRANDE AUDITÓRIO

DIA 26/8/80
Terça Feira

8,30 – 12,30 horas **SESSÃO CONJUNTA: GRUPOS A, B e C**

Exploração, conservação e melhoramento genético de Pinus Caribaea e Pinus Oocarpa — estudo da situação atual do programa.

1. Taxonomia (incluindo Quimiotaxonomia), variação e exploração.
2. Conservação.
3. Revisão do primeiro estágio dos testes de procedências internacionais.
4. Progresso do segundo estágio de pesquisas sobre procedências e planos para o futuro.
5. Progressos nos testes e bancos clonais cooperativos de Pinus Caribaea.
6. Trabalhos voluntários.

GRANDE AUDITÓRIO

14,00 – 17,00 horas **GRUPO C**

Silvicultura e rendimento em florestas de Rápido Crescimento.

1. Estabelecimento de plantações, incluindo práticas de viveiro.
2. Práticas culturais, adubação e controle de ervas daninhas.
3. Manejo para usos específicos: madeira para serraria, carvão, celulose e papel, conservação do solo e vida animal.
4. Interações genótipos/ambiente/nutriente incluindo irrigação.
5. Trabalhos voluntários.

SALÃO AZUL

GRUPO B

Exploração, conservação e variação em E. grandis — estudo da situação atual do programa.

1. Taxonomia, espécies afins, ocorrência natural, procedências colhidas, conservação.
2. Progressos efetuados nos testes de procedências — Austrália, Flórida (EUA), África do Sul, Zimbabwe, Rodésia, Zâmbia e Brasil.
3. Testes internacionais cooperativos de procedências de E. grandis.
4. Trabalhos voluntários.

GRANDE AUDITÓRIO

19,30
22,00 horas

GRUPO A

Exploração, conservação e melhoramento genético de Gmelina e Tectona — estudo da situação atual do programa.

1. Exploração, pesquisa e mapeamento de povoamentos para coleta de sementes em procedências selecionadas.
2. Conservação.
3. Desenvolvimento de raças locais e suas origens.
4. Progressos nos testes de procedências regionais e internacionais.
5. Características especiais para se avaliar forma das árvores.
6. Progressos na produção de sementes melhoradas.
7. Progressos no melhoramento genético.
8. Trabalhos voluntários.

GRANDE AUDITÓRIO

DIA 27/8/80
Quarta Feira

9,00
12,00 horas

GRUPO C

Respostas à adubação em plantações de Eucaliptos.

GRANDE AUDITÓRIO

GRUPO B

Procedências colhidas e testes de procedências em outras espécies de eucaliptos.

1. Breve resumo dos resultados de colheitas de sementes e instalação de testes de procedências para as espécies E. camaldulensis, E. cloeziana, E. deglupta, E. delegatensis, E. globulus, E. diversicolor, E. microtheca, E. nitens, E. obliqua, E. tereticornis, E. viminalis, E. urophylla e outras.
2. Trabalhos voluntários.

SALÃO AZUL

14,00
17,00 horas

GRUPO C

Evolução dos ecossistemas de rotações curtas.

1. Produtividade e componentes da biomassa.
2. Ciclagem mineral.
3. Fertilidade a longo prazo e estabilidade das plantações.
4. Efeito das explorações nos solos.
5. Trabalhos voluntários.

SALÃO AZUL

GRUPO B

Métodos de seleção e melhoramento em eucaliptos.

1. Métodos de estabelecimento de populações genéticas básicas pela seleção: planejamento a longo prazo, manutenção "ex situ" de populações para conservação genética e melhoramento genético de eucaliptos.
2. Sistemas de reprodução: floração, autofecundação, depressão por endogamia.
3. Problemas no melhoramento: seleção e herdabilidade.
4. Testes de progênies: sistemas de cruzamento e delineamento de testes de campo.
5. Trabalhos voluntários.

GRANDE AUDITÓRIO

19,30
22,30 horas

GRUPO A

Exploração, conservação, melhoramento genético de Araucária e Agathis — estudo da situação atual do programa.

1. Araucária hunsteinii — Papua/Nova Guiné/Malásia/Congo
   Trabalhos voluntários em relação ao comportamento e potencial da espécie.
2. Araucária cunninghamii — Papua/Nova Guiné/Austrália
   Trabalhos voluntários em relação ao comportamento e potencial da espécie.
3. Araucária angustifolia — Brasil/Argentina
   Trabalhos voluntários em relação ao comportamento e potencial da espécie.
4. Agathis — Taxonomia, exploração, conservação, teste de procedências, coleta de sementes e armazenagem.
   Trabalhos voluntários em relação ao comportamento e potencial das espécies de Agathis.

GRANDE AUDITÓRIO

DIA 28/8/80
Quinta Feira

6,00 – 14,00 horas — **TOUR TÉCNICO – GRUPOS A + B + C**

15,00 – 18,00 horas — **GRUPOS A + B + C**
Qualidade da Madeira de Florestas de Rápido Crescimento (efeitos de espécie, procedências e tratos culturais nas propriedades da madeira)

GRANDE AUDITÓRIO

19,00 – 22,00 horas — **GRUPO ESPECIAL**
Produtividade e Manejo de Plantações de Coníferas

GRANDE AUDITÓRIO

DIA 29/8/80
Sexta Feira

9,00 – 12,00 horas — **GRUPO C**

Nutrição e fisiologia dos eucaliptos — problemas gerais das plantações.

1. Respostas à adubação e irrigação.
2. Tolerância das espécies de Eucaliptos a geadas, secas e salinidade.
3. Problemas com pragas e doenças.
4. Trabalhos voluntários.

SALÃO AZUL

9,00
12,30 horas **GRUPOS A + B**

Cooperação nacional, regional e internacional.

1. Relatório da FAO sobre estudo da viabilidade de um programa de melhoramento genético cooperativo a nível internacional para o Pinus caribaea e outras coníferas tropicais.
2. Relatório dos progressos no estabelecimento de um programa cooperativo de melhoramento genético e coleta de sementes no Sudeste da Ásia.
3. Situação atual do Programa Global para conservação e utilização dos recursos genéticos florestais.
4. IPEF — Composição, objetivos e metas alcançadas.
5. Cooperação, controle e manejo de povoamentos para conservação genética.
6. Trabalhos voluntários no estabelecimento de programas de melhoramento genético cooperativos nas zonas tropicais e subtropicais.
7. Trabalhos voluntários de institutos e organização de suporte técnico não relacionados no programa.
8. Trabalhos voluntários em relação às restrições ao intercâmbio de material genético básico ao melhoramento — material vegetativo para enxertia e enraizamento, pólen, sementes, órgãos, tecidos ou culturas de células.

GRANDE AUDITÓRIO

14,30
17,30 horas **GRUPOS B + C**

Manejo de Eucaliptos para a produção de sementes.

1. Sementes de Rio Claro — São Paulo.
2. Pomar de sementes por enxertia de E. grandis Zammerkomst, África do Sul.
3. Pomar de sementes por mudas de E. grandis — Flórida, EUA.
4. Certificação de sementes de eucaliptos no Brasil.
5. Trabalhos voluntários em relação a experiências no campo de Áreas de Produção de Sementes e Pomares de Sementes.

Hibridação em eucaliptos e propagação vegetativa.

1. Híbridos: problemas e vantagens dos eucaliptos híbridos.
2. Produção massal de estacas enraizadas: Aracruz Florestal e Pointe Noire/Congo.
3. Enxertia e cultura de tecidos.
4. Trabalhos voluntários.

GRANDE AUDITÓRIO

19,30
22,00 horas **GRUPO A**

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

1. Espécies para zonas áridas.
2. Espécies para a agro-silvicultura.
3. Exploração da floresta tropical húmida com reimplantação de novas espécies.
4. Contribuições voluntárias sobre espécies promissoras de uso recente em reflorestamento: *Acacia mangium, Anthocephalus, etc.*

GRANDE AUDITÓRIO

DIA 30/8/80
Sábado

9,00
11,00 horas **SESSÃO CONJUNTA: A, B e C**
REVISÃO DAS SESSÕES

11,05 horas **SESSÃO DE ENCERRAMENTO**
Revisão Geral do Simpósio — E. Carlyle Franklin.
Recomendações Finais. — Sérgio Carlos Lupattelli

GRANDE AUDITÓRIO

14,00
17,00 horas Revisão Administrativa
Conclusões

General Program

Monday, August 25 th, 1980

8 AM to 6 PM — **Registration of Participants**
Distribution of material to Participants

CONVENTION CENTER
Executive Secretariat

11 AM: **SOLEMN OPENING SESSION OF THE SYMPOSIUM**

Speakers: **Sérgio Carlos Lupattelli**
President of SBS and of Symposium
Mauro Silva Reis
Presidente of the Brazilian Institute of Forestry Development, and Official Representative of the Minister of Agriculture,
Amaury Stabile

AUDITORIUM

12 AM: **CLOSING**

2.30 PM to 6.30 PM — **STARTUP OF TECHNICAL WORKING SESSIONS**
Chairman: **Newton Carneiro**

PRESENTATION OF OPENING POSITION PAPERS

1. "Ongoing programs and basic problems of established (man-planted) eucalypt forests". With special reference to Brazil and South America. – **Prof. Dr. João Walter Simões.**
2. "Established (planted) tropical pine forests". With special reference to establishing, managing and exploiting tropical pins forests. – **Dr. Francisco Bertolani.**
3. Intensive Silviculture and Genetic Improvement of Eucalyptus spp. – **Prof. Dr. Mário Ferreira.**
4. "Outlook for the improvement of tropical pines in the IPEF cooperative program". – **Prof. Paulo Yoshio Kageyama.**
5. "International provenance tests of tropical pines". – **Dr. R. Barnes** (United Kingdom).
6. "International provenance tests of eucalyptus". – **B. Martin,** engineer (France).
7. "National Coordination of Experiments on eucalypt provenances in Brazil". – **Prof. Dr. Antonio Paulo Mendes Galvão.**

AUDITORIUM

Tuesday, August 26 th, 1980

8.30 AM: **JOINT SESSION: GROUPS A, B, AND C**

to 12.30 PM: **Exploitation, conservation and genetic improvement of Pinus Caribaea and Pinus Oocarpa — study of the present situation of program.**

1. Taxonomy (including Chemitaxonomy), variation and exploitation.
2. Conservation.
3. Review of first stage of research on provenance tests.
4. Progress of the second stage of research on provenances and future plans.
5. Progress achieved on tests and cooperative clonal banks of Pinus Caribaea.
6. Voluntary written contributions.

AUDITORIUM

2 PM to 5 PM

GROUP C

Silviculture and yield in Fast-Growing Forests.

1. Establishment of plantations, including nursery practices.
2. Cultural practices, manuring and control of harmful herbs.
3. Management for specific uses: sawmill wood, charcoal, cellulose and paper, soil conservation and animal life.
4. Interactions genotype/environment/nutrient, including irrigation.
5. Voluntary written contributions.

SALÃO AZUL (BLUE ROOM)

GROUP B

Exploitation, conservation and variation of E. grandis — study of present situation of program.

1. Taxonomy, similar species, natural occurrence, collected provenances, conservation.
2. Progress achieved in provenance tests — Australia, Florida (U.S.A.), South Africa, Zimbabwe (Rhodesia), Zambia, and Brazil.
3. Cooperative internacional provenance testes of E. grandis.
4. Voluntary written contributions.

AUDITORIUM

7.30 PM to
10 PM

GROUP A

Exploitation, conservation and genetic improvement of Gmelina and Tectona — study of present situation of the program.

1. Exploitation, research and plotting of forest sites for the collection of seeds by selected provenances.
2. Conservation.
3. Development of local breeds and their origins.
4. Progress achieved on tests of regional and international provenances.
5. Special characteristic properties to evaluate form of trees.
6. Progress in the production of improved seeds.
7. Progress in genetic improvement.
8. Voluntary written contributions.

AUDITORIUM

Wednesday, August 27 th, 1980

9 AM to
12 AM

GROUP C

Response to manuring (fertilizing) of Eucalypt plantations.

AUDITORIUM

GROUP B

Collected provenances and provenance tests in other species of eucalypts.

1. Brief summary of the results of the collection of seeds and installation of provenance tests for the species: E. camaldulensis, E. cloeziána, E. deglupta, E. delegatensis, E. globulus, E. diversicolor, E. microtheca, E. nitens, E. obliqua, E. tereticornis, E. viminalis, E. urophylla and others.
2. Voluntary written contributions.

SALÃO AZUL (BLUE ROOM)

2 PM to
5 PM

GROUP C

Development of short-rotation/ecosystems.

1. Productivity and components of the biomass.
2. Mineral cyclage.
3. Long-term fertility and stability of plantations.
4. Effect of soil exploitation.
5. Voluntary written contributions.

SALÃO AZUL (BLUE ROOM)

GROUP B

Methods of selection and improvement in eucalypts.

1. Methods of establishment of basic genetic population (classes) for selection: long-term planning, maintenance of populations "ex-situ" for genetic conservation and genetic improvement of eucalypts.
2. Breeding systems: Flowering, self-fecundation, depression through endogamy.
3. Problems in the improvement: selection and heritage.
4. Progeny tests: systems of cross-breeding and outlining of field tests.
5. Voluntary written contributions.

AUDITORIUM

7.30 PM to 10.20 PM

GROUP A

Exploitation, conservation, genetic improvement of Araucaria and Agathis — study of present situation of the program.

1. Araucaria hunsteinii Papua/New Guinea/Malasia/Congo
   Voluntary written contributions in relation to the behaviour and potencial of the species.
2. Araucaria cunninghamii Papua/New Guinea/Australia
   Voluntary written contributions in relation to the behaviour and potential of the species.
3. Araucaria angustifolia Brazil/Argentina
   Voluntary written contributions in relation to the behaviour and potential of the species.
4. Agathis Taxonomy, exploitation, conservation, provenance test, collection of seeds and storage.
   Voluntary written contributions in relation to the behaviour and potential of the species of Agathis.

AUDITORIUM

Thursday, August 28 th, 1980

6 AM to 2 PM — TECHNICAL TOUR – GROUPS A, B, AND C

3 PM to 6 PM — GROUPS A, B, AND C

Wood Quality of Fast-Growing Forests (effects of species, provenances and cultural treatments in Wood Properties).

AUDITORIUM

7 PM to 10 PM — SPECIAL GROUP

Productivity and Management of Conifer Plantations.

AUDITORIUM

Friday, August 29 th, 1980

9AM to 12 AM — GROUP C

Nutrition and Physiology of eucalypts – General Problems of Plantations.

1. Response to manuring and irrigation.
2. Tolerance of the species of eucalypts to frost, drought and salinity.
3. Problems with plagues and illnesses.
4. Voluntary written contributions.

SALÃO AZUL (BLUE ROOM)

9 AM to 12.30 PM

GROUPS A AND B

Cooperations — national, regional and international.

1. FAO report on study of practicability of a cooperative genetic improvement program on an international level for Pinus caribaea and other tropical conifers.
2. Progress report on the establishment of a cooperative genetic improvement program and collection of seeds in Southeast Asia.
3. Present situation of the Global Program for the conservation and utilization of forest genetic resources.
4. IPEF — composition, objectives and goals fulfilled.
5. Cooperation, control and management of tree populations for genetic conservation.
6. Voluntary written contributions on the establishment of cooperative genetic improvement programs in tropical and sub-tropical zones.
7. Voluntary written contributions of institutes and organization of technical support not listed in the program.
8. Voluntary written contributions in relation to the restrictions to the exchange of genetic material basic to improvement — vegetative material for grafting and rooting, pollen, seeds, organs, tissues or cellular cultures.

AUDITORIUM

2.30 PM to 5.30 PM

GROUPS B AND C

Management of Eucalypts for seed production.

1. Seeds from Rio Claro — São Paulo.
2. Seed orchard by grafting of E. grandis — Zammerkomst, South Africa.
3. Seed orchard by seedlings of E. grandis — Florida (U.S.A.).
4. Certification of eucalypt seeds in Brazil.
5. Voluntary written contributions in relation to experiments in the field of Seed Production Areas and Seed Orchards.

Hybridization in eucalypts and vegetative propagation.

1. Hybrids: Problems and advantages of hybrid eucalypts.
2. Mass production of rooted poles:
   Aracruz Florestal and Pointe Noire/Congo.
3. Grafting and tissue culture.
4. Voluntary written contributions.

AUDITORIUM

7.30 PM to
10 PM

GROUP A

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

1. Trees for arid zones.
2. Trees for agro-forestry.
3. Exploration of the tropical rainforest for new plantation species.
4. Voluntary contributions on promising "new" species recently introduced to cultivation: *Acacia mangium, Anthocephalus, etc.*

AUDITORIUM

Saturday, August 30 th, 1980

9 AM to
11 AM

JOINT SESSION: GROUPS A, B, AND C

11.05 AM:

CLOSING SESSION

General Review of the Symposium – E. Carlyle Franklin
Final Recommendations – Sérgio Carlos Lupattelli

AUDITORIUM

2 PM to
5 PM

ADMINISTRATIVE REVIEW –

CONCLUSIONS

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POSITION

sessão 1
session 1
grupo ABC
group ABC

—Exploração, conservação e melhoramento genético de *Pinus caribaea* e *Pinus oocarpa* — Estudo da situação atual do programa.

—Exploration, conservation and genetic improvement of *Pinus caribaea* and *Pinus oocarpa* — Study of present situation of the program.

—Exploitation, conservation et amélioration génétique du *Pinus caribaea* et *Pinus oocarpa* — Etude de la situation actuelle du programme.

Chairman/Presidente — J. Groulez
Rappourter/Relator — R. D. Barnes
Reviewer/Revisor — P. Y. Kageyama

GRUPOS DE INTERESSE ESPECIAL

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

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

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

ESPECIAL INTEREST GROUPS

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

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

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

GRUPOS DE TRABALHO DA IUFRO ENVOLVIDOS NA PROGRAMAÇÃO

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

IUFRO WORKING GROUPS INVOLVED IN THE PROGRAM

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

POSITION

PROGRAMAS EM ANDAMENTO E PROBLEMAS BÁSICOS EM FLORESTAS IMPLANTADAS DE PINHEIROS TROPICAIS

Francisco Bertolani
Companhia Agro Florestal Monte Alegre
BRASIL

Resumo

A Silvicultura no Brasil atinge a marca dos 20 anos, onde os Pinus de procedência tropical ao lado do Eucalyptus, formaram a base de uma floresta com mais de 3,0 milhões de hectares. Apesar de relativamente jovem, o setor florestal brasileiro enfrentou sérios problemas de qualidade de sementes. Através de populações básicas pôde iniciar um trabalho de melhoramento genético. Outros problemas também estão sendo enfrentados, principalmente no Setor de Manejo pela falta de tradição e exploração florestal e pela ausência de maquinários especializados.

Ênfase é dado às florestas energéticas, ressaltando a necessidade de conciliar as múltiplas finalidades da floresta e propondo a utilização de florestas mistas, visando também a manutenção da rentabilidade, com destaque para os Pinus tropicais.

Destaca a política de incentivos ao reflorestamento e a caminhada para as regiões direcionadas pelo Governo, os problemas que serão enfrentados pelos florestais, sugerindo a adoção das florestas baseadas em Pinus tropicais dada as limitações que outros generos estão encontrando.

Analisa, à título de comparação, as densidades básicas de alguns Pinus em idades jovens com destaque ao Pinus oocarpa.

CURRENT PROGRAMMES AND BASIC PROBLEMS IN MAN MADE TROPICAL PINE FORESTS

Summary

The Brazilian Silviculture reaches the age of 20 years now, in which - the Pinus of tropical provenance beside Eucalyptus, combined the base of a forest with more than 3,0 millions of hectares. In spite of being quite - young, the Brazilian forest sector has already faced serious problems with the quality of seeds.

A genetic improvement work was possible to be made through basic populations. Other problems are still being faced, specially in the Sector of Managément due to the lack of tradition and logging operations and the absence of proper machinery.

Emphasis is given to the energetic forests, stressing the need of conciliating the forest multiple objectives and suggesting the usage of mixed forests, searching for the maintenance of rentability, pointing out the tropical Pinus.

This present paper stands out the incentives to reforestation and the course to the regions led by the Government, the problems that the forestries are supposed to come across, and also suggests the adoption of forests based on tropical Pinus because of the restriction the other genus are bearing - with.

Just for comparison, it analyses the basic densities of some Pinus at young ages, emphasizing Pinus oocarpa.

INTRODUÇÃO

Pode-se afirmar que a Silvicultura Técnica no Brasil iniciou na década dos anos 60, atingindo hoje a marca de 20 anos.

Com exceções honrosas de alguns países sul americanos como a Argentina e Chile, os demais sempre praticaram uma silvicultura extrativa e de uso do potencial disponível.

E tal situação não é peculiar somente aos países tropicais da América do Sul, mas a todos aqueles que se encontram em idênticas situações tropicalistas, cujos problemas são de ordem e números idênticos uns aos outros. Além de problemas sociais e de clima, a fertilidade de solo e a tradição de uso são significantemente indutoras de um mau uso dos recursos naturais, notadamente daqueles ditos renováveis.

É sabido que os países sub-desenvolvidos ou em desenvolvimento são fornecedores de matérias primas aos países ricos. E a maioria daqueles países se localizam exatamente entre os trópicos, pendurados de ambos os lados do Equador, na situação anteriormente descrita.

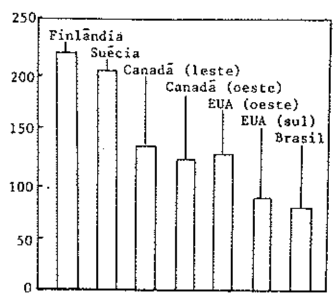
Mas, pessoalmente não considero essa situação alarmante ou deprimente, apesar das estatísticas e relatórios constantemente apresentados pela F.A.O. (Food and Agriculture Organization).

O mundo necessita de nossa produção madeireira, mesmo que os chamados - ricos a possuam abundantemente, mas nunca em condições de competir com os nossos custos de produção.

Uma estatística de custo de celulose apresentada pela English China Clays, mostra claramente que um país em desenvolvimento compete em custos com os países considerados os maiores produtores de célulose.

Gráfico 1 - Custos de Celulose (Em US$ por t)

Chart 1 - Cellulose Costs (In US$ per t)



Fonte: REVISTA DA MADEIRA

Bem, se nós temos baixo custo de produção, só nos falta disponibilidade suficiente para atendermos as demandas e uma política interna racional que nos permita ampliar e/ou garantir uma disponibilidade.

Além disso, dadas as características de também países pobres em tradição madeireira de florestas, enfatizar pesquisas florestais não somente voltadas a corrigir passados e prevenir futuros erros, mas consolidar sucessos pioneiros e principalmente, ampliar a técnica florestal através dos ganhos de produção, produtividade e poder de competição de qualidade.

Firmemente posso afirmar que é nas florestas, notadamente aquelas situadas nas regiões sub-tropicais e tropicais, sejam elas de madeira dura ou madeira mole, que iremos encontrar uma estabilidade social, política e econômica.

SITUAÇÃO DA AMÉRICA DO SUL E DO BRASIL

No quadro a seguir podemos analisar a situação das florestas plantadas em diferentes países sul-americanos.

Quadro I - Situação Florestal na América do Sul.

Table I - Forest Situation in South America.

	População	Área Florestal Plantada (Aprox.)
Argentina	26.000.000	600.000 ha.
Brasil	122.000.000	3.500.000
Chile	11.000.000	750.000
Colômbia	26.900.000	120.000
Equador	7.350.000	30.000
Peru	16.300.000	120.000
Surinam	350.000	10.000
Uruguai	2.680.000	10.000
Venezuela	12.000.000	100.000

Fonte: WORLD WOOD

Não foram considerados Paraguai, Guyana Francesa, Guyana e Bolívia em função de não possuírem reflorestamentos significativos.

No Brasil, a atividade florestal sofreu mudanças significativas com um desenvolvimento pronunciado à partir dos incentivos fiscais para reflorestamento, com a finalidade precípua de reduzir a atividade extrativa e de exploração dos recursos naturais além de garantir o suprimento das indústrias madeireiras instaladas.

À título de dimensionamento, o total de áreas reflorestadas à partir dos incentivos fiscais está contida no Quadro II.

Quadro II - Evolução das Áreas Reflorestadas de 1967 a 1979, com base nos Incentivos Fiscais.

Table II - Evolution of the Reforested Areas from 1967 to 1979, based on Fiscal Incentives.

Anos	Plantios (Ha)
1967	34.759
1968	102.909
1969	162.383
1970	222.005
1971	248.467
1972	304.356
1973	294.203
1974	324.378
1975	398.239
1976	469.199
1977	311.000
1978	411.693
1979	444.863
Total	3.728.454

Fonte: IBDF

Na situação atual do reflorestamento brasileiro, a posição das florestas de Pinus tropicais ainda é insipiente, representando somente cerca de 9% do total reflorestado. No Quadro III, analisamos por região, o total de reflorestamento com pinheiros tropicais.

Quadro III - Distribuição dos Reflorestamentos de Pinus de procedência tropical, por região.

Table III - Reforestation Distribution of tropical Pinus by Region.

Região	Ha.
Norte	50.000
Nordeste	50.000
Sudeste	195.000
Centro-Oeste	35.000
Total	325.000

Os plantios mais antigos estão localizados na região Sudeste, notadamente em São Paulo, representados pelos plantios da CAFMA e do Instituto Florestal de São Paulo.

Os maiores atualmente se concentram em Minas Gerais (Resa, Florestas Rio Doce), Bahia (Torras), Pará (Jari) e Amapá (AMCEL).

Do total de área apresentado no Quadro III, pode-se considerar que 70% é coberto com florestas de Pinus caribaea var. hondurensis, 15% com Pinus oocarpa e o restante 15% pelas demais espécies e variedades (Pinus caribaea var. caribaea, Pinus caribaea var. bahamensis, Pinus kesiya, Pinus elliottii var. densa, etc.).

SEMENTES E VIVEIROS

Para o estabelecimento dos primeiros plantios de Pinus tropicais, a nível de experimentação e populações semi-comerciais, as sementes foram importadas da América Central e Ásia, notadamente por pesquisadores e empresas pioneiras.

Assim, estabeleceram-se populações básicas de origem pouco desconhecidas, porém de qualidade superior, uma vez que as sementes eram coletadas, preferencialmente, em regiões de exploração de madeira para serraria. Foi tal vez a primeira seleção fenotípica com resultados proeminentes.

Posteriormente, com o crescimento da demanda dessas sementes, houve um período de comercialização intensa, onde o volume era mais importante que a qualidade.

A partir desta constatação, foi dado prioridade pelas principais empresas e universidades brasileiras ao melhoramento genético de sementes, a partir de populações existentes e introdução de procedências em conjunto com tradicionais fornecedores de sementes e organismos internacionais especializados em melhoramento.

Os trabalhos estão em ritmo acelerado e avançados à nível de testes de progênie e já demonstrando resultados animadores conforme será comprovado em diversos trabalhos que serão apresentados neste Simpósio.

Segundo NICOLIELO, BERTOLANI e GARNICA (1979), o consumo de sementes de Pinus tropical estaria em torno de 4.000 kg/ano, mantidos o ritmo de 60.000 ha por ano, para os programas brasileiros.

A produção atual mundial, segundo NIKLES (1979) para Pinus caribaea var. hondurensis apresenta um excedente de 4.078 kg, incluindo as produções e consumo do Brasil.

O balanço brasileiro, segundo aquele autor, apresenta consumo = 2.535 kg e produção = 225 kg, para a espécie acima citada, dando um deficit de 2.310 kg abastecido principalmente pela Guatemala, Honduras, Belize e Nicarágua porém de sementes de boa e má qualidade provenientes de florestas naturais.

Porém, esse deficit já está sendo coberto pela crescente produção das sementes melhoradas da CAFMA e CHAMPION já em 1980 e, antes de 1985 estará totalmente sanado por ocasião do início de produção dos pomares de sementes da CAFMA, CCGMPT, Jari e Openflora, para mencionar somente os mais importantes.

Mesmo que os programas sejam acelerados, conforme veremos no final do presente trabalho, a produção nacional de sementes será suficiente para atender a total demanda.

Dadas as características rudimentares do Pinus em geral, não existem problemas mais sérios na formação de mudas em viveiros.

A embalagem tradicional utilizada são os containers de laminados de Araucaria ou Pinus. Apesar do uso do saco plástico ser condenado, ainda algumas empresas utilizam-no por motivos econômicos.

A micorrização é um fator importante e segundo KRÜGNER e TOMAZELLO(1979) as espécies tropicais de Pinus são dependentes de micorrisas e o desenvolvimento é seletivo para a espécie.

O tempo de formação de mudas varia com a espécie e local de formação - mas, de uma maneira geral, pode-se estabelecer o limite de 4-8 meses, sendo que o Pinus caribaea var. hondurensis e Pinus oocarpa estão no limite inferior e Pinus elliottii var. densa, Pinus kesiya no limite superior.

Com exceção do Pinus merkusii que tem apresentado sérios problemas de germinação e desenvolvimento, os demais tem comportamentos normais.

Alguns problemas de tombamento (damping off) e com lagartas (Agrotis ipsilon) tem ocorrido em determinadas épocas de início de verão e com chuvas intensas, agravado normalmente devido a atrasos na semeadura.

PREPARO DE SOLO, PLANTIO E TRATOS CULTURAIS

Basicamente o preparo de solo é feito de duas formas diferentes, dependendo da cobertura vegetal primária, o que é o mesmo que definir se a área é representada por campos (sem vegetação de porte) ou por cerrados (com vegetação de porte).

Para as áreas de campos, usa-se um trator de pneus com lâmina frontal com cerca de 80 - 100 HP, para retirada da vegetação. O próprio trator poderá arar e gradear o solo.

Para as áreas com cerrados onde a vegetação é mais densa, necessário se faz utilizar máquinas de esteiras com correntões para desmatamento; trabalhando em pares ou simplesmente com rolos facas.

A aração e gradeação é feita por tratores de pneus idênticos ao descrito anteriormente ou também é prática utilizar-se da mesma máquinas de esteiras para fazer apenas uma operação arrastando uma grade-aradora.

Após o preparo, inicia-se o combate às saúvas (Atta spp), a principal praga que ataca as florestas e culturas brasileiras.

Após as primeiras chuvas de primavera (setembro) inicia-se o plantio. Em algumas regiões do Centro-Oeste, em função da extensão dos programas, plantam-se também no período das secas invernais, durante os meses de abril a agosto. No Norte e Nordeste do país, os períodos de seca são diferentes das demais regiões.

O espaçamento utilizado varia de empresa para empresa, mais em função do futuro uso das florestas, que propriamente pela diferença das espécies.

Normalmente a densidade de plantio está em torno de 1.300 a 2.000 árvores/ha., sempre se respeitando o mínimo de 2,5 metros por linhas, para permitir as mecanizações tanto de plantio como de tratos culturais.

No caso da CAFMA, os espaçamentos estão em função também da forma das espécies, visando um melhor índice de seleção. Assim, por exemplo, o Pinus caribaea var. hondurensis apresenta uma maior porcentagem de defeitos, como árvores tortas, bifurcadas e fox-tail, e é plantado numa densidade maior - (2.500 árvores por ha.) que o Pinus caribaea var. caribaea, de melhor homogeneidade de forma e crescimento (2.000 árvores por ha.).

A prática de fertilização ainda não está perfeitamente caracterizada, já que muitas vezes a própria variação genética interfere nos resultados. Porém para terrenos de baixa fertilidade, já foi determinado que adubações com fósforo tem dado significância de resultados. Alguns micro-nutrientes como bórax também tem sido usualmente utilizados. Maiores pesquisas deverão ser desenvolvidas nesse setor, principalmente quando o material a ser testado tenha padrões conhecidos.

O período de formação florestal dos Pinus tropicais variam conforme a região e solo, porém em geral após quatro anos pode-se considerar formado, dispensando-se as limpezas de cultivo. Essas, geralmente são em número de seis, assim distribuídas: 2 no primeiro ano, 2 no segundo, 1 no terceiro e 1 no quarto ano. A maioria das empresas se utilizam de tratores de pneus leves 60 - 70 HP, com grades ou roçadeiras.

Nesse período intensifica-se o combate à formigas.

PODA

Formada a floresta, o próximo trabalho é a operação de poda, cujos objetivos são vários.

A primeira finalidade de uma poda é de caráter protecionista. Após a sua formação, torna-se difícil o acesso para a continuação no combate à formigas. Dentro desse objetivo protecionista ainda devemos considerar que a eliminação dos galhos inferiores, já entrando em senescência devido à falta de luz, favorece a manutenção de um fogo próximo ao solo, evitando que ele passe para as copas, onde o vento o propagará com mais intensidade e causando perdas irreparáveis. Além disso um fogo de solo é muito mais fácil de ser combatido, mesmo durante o dia e em condições adversas.

Deve ser considerado que os Pinus tropicais possuem uma defesa natural contra o fogo, isto é, a grande percentagem de casca, com raras exceções, como o Pinus kesiya, o Pinus strobus var. chiapensis e Pinus taiwanensis. Porém as variedades de Pinus caribaea e o Pinus oocarpa possuem fortes defesas naturais; os primeiros apresentam em média 25% de casca nas idades mais jovens de 5-7 anos, enquanto que o Pinus oocarpa até 30%.

Do ponto de vista técnico, aos 5-6 anos iniciam-se as primeiras medições (inventários de falhas, volumétricos, etc.) onde precisamos fácil acesso à área.

Do ponto de vista comercial, é a preparação das primeiras toras, de uso mais nobre, que estarão sendo valorizadas pela eliminação de nós verticiliais.

Vários estudos estão sendo conduzidos por SIMÕES (1978) para se aquilatar o balanço de input = custos adicionais e output = receitas extraordinárias das operações de poda.

Logicamente deve ser considerada a rotação e finalidade da floresta para se estabelecer um plano de poda, assim como a sua própria qualidade. No Quadro IV, apresenta-se um modelo de plano para empresas de rotação longa - 25-30 anos e visando madeira de alto valor para serrarias, laminados, faqueados, etc.

Quadro IV - Plano Simplificado de Poda

Table IV - Simplified Plan of Pruning

Épocas	Nº árvores existente	Nº árvores a podar	Altura poda (m)	Idade anos
Anterior ao 1º desbaste	2.000	2.000	2.0	5
Posterior ao 1º desbaste	1.300	500	6.0	8
Posterior ao 2º desbaste	900-1.000	300	11.0	10-11

A tentativa do Plano de Podas apresentado serve apenas como base, e deverá ser adaptado e corrigido para as diferentes situações, qualidades de florestas e finalidade.

DESBASTE

Realmente torna-se difícil, e esse é o problema maior que entrentamos hoje no Brasil, estabelecer um plano de desbaste aliado a um sistema de exploração, já que não existe uma tradição florestal de povoamentos implantados, determinação de "sites" por espécie, rotações e comportamento.

Além disso, a variação genética existente, principalmente em Pinus tropicais, não permite uma generalização do problema. VEIGA (1975) e FISCHWICK (1978) trabalhando com Pinus elliottii var. elliottii, propuseram sistemas para determinação da época de desbaste e intensidade, visando maximização de acréscimos volumétricos para a região Sul e Sudeste do Brasil. Porém, quando o fator qualidade incide diretamente na rentabilidade, não se pode generalizar, e para todo o Brasil, um sistema eficiente de desbastes.

Mesmo entre empresas do mesmo ramo, por exemplo, voltadas à produção de celulose e papel, encontramos sistemas diferentes, tanto para Pinus taeda como para Pinus elliottii var. elliottii.

Quadro V - Sistemas de Desbastes em Empresas de Rotação Curta. Empresa A.

Table V - Systems of Thinnings at Short Cycle Companies. Company A.

	Anos	Intens.	Obs.
1º Desbaste	8	50%	Corte raso à cada 4a. linha desbastes nas laterais.
2º Desbaste	12	25%	Corte raso na linha remanescente e desbastes nas 2 linhas anteriormente desbastadas.
Corte Raso	16	-.-	-.-

Quadro VI - Sistemas de Desbaste em Empresas de Rotação Curta. Empresa B.

Table VI - Systems of Thinnings at Short Cycle Companies. Company B.

	Anos	Intens.	Obs.
1º Desbaste	7	50%	Corte raso a toda 2a. linha.
2º Desbaste	10	25%	Seletivo.
Corte Raso	15	-.-	-.-

Quadro VII - Sistemas de Desbastes em Empresas de Rotação Curta. Empresa C.

Table VII - Systems of Thinnings at Short Cycle Companies. Company C.

	Anos	Intens.	Obs.
1º Desbaste	8	40%	Total Seletivo. Corte a cada 25 linhas
2º Desbaste	11	30%	Total Seletivo. Corte a cada 25 linhas.
Corte Raso	16	-.-	-.-

Outras empresas se utilizam do sistema de área basal remanescente e à base de diâmetro futuro. Apesar de altamente técnico, colocamos em dúvida a sua praticidade e fiel acompanhamento. Um plano prático e de bom senso muitas vezes suplanta, pelo menos em redução de despesas, os planos altamente técnicos e de difícil execução. Normalmente esses planos não conseguem acompanhar o ritmo de exploração.

Para florestas de ciclo mais longo, onde outros fatores de qualidade interferem na rentabilidade florestal, poderíamos considerar o Quadro VIII, uma interpolação dos sistemas de desbaste atualmente utilizados pela CAFMA e Resa.

Quadro VIII - Estimativa da Produção (plantios de espaçamento 2,5 X 2,0 m., por desbaste para uma rotação estimada de 25 anos).

Table VIII - Estimative of Production (plantation with spacing 2,5 X 2,0 m, per thinning for an estimate cycle of 25 years).

Considerações	1º Desbaste 8º Ano	2º Desbaste 10º Ano	3º Desbaste 12º Ano	4º Desbaste 15º Ano	5º Desbaste 19º Ano	Corte Raso 25ºAno	Prod. Acumulada
Nº Árv.Retirar	600	400	300	200	200	300	-
m^3 s/c/árvore	0,058	0,100	0,150	0,250	0,350	1,570	-
Tot/ha m^3 s/c	35	40	45	50	70	470	710
I.M.A. V.R.C. s/c/ha/ano	-	-	-	-	-	-	28
Prod./ha m^3 s/c Fábr.	30	30	25	20	20	90	215
Prod./ha m^3 s/c Serr.	5	10	20	30	50	380	495

No presente quadro, a madeira produzida está representada em 2 classes: madeira de fábrica e madeira de serraria. Esta deverá ser subdividida em outras aplicações como laminados, faqueados, postes, etc. Isto não foi feito em vista da madeira de Pinus estar sendo somente agora utilizada em substituição à Araucaria angustifolia - o pinheiro do Paraná.

SIMÕES ET ALLI (1978) estão desenvolvendo trabalhos técnicos em Pinheiros tropicais em diferentes intensidades de seleção com a finalidade de determinar os melhores tratamentos para atendimento dos programas propostos aliado às necessidades de mercado, notadamente em Pinus caribaea var. hondurensis e Pinus oocarpa.

EXPLORAÇÃO FLORESTAL

O setor de exploração florestal em Pinus, tanto daqueles de procedência tropical, sub-tropical e de regiões temperadas, seguem um sistema similar. Esse sistema é baseado principalmente nas seguintes operações:

1. Dois homens no corte e traçamento utilizando-se moto-serras agrícolas ou semi-profissionais.
2. Desgalhamento com machados.
3. Arraste manual ou com tratores agrícolas.
4. Carregamento manual ou com carregadores hidráulicos.
5. Transporte por caminhões.
6. Descarga com gruas ou pontes rolantes.
7. Descascamento nos páteos.

Como a maioria das áreas plantadas com Pinus estão atingindo presentemente as idades do 1º desbaste, as técnicas mais avançadas de sistemas, métodos e nível de mecanização não foram acionadas.

Consequentemente, os custos de exploração atingem valores até mais altos que a própria madeira. De uma maneira geral, na região Sudeste, o preço da madeira de Pinus para fabricação, em pé, é de US$2,50/metro estere/com casca e para a região Sul em US$3,20 por metro estere com casca.

Em média os custos de exploração para corte, desgalhamento, arraste e empilhamento nas estradas é de US$2,60 por metro estere com casca para a região Sudeste e US$2,00 por metro estere com casca para a região Sul.

Além disso o trabalho envolve grandes contingentes de trabalhadores, normalmente não treinados para operações florestais ocasionando grande índice de acidentes. Infelizmente ainda não possuímos uma legislação específica para segurança nos trabalhos de exploração florestal.

Os maquinários envolvidos nessas operações, quando existem, são geralmente adaptados da área agrícola, portanto impróprios para qualquer sistema desenvolvido. Ainda não conseguimos determinar se os danos são maiores para o trabalhador ou para a floresta e solo.

Sintam a gravidade do problema: não existe nenhum guincho, "skider", "feller" ou processador de fabricação nacional. Alguns carregadores e auto-carregadores começam a surgir timidamente nas fábricas de tratores. Somente agora surgem as primeiras moto-serras profissionais, alguns equipamentos de segurança e ferramentas de trabalho para exploração florestal.

Somente três empresas trabalham com sistemas profissionais de exploração florestal em *Pinus* e outras tantas em *Eucalyptus*, visando principalmente a redução dos riscos de acidentes.

Normalmente essas empresas trabalham no seguinte esquema:

1. Um homem cortando, traçando, desgalhando e empilhando dentro da floresta, com moto-serras profissionais, equipamentos de segurança e ferramentas especiais.
2. Arraste com tratores agrícolas para os carreadores.
3. Carregamento com carregadores hidráulicos.
4. Transporte por caminhões.
5. Descarga com gruas ou pontes rolantes.
6. Descascamento nos pateos.

Esse sistema é atualmente utilizado nos 2ºs. e demais desbastes.

Existem outros sistemas, porém em geral, são variações daqueles apresentados, e com características próprias relacionadas principalmente com o tipo de topografia. SALMERON (1979) e BAGGIO e STÖHR (1978) desenvolveram trabalhos relevantes de sistemas de exploração e mecanização envolvida.

FLORESTAS ENERGÉTICAS

Ressaltar o porquê das florestas serem uma alternativa energética e os problemas internacionais com petróleo seria cansativo e desnecessário.

Porém, quando se fala em florestas energéticas, automaticamente nos vêm em mente florestas de madeira dura e de rápido crescimento (*Populus*, *Fagus*, *Eucalyptus*, etc.).

Realmente é a alternativa mais estudada e detalhada pelos pesquisadores florestais no mundo inteiro. As alternativas vão surgindo, as florestas vão sendo implantadas, analisam-se o poder calorífico da biomassa produzida, encurtam-se as rotações, dimensionam-se os módulos florestais energéticos.

A floresta é encarada não só como fonte de abastecimento de madeira e alternativa energética, mas sim como um componente ecológico de proteção e produção. Redutora das erosões, fixadora de dunas, mantenedora da água, purificadora de ar, protetora da flora e fauna, silenciadora dos ruídos, pacificadora das neuroses, enriquecedora dos solos.

Ao se conciliar toda essa gama de responsabilidade da floresta, devemos levar em conta que ela deve se auto-proteger e manter o seu índice de produção para uma continuidade de sua função.

Decididamente e em última análise, se a floresta deve assumir toda essa carga, uma unidade florestal, com uma espécie e com um manejo simples, nunca atenderá todas essas exigências. Para tanto, a própria floresta deve ter as suas próprias alternativas.

Uma delas seria o manejo de florestas de *Eucalyptus* através de desbastes - florestas multianas com multi-usos, inclusive energético.

A expansão do programa florestal brasileiro, utilizando-se *Pinus* tropicais, não está limitada a problemas técnicos e/ou disponibilidade de sementes, mas principalmente pelo direcionamento às prioridades atuais para fins energéticos e siderúrgicos, onde o substituto natural ainda é o *Eucalyptus*.

Porém, dada a rusticidade dos pinheiros tropicais aliado ao seu alto rendimento mesmo em solos pobres, uma substituição gradativa dar-se-á à curto prazo. Tal fato é reafirmado nas últimas pesquisas sobre ciclagens de nutrientes - POGGIANI (1980) e capacidade calorífica - BARRICHELO, BRITO e MIGLIORINI (1980) as quais demonstram que os Pinus tropicais se prestam mais para fins energéticos quando se consideram o conjunto dos dois objetos anteriormente mencionados.

Talvez por simplicidade, nossa atenção está voltada para as florestas homogêneas, já que as nativas heterogêneas exigem cuidados especiais e cujos rendimentos muitas vezes não os justificam. Mas por que não direcionar os estudos para florestas mistas? Por que não associarmos uma floresta de *Pinus* com uma espécie tolerante? Os exemplos estão em todas as partes do mundo: *Pinus* com *Liquidambar* ou *Betula*, *Picea* com *Fagus*, *Abies* com *Quercus*.

No Brasil, poucos são os exemplos, porém a pesquisa nos dará os horizontes. Disso temos certeza.

FUTURO E TENDÊNCIAS DOS *PINUS* TROPICAIS

A política de incentivos fiscais para reflorestamento adotada pelo Instituto Brasileiro de Desenvolvimento Florestal está voltada em preencher as áreas onde a carência sócio-econômica é mais pronunciada. Além disso, os valores das terras nas regiões Sul e Sudeste elevaram-se rapidamente e a nível de inviabilização econômica dos projetos.

Isto exposto, podemos afirmar com segurança que a tendência dos futuros programas florestais estarão voltadas para as seguintes regiões: Região Centro-Oeste, com ênfase para Mato Grosso do Sul e Goiás; Região Nordeste, principalmente nos Estados da Bahia, Pernambuco e Maranhão e Região Norte representada pelo Pará e Amapá.

Por algum tempo ainda, a região Sudeste será beneficiada com incentivos fiscais, porém limitados ao Norte e Nordeste do Estado de Minas Gerais, mas com tendências de avançarem para o Sul da Bahia e Leste de Goiás.

A característica dessas novas regiões é o clima mais seco representado por solos de campos e cerrados, de baixa fertilidade e com limitações de crescimento para espécies de rápido crescimento, limitando assim a espécie e gênero a ser plantado.

Como na maioria dos casos o *Pinus* de procedência tropical tem suportado muito bem essas adversidades, acreditamos que o seu percentual de participação será cada vez maior no contexto florestal brasileiro.

Aliado à alta rusticidade e incremento, assim como às várias opções de mercado de sua produção, algumas espécies, como o *Pinus oocarpa*, apresentam características surpreendentes de qualidade.

Isso nos dá uma perspectiva de futuro muito alentadora, já que essas regiões de tendência são carentes de madeira de fibra longa, sendo que a demanda é totalmente suprida pelos Estados sulinos.

O *Pinus oocarpa* e mesmo o *Pinus caribaea* var. *hondurensis* se apresentam com densidades compatíveis com o seu crescimento, descortinando um futuro promissor como alternativa madeireira.

No Quadro IX está demonstrada a densidade básica de diversas espécies de *Pinus*, em diferentes idades, para regiões de solos com cerrado.

Quadro IX - Densidade Básica da Madeira (Gr/Cm^3).

Table IX - Wood Specific Gravity (Gr/Cm^3) - Population Average.

Espécies	Idade - Anos					
	05	06	07	12	13	14
Pinus oocarpa		0,390		0,413	0,443	
Pinus caribaea var. hondurensis		0,351		0,408		0,417
Pinus caribaea var. caribaea	0,372					
Pinus caribaea var. bahamensis		0,374				
Pinus kesiya			0,352	0,379		0,390

Fonte: FERREIRA ET ALLI (1979).

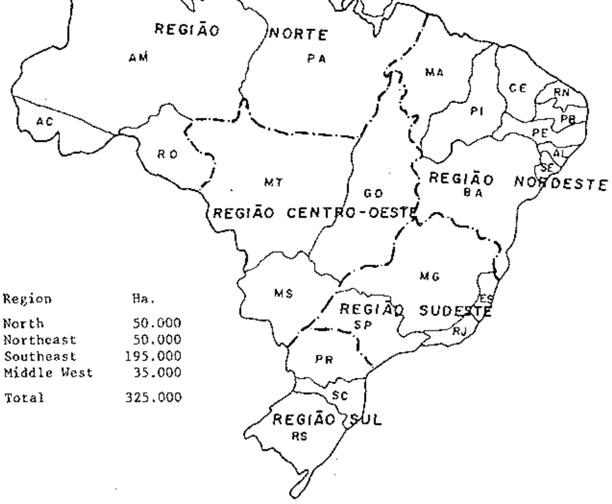
Verifica-se que a densidade média da árvore cresce com a idade, atingindo na metade da rotação já um valor de 0,443 gr/cm^3, podendo superar em muito este valor no final de uma rotação de 25-30 anos. Ora, quando comparamos a densidade da *Araucaria*, determinado pelo IPT - São Paulo variando de 0,52-0,61 gr/cm^3, para idades de 60 anos, verificamos que o *Pinus oocarpa* poderia ser considerado a *Araucaria* do cerrado, crescendo na mesma qualidade, na metade do tempo e em solos de baixa fertilidade.

Gostaríamos de reafirmar a nossa posição, esclarecendo que não estamos defendendo a substituição pura e simples do *Eucalyptus* pelos *Pinus* tropicais pois aquela folhosa faz parte inalienável do nosso contexto florestal. Apenas justificando que, pelas tendências de deslocamento dos reflorestamentos para as regiões apontadas, considerando as finalidades florestais, considerando os resultados das primeiras experimentações e pesquisas, considerando ainda a rentabilidade do empreendimento, nos motiva a apresentar-lhes essas tendências e alternativas.

Finalmente, para seguir essas tendências e atingirmos nossos objetivos que não são só nossos, mas de todos os países com vocação florestal, por natureza ou por necessidade, é imprescindível a colaboração e o trabalho dos Senhores, técnicos, pesquisadores, empresários.

Quadro III - Distruibuição dos Reflorestamentos de *Pinus* de procedência tropical, por região.

Table III - Reforestation Distribution of tropical *Pinus* by Region.



Region	Ha.
North	50.000
Northeast	50.000
Southeast	195.000
Middle West	35.000
Total	325.000

MELHORAMENTO FLORESTAL E SILVICULTURA INTENSIVA COM EUCALIPTO

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Resumo

Este trabalho discute a importância fundamental do melhoramento genético no desenvolvimento da silvicultura intensiva através do histórico e dos programas atuais de melhoramento florestal no Brasil. A filosofia, as linhas básicas e as necessidades atuais e futuras do programa de melhoramento genético de *Eucalyptus* do IPEF são também discutidos.

EUCALYPTS TREE IMPROVEMENT AND INTENSIVE SILVICULTURE

Summary

This paper discusses the fundamental importance of the tree breeding in the intensive silviculture development through the history and of the present tree improvement programmes in Brazil. The phylosophy of work, basic research lines and the present and future needs of the *Eucalyptus* breeding programme of IPEF are also discussed.

INTRODUÇÃO

O Brasil possui as mais extensas reservas de florestas higrofíticas do mundo. A inacessibilidade das florestas, as qualidades da madeira produzida pelas espécies, são fatores limitantes a sua utilização e atendimento da demanda de madeira necessária aos usos mais comuns.

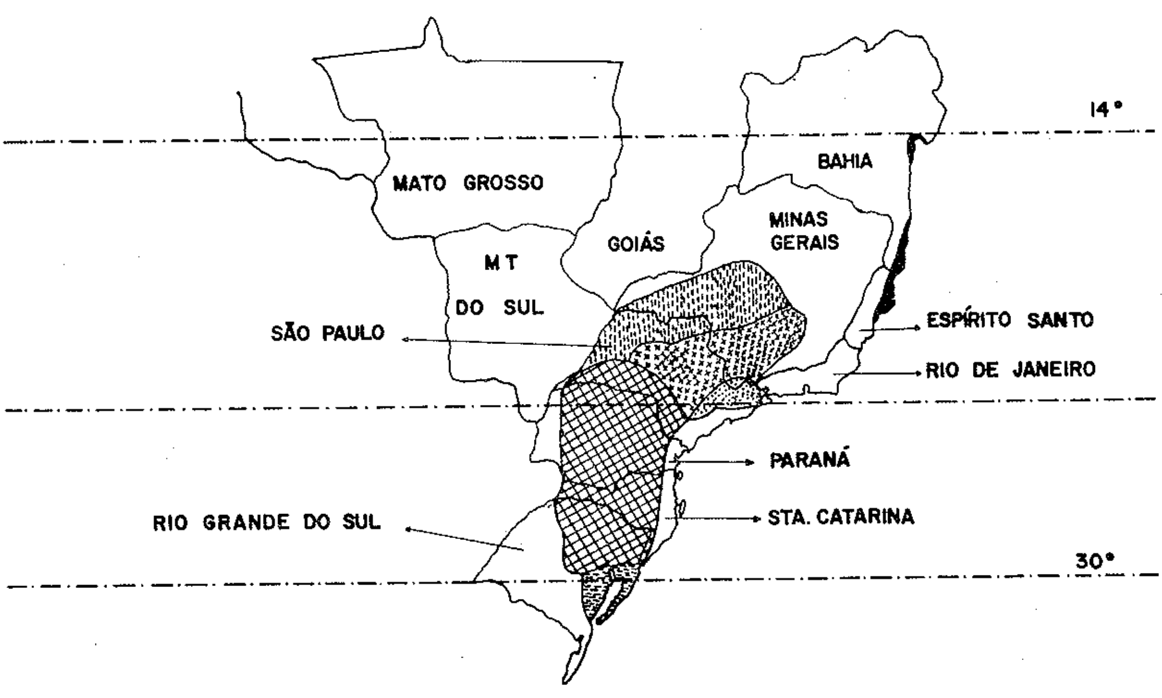
O consumo de madeira, no Brasil, é estimado em 200 milhões de m^3/ano, 160 milhões de m^3 oriundos da vegetação natural existente (floresta tropical úmida, floresta tropical estacional, floresta sub-tropical úmida e cerrados). O maior consumo concentra-se para fins energéticos (lenha e carvão).

As florestas cultivadas ocupam cerca de 3,5 milhões de hectares, contribuindo com 20% do total da madeira consumida. O reflorestamento e florestamento com espécies de rápido crescimento é um imperativo social econômico e fator decisivo ao programa de conservação e de estabelecimento das técnicas do manejo das florestas naturais para assegurar sua renovação. Estima-se hoje que são plantados no Brasil 400.000 ha/anuais de florestas, 52% desse total são florestas de eucaliptos.

Altas taxas de crescimento podem ser obtidas através da utilização de espécies não nativas aliada a Silvicultura intensiva e ao Melhoramento Florestal. Com base nessa filosofia, após o advento dos incentivos fiscais ao reflorestamento (41), surgiram os programas cooperativos de pesquisa florestal, dentre os existentes destaca-se o do I.P.E.F. (Instituto de Estudos e Pesquisas Florestais).

MELHORAMENTO GENÉTICO E SILVICULTURA INTENSIVA

O programa de melhoramento genético de eucaliptos do I.P.E.F. é basea-



do em convênio estabelecido entre empresas florestais e a Universidade de São Paulo (curso de Engenharia Florestal). O modelo para o IPEF foi baseado no North Carolina State University Cooperative tree Improvement, e vem sendo dinamicamente orientado pelo Prof. Helládio do Amaral Mello, seu idealizador, desde 1967, ano de sua fundação.

A área de atuação do IPEF está concentrada nos estados do Rio Grande do Sul, Paraná, Santa Catarina, São Paulo, Minas Gerais, Espírito Santo, Bahia e Mato Grosso do Sul. (fig. nº.1).

As 29 empresas, que hoje constituem o IPEF, plantam cerca de 250.000.000 de árvores/ano ou 100.000 ha/anuais de florestas de eucaliptos, nas diversas grandes áreas ecológicas representadas na fig. nº 1. A área total plantada por essas empresas está em torno de 1.000.000 ha.

Atualmente as espécies mais plantadas são:

- E. grandis - Regiões 2, 3, 4, 5 e 1 (1 restrições devido as geadas) e 6 (restrições devido ao cancro - fungo - Diaporthe cubensis).
- E. saligna - Regiões 2,3,4,5, e 1 (restrições devido as geadas).
- E. urophylla - Regiões 3, 4, 5, 6 e 2 (restrições devido as geadas)
- E. microcorys, E. paniculata, E. citriodora, E. maculata - Região 5.
- E. dunnii e E. viminalis - região 1 (E.grandis e E.saligna com restrições devido às geadas).

No brasil onde a Silvicultura intensiva vem sendo praticada a mais de 70 anos, o melhoramento genético é considerado parte integral dessa silvicultura. Seu objetivo básico é a maior produção de madeira no menor lapso de tempo com as qualidades necessárias para fins energéticos, celulose e papel, aglomerados e, ultimamente, serraria. Os fatores genéticos e ecológicos não são tratados separadamente e são integrados dentro da Silvicultura em seus diferentes setores: Produção de sementes, práticas de viveiro, preparo intensivo do solo, fertilização, estabelecimento e manejo das plantações.

PROGRAMAS ANTERIORES

O melhoramento genético dos eucaliptos iniciou-se no Brasil em Rio Claro, São Paulo, através dos trabalhos pioneiros do Dr. Edmundo Navarro de Andrade e do Departamento Florestal da Cia. Paulista de Estradas de Ferro (1,2, 35, 36).

Os resultados dos trabalhos pioneiros da silvicultura intensiva dos eucaliptos e melhoramento genético, seriam coroados com a Segunda Conferência Mundial do Eucalipto realizada em São Paulo em 1961.

Até 1967, em função da utilização primária da madeira dos eucaliptos, os técnicos florestais acreditavam que a pesquisa conduzida em Rio Claro, tinha resolvido a maioria dos problemas nacionais em relação a seleção das espécies e as qualidades genéticas e fisiológicas das sementes. Como consequência as espécies potenciais para São Paulo foram generalizadas para as diferentes áreas ecológicas do Brasil, e as sementes produzidas em Rio Claro as mais difundidas. A maioria das plantações assim estabelecidas apresentaram alta heterogeneidade, baixa capacidade de brotação após os cortes e baixo rendimento por área.

Todos esses problemas surgidos foram atribuidos a inadaptação das espécies/procedências, natureza híbrida das sementes e as práticas silviculturais não adequadas (22, 26, 41).

PROGRAMAS ATUAIS

A partir de 1967, com a implantação da lei dos incentivos fiscais ao reflorestamento, o melhoramento genético passou a ser prioritário principalmente para a definição das espécies/procedências potenciais e para o atendimento da demanda de sementes melhoradas.

Os principais programas de melhoramento genético dos eucaliptos são - IPEF, SIF (Universidade Federal de Viçosa), Instituto Florestal de São Paulo e EMBRAPA (Empresa Brasileira de Pesquisas Agropecuárias - Empresa do Governo Federal).

A assistência dada pelo programa cooperativo do IPEF pode ser resumida em:

a) estudo das melhores procedências de sementes para as espécies potenciais.
b) Estabelecer bases para o melhoramento genético a curto, médio e longo prazo (Populações base, Populações para melhoramento e Populações para produção de sementes).
c) estudo dos critérios de seleção de árvores superiores e treinamento para a seleção.
d) desenvolvimento de técnicas de propagação vegetativa.
e) assistência no estabelecimento e manejo de bancos clonais, pomares clonais e por mudas.
f) estudo da biologia da floração, reprodução e técnicas de polinização controlada.
g) delineamento de testes progênie.
h) análise dos dados.
i) banco de dados sobre o material genético disponível ao programa.
j) intercâmbio de material genético e cooperação internacional para implementação do programa.

Em função dos resultados obtidos a estratégia da programação do melhoramento genético dos eucaliptos está sendo baseada em métodos sexuados e assexuados. Para os métodos via sexuada procura-se aumentar a produção sem reduzir perigosamente a variabilidade natural. Na via assexuada procura-se obter o ganho genético máximo em uma única geração, utilizando-se todos os níveis da variabilidade entre e dentro das espécies. A seguir serão abordados de forma resumida as principais linhas básicas do programa.

LINHAS BÁSICAS DO PROGRAMA DE MELHORAMENTO

Variação entre e dentro das espécies.

Antes de 1967 houve pouca ou insuficiente atenção para a variação entre e dentro das espécies e, em especial, para as melhores fontes de sementes. As mais importantes introduções de espécies de eucalipto foram feitas sem um planejamento adequado e, ainda hoje, na maioria das espécies mais utilizadas, somente uma amostra muito pequena da variação genética natural existente vem sendo explorada.

A re-introdução das espécies e a introdução de novas procedências conduziram a resultados altamente positivos. Nas principais empresas, filiadas ao IPEF, os plantios efetuados antes de 1967, apresentavam rendimentos de 15 m^3/ha/ano*, para ciclos de corte aos 7 anos. A adoção de técnicas silviculturais intensivas (preparo intensivo do solo, fertilização mineral, combate a cupins e formigas), a partir de 1968 (42 43,44) permitiu elevar a produção para 21 m^3/ha/ano. As primeiras re-introduções em São Paulo, foram feitas pela Cia. Paulista de Estradas de Ferro, Instituto Florestal e as empresas Champion Papel e Celulose S.A. e Duratex S.A. As espécies principais re-introduzidas, em colaboração direta com C.S.I.R.O - Austrália, foram. E. grandis, E. saligna E. urophylla, E. robusta, E. resinifera, E. pilularis, E. maculata e E. microcorys. A introdução aliada a nova silvicultura intensiva elevou os incrementos para: E. grandis - 39 m^3/ha/ano, E. urophylla 30m^3/ha/ano, E. saligna - 25m^3/ha/ano, E. robusta - 26m^3/ha/ano, E. microcorys - 18m^3/ha/ano (53).

Em 1968, as primeiras procedências australianas de E. grandis eram introduzidas, por sugestão do Prof. D.L. Pryor, pelas empresas Champion Papel e Celulose S.A. e Duratex S.A. As sementes eram originárias de Coffs Harbour (N.S.W. Austrália), áreas de Bellingen e Bonville (17).

As plantações efetuadas atingiram aos 7 anos rendimentos médios de 35 m^3/ha/ano. Estes índices positivaram uma economia de 48% no custo unitário da madeira produzida (53). Após 7,5 anos as árvores tinham uma altura média de 25m e diâmetro médio 14 cm. As árvores plus selecionadas na duas empresas, naquela idade, apresentavam altura de 30 m. e diâmetro de 27 cm.

* volume sólido de madeira com casca.

Sucesso semelhante foi obtido em relação a procedências de *E. pilularis* (28, 49), *E. maculata* (50), *E. urophylla* (28, 46), *E. viminalis* - (24, 28, 38), *E. dunnii* (região 1) (24).

Em função desses resultados, a partir de 1970, foram aceleradas as re-introduções das espécies potenciais e a intensificação dos estudos de procedências. Esses trabalhos, nas diversas áreas ecológicas aptas ao reflorestamento, foram baseados em:

a) experimentos existentes
b) estudos comparativos das condições ecológicas do Brasil e Austrália (26).

Após a constatação do cancro do eucalipto (fungo *Diaporthe cubensis*) na região 6, em 1973, a pesquisa em relação às espécies/procedências foi modificada dando-se maior atenção a identificação de espécies/procedências, híbridos naturais e sintéticos resistentes. Como consequência existem, hoje, no Brasil, ensaios com 36 espécies de eucalipto - compreendendo 406 diferentes procedências, instalados em 50 diferentes localidades, distribuidas em 7 estados brasileiros. (26,27,28).

Em função dos resultados preliminares despontam, de modo geral, as seguintes espécies: *E. grandis*, *E. saligna*, *E. urophylla*, *E. citriodora* *E. pilularis*, *E. viminalis*, *E. tereticornis*, *E. camaldulensis* e *E. dunnii*. Como espécies secundárias aparecem: *E. maculata*, *E. microcorys* *E. propinqua*, *E. resinifera*, *E. robusta*, *E. cloeziana*, *E. punctata* e *E. pyrocarpa*. A intensificação dos estudos de procedências envolvendo uma amostragem mais intensiva e mais representativa das populações é necessária. A centralização das informações e dados relativos ao material genético em estudo, bem como a ativação do intercâmbio e cooperação internacional, são extremamente importantes.

Os trabalhos efetuados por Golfari (26,27, 28) demonstram a importância da intensificação dos estudos e da sua avaliação na época oportuna para a tomada de decisão.

ESTABELECIMENTO DE ÁREAS DE COLETA E DE PRODUÇÃO DE SEMENTES

A intensa hibridação existente nas sementes comerciais das espécies, o baixo número de sementes férteis por quilo e o alto consumo de sementes (1 kg para 10 ha), foram fatores importantes para que o IPEF iniciasse seu programa de produção de sementes. O estudo e identificação das populações de eucaliptos, existentes no Brasil, que fossem aptas a produção de sementes, foram iniciados baseando-se em:

a) Populações dentro do padrões fenotípicos da espécie, com bom vigor, homogeneidade, boa produção de sementes e isolamento de espécies

	Localização	Tipos de clima	Altitude m	Temperatura média anual	pluviosidade média anual mm	distribuição da pluviosidade	Geadas	Temperatura média absoluta
1	Planalto Sul - São Paulo até Rio Grande do Sul	menos úmido montanhoso	500-1300	12-18	1250-2500	uniforme	F	-12
2	Região montanhosa de São Paulo e Minas Gerais	menos úmido montanhoso	800-1800	13-18	1300-1200	periódica sem estação seca	F	-08
3	Sul do Rio Grande do Sul	quente úmido	0-500	16-19	1200-1650	uniforme com estação seca na primavera (1 - 3 meses)	O	-05
4	Região Central de São Paulo, Vale do Rio Paraiba e Áreas altas de Minas Gerais	frio úmido sub-tropical	400-1200	18-21	1300-1700	periódica com estação seca curta no inverno (2-3 meses)	M.R.	-02
5	Área ocidental de São Paulo e Central de Minas Gerais	úmido, sub-úmido, sub-tropical	200-1000	18-23	1100-1500	periódica com estação seca no inverno (3-5 meses)	A	+02
6	Costa Norte do Espírito Santo e Costa da Bahia (próximo de Salvador)	úmido, sub-tropical, úmido tropical	0-400	23-25	1100-1200	uniforme com estação seca curta para moderada (0-4 meses) no outono e inverno	A	+11

A = ausente
M.R. = muito rara
O = ocasional
F = frequente

afins. A população assim identificada, era transformada em Área de Coleta de Sementes (A.C.S.), ou Área de Produção de Sementes (A.P.S.).

Em populações derivadas de introduções anteriores a 1967, aptas a produção de sementes foi adotada a A.C.S., nas populações jovens das espécies/procedências reintroduzidas A.P.S. As A.P.S. foram instaladas com base em 160 árvores/ha (10% do número de árvores inicial) e com uma faixa de isolamento de 500 m. de largura (geralmente com árvores da mesma origem das sementes). Com base nas A.C.S. e A.P.S. constatou se um aumento no número de sementes viáveis/kg., uma maior uniformidade e rendimento na produção de mudas. As plantações estabelecidas com sementes das A.P.S. e A.C.S. apresentaram rendimentos variando de 28,0 a 50,6 m^3/ha/ano para o *E. grandis*, 27,9 a 38,3 m^3/ha/ano para o *E. saligna*, 30,5 a 47,6 m^3/ha/ano para o *E. urophylla*. (22,24,34,45).

Em função desses resultados o Governo Federal do Brasil através do Instituto Brasileiro de Desenvolvimento Florestal, criou a "Comissão de Controle de Sementes Florestais", com os objetivos de incentivar e fiscalizar a importação de sementes de boas procedências e a produção de sementes nacionais.

SELEÇÃO DE ÁRVORES PLUS

A seleção é feita em dois estágios:

a) vigor, retidão do tronco e características adequadas da copa e desrama.

b) qualidades da madeira relacionadas a densidade básica da madeira.

O uso de sementes de árvores superiores no estabelecimento de plantações deu origem a significativo melhoramento na produtividade. Através do programa cooperativo IPEF, conta-se hoje com cerca de 500 árvores plus selecionadas para as principais espécies. O programa de seleção visa dar maior ênfase ao estabelecimento de testes de progênie de polinização livre, testes clonais, bancos e pomares de sementes por mudas e clonais.

A seleção de árvores plus vem sendo feita, também, em plantações oriundas de sementes de Rio Claro. Em sua maioria essas árvores são híbridas, apresentando alto potencial para o melhoramento via assexuada. Esse programa é intenso nas regiões 5 e 6, onde a incidência do cancro do eucalipto é alta. Em populações híbridas de *E. urophylla*, *E. saligna* e *E. grandis* encontram-se árvores plus, nas idades de 6 a 8 anos, com DAP superiores a 28 cm e altura acima de 30 m. Na seleção considera-se a resistência ao cancro, vigor, forma, capacidade de brotação, capacidade de enraizamento das estacas e densidade da madeira como sendo os critérios fundamentais.

Os rendimentos esperados nas plantações clonais, situam-se em torno de 40m^3/ha/ano, **aos 7 anos de idade.**

SELEÇÃO CLONAL

Na reprodução sexuada, extrema variabilidade vem sendo encontrada na capacidade de brotação após o primeiro, segundo e terceiro corte (25). O desenvolvimento de métodos econômicos de propagação massal de estacas enraizadas, tornou possível estabelecimento de plantações clonais extensivas. A seleção de árvores plus, seguida da avaliação de sua capacidade de brotação ou da estimulação da formação de brotações para a produção de estacas, vem abrindo a possibilidade de se efetuar a detecção de genótipos superiores sem a influência dos problemas existentes na reprodução sexuada (13,16,19,18,32,33,37,46,60,61). Através da seleção clonal, a Aracruz Florestal S.A., conta hoje, com clones superiores de *E. urophylla* e *E. grandis*, com alta resistência ao cancro e incrementos volumétricos variando de 41 a 64,5 m^3/ha/ano aos 30 meses de idade. (8,9)

Plantações clonais de *E. dunnii* na região 1 vem sendo estabelecidas experimentalmente em função da inexistência de sementes que atenda a demanda atual.

POMARES DE SEMENTES

Os pomares de sementes clonais foram instalados a partir de 1967. Sete pomares com área de 2 a 4 ha. foram instalados em 5 empresas, envolvendo as espécies: *E. urophylla*, *E. grandis* e *E. saligna* (34). Esses pomares eram constituídos por 30 clones por espécie, oriundos de árvores plus selecionadas nas plantações das introduções originais. Em função da base genética restrita da população base, variação das características botânicas de algumas árvores, **comportamento insatisfatório das progênies** e problemas da incompatibilidade na enxertia, esses pomares perderam os seus objetivos e foram mantidos visando estudos experimentais de polinização controlada e manejo para produção de sementes (31).

A partir de 1975, em função dos avanços das técnicas de enxertia e enraizamento de estacas (52,55,56) e da melhoria das populações base, em função dos novos trabalhos de seleção de espécies/procedências, novos pomares clonais foram estabelecidos. Por exemplo, em 1977 com base em 52 clones de *E. grandis* foi instalado um pomar clonal pelo Departamento Florestal da Aracruz Florestal S.A., área de 10 ha., espaçamento 6x12m., cuja produção de sementes prevista para 1979 **era de 100 kg.** Em outras empresas estão sendo instalados novos pomares de *E. grandis*, *E. urophylla* e *E. citriodora*.

A continuidade do programa está baseada na instalação intensiva de pomares clonais visando a autosuficiência de sementes. Conjuntamente para evitar os problemas de incompatibilidade tardia, novos pomares estão sendo planejados, com base em estacas enraizadas dos melhores indivíduos selecionados nas melhores famílias, dentro dos testes de progênie. **Estudos de práticas culturais** para o manejo de pomares, visando maior produção de sementes a menor custo **estão paralelamente sendo conduzidos.**

Os pomares de sementes por mudas, especialmente delineados em função das árvores plus que vem sendo selecionadas, envolvem também, sementes de árvores plus de outros programas e de coletas de sementes **de árvores** na região de ocorrência natural dentro das melhores procedências. O objetivo básico desses pomares é ampliar a base genética da população para melhoramento.

Novos pomares de sementes por mudas oriundas de sementes de polinização controlada, serão estabelecidos em função da polinização controlada nos bancos e pomares clonais.

TESTES DE PROGÊNIE

Na estratégia de melhoramento para as principais espécies atribui-se que a reprodução sexuada seja predominantemente alogama. A ocorrência de autofecundação e cruzamentos não casualizados podem ocorrer, (1,13,15,16,18,19,30,32,33,35,46,59,60,61), o que poderá conduzir a valores superestimados da variância genética. A maioria dos testes de progenie de polinização aberta, em andamento, referem-se a *E. grandis* *E. saligna* e *E. urophylla*. Esses testes revelam haver suficiente variancia genética para as principais características sob seleção, podendo-se obter considerável melhoramento através do programa de seleção **recorrente** (13,16,15,18,29,34,45,59), **embora esses resultados apresentem ainda, limitações em função das diferenças existentes entre as populações básicas e as condições em que a seleção foi efetuada.**

HIBRIDAÇÃO

Em 1947/48, estudos de polinização controlada foram efetuados em Rio Claro (1,30). Os objetivos eram desenvolver métodos eficientes de autofecundação e de cruzamentos controlados. Os primeiros híbridos - *E. urophylla* x *E. tereticornis*, *E. urophylla* x *E. grandis*, *E. grandis* x *E. urophylla* foram sintetizados. Os híbridos, aos 11 anos de idade, comparados com as espécies que lhes deram origem, apresentaram alto - vigor heterótico. As espécies apresentaram elevada perda de vigor, alta porcentagem de falhas e defeitos nas árvores em função da autofecundação (1,30). Com a evolução dos métodos de propagação de estacas enraizadas, os híbridos naturais e sintéticos (polinização controlada) vieram desempenhar papel importante na ocupação de áreas ecológicas específicas e no aumento da produtividade e melhoria da qualidade da madeira. Híbridos de *E. urophylla* x *E. tereticornis*, *E. grandis* x *E.* - *pellita*, *E. urophylla* x *E. grandis* e *E. grandis* x *E. saligna*, propagados assexualmente deram origem a plantios piloto com incrementos estimados de 30 a $50m^3$/ha/ano aos 7 anos de idade (8,9). A utilização - das árvores híbridas propagadas vegetativamente em massa, segue em linhas gerais, as bases dos trabalhos efetuados na República Popular do Congo. (12,13,14)

PRODUÇÃO DE SEMENTES

O consumo anual de sementes de eucalipto no Brasil é estimado em 20 t (1 kg de sementes para 10 ha de plantio). Para o atendimento dessa demanda são importadas 14 t dos seguintes países: África do Sul, Rodésia e Angola. A importação foi incentivada pelo IBDF baseando-se principalmente no *E. grandis*, e na necessidade de sementes para os reflorestamentos nas regiões ecológicas situadas em latitudes superiores a 17ºS.

O elevado consumo de sementes deve-se a tradicional seleção intensiva das mudas no canteiro; essa técnica é hoje discutível (4,11,60). A reintrodução das espécies, ampliação da base genética das populações e implantações de A.C.S. e A.P.S. elevaram para o *E. grandis* o número de sementes viáveis por quilo de 300.000 para 600.000/800.00. Independentemente do número de sementes viáveis/kg., selecionam-se somente de 20.000 a 40.000 mudas/kg de sementes. Há a necessidade de estudos básicos relativos a utilização racional das sementes e dos padrões para a sua comercialização (10) e movimentação dentre das áreas ecológicas.

Em áreas ecológicas tão diversas há necessidade de serem intensificados os estudos relativos a biologia da floração e reprodução, manejo e práticas culturais adequadas e econômicas, visando aumentar a produtividade das populações utilizadas para produção de sementes.

Deve-se prever, na estratégia de melhoramento, que o programa forneça sementes em escala adequada, procurando-se atingir a autosuficiência em sementes de qualidades genéticas e fisiológicas aceitáveis.

NECESSIDADES ATUAIS E FUTURAS DO PROGRAMA

O programa cooperativo de melhoramento do IPEF, atuando em regiões - ecológicas tão distintas depende, acima de tudo, de:

a) estrutura de pesquisa das entidades associadas.

b) revisão periódica dos objetivos, estrategia do programa, novas tendências das empresas na utilização dos recursos para reflorestamento.

c) evolução dos custos da terra, dos insumos básicos, transporte da - madeira, etc.

d) produtividade do site, ligada aos sistemas de rotações curtas, métodos de exploração e manejo das plantações nas rotações necessárias.

e) estabilidade das populações em função da monocultura extensiva, incidência de pragas e doenças, etc., fatores ecológicos não previstos, etc.

f) proteção florestal contra formigas (*Atta sexdens rubopilosa*, *Atta laevigata* e *Acromymex actospinosa*) e contra cupins (*Syntermes* sp. *Anophotermes* sp.).

Como consequência a estratégia de melhoramento genético deverá envolver várias espécies em cada área ecológica particular, em função da - adaptabilidade e importância das espécies, dos objetivos básicos do - melhoramento, do custo e ganhos das diferentes etapas do programa, - dos recursos financeiros para a pesquisa e da cooperação regional, nacional e internacional.

É importante que o programa de melhoramento genético seja extremamente flexível e que na situação atual dê maior ênfase a exploração da - variabilidade entre e dentro das populações das principais espécies , para que se possa contar com um maior acervo genético para utilização a curto, médio e longo prazo. As recentes geadas na região 1 (fig.1) e o aparecimento de cancro de eucalipto nas regiões 5 e 6, servem muito bem para ilustrar a importância desses estudos.

A colheita de sementes na região de origem das espécies e a instalação de bancos de conservação dos recursos genéticos envolvendo populações, com tamanho efetivo adequado e representativas das diferentes origens geográficas importantes ao programa deve a curto prazo, ser incentivada.

Estabelecimento de diferentes tipos de pomares de sementes, para as - espécies mais intensamente utilizadas, para que permitam contornar os problemas da incompatibilidade tardia nos pomares clonais por enxertia.

Instalação de bancos clonais dinâmicos, eficientemente delineados, - com os objetivos de acompanhamento da evolução dos clones, estudos fenológicos básicos, polinização controlada e a produção de sementes. Esses bancos clonais deverão permitir a inclusão de novas seleções - continuamente.

Com base nos estudos de enraizamento de estacas de brotação, acelerar os testes clonais, aliados aos testes de progênie de polinização livre e controlada, para se dispor de mais opções para a estimativa mais precisa dos parâmetros genéticos e das interações entre o material genético e as práticas culturais intensivas que o programa, a curto prazo, em função da demanda de sementes para as espécies em cada área ecológica, forneça sementes, em larga escala, em todas suas etapas, substituindo a importação indiscriminada. Paralelamente, intensificar os estudos de manejo das populações, visando a produção de sementes a custos mais baixos e qualidades genéticas e fisiológicas adequadas. Seja incentivada, em todas as fases do programa, a cooperação regional nacional e internacional.

Em função da nova disponibilidade de sementes e estacas, geneticamente melhoradas, rever e intensificar as técnicas silviculturais para melhor utilização do potencial de produção das regiões ecológicas.

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COORDENAÇÃO NACIONAL DE EXPERIMENTAÇÃO SOBRE PROCEDÊNCIAS DE EUCALIPTO NO BRASIL

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Resumo

Estão em andamento 1.067 testes de espécies/procedências com Eucalipto no Brasil. Há evidências do excesso de experimentos nesse setor, com dispersão de recursos humanos e financeiros que poderiam ser alocados para outras áreas de pesquisa florestal do País. A causa básica dessa distorção é o isolamento existente entre as instituições de pesquisa brasileiras e a falta de uma coordenação nacional para os referidos testes.

A organização de um Grupo Permanente de Trabalho em Melhoramento Genético Florestal em 1979, integrado pelos melhores especialistas brasileiros do setor, sob o estímulo do PNPF (EMBRAPA/IBDF), constitui importante etapa de um processo efetivo para coordenar e orientar tecnicamente os testes de procedência de eucalipto no País. O Grupo já está contribuindo para padronizar e racionalizar os procedimentos relacionados com o melhoramento genético florestal.

É proposta a análise conjunta dos testes de procedências com eucalipto em andamento no Brasil, a adoção de uma metodologia padronizada assim como a organização de uma rede interinstitucional de pesquisa para fornecer as informações ainda necessárias sobre o assunto.

NATIONAL COORDINATION OF EXPERIMENTS ON EUCALYPT PROVENANCES IN BRAZIL

Summary

1067 specie/provenance trials of Eucalyptus are being carried out in Brazil. There are evidences of an excess of trials causing wasteful use of research work and funds. The basic reason for the large number of trials being carried out is the isolationism of the brazilian forest research institutes and the lack of national coordination of provenance tests.

The National Forest Research Program (PNPF) of EMBRAPA and IBDF encouraged the establishement of a Working Group on Forest Genetics in 1979 wich is comprised by researchers of brazilian forest research institutes. Objectives of the Working Group also refer to analysis and advicing on specie/provenance test

This paper proposes: a) the overall, combined analysis of the research on specie/provenance of Eucalyptus being carried out in Brazil; b) standardized metodology for the new trial c) the establishment of a Cooperative program for new provenance trials.

INTRODUÇÃO

É relativamente elevado o número de testes de espécies/procedências com eucalipto no Brasil, havendo evidências de excesso de experimentação nesse setor. Não há, até o momento, mecanismo que coordene efetivamente esses testes evitando repetições desnecessárias. A coordenação é exercida, atualmente, apenas a nível de áreas de influência das instituições de pesquisa. Assim, a SIF (Sociedade de Investigações Florestais) e o IPEF (Instituto de Pesquisa e Estudos Florestais) que conjugam empresas privadas, coordenam a pesquisa dentro do âmbito das suas associadas. Por outro lado, instituições governamentais como a EMBRAPA (Empresa Brasileira de Pesquisa Agropecuária) através do PNPF (Programa Nacional de Pesquisa Florestal), e I.F. (Instituto Florestal de São Paulo) vinham trabalhando em faixas próprias, isoladas dos institutos anteriormente citados.

O presente trabalho analisa aspectos relacionados com a coordenação da pesquisa referente a testes de espécies/procedências de eucalipto no Brasil propondo medidas para evitar a proliferação dos mesmos, com a consequente dispersão de recursos humanos e financeiros.

SITUAÇÃO ATUAL DOS TESTES DE PROCEDÊNCIA NO BRASIL

Os testes de espécies/procedências do Brasil refletem a preocupação de se aumentar a produtividade dos povoamentos florestais através do melhoramento genético. Levantamento de pesquisas em andamento no Brasil de GALVÃO et al (1980) permite estimar a existência de 1.067 ensaios com espécies/procedências de eucalipto no Brasil. Somente no Estado de Minas Gerais os testes do Projeto de Desenvolvimento e Pesquisa Florestal (PRODEPEF), atualmente sob a responsabilidade do PNPF, envolvem 17 locais. Outra evidência do excesso dos referidos experimentos é o fato de terem sido constatados 80 locais onde estão sendo ensaiadas procedências de E. grandis.

Apresenta-se a seguir relação das espécies do gênero Eucalyptus que tem sido testadas quanto à procedência no Brasil, com base em dados de GALVÃO et al (1980):

- Eucalyptus acmenioides Schau
- Eucalyptus alba Reinw.ex Blume
- Eucalyptus andrewsii Maiden
- Eucalyptus brassiana S.T. Blake
- Eucalyptus camaldulensis Dehnh
- Eucalyptus citriodora Hook
- Eucalyptus cloeziana F. Muell
- Eucalyptus crebra F. Muell
- Eucalyptus dalrympleana Maiden
- Eucalyptus deanei Maiden
- Eucalyptus drepanophylla F. Muell ex. Benth
- Eucalyptus dunnii Maiden
- Eucalyptus exserta F. Muell
- Eucalyptus grandis W. Hill ex. Maiden
- Eucalyptus houseana W. V. Fitzg. ex. Maiden
- Eucalyptus intermedia R.T. Bak
- Eucalyptus jacobsiana Blakely
- Eucalyptus maculata Hook
- Eucalyptus maidenii F. Muell
- Eucalyptus microcorys F. Muell
- Eucalyptus nesophylla Blakely
- Eucalyptus nitens Maiden
- Eucalyptus nova-anglica Deane et Maiden
- Eucalyptus paniculata Sm.
- Eucalyptus papuana F. Muell
- Eucalyptus pellita F. Muell
- Eucalyptus phaeotricha Blakely et Mc Kie
- Eucalyptus pilularis Sm.
- Eucalyptus polycarpa F. Muell
- Eucalyptus populnea F. Muell
- Eucalyptus propinqua Deane et Maiden
- Eucalyptus quadrangulata Deane et Maiden
- Eucalyptus resinifera Sm.
- Eucalyptus robusta Sm.
- Eucalyptus rostrata Schlecht
- Eucalyptus saligna Sm.
- Eucalyptus tereticornis Sm.
- Eucalyptus tetrodonta F. Muell
- Eucalyptus tessellaris F. Muell
- Eucalyptus torelliana F. Muell
- Eucalyptus trachyphloia F. Muell
- Eucalyptus urophylla S.T. Blake
- Eucalyptus viminalis Labill

Os dados anteriores apresentados, a localização dos experimentos apresentada no trabalho de GALVÃO et al (1980), as sim como indicações de GOLFARI et al (1978) referentes ao número de regiões bioclimáticas do País, sugerem a existência de um excesso de testes de procedência de eucalipto no Brasil.

A dispersão dos testes de espécies/procedências no Brasil implica no dispêndio adicional de recursos financeiros que poderiam ser alocados para outras fases do processo de experimentação com eucaliptos no Brasil. É necessário ainda considerar que os recursos utilizados na pesquisa florestal provêm em sua maioria, direta ou indiretamente, de recursos governamentais que tendem a se tornar escassos e portanto necessitam ser o mais racionalmente possível administrados.

Esse excesso de testes de espécies/procedências pode ser atribuído ao fato das instituições de pesquisa e empresas privadas estarem trabalhando isoladamente. Há falta de diálogo sobre a localização, frequência e delineamento de testes de procedência, entre as instituições e empresas que desenvolvem pesquisa florestal. Tornou-se também uma questão de "status" para empresas e unidades de pesquisa, possuírem testes de procedência em suas propriedades, a exemplo do que ocorre em relação aos pomares de sementes clonais. Essa situação, dentre outros inconvenientes, tem levado à repetição de experimentos que são conduzidos com as mesmas espécies e procedências em "sites" semelhantes. Assim, perde-se a oportunidade de melhor aproveitar material genético valioso, por vezes de difícil obtenção nos locais de origem.

A coordenação dos testes, assim como da pesquisa florestal em geral no País, ocorre apenas no âmbito de instituições e programas, como por exemplo, a SIF, IPEF e PNPF. No caso das duas primeiras instituições, a coordenação processa-se no âmbito das suas associadas. Não existe, entretanto, mecanismo interinstitucional de coordenação. A situação descrita tem provocado número relativamente alto de pedidos de instituições e empresas brasileiras às suas congêneres australianas, solicitando material genético para testes de espécies/procedências neste País. Os inconvenientes de tal fato são perfeitamente compreensíveis.

A organização de uma comissão de melhoristas e geneticistas florestais de renome no País, capaz de desencadear um processo natural de coordenação, é a solução para o problema descrito. O PNPF(EMBRAPA/IBDF) abrigando essa idéia estimulou a criação de um grupo permanente de trabalho em melhoramento genético florestal que iniciou recentemente suas atividades.

O GRUPO PERMANENTE DE TRABALHO EM MELHORAMENTO GENÉTICO FLORESTAL (GTMGF)

O GTMGF é basicamente formado por especialistas da área de genética e melhoramento florestal representando entidades de pesquisa do Brasil. Foi instituido em julho de 1979. As atividades do Grupo estão evidentemente relacionadas com a coordenação de testes de procedência, como se pode verificar dos objetivos do mesmo apresentados a seguir:

a) "Sugerir a padronização dos experimentos e de linguagem técnica do setor de melhoramento florestal";
b) "Orientar a utilização de material genético para programas de melhoramento e conservação genética";
c) "Propiciar maior intercâmbio de material genético com entidades envolvidas no setor";
d) "Analisar os principais programas de pesquisa em melhoramento genético do Brasil".

A análise prevista neste último objetivo está sendo efetuada e sob ela assentar-se-ão as diretrizes básicas que permitirão propor um sistema nacional de testes de procedência de eucalipto. Entretanto, deve ser salientado que as atividades já desenvolvidas pelo GTMGF visam unificar as empresas e instituições nos seus procedimentos no setor de melhoramento, dentre os quais se incluem os testes de procedência. As atividades mencionadas são:

1a.) Elaboração de trabalho sobre termos técnicos de melhoramento florestal.

É uma proposição à comunidade científica brasileira no sentido de padronizar os termos técnicos utilizados no setor de genética e melhoramento florestal no Brasil. É básico, por exemplo, para o trabalho que o CENARGEN (Centro Nacional de Recursos Genéticos) da EMBRAPA está desenvolvendo, visando cadastrar o material genético florestal existente no Brasil.

2a.) O estabelecimento de critérios para implantação de populações base.

Trata-se de normas para a implantação de populações base considerando inclusive critérios para utilização de material de procedências distintas.

CONCLUSÕES

Considerando as dificuldades envolvidas na obtenção de material genético no exterior, a escassez de recursos financeiros que tende a se agravar e a necessidade de gerar informações sobre as espécies/procedências mais adaptadas as diferentes condições ecológicas do Brasil, propõe-se:

a) Que as instituições e empresas brasileiras do setor florestal dêm o máximo apoio ao Grupo de Trabalho em Melhoramento Genético Florestal, já em plena atividade;
b) A análise conjunta de toda a experimentação relativa a testes de procedências de eucalipto em andamento no Brasil;
c) A organização de uma rede nacional de testes de procedências de eucalipto de âmbito interinstitucional que possibilite completar as informações que a atual rede não pode ou poderá fornecer;
d) A adoção de uma metodologia padronizada para os testes de procedência.

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FAST GROWING TREES

REVISÃO DOS TESTES INTERNACIONAIS DE PROCEDÊNCIAS DE *Pinus Caribaea* MORELET E *Pinus oocarpa* SCHIEDE

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Resumo

Trinta e seis procedências de *Pinus caribaea* Morelet e 46 de *Pinus oocarpa* Schiede foram distribuidas a 49 e 35 países respectivamente para a implantação dos testes internacionais de procedências. A cooperação entre os participantes dos testes propiciou um conjunto de dados básicos para uma avaliação ampla das procedências. Uma estimativa dos dados revelou que certas procedências foram consistentes em seu comportamento relativo, em uma grande amplitude de condições ecológicas.

As mais promossoreas procedências de *P. caribaea* foram as de Almicamba, Karawala e Brus Lagoon nas terras baixas do litoral da Nicaragua e Honduras, e de Poptun, Culmi e Santa Clara nas regiões mais altas e mais secas do interior. As procedências mais exteriores floresceram mais precocemente mas foram mais suscetíveis a brotações com acículas deficientes e morte dos ponteiros, em localidades de baixa altitude com climas tropicais úmidos próximos ao Equador.

As procedências de *P. oocarpa* de Montain Pine Ridge em Belize, e de Yucul, Camêlias e Rafael na Nicaragua

crescem notavelmente bem na maioria das localidades, mas foram suscetíveis a quebras do caule em raras ocasiões. Procedências alternativas para localidades mais expostas foram as de Valle de Angeles de Honduras, Bucaral e Conacaste da Guatemala.

A REVIEW OF THE INTERNATIONAL PROVENANCE TRIALS OF *Pinus caribaea* MORELET AND *Pinus oocarpa* SCHIEDE

Summary

Thirty six provenances of Pinus caribaea Morelet and 46 provenances of Pinus oocarpa Schiede were distributed to 49 and 35 countries respectively for the international provenance trials of these species. Cooperation among the trial participants led to the collation of a broad provenance assessment data base. An appraisal of the data revealed that certain provenances were consistent in their relative performances over a wide range of sites.

The most promising P. caribaea provenances were from Alamicamba, Karawala and Brus Lagoon in the coastal lowlands of Nicaragua and Honduras, and from Poptun, Culmi and Santa Clara in the higher and drier interior. The inland provenances flowered early but were predisposed to suffering from needleless shoots and die-back on humid lowland sites close to the equator.

The P. oocarpa provenances from the Mountain Pine Ridge in Belize, and from Yucul, Camelias and Rafael in Nicaragua grew outstandingly well on most sites, but were susceptible to stem-break on rare occasions. Promising alternative provenances for exposed sites were Valle de Angeles from Honduras, and Bucaral and Conacaste from Guatemala.

INTRODUCTION

Seed collection expeditions may be mounted by individual countries in support of their national forest research, but this involves much duplication of effort, and few organisations have the resources for sustaining a seed collection programme over several seasons. A more efficient approach is for a single agency to undertake the planning and coordination of the exploration, seed collection and seed distribution in such a way as to meet the national requirements of the recipient countries, whilst at the same time establishing international provenance trials in which the local components are of compatible composition and design, thus enabling further advances to be made by international cooperation through exchange of information (Burley and Kemp, 1973). It was with these objectives in view that the Commonwealth Forestry Institute (CFI) undertook the exploration and seed collection for the international provenance trials of Pinus caribaea Morelet and Pinus oocarpa Schiede.

THE NATURAL POPULATIONS

The natural populations of P. caribaea were described in detail by Lamb (1973) and Greaves (1978a), and those of P. oocarpa by Greaves (1979). Both species are indigenous to the Central American and Caribbean region and fall within the same latitudinal limits of approximately 12°N and 27°N, but whereas P. oocarpa is entirely restricted to the mountainous uplands of Central America and Mexico between 600m and 2,400m, P. caribaea is mostly found on the coastal lowlands and comprises three varieties with distinctly separate territorial distributions. P. caribaea var. caribaea Morelet occurs in western Cuba, P. caribaea var. bahamensis Barret and Golfari is found on several islands in the Bahamas and Turks and Caicos Islands, and P. caribaea var. hondurensis Barret and Golfari forms discontinuous stands in Central America extending from north-eastern Nicaragua, through north and central Honduras, and eastern Guatemala, to northern Belize. Although the distribution of P. caribaea var. hondurensis is predominantly coastal some populations are found in inland locations, mostly spreading from the coastal plains along valleys up to 800m altitude and merging in places with the lower limits of the P. oocarpa distribution.

SEED COLLECTION AND DISTIBUTION

The CFI acquired provenance seed collections that were representative of the entire P. caribaea range, and the Central American P. oocarpa populations (Kemp, 1972; Greaves, 1978a; 1979).

One 'improved' provenance of P. caribaea var. hondurensis was included through the donation by Dr. D. G. Nikles of seed from a clonal reservoir at Byfield, Queensland, Australia. A provenance of P. oocarpa from Chiapas, Mexico, collected by Mortenson (1969), was acquired by seed exchange with the East African Agriculture and Forestry Research Organisation.

Seed distribution for the international provenance trials commenced in 1971 and has continued to the present day. This was undertaken without seeking committments from the recipients, but many recognised the advantages of a standardised experimental design and opted to use the field layouts that were available on request from the CFI.

The large number of available provenances precluded the testing of them all on all sites, hence it was necessary to select a suitable range of provenances for each trial. Whenever possible several provenances from native environments similar to the trial site were chosen, but since the most favourable provenance x environment interaction is not necessarily produced by a homoclimal introduction other provenances from contrasting environments were also incorporated. Some recipients opted to include one provenance of P. caribaea in their P. oocarpa trials and vice versa, so enabling the two species to be compared.

The seed distributed to date comprises 36 provenances of P. caribaea and 46 provences of P. oocarpa with 49 countries participating in the P. caribaea trial and 35 in the P. oocarpa trial (see Appendices).

PROVENANCE TRIAL ASSESSMENTS

Many investigators who are participating in the international provenance trials have published the results of their assessments, mostly in the proceedings of the joint meetings of IUFRO Working Parties S2.02.08 and S2.03.01 (Burley and Nikles, 1973; Nikles, Burley and Barnes, 1978). Others have made summaries of assessment data available to the CFI where all the information on the provenance trials is processed and collated with the aid of a purpose-designed computerised data storage system (INFORPROV). Free access to this data base is available to those who have contributed information. Greaves (1980) reviewed all the assessment data and made recommendations on the choice of provenances for plantation development and the establishment of broadly-based ex situ conservation stands. This paper presents a condensed version of those findings.

P. caribaea

Differences among the three P. caribaea varieties were evident in both the nursery and the field. Distinct variations in seedling growth traits were detected for hypocotyl colour, chlorophyll concentration, length of primary needles, time of secondary needle emergence, and vigour (Bryndum, 1972; Fishwick, 1975; van der Sijde, 1973; Venator, 1976a; 1976b; Venator et al 1977; Vivekanandan, 1973).

After 3 years in the field the three varieties fell in the sequence var. caribaea, var. bahamensis, var. hondurensis when ranked in order of increasing height growth, and in the reverse order when ranked according to improving stem and crown form.

Consistent differences were not apparent among the seven P. caribaea var. caribaea provences either in the nursery or in the field. The trees typically showed very uniform growth with narrow pyramidal crowns and regularly-spaced whorls of fine horizontal branches. Foxtails were rare and the stems straight, but the leaders were susceptible to kinking from age 6 years.

Only the Andros provenance represented P. caribaea var. bahamensis and this sometimes surpassed the slowest-growing provenances of P. caribaea var. hondurensis in height growth. The stem and crown form of P. caribaea var. bahamensis resembled that of P. caribaea var. caribaea, but tree-uniformity was less pronounced and some foxtails occurred. Craciun (1978) reported that this variety had a high incidence of ramicorn branches.

P. caribaea var. hondurensis was the only variety in which there was evidence of consistent variation among provenances. At the seedling stage the increase in the chlorophyll concentration which followed planting out in the field was greater in the provenances from high altitudes than in those from low altitudes (Venator et al, 1977). Parallel differences in flowering tendencies were recorded by Egenti (1978) who observed that all the inland provenances of P. caribaea var. hondurensis were flowering at age 3.5 years on sites in Nigeria, but of the lowland sources only the Santos provenance was doing so. Greaves (1978b) noted the same pattern of P. caribaea var. hondurensis flowering in Sri Lanka at 5 years as well as flowering of P. caribaea var. bahamensis and P. caribaea var. caribaea.

On the Sri Lanka sites all the early flowering provenances suffered from needleless shoots in lowland trials, but in the highlands only the Los Limones provenance from an exceptionally dry site in the interior of Honduras suffered slightly from this growth defect.

Several of the most vigorous provenances came from southern lowland sources, notably Karawala and Alamicamba from Nicaragua and Brus Lagoon from Honduras. The northern lowland provenances from Santos and Melinda in Belize were persistently slow growing.

High frequencies of foxtails were recorded in the fast-growing southern lowland provenances. The foxtails in these provenances also tended to be exceptionally tall and persistent which may have been partly resposible for the provenances' superior growth rates. Despite the high incidence of foxtails the southern lowland provenances included trees with desirable stem and branching characteristics, especially Karawala and Alamicamba, and Brus Lagoon slightly less so. The stem form of the Slilma Sia provenance was conspicuously poor with a high proportion of persistent foxtails and sinuosity defects.

Few foxtails occurred in the Santos and Melinda provenances. Melinda had distinctly better stem and crown form and, despite its overall slow growth, a few vigorous trees.

Guanaja from off the north coast of Honduras, the only insular provenance of *P. caribaea* var. *hondurensis*, was somewhat distinctive in its general appearance. Many stems showed a strong multi-nodal trait with very short internodes.

Overall, the provenances from higher and drier inland sites were slower-growing than the southern lowland provenances, with the exception of Poptun, Culmi and Santa Clara. The Poptun provenance also contained large numbers of foxtails whilst the stem form varied greatly among sites.

The remaining provenances from high altitude inland sites produced relatively few foxtails compared with the fast-growing lowland provenances. Most also contained many well-formed trees, especially Los Limones and Santa Clara. These also had a number of trees with the paler green foliage and crown form of *P. oocarpa*. Both seed sources are in areas where the distributions of *P. caribaea* and *P. oocarpa* overlap and there is speculation that these provenances may contain hybrids, but such hybridisation has yet to be confirmed under controlled pollination conditions.

The Potosi provenance from northern Honduras suffered from some of the worst stem and crown defects of the *P. caribaea* provenances.

The southern coastal provenances, especially Brus Lagoon and Laguna del Pinar, were less susceptible than the inland provenances to developing bowed stems following cyclones.

The Mountain Pine Ridge provenance, a long-standing commercial seed source, was generally of medium vigour. Diabate (1978) recorded above average numbers of forked trees in both this and the neighbouring Poptun provenance. Craciun (1978) reported large numbers of ramicorn branches in the same provenances and also in the improved Byfield provenance which is of particular significance since Mountain Pine Ridge stock was the Byfield selection base.

The vigour of the Byfield provenance was usually good, but the stem and crown form varied greatly depending on the site. Good growth appeared to be assured on sites with similar environments to the conditions in Queensland where the selections were made. In Queensland it was the only provenance that consistently ranked high in height growth and was highly wind stable over ten sites (Nikles, 1978).

P. oocarpa

At the seedling stage the only evidence for clinal variation in *P. oocarpa* was given by Venator (1977) who described the development of carrot-like root storage organs. These occurred most frequently in provenances from sites with less than 1,250mm mean annual rainfall and may be an adaptation for survival in dry, fire-frequented environments.

There were pronounced differences in the *P. oocarpa* provenance growth traits within one year of planting. Highly distinctive combinations of vigour and crown form, that were consistent across all sites, developed in several provenances. The Mountain Pine Ridge provenance from Belize, and the Yucul, Camelias and Rafael provenances from Nicaragua, generally showed the greatest vigour. Foxtails only persistently arose in the Mountain Pine Ridge provenance, but many of the trees of this provenance, as well as of Yucul, Camelias and Rafael, were superior to most other provenances in their stem and crown forms.

The remaining provenances were of medium vigour with their relative growth rates varying greatly depending on the site, with the exception of the Malacatancito provenance from northern Guatemala which was persistently slow-growing. This provenance also had the worst-formed trees. Some of the others frequently contained trees with desirable stem and crown qualtities, particularly Valle de Angeles from Honduras, and Bucaral and Conacaste from Guatemala.

Jitotil was the only Mexican provenance for which assessment data were available. Its overall performance was not impressive, but an inspection of earlier plantings of the same provenance in East Africa showed that it comprised two taxa (Greaves, 1979). One consisted of fast-growing well-formed trees with a smooth red-brown bark and thin papery scales. The other was made up of slow-growing poorly-formed trees with greyish- or blackish-brown bark cracking deeply into square blocks when mature.

There was some evidence that the fast-growing *P. oocarpa* provenances were susceptible to stem-break. The Yucul provenance was recorded as growing well at age 4 years on two highland sites in Sri Lanka (Vivekanandan, 1977; 1978), but when one of the sites was inspected at age 5 years there had been considerable stem-break on exposed ridges (Greaves, 1978b). A few stem-breaks were also seen in the Yucul, San Rafael and Camelias provenances in South Africa.

Early flowering was common in the *P. oocarpa* provenances but, like *P. caribaea*, most of the flowers were female.

Provenance x environment interaction

Apart from wind stability and needleless shoot tendencies in *P. caribaea* there was no evidece of pronounced provenance x environment interaction that changed the relative merits of the provenances in terms of stem and crown form. The form of all provenances deteriorated with increased growth rates, with the most vigorous provenances showing the greatest deterioration, as recorded by Granhof (1978a; 1978b). Thus fertile sites tended to accentuate the differences between provenances. On poor sites where slow growth was encountered the differences between many *P. caribaea* provenances were often reduced to a level where all were apparently equally suited to the site. A similar effect was seen in *P. oocarpa* but the most vigorous provenances usually maintained their superiority.

DISCUSSION AND CONCLUSIONS

Throughout the provenance trials there was little evidence of pronounced provenance x site interaction with regard to the relative rankings of the provenances in terms of vigour. In both species, especially in *P. oocarpa*, there were several provenances that consistently showed superior growth rates. Some of the provenances of medium vigour might catch up with the leaders in the future, but since ease of establishment and suppression of weed competition are primary considerations for most afforestation enterprises, early vigorous growth is of paramount importance in provenance selection. The outstanding *P. caribaea* provenances in this respect were Karawala, Alamicamba, Brus Lagoon, Poptun, Culmi and Santa Clara. The first three are of coastal origin with evidence of superior wind stability and are therefore to be preferred in exposed situations, especially regions where cyclones or hurricanes occur.

The extent to which the inland Poptun, Culmi and Santa Clara provenances may be planted is limited by their susceptibility to suffering from needleless shoots and dieback. Slee et al (1976) first reported this growth disorder in Malaysia where it was found on perpetually warm and humid lowland sites but not in higher and cooler environments. He suggested that it was brought about by an adverse combination of climate and daylength which caused a physiological malfunction in the flower primordia, and that the likelihood of the disease developing could be predicted from a model based on daylength and mean annual temperature (Slee, 1977). Slee's observations were made on material that was probably of Mountain Pine Ridge origin, a relatively cool high altitude inland site. The Sri Lanka provenance trials have shown that the provenances from hotter and more humid coastal lowland sites remain free from these growth defects, but unlike the inland provenances they have not yet produced many flowers. If the coastal provenances do begin to flower at a later age needleless shoots may occur simultaneously.

The early flowering tendencies of the inland provenances might be advantageous for seed production, and these provenances may be preferred at latitudes distant from the equator or on high altitude equatorial sites. On equatorial lowland sites only the coastal provenances should be planted unless there is evidence from local trials that the inland provenances grow satisfactorily.

The outstandingly vigorous *P. oocarpa* provenances were Yucul, Camelias, Rafael and Mountain Pine Ridge, but on rare occasions stem-break was recorded in them. The Valle de Angeles, Bucaral, and Conacaste provenances, although slower-growing, were suitable alternatives on exceptionally exposed sites.

The final conclusions on the relative merits of the provenances must await the time when the trials have reached a greater degree of maturity. It is essential to confirm that those provenances which appear to be the most promising during the juvenile phase maintain their desirable characteristics and do not suffer from physiological disorders, windthrow, or undue susceptibility to pests and diseases in later years. It is also useful to determine the age at which seed production commences, and the influence of site parameters on its onset and intensity. Moreover it is important to evaluate the wood properties of mature trees to ascertain whether or not a provenance's impressive growth traits are matched by a satisfactory utilisation potential.

The continued maintenance of the provenance trials also serves conservation objectives. Whilst every endeavour has been made to collect large quantities of seed of endangered provenances for establishing *ex situ* conservation stands, this has not been possible in every case. For example, the small amount of seed that was acquired of the very promising *P. oocarpa* Camelias provenance was used for the provenance trials, and the stands where it was collected have now been felled. Consequently the trials constitute the only identified gene pool of this probably very valuable ecotype. It would be inappropriate to use the provenance trials as seed sources because of the inevitable cross-pollination among provenances, but they make a valuable candidate plus tree selection base for clonal propagation, especially as a wide range of sites are covered.

The provenance trials will only continue to serve evaluation and conservation purposes efficiently if vigorous and healthy growth is encouraged through the avoidance of overstocking and excessive competition. It was recommended that a planting distance of 3m x 3m and 49 (7 x 7 rows) tree plots should be used in the trials. Where this was followed the wider-than-usual planting distance has delayed the onset of between-tree competition and helped to accentuate the differences in growth traits among provenances that are often masked when trees are growing in close competition with one another. The 49 tree plots are of adequate size to maintain sufficient trees for continued assessment whilst implementing thinning procedures that are compatible with normal plantation management. It is recommended that such a thinning policy should adopted where it does not conflict with other overriding research considerations.

This review of assessment results from the international provenance trials would not have been possible without the admirable spirit of collaboration that has prevailed among the provenance trial participants. The CFI will endeavour to promote further international cooperation in this field by collating information as it becomes available, by maintaining bibliographies of all the published material relating to the provenance trials and allied subjects, and by providing rapid computerised access to the accumulated data base. It is sincerely hoped that the provenance trial collaborators will continue to contribute to these facilities and to employ them to their common benefit.

Appendix I

PROVENANCE SEED COLLECTIONS OF PINUS CARIBAEA

Site No.	Country	Site	Latitude	Longitude	Altitude (m)
PC 1	Nicaragua	Kuakuil	14°12'N	83°30'W	20
PC 2	''	Karawala	12°58'N	83°34'W	10
PC 3	''	Alamicamba	13°34'N	84°17'W	25
PC 4	''	Pinar	12°13'N	83°42'W	10
PC 5	''	Slilma Sia	14°45'N	83°55'W	50-100
PC 6	Guatemala	Poptun	16°21'N	89°25'W	500
PC 7	Honduras	Brus Lagoon	15°45'N	84°40'W	10
PC 8	Honduras	Guanaja	16°27'N	85°54'W	50-100
PC 9	Belize	Silver Creek	16°40'N	88°25'W	30-100
PC10	''	Las Lomitas	16°28'N	88°33'W	30
PC12	Honduras	Los Briones	15°34'N	86°44'W	600
PC13	''	Los Limones	14°03'N	86°42'W	700
PC14	''	Culmi	15°06'N	85°37'W	500-600
PC16	''	Guanaja	16°28'N	85°54'W	50-100
PC17	''	Potosi	15°20'N	88°25'W	600-700
PC19	Belize	Santos	17°34'N	88°33'W	20-40
PC20	''	Mt. Pine Ridge	17°00'N	88°55'W	400
PC21	Nicaragua	Santa Clara	13°48'N	86°12'W	700
PC22	Australia	Byfield			
PC23	Belize	Melinda	17°01'N	88°20'W	10-15
PC24	Cuba	Marbajita	22°48'N	83°29'W	80
PC25	''	Los Palacios	22°34'N	83°12'W	50
PC26	''	Los Cabanos	22°40'N	83°23'W	160
PC27	''	Manuel	22°37'N	83°40'W	150
PC28	''	Cayo La Mula	22°33'N	83°48'W	110
PC30	''	El Buren	22°45'N	83°28'W	300
PC31	Bahamas	Andros	24°53'N	78°07'W	3
PC38	''	Grand Bahama	26°40'N	78°12'W	20
PC39	Cuba		22°30'N	83°50'W	100
PC40	''	A composite sample comprising PC24 to PC23			
PC46	Bahamas	Andros	25°05'N	78°04'W	3
PC47	''	New Providence	25°01'N	77°28'W	3
PC48	''	Great Abaco	25°59'N	77°15'W	3
PC49	''	Andros	25°02'N	78°06'W	3
PC55	Cuba	Batey	22°50'N	83°27'W	
PC56	Cuba	Pinar del Rio	22°49'N	82°57'W	

Appendix II

PROVENANCE SEED COLLECTIONS OF PINUS OOCARPA

Site No.	Country	Site	Latitude	Longitude	Altitude (m)
PO 1	Nicaragua	Camelias	13°46'N	86°18'W	900
PO 3	''	Sullates	13°51'N	86°16'W	1,050
PO 4	Honduras	Zapotillo	14°37'N	87°02'W	1,000
PO 5	''	San Marcos	14°36'N	87°00'W	1,100
PO 6	Guatemala	Canas	15°10'N	89°23'W	1,200
PO 7	''	Lima	15°11'N	89°21'W	1,000
PO 8	''	Conacaste	15°10'N	89°21'W	550-700
PO 9	Honduras	Zamorano	14°02'N	87°03'W	1,100
PO10	''	Maraquito	14°13'N	86°50'W	1,000
PO11	''	Agua Fria	15°16'N	87°06'W	1,100
PO12	Guatemala	Pueblo Caido	15°12'N	89°18'W	800
PO13	Honduras	Junquillo	13°42'N	86°35'W	1,000
PO14	Nicaragua	Bonete	12°50'N	86°18'W	950
PO15	Guatemala	Bucaral	15°01'N	90°09'W	1,000-1,300
PO16	Honduras	Angeles	14°07'N	87°04'W	1,300
PO17	''	Zamorano	13°58'N	86°59'W	1,100
PO18	Nicaragua	Yucul	12°55'N	85°47'W	900
PO19	Guatemala	Lagunilla	14°42'N	89°57'W	1,600
PO20	''	Rafael	13°14'N	86°08'W	1,200
PO21	Honduras	Siguatepeque	14°32'N	87°50'W	1,100
PO22	Guatemala	Chuacus	15°02'N	90°16'W	1,300
PO23	''	San Jose	14°28'N	89°28'W	1,000
PO24	''	Malacatancito	15°13'N	91°32'W	1,700
PO25	Mexico	Jitotil	17°05'N	92°30'W	1,650
PO26	Belize	Mt. Pine Ridge	17°00'N	88°55'W	700
PO27	Honduras	Zamorano	14°02'N	87°03'W	1,000-1,240
PO28	''	''	14°02'N	87°03'W	1,300-1,420
PO31	Nicaragua	Dipilto	13°43'N	86°32'W	1,000-1,200
PO32	''	''	13°43'N	86°37'W	1,200
PO33	Honduras	Yoro	15°16'N	87°06'W	1,100
PO34	''	Rio Viejo	14°30'N	86°50'W	1,100
PO35	Guatemala	Jutes	15°05'N	89°15'W	600-800
PO36	''	Chimaltenango	14°45'N	90°50'W	1,750
PO37	Honduras	La Union	14°32'N	86°38'W	800
PO39	''	Villa Santa	14°12'N	86°25'W	900
PO40	Nicaragua	San Fernando	13°39'N	86°17'W	800-1,000
PO41	Honduras	San Juan	14°24'N	88°23'W	1,250-1,330
PO42	''	Pimientilla	14°54'N	87°30'W	650-850
PO43	''	Valle Bonito	14°53'N	87°31'W	850-950
PO44	Guatemala	Pueblo Viejo	15°22'N	91°36'W	1,700-1,900
PO45	''	Pinalon	14°43'N	89°46'W	1,300-1,400
PO46	''	Mal Paso	15°11'N	89°21'W	1,000
PO47	Nicaragua	Cusmapa	13°17'N	86°39'W	1,250
PO48	''	Jalapa	13°50'N	86°15'W	1,000-1,300
PO74	''	San Fernando	13°46'N	86°22'W	1,000-1,200
PO97	''	Apanti	12°54'N	85°56'W	950

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MELHORAMENTO GENÉTICO DE PINHEIROS TROPICAIS NO BRASIL

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Resumo

As plantações com espécies do gênero *Pinus* no Brasil, cerca de 35% dum total de aproximadamente 2,5 milhões de hectares plantados até 1977, foram estabelecidas com as espécies *P. caribaea* Morelet, *P. oocarpa* Schied, *P. kesiya* Royle ex Gordon, *P. taeda* L. e *P. elliottii* var. *elliottii* Engelm, que representam as mais importantes espécies do gênero no País.

A partir dessas espécies, grande ênfase vem sendo dada aos programas de melhoramento genético, através de instituições de pesquisa e empresas florestais, entre elas destacando-se o Instituto de Pesquisas e Estudos Florestais. Foram instalados testes de procedências e o padrão que vem sendo verificado para a variação dentro das espécies tem orientado a estratégia de utilização das plantações existentes para seleção intra-populacional.

Tem sido instaladas Áreas de Produção de Sementes para as principais espécies, totalizando 2600 hectares até 1978, visando suprir as necessidades imediatas de sementes. Pomares de sementes vêm sendo instalados para as espécies mais importantes, totalizando em torno de 300,0 hectares até 1979, utilizando-se um amplo número de árvores superiores, visando garantir a base genética para a continuidade da seleção recorrente.

As condições mais adequadas para a produção de sementes, a efetividade da dispersão do pólen, a eficiência dos métodos de seleção e a polinização controlada vêm sendo as preocupações das pesquisas em Pomares. Os testes de progênies objetivando a avaliação do valor de cruzamento das árvores superiores e a determinação dos parâmetros genéticos das populações vêm sendo também enfocados, visando a melhor definição da estratégia de continuidade do melhoramento com as espécies.

TREE IMPROVEMENT AND BREEDING OF TROPICAL PINES IN BRAZIL

Summary

The forest plantations with *Pinus* species in Brazil, around 35% of the total 2,5 millions hectares planted up to 1977, were established with the species *P. caribaea* Morelet, *P. oocarpa* Schiede, *P. kesiya* Royle ex Gordon, *P. taeda* L. and *P. elliottii* var. *elliottii* Engelm, the most important species in our Country.

With these species, great emphasis has been given to tree improvement programmes, by Institutions and forest companies. Provenance trials were established and the patterns verified to the within species variation have guided the strategy of the utilization of existing plantations for intra-populational selection.

Seed Production Areas were established for the most important species, 2600 hectares until 1978, to suply the immediate seed necessity. Seed Orchards have been established for the most important species, totalizing 300,0 hectares until 1979, using a large number of superior trees, to guarantee the genetic basis for the recurrent selection.

The most adequate site conditions for seed production, the efficiency of pollen dispersion, the efficiency of selection methods and the control pollination methods have been the main preoccupattions in the Seed Orchard research. The progeny trials, either to evaluate the breeding value of superior trees or to estimate the genetic parameters, have been also considered to better define the strategy of the tree improvement continuity.

INTRODUÇÃO

A área total reflorestada no Brasil, segundo o Instituto Brasileiro de Desenvolvimento Florestal - IBDF, representa um total de 2.500.000 ha até 1977, com uma média em torno de 300.000 ha anuais. Desse total anual, cerca de 35% referem-se a plantações com os *Pinus*, havendo ultimamente uma tendência para um aumento de plantio com as espécies desse gênero, em relação as do gênero *Eucalyptus* que, por sua vez, vêm ocupando praticamente os 65% restantes.

As áreas reflorestadas com *Pinus* distribuem-se praticamente em duas regiões bastante distintas, em relação às suas características climáticas e ao grupo de espécies plantadas. Uma ao sul do trópico de Capricórnio (Estados de São Paulo, Paraná, Santa Catarina e Rio Grande do Sul), utilizando-se basicamente das espécies *Pinus taeda* L. e *P. elliottii* var. *elliottii* Engelm, e outra ao norte desse paralelo (Estados de São Paulo, Mato Grosso do Sul, Minas Gerais, Espírito Santo e Bahia), a partir das espécies oriundas de regiões mais tropicais, tais como: *Pinus oocarpa* Schiede, *Pinus caribaea* Morelet e *Pinus kesiya* Royle ex Gordon.

Essas podem ser consideradas as mais importantes espécies de *Pinus* no Brasil, e a partir das quais vêm sendo conduzidos os programas de melhoramento genético, através de Instituições de Pesquisas, Universidades e empresas florestais (BERTOLANI e NICOLIELO, 1978 e FONSECA et alii, 1978).

O presente trabalho enfocará os principais avanços verificados no programa de melhoramento genético dessas espécies no Brasil, a filosofia e estratégias adotadas nesses programas, e as preocupações existentes nesse campo de pesquisa. Os principais resultados a serem relatados se referem, principalmente, a pesquisas realizadas pelo Instituto de Pesquisas e Estudos Florestais - IPEF, através de suas empresas florestais associadas.

TESTES DE PROCEDÊNCIAS

A partir das espécies de maior potencial para as diversas regiões do Brasil, estudos de procedências vêm sendo conduzidos, visando a escolha de origens mais adequadas de sementes para estabelecimento tanto de plantios comerciais como de populações base adequadas ao programa de melhoramento genético. Para a realização desses testes de origens de sementes, de alta importância têm sido os convênios e colaborações com instituições de pesquisa estrangeiras, que têm fornecido lotes de sementes colhidos com com todo o rigor de amostragem das populações, tal como ocorreu para *P. oocarpa* Schiede e *P. caribaea* Morelet, com a cooperação do COMMONWEALTH FORESTY INSTITUTE - Oxford, e para *P. kesiya* Royle ex Gordon com a cooperação do Forestry Research Institute - Canberra.

Para o início do programa de melhoramento genético com as diferentes espécies de *Pinus* no Brasil, diferentes estratégias vem sendo adotadas, conforme o padrão de variação genética que os resultados dos testes de procedência tem revelado para cada espécie. Assim, para as espécies mais variáveis em relação a procedências, vem sendo dada maior atenção à escolha de populações-base para programa de seleção intra-populacional e melhoramento. Ao contrário, as espécies mais uniformes em relação a procedências têm facilitado o trabalho de escolha de populações para início do programa.

Os principais resultados obtidos a partir dos ensaios de procedências das diferentes espécies são apresentados, resumidamente, a seguir:

P. oocarpa Schiede: os ensaios com a espécie têm revelado altas variações entre origens de sementes, com resultados bastante similares em toda a região potencial para a espécies. As procedência Yucul e Camélias da Nicarágua têm se revelado com superioridade em vigor e forma das árvores, enquanto a procedência Mt Pine Ridge de Belize tem também se sobressaído em vigor, porém com forma inferior às anteriores. As procedências do centro de Honduras, e que acredita-se seja a origem da maioria das populações existentes no Brasil, têm-se revelado como de comportamento médio a superior para vigor e forma das árvores, mostrando-se adequadas para programas de seleção e melhoramento, até que populações das melhores procedências estejam disponíveis (KAGEYAMA, 1977; KAGEYAMA et alii, 1978; FERREIRA e KAGEYAMA, 1978; BERTOLANI e NICOLIELO, 1978; GREAVES, 1980).

P. caribaea Morelet: ensaios envolvendo as três variedades: var. *hondurensis*, var. *bahamensis* e var. *caribaea*, têm revelado resultados mais ou menos similares, aos 4 anos de idade, para todos os locais ensaiados e potenciais à espécies. Os resultados vêm revelando diferenças significativas entre variedades, porém, com relativamente pequena variação genética entre procedências dentro de variedades, para as características de crescimento das árvores (KAGEYAMA et alii, 1978b; PINTO JR. e JACOB, 1979). A variedade *hondurensis* mostra variação significativa entre procedências para incidência de "fox-tail", mostrando ser essa característica a maior determinante para a variação entre procedências da variedade (GREAVES, 1980; NICOLIELO, BERTOLANI e GARNICA, 1980). Esses resultados têm levado à utilização das melhores plantações da espécie existentes nas condições brasileiras para seleção e melhoramento, minimizando-se os riscos para a não adequação de procedência.

P. kesiya Royle ex Gordon: Os resultados obtidos com a espécies têm revelado variações significativas entre procedências, com um comportamento superior para determinadas origens das Filipinas. As populações existentes em nossas condições, colocadas como testemunha nos ensaios, revelam-se altamente potenciais, tendo sido consideradas como adequadas para programa de seleçao e melhoramento (KAGEYAMA et alii, 1978b; NICOLIELO, BERTOLANI e GARNICA, 1978).

P. taeda L.: Os resultados dos testes de procedências têm revelado variações genéticas bastante expressivas para as principais características silviculturais, mostrando ser esse um dos fatores para a alta variação na qualidade dos talhões implantados com a espécies (FONSECA et alii, 1978; BARRICHELO et alii, 1977). Esses ensaios revelam uma clara tendência para um comportamento superior das procedências do extremo sudeste de sua região de ocorrência, concordando com os resultados de outros países em condições similares. Em função desses resultados, grande cuidado vem sendo tomado na escolha de populações para programa de seleção e melhoramento com a espécie.

P. elliottii var. *elliottii* Engelm: Essa espécie, diferentemente do *P. taeda* L., tem mostrado relativamente pouca variação genética entre procedências, para as principais características, como tem revelado os ensaios instalados no sul do Brasil (FONSECA et alii, 1978). Esses resultados, aliados a não existência de uma tendência definida para a relação comportamento x local de origem, tem orientado os trabalhos de escolha das populações-base para seleção intra-populacional, com boa segurança para a utilização das extensas plantações existentes.

Os ensaios de procedências têm também orientado o programa no sentido de instalação de populações-base, a partir das melhores procedências, visando a sua futura utilização nos programas de seleção e melhoramento.

SELEÇÃO INTRA-POPULACIONAL

Seleção Massal

A seleção massal dentro das populações de melhor comportamento tem sido conduzida para estabelecimento de "Áreas de Produção de Sementes". Esse tipo de seleção tem sido praticada para todas as espécies potenciais, para produção de sementes a curto prazo, e visando suprir as necessidades internas. Essa política de eliminação de importação de sementes, principalmente de origem e qualidade duvidosa, foi implantada pelo IBDF, a partir de 1977, incentivando e certificando áreas produtoras de sementes com características mínimas desejáveis. Em levantamento efetuado por esse órgão governamental, detectou-se que do total de sementes de *Pinus* utilizadas no Brasil, correspondente a 18.289 kg em 1978, cerca de 60% eram importadas. O controle de qualidade dos talhões para certificação é efetuado através da "Comissão de Controle de Sementes Florestais", num sistema que pode ser considerado como um primórdio da Certificação de Sementes Florestais no Brasil.

As áreas com certificação do IBDF, existentes no País até 1978, para os principais espécies de *Pinus*, são relacionadas na tabela a seguir.

Tabela 1- Áreas de Coleta (ACS) e Áreas de Produção de Sementes (APS) de espécies de *Pinus* instaladas no Brasil com certificação do IBDF.

Table 1- Seed Collecting and Seed Production Areas of *Pinus* in Brazil certified by IBDF.

Espécie	Tipo de Área	Instituição ou Empresa	Local	Área total (ha)
P. oocarpa	APS	Champion	Casa Branca-SP	94
P. oocarpa	APS	CAFMA	Agudos - SP	321
P. oocarpa	ACS	CAFMA	Agudos - SP	654
P. oocarpa	APS	IFSP	Vários	50
P. kesiya	APS	CAFMA	Agudos - SP	35
" "	ACS	CAFMA	Agudos - SP	83
" "	APS	IFSP	Vários	400
P. taeda	APS	Klabin	Telêmaco Borba-PR	85
" "	APS	Rigesa	Três Barras-SC	22
" "	APS	IFSP	Vários	65
P. elliottii var. *elliottii*	APS	Klabin	Telêmaco Borba-PR	30
" " " "	APS	Tigesa	Três Barras-SC	3
" " " "	APS	IFSP	Vários	110
P. caribaea var. *hondurensis*	APS	Champion	Casa Branca-SP	149
" " " "	APS	CAFMA	Agudos - SP	304
" " " "	ACS	CAFMA	Agudos - SP	750
" " " "	APS	IFSP	Vários	800
P. caribaea var. *bahamensis*	APS	CAFMA	Agudos - SP	13
" " " "	ACS	CAFMA	Agudos - SP	173
" " " "	APS	IFSP	Vários	20
P. caribaea var. *caribaea*	APS	CAFMA	Agudos - SP	54
" " " "	ACS	CAFMA	Agudos - SP	292
" " " "	APS	IFSP	Vários	100

Fonte: KANO et alii (1979 e FERNANDES (1979).

Área total ACS = 1.952 ha
Área total APS = 2.655 ha

A previsão para a produção de sementes, a partir das áreas relacionadas, é, segundo KANO et alii (1979), da ordem de 7000 kg, com tendência a um aumento gradativo, mostrando a perspectiva de auto-abastecimento a curto prazo. Essas sementes de ACS e APS serão gradativamente substituídas por sementes de Pomares de Sementes, que foram e vêm sendo instalados, a medida que os mesmos iniciem a produção comercial.

Seleção Fenotípica Individual

As melhores populações existentes, com condições de seleção, vêm sendo intensamente vasculhadas para a detecção de indivíduos superiores, para estabelecimento dos Pomares de Sementes Clonais. A escolha dessas populações-base se têm sido realizada em função do padrão de variação intra-específica verificada para a espécie. Nas que apresentam maior variação genética entre procedências, tais como *P. oocarpa* Schiede e *P. taeda* L., o critério de escolha das populações-base tem sido mais cuidadoso, tomando-se para tal somente as populações asseguradamente com características de boa qualidade. Também, essas espécies vêm sendo selecionadas geralmente com maior intensidade de seleção, visando controlar o problema de diferenciação entre procedências. Por outro lado, as espécies que apresentam um padrão mais restrito de variação entre procedências, dentre as quais se incluem: *P. caribaea* var. *hondurensis* Barr. et Golf., *P. caribaea* var. *bahamensis* Barr. et Golf., *P. caribaea* var. *caribaea* e *P. elliottii* var. *elliottii* Engelm, têm permitido uma utilização menos restritiva das populações existentes, com menor rigor para a escolha de populações-base.

A seleção de árvores selecionadas para programas de Pomares de Sementes para as diferentes espécies potenciais é apresentada na tabela 2.

Tabela 2- Número de árvores superiores selecionadas para as diferentes espécies pelas diversas Instituições e Companhias Florestais no Brasil

Table 2- Number of superior trees selected by various Institutions and Forest Companies in Brazil.

Espécies	Nº de árvores	i.s.	Instituição ou Empresa	Referência
P. caribaea var. *hond.*	200	1:10000	CAFMA/IPEF	Nicolielo et alii (1978)
	1042	-	IFSP	Fernandes (1978)
	75	1:2500	CHAMPION/IPEF	*
P. ooocarpa	200	1:10000	CAFMA/IPEF	Nicolielo et alii (1978)
	117	-	IFSP	Fernandes (1978)
	75	1:3000	CHAMPION/IPEF	*
P. kesiya	50	1:2500	CAFMA/IPEF	Nicolielo et alii (1978)
	781	-	IFSP	Fernandes (1978)
	75	1:3000	JOHAN FABER/IPEF	*
P. caribaea var. *bah.*	150	1:2500	CAFMA/IPEF	Nicolielo et alii (1978)
	55	-	IFSP	Fernandes (1978)
	30	1:1000	DURATEX/IPEF	*
	36	-	CHAMPION/IPEF	*
P. caribaea var. *car.*	150	1:2500	CAFMA/IPEF	Nicolielo et alii (1978)
	279	-	IFSP	Fernandes (1978)
P. taeda	29	1:200000	RIGESA/IPEF	Fonseca e Kageyama (1978)
	22	1: 45000	PCC/IPEF	" " "
	17	1: 53000	IKPC/IPEF	" " "
P. taeda	7	1:14000	MANASA/IPEF	Fonseca e Kageyama (1978)
	39	1:48000	BRASKRAFT/IPEF	" " "
P. elliottii var. *el.*	276	-	EMBRAPA/IFSP	URPFCS/EMBRAPA

* KAGEYAMA, P.Y. - não publicado.

Na seleção de árvores superiores de *P. taeda*, bem caracterizada e descrita por KAGEYAMA e FONSECA (1979), os pontos máximos e que refletem os coeficientes dados às características no "índice de seleção empírico" foram: vigor: 40, forma do tronco: 30, ramificação: 21, conicidade: 5, e tamanho de copa: 4. Para as outras espécies, dependendo das características da espécie, outro balanço de coeficientes foi arranjado. Nesse processo de seleção, utilizou-se o método de estratificação da população, comparando-se a árvore candidata com as 5 árvores dominantes situadas ao redor da mesma, dentro de um raio de até 15 metros. O esquema de avaliação de campo através do sistema de fichas, tem sido bastante sistematizado, procurando minimizar subjetividades e facilitar a avaliação de cada característica no campo, bem como possibilitar o emprego de computação eletrônica para a atribuição de notas à cada árvore. Esse sistema facilita também o agrupamento das árvores em classes de frequência, com base nos pontos totais alcançados (Tabela 3).

Tabela 3- Distribuição dos Indices Totais obtidos pelas árvores pré-selecionadas de *P. taeda* L. no sul do Brasil.

Table 3- Distribution of Total Indices obtained by pre selected trees of *P. taeda* L. in southern Brazil.

Indices Centro de Classe / Center of Classe	Frequência Observada / Observed Frequency	Frequência Esperada / Expected Frequency	X^2
31,25	4	3,0	0,25
33,25	6	5,0	0,17
35,25	9	7,0	0,44
37,25	12	10,0	0,33
39,25	15	14,0	0,07
41,25	15	17,0	0,27
43,25	18	21,0	0,50
45,25	24	23,0	0,04
47,25	32	27,0	0,78
49,25	18	24,0	2,00
51,25	19	23,0	1,32
53,25	15	20,0	1,67
55,25	23	16,0	2,13
57,25	14	13,0	0,07

(Continua)

Tabela 3- (Continuação)

Indices Centro de Classe Center of Classe	Frequência Observada Observed Frequency	Frequência Esperada Expected Frequency	x^2
59,25	9	9,0	0,00
61,25	4	6,0	1,00
63,25	4	4,0	0,00
65,25	5	3,0	0,80
67,25	1	2,0	1,00
69,25	1	1,0	0,00
Total	248	248	12,84 ns

Média
Average= 47,97 — Desvio padrão=
Standard deviation= 8,009 — Coeficiente de variação=
Coefficient of variation= 16,70%

Fonte: FONSECA e KAGEYAMA (1978).

Outro aspecto estudado por FONSECA e KAGEYAMA (1978), foi o de avaliação do verdadeiro valor da intensidade de seleção (i) para cada característica, quando se pratica seleção não truncada para diversas características simultaneamente, através do "índice de seleção empírico". Os valores reais obtidos do i para altura e DAP foram de 2,33 e 1,41, respectivamente, representando a pressão de seleção efetivamente exercida sobre essas características. O valor geral de i obtido pela proporção de árvores selecionadas, igual a 3,60 e equivalente à seleção de 1:5500, não é comparável a nenhum dos dois valores encontrados acima, mostrando o real valor que se deve dar ao parâmetro, quando se pretende fazer estimativas de ganhos genéticos. A grande diminuição do valor real de i para cada característica, quando se pratica seleção para múltiplas características simultaneamente, impõe a necessidade de considerar um mínimo de intensidade de seleção geral para que não se tenha valores de i individuais muito reduzidos.

POMARES DE SEMENTES CLONAIS

A relativa facilidade de propagação vegetativa por enxertia das espécies do gênero *Pinus* e o pleno sucesso obtido no pegamento e sobrevivência no campo têm facilitado a instalação de Pomares de Sementes para as nossas espécies mais importantes (FONSECA et alii, 1978; NICOLIELO, BERTOLANI e GARNICA, 1979; PINTO JR., KAGEYAMA e JACOB, 1979).

Assim, a partir das árvores superiores selecionadas, vêm sendo instalados os Pomares de Sementes, que vão relacionados na tabela 4.

Tabela 4- Relação de Pomares de Sementes instalados para as diversas espécies de *Pinus* por Região e Instituição.

Table 4- Seed Orchards of *Pinus* established by Institutions.

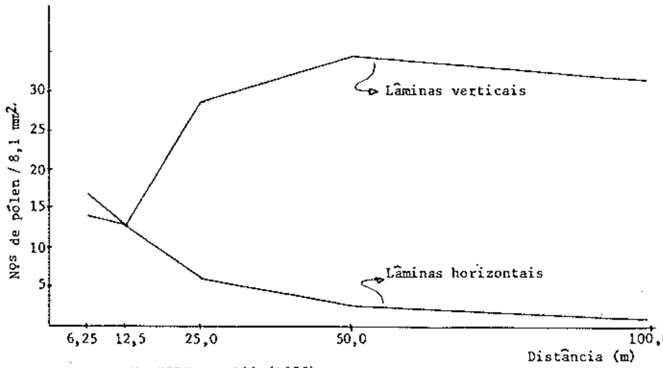
Espécie	Local	Instituição	Instalação	Área (ha)	Nº de clones	Referência
P. caribaea var. *car.*	Agudos-SP	CAFMA/IPEF	1972	3	30	Nicolielo,
P. oocarpa	" "	" "	1975	25	200	Bertolani
P. caribaea var. *hond.*	" "	" "	1977	26	200	e Garnica
P. kesiya	" "	" "	1977	26	100	(1978)
P. caribaea var. *hond.*	Aracruz-ES	CCGM-PT	1978/80	50	400	Pinto Jr., Jacob e
" " " *car.*	" "	"	" "	50	300	Kageyama
" " " *bah.*	" "	"	" "	50	233	(1979)
P. caribaea var. *hond.*	Vários	IFSP	1978	20	200	Fernandes
" " " *car.*	"	"	1976	10	100	(1978)
" " " *bah.*	"	"	1979	10	80	"
P. oocarpa	"	"	1973	10	100	"
P. kesiya	"	"	1978	10	100	"
P. taeda	"	Várias/IPEF	1972/73	11	30	Fonseca et alii(1978)
P. taeda	"	" "	1980*	-	114	Fonseca e Kageyama (1978)
P. oocarpa	Anhembi	ESALQ/IPEF	1977	1	75	Mora et
P. caribaea var. *hond.*	"	" "	1977	1	75	alii
P. kesiya	"	" "	1977/79	5	150	(1980)

* em instalação

Os Pomares de Sementes que vêm sendo instalados têm se baseado em um número relativamente elevado de árvores para formação da população de cruzamento. Assim, um mínimo de 100 árvores tem sido preconizado para instalação dos Pomares de Sementes, visando com isso garantir a possibilidade de seleção por famílias, muito mais eficiente, além de permitir a manutenção de um número de indivíduos não muito baixo nas gerações seguintes, indo de encontro às proposições de BURDON e SHELBOURNE (1973). O enriquecimento e ampliação da base genética dos Pomares que vêm sendo instalados, constituem-se numa estratégia do programa, quando então novos indivíduos deverão ser selecionados e incluídos na população de cruzamento, à medida que os mesmos forem sendo detectados nas novas populações.

Outra preocupação importante na pesquisa vem sendo o estudo de dispersão de pólen, visando obter informações básicas aos Pomares de Sementes. ALBERTIN RIZZI et alii (1978) examinaram o padrão de dispersão das espécies: *P. oocarpa* Schiede, *P. caribaea* var. *hondurensis* Barr. e Golf., *P. kesiya* Royle ex Gordon e *P. elliottii* var. *elliottii* Engelm, utilizando-se de armadilhas coletoras a diversas distâncias da fonte dispersora e a diversas alturas do solo. O padrão de dispersão do pólen, quando se analisou as armadilhas dispostas na posição horizontal, captando o pólen em queda, foi semelhante ao padrão geral relatado na literatura, com uma queda rápida e progressiva na densidade de pólen, em função da distância. Por outro lado, surpreendentemente, o padrão verificado para o pólen coletado em armadilhas dispostas verticalmente, captando o pólen em vôo, apresentou-se bastante diferente do observado para as armadilhas horizontais, com uma tendência para um aumento na densidade de pólen com a distância, mostrando a necessidade de reflexões sobre o assunto.

A curva de dispersão de pólen para *P. kesiya*, tomado como exemplo, pode ser observada na Figura 2.



FONTE: ALBERTIN RIZZI et alii (1978).

Figura 1- Curvas de dispersão de pólen de *P. kesiya* Royle ex Gordon em função da distância

Figure 1- Patterns of pollen dispersion with distances.

As condições mais adequadas para o florescimento e frutificação dessas espécies vêm sendo estudadas, concentrando-se os Pomares de Sementes nas regiões mais aptas à produção de sementes. Para *Pinus oocarpa* Schiede e *P. kesiya* Royle ex Gordon, as condições do planalto do Estado de São Paulo têm sido as mais adequadas para a produção de sementes; para as três variedades de *P. caribaea* Morelet as regiões litorâneas no norte do Espírito Santo e sul da Bahia mostram-se as mais favoráveis; para o *P. taeda* as indicações sugerem que as condições do planalto do Estado do Paraná (24º Latitude) sejam os de maior produção de sementes (ZANI et alii, 1980). Por outro lado, o estudo das características de frutificação e produção de sementes de *P. oocarpa* Schiede tem sido objeto de estudo de MÁRQUEZ e KAGEYAMA (1980), encontrando-se uma alta variabilidade individual na população estudada.

A propagação vegetativa tem também sido enfocada no sentido de conservação genética de populações em perigo de destruição, como ocorreu com plantações de *P. kesiya*. O Centro de Concervação Genética e de Melhoramento de Pinheiros Tropicais onde foram concentradas as principais populações das três variedades de *P. caribaea* Morelet, para conservação e produção de sementes é um exemplo desse objetivo da propagação vegetativa.

A polinização controlada, visando a produção de progênies "ful-sib" para estudos genéticos, tem sido considerada como altamente importante na continuidade do programa para estudos de cruzamentos intra e inter-específicos.

TESTES DE PROGÊNIES

Paralelamente à instalação dos Pomares de Sementes Clonais, para os principais espécies já citadas, vêm sendo instalados testes de progênies, a partir de sementes das árvores originais (ortets), considerando-se o parentesco de meios-irmãos para as famílias.

Esses ensaios de progênies vêm sendo conduzidos como instrumento de seleção, através da determinação do valor de cruzamento das árvores selecionadas. A seleção por famílias vem sendo considerada altamente importante para as características de baixa herdabilidade, assim como as de difícil avaliação fenotípica, tais como as características de qualidade da madeira, conforme enfatizam KAGEYAMA e FONSECA (1979).

Os ensaios de progênies têm permitido ainda o conhecimento da estrutura genética das populações, fornecendo informações genéticas importantes para a definição da estratégia do melhoramento através da seleção recorrente, conforme relatado por KAGEYAMA et alii (1977) e KAGEYAMA e JACOB (1979).

A utilização de progênies de polinização aberta tem sido considerada a melhor opção nesse primeiro estágio de seleção e melhoramento, em função de sua facilidade, rapidez e baixo custo de instalação, conforme enfatizam SHELBOURNE E COCKREM (1969), muito embora se reconheçam as restrições que os mesmos apresentam, relativamente aos de polinização controlada, conforme coloca NAMKOONG (1966). Dessa forma, ensaios de progênies de polinização aberta foram e vêm sendo instalados para *P. oocarpa*, *P. caribaea* var. *hondurensis*, *P. kesiya* e *P. taeda* a partir de 1978 (NICOLIELO et alii, 1978).

Ensaios envolvendo progênies de árvores selecionadas na Rodésia e EUA de *P. taeda*, *P. elliottii* var. *elliottii* e *P. patula* vêm sendo instalados a partir de 1971, tendo sido importantes para acúmulo de experiência com as espécies, além de fornecer material para enriquecimento da base genética do programa de melhoramento com essas espécies.

Tabela 5- Resultados de teste de progênie de árvores de *Pinus caribaea* var. *hondurensis* Barr. e Golf. selecionadas na Austrália.

Table 5- Results of progeny trials of selected trees from Australia.

Procedência das Progênies	Tipo de Progênie	LOCAIS: T. FREITAS (BA) Idade = 2 anos				ROMARIA (MG) Idade = 2 anos				AGUDOS (SP) Idade = 2 anos		
		Nº famílias	ALT.	DIAM.	%F	Nº famílias	ALT.	DIAM.	%F	Nº famílias	ALT.	%F
Beerburrunn Aust	"ortet"	4	2,66	5,00	0	2	2,35	3,48	0	7	3,31	1
Byfield Aust	"ortet"	16	2,50	4,88	1	17	2,44	3,56	3	22	3,33	1
Byfield Aust	"ramet"	17	2,50	4,86	0	10	2,37	3,55	3	14	3,27	3
Kenned-Landwel Aust	"ortet"	5	2,48	4,92	0	7	2,38	3,68	1	13	3,20	3
Casa Branca Brasil	"ortet"	5	2,54	4,87	0	3	2,51	3,52	6	5	3,36	5
Guatemala	commercial	2	2,57	4,66	0	1	1,93	2,53	39	3	3,17	4

FONTE: PINTO JR. et alii, 1980 (não publicado).

A estratégia de intercâmbio de sementes de árvores selecionadas, conforme preconiza NIKLES (1973) para *Pinus caribaea* var. *hondurensis* vem sendo adotada desde 1977. Os resultados preliminares desses testes de progênies em diversos locais do Brasil, colocando-se como testemunha progênies de árvores selecionadas em populações do Brasil, são apresentados na tabela 5.

Esses resultados obtidos, embora preliminares, não mostram ainda uma diferenciação clara entre os materiais genéticos provenientes de árvores selecionadas da Austrália e do Brasil, para as características de crescimento em altura e diâmetro. A partir de resultados à idades mais avançadas, e avaliando-se outras características importantes, melhores conclusões poderão ser obtidas.

Os ensaios de progênies instalados em condições locais fornecem grande experiência ao melhorista para melhor visão das possibilidades de manipulação genética das populações. Os principais resultados obtidos no Brasil, acerca de variâncias genéticas e coeficientes de herdabilidade, são apresentados a seguir.

Tabela 6- Coeficientes de herdabilidades obtidos a partir de ensaios de progênies de polinização aberta para diversas características e espécies no Brasil.

Table 6- Heritability Coefficients obtained from open pollinated progeny trials for various characteristics and species in Brazil.

ESPÉCIE	LOCAL	IDADE	Nº FAMÍLIAS	HERDABILIDADE (%) ALTURA	DIAMETRO	REFERÊNCIA
P. elliottii var. *elliottii*	T. Borba-PR	4	15	12,7	31,1	Kageyama (1976)
P. patula	T. Borba-PR	4	36	24,9	31,8	Kageyama et alii (1977)
Araucaria angustifolia	Campos do Jordão - SP	3,5	40	26,2	25,5	Kageyama e Jacob (1979)
Eucalyptus grandis	5 Locais	2,0	49	10,0	4,9	Kageyama (1980)

Os testes de progênies de *P. oocarpa*, *P. caribaea* var. *hondurensis*, *P. kesiya* e *P. taeda* encontram-se em fase muito inicial de instalação, não apresentando ainda possibilidades de análise e obtenção de parâmetros genéticos. Com o decorrer dos anos, o acúmulo de informações genéticas sobre as populações em estudo possibilitarão melhores definições sobre as estratégias de melhoramento para cada espécie. Na obtenção das informações genéticas, têm sido consideradas as preocupações de um número mínimo de progênies representativas da população, a utilização de delineamentos adequados e a utilização de um número representativo de locais, procurando extrair a componente devida à interação de genótipos por locais.

CONSIDERAÇÕES FINAIS

O programa de melhoramento genético que vem sendo conduzido no Brasil, para as espécies de *Pinus* mais importantes, tem orientado sua estratégia em função da variabilidade apresentada pelas espécies, da existência de populações-base adequadas e da necessidade de produção de sementes para auto-abastecimento.

Os estudos básicos, e que permitam dar melhor suporte ao programa de melhoramento, vêm sendo bastante enfatizados, principalmente visando a melhor definição da continuidade da seleção recorrente. Isso se torna de alta importância quando se considera o grande número de espécies que vem sendo trabalhadas.

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ENSAIOS INTERNACIONAIS DE PROCEDÊNCIAS DE *Eucalyptus*: Estado Atual e Desenvolvimento

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Resumo

Os eucaliptos são muito usados pelos silvicultores de numerosos países, especialmente para aquecimento, usos múltiplos e industriais. As espécies, extremamente variáveis genética e fisiologicamente, tornam-se um material adequado para os melhoristas. A origem das espécies é fator essencial. Os testes comparativos de procedências desenvolveram-se intensamente após 1967, coincidindo com o ano em que F.A.O. iniciou o projeto envolvendo o *E. camaldulensis*. Dessa data em diante os conhecimentos tornaram-se maiores em função da ampliação das coleções em teste e do acesso a um número maior de parâmetros.

Os testes de procedências internacionais, em seu sentido exato, são em número limitado e envolvendo somente as seguintes espécies: *E. dalrympleana*, *E. camaldulensis*, *E. deglupta*, *E. urophylla*, *E. tereticornis*, *E. alba*, *E. cloeziana*, *E. globulus*, *E. microtheca* e *E. grandis*. Poucos deles são realmente coordenados.

O valor desses ensaios pode ser avaliado em vários níveis, em função da qualidade da coordenação e da amplitude das coleções. O Centre Technique Forestier Tropical, com suas colheitas na Austrália e suas numerosas atividades no mundo tropical propicia a abertura de novos caminhos para uma nova filosofia de ensaios internacionais.

Os primeiros resultados são muito promissores tanto no plano científico como econômico.

No futuro será necessário conduzir novas coletas, dando continuidade à experimentação e ampliando-as através da sua maior intensificação e beneficiando maior número de países.

Todavia, quaisquer resultados já obtidos nos ensaios serão publicados ou divulgados da maneira mais ampla possível.

INTERNATIONAL TESTS WITH *Eucalyptus*: Present Stage and Future Development

Summary

Eucalyptus is much used by foresters from numerous countries, especially for heating, different uses and industry.

The extremely varied type offers physiological and genetical peculiar natures, so that it forms a chosen material for tree breeders.

The origin of the species is quite essential. The comparative provenance trials have especially been developed after 1967, the time when the F.A.O. plan about the *E. camaldulensis* was started. From that date forward, the experience has become very intensive in consequence of the richness of the collections grown, of the improving of the appliances and of considering more parameters.

The international provenance trials, in the exact meaning, are in a limited number and only concern the following species : *E. dalrympleana*, *E. camaldulensis*, *E. deglupta*, *E. urophylla*, *E. tereticornis*, *E. alba*, *E. cloeziana*, *E. globulus*, *E. microtheca*, and *E. grandis*. Few of them are really co-ordinated.

Several levels in the value of these trials must be considered according to the quality of the co-ordination and the richness of the collections. The Technical Forest Tropical Centre, with their crop seasons in Australia and their numerous realizations through the tropical world have opened the way to a new generation of international trials.

The first results are quite promising as much on the scientific plan as on the economic one.

In the future it will be needful to undertake new crop seasons, to follow the experimentings by intensifying them and make more countries benefit from them.

Nevertheless, every result of the trials abready got, will have to be drawn and published in the most widely possible way.

LES ESSAIS INTERNATIONAUX DE PROVENANCES D'*Eucalyptus*: Etat Actuel et Developpement Souhaitable

Resume

Les Eucalyptus sont très utilisés par les Forestiers de nombreux pays, principalement pour le bois de chauffage, de service et d'industrie.

Le Genre, extrêmement diversifié, présente des particularités physiologiques et génétiques, telles qu'il constitue un matériel de choix pour les Améliorateurs forestiers. En particulier le niveau provenance est capital.

Les Essais comparatifs de provenances ont surtout été développés après 1967, date du lancement du projet *F.A.O.* sur l'*E. camaldulensis*. A partir de cette date, les expériences sont devenues très intensives du fait de la richesse des collections obtenues, du perfectionnement des

dispositifs et de la prise en compte d'un plus grand nombre de paramètres.

Les Essais internationaux de provenances au sens strict sont en nombre assez restreints et ne concernent que les espèces suivantes : *E. dalrympleana, E. camaldulensis, E. deglupta, E. urophylla, E. tereticornis, E. alba, E. cloeziana, E. globulus, E. microtheca,* et *E. grandis*. Peu sont vraiment coordonnés.

Il faut distinguer plusieurs niveaux dans la valeur de ces essais suivant la qualité de la coordination et la richesse des collections. Le Centre Technique Forestier Tropical, avec ses campagnes de récolte en Australasie et ses nombreuses réalisations dans le monde tropical, a ouvert la voie à une nouvelle génération d'essais internationaux.

Les premiers résultats sont très prometteurs, tant sur le plan scientifique qu'économique.

Pour le Futur, il sera nécessaire d'entreprendre de nouvelles campagnes de récoltes, de poursuivre les expérimentations en les intensifiant et d'en faire profiter encore davantage de pays.

Il faudra cependant s'efforcer de tirer tous les résultats des essais déjà installés et de les publier le plus largement possible.

I - GENERALITES :

- L'irrésistible ascension des Eucalyptus

Véritable conquérant du monde végétal, le genre Eucalyptus constitue l'Essence forestière la plus *largement disséminée* par l'homme à la surface de la Terre. Les Forestiers d'un très grand nombre de pays lui ont consacré une bonne part de leur effort.

Doués d'une croissance *extrêmement rapide*, les Eucalyptus produisent des bois très diversifiés, souvent de densité très élevée, ce qui fait d'eux les *"Champions de la Biomasse"*, que ce soit à des fins industrielles ou énergétiques.

L'optique Bois d'oeuvre est souvent moins évidente. C'est le principal défaut du Genre, mais il faut avoir foi dans le génie génétique auquel les Eucalyptus peuvent parfaitement répondre. Les autres utilisations sont également variées (protection, ornement, huiles essentielles, miel, etc...).

Avec des durées de révolution souvent très courtes (5 à 15 ans), une maturité sexuelle précoce (1 à 7 ans), un temps nécessaire à la maturation des graines assez réduit (4 à 12 mois depuis la floraison), l'Eucalyptus est un *matériel de choix pour les Généticiens forestiers*. Il se prête bien aux études de croisements inter et intra-spécifiques.

Alors qu'en Australie, il existe des barrières écologiques naturelles à la dissémination des hybrides interspécifiques, ce qui élimine tout risque de pollution génétique, dans l'aire artificielle, au contraire *les hybrides présentent fréquemment un fort hétérosis*, alternative intéressante à une charge génétique souvent trop faible pour assurer aux espèces pures une bonne adaptation et une valeur sélective élevée.

Conservant pendant longtemps une grande réserve de juvénilité (lignotubers, feuillage juvénile des pousses épicormiques), la plupart des espèces présentent une *possibilité aisée de multiplication végétative* par bouturage à partir de rejets de souche. Ce résultat permet un large développement vers la ligniculture ultra-intensive (CONGO, BRESIL), à partir de clones hybrides hyperproductifs. L'Eucalyptus devient alors *un précieux outil de développement économique*.

- Une nécessité : l'étude des Provenances

L'Australie, terre d'origine de la presque totalité des espèces du Genre, vaste continent, isolé depuis l'ère secondaire, a permis à la sélection naturelle de s'exercer pendant très longtemps dans un environnement particulièrement stable, d'où *la diversification extrême du genre Eucalyptus* qui compte environ 600 espèces et l'adaptation très poussée des écotypes aux sites. *L'effet provenance est souvent considérable* pour les espèces à large répartition.

Par contrecoup, les pools génétiques risquent d'être localement très "dilués" ou réduits, ce qui entraîne une *interaction génotype-environnement élevée* (avec heureusement des exceptions). La charge génétique souvent faible au niveau provenance est, par contre, généralement très élevée au niveau spécifique. La très grande diversification du Genre a amené *un large polymorphisme des espèces*, indice d'un haut potentiel d'adaptation. Cela confère au Genre des propriétés génétiques particulières comme *l'hypersensibilité à la consanguinité* et la réaction rapide à des milieux nouveaux.

L'amélioration génétique des Eucalyptus peut être poussée très en avant, mais il est par contre indispensable au départ de disposer de *populations de sélection bien adaptées* et suffisamment riches en gènes donnant prise à une sélection efficace ou à une création variétale profitable. Seuls les Essais de Provenances peuvent donner accès localement à une base génétique suffisamment large.

II - ETAT DES EXPERIMENTATIONS :

Dans les expériences, deux niveaux sont à considérer, reflets d'une évolution assez récente dans la prise de conscience de l'importance de l'étude précise des provenances, unités fondamentales de la variabilité intra-spécifique.

2.1. Les essais classiques ("extensifs") :

Jusqu'en 1967, date du lancement par la F.A.O. de l'Essai international de Provenances d'*Eucalyptus camaldulensis*, principalement dans la zone méditerranéenne, on ne cherchait pas dans les essais de provenances une étude exhaustive de la variabilité de l'Espèce dans son ensemble.

On se bornait à essayer les semences que l'on parvenait à obtenir auprès des marchands ou des services spécialisés. Les *collections étaient très incomplètes, les origines mal connues et les populations testées mal représentées* (très faible nombre de descendances). De plus, les essais étaient souvent pulvérisés dans un grand nombre de sites. Aussi, les résultats enregistrés ont posé plus de problèmes qu'ils n'en n'ont résolus, même si dans certains états des gains importants de productivité ont été enregistrés.

Partout, on a signalé :

- l'impression de ne pas détenir les meilleures populations,
- l'impossibilité d'en tirer des lois générales sur la variabilité,
- l'impossibilité d'apprécier l'interaction génotype-milieu.

Cependant, ces essais n'ont pas été inutiles. Ils ont surtout contribué à sensibiliser les expérimentateurs sur la nécessité de lancer des essais de provenances beaucoup plus détaillés, quitte à les limiter à un petit nombre de sites. Ces premières tentatives ressemblent plutôt à des essais spécifiques ; elles ont permis de trier les espèces les plus prometteuses.
Il faut donc classer ces expériences, en faire le point, et s'efforcer d'en tirer définitivement les résultats avant de s'engager dans des études plus approfondies.

2.2. Les essais modernes ("intensifs") :

Ils correspondent à une notion plus récente, fondée sur la recherche d'une exploitation optimale de *collections complètes* de semences, à partir d'essais fortement concentrés dans un nombre restreint de sites bien choisis.

L'Essai F.A.O. sur l'*E. camaldulensis* en est un bon exemple, encore que les scientifiques, qui ont cherché localement à exploiter au maximum cette expérience, ont conclu à un échantillonnage trop pauvre de provenances (R. KARSCHON, Israël).

Plus récemment, avec ses campagnes de récolte de graines en AUSTRALASIE, suivies d'expérimentations très complètes, en particulier avec l'*E. urophylla* (CONGO, COTE-D'IVOIRE, GUYANE, CAMEROUN, GABON, MADAGASCAR), le Centre Technique Forestier Tropical (FRANCE) a résolument ouvert la voie à une nouvelle génération d'Essais très intensifs.

Signalons notamment les expériences de la Station de Pointe-Noire au Congo, qui rassemblent, pour la seule espèce *urophylla*, 430 descendances séparées, réparties en 86 provenances appartenant à 18 régions classées en 7 îles couvrant la *totalité de l'aire naturelle*.

D'autres espèces ont fait l'objet d'essais relativement complets :

E. camaldulensis (Sénégal, Niger, Haute-Volta, Cameroun, République Centre Africaine, Congo).

E. tereticornis (Sénégal, Niger, Haute-Volta, Côte-d'Ivoire, Cameroun, République Centre Africaine, Gabon, Congo).

E. alba (Niger, Haute-Volta, Congo).

E. cloeziana, E. grandis (Congo).

Dans les zones subtropicales et tropicales, il faut souligner également l'effort de plusieurs Etats :

Le Brésil, qui a d'ailleurs pu bénéficier d'une partie des récoltes du C.T.F.T. par l'intermédiaire du F.T.B. ou du C.S.I.R.O. et du Service forestier de TIMOR.

Dans les régions tempérées chaudes et humides de plaines, de montagnes et dans les zones subtropicales fraîches, on compte dans ce pays 257 provenances introduites pour 44 espèces d'Eucalyptus testées.

Dans les zones tropicales et subtropicales chaudes, les essais portent sur 54 espèces réparties en 534 provenances.

Ces essais ont souvent une valeur très élevée, du fait d'une situation dans un milieu particulièrement bien défini (classification en régions climatiques), et du fait de la très grande diversité écologique, en particulier dans la zone comprise entre les climats tempérés chauds et tropicaux subhumides.

Ce vaste éventail permet de cerner avec plus de précision le tempérament des espèces.

<u>L'Afrique du Sud</u>, qui fait état de 78 essais de provenances pour 16 espèces testées; les principaux concernent les espèces suivantes :

E. grandis	13 essais
E. camaldulensis/E. tereticornis	9 "
E. maculata	8 "
E. citriodora	7 "
E. saligna	7 "

<u>L'Australie</u> : on compte de nombreux essais de provenances multistationnels, principalement dans le Sud du pays (WA. NSW., Vict., Tasm.). Les principales espèces testées sont :

E. globulus/maideni/pseudoglobulus/bicostata (31 provenances en 10 stations) ;

E. delegatensis (50 provenances) ;

E. regnans (plus de 40 provenances).

<u>Le Zimbabwe-Rhodésie</u>, qui totalise, depuis 1965, 22 essais de provenances relatifs à 12 espèces et couvrant 47 hectares de plantations avec la répartition suivante :

ESPECES	Nombre d'essais	Surface totale (ha)
E. camaldulensis	6	10,98
E. deglupta	1	0,44
E. grandis	3	7,64
E. grandis/saligna/botryoides/deanei/dunii	5	15,82
E. maculata	1	0,43
E. nitens/regnans	2	1,54
E. pilularis	1	1,37
E. tereticornis	3	8,66

<u>La Nouvelle Zélande</u> : plus récemment (1976-79), ce pays a lancé des essais portant sur 5 espèces, orientés vers la sélection pour la résistance aux basses températures.

Plus les essais sont "intensifs", plus le coût est élevé, mais les avantages sont considérables surtout lorsque l'expérience revêt un caractère international, voire intercontinental:

- grande fiabilité des résultats,
- connaissance fine et complète de l'Espèce,
- établissement des lois de variabilité génétique,
- possibilité d'extrapoler les résultats en minimisant les risques,
- obtention d'une base génétique maximum,
- accès à une logique de l'interaction génotype-milieu,
- gain de temps important, surtout si le niveau descendance est pris en compte simultanément.

Le tableau suivant indique très approximativement le nombre de lots de semences testés par pays et par espèce :

PAYS \ ESPECES	*UROPHYLLA*	*TERETICORNIS*	*GRANDIS*	*CLOEZIANA*	*ALBA*	*SALIGNA*	*PILULARIS*	*GLOBULUS*	*BRASSIANA*	*CAMALDULENSIS*	*MACULATA*	*FASTIGATA*	*REGNANS*	*NITENS*	*DELEGATENSIS*
CONGO	85	38	15	33	26	10	5	-	8	56	-	-	-	-	-
BRESIL	55	47	42	35	30	23	28	10	19	47	12	4	9	7	10
ZIMBABWE RHODESIE	-	-	11	-	-	10	-	-	-	32	-	-	3	9	-
AFRIQUE DU SUD	20	17	64	-	-	19	-	-	-	43	24	4	-	22	-
AUSTRALIE	-	-	-	-	-	-	-	31	-	-	-	-	40	-	50
NOUVELLE ZELANDE	-	-	-	-	-	25	-	-	-	-	-	20	36	8	50

III - LES ESSAIS INTERNATIONAUX :

La définition de ce type d'essais n'est pas claire. Il est évident que lorsqu'une même provenance est essayée dans deux pays différents, l'essai revêt un caractère international, même si les stations sont très proches ; par contre, les résultats ont peu de chance d'être un jour comparés.

Les vrais essais internationaux sont fondés sur une volonté d'organisation commune pour les récoltes de graines, les mises en place et la ventilation des résultats.

Une telle volonté est particulièrement louable ; on ne compte malheureusement qu'un nombre très restreint d'expériences de ce type :

ESPECES	DATES	ORGANISATION	OBSERVATIONS
dalrympleana	1965	F.A.O.-F.T.B.	niveau descendance, FRANCE, ITALIE seulement
camaldulensis	1967	F.A.O.-F.T.B.	coordonnateur : J.F. LACAZE
deglupta	1970	F.T.B.Australie	7 provenances seulement
urophylla	1973, 75, 80	C.T.F.T. France	extension à partir de 1980
camaldulensis/ tereticornis/ alba	1973 - 1980	C.T.F.T.-C.S.I.R.O.	Niger,Hte-Volta, Sénégal, Congo.
cloeziana	1977	C.S.I.R.O.	Brésil, Congo, Afrique du Sud.
globulus	1977 - 1980	Forestry Commission, Tasmanie (Australie)	coordonnateur : R.K. ORME
microtheca	1980	F.A.O.-C.S.I.R.O	en cours (22 provenances)
grandis / tereticornis	1980	I.U.F.R.O. - C.S.I.R.O.	en cours

On constate également une gradation dans l'intensification des essais et on doit distinguer plusieurs niveaux :

3.1. Niveau 1 :

Collection de graines expédiées sans suite dans différents pays.

Il s'agit d'une procédure liée aux récoltes non systématiques exécutées depuis longtemps en Australasie, principalement par le C.S.I.R.O. de Canberra. (autrefois le F.T.B.), mais aussi par des récolteurs privés, pour répondre aux demandes des organismes de recherche et de développement. A cette époque, les moyens mis en oeuvre pour la récolte étaient, en général, assez faibles. Les collections, une fois rassemblées, étaient envoyées dans différents pays. Il en résultait des expériences non planifiées à partir de collections pauvres donnant souvent des résultats plus significatifs.

Beaucoup d'essais de provenances pourraient être classés à ce niveau. En tant qu'expérience internationale, celui sur *E. deglupta*, réalisé en 1970, correspond bien à cette classification.

L'*E. deglupta* est une espèce particulièrement intéressante pour les zones tropicales humides de basse altitude. Avec une aire naturelle très étendue, c'est la seule espèce représentée dans l'hémisphère Nord (Philippines). La collection n'avait rassemblé que 7 provenances originaires de 3 pays (Papouasie Nouvelle Guinée, Indonésie (Iles Célèbes), Philippines). Cette collection a été envoyée, en 1970, dans 22 pays tropicaux et subtropicaux.

Aujourd'hui, il est très difficile d'obtenir des renseignements sur les expériences qui ont suivi et il est à craindre que beaucoup d'entre elles aient disparu. Il est impossible de se faire une idée précise de la variabilité infraspécifique et de l'interaction génotype-environnement.

3.2. Niveau 2 :

Collections de graines contrôlées par un organisme international.

Ce type correspond au projet F.A.O. n° 6, relatif aux Provenances d'*E. camaldulensis*. Ce projet a été décidé en 1962 par le Comité de la Recherche forestière méditerranéenne. Les graines ont été récoltées par une équipe tunisienne guidée par des spécialistes australiens.

La collection comportait 32 provenances australiennes auxquelles on avait ajouté 2 provenances artificielles d'Israël.

21 pays dont 4 tropicaux (Congo, Madagascar, Nigeria, Zambie) ont participé à cette expérience qui était planifiée et coordonnée par J.F. LACAZE (I.N.R.A. - France). On compte 34 plantations comparatives, dont 9 en Israël et 7 au Nigéria. Des résultats généraux ont déjà été publiés en 1970 et 1977.

On peut classer également ici les essais en cours sur *E. globulus* organisés par R.K. ORME (Forestry Commission de Tasmanie) 31 provenances ont été distribuées à 9 pays (Australie, Nouvelle Zélande, France, Portugal, Colombie, Brésil, Uruguay, Afrique du Sud et Népal). Il faut noter cependant une faible coordination entre ces divers essais pas tous connus.

Ce type d'expérience permet d'accéder à une bien meilleure connaissance des lois de variabilité de l'espèce. L'établissement de celles-ci est d'une importance capitale dans la prévision des variations de comportement d'un site à un autre et donc pour conseiller l'utilisation des provenances, en fonction des conditions écologiques locales. Seules des expérimentations complètes et des exploitations poussées des résultats peuvent conduire à ces lois.

Ce niveau 2 (vaste échantillonnage, grand nombre de stations) est beaucoup plus avantageux que le niveau précédent. Par contre, on note encore un certain nombre d'inconvénients :

- conditions écologiques des lieux de récolte pas toujours bien connues,
- échantillonnage encore trop faible pour une aire naturelle aussi vaste,
- niveau descendance trop souvent négligé,
- résultats des essais pas toujours disponibles.

3.3. Niveau 3 :

Collections récoltées et expérimentées par le même organisme.

L'exemple en est donné par les travaux récents du Centre Technique Forestier Tropical (C.T.F.T.), qui a lancé, à partir de 1972, plusieurs campagnes de récoltes de graines en Australasie, toutes dirigées sur place par C. COSSALTER, en collaboration avec le F.T.B. et le C.S.I.R.O., ainsi qu'avec le Département des Forêts d'Indonésie.

3.3.1. Collectes :

On distingue 4 campagnes successives :

- en 1972-73 : une campagne de 14 mois avait réuni les collections de graines d'Eucalyptus suivantes :

AUSTRALIE : 300 provenances de 10 descendances chacune réparties en 112 espèces,

INDONESIE : 70 provenances d'*E. urophylla*,
: 17 " " d'*E. alba*.

- en 1975 : Le but était de récolter les provenances d'*E. deglupta* des Iles Célèbes et de Céram. Les arbres n'étant pas porteurs de graines, il n'y a pas eu de collecte. On a pu, cependant, inventorier en détail 40 provenances de cette espèce.
Par contre, on a pu compléter la collection d'*E. urophylla* avec 16 provenances récoltée sur les Iles d'ALOR, PANTAR et WETAR.

- en 1979 : Nouvelle campagne en INDONESIE (Ile de FLORES) pour l'*E. urophylla* : 3 provenances composées chacune de 30 à 50 descendances séparées.

- en 1980 : Campagne récente exécutée en Australie pour la satisfaction des besoins de la zone sahelienne. On a récolté 4 espèces (principalement *E. camaldulensis*), réparties en 6 provenances composées de 25 descendances séparées.

3.3.2. Expérimentations :

Soucieux d'une grande précision dans les recherches, cet organisme a constitué des collections d'une grande richesse et d'une haute valeur :

- provenances bien représentées (5 à 50 semenciers),
- descendances toutes individualisées,
- sélection des semenciers sur la forme et l'environnement,
- description précise du milieu écologique,
- établissement de fiches de récoltes détaillées.

Un réseau d'essais a pu être mis en place, largement ouvert sur l'amélioration génétique (prise en compte du niveau familial), et on commence à en tirer des résultats hautement significatifs.

3.3.3. Banque de graines :

Une banque de graines a été constituée au siège du C.T.F.T. à Nogent-sur-Marne. En particulier pour l'espèce *urophylla*, à la lumière des résultats actuels, 17 provenances ont été constituées à partir des récoltes 1973-75 et 79, réparties sur les Iles de TIMOR, FLORES, LOMBLEN, ALOR, PANTAR et WETAR et mises à la disposition de la F.A.O. pour l'organisation d'un très large essai international destiné aux zones tropicales humides et subhumides.

IV - PRINCIPAUX RESULTATS :

4.1. Zones tempérées et subtropicales :

E. camaldulensis :

Le résultat le plus remarquable tient à la mise en évidence de la provenance n° 6845, LAKE ALBAKUTYA, très performante et très stable dans tous les pays méditerranéens et même tropicaux, sauf sous les climats à forte hygrométrie.

A Pointe-Noire (Congo), en particulier on note une inadaptation notoire de l'ensemble des provenances, même pour les 2 premières : Katherine (6869) et Petford (6953) classées souvent en tête dans la zone tropicale.

Globalement, la latitude du lieu d'introduction semble moins influer sur l'ensemble de l'espèce que *la forte hygrométrie* vis-à-vis de laquelle l'*E. camaldulensis* cède le pas à l'*E. tereticornis*.

Des études plus fines ont été réalisées. Il faut souligner, en particulier, les travaux de Karschon en Israël, qui a étudié de nombreuses variables. Les résultats les plus importants, établis *dans ce pays*, sont les suivants :

Production : (variations importantes, de 1 à 8 selon la provenance
(corrélation directe avec la latitude du lieu d'origine

Aptitude à rejeter de souche : liaison positive avec la taille des arbres avant la coupe

Rectitude : corrélation négative avec la latitude du lieu d'origine

Taux de survie : corrélation positive avec la longitude du lieu d'origine

Résistance au froid : corrélation positive avec la teneur en matière sèche des feuilles, l'altitude et l'éloignement de la mer du lieu d'origine

Résistance à la chaleur : pas de corrélation évidente avec les éléments climatiques du lieu d'origine. Ne semble pas être un caractère sélectif.

Teneur en matière sèche des feuilles : corrélation positive avec la latitude et la température minimale du mois le plus froid au lieu d'origine.

Tolérance à la salinité et à l'hydromorphie du sol : il s'agit d'un caractère sélectif en relation avec la présence de conditions écologiques particulièrement contrastées, au lieu d'origine (lacs salés secs, rives de cours d'eau, ruisseaux temporaires). La provenance la plus résistante est celle du LAKE ALBAKUTYA (6845) (située à proximité d'un lac salé le plus souvent sec) suivie de KATHERINE (6869), puis de WYNDHAM (8409). D'une façon générale, l'espèce est jugée comme très résistante à une inondation non salée pendant 4 mois (indépendamment des provenances).

Fréquence des lignotubers sur les jeunes plants : en relation étroite avec le lieu d'origine des graines. On distingue une zone où la fréquence est très élevée (Centre Queensland) qui diminue vers l'Ouest et le Sud et finit par s'annuler à l'extrémité de l'aire (Victoria). Cette fréquence reste toujours élevée au Nord de l'Australie. L'auteur en déduit une hypothèse sur la migration de l'espèce au cours des temps géologiques.

Il faut noter que des plantations conservatoires de provenances ont été installées dans plusieurs pays :

Provenances conservées	Pays
LAKE ALBAKUTYA (V.)	MAROC, TUNISIE, ITALIE
KATHERINE (N.T.)	NIGERIA, AUSTRALIE
PETFORD (QLD)	NIGERIA, AUSTRALIE, THAILANDE
GIBB RIVER (W.A.) *	AUSTRALIE, THAILANDE

* Cette provenance s'est révélée souvent très performante (Thaïlande, Malawi, Equateur).

E. globulus :

Cette espèce présente beaucoup d'intérêt dans différents pays (BRESIL, ESPAGNE, PORTUGAL, ITALIE, INDE, etc...).

Les résultats sont encore trop récents. On constate cependant de grandes variations aussi bien entre les espèces du groupe (*E. maidoni, E. bicostata, E. pseudoglobulus, E. globulus*) qu'à l'intérieur de la principale espèce *E. globulus*.

En Tasmanie, les meilleures performances actuelles,du point de vue de la croissance, reviennent à *E. globulus & E. pseudoglobulus*, principalement à partir des provenances de la côte Ouest (la meilleure à 2 ans est OTWAYS, VICTORIA).

On attend les résultats des autres pays pour émettre des recommandations. Une particularité de cette expérience tient à l'étude des propriétés du bois. Des différences très grandes entre provenances ont été détectées, en particulier en ce qui concerne le rendement en pâte à papier, ce qui ouvre des perspectives d'amélioration très intéressantes.

E. grandis :

Cette espèce apparaît souvent mieux classée qu'*E. saligna*. Il s'agit, comme pour *E. camaldulensis & E. tereticornis*, d'une espèce ayant deux types de réponse, selon la zone climatique.

En climat subtropical, ce sont les provenances du Sud de l'aire naturelle (N.S.W.) qui sont les plus performantes en particulier : COFFS HARBOURG (AFRIQUE DU SUD, ZIMBABWE-RHODESIE, BRESIL) ;GYMPIE et COOPERNOOK (AFRIQUE DU SUD), KYOGLE (BRESIL).

De nouveaux essais plus intensifs sont en cours, aidés par l'I.U.F.R.O.

4.2. Zones tropicales :

4.2.1. Régions tropicales sèches :

Dans la zone sahelienne, au Sud du Sahara, *la très grande sécheresse* est *une limite* importante au genre Eucalyptus. Les recherches, en fait, sont plutôt des essais spécifiques, dans lesquels *les provenances jouent un rôle capital*, ce qui complique l'action des chercheurs en obligeant à multiplier les placettes de contrôle (on retrouve exactement cet aspect, lorsque l'on cherche à franchir une autre limite importante du genre : *le froid*).

Actuellement, les expériences, aidées le plus souvent par le C.T.F.T., concernent 40 espèces. Il est encore trop tôt pour conclure mais on peut dès maintenant mettre l'accent sur 3 espèces :

E. alba :

Limité à l'isohyète 600 mm en zone continentale, il présente à partir de 800 mm un bon comportement, mais produit moins qu'*E. camaldulensis*.

E. camaldulensis :

Les graines en provenance des pays méditerranéens sont totalement inadaptées. Seules semblent convenir, à partir de l'isohyète 750 mm, les provenances du Queensland (Centre - Nord) et du Western-Australia (Derby et Halls Creek).

E. microtheca :

Les essais vont heureusement s'intensifier avec le lancement d'une expérience internationale encouragée par la F.A.O. Jusqu'ici, cette espèce semble très résistante à la sécheresse (en particulier la provenance 8036, FITZROY CROSSING - W.A.). Sa production est cependant très faible et il faut poursuivre les tests.

Ces résultats se trouvent confirmés par différents pays (TANZANIE en particulier).

Si pour l'instant, les Espèces pures ne semblent pas donner de résultats spectaculaires, il y a lieu cependant de porter la plus grande attention aux hybridations entre ces trois espèces.

4.2.2. Régions tropicales humides :

E. deglupta :

Quelques résultats très partiels ont été publiés (Papouasie-Nouvelle Guinée, Porto-Rico, Malawi, Kenya). Les essais, installés en Nouvelle Bretagne (P.N.G.),permettent de tirer quelques remarques générales :
Les provenances d'altitude de Papouasie-Nouvelle Guinée s'adaptent mal à basse altitude en climat insulaire; Par contre, les provenances d'Indonésie et des Philippines semblent au moins aussi bonnes que les provenances locales (J.L. AUNA, communication personnelle).

E. urophylla :

La forte hygrométrie constitue une 3ème limite pour le genre. En dehors d'*E. deglupta*, très peu d'espèces tropicales se rencontrent naturellement en "rain forest".

Entre l'*E. deglupta* et les espèces australiennes le plus souvent adaptées à des zones sèches, il semblait manquer un maillon écologique important. Celui-ci existe, il est constitué par l'espèce *E. urophylla (= E. decaisneana)*, dont l'aire naturelle comprend la plupart des Iles de la Sonde (TIMOR, FLORES, LOMBLEN, ADONARA, PANTAR, ALOR, WETAR).

Parmi les espèces récemment introduites, l'*E. urophylla* se présente comme l'une des plus attractives et des plus prometteuses.

En comparant les résultats de la Côte-d'Ivoire, du Congo, de la Guyane et du Brésil (ARACRUZ FLORESTAL), on constate, pour la majorité des régions de provenance, une *remarquable stabilité* des classements. On peut donc en tirer les premières lois de variation :

La variabilité de l'espèce est considérable à tous les niveaux (provenances, familles, individus).

Les deux principaux facteurs de variation sont la latitude et l'altitude qui varie de 300 à 2500 m dans l'aire naturelle.

Une différence importante existe entre les provenances de l'arc Sud et celles de l'arc Nord de l'archipel. Deux variétés semblent exister :

- Arc Sud (surtout) : une variété à petit fruit et à écorce rugueuse d'altitude, adaptée à un climat plus humide et plus frais.

Pour les zones tropicales humides et subhumides de basse altitude, ce sont les provenances de l'arrière pays de DILI (zone de REMEXIO et peuplement relique de RAILACO), qui donnent les meilleurs résultats. Par contre, les provenances de haute altitude (région de MAUBISSE et MONTE MOUTIS) ne s'adaptent pas et régressent rapidement, ce qui ne semble pas être le cas sous des climats plus tempérés (Sud du BRESIL).

- Arc Nord : une variété à gros fruit et à écorce lisse, adaptée à une altitude plus basse et à un climat tropical chaud et à saison sèche marquée.

Cette variété s'est montrée la meilleure. En particulier, les provenances de FLORES (MONTE EGON, MONTE LEWOTOBI) et d'ALOR (région Ouest : BOKA AFANG, MONTE MOENA).

L'adaptation, la forme et la croissance sont excellentes. Au Brésil, l'espèce est résistante à Diaporthe cubensis. Les résultats enregistrés sont spectaculaires. La provenance n° 82 (MONTE LEWOTOBI) donne, par exemple, les résultats suivants à la station de LOUDIMA (CONGO) :

Hauteur totale à 51 mois	: 18,40 m
Circonférence à 1,50 m à 51 mois	: 40 cm
Production	: de l'ordre de 40 m3/ha/an à 5 ans

E. tereticornis :

Les essais du C.T.F.T. (Côte-d'Ivoire, Cameroun et Congo) montrent que les provenances les meilleures sont situées au Centre du Queensland : MOUNT GARNET, COOKTOWN, MOUNT COOLON, HERBERTON.

Au Congo, la production est de l'ordre de 30 m3/ha/an et la variabilité intraprovenance est assez grande. Ces résultats se retrouvent dans d'autres pays, en particulier au BRESIL et au MEXIQUE.

Des peuplements conservatoires de provenances ont été installés au CONGO en 1977 (COOKTOWN et MOUNT GARNET). Cette dernière provenance a également été mise en conservation ex situ en ZAMBIE, au NIGERIA et à FIDJI.

E. cloeziana :

Cette espèce a fait l'objet d'essais de provenance de niveau 1, puis récemment de niveau 2, grâce à la collaboration du C.S.I.R.O. qui a procédé à des récoltes précises dans toute l'aire naturelle (QLD). Bien que non coordonnés, ces essais ont été installés dans divers pays (BRESIL, AFRIQUE DU SUD, CONGO).

Au Congo, de 1971 à 1974, on a introduit 14 provenances, dont 2 : MONTO et CARDWELL étaient représentées respectivement par 10 et 6 descendances. En 1977, les 19 provenances du C.S.I.R.O. (+ 1 locale) ont été installées par descendances séparées (en tout 118 descendances). Cette espèce a une croissance lente au départ, mais régulière et soutenue. Sa productivité devient très grande vers l'âge de 12 ans en savane sableuse pauvre et tend à rattraper, à cet âge, les meilleures espèces. L'adaptation est excellente et le bois de bonne qualité. De plus, la couverture du sol est forte, ce qui conduit à une *afforestation stable.*

La provenance de MUNTO (Sud Queensland) semble, jusqu'ici, la meilleure. L'espèce réagit bien à la fertilisation et montre une *très forte variabilité interdescendance*, ce qui donne une prise excellente à la sélection (gain de 35 % sur la hauteur totale à 3 ans en choisissant la meilleure famille).

L'espèce a fortement retenu l'attention des chercheurs des autres pays. Au Zimbabwe-Rhodésie, elle est la meilleure espèce pour la production de poteaux.

E. grandis :

Dans les zones humides, cette espèce avait été éliminée par manque d'adaptation. Par contre des essais récents au CONGO et au BRESIL (ARACRUZ FLORESTAL) ont montré que les provenances de l'extrémité Nord de l'aire naturelle de cette espèce (région d'ATHERTON) s'adaptaient bien et résistaient au BRESIL à Diaporthe cubensis.

L'espèce reprend donc de l'intérêt pour ces zones. En particulier, elle donne des hybrides extrêmement productifs avec *E. urophylla.*

V - RECOMMANDATIONS :

5.1. Poursuite des essais internationaux de provenances :

5.1.1. Lancer de nouvelles campagnes de récoltes :

- Il est urgent de constituer des collections complètes pour l'*E. deglupta*, qui intéresse tous les pays tropicaux à climat humide.
  Il s'agit d'une campagne difficile et il est nécessaire d'établir une collaboration efficace (F.A.O. - I.U.F.R.O.- C.T.F.T. - C.S.I.R.O.).
- Il faut également établir des collections de provenances pour des espèces nouvelles présentant de l'intérêt pour les zones tropicales :
  E. brassiana
  E. pellita
- Il faut reprendre des collections détaillées pour des espèces intéressantes dans les zones subtropicales, mais assez mal représentées :
  E. dunnii
  E. deanei
  E. nitens

Les aires naturelles sont très peu étendues, et il sera nécessaire de travailler au niveau de la descendance.

5.1.2. Poursuivre les expérimentations :

Dans beaucoup de pays, les essais de provenances sont encore trop pauvres. Il est indispensable de lancer de *nouvelles séries d'expérimentations* à partir des collections actuelles complètées si nécessaire , en particulier pour les espèces suivantes :

E. microtheca, E. alba, E. camaldulensis, E. tereticornis, E. grandis, E. saligna, E. cloeziana, E. urophylla, E. globulus.

Les instances internationales doivent *recenser les besoins* et pousser vers une plus large utilisation des collections.

Pour chaque expérience, il est nécessaire de *nommer un coordonnateur* chargé de veiller à *la cohérence* des expérimentations, de *centraliser les données* et de *diffuser les résultats.*

5.1.3. Intensifier les nouvelles expérimentations :

Il est indispensable d'attirer l'attention des futurs coordonnateurs sur quelques points importants : on doit éviter les erreurs du passé (mauvaises représentations des provenances, essais trop restreints, mauvais dispositifs, etc...).

La qualité est préférable à la quantité, et le réseau d'expériences doit être le fruit d'un choix méticuleux des sites.

Ce réseau doit comprendre deux types de réalisations :

- des *essais majeurs*, comprenant des collections complètes, installés dans un petit nombre de sites choisis en fonction de leur intérêt écologique général, mais aussi plus localement dans un but économique et pour des raisons pratiques.
- des *essais mineurs*, comprenant des collections moins détaillées.
  Véritables éléments de liaison dans la compréhension de l'ensemble de l'expérience, ils peuvent cependant répondre parfaitement à des objectifs économiques locaux.

5.2. Suivre les expérimentations en place et en tirer les résultats :

Il est demandé, à tous les chercheurs, un effort dans la continuité des expérimentations et dans la publication des résultats, dont la valeur dépend surtout de la confrontation avec ceux enregistrés dans d'autres milieux, seule possibilité pour l'établissement des lois de variabilité génétique, et donc l'extrapolation des résultats à des sites nouveaux.

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IMPLANTAÇÃO E MANEJO DE FLORESTAS DE RÁPIDO CRESCIMENTO

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ESTABLISHMENT AND MANAGEMENT OF FAST GROWING FORESTS IN BRAZIL

Summary

Wood activities are actually concentrated in Central-East and Southern Brazil, due to existed Tropical Seasonal and Temperate Rainforest, that developed wood industries in this region. These forests are almost exhausted and Amazon is too far.

Thus the present and future wood supply for fuel, charcoal, pulp, board, poles and saw timber, is dependent more and more of man-made forests.

The demand of forest products is presented in table 2.

Due to native species low economic possibilities, reforestation has been based in exotics, mainly Eucalyptus and Pinus, that can be cultivated in the whole Brazil.

Government incentives, started in 1967, has been stimulating reforestation from southern toward eastern and central country, where 150 million hactars of suitablé soil under "cerrado" or savanna type covering vegetation is available.

Table 3 shows planted area through incentives in 10 years.

Presently strong emphasis is being done to produce wood for energy. At the same time ecologycal aspects has raised attention and the integrated use of man-made forests for production, protection and recriation has been considered very important.

Main planted species are: a) sub-tropical - Pinus elliottii, P.taeda, Eucalyptus viminalis and Araucaria angustifolia (Parana pine); b) tropical - Pinus oocarpa, P.caribaea hondurensis, bahamensis and caribaea, P.patula, P.strobus chiapensis, Eucalyptus saligna, E.grandis, E.urophylla, E. citriodora, E.tereticornis, Cunninghamia lanceolata, etc.
Potential species: Tectona grandis, Toona ciliata, Anthocephalus cadamba, E.pilularis, E.pellita, E.camaldulensis, E.cloeziana, E.deglupta, E.dunii, etc.

- Establishment -

The new forest objectives are very important and must be defined, in order to permit select proper species to be planted, capable to produce adequate wood quality.

1. Seedlings - usually are produced locally, by direct sowing, in plastic bags, containing sub-soil. Mineral fertilization is applied, parcelled, by irrigation.

It is necessary to develop better container permeable to root and that permit mechanized planting operation.

Time needed for seedlings to be ready is for eucalipts: 2-4 months, for pines 4-8 months and for native species 10-12 months.

2. Soil preparation -

Mechanized operations are requested in all fases of wood production. So, flat terrains is needed and, soils under "cerrado" vegetation, has been prefered, also because is cheaper and available.

Land is cleared, plowed and disked.

3. Spacing for planting -

It affects silvicultural operations, costs, tree growth, management, exploitation, prodution and wood uses.

Spacing used better are 2x2m, 2x2,5m, 3x1,5 and 3x2,0m. Is important that the spacing permits mechanized operations for weeding, exploitation, etc. in order to reduce costs.

4. Liming and mineral fertilization.

Soils used for man-made forests are usually those not suitable for agriculture, for being sandy, poor and acid.

Liming is necessary mainly for eucalipts. Has been applied 2-3 ton/ha, during soil preparation.

Fertilization is generally used of about 100g/plant of NPK 10:28:6 + Boron, inside furrow, mecanically, at planting time only. Volume increments has been possible up to 50% or more.

Due to fertilizers high costs new elements sources and application time and form is needed to study.

Pines usually do not respond to fertilization.

5. Ants and termites control -

The genus Atta, Acromyrmex and Syntermes are very much incident particularly in "cerrado" soil.

Ants control is done during soil preparation and is continued after planting, periodically.

Termites control is preventive by applying insecticide in the planting hole, just once.

There are few other insect pests that eat leaves. They are controled better through biological control.

Main desease problems are damping off in seedling bed, and recently, some bole canker caused by Diaporthe cubensis in some eucalipts, when planted out of ecological conditions.

6. Planting -

Seedlings are planted manually in hole or mecanically in furrow.

Prefered season is rainy one, but for large annual program, some companies plant during the whole year, by watering in dry season.

In Southern states bare root pine seedlings are planted, during rainy winter, with good survival.

7. Weeding -

Eucalipts need strongly to keep land surface clean during the first year. Disking is used in rows and manual weeding or pre-emergency herbicide is applied along plant lines. For pines, weeding is needed up to the second year.

- Management -

Normal long rotation management system is used for

pine stands through several thinnings and prunings. The main objective is saw logs, from crop trees, and wood from thinning is used for pulp, particle board, etc.

Eucalipts are usually exploited, by clear cut, each seven year rotation. Good stands can produce 45 steres/ha/year.

Recently a new interest is raised, for saw log, and some companies are trying to join both objectives: industrial wood plus saw logs.

Instead of thinning, normal clear cut is done each seven year for producing thin wood for industry, and about 160 best trees/ha are kept for future log crop, at about 20 year old.

- Regeneration of eucalipt stand

After the first clear cut, regeneration is possible by stump sprouting. In average, three economical rotations is possible, when sprouts are maneged adequately. For this purpose ant control, mineral fertilization, disprouting and weeding are very important and good volume increments, up to 60 steres/ha/year of wood with bark, can be obtained.

Stand density is tried to be kept by enrichment through planting a new seedling, in place of each dead stump.

1. INTRODUÇÃO -

A atividade madeireira no Brasil, representada pelas indústrias que usam a madeira como matéria-prima, está concentrada na região centro-sul, compreendida pelos estados de Minas Gerais, Espírito Santo, São Paulo, Paraná, Santa Catarina e Rio Grande do Sul. Esta região, originariamente recoberta por florestas naturais, propiciou um desenvolvimento mais rápido dessas indústrias, principalmente as serrarias, pela grande disponibilidade de madeira de boa qualidade, tanto de espécies folhosas como, e especialmente, a do Pinheiro do Paraná (*Araucaria angustifolia*) Bert. O. Ktze nos estados do sul.

A partir daí, com o progressivo aumento do consumo de madeira, associado ao rápido desmatamento destinado a abrir terras para a agricultura e pecuária e, com o esgotamento das reservas de Araucaria, destinada principalmente para exportação, o abastecimento do mercado interno passou a ser, cada vez mais dependente da madeira produzida através dos reflorestamentos.

Devido à pouca possibilidade econômica das espécies nativas, os reflorestamentos tem sido baseados em espécies introduzidas, de rápido crescimento, representadas, na maioria das áreas, pelos generos Eucalyptus e Pinus.

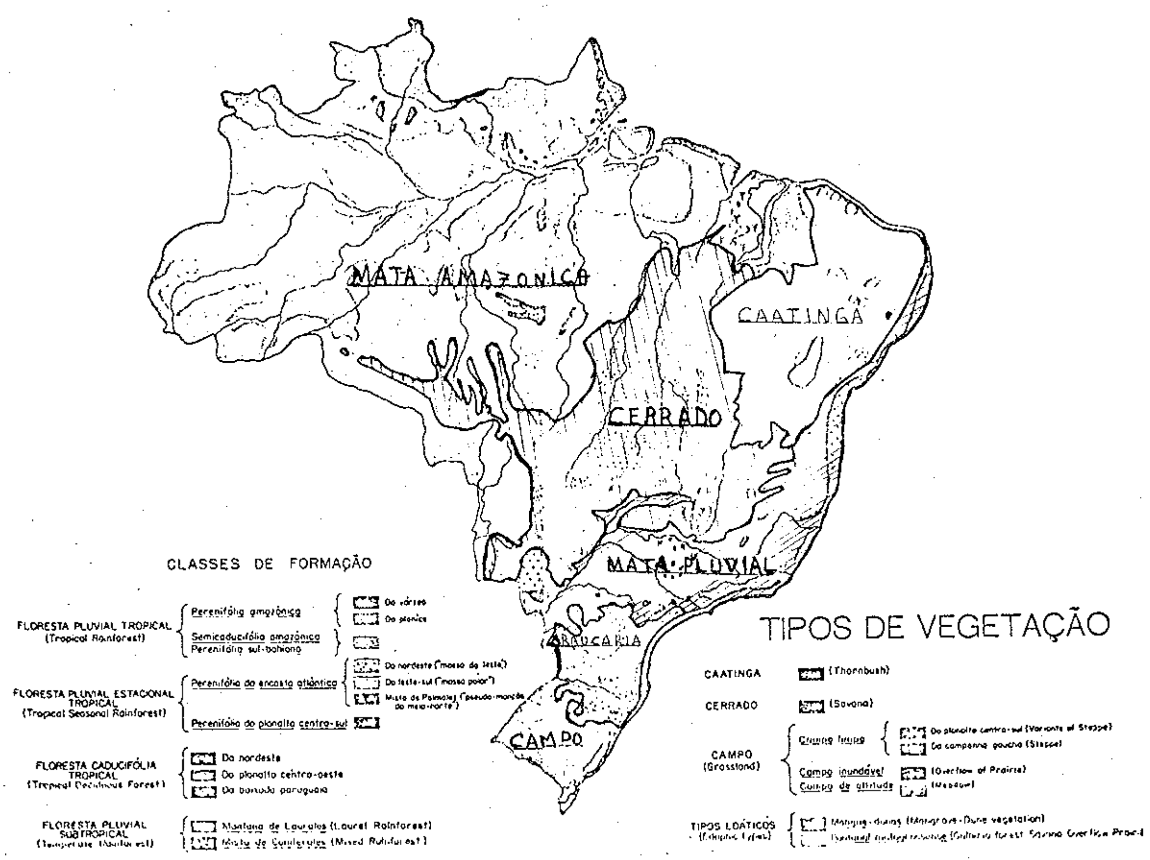
Quadro 2. DEMANDA TOTAL PROJETADA DE PRODUTOS FLORESTAIS NO BRASIL, POR REGIÃO, 1979-1985: EQUIVALÊNCIA EM MADEIRA ROLIÇA - Unidade: 1000 m^3.

- TOTAL PROJECTED DEMAND OF FOREST PRODUCTS IN BRAZIL, BY REGION 1979-1985: EQUIVALENCE IN ROUND WOOD - Unit: 1000 m^3.

Ano Year	Norte North	Nordeste Northeast	Sudeste Southeast	Sul South	Centro-Oeste Center-West	Total Total
1979	8262,0	65964,5	116421,4	33373,9	12030,7	236052,5
1980	8345,6	66983,8	121215,8	34578,5	12461,0	243584,7
1981	8452,6	66876,1	126140,9	35720,1	12837,2	250006,9
1982	8560,8	66860,8	130495,2	36866,1	13238,6	256011,5
1983	8688,8	66940,2	135184,3	38106,7	13673,8	262593,8
1984	8833,2	67132,0	140112,0	39456,0	14141,9	269675,1
1985	8997,2	67455,5	145301,7	40869,6	14654,7	277277,7

Fonte: FAO/SUPLAN/COPLAN-IBDF

São generos que, pelo grande número de espécies e ampla dispersão de ocorrência natural, podem ser cultivados em todo o Brasil. Apresentam capacidade de boa adaptação tanto cli



Quadro 3. - ESTATÍSTICA DOS PLANTIOS REALIZADOS ENTRE 1967 - 1977
(Por espécie/ano de plantio - Lei nº 5.106 e Decreto - Lei nº 1.134)

- STATISTICS OF PLANTED AREAS BETWEEN 1967 - 1977

Ano Year	Pinus	Eucaliptos Eucalyptus	Araucária	Nativas Natives	Frutíferas Fruits	Palmito Palmeto	Outras Others	Total (ha)
1967	18.159,08	13.876,95	1.728,91	821,87	172,72	-	-	34.759,53
1968	60.898,73	30.057,32	7.329,68	1.892,35	2.062,72	-	669,10	102.909,90
1969	96.797,93	53.800,22	7.669,92	2.716,85	1.278,47	-	120,00	162.383,39
1970	119.913,40	83.609,42	12.029,50	4.451,06	1.779,41	26,00	196,44	222.055,23
1971	98.053,27	129.053,40	8.079,69	3.834,77	2.410,01	3.350,00	3.688,81	248.469,95
1972	101.059,55	172.440,71	7.755,71	3.448,28	9.088,64	3.265,79	7.297,68	304.356,36
1973	86.180,99	161.132,11	7.828,15	6.535,90	7.023,34	21.802,29	3.651,09	294.153,87
1974	83.245,08	188.335,74	7.529,73	3.803,83	8.857,02	28.088,01	4.519,58	324.378,99
1975	94.221,67	222.717,95	6.617,77	5.890,96	6.816,20	58.519,16	3.455,91	398.239,62
1976	107.001,06	262.337,23	4.845,45	4.501,90	11.345,42	73.193,61	6.024,54	469.249,21
1977	99.277,40	194.351,90	758,08	850,91	30.269,93	20.047,80	875,91	346.431,93
TOTAL	964.808,16	1.511.712,59	72.171,59	38.748,68	81.103,88	208.296,66	30.499,06	2.907,337,98

mática como edáfica, para crescer rápida e economicamente em diferentes regiões do país, inclusive nas extensas áreas dos cerrados no Brasil Central.

Os reflorestamentos incentivados, a partir de 1967 iniciaram suas atividades nos estados do sul e, gradualmente estão sendo deslocados para as regiões tropicais do Brasil Central, Leste e Nordeste.

A área reflorestada nos últimos anos foi de aproximadamente 350000 ha/ano.

Esses reflorestamentos foram destinados bàsicamente - ao suprimento das indústrias de celulose e papel, painéis, óleo essencial e serraria, além da produção de postes, dormentes moirões, carvão e lenha.

Atualmente grande enfase está sendo dada aos reflorestamentos para a produção de energia, e uma nova tecnologia está sendo desenvolvida, pela pesquisa, visando a formação das chamadas florestas ènergéticas.

Da mesma forma já se considera que a continuidade de produção de toras para serraria, laminação e faqueado, na região centro sul do país, depende integralmente dos reflorestamentos.

Paralelamente, vem existindo uma crescente preocupação ecológica, onde se consideram importantes os aspectos de uso integrado das florestas implantadas para fins de proteção ao solo, a água, a fauna silvestre e equilíbrio biológico, além da recreação nos reflorestamentos próximos aos grandes centros.

As principais espécies cultivadas são:

a) na região sub-tropical (estados do sul) - com chuvas bem distribuídas e ocorrência de geadas.

Pinus elliottii, *Pinus taeda*, *Eucalyptus viminalis* e *Araucaria angustifolia*.

Espécies com potencial para a região: *Eucalyptus dunii*, *E.deanei*, *Mimosa bracatinga*, etc.

b) na região tropical (de São Paulo para o norte) - com clima quente e inverno seco.

Pinus oocarpa, *P.kesiya*, as 3 variedades do *P.caribaea*, *P.patula* e outros; *Eucalyptus saligna*, *E.grandis*, *E.urophylla*, *E.citriodora*, *E.tereticornis*, *E.maculata*, *Cunninghamia lanceolata*, *Cupressus luzitanica*, etc.

Espécies com potencial para a região (ainda pouco cultivadas): *Tectona grandis*, *Toona ciliata*, *Anthocephalus cadamba* *Eucalyptus pilularis*, *E.pellita*, *E.camaldulensis*, *E.cloeziana*, *E.deglupta*, etc.

O uso destas espécies está limitado ainda pela pequena disponibilidade de sementes.

2. IMPLANTAÇÃO -

Definidos os objetivos do reflorestamento, são escolhidas as espécies com potencial econômico, que sejam capazes de produzir madeira com as qualidades desejadas e que sejam bem adaptadas às condições ecológicas da região a ser reflorestada, de modo a garantir alta produtividade volumétrica de madeira.

2.1. Produção de mudas -

As sementes são adquiridas e semeadas em viveiros próprios das empresas reflorestadoras.

As mudas no geral são produzidas por semeadura direta nos recipientes. Como substrato utiliza-se sub-solo, por ser livre de fungos, ervas invasoras, insetos, nematoides, etc. Desta forma dispensa-se a desinfestação do solo. Depois de encanteirados os recipientes são regados, as sementes são distribuídas, cobertas com leve camada de terra e protegida por uma camada de casca de arroz. Mantida a irrigação, ocorre normalmente a germinação e, quando necessário, procede-se ao desbaste das mudas em excesso em cada recipiente. A muda remanescente no recipiente individual recebe cuidados até alcançarem altura própria para o plantio no campo.

A fertilização mineral pode ser suprida através da irrigação de solução aquosa de NPK, parceladamente à medida da necessidade, durante toda a fase de viveiro.

Os recipientes mais usados são o saco plástico, laminados de madeira e torrão paulista. Todos esses tipos apresentam inconvenientes próprios, seja devido ao enovelamento das raízes ou devido às perdas de mudas ou a dificuldade da mecanização da operação plantio. Há necessidade de desenvolver-se recipientes a partir de papel tratado, que seja, ao mesmo tempo, permeável às raízes e resistentes ao manuseio.

Em condições especiais de clima, como nos estados do sul, o plantio de pinus é feito com mudas de raiz nua. Neste caso todas as operações de produção de mudas e de plantio no campo são feitas mecanicamente.

O tempo de formação das mudas no viveiro é variável entre as espécies; região e época do ano.

Para eucalipto - 2 a 4 meses
Para pinus - 4 a 8 meses
Espécies nativas 10 a 12 meses

As mudas formadas em recipientes, quando atingem a fase de plantio, são removidas, selecionadas e encaixotadas, com uma semana de antecedência, para forçar a sua rustificação visando aumentar a sua resistência de modo a garantir maior sobrevivência no campo.

Com respeito às essências nativas muito pouco tem sido feito. O mesmo método de produção de mudas é viável para a Araucaria e várias outras espécies.

2.2. Preparo do solo -

Com poucas exceções de reflorestamentos comerciais implantados em terrenos acidentados, onde todas as operações são obrigatoriamente manuais, a maioria dos projetos incentivados tem sido direcionada para terrenos mecanizáveis.

A mecanização é imperiosa, atualmente, sendo necessária em todas as fases da produção de madeira.

Como consequência disso, para os reflorestamentos tem sido preferidos os terrenos sob a cobertura vegetal tipo cerrado. São terras levemente onduladas, baratas, bem localizadas, cortadas por estradas e pouco utilizadas pela agricultura por serem solos ácidos e de baixa fertilidade.

A área de cerrado no Brasil é estimada em mais de 180 milhões de hectares e localiza-se, principalmente, na região central do país ocupando boa parte dos estados de Mato Grosso, Goiás, Minas Gerais e Maranhão.

Os grandes projetos de reflorestamento caminham para essa região.

O preparo do solo no geral consiste do desmatamento, onde o abate da vegetação é feito por máquinas pesadas equipadas com lâminas frontais e/ou correntões. Depois de seco esse material é enleirado para posterior queima.

Nessa fase é feita a erradicação das formigas cortadeiras.

O revolvimento do solo consta de gradagem pesada, cruzada por uma gradagem leve. Em seguida entra o sulcamento, a fertilização mineral e o plantio.

Tem sido demonstrado, experimentalmente, a conveniência de um preparo bem feito do solo para propiciar alta sobrevivência e maior crescimento das árvores em cultura intensiva. Tal preparo do solo reduz a necessidade de tratos culturais, permite uma rápida implantação da floresta e contribui para aumentar a sua produtividade.

2.3. Espaçamento entre plantas -

A escolha do espaçamento de plantio é função de uma série de fatores. Influi sobre as operações silviculturais, os custos, o crescimento das árvores, o manejo, a exploração, a produção e os usos da madeira.

Os espaçamentos usados são sempre superiores a 4 m^2 por planta, preferindo-se 2,5 x 2m, 3 x 1,5m e 3 x 2,0m. A população varia portanto de 1667 a 2500 árvores por hectare.

Os fatores mais considerados nessa definição do espaçamento são a possibilidade da mecanização das operações e a produtividade em termos de volume comercial, em função do uso que se vai dar à madeira.

É importante que o espaçamento permita a entrada de máquinas para os tratos culturais e para a exploração da madeira, seja através de desbastes nas rotações longas ou por cortes rasos em rotações curtas.

Um aspecto importante que está merecendo novos estudos é o efeito do espaçamento de plantio sobre a qualidade da madeira para fins mais nobres. A proporção alta de madeira juvenil e a quantidade de nós, nas peças, tem depreciado a madeira obtida dos reflorestamentos.

Espaçamentos iniciais pequenos propiciariam à contenção da madeira juvenil em um pequeno diâmetro, além de forçar a formação de ramos leves com menor prejuizo à qualidade da madeira.

2.4. Correção do solo e fertilização mineral -

Os solos utilizados para o reflorestamento são, usualmente, aqueles marginalizados pela agricultura, por serem ácidos e pobres. Nessas condições, o cultivo de espécies exigentes, como por exemplo os eucaliptos, depende dessas providências iniciais.

A correção se faz necessária, não só pela elevação do pH, mas também pela neutralização do alumínio livre e o suprimento de Cálcio e Magnésio.

O calcário dolomítico é aplicado a lanço sobre toda a superfície do terreno após o desmatamento. A sua incorporação será feita durante o revolvimento, operação que faz parte do preparo do solo. A dosagem usual tem sido de 2 a 3 toneladas/ha.

Como a fertilidade natural desses solos é muito baixa em todos os elementos minerais, a fertilização tem sido feita com NPK e alguns micro-nutrientes, como o Boro e Zinco.

Em solos muito pobres é comum observar-se sintomas típicos de carência desses elementos. No caso do Boro, o sintoma característico é a morte do ponteiro, que prejudica sensivelmente o crescimento em altura e a forma da árvore.

A aplicação da mistura fertilizante é feita mecanicamente, em filete contínuo, no fundo do sulco de plantio, para a devida incorporação do adubo ao solo.

Aplicações em cobertura, após o plantio, atrasam o crescimento. Se aplicado após o segundo ano de idade, praticamente não respondo.

Resposta considerável pode ser obtida, entretanto, no crescimento da brotação, após o corte raso do eucalipto. A aplicação do NPK deve ser feita, de preferência imediatamente antes do corte, em sulco na entre linha de árvores. Tem mostrado, através da experimentação, respostas significativas também quando aplicado o fertilizante a lanço sobre a superfície do terreno após a exploração.

Devido aos custos continuamente elevados dos fertilizantes, estudos merecem ser feitos para melhor adequação da fertilização mineral nos reflorestamentos. Formulações e dosagens economicas devem ser pesquisadas para diferentes tipos de solo e espécies plantadas. Da mesma maneira, novas fontes de elementos devem ser consideradas especialmente os fosfatos naturais, mais baratos, porém de baixa solubilidade, cuja dosagem e forma de aplicação precisam ser ajustadas.

Outro aspecto importante a ser considerado para garantir altas produtividades de madeira é a escolha apropriada da espécie em função de suas exigências e tolerância aos solos mais pobres.

Os pinus, no geral, tem demonstrado pequena resposta à aplicação de fertilizantes. Em condições de extrema pobreza de solo, entretanto, responde positivamente à calagem e a aplicação de fosfato. Crescendo bem em solos pobres, os pinus tropicais apresentam maior potencial produtivo que os eucaliptos, principalmente, nos cerrados do Brasil Central onde as condições ecológicas são agravadas pela ocorrência de estiagem prolongada durante o ano, e intenso deficit hídrico no solo. São condições limitantes para os eucaliptos.

2.5. Desinfestação do solo -

2.5.1. Controle das formigas cortadeiras -

As formigas mais importantes que causam sérios prejuízos aos reflorestamentos são as espécies do gênero Atta e Acromyrmex.

O primeiro combate visa a erradicação dessas formigas antes da instalação da cultura florestal. Assim durante o preparo do terreno, ou seja, na fase após a sua limpeza, porém, antes do revolvimento da superfície, tem-se maior facilidade de localização dos formigueiros.

Para isso aplicam-se dosagens maciças de formicidas na forma de iscas, durante a época seca do ano. Outros métodos utilizados, que não tem restrição de época, constam de aplicação Brometo de Metila ou de Termonebulização de formicidas líquidos que, através de equipamento próprio, são insuflados nos formigueiros.

Todos os métodos apresentam alta eficiência no combate às formigas do gênero Atta. As formigas Acromyrmex apresentam ninhos superficiais, facilmente combatidas pelo polvilhamento de formicidas clorados.

Essa pretensa erradicação, no entanto, não previne a necessidade de ser mantido um esquema especial de controle frequente durante a implantação, além de um repasse anual durante a época seca.

2.5.2. Controle do cupim subterrâneo -

Os cupins Syntermes spp ocorrem generalizadamente nas áreas utilizadas para reflorestamento, principalmente nos terrenos de cerrado. Esses cupins são predadores das partes lenhosas, atacando o colo das plantas logo abaixo da casca. O ataque inicia-se nas mudas logo após o plantio, e o prejuizo, daí decorrente, pode ser grande.

O controle é preventivo e, para se obter bons resultados, basta aplicar inseticida clorado de solo na cova de plantio ou polvilhando-se o colo das mudas, pouco antes de serem plantadas.

Como sintomas do ataque de cupins encontra-se plantas mortas, esparsas, com secamento da folhagem que se mantem persistente. O colo mostra o estrangulamento da circulação da seiva, pelas galerias formadas sob a casca, e a presença dos cupins. Geralmente uma única aplicação do inseticida é suficiente para um bom controle.

2.5.3. Outras pragas

Embora menos importantes, outras pragas ocorrem nos eucaliptos, destacando-se os bezouros que atacam a folhagem (Costalimaita ferruginca), cujo controle é obtido facilmente por polvilhamento com inseticida clorado.

Há ainda diversas espécies de lagartas comedoras da folhagem (Eupseudosoma involuta, Sarsina violascens, etc.) - contidas normalmente através do controle biológico.

Ultimamente tem surgido coleobrocas atacando a madeira em povoamentos de Eucalyptus urophylla.

2.5.4. Doenças

As pricipais doenças têm ocorrido no viveiro durante a formação das mudas, caracterizando-se pelo aparecimento do "damping off" ou mela, provocada por ataque de fungos. Os principais são: Cilindrocladium clavatum, Pithium sp, Rhizoctonia sp, etc.

Como doença importante, no campo, tem sido constatadas incidências expressivas de Cancro no tronco das árvores de algumas espécies, principalmente Eucalyptus saligna e E.grandis, quando mal adaptadas ecologicamente. É provocado pelo fungo Diaporthe cubensis cujo controle é impraticável, tendo sido preferível a substituição dessas espécies e a seleção de indivíduos resistentes em um programa de melhoramento florestal.

2.6. Plantio e replantio -

Após o preparo do solo, este está em condições de receber o plantio das mudas.

No geral segue a operação de sulcamento e aplicação do fertilizante mineral em filete contínuo no fundo do sulco o que é possível pelo uso de máquina conjugada, tracionada por trator médio, em uma única operação. Em seguida, outra máquina executa a distribuição das mudas, de acordo com o espaçamento desejado, sendo que a complementação do plantio é feita manualmente, retirando-se o invólucro e ajustando-se a terra às raízes das mudas.

Para o plantio prefere-se a época chuvosa do ano, pela maior disponibilidade de umidade no solo. Porém em caso de programas anuais de reflorestamento muito grande, algumas empresas tem preferido plantar durante o ano todo. Assim, em qualquer época, quando falta umidade no solo, entra-se com o equipamento de irrigação. Aplica-se cerca de 3 litros de água por muda, imediatamente após o plantio. Repete-se por mais uma ou duas vezes, para garantir boa sobrevivência.

Nos estados do sul, onde ocorrem chuvas no inverno, os pinus sub-tropicais são plantados de preferência por mudas de raiz nua, em operações totalmente mecanizadas de alto rendimento e baixo custo, além de sobrevivência de até 98%.

Nessa região, a <u>Araucaria angustifolia</u> pode ser plantada por semeadura direta, em covas, no campo.

2.7. Tratos culturais -

Na primeira fase de crescimento, as espécies florestais são muito sensíveis à competição pelas plantas invasoras. Os eucaliptos são especialmente exigentes na manutenção do terreno limpo. Isto é fator de sucesso na implantação dos eucaliptos, que quando tecnicamente conduzida, recobre totalmente a superfície do terreno em apenas um ano.

Usam-se, o quanto possível, capinas mecanizadas nas entre-linhas, associadas às capinas manuais ou aplicação de herbicidas na linha de plantas.

São aplicados herbicidas de pré-emergência, no terreno ainda limpo, sobre a linha de plantas da cultura florestal, em uma faixa de um metro de largura. Para boa eficiência do herbicida é preciso aplicá-lo em solo úmido. Este se mantem limpo por mais de quatro meses, geralmente suficiente, evitando -se novas operações de capinas dentro da linha, durante a formação dos eucaliptais. Nas entre-linhas são suficientes, as vezes, apenas duas capinas mecanizadas.

Herbicidas de pré-emergência testados tem demonstrado ser totalmente inócuos à folhagem das várias espécies de eucalipto e pinus.

A sua aplicação mecanizada permite, portanto, evitar o uso de mão de obra nos tratos culturais, assegurando-se, assim, o atendimento mais perfeito à medida da necessidade da cultura florestal. Uma limitação ainda é o alto custo dos produtos herbicidas.

3. Manejo das florestas implantadas -

É natural que as florestas sejam manejadas, em rotações longas, para uso múltiplo, onde se procura aproveitar, ao mesmo tempo, os valores diretos, isto é, os produtos retirados da floresta, e seus valores indiretos, ou seja, aqueles decorrentes de sua presença em uma determinada região.

Embora esse sistema de manejo seja comum para as florestas de pinus, para os eucaliptais, entretanto, tem sido pouco aplicado.

No Brasil, tradicionalmente, são aplicados sistemas de corte raso, em rotações curtas, para produzir madeira fina, com aplicações restritas ao abastecimento das indústrias de transformação, além de moirões, lenha e carvão. Esses tem sido os objetivos da quase totalidade dos eucaliptais brasileiros, visando altas produtividades.

Recentemente reconhecendo-se a possibilidade e o potencial que os eucaliptos apresentam em produzir ao mesmo tempo, madeira grossa para fins mais nobres, é que se tem iniciado algumas tentativas, com esse novo objetivo, em paralelo. Isto quer dizer que embora se possa conduzir os eucaliptos, como qualquer outra espécie florestal, em rotações longas, utilizando-se vários desbastes, mas cujo objetivo é a madeira grossa do corte final, este não é o sistema mais atrativo para produzir toras de eucalipto.

Devido à crescente dificuldade de aquisição de madeira serrada para embalagem de seus produtos, algumas empresas industriais tem procurado diversificar a produção de madeira de seus eucaliptais. Assim mantendo-se o objetivo primeiro de produção de madeira fina para cavacos, procura aliar, simultaneamente, a produção de toras para serraria. Para isso, aos dois anos de idade, seleciona as 160 melhores árvores por hectare, bem distribuidas pela área.

Em seguida procede-se à primeira desrama artificial dessas árvores que serão mantidas em rotação longa ou seja, cerca de 20 anos.

O restante das árvores não recebe qualquer tratamento e serão exploradas em corte raso, para abastecer a indústria.

O conjunto visa a produção de madeira para indústria integrada, em rotações conjugadas curtas e longas.

As espécies mais cultivadas para fins industriais são <u>Eucalyptus saligna</u>, <u>E.grandis</u> e <u>E.urophylla</u>. Destes, o <u>E.grandis</u> apresenta melhor possibilidade para esse sistema de manejo, devido a forma de seu fuste, sua uniformidade e qualidade da madeira.

Outras espécies poderão ser utilizadas na produção integrada, como exemplo o <u>E.citriodora</u> que produz folhas para óleo essencial, lenha, postes, dormentes e toras quando bem manejado.

Dentro ainda dessa integração, recentemente se tem procurado associar o manejo de fauna silvestre, especialmente das aves, dentro dos eucaliptais.

O objetivo maior é assegurar o equilíbrio biológico conveniente para o controle biológico de pragas. Isso tem sido possível pela preservação das faixas ciliares de vegetação natural distribuídas cortando os eucaliptais. Estudos estão sendo realizados visando o aumento das populações de aves silvestres pelo enriquecimento desses habitats, através do plantio de espécies frutíferas arboreas e arbustivas.

4. Exploração -

Tradicionalmente a exploração dos eucaliptais é feita por corte raso, em rotações de 7 anos, visando a regeneração natural para nova rotação.

Esse método só se aplica, entretanto, às espécies lucífilas e capazes de brotar após o corte.

Apresenta a vantagem de ser um método simples, prático, barato e com altos rendimentos tanto de operação, como de produção volumétrica de madeira por hectare.

A produtividade dos eucaliptos bem conduzidos está ao redor de 45 estereos/ha/ano, podendo chegar em condições especiais a 60, considerando-se o volume total de madeira com casca.

O corte da madeira no campo é feito regularmente por moto-serras. O descascamento, quando necessário, pode ser feito no próprio local, mas a tendência é fazê-lo por descascadores estacionários no pátio da fábrica.

O carregamento da madeira é feito por carregadores mecânicos, diretamente para caminhões de porte médio, que entram dentro dos povoamentos e dali transportam direto para a fábrica.

No sistema integrado de produção simultanea de madeira fina para a indústria e toras para serraria, as 160 árvores previamente selecionadas e marcadas permanecem em pé, para ser cortadas futuramente.

A intenção é poder cortar 100 árvores por ocasião do 2º corte raso, isto é aos 12 a 13 anos de idade, já com possibilidade de uso para poste ou serraria. As 60 árvores finais deverão ser exploradas juntamente com o 3º corte raso, aos 18 a 20 anos de idade.

Ao final dessa rotação pretende-se reformar o povoamento através de novo plantio de mudas.

Até agora não há, todavia, qualquer resultado de produção dessas toras, pois não se chegou ainda à fase de sua exploração.

Uma preocupação que existe é com as brotações que surgem ao longo do fuste após o corte raso das demais árvores, e seu efeito sobre a qualidade futura das toras.

5. Regeneração após o corte raso -

Após a exploração as touças voltam a brotar permitindo regenerar o povoamento.

Dessa forma, quando bem conduzida a brotação, permite-se realizar em média três rotações sucessivas econômicas.

A sobrevivência das touças é progressivamente reduzida nessa sucessão de cortes, o que induz a decrescer, em consequência, as produtividades de madeira a ponto de tornar anti-econômica uma nova rotação.

O manejo dessa brotação é muito importante para assegurar alta produção no corte seguinte. Assim, o combate às formigas cortadeiras é um fator de suma importância para evitar uma drástica redução da sobrevivência das touças.

Outro fator muito importante para manter alta produtividade é a fertilização mineral, cujas respostas são altamente significativas, quando aplicada no início da brotação.

A desbrota é necessária devendo-se reduzir a 2 ou 3 o número de brotos por touça, operação que é feita 10 a 12 meses após o corte.

Para algumas espécies com menor capacidade de brotar, como por exemplo o E. grandis, recomenda-se proceder à exploração durante a época chuvosa, manter as touças com altura de 10-15 cm, para aumentar o número de gemas capazes de brotar. Da mesma forma a desbrota, na época mais quente do ano, tem favorecido o crescimento e a produção futura.

A densidade da população poderá ser recuperada, de forma promissora, através do plantio de novas mudas em substituição às touças falhadas. É uma técnica recente, ainda em estudo, que mostra, entretanto, boas perspectivas.

É importante para esse plantio, detectar-se as falhas o mais breve possível. As mudas são plantadas em covas abadas, ao lado das touças mortas. É importante que estas cresçam simultaneamente com a brotação das demais touças.

Essa nova metodologia, quando aperfeiçoada deverá substituir a necessidade de reforma dos eucaliptais, mantendo-os produtivos quase que indefinidamente.

FIGURA 1 - Volume total de madeira no espaçamento 3 x 1,5 m
Total wood volume in spacing 3 x 1,5 m

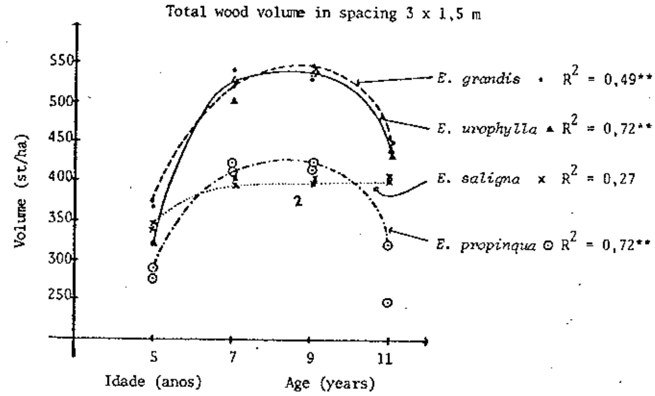


FIGURA 2 - Volume total de madeira no espaçamento 3 x 2,0 m
Total wood volume in spacing 3 x 2,0 m

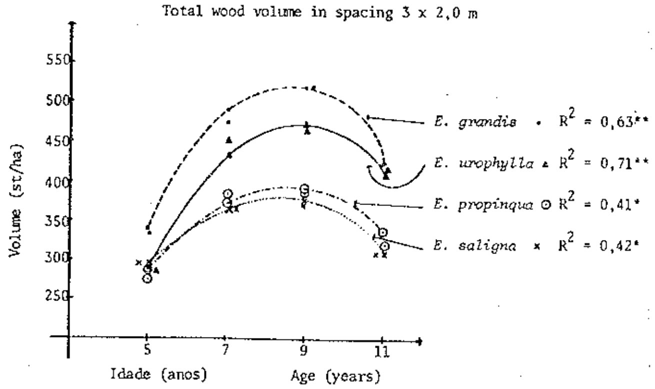


FIGURA 3 - Peso total de madeira no espaçamento 3 x 1,5 m
Total wood weight in spacing 3 x 1,5 m

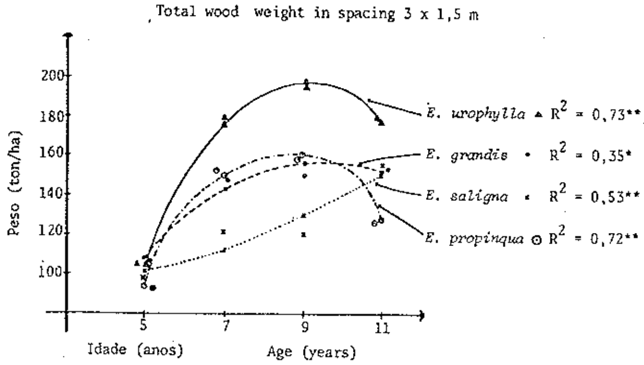
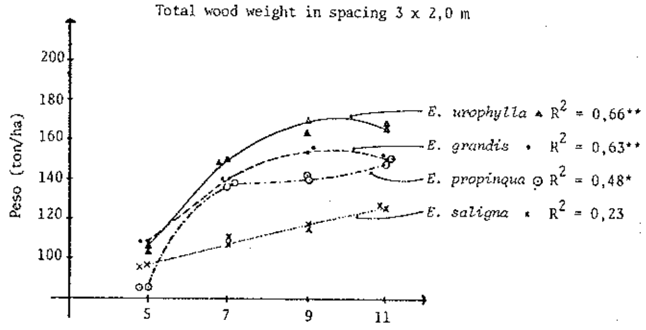


FIGURA 4 - Peso total de madeira no espaçamento 3 x 2,0 m
Total wood weight in spacing 3 x 2,0 m



sessão I
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VARIAÇÃO E INTERAÇÃO GENÓTIPO-AMBIENTE, NO TESTE INTERNACIONAL DE PROCEDÊNCIAS DE *Pinus caribaea* E IMPLICAÇÕES PARA A ESTRATEGIA DE MELHORAMENTO DAS POPULAÇÕES

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Resumo

Os testes internacionais de *Pinus caribaea* Morelet e *P. oocarpa* Shiede, foram plantados numa grande amplitude de condições ambientais, e têm o potencial de fornecer valiosas informações no controle genético e ambiental da variação e da interação genótipo-ambiente. Para compreender esse potencial foi necessário se obter um conjunto de dados intelegíveis e compatíveis.

Um programa cooperativo foi delineado no Commonwealth Forestry Institute (CFI), no qual 14 ensaios importantes de cada espécie foram selecionados em 12 países, nas idades de 6 a 7 anos. As árvores estão sendo avaliadas, através de um grande número de características de campo, propriedades da madeira composição da resina, e as características bióticas, climáticas e edáficas das localidades, também estão sendo determinadas. Os trabalhos de campo iniciaram-se em 1978, e espera-se sejam completados em final de 1980.

As análises preliminares discutidas neste trabalho são baseadas numa pequena amostra dos dados – 13 características de 9 procedências de *Pinus caribaea* em ensaios envolvendo 5 localidades; eles servem para ilustrar as técnicas utilizadas, e as prováveis tendências dos resultados. As análises de variância, e de regressão conjunta mostraram que as características quantitativas, tendem a apresentar menor controle genético (procedência), do que as características qualitativas. Nenhuma procedência foi superior para produtividade em todas as localidades; no entanto algumas como Santa Clara deram origem a indivíduos superiores, em certas localidades. Guanája, uma procedência de alta produção volumétrica, teve a mais alta densidade da madeira, porém, também a taxa mais espessa.

Alamicamba foi a procedência que apresentou Geralmente, árvores mais retas, e menos bifurcadas, mas teve baixa densidade, e um hábito de ramificação instável. Guanája teve esse hábito mais estável. A produção de conídeos apresentou forte controle genético. As procedências interiores produziram mais conídeos do que as procedências litorâneas.

Geralmente, uma grande proporção da variação foi tributada às árvores, dentro das parcelas, o que tendeu a diluir as diferenças entre procedências. Os futuros testes deveriam ser planejados para permitir investigação mais detalhada dessas causas de variação. A variância devida à interação genótipo – ambiente foi alta quando comparada com a variância devida à procedência particularmente para características quantitativas. Todavia existiam indicações em algumas características, que uma proporção dessa interação fora devida à heterogeneidade da regressão, que prometia alguma espectativa na predição do comportamento.

VARIATION ET ACTION RÉCIPROQUE (GÉNOTYPE – MILIEU), DANS LES ESSAIS INTERNATIONAUX DE PROVENANCE DE *Pinus caribaea*, ET IMPLICATIONS POUR LA STRATÉGIE D'AMELIORATION DES POPULATIONS

Resume

Les essais internationaux, de provenances sur le Pinus caribaea, MORELET, et le Pinus oocarpa, SCHIEDE, ont été entrepris dans des milieux écologiques très différents. Ils ont, ainsi, la possibilité de fournir d'importantes informations sur le contrôle génétique et écologique des variations en même temps que sur l'action réciproque du génotype et du milieu.

Pour obtenir ces résultats, il a été nécessaire de se procurer un ensemble de données aussi complet, et utilisable, que possible.

Un programme de coopération a été conçu à l'INSTITUT FORESTIER du Commonwealth d'OXford dans lequel 14 essais essentiels pour chaque espèce, s'échelonnant sur 6 à 7 ans, ont été sélectionnés. Les études ont porté sur un grand nombre de caractéristiques du port de l'arbre sur pied, sur les propriétés du bois, la composition de la résine, ainsi que sur les données climatiques, édaphiques et biotiques des lieux de plantation. Les travaux sur l'emplacement des essais commencés en 1978 devraient se terminer à la fin de 1980.

Les analyses préliminaires examinées ici se fondent sur un échantillon de petite dimension : 13 caractéristiques de 9 provenances de Pinus caribaea, observées dans les essais de 5 localités. Elles servent à illustrer les techniques utilisées et à se rendre compte du genre de résultats obtenus.

Les analyses de variance et celles de régression cumulées montrent que les caractéristiques quantitatives ont tendance à fournir moins d'indications génétiques sur la provenance que les caractères qualitatifs. Aucune provenance n'a été distinguée pour sa productivité sur l'ensemble des essais, bien que certains individus se soient développés de façon remarquable en certains endroits, comme par exemple la provenance de Santa-Clara. Celle de Guanaja produit un volume élevé. Son bois a la densité la plus élevée, mais elle a aussi l'écorce la plus épaisse. La provenance d'Alamicambo fournit généralement les tiges présentant la plus grande rectitude de fût, le moins de fourches, mais le port des branches est variable et la densité du bois faible. La provenance Guanaja a le port de branches le plus stable. La production de conelets dépend, essentiellement du facteur génétique. Les provenances de l'intérieur du pays produisent plus de conelets que les provenances côtières.

En général, une très forte proportion de variations d'origine locale, est attribuée aux tiges des placeaux d'essais, ce qui tend à rendre plus difficilement discernables les différences entre provenances. Les futurs protocoles d'essais devraient comporter des recherches plus détaillées sur cette source de variation. Les relations réciproques entre génotype et milieu sont élevées par rapport à la variance des provenances, particulièrement pour ce qui

concerne les caractères quantitatifs. Cependant, certaines indications constatées d'après certains caractères ont montré qu'une proportion significative de cette interaction est due à l'hétérogénéité de régression qui permet d'espérer d'obtenir des éléments pour prévoir la performance de ces provenances.

VARIATION AND GENOTYPE – ENVIRONMENT INTERACTION IN INTERNATIONAL PROVENANCE TRIALS OF *Pinus caribaea* AND IMPLICATIONS FOR POPULATION IMPROVEMENT STRATEGY

Summary

The international provenance trials of Pinus caribaea Morelet and P. oocarpa Schiede have been planted over a wide range of environments and have the potential for yielding valuable information on genetic and environmental control of variation and on genotype-environment interaction. To realize this potential, it was necessary to obtain a set of comprehensive and compatible data. A cooperative programme was drawn up at the Commonwealth Forestry Institute (CFI) in which 14 six- to seven-year-old key trials of each species were selected in 12 countries. Trees are being assessed for a large number of field traits, wood properties and resin composition and the sites' climatic, edaphic and biotic characteristics are being determined. Field work work was started in 1978 and is expected to be completed by the end of 1980.

The preliminary analyses discussed here are based on a small sample of the data - 13 traits of nine provenances of P. caribaea in trials in five localities; they serve to illustrate the techniques used and the likely trend of results. Analyses of variance and joint regression analyses showed that quantiative traits tend to be under less genetic (provenance) control than qualitative traits. No provenance was outstanding for productivity over all sites although some, e.g. Santa Clara, produced outstanding individuals in certain localities. Guanaja, a high volume producer, had the highest wood density but also the thickest bark. Alamicamba was generally the straightest and least forked provenance but it had low density and an unstable branching habit. Guanaja had the most stable branching habit. Conelet production was under strong genetic control; inland produced more conelets than coastal provenances.

Generally, a very large proportion of the total variation was attributable to trees in plots which tended to obscure differences between provenances. Future trials should be designed to permit more detailed investigation of this source of variation. Genotype-environment interaction variance was high compared with provenance variance, particularly for the quantitative traits. However, there were indications in some traits that a significant proportion of this interaction was due to heterogeneity of regression which promises some prospects for prediction of performance.

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

In 1962 the Commonwealth Forestry Institute at Oxford (CFI) undertook to explore the natural forests of Pinus caribaea Morelet and P. oocarpa Schiede and to collect and distribute seed for international provenance trials. Most of the 300-400 trials now established in 49 countries were planted in the early 1970's. Many participants have published the results of their trials and an overall assessment has been made possible through information supplied to the data base (INTFORPROV) at the CFI (Greaves, 1980a, 1980b).

Forest tree yields are dependent upon physiological responses in growth of various organs to the soil, climate, competition, pathogens etc. To attain maximum yield, the genetics of these responses require manipulation but this manipulation in turn requires detailed knowledge on how variation in a species is dictated by its genes and its environment. In 1977, there was a growing realization that the international provenance trials had the potential for yielding much more infomation on growth and on the possibility for genetic development of populations provided that a complete and compatible set of data could be collected across the whole range of environments over which the species had been planted. Many of the trials were approaching seven years, which is a critical age for assessment (Barnes and Gibson, 1980). It was suggested to participants with key trials that there should be a coordinated approach to the collection of data. Response was generally enthusiastic and resulted in the drawing up and implementation of an intensive assessment programme covering 28 trials in 12 countries.

T H E   T R I A L S

The trials of both species have been planted throughout the tropical and sub-tropical world from latitudes 22°N to 29°S and at altitudes from sea level to 2500 m. Soils vary from swamplands through infertile sands to deep and highly fertile loams. Annual rainfall ranges from 1000 to over 3000 mm and mean annual temperature from 14 to 28°C. Provenance representation does vary from trial to trial but a core of important seed sources is common to many. Experimental design generally consists of from three to five replications of 7 to 49-tree plots at a 2.5 to 3.5 m square, or equivalent rectangular, spacing.

It was deduced that comprehensive data from about 12 carefully selected trials per species should be sufficient to elucidate general principles regarding the relative contributions of elements of the environment and genetics to variation and genotype-environment interaction. In order to establish trends, it was necessary to include trials at the extremes of environmental tolerance for the species rather than concentrate on those growing under optimum conditions. First priority was given to sampling the full range of climates. It was appreciated, however, that soils can have a profound effect in ameliorating climatic stress and so some attention was also given to covering a range of edaphic conditions. In addition, provenance representation, experimental design and condition of the trial had to be acceptable for any trial to be included.

A S S E S S M E N T S   A N D   P R O C E S S I N G   O F   T H E   D A T A

Given that the main value of the data from this programme lies in its predictive rather than empirical use, assessment of climatic, edaphic and biotic factors of the planting site has been as important as measurement of the tree characteristics. The only sources of climatic data have been local meteorological stations which vary greatly in the comprehensiveness of their observations although basic rainfall and temperature records are available for all sites. Past results of soil analysis were available for some trials but, for the sake of uniformity, soils have been sampled at seven levels to a depth of 1200 mm at every site. Needles were collected from every provenance at every site for foliar analysis. Although sampling points in the tree were consistently located, seasonal variation between trials at time of collection will inevitably increase variation in elemental content of needles and climatic, edaphic and genetic effects will be obscured to some extent; however, the range of conditions is so full that the extremes may indicate some relationships. Trial site and management records were scrutinized for the biotic history.

The field characteristics assessed on individual trees included those normally used to describe the qualitative and quantitative properties of stem, branches and crown, 'flowering' status and the level of some abnormalities commonly found in the species. Primary field assessments were a mixture of objective measurements (where feasible) and subjective ocular assessments (where unavoidable) and included height, diameter at breast height and at six metres, bark thickness, forking details, stem straightness and lean; branch number, distribution, diameter, angle, order and internode length (foxtailing tendency); crown depth; conelet, cone and male 'flower' counts; and the incidence of abnormalities such as basket whorls, kinky shoots, needleless shoots and dieback. Assessment of these and the construction of traits derived from them are described and discussed elsewhere (Barnes and Gibson, 1980).

Wood and resin samples were also collected for assessment in the laboratory. Eight-millimetre cores were taken from bark to bark through the pith at breast height from three trees in every plot and xylem resin samples were collected in five ml vials from the same trees in a sub-sample of trials.

Assessment and sampling of each trial has been carried out by staff in the individual countries concerned but, in every case, with participation by a specially appointed research officer from the CFI whose role has been to contribute the essential coordination and uniformity in the implementation of the measuring and sampling procedure and particularly in the subjective assessments.

Editing, conversion and primary analysis of the field data is carried out at the CFI and further analysis, interpretation and publication of individual trial results are then dealt with by each participating country. Densitometric and fibre dimension studies on the wood cores are also performed in the CFI laboratories and the Tropical Products Institute (TPI) in London is assisting with the resin analysis. Soil and foliage samples are being processed in CSIRO (Forest Research Division) Laboratories in Queensland, Australia. Results from laboratory processing samples are sent back to participating countries as they become available. Combined analysis, interpretation and publication of the data is being coordinated by the CFI.

R E S U L T S

The results described here include only nine common provenances in five of the eventual 14 P. caribaea trials. Provenances of the varieties bahamensis Barrett and Golfari and caribaea have been omitted; differences in performance between these and var. hondurensis Barrett and Golfari are well known and it is more appropriate here to examine the analyses of the var. hondurensis provenances alone without the disturbing influence of the other two varieties. Only 12 of the 50 primary and derived traits are described. This small sample of the data being collected in the programme is used here to illustrate the likely extent and implications of genotype-environment interaction in P. caribaea and the type of treatment and analysis which will also be applied to the P. oocarpa data.

The traits are described in Table 1. Provenance names, location and climate are given in Table 2 and trial locality details in Table 3. Table 2 also gives the analysis of variance for provenances combined over

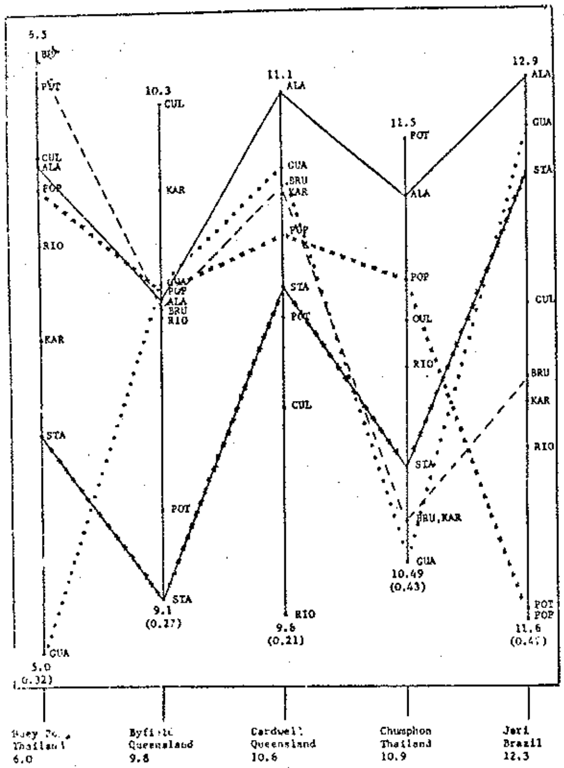

Figure 1. Genotype-environment interaction of height (HGT)(m) at 6-7 years for nine provenances of *Pinus caribaea* var. *hondurensis* over five localities showing provenance ranks, ranges and standard errors within localities and locality means

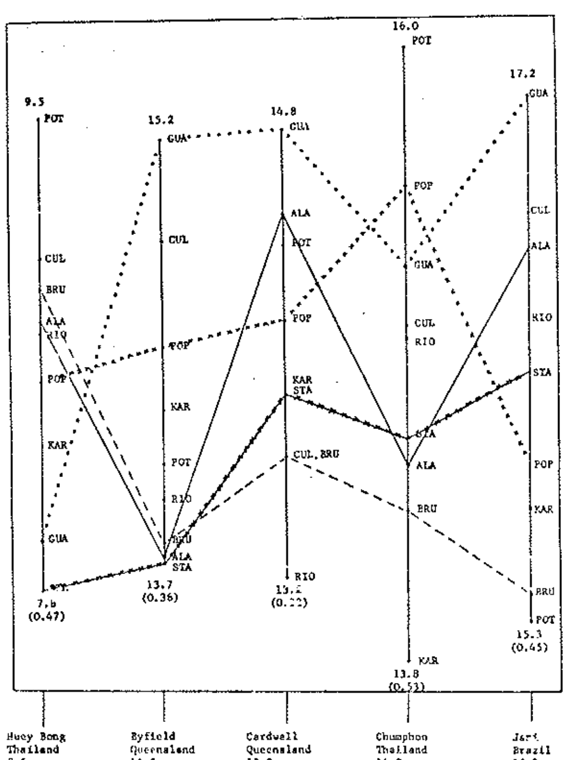

Figure 2. Genotype-environment interaction of diameter at 1.3 m over bark (DBH)(cm) at 6-7 years for nine provenances of *Pinus caribaea* var. *hondurensis* over five localities showing provenance ranks, ranges and standard errors within localities and locality means

Table 1. Trait codes and descriptions*

Trait	Code	Description
Height	HGT	Total height (m)
Diameter	DBH	Diameter over bark at 1.3m (cm)
Volume	VOB	Total stem volume over bark; based on diameters at 1.3m, 6.0m and total height. (dm^3)
Volume of best tree	VBT	Volume over bark of the largest tree in the plot; based on VOB. (dm^3)
Bark percentage	BKP	Bark volume expressed as a percentage of VOB; (%) based on bark thickness at 1.3m.
Stem straightness	STR	Index for first 6m of stem; weighted for quality of upper stem; 0.9 = most crooked to 28.6 = straightest stem.
Forking index	FKI	Index for severity; weighted for height and frequency of forks: higher value = more forks.
Branching index	BI2	Index of branching quality with diameter, angle, number, internode length and abnormalities taken into account: higher value = more desirable.
Longest internode	LIL	Longest internode on the tree (m).
Index for average tree	IAT	Index of excellence based on VOB, BKP, STR, and BI2. This is a crude index in which volume contributes 70-90% of the value.
Index for best tree	IBT	Index for the best tree in the plot: same basis as IAT.
Number of conelets	CLN	Count of the number of first year female strobili in six categories - 0, 1-5, 6-25, 26-50, 51-100, 101+

*For complete trait descriptions see Barnes and Gibson (1980)

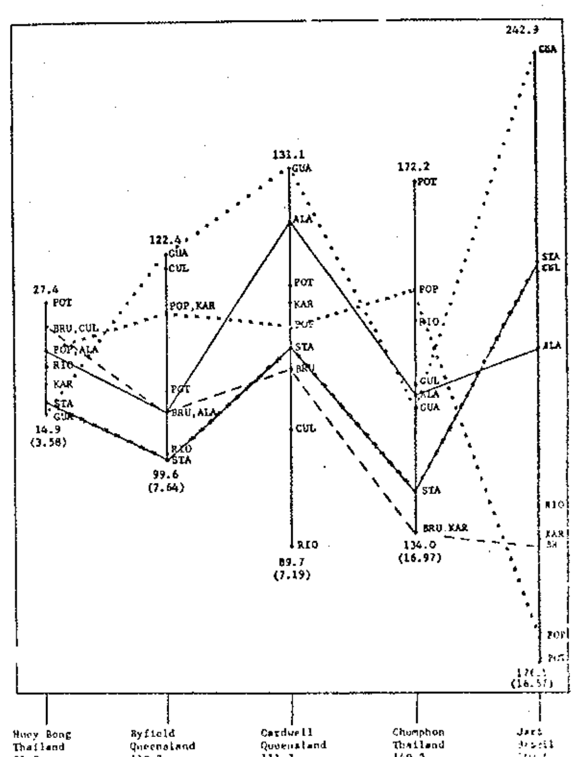

Figure 3. Genotype-environment interaction of total volume over bark (VOB)(dm^3) at 6-7 years for nine provenances of *Pinus caribaea* var. *hondurensis* over five localities showing provenance ranks, ranges and standard errors within localities and locality means

localities and the joint regression analysis (after Freeman and Pérkins, 1971) in which the interaction mean square is partitioned into variance due to heterogeneity of regression and that remaining. In addition, some details of the individual regression analyses for each provenance are given, viz. the overall mean, the slope, the F-ratio and the proportion that each provenance contributes to the total interaction variance.

Table 3 includes the analysis of variance of data from individual sites. All the analyses of variance are given in the form of the percentage contribution of each source to the total variance with an indication of the significance of the F-test for each source. A fully random model was used in each case. The relationship of the variance to the means for quantitative traits for the individual sites suggested that a square root transformation should have been used for the combined analysis. This transformation was used for HGT where the variance was proportional to the mean but it made virtually no difference to the F ratios or to the relative sizes of the components. Nevertheless, it is stressed that these analysis are preliminary and that they may be modified later through the use of appropriate statistical techniques.

Figures 1 to 12 provide graphic illustrations of the relative performances of the provenances at the different localities for twelve traits, and at the same time give the within environment rankings, ranges and standard errors, and the trial means. The trials are placed in the same order in each figure with the least productive site on the left. The figures do not relate to the regression analyses (Table 2); they are designed purely to provide a visual aid in describing genotype-environment interaction. All means relate to the analyses of variance (Table 3) except for STR and IAT at Huey Bong.

Data are shown for gross wood density (based on fresh volume cores taken at 1.3 m on two radii conditioned to 12% moisture content) for 17 provenances in various combinations over eight localities (Figure 13). Five provenances only were common to all sites and a combined analysis of various is given for these in the figure.

D I S C U S S I O N

The analysis of variance for provenances combined over localities (Table 2) shows the large effect of locality on quantitative traits (HGT, DBH, BKP and VOB) which was expected, given the extreme diversity of sites over which the trials have been planted. Less expected was the very much smaller contribution from locality in the qualitative traits (STR, FKI, BI2 and LIL) and in flowering (CLN). Variation due to provenance and variation due to tree to tree differences were also greater for the latter group of traits.

The practical significance of the genotype-environment interaction (gei) variance depends upon its size. For these particular provenances and trials, it was small for the quantitative traits in relation to the locality and individual trees sources; this was a reflection of the equally small amount of variation for provenances in the individual localities (Table 3) since, except for BKP, almost all the latter variance was lost to interaction in the combined analysis. The very considerable ranges of provenance means within trials and the high standard errors were due mainly to the large tree to tree differences.

Table 2. Analysis of variance and regression analysis for nine *Pinus caribaea* var *hondurensis* provenances over five localities. Twelve 6-7 year-old traits (see Table 1 for trait descriptions)

		HGT (m)	DBH (cm)	VOB (dm^3)	VBT+ (dm^3)	BKP (%)	STR (ind)	FKI+ (ind)	BI2 (ind)	LIL (m)	IAT (ind)	IBT+ (ind)	CLN+ (cm)
Analysis of variance and joint regression: proportional contribution to total variation (%) and significance of F ratio (* = 95%, ** = 99%, * = 99.9%)**													
Localities (L)	4 (df)	59***	46***	36***	76***	54***	15***	21***	6***	8***	41***	75***	53***
Provenances (P)	8	0	1 *	0	0	1 ***	4 ***	11 **	1	2***	0	0	19***
Interaction (PxL)	32	<1 *	1 *	1	4 **	0	2 **	14***	2***	2***	0	3 **	15***
(heterogeneity of regression)	(8)	- *	- *	-	- ***	-	- ***	- **	-***	- **	- *	- **	- ***
(remainder)	(24)	-	-	-	- **	-	-	- ***	-***	1 *	-	- *	-
Replications (R) in L	20	6 ***	4 ***	5 ***	5 ***	8 ***	3 ***	8 ***	5***	1***	5 ***	5 ***	1 **
Residual (E)	158	4 ***	2 ***	3 ***	15	4 ***	2 ***	46	0	0	2 ***	16	11
Trees in plots (T)	±3100	30	46	52	-	33	73	-	87	87	52	-	-
TOTAL VARIANCE		9.18	17.7	10643	19821	123	14.2	249	85.5	2.29	1712	5214	0.372
Individual regression analysis for each provenance: mean ($\bar{x}$), slope (b), Variance ratio reg.m.s./rem.m.s. (F) and proportional contribution to total interaction variance (%)													
Karawala (Nicaragua)	$\bar{x}$	9.9	13.2	114	186	35	8.0	9.5	27.5	1.6	63.3	119	0.13
(KAR)	b	1.02	0.98	0.93	1.02	1.06	1.36	0.89	1.24	1.25	0.94	1.02	0.53
Lat. - 13° 25'N, Alt. - <10m	F	0.05	0.10	1.29	0.03	1.70	3.35	0.03	1.21	8.34	0.94	0.01	29.06
MAR - 3897 mm, MAT - 26.4°C	%	4	6	4	8	10	16	18	5	3	4	13	9
Alamicamba (Nicaragua)	$\bar{x}$	10.3	13.6	122	174	34	8.0	5.7	26.2	1.9	54.4	111	0.18
(ALA)	b	1.06	1.01	1.04	0.83	1.05	1.39	0.55	1.46	1.33	1.04	0.84	0.57
Lat. - 13° 20'N, Alt. - 10 m	F	2.24	0.01	0.49	2.02	4.18	17.65	39.75	3.77	0.55	0.55	1.76	243.71
MAR - 2610 mm, MAT - 27.3°C	%	3	8	3	10	5	12	3	11	28	3	10	9
Brus Lagoon (Honduras)	$\bar{x}$	9.8	13.0	106	167	35	7.6	9.4	27.0	1.9	59.6	108	0.23
(BRU)	b	0.87	0.83	0.86	0.94	0.94	1.02	0.84	1.72	1.57	0.87	0.94	0.71
Lat. - 15° 45'N, Alt. - <10 m	F	1.14	3.92	1.33	0.12	1.58	0.01	0.24	5.17	27.26	1.57	0.11	14.02
MAR - 2840 mm, MAT - 26.5°C	%	21	17	17	13	11	8	4	22	14	16	13	4
Rio Coco (Nicaragua)	$\bar{x}$	9.7	13.4	112	161	35	7.0	7.4	28.0	1.7	60.8	104	0.22
(RIO)	b	0.95	1.00	0.99	0.86	0.98	1.03	0.52	0.87	1.11	0.97	0.86	0.72
Lat. - 14° 37'N, Alt. - 70 m	F	0.35	0.00	0.00	7.95	0.20	0.08	2.34	0.06	0.11	0.05	10.33	7.43
MAR - 2863 mm, MAT - 25.8°C	%	8	8	10	4	5	3	7	23	14	15	4	4
Guanaja (Honduras)	$\bar{x}$	9.8	14.1	131	195	38	6.4	10.7	28.3	1.3	67.0	122	0.13
(GUA)	b	1.21	1.20	1.22	1.06	1.06	1.06	0.95	0.30	0.97	1.24	1.10	0.39
Lat. - 16° 28'N, Alt. - 2 m	F	9.80	16.97	5.83	0.64	1.94	0.24	0.06	4.76	0.01	6.04	3.93	191.89
MAR - 2306 mm, MAT - 27.1°C	%	21	15	19	3	8	3	2	22	9	27	2	15
Santa Clara (Nicaragua)	$\bar{x}$	9.7	13.2	117	213	36	6.8	10.9	29.6	1.1	63.1	131	0.71
(STA)	b	1.11	1.11	1.11	1.44	1.06	1.10	0.90	0.86	0.76	1.08	1.43	1.57
Lat. - 13° 55'N, Alt. - 680 m	F	2.16	13.61	1.82	3.47	4.27	0.12	1.08	0.73	0.68	0.90	3.8	33.71
MAR - 1818 mm, MAT - 23.4°C	%	10	5	8	53	6	16	1	3	11	9	51	14
Culmi (Honduras)	$\bar{x}$	10.1	13.8	123	175	34	5.3	13.6	29.0	1.3	63.9	111	0.96
(CUL)	b	0.97	1.01	1.07	0.97	0.96	0.77	1.05	0.72	1.41	1.06	0.98	1.88
Lat. - 14° 54'N, Alt. - 442 m	F	0.19	0.01	0.76	0.42	0.54	1.54	0.03	2.91	15.14	0.71	0.19	30.54
MAR - 1325 mm, MAT - 24.3°C	%	6	7	6	1	11	11	3	5	5	6	1	34
Potosi (Honduras)	$\bar{x}$	9.9	13.9	120	173	36	4.3	13.6	28.2	1.3	60.9	109	0.51
(POT)	b	0.89	0.85	0.88	0.89	0.88	0.50	1.09	0.85	0.54	0.90	0.90	1.36
Lat. - 15° 20'N, Alt. - 650 m	F	0.94	1.06	0.64	0.94	6.84	11.61	0.29	0.57	34.92	1.37	1.19	3.99
MAR - 1205 mm, MAT - 23.7°C	%	18	27	21	7	20	21	1	4	9	10	5	9
Poptun (Guatemala)	$\bar{x}$	9.9	13.7	117	177	35	6.1	26.9	26.9	1.5	62.4	112	0.42
(POP)	b	0.92	1.02	0.90	0.99	1.01	0.77	2.22	0.99	0.77	0.90	0.93	1.25
Lat. - 16° 20'N, Alt. - 475 m	F	0.99	0.07	0.81	0.14	0.01	1.45	[illegible]	0.00	0.98	1.59	3.82	5.31
MAR - 1688 mm, MAT - 24.2°C	%	9	7	12	1	24	11		6	7	10	1	4

+ analysis based on plot means.

For the qualitative traits and flowering, much more of the variation was due to provenances in the individual localities (Table 3), the standard errrors of the differences between means were smaller and only an average third to a half of that variance was lost to interaction in the combined analysis.

Despite being relatively small for some traits, the interaction variance was statistically significant in most cases and, nearly always, a significant proportion of this was due to heterogeneity of regression (Table 2); in other words it was due to a difference in slope of the regression line which indicates that there may be prospects for predicting genotype-environment response through the linear effect of environments. Provenance stability, gauged by the extent to which b (Table 2) fell short of (stable) or exceeded (unstable) unity, ranged for various traits from 0.3 to 2.22. The proportion of the total interaction variance attributed to the various provenances also varied greatly and in VBT over 50 percent was accounted for by Santa Clara alone.

The above points must be taken into account when interpreting the significance of the gei diagrams for individual traits (Figures 1 to 12). Thus the apparently spectacular changes in ranking for HGT and DBH (and consequently VOB) must be treated with caution because of the large standard errors within localities. Generally, the indications are that no provenance can be discarded on the basis of poor prôductivity performance at all localities. A remarkable reversal did take place between the Alamicamba and Santa Clara provenances which had similar average tree performances for VOB (Figure 3) but ranked significantly lowest and highest respectively for their best tree performers, VBT (Figure 4). BKP (Figure 5) on the other hand, was a characteristic governed almost entirely by provenance and locality with a minimum of gei

There were significant differences in stem straightness at every site (Table 2) and therefore more weight can be placed on the indications of gei in the diagram (Figure 6). The straightest provenances at one locality were not necessarily the straightest at others but a large amount of the gei variance was due to heterogeneity of regression and therefore there are prospects for prediction.

The forking and branching characteristics FKI and LIL both varied appreciably and significantly at the provenance level and in interaction with environment. Provenances varied widely in their stability, e.g. Brus was most unstable (b = 1.57) in its tendency to produce foxtails and Rio Coco and Alamicamba were stable (b = 0.52 and 0.55) over environments in their disinclination to fork. The whole range of branching characteristics contributed to the branching index, BI2, and therefore it is not surprising that there was a high proportion of gei variance compared with provenance. Guanaja was outstanding in its stability, in branching over localities ((b = 0.3) and Brus was highly unstable (b = 1.72) (Table 2).

Table 3. Analysis of variance by locality for nine common provenances of *Pinus caribaea* var. *hondurensis*: proportional contribution (%) of components to total variation and significance of the F ratio (* = 95%, ** = 99%, *** = 99.9%) for 12 traits

Source (df)	HGT	DBH	VOB	VBT+	BKP	STR	FKI+	BI2	LIL	IAT	IBT+	CLN+
Huey Bong (Thailand): Lat. - 18°12'N, Alt. - 790m, MAR - 1191mm, MAT - 22°C, Age - 6 9/12 years												
Provenances (8)	6	<1	1	0	0	3 **	11	<1	0	2	0	47***
Replication (4)	11 **	8 *	9 *	18 *	16***	<1	2	0	3 *	7 **	16 *	4
Residual (32)	27***	25***	28***	82	22***	2	87	0	4 *	9***	84	49
Trees (564)	56	66	42	-	62	94	-	99	93	82	-	-
TOTAL VARIANCE	1.71	3.79	203	197	65.6	3.72	5.16	1.52	0.295	33.8	51.4	.0407
Byfield (Queensland): Lat 22°50'S, Alt. - 30m, MAR - 1820mm, MAT - 22.8°C, Age - 6 years												
Provenances (8)	2	2	<1	2	2 *	8***	0	2 **	4 **	<1	0	62***
Replication (4)	40***	29***	35***	60***	47***	<1	15	5***	3 **	27***	50***	2
Residual (32)	7***	4***	6***	38	5***	3 *	85	0	1	6***	50	36
Trees (671)	53	65	58	-	46	88	-	93	92	66	-	-
TOTAL VARIANCE	3.63	7.90	3145	3150	73.9	25.5	302	76.7	2.46	487	731	0.067
Cardwell (Queensland): Lat. - 18°16'S, Alt. - 20m, MAR - 2127mm, MAT - 24.1°C, Age - 6 years												
Provenances (8)	4 *	3 *	4 *	<1	<1	6***	11	2 *	4 **	2	4	34 **
Replication (4)	6 **	<1	2	0	7 **	0	0	<1	<1	1	0	2
Residual (32)	5 **	3 *	5 **	99	11***	1	89	2	1	5 **	96	64
Trees (641)	85	93	89	-	81	93	-	95	94	92	-	-
TOTAL VARIANCE	2.18	5.75	2419	1108	43.7	28.2	67.5	82.7	2.45	396	260	.0188
Chumphon (Thailand): Lat. - 10°32'N, Alt. - 70m, MAR - 3070, MAT - 26.8°C, Age - 6 9/12 years												
Provenances (8)	1	3 *	<1	0	3	6 **	57***	2	8***	0	0	12
Replication (4)	17***	6 **	18***	22 *	3 *	8***	4	12***	<1	14***	22 *	13
Residual (32)	14***	5 **	19***	78	6***	5 **	39	2	2	9***	78	75
Trees (623)	68	86	78	-	88	81	-	86	89	77	-	-
TOTAL VARIANCE	5.16	13.4	9925	14200	51.1	79.7	418	108	2.45	1643	4379	4.27
Jari (Brazil): Lat. - 0°52'S, Alt. - 76m, MAR - 2393mm, MAT - 27.5°C, Age - 7 3/12 years												
Provenances (8)	<1	1 *	1	39 **	3 *	5 **	41***	6***	3***	2 *	36 **	76***
Replication (4)	0	1 *	1	0	1	2 *	20 **	<1	0	1	0	3
Residual (32)	9***	0	3	61	1	2	39	0	0	1	64	22
Trees (655)	90	98	95	-	95	91	-	93	97	96	-	-
TOTAL VARIANCE	5.79	16.3	15863	9210	48.5	21.1	230	104	2.81	2395	2503	0.540

+ Analysis based on plot means

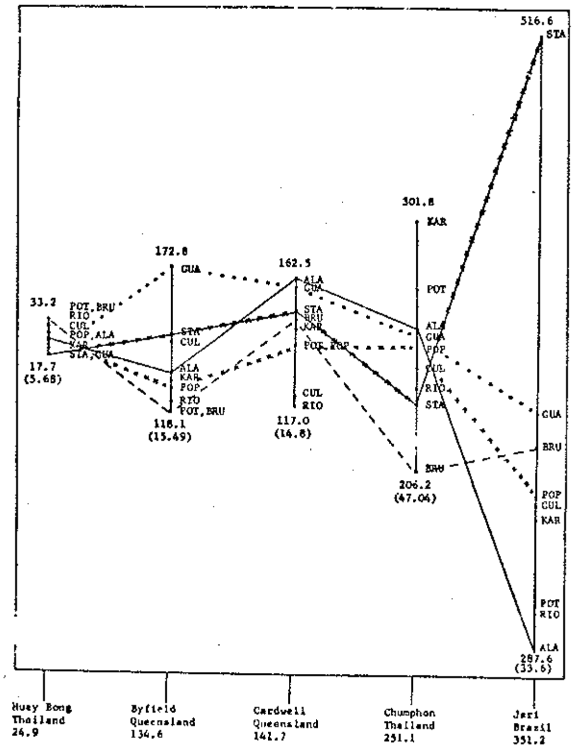

Figure 4. Genotype-environment interaction of volume of the best tree (VBT)(dm^3) at 6-7 years for nine provenances of *Pinus caribaea* var. *hondurensis* over five localities showing provenance ranks, ranges and standard errors within localities and locality means

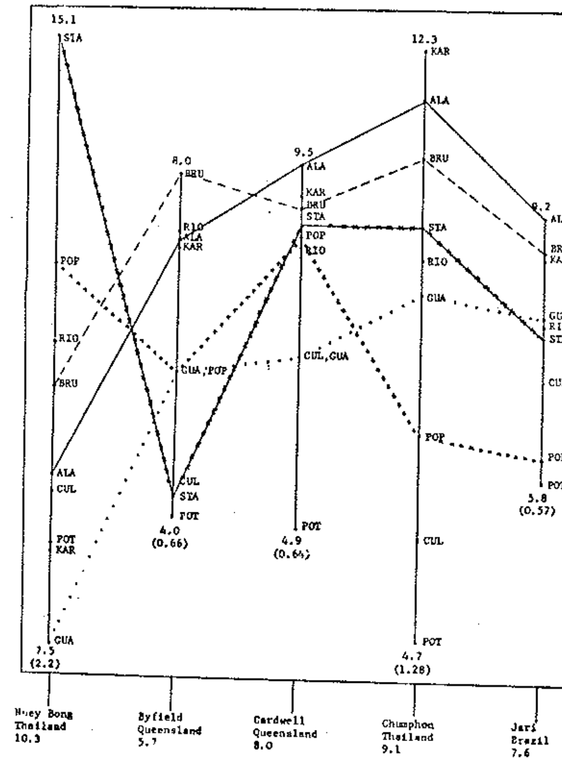

Figure 6. Genotype-environment interaction of stem straightness (STR) (index) at 6-7 years for nine provenances of *Pinus caribaea* var. *hondurensis* over five localities showing provenance ranks, ranges and standard errors within localities and locality means

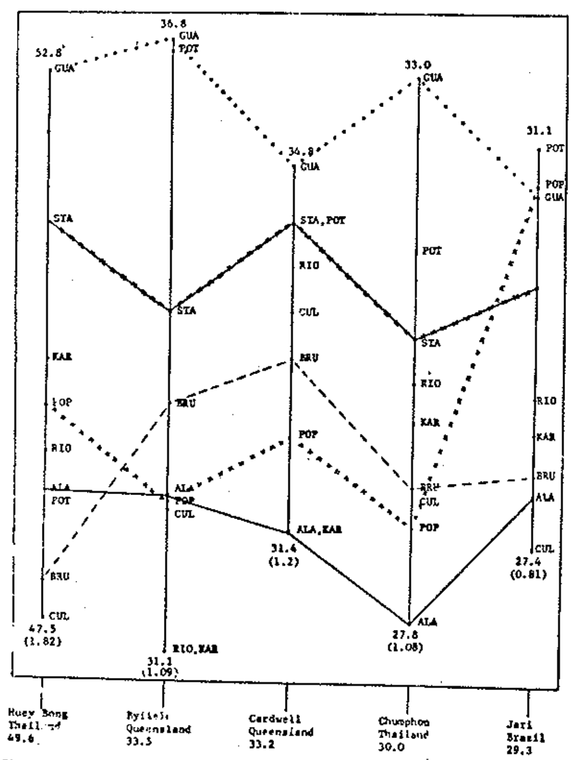

Figure 5. Genotype-environment interaction of bark percent (BKP)(%) at 6-7 years for nine provenances of *Pinus caribaea* var. *hondurensis* over five localities showing provenance ranks, ranges and standard errors within localities and locality means

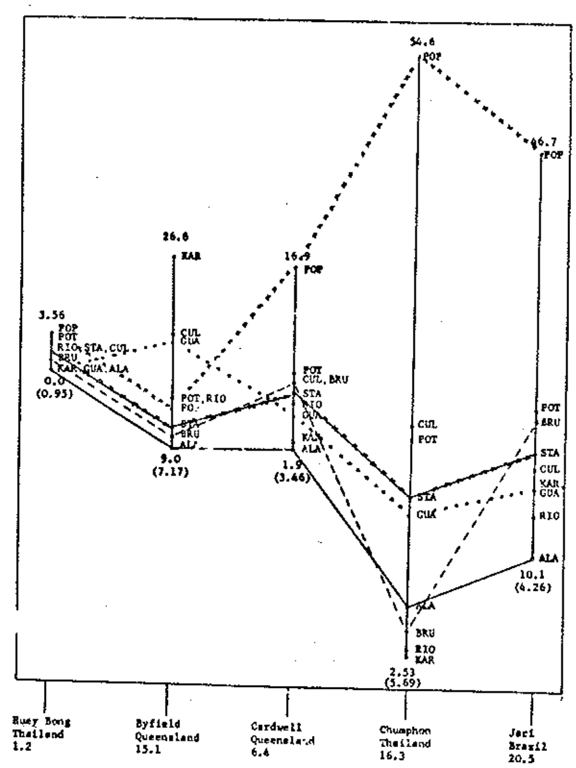

Figure 7. Genotype-environment interaction of forking (FKI)(index) at 6-7 years for nine provenances of *Pinus caribaea* var. *hondurensis* over five localities showing provenance ranks, ranges and standard errors within localities and locality means

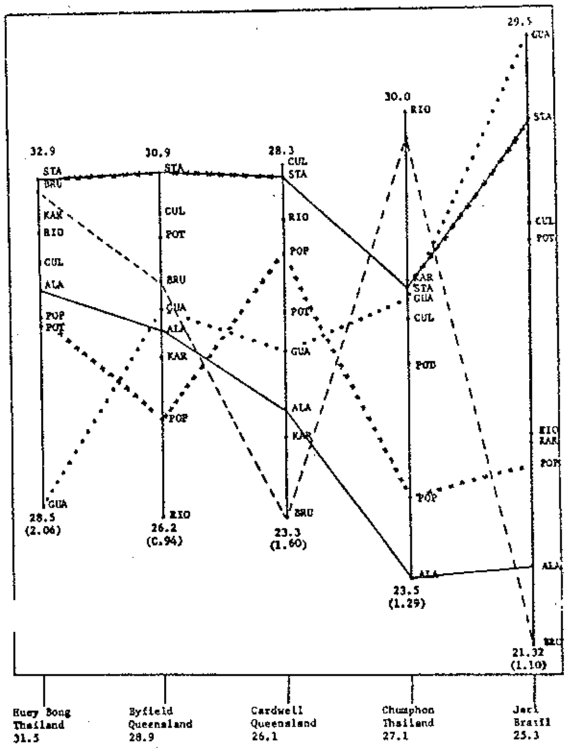

Figure 8. Genotype-environment interaction of branching (BI2)(index) at 6-7 years for nine provenances of *Pinus caribaea* var. *hondurensis* over five localities showing provenance ranks, ranges and standard errors within localities and locality means

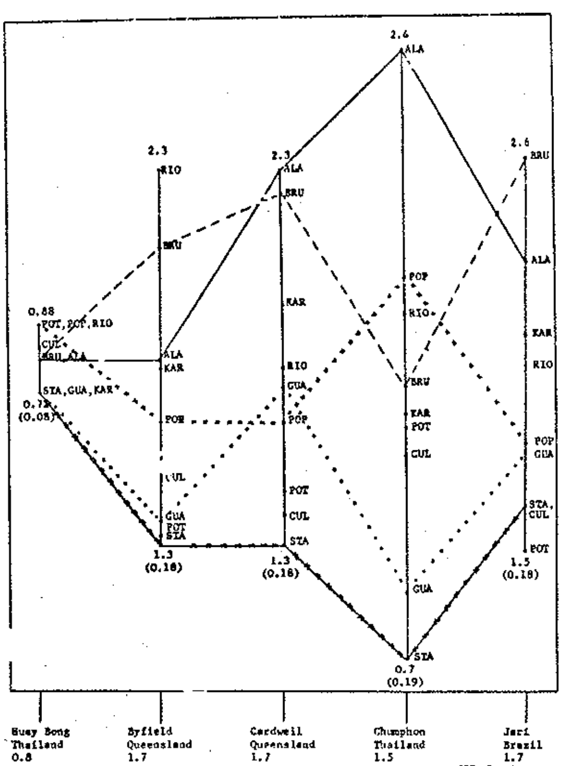

Figure 9. Genotype-environment interaction of longest internode (LIL) (m) at 6-7 years for nine provenances of *Pinus caribaea* var. *hondurensis* over five localities showing provenance ranks, ranges and standard errors within localities and locality means

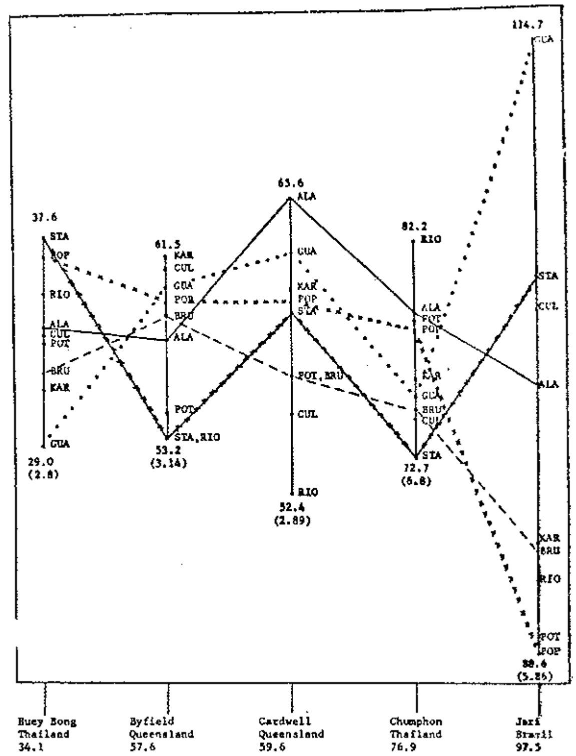

Figure 10. Genotype-environment interaction of index for average tree (IAT) at 6-7 years for nine provenances of *Pinus caribaea* var. *hondurensis* over five localities showing provenance ranks, ranges and standard errors within localities and locality means

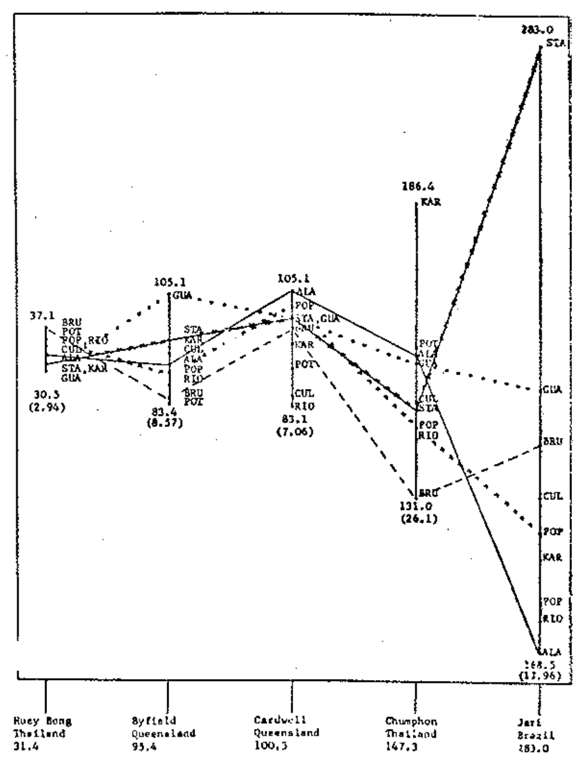

Figure 11. Genotype-environment interaction of index for best tree (IBT) at 6-7 years for nine provenances of *Pinus caribaea* var. *hondurensis* over five localities showing provenance ranks, ranges and standard errors within localities and locality means

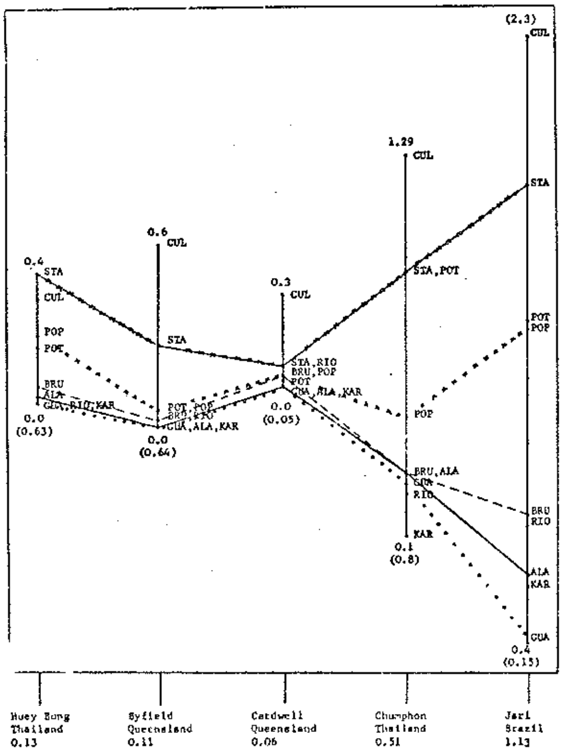

Figure 12. Genotype-environment interaction of conelet production (CLN) (class) at 6-7 years for nine provenances of *Pinus caribaea* var. *hondurensis* over five localities showing provenance ranks, ranges and standard errors within localities and locality means

IAT is a crude index of excellence for the average tree; VOB, STR and BI2 were used in its construction. The combined analysis (Table 2) shows that when trees were evaluated on this basis, none of the variance was due to provenance or gei and any genetic variance would therefore be in the large between tree, within provenance, variance. This suggests that there may not have been favourable correlations between volume, stem straightness and branching habit and it also suggests that several provenances might advantageously contribute to the breeding population at a particular locality. The interaction variance returns when it is the tree in the plot with the best index (IBT) and this again is due to the remarkable performance of individual trees in the Santa Clara provenance when compared with Alamicamba at Jari (Figure 11).

Conelet production (CLN) was under greater genetic (provenance) control than any of the other traits discussed here. There was, however, almost as much gei as there was provenance variance but most of it was clearly due to heterogeneity of regression which is confirmed by the very large F-ratios for the regression analyses for all the individual provenances (Table 2); Karawala was stable in producing very few conelets at any site (b = 0.53) whereas Culmi increased steeply with more favourable conditions for 'flowering' (b = 1.88) (Figure 12).

Five provenances were common to eight trials in the data presented here for wood density (Figure 13). The insular Guanaja stood out as having the highest density of the five provenances in six of the eight trials. The coastal group Alamicamba, Brus Lagoon and Rio Coco had quite consistently lower density whereas the inland Poptun was intermediate. The reason for the F-ratios for provenances not being significant was probably that the analysis was based on a lowest common denominator of three replications per trial; the chart means were based on five replications for most localities. These density results are somewhat surprising but gratifying in that Guanaja also had the highest average volume at three out of five localities (Figure 3) and although it did have a high proportion of bark (figure 5), the five percent or so by which it exceeded the provenances with thinnest bark would not affect its ranking on these sites for under bark volume.

F U T U R E   S T R A T E G Y

This data from the intensive assessment programme of the international provenance trials is only a very small part of the material being collected; we have not included *P. oocarpa*, many *P. caribaea* provenances and trials, many traits, the detailed wood property and resin analyses and all the environmental data. However, this brief look at nine *P. caribaea* provenances at five localities does enable us to make some informed comment on the implications of the results of the trials for future strategy and the most fundamental of these are listed below.

1. There is unlikely to be any one universally superior provenance of *P. caribaea* var. *hondurensis*. There could be circumstances in which the properties of one provenance may be preferable for a special situation, but it is more likely that it will be an advantage for most countries to base their commercial and breeding populations on a number of provenances.

2. For all traits, very large proportions of the total variation were contained in the localities and the trees in plots sources. From a strategy point of view, we are not interested in the former but there is much more that we need to know, and can find out, about the tree to tree variation within provenances. We have no information yet on genetics or gei at that level. In addition, lack of control of the genetic contribution from plot to plot has probably contributed substantially to the large standard errors of provenance means. There is no doubt in our minds that, in the second phase of provenance testing, provenances should be represented by identified half-sib wind-pollinated families raised from seed collected from individually selected trees in the natural, or exotic, stands. This will not only yield information on gei and make the experiments more precise for their size, but will provide a base for a breeding population in which selection would be on proven genotypic performance at two levels, provenance and family.

3. These results indicate that the provenance with the highest mean productivity (per tree or per unit area) is not necessarily the provenance which contains the most outstanding individual trees. It appears that on some sites some provenances express latent genotypic variability more keenly and it may be among the best trees in such provenances that the best founder members for breeding populations will be found. Uniformity and maximum productivity per hectare may be prime requirements if seed is being imported for industrial plantations but outstanding individual trees are a prime requisite for breeding.

4. Qualitative traits, and wood density, seem generally to be under a greater degree of genetic control than are quantitative traits and they are also less likely to interact with environment. This suggests that when collecting seed in natural stands, it may be profitable to select trees for good stem and branch form rather than place any special premium on size. Selection on this basis is not likely to result in a restricted sampling of the population for other genes of interest.

5. There are already indications from this small sample of provenances and trials, and from the broader interpretation of results (Greaves, 1980b), of patterns of variation which may be used in predicting the response of a provenance from a given natural environment to given exotic surroundings. When all the assessment data are in, the samples processed and the climatic and edaphic information has been incorporated in the analyses, it is anticipated that we shall be able to gain a much improved understanding of how the traits of interest in these two tropical pines vary and of the relative importance of the way in which genetic factors and elements of the environment control this variation. Hopefully, this will contribute to the information needed for deciding on strategies for the construction of useful domestic populations and ultimately to a rational plan for the international development of the species (Namkoong *et al.*, 1980).

A C K N O W L E D G E M E N T S

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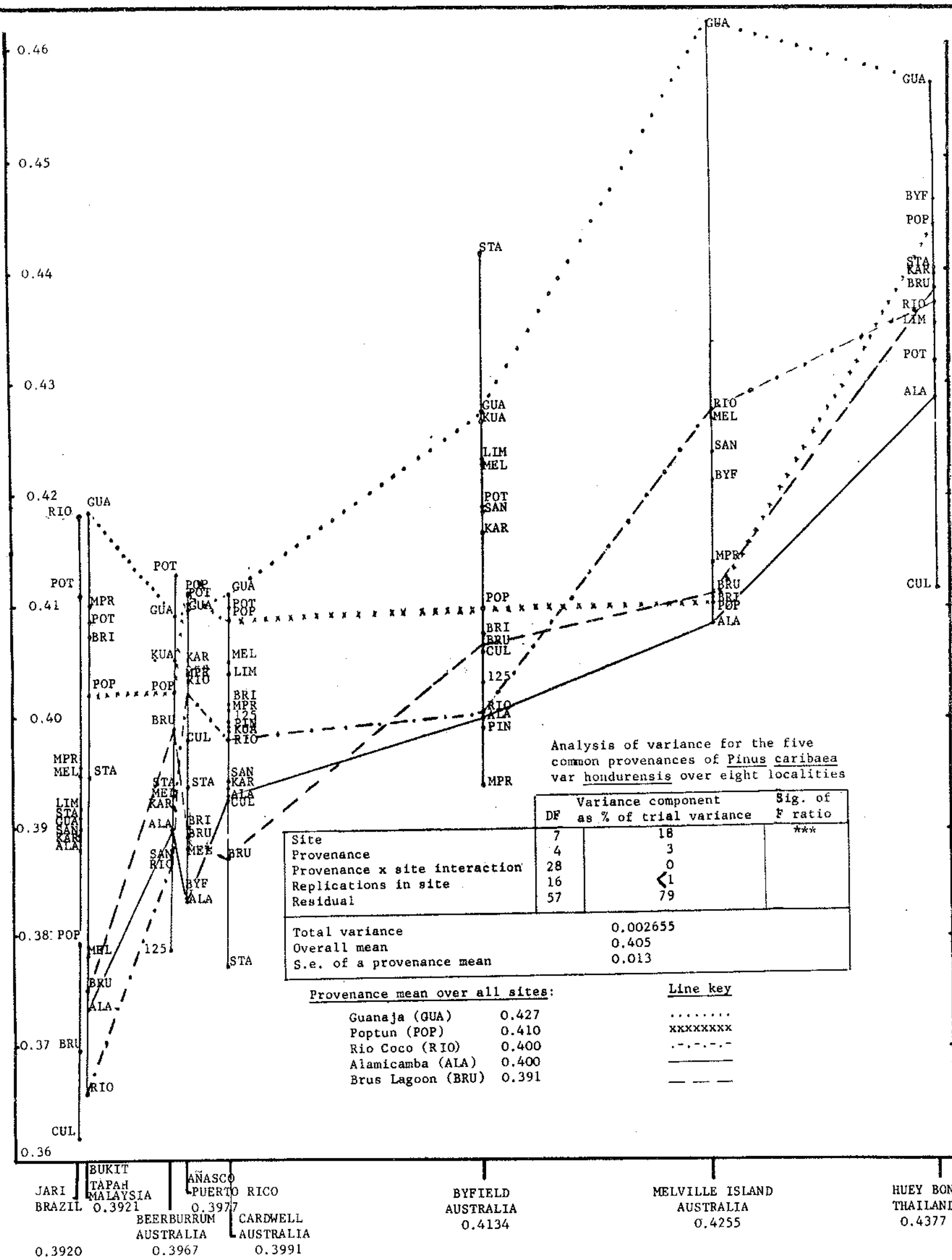

Analysis of variance for the five common provenances of *Pinus caribaea* var *hondurensis* over eight localities

	DF	Variance component as % of trial variance	Sig. of F ratio
Site	7	18	***
Provenance	4	3	
Provenance x site interaction	28	0	
Replications in site	16	<1	
Residual	57	79	
Total variance		0.002655	
Overall mean		0.405	
S.e. of a provenance mean		0.013	

Provenance mean over all sites:		Line key
Guanaja (GUA)	0.427	....
Poptun (POP)	0.410	xxxxxxxx
Rio Coco (RIO)	0.400	.-.-.-.-
Alamicamba (ALA)	0.400	———
Brus Lagoon (BRU)	0.391	— — —

Figure 13. Analysis of wood density (at 12% moisture content) for 17 provenances of *Pinus caribaea* var *hondurensis* over eight localities

SELEÇÃO E MELHORAMENTO DE *Pinus caribaea* EM FIJI

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Resumo

Há dez anos Fiji vem desenvolvendo um ativo programa de melhoramento de pinheiros. Esse trabalho consentrou-se em *Pinus caribaea* var. *hondurensis* de Mt. Pine Ridge, e Belize. Até a presente data, 27 hectares de pomares de sementes foram instalados. Outras procedências além das M.P.R., que estão se mostrando potenciais, nos testes internacionais, serão incluídas no futuro programa de melhoramento.

SELECTION AND BREEDING OF *Pinus caribaea* IN FIJI

Summary

Fiji has had an active pine tree breeding programme for over 10 years. Work has mainly been with P.caribaea var. hondurensis of Mountain Pine Ridge, Belize provenance. To date 27 ha of seed orchards have been established. Provenances other than M.P.R. that are showing promise in international trials will be included in the future breeding programme.

SÉLECTION ET AMÉLIORATION DE *Pinus caribaea* À FIJI

Resume

Depuis 10 ans, les Iles Fidji entreprennent un programme intensif d'amélioration génétique des Pins. Le travail porte essentiellement sur le *Pinus caribaea*, var *hondurensis* Barrett et Golfari, provenance de Mt. Pine Ridge Belize.

On a planté jusqu'à maintenant 27 hectares de vergers grainiers.

Les provenances outres que celle de Mt. Pine Ridge qui se montrent prometteuses par rapport aux essais internationaux, feront partie des futurs programmes d'amélioration génétique

Introduction

The Fiji islands lie between 16°S and 19°S latitude. Pine planting is mainly carried out in the western dry zone of the two main islands, most of which falls below 600m elevation. The dry zone has a distinct dry season with more than 50% of the annual rainfall occurring during the first three months of the year. The main species is Pinus caribaea var hondurensis of Mountain Pine Ridge, (M.P.R.) Belize provenance. This is planted on burnt-over grasslands on the lower hillsides. The annual planting programme is about 5,000 ha. and at the time of writing there were over 35,000 ha. of P.caribaea plantations in Fiji.

The soils in the areas available for planting are mainly ferruginous or humic latosols and nigrescent soils. As a result of soil and foliage analyses carried out in pine plantations, Bevege and Humphreys (1977) noticed a widespread marginal deficiency of boron and sulphur. Although accepting that there are site problems, particularly with the heavy nigrescent clay soils, they concluded that there are no major nutrient deficiencies in the Fiji pine plantations that need immediate remedial treatment. They recommended that the approach to overcoming these marginal deficiencies should be by selecting provenances and genotypes adapted to the site.

Provenance Trials

Provenance trials were established in 1968, 1975 and 1976 to compare the survival, growth rate, form and other relevant characteristics of 36 provenances of P.caribaea on several contrasting sites in Fiji. Site details and early growth rate are described by Bell (1978). The 1975 trial includes 22 provenances raised from seed supplied by the Commonwealth Forestry Institute, Oxford (Kemp 1973) and is represented on five sites in Fiji ranging from 35m to 450m elevation and 1862mm to 3119mm annual rainfall. This trial was considered to be too young for the C.F.I. assessment carried out during 1979. An intermediate assessment for height and diameter was made by local staff on one site, Nanuku, at age 5. Provenances that appeared in the top rank for diameter and height at Nanuku at age 5 and for height on all other sites at age 1 were Karawala, Alamicamba, Santa Clara (Nicaragua) and Brus (Honduras). Appearing in the top rank on all but the seasonally waterlogged site at Nabou were Poptun (Guatemala) Culmi (Honduras) and Byfield (Queensland). These are all recorded as promising provenances by Greaves (1980). The Mountain Pine Ridge provenance has performed moderately well in Fiji and appears in the second ranking for height and top ranking for diameter in the 1980 Nanuku assessment.

Plus Tree Selection

Growth of Pinus caribaea var hondurensis is good on most sites in Fiji but form is variable, with frequent cases of foxtailing. Plus tree selection started in 1967 in plantations aged seven or older using a points system proposed by Shepherd (1969). Selection criteria include vigour, straightness, taper, crown appearence, branch size and angle. Timber structural features are being appraised at Oxford University. In the early stages of selection more attention was paid to straightness and good form than to vigour. Over 230 plus trees have been selected from Fijian plantations and a further 87 have been imported from Queensland on an exchange basis.

Seed Production

The Fiji climate appears to be ideal for flowering and fruiting of P.caribaea. Since 1977 seed collections of up to 2 tonnes a year have exceeded the local demand and substantial quantities have been exported (Bell 1979). Most of this seed is harvested from unimproved stock but the quantity of genetically improved seed is increasing annually. Early in 1970 a Tree Improvement section was appointed following recommendations made in a Development Plan prepared by Shepherd (1969). The work programme was aimed at providing improved seed from selected trees, seed stands, untested and progeny tests clonal seed orchards and the conversion of progeny trials to seedling seed orchards. Each stage was to be phased out as the better seed source came into production.

Picking from widely scattered selected trees in plantations was expensive and soon discontinued. Seed stands are established by reducing plantations to the best 200 stems per hectare by thinning at age five and at age seven or eight. There are over 50 hectares of P.caribaea seed stands in Fiji. Grafting of plus tree scions into seed orchards started in 1973. At the end of 1979 there were 19 ha of clonal seed orchards, of which 3 ha had been rogued using data from progeny trials, and 8 ha of seedling seed orchards. Seven years after grafting the oldest orchard yielded 17 kg of seed per ha.

Progeny Trials

Progeny from plus trees selected in Fiji and Queensland were planted in replicated plots at several sites in both countries in 1972. Most families were from open-pollinated ortets but seed from several of the Queensland families came from a clonal bank. At age 4.5 years the best performance had come from the Queensland families, particularly those from the clonal bank (Nikles et al 1978). In an assessment at one Fijian site at age 6 the Queensland families were still mainly superior in growth and straightness but had a greater tendency to foxtailing than the Fijian families (Wilcox 1978). Two Fijian families were amongst the highest ranked families. Using data from this trial, clones from the six worst families have been removed from clonal seed orchards in Fiji and will be permanently removed from the breeding programme. Seven second generation plus trees have been selected from the top ranking families in the trial. Other open pollinated progeny trials were established in Fiji in 1974, 1978, 1979 and 1980 using progeny from *P. caribaea* plus trees selected in Fiji, Queensland and New Caledonia.

Polycross Mating

A polycross mating system for the Fijian pine breeding programme was proposed by Wilcox in 1978 and initiated in 1979 (Firth 1979). Equal volumes of pollen from 22 Fijian and 10 Queensland clones were used to make a pollen mix. Female flowers on 21 Fijian and 19 Queensland clones were isolated with a cellulose casing into which the pollen mix was injected periodically for several weeks. Seed from this partly experimental trial is scheduled for collection and sowing in 1981 to establish a progeny trial in 1982. In 1979 a clonal orchard was established with the 40 polycrossed families and this will be rogued using data from assessments of the progeny trial. Eventually, the progeny trial will be searched for second generation plus trees and will be converted to a seedling seed orchard.

Conclusion

Pine breeding activities in Fiji have mainly been concentrated on the M.P.R. provenance of var *hondurensis* and a broad genetic base has been established. Other provenances are showing promise and breeding material from the best performers will be introduced to the Fijian programme. Fiji has taken part in international cooperative projects and will continue to do so but on a scale related to the limited resources of the country.

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TESTES DE PROCEDÊNCIA DE *Pinus caribaea* NO TERRITORIO NORTE DA AUSTRÁLIA – AVALIAÇÕES AOS SEIS ANOS

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Resumo

O teste internacional de procedências de *P. caribaea* var. *hondurensis* Barrett e Golfari localizado na ilha Melville (Lat. 11°40' s, Long. 130°42' E) foi avaliado, considerando-se um grande número de características, na idade de seis anos pelos técnicos do Commonwealth Forestry Institute. O experimento incluía uma procedência de *P. caribaea* Morelet var. *caribaea*, *P. caribaea* var. *bahamensis* Barrett e Golfari e *P. oocarpa* Schiede. Catorze das mais importantes características foram analisadas e são a seguir relatadas e discutidas. As procedências mais produtivas foram Alamicamba, Rio Coco, Guanaja, Mountain Pine Ridge e Brus Lagoon e também a Byfield oriunda do programa de melhoramento Queensland. Todavia, algumas dessas procedências foram aquelas que apresentaram a mais alta ocorrência de defeitos no tronco ou nos ramos, por exemplo, Brus Lagoon, Alamicamba e Byfield. Não se constatou uma relação negativa entre densidade da madeira e produção volumétrica. A procedência insular Guanaja combinou alta produtividade com alta densidade e boas características de troncos e ramos. Há indicações, portanto, de que a seleção e o melhoramento, visando a produção de uma linhagem adaptada para futuras plantações, no território norte, deveriam ser baseadas em introduções posteriores Guanaja, Rio Coco e Alamicamba.

PROVENANCE TESTS OF *Pinus caribaea* IN THE NORTHERN TERRITORY OF AUSTRALIA – SIX - YEAR ASSESSMENTS

Summary

The International Provenance Trials of *Pinus caribaea* var. *hondurensis* Barrett and Colfari located on Melville Island (Lat. 11° 40'S, Long. 130° 42'E) was assessed for a large number of traits by a team from the Commonwealth Forestry Institute at age 6 years. The trial also included one provenance each of *P. caribaea* Morelet var. *caribaea*, *P. caribaea* var. *bahamensis* Barrett and Golfari and *P. oocarpa* Schiede. Fourteen of the most important characteristics were analysed and are reported and discussed here. The most productive provenances were Alamicamba, Rio Coco, Guanaja, Mountain Pine Ridge and Brus Lagoon, and also the Byfield source from the Queensland breeding programme. However, some of these provenances were also those with the highest occurrence of stem or branch defects, *e.g.* Brus Lagoon, Alamicamba and Byfield. There was no suggestion of a negative relationship between volume production and wood density and the insular provenance, Guanaja, combined high productivity with high density and a general lack of stem and branch defects. There are indications that selection and breeding to produce an adapted strain for future Northern Territory plantations should be based on further introductions from Guanaja, Rio Coco and Alamicamba.

TESTS DE PROVENANCE DE *Pinus caribaea* AU NORT D'AUSTRALIE – ÉVALUATIONS À L'AGE DE SIX ANS

Resume

Une équipe de l'INSTITUT FORESTIER du Commonwealth d'Oxford a procédé à des mensurations et des observations sur des plantations entreprises sur l'Ile Melville (Latitude 11° 45' Sud, Long. 130° 42' E) au titre des essais internationaux de provenance du *Pinus caribaea*, var. hondurensis, BARRETT et GOLFARI.

Ces essais portaient également sur une seule provenance des variétés et espèces suivantes : Pinus caribaea, MORELET, var. caribaea, Pinus caribaea, var. bahamensis, BARRET et GOLFARI et Pinus oocarpa, SCHIEDE. On examine ici 14 des caractéristiques observées les plus importantes. Les provenances les plus productives sont les suivantes : Alamicamba, Rio Coco, Guanaja, Mountain Pine Ridge et Brus Lagoon, ainsi que la source d'approvisionnement en graines de Byfield, issue du programme d'amélioration du Queensland. Cependant, certaines de ces provenances présentent un taux très élevé de fûts et branches défectueux comme par exemple les provenances Brus Lagoon, Alamicamba et Byfield. Ce qui n'implique pas de relation négative entre la production en volume et la densité du bois.

La provenance de l'île de Guanaja totalise à la fois une productivité élevée, une forte densité et aussi un développement qui ne présente, en général, pas de défaut de fût ou de branches. Pour obtenir une variété adaptée aux conditions du Northern Territory et y procéder à des plantations, des indications sont données sur le mode de sélection et d'amélioration à entreprendre à partir d'introductions de provenances de Guanaja, de Rio Coco et d'Alamicamba.

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

Pinus caribaea Morelet plantations will make a major contribution to future timber needs of the Northern Territory. The history of introduction and provenance testing of the species have been described by Cracium (1978).

The trial reported here is part of the co-operative International Trials organised by the Commonwealth Forestry Institute, Oxford, who also provided the seed. This report is based upon some of the data collected by the CFI assessment team in December 1978. Another replication of the trial was established at Humpty Doo near Darwin but this was burnt out in 1978 and was not assessed at the same time. However, data from a 1978 assessment have been analysed and results are included here.

M A T E R I A L S   A N D   M E T H O D S

Nine provenances of P. caribaea var. hondurensis Barrett and Golfari were tested and one provenance each of P. caribaea var. bahamensis Barrett and Golfari, P. caribaea var. caribaea and P. oocarpa Schiede were included for comparison. The abbreviations for provenance identification used in all the tables and figure below are:-

Brus Lagoon (BRU)	Melinda (MEL)
Byfield (BYF)	Palacios (PAL) (var. caribaea)
MPR (MPR)	Poptun (POP)
Rio Coco (RIO)	Guanaja (GUA)
Santos (SAN)	Alamicamba (ALA)
Andros (AND) (var. bahamensis)	P. oocarpa (OOC) (Pueblo caido)

For provenance source details see Greaves (1978). The nursery and establishment techniques and sites have been described elsewhere (Cracium, 1978).

The trial was established in January, 1973, and the experimental design was a randomized complete block with four replications of 49-tree square plots at a spacing of 3 x 3 m. No pruning or thinning had been carried out since establishment. Results of earlier assessments have been reported (Cracium, 1978).

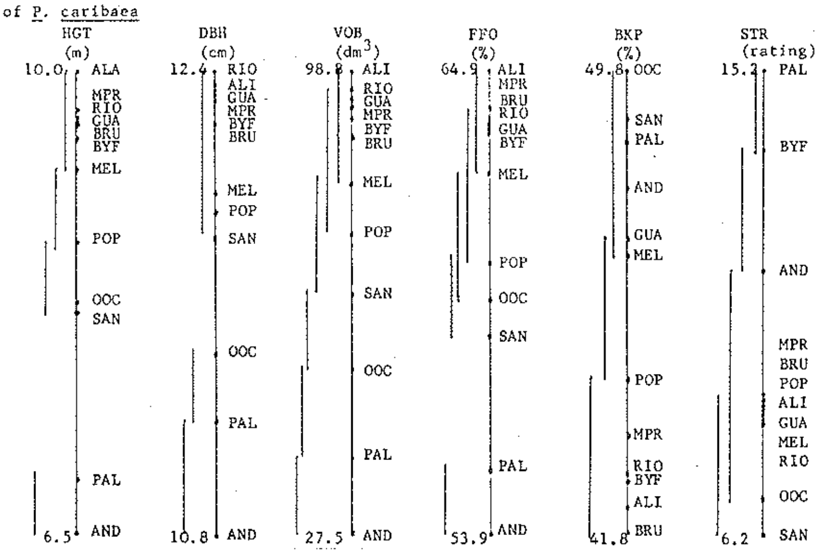
The detailed assessments carried out by the CFI team in December 1978 included a large number of traits, (Barnes and Gibson, in press). Only those characters which are thought to be of greatest value in the selection of provenances suitable for this environment are discussed here; they were height (HGT), diameter at breast height over bark (DBH), total over bark volume (VOB), form factor based on diameters at 1.3 m and 6 m (FFO), bark expressed as a percentage of total volume (BKP), straightness of the first 6 m of stem (categories 1 = worst, to 26 = best) (STR), foxtailing i.e. proportion of trees with internodes over 2 m (FTP), number of whorls between 1 and 6 m (NWH), number of branches per metre between 1 and 6 m (BPM), proportion of trees with ramicorns (RCP), the proportion of forked trees (FKP), number of cones (CNN), severity of needleless shoot condition in five categories (NLS), and density based on volume of a fresh, 8 mm, bark to bark core and core weight at 12% moisture content (DEN).

R E S U L T S

Appendix I deals with stem characteristics affecting production and utilization, i.e. HGT, DBH, VOB, FFO, BKP and STR based on individual tree values. Provenances of ALA, RIO, GUA, MPR, BYF and BRU ranked highest and generally were not significantly different from each other. These provenances also had less stem taper (FFO) and thinner bark (BKP). However, of this group, only BYF ranked highly for STR, an indication of achievement in the Queensland improvement programme. The varieties caribaea and bahamensis and P. oocarpa ranked lower than all the var. hondurensis for volume production but the P. oocarpa provenance was not one of the more vigorous of that species.

Appendix II includes the branching and forking characteristics, FTP, NWH, BPM, RCP, and FKP. BRU and ALA ranked high in the incidence of foxtails; BYF also ranked highly with 31%. Expression of this defect could indicate strong environmental influence since there was selection against it in the Queensland programme. NWH is closely correlated with BPM and, among the var. hondurensis provenances, the coastal sources

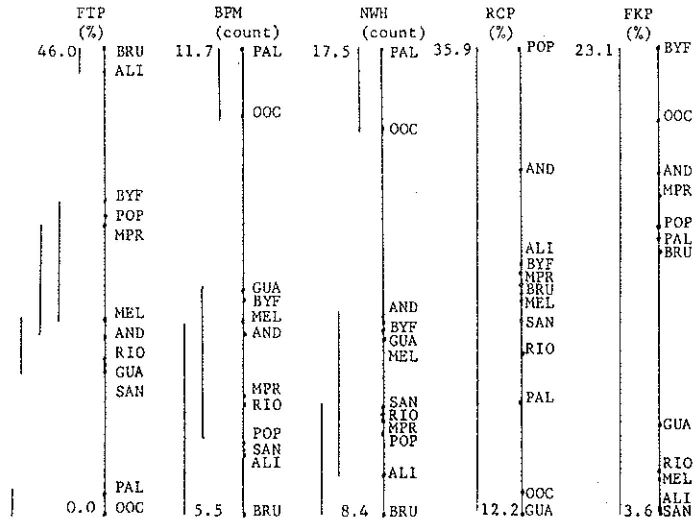
APPENDIX I - Analysis of variance, ranked means and studentized range tests for traits HGT, DBH, VOB, FFO, BKP and STR in six-year-old provenance trial of P. caribaea



	HGT	DBH	VOB	FFO	BKP	STR
Mean	8.35	12.52	75.41	61.21	45.59	9.45
LSD	0.37	0.62	9.00	1.44	1.39	1.70

Source	Df	Mean Square and significance of F-ratio					
PRC	11	*** 83.09	*** 116.8	*** 36370.	*** 846.3	*** 544.1	*** 443.7
REP	3	3.780	14.29	3809.	70.09	* 183.4	* 272.3
RESIDUAL	33	** 3.216	*** 8.785	*** 1876.	*** 48.29	44.01	* 67.06
TREES	695	1.621	4.233	1097.	21.38	44.90	40.05

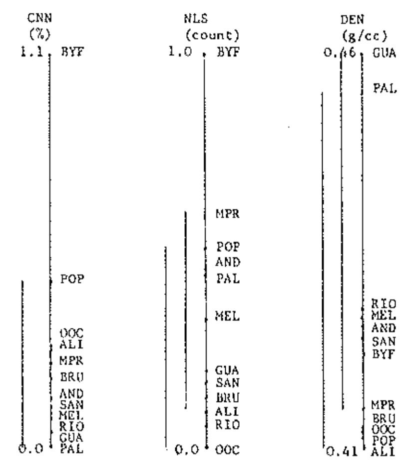
APPENDIX II - Analysis of variance, ranked means and studentized range tests for traits FTP, BPM, NWH, RCP and FKP in six-year-old provenance trial of *P. caribaea*



		FTP	BPM	NWH	RCP	FKP
Mean		25.26	7.88	11.77	22.64	12.11
LSD		14.19	0.99	1.17	8.31	7.48

Source	Df	Mean Square (Significance of F-ratio)				
PRC	11	*** 423.6	*** 222.1	*** 451.9	169.1	* 20.63
REP	3	*** 798.8	27.30	45.30	29.06	983.8
RESIDUAL	33	97.08	** 23.42	** 31.70	100.1	2671.
TREES	695		12.06	18.72		

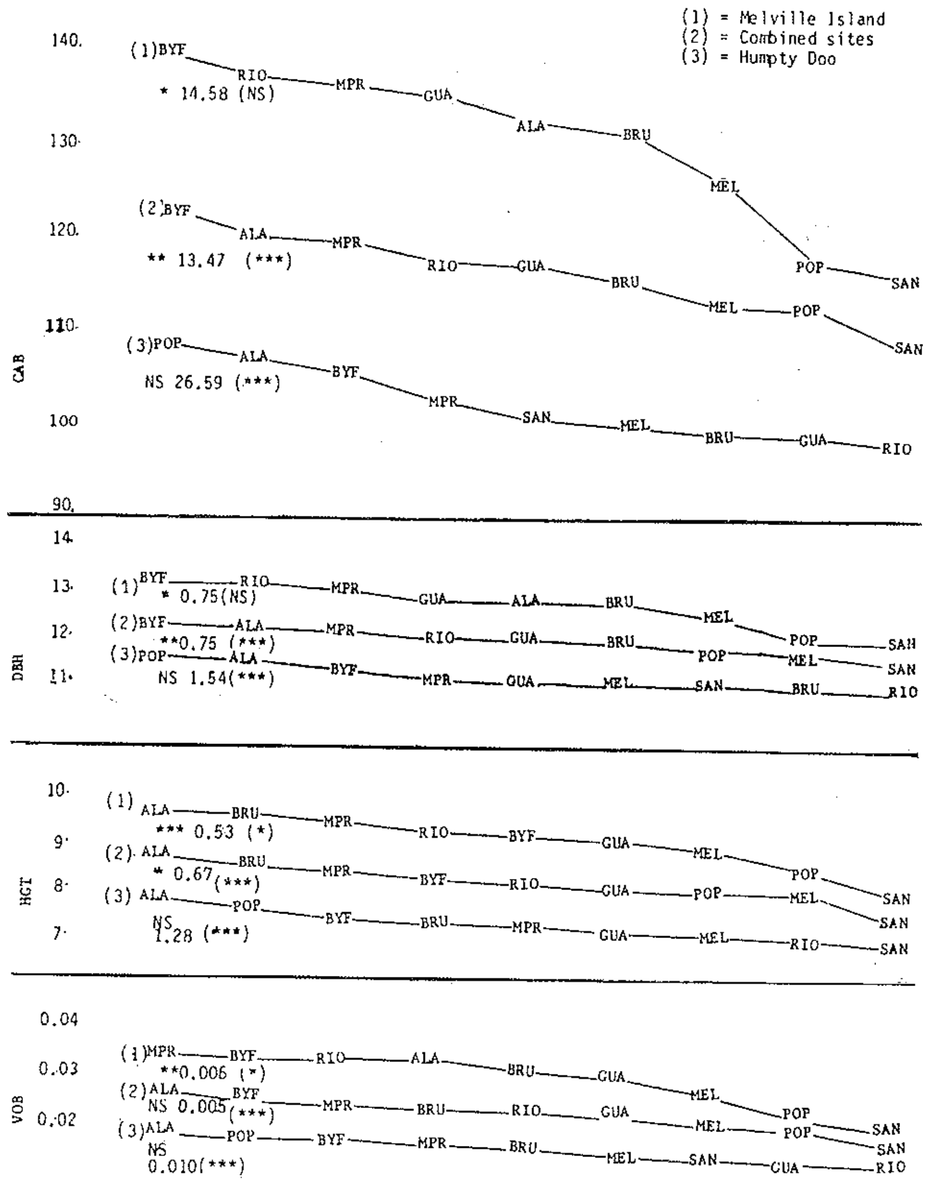
APPENDIX III - Analysis of variance, ranked means and studentized range tests for traits CNN, NLS and DEN in six-year-old provenance trial of *P. caribaea*



		CNN	NLS	DEN
Mean		0.26	0.35	0.425
LSD		0.18	0.19	0.010

Source	Df	Mean Square (Significance of F-ratio)		
PROV	11	*** 32.19	*** 35.32	* 0.00372
REP	3	293.4	119.5	** 0.00918
RESIDUAL	33	472.0	538.4	0.00137
TREES	96			0.00182

APPENDIX IV - A comparison of CAB (stem basal area over bark at breast height - cm^2), DBH, HGT and VOB (m^3) in provenance trials of *P. caribaea* at Melville Island and Humpty Doo.



tended to have fewer branches except in the case of GUA which had a large number of branches and was more like vars. *caribaea* and *bahamensis* and *P. oocarpa* in these traits. POP was the worst provenance for ramicorns; otherwise there was not much variation except that GUA, var. *caribaea* and *P. oocarpa* were significantly better in this respect. Forking at two years is a common trait in local plantations and forking of foxtails at the commencement of each flush of growth often occurs. BYF and MPR were among the provenances with the highest incidence of forking; it is interesting that the Byfield material was derived from material of the MPR provenance.

Appendix III gives the data for CNN and NLS. Needleless shoots (NLS) are a common defect in trials are are associated with multiple coning. Cone number (CNN) was a count of all mature cones and included cones which resulted from abnormal flowering associated with needleless shoots. BYF provenance had the highest cone count and the highest incidence of needleless shoots which suggested a relationship between precocity of flowering and incidence of the defect.

Appendix III also shows gross density values. There did not appear to be any negative correlation between density and volume production; in fact the high volume producer GUA also ranked highest for density.

Appendix IV shows a comparison of growth on the two sites and average growth on the two sites combined. Here, BYF and ALA ranked highly but site variation masked provenance differences on the Humpty Doo site (signficance levels shown in brackets).

D I S C U S S I O N

The results of this assessment must influence the choice of provenances which will in future be introduced to the region; further refinement will then take place through selection and breeding, within these provenances to develop well adapted material with which to establish plantations. Other than Byfield and its original source provenance, MPR, the provenances which stand out in both high productivity and lack of detractive characters, such as foxtailing, branching defects, forking, and needleless shoots, are Alamicamba, Rio Coco and Guanaja.

This trial will be maintained in its unthinned state for the foreseeable future and periodic assessments will be made and results reported.

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TESTE DE PROGÊNIES DE *Pinus caribaea* VAR *hondurensis* NO TERRITORIO NORTE DA AUSTRÁLIA

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Resumo

Mudas produzidas de sementes de polinização livre, colhidas de árvores superiores, selecionadas em Queensland e Fiji, dentro das procedências de M.P.R. de *Pinus caribaea*, demonstraram haver considerável variabilidade genética, quando plantadas nas condições ecológicas do território norte. Resultados das avaliações de um teste de progênie na idade de 2 anos e meio, e 3 anos e meio, indicam que ganhos genéticos podem ser obtidos para crescimento, e a redução de problemas fitossanitários e, eliminação de características morfológicas indesejáveis, que são comuns às procedências M.P.R., quando plantadas nesse ambiente. Esses ganhos genéticos poderiam ser esperados nas futuras gerações derivadas de populações com a base genética originária do teste de progênie.

PROGENY TESTING OF *Pinus caribaea* VAR *hondurensis* IN THE NORTHERN TERRITORY OF AUSTRALIA

Summary

Seedling stock, derived from open-pollinated seed from Queensland and Fiji parent trees of the M.P.R. provenance of Pinus caribaea, have demonstrated considerable genetic variability when grown under Northern Territory conditions. Results of assessments of a progeny trial at age 2.5 and 3.5 years indicate that useful gains in growth and a reduction in the incidence of health problems and undesirable morphological characters, which are common in the M.P.R. provenance when grown in this environment, could be expected in future generations derived from the genetic base developed from progeny testing.

TEST DE DESCENDANCE DE *Pinus caribaea* VAR *hondurensis* AU NORT D'AUSTRALIE

Resume

Un stock de semis provenant de graines obtenues après pollinisation libre entre parents sélectionnés de haute qualité des Fidjis et du Queensland, d'une provenance M.P.R. de Pinus Carabaea, a montré une grande variabilité génétique, quand on les fait pousser dans les conditions climatiques du "Northern Territory d'Australie". Les résultats d'un test de descendance fait à l'âge de 2 ans et demi et 3 ans et demi, indiquent que des gains importants en croissance et une réduction des maladies, ainsi que des caractéristiques morphologiques indésirables, contrairement à ce qui se passe couramment quand des semis de provenance M.P.R. poussent dans cet environnement. Ces gains pourraient être envisagés pour les générations à venir qui proviennent de la base génétique développée à partir de ce test de descendance.

INTRODUCTION

The first small planting of P. caribaea in the Northern Territory (N.T.) in 1965 was followed by a program of provenance testing, the results of which have been reported (Craciun 1978, Brigden and Gibson, 1980). These indicated those provenances likely to prove most productive in this region. However, almost all of the local plantations established to 1979 (approximately 1500 ha.) are M.P.R. provenance which ranks high in productivity but has a high incidence of foxtails, die-back and needle-less shoots.

Sufficient material of other provenances upon which to develop an improvement program is not yet available. There is, however, considerable genetic variability within the M.P.R. material and early results in current progeny tests indicate that useful gains could be achieved in a relatively short time. The availability of improved seed (and clonal material) from the advanced Queensland and Fiji improvement programs will be invaluable in achieving the goals of the Northern Territory program.

Progeny testing commenced in 1972 when a small trial containing families from Queensland and Fiji was established (Nikles *et al*, 1977). The trial reported here was established in December 1975. While a major objective of the trial is to contribute to the development of a breeding base for future generations, the trial is sufficiently replicated to allow for superimposed thinning and fertilizer treatments which may improve production of viable seed and reduce the incidence and severity of the undesirable characters evident in local plantations.

The trial is located on Melville Island at approximately 130°41'E, 11°40'S at an elevation of 85 m asl. The climate is distinctly monsoonal with the average annual precipitation of 1500 mm falling from October to April and a near-rainless period from May to September.

MATERIALS AND METHODS

The trial tests 100 'families' which includes a 'local' collection of plantation quality seed and a 'control' from British Honduras. The seed sources were Queensland Department of Forestry (courtesy of Dr. Nikles) -79 families (including failed seed lot) and Fiji (courtesy of Fiji Pine Commission) -18 families.

Seed was tray sown on sand and pricked out into clear polythene tubes 2.5 cm top diameter x 17 cm deep. A granular NPK fertilizer mix at 1 g per application was added by hand at fortnightly intervals during the nursery phase. Sowing was made in June/July 1975 and planting completed in mid December 1975. A pocket application of 150 g of NPK (12-5.2-16.6) per tree was made at planting and a further 150 g per tree was applied at 1 year. Spacing was 3 m x 3 m (1100 s.p.ha.).

The design comprises 60 blocks each containing 100 single tree plots with a different randomization of families in each block. The blocks are contiguous except where separated by windrows and this design is replicated on two sites. One of these replications has been subjected to thinning and added nutrient treatments and this replication is reviewed here.

After planting, the site was kept reasonably clean of regrowth by hand pulling of Acacia spp. seedling regeneration during the wet season of planting followed by a disc harrowing at age 1 year. A disc harrow knock-down of Acacia spp. regrowth followed by a basal bark treatment of inter-tree regrowth with 245-T Ester 80 in diesel was carried out prior to measurement, thinning and nutrient application at age 3.5 years.

The planting site is generally flat and carried Eucapypt forest to 25 m with a moderately dense understorey of Livistona palm, Grevillea spp., Acacia spp., etc. The soil is a lateritic red earth to approximately one metre overlaying a gravelly clay and has good internal drainage.

Assessment schedule to June 1979 is as follows:

Year	Age	Ht.	Dbhob	Bark thickness	Health	Acceptability
1975	0	x				
1976	0.5	x				
1977	1.5	x	x			
1978	2.5					x
1979	3.5	x	x	x	x	

The 'Acceptability' assessment was designed as a subjective method for selecting families with a standard of straightness, relative vigour, health and other qualities which would allow their retention in the thinning operation. Characters assesed were:

Straightness	- major defects
Vigour	- relative to surrounding stem neither co-dominant nor dominant
Health	- presence of major symptoms such as fasciation, die-back or dead needles on actively growing areas of the crown
Multiple stems	- presence
Foxtail	- presence
Ramicorns	- presence
Branching	- excessively small angle or excessively large branches in proportion to the stem

Trees with none of the above defects were classified as acceptable.

The 'Health' assessment was subjective and examined each tree in close detail using 27 categories including general health, needle length, needle colour and density, die-back, terminal shoot dominance and fasciation. The assessment will be repeated in June 1981 and the results of both assessments will then be computer analysed to determine changes that may have occurred over the period and the influence of thinning and fertilizing.

Following the assessment in June 1979, thirty blocks (as two non-contiguous groups of 15 blocks) were thinned to 50% of original stocking i.e. 550 s.p.ha. retained. Initially it was proposed to retain only stems of families which contained 40% or better of acceptable individuals. However, when it came to selection in the field it was found that too many unacceptable stems from high ranking families would be retained and many high quality stems from the lower ranking families would be removed. It was therefore decided to select for retention on an individual tree basis.

Fertilizer treatments were applied in November, following thinning, to coincide with commencement of the wet season. On a per tree basis the treatments were:

1. nil
2. 400 g superphosphate
3. (2) + 80 g urea + 40 g $ZnSo_4$
4. (3) + 40 g Boron + 40 g $MnSo_4$ + 20 g $CuSo_4$
5. (4) + 1 g Na_2MoO_4 + 50 g K_2So_4 + 50 g $MgSo_4$

The treatments were applied individually as a surface ring application to each tree. Fertilizer levels were randomized within the groups of thinned and unthinned blocks; hence each group of blocks contained 3 repeats of each of the fertilizer levels.

It is intended to assess the following characters in June 1981: dbhob, ht., bark thickness, count of females, estimate of males, health (as described above), wood density, form factor (dob @ 3 m) and foliar sampling will be carried out to measure uptake of elements applied.

RESULTS

Table 1 lists the best and poorest 20% of families, ranked according to 1979 height and with the overall ranking for 1976 and 1977 measures. Also included are dbhob at 1979 (with overall ranking) and acceptability assessment results.

The percentage incidence of characters for all stems assessed was as follows: branching (3), foxtailing (14), health (5), multiple stems (7), straightness (6), vigour (23) and acceptable stems (42).

Table II lists the top and lowest 20% of families according to ranking for 'acceptable' stems.

DISCUSSION

Although the assessments have been made at an early age, it could reasonably be expected that those families presently ranking highly in vigour will continue to do so. It is also expected that the branching and

TABLE II

P. CARIBAEA PROGENY TEST - 1978

AGE 2.5 YEARS

ACCEPTABILITY ASSESSMENT

Best 20%			Poorest 20%		
Family	Acceptable	Ranking	Family	Acceptable	Ranking
CH2-55R	77	1	CH4-118(O)	32	81
D12	72	2 x	CH1-112(O)	32	82 x
CH6-20(O)	64	3 +	CH1-105(O)	31	83
CH1-109(O)	64	4	CH6-22(O)	30	84 x
CH4-66R	63	5	CH4-74(O)	30	85
CH4-53R	61	6	T1*	30	86
CH4-46(O)	61	7 +	C20**	30	87
NH6	61	8	CH4-121(O)	29	88
CH1-63R	60	9	CH4-76(O)	28	89
C54**	58	10	CH6-30(O)	27	90
CH4-54R127B	58	11	CH1-38R	27	91
2CH4-108(O)	57	12 +	CH6-6(O)	27	92 x
CH4-124(O)	57	13 +	local	26	93
CH4-J(O)	57	14 +	CH4-127(O)	26	94 x
CH4-111(O)	57	15	N3*	26	95
CH7-56R	56	16	CH4-43R	26	96
D13*	56	17	CH6-18(O)	25	97
CH4-BR	56	18 +	CH6-4(O)	22	98
CH6-31(O)	55	19	NH13*	21	99 x
CH4-59R	55	20	CH4-111(O)	13	100 x

* Fiji families + occurring in top 20 for height @ 1979
x occurring in lowest 20 in height @ 1979

** Are families from Queensland selections established in a Fijian clonal orchard comprising Fijian and Queensland selections.

TABLE I

P. Caribaea Progeny Test - 1979 Measurement - Age 2.5 years | Acceptability Assessment 1978 - Age 2.5 years

Family	Ht (m)	Rank '76	Rank '77	Rank '79	Dbhob (cm)	Rank	Branch %	Foxtail %	Health %	Mult. %	Ramic %	Str. %	Vig.	Accept. %
CH6-23(O)	7.09	1	2	1	9.99	9	0	32	2	19	2	9	3	49
CH4-J(O)	6.94	2	4	2	10.35	4	0	12	2	10	5	14	7	57
CH6-14(O)	6.87	37	24	3	9.54	33	5	24	2	9	7	3	15	51
2CH4-108(O)	6.85	7	55	4	10.54	2	3	5	7	17	3	3	22	57
CH6-8(O)	6.83	3	11	5	10.02	7	0	35	5	28	15	5	12	27
CH6-20(O)	6.73	56	40	6	9.58	31	0	12	2	12	7	7	10	64
CH6-4(O)	6.71	15	18	7	9.96	10	10	34	10	46	10	12	14	22
CH4-24R	6.71	24	6	8	9.83	14	0	15	4	20	7	7	11	50
CH4-93(O)	6.70	29	39	9	9.61	29	0	17	0	19	9	12	10	51
CH4-97(O)	6.69	4	3	10	9.81	16	0	12	9	21	7	10	16	50
CH4-46(O)	6.68	6	9	11	10.64	1	0	7	2	13	5	11	11	61
CH4-46R	6.68	5	7	12	10.35	3	0	9	0	14	5	17	14	53
CH6-17(O)	6.63	11	16	13	9.54	32	2	12	2	22	10	3	12	51
N3	6.58	90	38	14	9.10	51	4	48	4	17	4	13	22	26
CH4-124(O)	6.58	27	30	15	9.78	19	2	16	2	14	7	3	5	57
CH4-92(O)	6.57	52	36	16	9.66	22	2	20	0	22	3	3	15	53
CH6-7(O)	6.57	33	32	17	9.22	45	0	24	2	10	0	2	13	48
CH4-BR	6.55	10	5	18	9.06	54	2	2	7	25	9	2	9	56
CH6-22R	6.55	36	27	19	9.65	23	2	14	5	30	11	7	16	37
CH4-NR	6.52	16	8	20	9.92	11	5	21	9	14	7	5	16	47
CH6-11(O)	5.83	82	98	81	8.37	94	2	14	5	22	9	2	34	36
CH6-19(O)	5.82	57	48	82	8.62	87	0	10	15	18	2	3	32	43
D12	5.81	79	89	83	9.12	49	0	6	6	11	11	0	17	72
CH4-52R	5.79	60	64	84	8.41	93	7	4	2	18	11	4	27	42
CH2-41R	5.77	86	91	85	8.58	88	4	19	2	26	4	2	26	37
CH4-DR	5.75	71	75	86	8.86	73	5	9	9	21	9	7	32	34
CH6-16(O)	5.75	25	37	87	9.15	48	2	3	7	27	3	3	35	35
CH6-29(R)	5.73	38	69	88	9.46	38	0	3	4	14	2	7	27	52
CH6-22(O)	5.71	95	99	89	8.26	98	2	23	3	20	9	5	36	30
NH13	5.69	89	94	90	8.77	78	2	7	9	45	13	9	36	21
CH6-50R	5.68	66	66	91	9.05	57	4	2	4	16	7	7	30	51
CH4-87(O)	5.66	97	97	92	8.20	99	3	10	2	26	10	2	33	33
CH4-P(O)	5.63	74	52	93	8.92	68	4	7	9	16	4	7	35	46
CH6-28(O)	5.62	94	92	94	8.33	97	2	0	2	9	9	5	41	41
CH1-112(O)	5.61	92	96	95	8.48	91	2	11	0	21	7	4	43	32
CH4-111(O)	5.60	83	67	96	8.50	90	9	20	27	36	15	7	36	13
CH4-127(O)	5.56	48	87	97	9.01	62	5	7	12	28	5	5	47	26
CH1-1R	5.53	93	95	98	8.92	69	5	7	2	20	2	5	33	40
CH1-38R	5.52	81	86	99	8.35	96	6	6	6	11	4	11	44	36
CH6-6(O)	5.47	78	79	100	8.70	81	3	0	6	27	6	15	44	27
L.S.D.	0.38				0.56									

straightness traits will not alter greatly. The unstable traits are foxtailing, health defects (die-back, fasciation and needle-less shoots particularly), multiple stems and ramicorns since it has been observed that these defects can develop at any time in the life of a tree. It is suggested that with the M.P.R. provenance growing in this region, these defects are under strong environmental influence (Brigden and Gibson, 1980) and as the data presented here illustrates, a genetic control operates also. There are indications that a fertilizer and supplementary trace element application may reduce the incidence and severity of these defects and the superimposed fertilizer treatment may give more positive evidence of this (unpublished data).

The results of this trial have already been put to practical application in that a request has been made to the Queensland Department of Forestry to provide more seed of the top ranking families (in terms of acceptable stems) for routine planting.

Immediately following the detailed assessment planned for June 1981, the thinned blocks will be further thinned to 275 s.p.ha. Selection will again be on an individual tree basis. All blocks will then be pruned to 2.5 m. Future assessments will be at 2 or 3 year intervals.

With the commencement of the second stage of the "Provenance/Progeny Trials of Pinus caribaea and P. oocarpa" sponsored by the Commonwealth Forestry Institute at Oxford, it is planned to introduce as much seed as possible of the provenances most suited to this region (Brigden and Gibson, 1980). It is proposed to canvas other collaborators in this program for scions from their best clones in those provenances to enable the rapid build-up of a breeding base. Clonal material from N.T. stands is readily available.

A further 120 families of M.P.R. origin supplied by Queensland Department of Forestry under their co-operative progeny study program were planted out on Melville Island in January 1980. Approximately 8000 seedlings were involved and the families came from Fiji, New Caledonia, Congo, Queensland and the N.T.

The present genetic base of M.P.R. provenance will possibly be combined with the Guanaja and Rio Coco material, as it becomes available.

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ALFORQUIA DE RAMOS ADULTOS DE *Pinus caribaea* VAR *hondurensis* NO TERRITORIO NORTE DA AUSTRÁLIA

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Resumo

Em enxertos de *Pinus caribaea* de oito anos de idade, pertencentes a clones de árvores "plus" adultas, foi aplicada a alforquia com sucesso, durante todo o ano, na localidade de Darwin, território norte.

A sobrevivência no campo, das plantas resultantes foi muito alta. O desenvolvimento das raízes e da protação dos "ramets", um ano após o plantio foi comparável ao desenvolvimento das plantas de 2 anos de idade, derivadas de mudas produzidas em viveiro, por semeadura.

MARCOTTING OF MATURE *Pinus caribaea* VAR *hondurensis* IN THE NORTHERN TERRITORY OF AUSTRALIA

Summary

Eight-year-old grafted plants of Pinus caribaea belonging to clones of mature plus trees have been successfully marcotted throughout the year near Darwin in the Northern Territory. The survival in the field of the resulting plants was very high. Root and shoot development of the ramets one year after outplanting was comparable with that of a two-year-old seedling tree.

MARCOTTAGE DE TIGES ADULTES DE *Pinus caribaea* VAR *hondurensis* AU NORT D'AUSTRALIE

Resume

Au cours de l'année, près de Darwin dans le Northern territory, on a marcotté avec succès des tiges greffées de *Pinus caribaea* Morelet, âgés de 8 ans, provenant de clones d'obres d'élite adultes. Le pourcentage de plants survivants issus de ces marcottes est très élevé. Un an après la mise en place, le développement de la racine et des rejets des romets est comparable à celui d'une tige de 2 ans provenant de graines.

INTRODUCTION

As part of the tree improvement program for Pinus caribaea var. hondurensis in the Northern Territory grafted clone banks were started in January 1977. Rootstock-scion incompatability has been evident, and has caused the loss of 10% of the plants within two years of planting. Serious losses of ramets, or even whole clones, would be avoided by using self-rooted plants, but neither a satisfactory technique for the striking of cuttings, particularly from mature trees, nor techniques of plant tissue culture are available for P. caribaea. Barnes (1974) considered that marcotting (air layering) in the tops of plus trees had practical difficulties and that the morphological position and nutrient status of this material would reduce success. His approach, therefore, was to marcott grafted potted plants at the base of the scion in the callus tissue at the graft union, and subsequently to deep-plant the entire rootstock and rooted scion. Neither Kedharnath and Dhaundiyal (1963) who worked with an 18-year-old tree, nor Lowery (1978), who used 2-year-old trees, reported the survival and growth of their marcotts in the field. Lowery emphasised the importance of using woody shoots, and Kedharnath and Dhaundiyal found that the use of one-year-old shoots on the mature trees was unsuccessful. Slee et al. (1970) found that, if the marcott was covered to reduce bird damage, rooted plants could be obtained, but root development appeared to be relatively poor and the method has not been adopted in practice in Queensland (Slee and Nikles, pers. comm.)

The purpose of this paper is to describe marcotting of mature-age material throughout the year, to report the survival of the marcotts in the field and to compare the subsequent development of successful marcotts with that of a seedling tree.

The work was carried out in grafted clone banks on Melville Island and near Darwin. The climate of the region is distinctly monsoonal with the average annual precipitation of 1500 mm falling from October to April, and a near-rainless period from May to September. Under these conditions Pinus caribaea grows continuously, although the rate is reduced during the dry season.

MATERIALS AND METHODS

Marcotts were applied under both wet and dry season conditions (Table 1) to shoots of two-year-old seedling trees and two- and eight-year-old grafts of scions from mature ortets ('old grafts'). The eight-year-old grafts were 15 m tall and the marcotts were applied in the top two metres of the crown.

Each marcott was applied to an actively growing branch or the leader at a point where the underbark diameter was preferably 7-10 mm. The bark was removed completely for a distance of two to three centimetres and a proprietary rooting powder (Serdix 3, containing indole-3-butyric acid) applied liberally to the exposed cut surface at the distal end of the ringbarked section.

A tube of clear flexible plastic film 17 cm long x 10 cm wide (when flat) x 0.1 mm gauge was slipped over the shoot and the lower end tied so that the mid section of the tube aligned with the ring barked section of the shoot. Moist peat moss was then packed into the tube and the top end tied tightly with plastic-covered copper wire ties. The upper tie was loosened later as the branch above the marcott grew in diameter.

A quantity of a proprietory rooting solution (10 ml of 1% 'Formula 20') was injected into the medium of some of the marcotts made in September 1977, six weeks after they had been made. The solution contained vitamins B_1, B_2 and B_6, niacin, indole acetic acid and napthalene acetic acid.

Following their severence from their ortets, the marcotts were potted into a 50:50 coarse sand-peat mix without added nutrients and held under 72% shade for 3 to 6 weeks before being moved into full sunlight, when 10 g of an NPK (12:5.2:16.6) fertiliser mix was applied to the soil surface in the pots.

Field establishment was carried out during the wet season months. The planting site was a red sandy loam. One hundred and fifty grams of an NPK (12:5.2:16.6) fertiliser mix was applied in a hole beside the tree at planting.

In March 1979, one marcott from a seedling tree, one marcott from an 'old graft' both outplanted in January-February 1978, and one seedling tree (the most vigorous available in its age class) planted nearby in November 1976 in a routine plantation were carefully dug up to compare root development.

RESULTS

When slender young growth (less than 7 mm DUB or one year old) was used, death of the shoot occurred within three weeks of application of the marcott. Excluding those marcotts on such shoots the fraction of marcotts which were successful at the time of removal from the tree ranged from 38% and 67% (Table 1). The major causes of failure were breaking off (which was later avoided by supporting the marcott with ties to other branches) and death while on the tree. On only one occasion (March 1978, Table 1) were losses attributable to damage caused to the covers by birds or insects.

Table 1. Marcotts applied and causes of failure

Month and year of application	Age and type* of ortet	Number of marcotts attempted	Fraction alive and with roots when severed (%)	Losses** Fraction (%)	Losses** Condition, cause
Jan. 1977	1.5 y.o.graft	9	56	44	a2
Sept.1977	2 y.o. graft	18#	30	28	a3
				19	b2
				23	c2
		18##	28	24	a3
				21	b2
				27	c2
Sept.1977	2 y.o. seedlings	12#	67	33	a2
Dec. 1977	8 y.o. grafts	21	38	38	a1
				14	a2
				10	c1
Jan. 1977	1.9 y.o.grafts	24	62	38	a3
Mar. 1977	2 y.o. grafts	61	45	31	b4
				24	b1
May 1978	9 y.o. grafts	92	62	13	a2
				25	b5
Aug.1978	2.3 y.o.grafts	151	65$	7	a1
				18	b1
				10	a2

* All grafts were with scions from mature-age ortets on seedling rootstocks

**Key to code:

Condition a = no callus; b = callus but no roots; c = callus with roots

Cause 1 = broken off; 2 = died *in situ*; 3 = undersize; 4 = covers damaged; 5 = removed from tree prematurely for another trial

With a 10 ml injection of 'Formula 20' in the medium 6 weeks after marcotting

##Without 'Formula 20' injection

$ Includes 3% still on tree alive at time of assessment

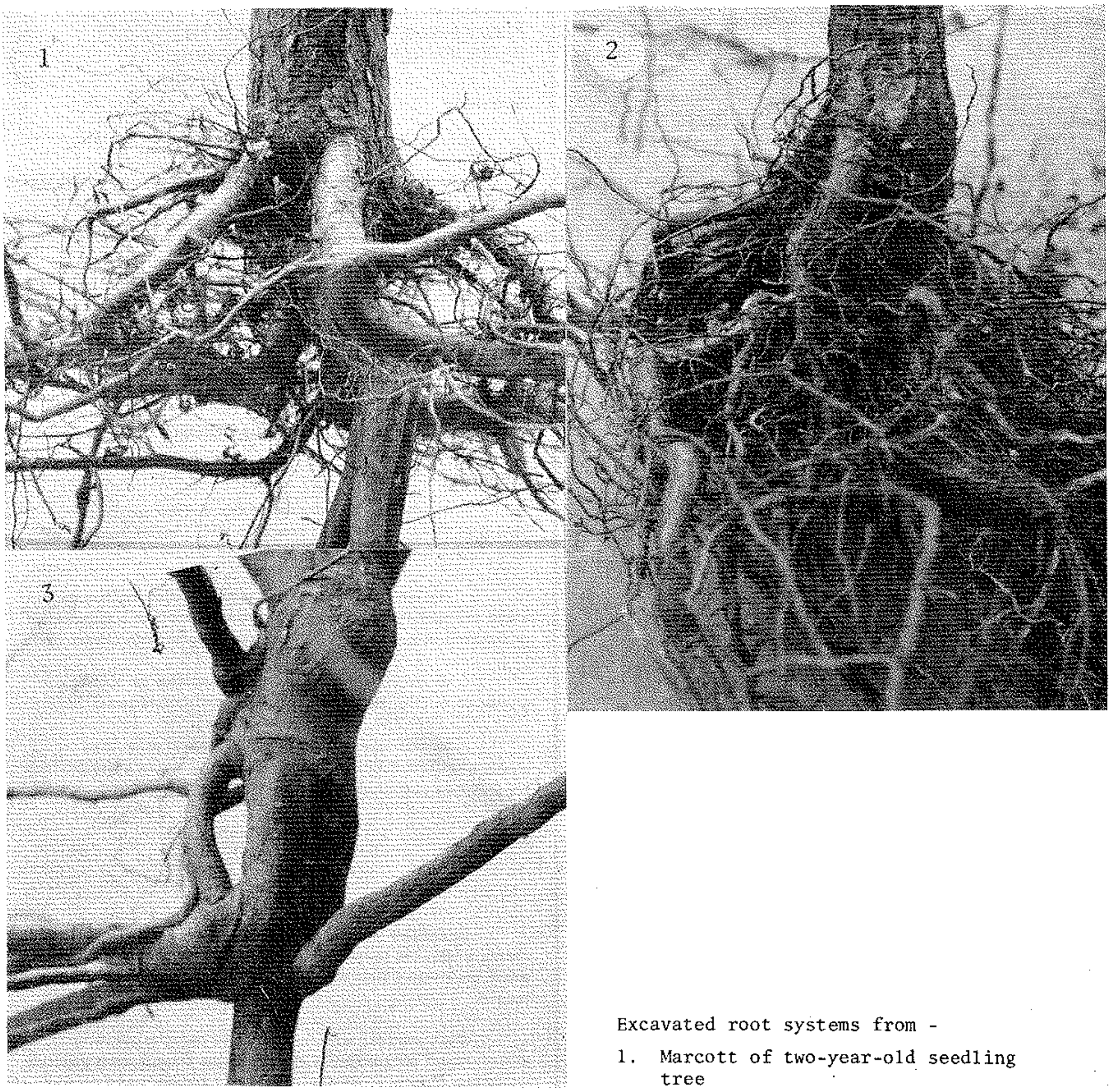
Table 2. Shoot and root development of two marcott trees and a seedling tree

Plant type	Month in the field	Height at planting (m)	Height Feb.79 (m)	Diam.# Feb.79 (mm)	Tap root Length* (m)	Tap root Taper+ (mm)	Major lateral roots No.	Major lateral roots Length of longest* (m)	Major lateral roots Taper of longest# (mm)
Marcott from seedling tree	12	0.45	2.40	55	0.73	12 to 5	23	0.72	10 to 5
Marcott from 'old graft'	13	0.38	1.74	37	0.83	10 to 2	16	0.50	5 to 2
Seedling tree	28	0.20	2.42	70	0.67	27 to 2	10	0.95	13 to 5

Overbark at ground level

* To point of break

\+ The figures are the diameters at the large end and the small end
The latter point was determined by the point at which the root broke when the plant was excavated



Excavated root systems from -

1. Marcott of two-year-old seedling tree
2. Marcott of mature-age tree
3. Two-year-old seedling. Fusion of major roots is a reflection of crowding in the nursery container

Although generally the marcotting medium was re-wetted during the dry season, some marcotts which were missed during the re-wetting operation had good roots in the dry medium and were successfully potted. Free moisture was not detrimental. The use of 'Formula 20' appreciably improved the success rate but the result on this one occasion can be no more than an indication of possible value.

Success at the potting stage, following severance from the ortet, was directly related to the development of the root system at time of severence. Plate 1 shows a well developed root system at time of severence from the ortet and Plate 2 shows the same marcott 2 months after potting. Almost all the potted marcotts, which were planted in the field, have grown well: three from seedling trees and nine from 'old grafts' were outplanted in wet season of 1977-78 and sixty from 'old grafts' in 1978-79. The only two deaths have been caused by accidents.

The constriction of the stem by the upper tie, which is commonly reported in work on marcotting, was experienced (Plate 2) but was found not to be detrimental to growth in the field during the period of observation.

The dimensions of the stems and major roots of the specimens which were dug up (Table 2) indicate that root development of the marcotts compares favourably with that of the longer-established seedling tree.

DISCUSSION

Marcotting can circumvent the serious problem of rootstock-scion incompatibility of P. caribaea. The major factor limiting successful marcotting in the tops of tall trees apart from the difficulty of access is breakage of the shoots (December 1977, Table 1) which can be avoided by using supports (May 1978 Table 1). However, the routine use of such tall trees is somewhat impracticable. The necessity to support the shoots and the unsuitability of slender young shoots confirms results of Slee (1970), and Kedharnath and Dhaundiyal (1963) and Lowery (1978) respectively. No upper limit to the size of suitable shoots has been determined.

While damage to the plastic tubes by birds or other creatures was not a major cause of concern in the trials reported here, it would be a worthwhile precaution to apply calico covers (Slee et al. 1970). The use of aluminium foil for covers, as reported by Lowery (1978), has been tried on a small scale and has advantages in ease of application.

Root development and aerial growth of the marcotts after establishment in the field is satisfactory (cf Barnes 1974 and Nikles and Slee, pers. comm.) and wind firmness appears to be satisfactory.

A subjective assessment of the marcotts from the oldest 'old grafts' and seedlings indicates that the branches of the former will be shorter and less dense than those on the latter, which is similar in development to a seedling tree.

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MELHORAMENTO GENÉTICO DE *Pinus caribaea* VAR *hondurensis*, NA REPÚBLICA POPULAR DO CONGO

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Resumo

Pinus caribaea foi introduzido na República Popular do Congo em 1959.

A espécie revelou boa adaptação às condições ecológicas locais.
Seu bom comportamento em solos argilosos e arenosos, ocupados por savanas, fez com que fosse conduzidc um amplo programa de melhoramento genético para ela.
Um programa de propagação vegetativa por estaquia, foi iniciado em 1976. Os resultados obtidos são satisfatórios. A técnica de enraizamento de estacas está quase definida.
Nos próximos anos será possível estabelecer as primeiras plantações clonais de *Pinus caribaea* var. *hondurensis*.

THE GENETIC IMPROVEMENT OF *Pinus caribaea* VAR *hondurensis* IN THE PEOPLE'S REPUBLIC OF THE CONGO

Summary

Pinus caribaea was first introduced in People's Republic of Congo in 1959.

The species revealed a good adaptation to local, ecological conditions.

Its good performances on sandy and clayey savannas led Forest Research to undertake a wide genetic improvement programme of this species.

A vegetative propagation programme by cuttings began in 1976. The registered results are satisfactory. The cutting technique is almost determinated.

In the coming years, Forest Research will be able to establish the first clonal plantations of Pinus caribaea var. hondurensis.

L'AMELIORATION GENETIQUE DE *Pinus caribaea* VAR *hondurensis* EN REPUBLIQUE POPULAIRE DU CONGO

Resume

La première introduction réussie de Pinus caribaea, en République Populaire du Congo, remonte à 1959. L'espèce présente une bonne adaptation aux conditions écologiques locales.

Ces bons résultats sur les sols sableux et argileux de savane ont conduit la station de recherches forestières à entreprendre un important programme d'amélioration génétique de cette espèce.

Un programme de multiplication végétative par bouturage a commencé en 1976. Les résultats obtenus sont satisfaisants.

La technique de bouturage est presqu'au point. Dans les années à venir, la station de recherche sera en mesure d'entreprendre les premières plantations clonales de Pinus caribaea.

- INTRODUCTION

La première introduction réussie de Pinus caribaea au Congo remonte à 1959. Les introductions ultérieures (1960 à 1963) nous ont montré que l'espèce était bien adaptée aux conditions écologiques locales.

C'est pourquoi, après cette première phase, de nombreuses provenances ont été introduites et un programme d'amélioration génétique (sélections d'arbres +, création de vergers à graines, pollinisation contrôlée) a été largement entamé.

Plus récemment le C.T.F.T. Congo a lancé un programme de multiplication végétative par bouturage qui devrait déboucher prochainement sur des applications pratiques mais qui se heurte encore à un certain nombre de problèmes, notamment à celui du rajeunissement des arbres ÷.

- ESSAIS PROVENANCES

Les introductions de 1960-1963 nous ont permis de réaliser les premièrs boisements de Pins et la croissance de ceux-ci a été régulièrement suivie. A l'heure actuelle :

- sur sols sableux, profonds, pauvres, de la région de Pointe-Noire, la production est de l'ordre de 10 à 15 m^3/ha/an.

- sur sols argileux, riches, de la vallée du Niari, la production est de l'ordre de 25 à 30 m^3/ha/an.

Pinus caribaea var. hondurensis est donc adapté et présente une croissance satisfaisante.

De nombreuses provenances ont alors été introduites, notamment en 1971, 1972 (essai international) et 1979. Ces provenances sont originaires de :
BELIZE (5 pro.), GUATEMALA (1 pro.) HONDURAS (14 pro.) et NICARAGUA (10 pro.).

Les provenances côtières du NICARAGUA semblent les plus prometteuses, tant du point de vue production (Puerto Cabezas, Alamicamba) qu'au point de vue forme (Karawala).

- SELECTION D'ARBRES + - VERGERS A GRAINES

Dans le but d'établir des vergers à graines, 75 arbres furent sélectionnés en 1968-1969 dans les plantations existantes dont l'âge s'échelonnait entre 2 et 8 ans. A partir de ces premières sélections, deux vergers à graines furent mis en place (Pointe-Noire et Malolo).

Des tests de descendances, effectués depuis 1972 (récolte sur les ortets ou dans les vergers à graines) nous ont permis d'apprécier le génotype d'une partie de ces 75 arbres.

C'est ainsi, qu'en 1979, en fonction de l'état des ortets et de leur descendance, libre ou contrôlée, nous avons retenu, 17 arbres + parmi cette sélection précoce.

Des sélections ultérieures furent effectuées dans des plantations âgées de dix ans de 1977 à 1979 et sept nouveaux arbres + furent choisis en 1979 parmi ces sélections portant à 24 le nombre de nos arbres +.

Parallèlement nous avons introduit, depuis 1976, des descendances d'arbres + originaires du Queensland, de Fidji et de Nouvelle Calédonie ainsi que des arbres issus de pollinisations contrôlées réalisées au Queensland (Dr. NIKLES).

Ce nouveau matériel d'élite, ainsi que les sélections à effectuer en 1981 et 1982 parmi les essais provenances 1971 et 1972 devraient nous permettre d'obtenir un nombre d'arbres + relativement important nous permettant la mise en place de vergers à graines plus performants que les premiers.

Nous mettrons par ailleurs en place, fin 1980, un essai international portant sur la comparaison de 133 descendances différentes.

Enfin, dans le cadre du projet de conservation de ressources forestières (FAO-PNUE), nous sommes intervenus, avec l'Office Congolais des Forêts, dans la mise en place de parcelles conservatoires des provenances suivantes :

K25	Poptun
K106	Alamicamba
K124	Los Limones.

- POLLINISATION CONTROLEE

Les premières pollinisations contrôlées ont été réalisées au Congo en 1970 ; elles ont permis de mettre en place des tests diallèles à partir de 1972.

Certains croisements ont montré une excellente aptitude spécifique à la combinaison. Il en va en particulier du croisement HB1 x HV16 qui se révèle être le meilleur (vigueur, homogénéité, forme des individus, finesse et angle d'insertion des branches).

A partir de 1980 nous essaierons de nouveaux croisements en incluant comme source de pollen les nouvelles sélections, certains phénotypes prometteurs des provenances Alamicamba, Karawala et Puerto Cabezas ainsi que, le cas échéant, du pollen obtenu auprès d'autres centres de recherches.

- BOUTURAGE DU PIN

Si certains caractères anatomiques ou morphologiques du Pin des Caraïbes présentent une bonne héritabilité, il n'en va pas de même pour d'autres caractères, notamment la production. Par ailleurs il y a rarement corrélation entre les caractères anatomiques, morphologiques (finesse des branches) et les caractères de productivité.

La multiplication végétative permet la reproduction des individus exceptionnels présentant une telle corrélation et nous avons donc tenté de mettre au point une technique de bouturage de cette espèce.

1 - Technique de bouturage

Depuis les premières expérimentations de 1976-1977, la technique a rapidement évolué et nous considérons qu'elle est actuellement presqu'au point :

- Récolte du matériel sur des sujets jeunes : nos parcs multiplicatifs sont recépés à l'âge de deux ans, en début de saison des pluies; en plusieurs récoltes successives (8 à 10 récoltes), ils peuvent donner environ 400 boutures par pied et par an.

- Le matériel récolté est constitué de jeunes pousses, induites à partir des brachyblastes, avant l'apparition des pseudophylles.

- Ces jeunes pousses sont traitées par une solution antifongique (benomyl) et leur base est trempée dans une solution d'hormone à 0,1% d'AIB.

- Ils sont mis en place dans des petits conteneurs (fertil-pot) remplis d'un substrat filtrant (sable) et mis en place sous chassis.

- Ces chassis sont arrosés au brumiseur de manière à maintenir autour des boutures une atmosphère ayant un taux d'humidité voisin de 100%.

- Le sevrage a lieu lorsque les racines sont apparentes, bord de pot ; vers 1 mois dans les meilleures conditions.

- Les plants sont alors transplantés dans des pots contenant de la terre mycorhizée avec séjour à l'ombre et passage progressif de l'arrosage au pulvérisateur à l'arrosage au jet.

Nous parvenons, avec cette technique, sur du matériel de 2 ans, à un taux de reprise d'au moins 50%.

Nous noterons que les boutures obtenues par cette méthode depuis 1976 présentent un comportement analogue à celui de plants issus de semis.

2 - Le rajeunissement

Notre technique de bouturage ne donne de résultats satisfaisants qu'avec du matériel jeune (moins de 5 ans) et ne peut donc être utilisée pour la multiplication végétative des arbres +. Il faut donc, en ce qui les concerne, passer par une phase de rajeunissement.

Nous avons, pour cela, expérimenté plusieurs méthodes :

- Le recépage des cimes d'arbres âgés donne des résultats decevants. Le bouturage des rejets est très difficile et les rares boutures obtenues ne présentent guère de caractères juvéniles.

- Le rajeunissement par greffe, taille et bouturage combinés aboutit effectivement à un rajeunissement mais l'aptitude au bouturage des rejets induits est très fugace : nous avons ainsi pû obtenir, en 1979, des boutures de 7 arbres +.

- Le rajeunissement par greffe, marcottage et bouturage combinés : nous venons de réussir les premières marcottes d'arbres + et nous espérons que la phase "marcottes" nous permettra d'obtenir un rajeunissement plus durable que la phase "greffe".

Les boutures d'arbres âgés obtenues en 1979 ont été placées en parc multiplicatif. Nous ignorons pour l'instant si elles ont effectivement regagné toutes les potentialités d'un jeune plant et si elles se bouturеront aisément à l'âge de deux ans.

3 - Utilisation pratique du bouturage

Trois voies sont actuellement explorées :

- Si le rajeunissement de nos arbres + est effectif c'est-à-dire si les boutures actuellement réussies expriment bien toutes les potentialités de l'ortet, nous pourrons, à l'aide des parcs multiplicatifs, réaliser des plantations clonales d'extension.

- La sélection récurrente qui consiste à garder à l'état juvénile des copies végétatives de plants issus de semis en attendant que ceux-ci expriment toutes leurs potentialités est une voie relativement lourde demandant des moyens assez importants. Aussi ne l'avons nous utilisé, à ce jour, que sur des sélections précoces effectuées sur des plants issus de pollinisations contrôlées d'origine Queensland : les ramets ont été obtenus par bouturage de rejets après recépage de branches basses.

- Les meilleures pollinisations contrôlées obtenues au Congo présentent des caractères exceptionnels : dès 1978 nous en avons réservé des plants pour des parcs multiplicatifs.

- CONCLUSION

Le Congo dispose, pour l'amélioration génétique de Pinus caribaea var. hondurensis d'un matériel important constitué par des arbres +, des vergers à graines, de nombreuses provenances, des pollinisations contrôlées et d'assez vastes plantations d'extension.

La mise en place de nouveaux vergers à graines devrait aboutir à la production de produits de qualité nettement supérieure à ceux actuellement utilisés.

Parallèlement, la technique de bouturage va nous permettre, à partir de parcs multiplicatifs existants, de mettre en place des plantations de clones sélectionnés.

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O MELHORAMENTO DO *Pinus caribaea* NA COSTA DO MARFIM

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CÔTE D'IVOIRE

Resumo

As procedências de Nicarágua, Belize, Guanaja e Limones de Honduras são as de crescimento mais rápido nos testes de procedências instalados em 1971 e 1972, em S. Pedro. Pretende-se fazer uma avaliação geral em 1980. Povoamentos para conservação genética e seleção foram instalados envolvendo algumas das melhores procedências.

Técnicas de enxertia estão sendo desenvolvidas e os resultados experimentais da estaquia são promissores.

A frutificação é deficiente. A reprodução sexuada é portanto um dos principais problemas a ser resolvido.

Condições ecológicas boas para produção de sementes estão sendo procuradas.

Um pomar clonal de sementes foi instalado baseado em árvores "plus" selecionadas em l'Anguededou em povoamentos de algumas procedências de Honduras. Novas árvores fenotípicamente superiores serão selecionadas nas melhores procedências.

Pinus caribaea
GENETIC IMPROVEMENT IN IVORY COAST

Summary

Provenances from Nicaragua, Belize and Guanaja, Limones from Honduras are the fastest growers in the local and the international provenance trials planted in 1971 and 1972. It is intended to carry ont a general assessment in 1980. Conservation - selection stands have been established with some of the best provenances.

Grafting technics are developed and the results of experimentations on cutting are promising.

The fructification is deficient. The sexual reproduction is therefore one of the main problem to be resolve. Good seeding sites are investigated.

A clonal seed orchard is established with plus trees selected in l'Anguededou in stands of some Honduras provenances. New phenotypically superior trees from the best provenances will be selected.

L'AMELIORATION DE *Pinus caribaea* EN CÔTE D'IVOIRE

Resume

Les provenances du Nicaragua et de Belize sont avec Guanaja et Limones du Honduras, les plus vigoureuses dans les essais de provenances installées en 1971 et 1972 à San Pedro. Les provenances de ces essais feront bientôt l'objet d'une évaluation complète. Des parcelles conservatoires de certaines bonnes provenances ont pu être constituées.

Le greffage est mis au point et les résultats des essais de bouturage sont encourageants.

Du fait de l'insuffisance de fructification, la reproduction sexuée constitue l'un des problèmes les plus importants à résoudre. La recherche de sites favorables est envisagée.

Un verger à graines expérimental est constitué à partir de phénotypes sélectionnés à l'Anguédédou dans les provenances du Honduras. De nouvelles sélections sont en cours dans les meilleures provenances des essais de San Pedro.

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

L'intérêt de Pinus caribaea pour les reboisements papetiers en Côte d'Ivoire est reconnu à la suite des essais d'introduction réalisés de 1965 à 1967 avec différentes espèces de Pins tropicaux et subtropicaux.
Les trois variétés ont été testées mais seule la variété hondurensis présente une bonne adaptation et une productivité de près de 350 m3 à 12 ans. L'espèce présente une grande variabilité géographique qui permet d'espérer une amélioration subtantielle de la production par voie génétique. C'est l'objectif du programme mis en route en 1974-75, que cette note aborde dans ses grandes lignes et à travers les travaux réalisés dans les 5 premières années.

E S S A I S   D E   P R O V E N A N C E S

Deux essais de provenances dont un essai international, sont mis en place en 1971 et 1972 à San Pedro. Les caractéristiques du site d'installation, les dispositifs adoptés, de même que les résultats des 1ers inventaires ont fait l'objet d'une note (Diabaté, 1977).

Les inventaires récents (voir tableaux I et II en annexe) confirment la supériorité au niveau de la croissance des provenances Alamicanba, Karawala, Santa Clara du Nicaragua, Guanaja et El Limones du Honduras. Il y a par ailleurs ralentissement de la croissance de Poptun (Guatemala) qui n'apparait plus dans le groupe de tête. Rio Coco (n° 191 et K 22 Nicaragua) qui occupe une bonne position dans le classement du 1er essai, a une mauvaise croissance dans le 2è. Il faut enfin noter l'apparition de différences significatives entre les provenances de Cuba et du Bahamas.

Dans un cadre international, en collaboration avec le C F I, les provenances de l'essai international sont évaluées en 1980 au niveau de la croissance, de la forme des arbres, de la fructification et de la qualité du bois.

Un 3è essai comprenant 17 provenances dont 11 nouvelles (7 du Honduras et 4 du Nicaragua) est mis en place en 1979 à l'Anguédédou à partir de graines fournies par le CTFT Nogent.

Nous disposons désormais d'un nombre relativement important de provenances de la variété hondurensis, la mieux adaptée et la plus performante des 3 variétés toutes représentées dans nos essais de provenances de Pinus caribaea.

Au vu des résultats de croissance dans les essais, 8,5 ha de parcelles conservatoires de provenances du Guatemala et du Congo (Loandjili) ont été constitués en 1975 et 1976. En 1977, 22 ha de parcelles sont créés dans le cadre du Projet FAO/ P N U E de conservation des ressources génétiques Forestières. Cette mesure de conservation porte sur Poptun (Guatemala) et la très intéressante provenance de Almicamba (Nicaragua).

M U L T I P L I C A T I O N   V E G E T A T I V E

G r e f f a g e

La greffe en fente terminale, la greffe par approche dite en bouteille, et la greffe par placage ont été expérimentées lors des essais préliminaires de greffage réalisés en 1974. Des taux de réussite assez encourageants (20 à 35 %) ont été obtenus avec les deux premiers types qui ont été repris en 1975-1977 pour le greffage en vue de la constitution d'un verger à graines de clones. Les résultats sont les suivants :

Date de greffage	3/1975	9/75	3/76	2/77	3/77	5/77	7/77	10/77
Réussites (%)	32,9	25,6	27	30,3	27	51,9	25,9	4,6

Les taux de réussites moyens sur l'ensemble des séries, sont les suivants, au niveau des clones âgés de 9 à 12 ans :

Nombre de Clones	1	7	5	5	5	1
Réussites(%)	12	16,1-20,6	21-30	31,9-40,6	42,5-49,3	55

Il y a un effet clone en partie déterminé par la vigueur et l'état végétatif des greffons et des porte-greffes.

B o u t u r a g e

Il s'agit de pousser à l'enracinement des boutures provenant de brachyblastes dont le développement a été induit par la taille des plants.

Les 1ers essais ont été réalisés en 1977-78 à partir de boutures provenant d'ortets âgés de 18 et 28 mois. Sommairement, après 2 mois de bouturage, on obtient:

- 66 % d'enracinements sous châssis (avec des boutures provenant de plants âgés de 18 mois).
- Jusqu'à 35 % d'enracinements sous brouillard continu de jour et 22 % d'enracinements sous châssis. Les boutures proviennent alors d'ortets âgés de 28 mois.

Sous brouillard les boutures prennent une teinte vert-pâle; elles connaissent une dévitalisation qui affecte défavorablement la reprise après repiquage.

Des préparations hormonales à base d'AIB (0,4 %) stimulent l'inithtion des racines sans semble-t-il affecter notablement les taux d'enracinements.

L'amélioration de ces résultats passe par une meilleure connaissance du matériel végétal à laquelle contribuent les essais en cours qui sont orientés vers :

- la recherche du niveau de développement optimum des boutures
- la recherche des périodes les plus favorables au bouturage
- l'étude du comportement de boutures provenant d'ortets âgés de 2,5 ans, 4,5 ans, 6,5 et 8,5 ans.

Les résultats ne sont pas encore disponibles. On peut néanmoins observer que les ortets âgés de 5 ans et plus produisent un matériel peu apte à l'enracinement. Les 1ères tentatives de bouturage de brachyblastes provenant de plants greffés se sont soldées par des échecs. Cela souligne la complexité de l'opération, pourtant indispensable, du rajeunissement d'un tel matériel.

R E P R O D U C T I O N   S E X U E E

Les fructifications du Pinus caribaea sont faibles et irrégulières à l'Anguédédou (latitude 05° 22'N longitude 04° 07' W altitude 40m).
Des parcelles à vocation semencière ont donc été créées dans la région de San Pedro dont le climat moins humide, comportant des saisons sèches marquées, était à priori plus favorable. Il s'agit principalement de :

- 8,5 ha de parcelles conservatoires constituées à Sassandra en 1975 et 1976.
- 22 ha de parcelles créées à San Pedro (Binié) en 1977 dans le cadre du Projet FAO/PNUE de conservation des ressources génétiques forestières.
- 1,5 ha de verger à graines de clones à San Pedro en (1977).

L'éloignement latitudinal est grand entre nos stations d'introduction (4°45' et 5° 22'N) et les régions d'origine des provenances de Pinus caribaea (entre 12° 58'N et 17°00'N). Conséquemment les variations de températures moyennes mensuelles et de la durée du jour dont les effets ont été étudiés par Slee (1977) sont insuffisantes à l'Anguédédou et à San Pedro pour être favorables à une bonne fructification.

L'étude de la fructification sera poursuivie dans le cadre de petites parcelles installées dans 12 stations de forêts denses sempervirentes ou semi-décidues. Elle permettra de choisir les sites les plus favorables à une fructification massive.

S E L E C T I O N   I N D I V I D U E L L E

Les phénotypes sélectionnés sont dominants et portent de bons caractères de forme (rectitude du fût, absence de fourches, finesse et grand angle d'insertion des branches).

La base des 1ères sélections est constituée de parcelles de l'Anguédédou créées avec des graines du Honduras (provenance inconnue). 24 arbres + sont donc sélectionnés en 1974 à l'âge de 11 et 12 ans.

La 2è campagne de sélection lancée en 1978 a pour cadre les essais de Pinus caribaea de San Pedro âgés de plus de 7 ans. Au total 61 arbres sont présélectionnés :

- dans les provenances les plus vigoureuses des essais de provenances (1971 et 1972).
- dans les parcelles diverses constituées avec des provenances du Nicaragua, de Belize et la provenance artificielle du Congo.

Les caractéristiques du bois seront désormais prises en compte et permettront d'opérer nos sélections dans le double but de la production de bois de pâte à papier et de bois d'oeuvre.

Les sélections à venir porteront sur :

- 240 ha de peuplements constitués par la Société de Reboisements (la SODEFOR) à partir de provenances de Belize et du Guatemala.
- 30 ha de parcelles conservatoires des provenances Alemicamba (Nicaragua) et Poptun (Guatemala).

V E R G E R S   A   G R A I N E S

A l'intérieur du périmètre papetier, les variations des conditions climatiques et édaphiques sont faibles. On peut donc attendre du matériel (sélectionné) des performances constantes d'une station à l'autre. Dans ces conditions, un verger à graines a été constitué pour les reboisements papetiers. D'autres vergers pourraient être envisagés pour la production de bois d'oeuvre si l'aptitude pressentie chez le Pinus caribaea se confirme.

Le verger à graines expérimental est mis en place de 1977 à 1979 à San Pedro et comprend 24 clones, chacun représenté par 20 ramets. Un dispositif en blocs complets randomisés (Faulkner, p. 27) est adopté. Il est constitué de 20 blocs de 24 plants à 5m x 6m d'écartement.

Ce verger pourrait entrer en production dans 3 ou 4 ans ou les conditions stationnelles le permettent sinon, un nouveau verger devra être créé dans un site plus favorable à la fructification.

C O N C L U S I O N S

L'insuffisance de fructification compromet sérieusement la bonne exécution du programme conçu pour l'amélioration par voie sexuée de Pinus caribaea var. hondurensis. Elle constitue une hypothèque qui devra être levée en priorité par une identification de localités favorables pour la production de graines.

L'étude de la variabilité infraspécifique est abordée à partir de trois essais renfermant une gamme assez complète de provenances. Elle vise indépendamment du choix de provenances, la connaissance des principaux caractères portés par ces populations.

Le matériel en reproduction est sélectionné localement; il sera complété par une importation sélective de matériel envisagée dans le cadre d'échanges avec d'autres organismes.

L'utilisation du bouturage pour l'amélioration par voie végétative pourrait être avantageusement envisagée une fois résolu le problème de la réjuvénilisation.

ANNEXE TABLEAU I : Essai de provenances 1971

Août 1972		Mai 1973		Février 1975		Janvier 1980	
N°	Hauteur(m)	N°	Hauteur(m)	N°	Circ. (cm)	N°	Circ. (cm)
189	1,35	189	2,93	192	33,2	192	57,1
168	1,33	154	2,79	189	32,5	191	54,9
190	1,27	192	2,74	154	32,0	189	54,8
200	1,23	168	2,70	190	31,8	199	54,7
192	1,20	200	2,69	153	31,6	154	54,3
153	1,20	153	2,68	193	31,4	193	53,5
154	1,18	190	2,68	200	31,3	200	53,4
191	1,16	191	2,66	191	31,2	190	52,2
199	1,09	193	2,58	199	30,4	168	52,1
193	1,01	199	2,42	168	30,0	152	52,0
152	1,00	152	2,29	152	28,7	153	51,5
197	0,61	197	1,59	197	22,4	197	46,0
151	0,53	151	1,40	151	20,1	151	40,4
Ppds (5 %) = 0,21		Test Tukey-Hartley Dif.signif.5 %		Test Tukey-Hartley Dif.signif. 5%		Test Tukey-Hartley Dif.signif.5 %	

TABLEAU II : Essai international provenances 1972

Mars 1973		Février 1975		Sept. 1979	
N°	Hauteur (cm)	N°	Hauteur (m)	N°	Circ. (cm)
K20	92,0	K20	4,40	K20	53,4
K29	82,9	K61	4,08	K53	53,3
K61	80,8	K19	3,98	K24	52,1
K56	76,6	K29	3,95	K61	51,6
K24	75,3	K53	3,92	K19	51,4
K54	75,0	K66	3,83	K56	51,3
K60	74,7	K54	3,83	K60	51,3
K19	74,6	K24	3,83	316	51,2
K53	73,9	K58	3,75	K18	51,1
K58	72,0	316	3,74	K54	50,6
K65	71,5	K60	3,63	K57	50,4
316	69,2	K65	3,56	K29	50,1
K57	68,8	K57	3,53	168	50,1
252	62,9	K18	3,44	252	49,9
K18	61,6	252	3,22	K58	49,6
K22	56,1	K22	3,01	K65	48,5
K64	51,2	K64	2,95	K64	48,4
168	45,8	168	2,93	K22	47,4
24/71	24,2	24/71	1,93	24/71	41,9
302	22,6	18/71	1,76	18/71	40,9
18/71	22,1	302	1,75		
Ppds (5 %) = 9,1 cm		Ppds (5 %) = 43,2		Test Tukey Hartley Dif.signif. 5 %	

Provenances : Andros (Bahamas) : n° 151, 302; Belize : n° 152, 154, 199, 200 ; Byfield (Queensland) : n° 316; Guanaja (Honduras) : n° 192; Poptun (Guatemala) : n° 153, 190 ; Alamicamba (Nicaragua) : 189; Rio Coco (Nicaragua) : n° 191 ; Slilma Sia (Nicaragua) : n° 168; Loandjili (Congo) : n° 193, 252 ; Cuba n° 197.

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Pinus caribaea – PROGRESSOS EM TESTES INTERNACIONAIS DE PROCEDÊNCIA AOS SEIS ANOS E MEIO, NA NIGÉRIA

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Resumo

Aos 6 anos e meio as procedências diferiram em seu vigor nas três localidades. As diferenças entre localidades parecem ser os fatores que mais influenciaram os padrões de crescimento nesse estágio. As técnicas culturais adotadas nos estágios iniciais dos experimentos nas três localidades, também influenciaram os padrões de cre.cimento e a sobrevivência das procedências. A localidade de Ibadan vem mantendo melhor crescimento do que as outras duas. Algumas das procedências não apresentaram bom comportamento, e o númeio de indivíduos com frutificação aumentou, embora as sementes não tivessem chegado a germinar. Planos futuros envolvem a seleção de árvores "plus" das melhores procedências, visando a instalação de pomares clonais de sementes.

Pinus caribaea – PROGRESS IN INTERNATIONAL PROVENANCE TRIALS AT AGE SIX AND HALF YEARS IN NIGERIA

Summary

At the age of 6½ years, provenances differed in vigour at the three sites. Site differences appeared to be the major factor influencing growth patterns at this stage. The cultural techniques adopted at the three sites particularly at the early stages also influenced growth patterns and survival of provenances. The Ibadan site continued to support better growth than the other two sites. Some of the provenances did perform well and the number of fruiting individuals have increased although seeds failed to germinate. Plans are ahead to select plus trees from the best provenances for the establishment of clonal seed orchards.

Pinus caribaea – PROGRÈS DANS LES TESTS INTERNATIONAUX DE PROVENANCES À L'ÂGE DE SIX ANS ET DEMI, EN NIGERIA

Resume

A six ans et demi, le taux de vigueur des provenances varie sur les 3 stations. Les différences entre les sites semblent être le facteur le plus important qui influence, à ce stade, les comportements de croissance. Les techniques culturales, adaptées sur chaque station, influencent aussi, particulièrement à ce premier stade, les comportements de croissance et le taux de survivance des provenances. La station d'Ibadan continue de favoriser une meilleure croissance que les deux autres sites. Certaines provenances ont donné d'excellents résultats et le nombre des sujets arrivant à fructification a augmenté. Cependant, les semences produites ne germent pas. On a prévu de sélectionner les arbres d'élite des meilleures provenances pour constituer des vergers grainiers à partir de clones.

Introduction

The background of early introduction of Pinus spp. in Nigeria in 1954, and the introduction of Pinus caribaea Morelet in 1965 and 1966 in Nigeria have been described by the author (see Nikles et al. 1978). Also described was the present trial, its establishment in 1973 and its management; the results obtained at the ages of 8, 22 and 42 months.

In the present paper, the results obtained following the assessment made at age 6½ years are described. For a description of the list of provenances represented, the sites in which the trial was established in Nigeria, and the planting design used, see Nikles et al. (1978)

Selection and breeding work

Although selection and breeding work have not started in the trial established at three locations in Nigeria, plans are ahead to select best provenances of Pinus caribaea from each location. This will be followed by the selection of plus trees from the best provenances at each location. Clonal seed orchards will be established through grafting of scion materials obtained from plus trees.

Table 1 Survival Fox-tailing and fruiting (in percentages) of P. caribaea at the age of 6½ years

Provenance	IBADAN			UZAIRUE			ENUGU – NGWO		
	Survival	Fox-tailing	fruiting	Survival	Fox-tailing	fruiting	Survival	Fox-tailing	Fruiting
K22 Nicaragua, Rio Coco	79.	–	10.2	23	–	4.3	13	–	–
K60 Honduras Rep. Potosi	70.6	–	24.5	41	–	5.6	26	–	3
K23 Honduras Rep. Brus	n.p.	n.p.	n.p.	30	–	4	2/4	–	–
K61 Nicaragua, Santa Clara	75	–	12.8	28.6	–	5	n.p.	n.p.	n.p.
K29 Guatemala, Poptun	85	–	10	33	–	8	20.8	–	6
K24 Honduras Rep. Gunaja	72.9	–	15	n.p.	n.p.	n.p.	17.6	–	3
K53 Nicaragua, Karawala	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	5.6	–	20
K57 Honduras Rep., Culmi	79.2	–	25	22.4	–	15	3.2	–	34
K18 Nicargua, Kuakil	88.8	–	40	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
K20 Nicaragua, Alamicamba	80.8	–	35	44.6	–	20	23.2	–	15
K64 Belize, Santos	71.2	–	18	22	–	12	21.6	–	30
K58 Honduras Rep., Brus (same as K23)	77.6	–	28	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
23/71 Cuba Batey	n.p.	n.p.	n.p.	14.4	–	6.3	n.p.	n.p.	n.p.
2578 (non-C.F.1. seed)	n.p.	n.p.	n.p.	24.8	–	13.2	n.p.	n.p.	n.p.

Note: n.p. = not planted

Assessment Of Trial At Age Six And Half Years

The trial established in 1973 at Enugu-Ngwo, Ibadan and Uzairue all in southern Nigeria was assessed for the fourth time in December, 1979 at the age of 6½ years. Data in respect of height, girth, survival, fox-tailing and fruiting were collected and analysed.

R e s u l t s

Height growth:

Significant differences at 1% level in height growth between provenances established at Enugu-Ngwo occurred. However, at Ibadan and Uzairue sites, variation in height growth was significant at the 5% level. Provenances varied significantly at the 1% level between the three sites.

Girth growth

Enugu-Ngwo site is the only site in which variation in girth growth between provenances was not significant. This was also the case at the age of 42 months. At Ibadan and Uzairue, variation in girth growth was significant at the 5% level. Variation in girth growth between the three sites was significant at the 5% level.

Table 2

Ranking of provenances at each site at the age of 6½ years

IBADAN SITE

Provenance	Mean height (m)	Provenance	Mean girth (cm)
K58 (same as K23) Honduras Rep., Brus	7.93	K60	36.00
K60 Honduras Rep. Potosi	7.78	K58	35.40
K18 Nicaragua, Kuakil	7.73	K57	34.10
K61 Nicaragua, Santa Clara	7.68	K24	34.06
K20 Nicaragua, Alamicamba	7.60	K18	33.80
K57 Honduras Rep., Culmi	7.59	K20	33.80
K29 Guatemala, Poptun	7.55	K61	33.30
K24 Honduras Rep., Gunaja	7.40	K29	33.30
K64 Belize, Santos	7.27	K64	32.90
K22 Nicaragua, Rio Coco	7.21	K22	31.20
UZAIRUE SITE			
K61 Nicaragua, Santa Clara	6.82	K61	28.20
K29 Guatemala, Poptun	6.38	K57	21.80
K57 Honduras Rep., Culmi	5.46	K60	21.40
K60 Honduras Rep., Potosi	5.32	K29	21.00
K20 Nicaragua, Alamicamba	5.29	K20	20.00
K23 (same as K58) Honduras Rep., Brus	4.94	K23	19.60
K64 Belize, Santos	4.09	K22	19.10
23/71 Cuba Batey	3.96	K64	17.30
2578 (non-C.F.1. Seed)	3.87	2578	16.60
K22 Nicaragua, Rio Coko	3.53	23/71	15.64

ENUGU - NGWO

Provenance	Mean height (m)	Provenance	Mean girth (cm)
K20 Nicaragua, Alamicamba	5.02	K60	28.60
K60 Honduras Rep., Potosi	4.68	K20	28.50
K29 Guatemala, Poptun	4.43	K23	27.80
K23 Honduras Rep., Brus	4.32	K22	26.80
K53 Nicaragua, Karawala	4.29	K29	26.30
K24 Honduras Rep., Gunaja	4.10	K53	25.70
K22 Nicaragua, Rio Coco	3.96	K24	24.90
K57 Honduras Rep., Culmi	3.73	23/71	24.30
23/71 Cuba Batey	3.51	K57	24.10
K64 Belize, Santos	3.17	K64	23.40

Survival, Fox-tailing and Fruiting:

Table 1 shows the figures (in percentages) recorded for survival, fox-tailing and fruiting at the age of 6½ years. Compared with figures presented at age 42 months (see Nikles *et al.* 1978) the survival and fox-tailing have not changed much. However, the number of individual provenances fruiting at each site has increased. Few seeds collected failed to germinate. The reason for the loss in viability is not known though it appears the cones were collected very late. Survival figures were poor at Enugu-Ngwo and Uzairue.

Performance of provenances

Table 2 shows the ranking of the provenances at each location according to their mean height and mean girth. At Enugu-Ngwo mean height ranged from 3.17 m to 5.02 m and mean girth from 23.4 cm to 28.6 cm. At Ibadan mean height ranged from 7.21 m to 7.93 m and mean girth from 31.20 cm to 36.0 cm. At Uzairue mean height ranged from 3.53 m to 6.83 m and mean girth from 5.64 cm to 28.20 cm. The Ibadan site was best in vigour followed by Uzairue and Enugu-Ngwo. However, Enugu-Ngwo had better girth growth than Uzairue. Site differences appear to be a major factor influencing growth differences at this stage rather than the seed sources of the provenances. At age 6½ years, the following provenances have performed well.

Enugu-Ngwo site

K20 Nicaragua, Alamicamba
K60 Honduras Rep., Potosi

Ibadan site

K58 Honduras Rep.. Brus (same as K23)
K60 Honduras Rep., Potosi
K18 Nicaragua, Kuakil

Uzairue site:

K61 Nicaragua, Santa Clara
K29 Guatemala, Poptun

R e f e r e n c e s

Nikles, D.G., J. Burley and R.D. Barnes (1978). Progress And Problems of Genetic Improvement of Tropical Forest Trees. Dept. of For. C.F.1. Oxford.

Pinus oocarpa — PROGRESSOS EM TESTES INTERNACIONAIS DE PROCEDÊNCIAS AOS SETE ANOS E MEIO NA NIGÉRIA

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Resumo

Variações nos padrões de crescimento, entre procedências, relatadas nas idades 6, 18 e 54 meses, continuam a existir aos 7 anos e meio. As procedências indicadas como as melhores em vigor, aos 54 meses, foram suplantadas por novas, aos 7 anos e meio. A localidade de Ibadan continua a manter melhor crescimento do *Pinus oocarpa* do que a localidade Enugu – Nguo. Tal fato pode ser atribuído não só a diferenças entre localidades, como também às operações culturais aplicadas em Ibadan. Algumas procedências comportam-se bem em ambas localidades. A sobrevivência foi geralmente baixa, e em particular para a localidade de Enugu – Nguo, onde os danos causados pelo fogo afetaram os estágios iniciais do experimento.

Pinus oocarpa — PROGRESS IN INTERNATIONAL PROVENANCE TRIALS AT AGE SEVEN AND HALF YEARS IN NIGERIA

Summary

Variations in growth patterns between provenances reported at ages 6, 18 and 54 months continue to show at the age of 7.5 years. Provenances reported to be the best at 54 months in vigour were overtaken by new provenances at age 7.5 years. The Ibadan site continue to favour better growth of Pinus oocarpa than the Enugu-Ngwo site and this could be attributed not only to site differences but also to cultural operations available at Ibadan. Some of the provenances performed well at both sites. Survival figures were generally poor particularly at the Enugu-Ngwo site due to fire hazards at the initial stages.

Pinus oocarpa — PROGRÉS DANS LES TESTS INTERNATIONAUX DE PROVENANCES, L'AGÉ DE SEPT ANS ET DEMI, EN NIGERIA

Resume

Les variations de comportement au cours de la croissance des différentes provenances signalées à l'âge de 6, 18 et 54 mois sont toujours apparentes à 7 ans et demi. Les provenances les plus vigoureuses à 54 mois sont dépassées à 7 ans et demi par d'autres provenances.

Le site d'Ibadan continue de favoriser une meilleure croissance chez le Pinus oocarpa que le site d'Enugu-Ngwo, ce qui peut s'expliquer par les différences que présentent les deux stations, mais aussi à l'action bénéfique des opérations culturales pratiquées à Ibadan. Certaines provenances donnent des résultats également bons dans les deux stations.

Au stade initial, le nombre des manquants est généralement important, notamment à Enugu-Ngwo ; il est dû au hasard des feux courants.

Introduction

During the 1977 Joint IUFRO Workshop, S2.02-08 and S2.03-01, Brisbane, Australia, the initial results of Pinus oocarpa international provenance trial in Nigeria were presented and later the results appeared in the Proceedings of the Workshop (see "Progress And Problems of Genetic Improvement of Tropical Forest Trees," edited by D.G. Nikles, J. Burley and R.D. Barnes, 1978). Results presented include those obtained at the ages of 6, 18 and 54 months. The background of Pinus oocarpa introduction to Jos Plateau in 1954, and introduction to southern Nigeria through the international provenance trial in 972 were given. In addition the description of the sites, planting design, and the management of established trials were presented.

In the present paper the results obtained at the age of seven and half years are given.

Provenances represented

The list of provenances represented which appeared in Nikles et al (1978) are all still in the trial. See Nikles et al. (1978) for detailed description of provenances including the Latitude and Longitude, altitude, mean annual rainfall and soil characteristics.

Selection and breeding work

No provenance has been selected and replicated to other sites and no plus trees from individual provenances have been selected for vegetative propagation. Breeding work has not started. However, selection of pine plus trees from other pine plantations in northern Nigeria was done recently and grafts were made. Plans are ahead to establish clonal seed orchards in different parts of the country using the grafted scion materials.

Meanwhile preliminary plans are being worked out for future selection of plus trees from best provenances at each site from where scion materials will be obtained for the setting up of clonal seed orchards of Pinus oocarpa Scheide in southern Nigeria.

Assessment At Age Seven And Half Years

The trials established at Enugu-Ngwo in Anambra State and at Ibadan in Oyo State in 1972 was assessed for the fourth time in December, 1979 at the age of seven and half years. Data for height, girth, survival and fox-tailing were collected. After the analysis of data, provenances were ranked according to their performance at each location.

Results

Variations in height and girth within locations

At Enugu-Ngwo, variations in height and girth between provenances were found to be significant at the 1% level and the same applied to the Ibadan site.

Variations in height and girth between locations.

The provenances varied significantly at the 1% level between the two locations in height and girth. In general, Ibadan site had more trees of each provenance in good vigour than the Enugu-Ngwo site. Site differences appear to be an important factor influencing the performance of Pinus oocarpa in southern Nigeria rather than the seed source of provenance (see Table 2).

Survival and fox-tailing

These are presented in Table 1. The survival percentages at both sites are low as a result of high mortality. Mortality was higher at Enugu-Ngwo than at Ibadan.

Ranking of provenances at each location

The provenances performance at each location based on mean height and mean girth is presented on Table 2. At Ibadan site, the provenances mean height ranged from 6.18 m to 7.61 m and girth from 28.65 cm to 38.33 cm. At Enugu-Ngwo, the mean height ranged from 3.57m to 5.87m and girth from 16.22 cm to 35.04 cm.

At the Ibadan site the following provenances appear at age 7½ years to be performing well:

K16 Honduras, Agua Fria
K34 Guatemala, Bucaral
K47 Guatemala, San Jose
K45 Nicaragua, Siguatepeque
K6 Honduras, Zapotillo

Table 1

Survival and fox-tailing at age 7½ years (in percentages)

ENUGU - NGWO			IBADAN		
Provenance	Survival	fox-tailing	Provenance	Survival	Fox-tailing
K1 Nicaragua, Camelias	14	Nil	K1 Nicaragua, Camelias	40	Nil
K9 Guatemala, Canas	34	"	K6 Honduras, Zapotillo	46	"
K10 Guatemala, Lima	30	"	K7 Honduras, San Marcos	40	"
K11 Guatemala, Conacaste	13	"	K11 Guatemala, Conacaste	51.2	4
K15 Honduras Maraquito	27.2	"	K16 Honduras Agua Fria	39.2	3
K20 Nicaragua, Alamicamba	20.8	"	K20 Nicaragua Alamicamba	51	Nil
K29 Guatemala, Poptun	14	"	K34 Guatemala Bucaral	39.2	"
K31 Nicaragua, Junquillo	14.4	"	K35 Honduras, Angeles	37.6	"
K34 Guatemala, Bucaral	13	"	K36 Honduras, Zamorano	42	"
K35 Honduras Zamorano	22	"	K42 Nicaragua Yucul	40.8	"
K42 Nicaragua, Yucul	24	"	K43 Nicaragua Lagunill	50.8	"
K43 Nicaragua, Lagunilla	12	"	K44 Nicaragua, Rafael	44.8	3
K45 Honduras, Siguatepeque	30	"	K45 Honduras Siguatepeque	56	Nil
K49 Belize, Mt. Pine Ridge	29	"	K47 Guatemala San Jose	28.8	"
G00 Guatemala (non CFI seed)	25	"	K48 Guatemala Huehuetenange	41	5
H00 Belize (non CF1 seed)	10.4	"	K49 Belize Mt. Pine Ridge	50.4	Nil

Table 2

Ranking of provenances according to performance at each site by mean height (m) and mean girth (cm)

IBADAN SITE

Provenance	Mean height (m)	Provenance	Mean girth (cm)
K16 Honduras, Agua Fria	7.61	K16	38.33
K34 Guatemala, Bucaral	7.58	K47	37.54
K47 Guatemala San Jose'	7.10	K45	37.02
K45 Nicaragua, Siguatepeque	7.09	K35	35.87
K35 Honduras, Angeles	7.02	K44	35.77
K6 Honduras, Zapotillo	7.02	K1	35.44
K1 Nicaragua, Camelias	6.96	K42	35.36
K42 Nicaragua, Yucul	6.85	K6	35.11
K11 Guatemala, Conacaste	6.81	K11	34.21
K44 Nicaragua, Rafael	6.75	K7	33.46
K49 Belize, Mt. Pine Ri	6.73	K34	33.28
K20 Nicaragua, Alamica	6.54	K49	32.85
K7 Honduras, San Marc	6.50	K36	31.49
K43 Nicaragua, Laguni	6.20	K48	29.62
K36 Honduras, Zamora	6.20	K20	29.13
K48 Guatemala, Hueh	6.18	K43	28.65

ENUGU-NGOWO SITE

Provenance	Mean height (m)	Provenance	Mean girth (cm)
K34 Guatemala, Bucaral	5.87	K34	35.04
K29 Guatemala, Poptun	5.78	K20	32.26
K1 Nicaragua, Camelias	4.96	K1	30.82
K10 Guatemala, Lima	4.92	K45	3021
K11 Guatemala, Conacaste	4.91	G00	28.27
K36 Honduras, Zamorano	4.87	K36	27.05
H00 Belize (non CF1 Seed)	4.85	H00	26.11
K20 Nicaragua, Alamicamba	4.84	K42	26.03
K45 Nicaragua, Siguatepeque	4.52	K29	25.98
K43 Nicaragua, Lagunilla	4.29	K43	23.78
G00 Guatemala (non CF1 Seed)	4.23	K10	23.12
K15 Honduras, Maraquito	4.16	K9	22.40
K42 Nicaragua, Yucul	4.03	K11	21.29
K9 Guatemala, Canas	3.98	K49	20.46
K31 Nicaragua, Junquillo	3.95	K31	18.63
K49 Belize, Mt. Pine Ridge	3.57	K15	16.22

K1 Nicaragua, Camelias
K42 Nicaragua, Yucul

It appears K16 is particularly adapted to Ibadan site and so also is K47.

At the Enugu-Ngwo site, the following provenances are doing well:

K34 Guatemala, Bucaral
K29 Guatemala, Poptun
K1 Nicaragua, Camelias
K10 Guatemala, Lima
K11 Guatemala, Conacaste

The provenance, K34 is particularly adapted to Enugu-Ngwo site at this age.

Constancy of provenance performance

The performance of the provenances at both sites is very variable. In the assessment of 1976 December, which appeared in Niklos et al (1978), the following provenances were mentioned to be very good in vigour at Ibadan site at the age of 4½ years (54 months).

K48 Guatemala, Huehuetonango
K11 Guatemala, Conacaste
K7 Honduras Republic, San Marcos
K42 Nicaragua, Yucul

At Enugu-Ngwo site the following were also said to be good and suitable:

K9 Guatemala, Canas
K36 Honduras Rep., Zamorano
K49 Belize, Mt. Pine Ridge

A comparison of this information at age 4½ years with the one already given at age 7½ years shows that provenances which were said to be good at age 4½ are not the same ones which have emerged as best at both sites at age 7½ years.

R e f e r e n c e s

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

INVESTIGAÇÕES PRELIMINARES EM RELAÇÃO À VARIAÇÃO E INTERAÇÕES PROCEDÊNCIA x AMBIENTE EM *Pinus caribaea* MOR. VAR. *hondurensis* BARR. E GOLF. EM TESTES INTERNACIONAIS DE PROCEDÊNCIAS IMPLANTADOS EM QUEENSLAND

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Resumo

Os dados de um conjunto de testes de procedências são relatados e discutidos. Os efeitos dos sítios, adubação, procedências, e a importância das interações procedência x ambiente nas plantações do litoral de Queensland foram estudados para crescimento e qualidade do tronco nas idades de 5 $\frac{1}{2}$ 6 $\frac{1}{2}$ anos.

Diferenças no crescimento das procedências foram notadas em sete dos 10 ensaios implantados. Respostas à adubação foram também observadas em 3 ensaios, mas houve pouca evidência das interações procedências x adubação. O crescimento variou significativamente entre sítios, mas houve pouca evidência das interações procedência x sítio, todavia ela foi notada em um sub-conjunto de ensaios envolvendo uma grande amplitude de sítios. A variação associada com estas interações foi relativamente pequena, e as correlações entre sítios geralmente indicaram que a classificação das procedências em função dos sítios não foi alterada substancialmente.

As procedências diferiram aos 6 anos de idade, na retidão do tronco para todos os sítios. Em geral as procedências litorâneas foram mais retas do que a média geral. Diferenças entre procedências foram também observadas em relação à incidência de "fox-taill", tortuosidade, inclinações devidas ao vento, bifurcações, ramificações espiraladas e resistência ao vento.

Nenhuma procedência foi superior para todas as características, e as diferenças entre as procedências melhores classificadas foram geralmente pequenas. As procedências de Karawala, Guanaja, Poptun, Culme, Brus Lagoon e Santa Clara geralmente crescem melhor; as procedências de Melinda, Santos, Rio Coco apresentaram crescimento inferior. As procedências litorâneas (Karawala, Alamicamba, Brus Lagoon, Pinar, Kuakuil e Melinda) geralmente apresentaram melhor retidão do tronco. Nenhuma procedência competiu com a testemunha genética melhorada para crescimento e retidão do tronco. Várias procedências litorâneas aparentam ter potencial para serem incluidas no programa de melhoramento genético em Queensland.

PRELIMINARY INVESTIGATIONS OF VARIATION AND PROVENANCE – ENVIRONMENTAL INTERACTIONS IN *Pinus caribaea* MOR. VAR. *hondurensis* BARR. AND GOLF. IN QUEENSLAND PLANTING TRIALS

Summary

Data for a comprehensive set of plantings of the international provenance trials are reported and discussed. The effects of sites, fertilizers and provenances and the importance of provenance-environmental interactions in coastal Queensland plantations are investigated for growth and stem quality characteristics at 5½-6½ years of age.

Differences in the growth of provenances were indicated in seven out of 10 trials. Responses to fertilizer were also observed in three trials, but there was little evidence of provenance-fertilizer interactions. Growth varied greatly across sites, but there was little evidence of provenance-site interactions, although they were indicated in one subset of trials covering a broad range of sites. However, variation associated with these interactions was relatively small, and correlations between sites generally indicated that the ranking of provenances across sites was not altered substantially.

Provenances differed in stem straightness at all sites at 6 years of age. In general, coastal provenances were straighter on average. Differences between provenances were also observed in incidence of foxtailing, wind-kinking, forking, ramicorn-branching and wind-resistance.

No single provenance was superior in all respects, and differences among top-ranking provenances were generally small. Provenances from Karawala, Guanaja, Poptun, Culmi, Brus Lagoon and Santa Clara generally grew well, but sources from Melinda, Santos and Rio Coco were poor. Coastal provenances (Karawala, Alamicamba, Brus Lagoon, Pinar, Kuakuil and Melinda) generally showed best stem straightness. No provenance matched a genetically-improved control for growth or stem straightness. Several coastal provenances appear to have potential for inclusion in the Queensland breeding programme.

ENQUÊTES PRÉLIMINAIRES PAR RAPPORT À LA VARIATION ET AUX ACTIONS RÉCIPROQUES PROVENANCES – ENVIRONNEMENT DANS LE *Pinus caribaea* MOR. VAR. *hondurensis* BARR. ET GOLF. DANS DES TESTS INTERNATIONAUX DE PROVENANCES IMPLANTÉS À QUEENSLAND

Resume

Il est question ici d'un compte-rendu et d'une discussion portant sur les données obtenues à partir d'un ensemble complet de plantations, effectuées au titre des essais internationaux de provenances. On étudie, ici, l'influence du site, des engrais et des provenances dans les plantations côtières du Queensland, ainsi que l'importance des interactions provenances-milieu d'introduction, sur la croissance et les caractéristiques de qualité des tiges entre 5 ans ½ et 6 ans ½.

Dans 7 des 10 essais effectués, on a trouvé des différences de croissance parmi les provenances. On a découvert très peu d'interactions évidentes provenance-engrais lors des 3 essais entrepris à cet effet.

Le taux de croissance varie sensiblement d'un site à l'autre mais il est peu probable qu'il y ait des interférences au niveau provenance - site et cela malgré le fait qu'on en ait observé les signes dans un sous-groupe d'essais portant sur un large éventail de sites. La variation de croissance due à ces interactions était cependant relativement faible car des comparaisons entre les sites n'ont pas montré de différences fondamentales parmi les classifications de provenances d'un site à l'autre.

A l'âge de 6 ans, les provenances diffèrent. Quant à la

Table 1. Details of multi-site provenance trials of *P. caribaea* var. *hondurensis* established in Queensland, Australia in 1973

Item	Details									
Site	Cardwell	Kennedy	Clement	Pinnacle		Byfield		Elliott River	Tuan	Beerburrum
				Site 1	Site 2	Site 1	Site 2			
Identifier code	CAR	KES	CLR	PIR	PIS	BYR	DYS	ERR	TUS	BER
Latitude (°S)	18°15'	18°10'	19°00'	21°15'	21°15'	22°50'	22°50'	25°05'	25°40'	27°00'
Elevation (m)	15	9	3	240	230	30	30	30	18	15
Soil group	red podsolic	gleyed sand/ clay alluvium	deep sand	yellow-brown podsolic	gleyed podsolic	lateritic podsolic	gleyed podsolic	podsol	gleyed podsolic	lateritic podsolic
Natural vegetation	tall eucalypt	tall tea-tree	medium eucalypt	medium eucalypt	tall eucalypt	tall eucalypt	low tea-tree	medium eucalypt	low tea-tree	tall eucalypt
Site type	sloping well-drained	flat poorly-drained	flat well-drained	sloping well-drained	flat poorly-drained	well-drained	poorly-drained	flat well-drained	flat poorly-drained	flat well-drained
Annual rainfall (mm)	2030	2167	1131	1109	1109	1697	1697	1071	1314	1586
Length of dry season[1] (months)	5	5	6	5	5	4	4	5	2	2
Planting date	2/73	2/73	2/73	4/73	4/73	1/73	1/73	3/73	3/73	3/73
Site preparation	plough	mound drain	rip	rip	rip mound drain	plough	plough mound drain	rip plough	plough mound	plough
Spacing (m)	2.7 x 2.4	2.7 x 2.4	2.7 x 2.4	2.7 x 2.4	2.7 x 2.4	2.7 x 2.4	2.7 x 2.4	2.7 x 2.4	2.7 x 2.4	3.0 x 3.0
Fertilizer[2] treatments	M_0(1) M_1(2) M_4(2)	M_1(2) M_3(2) M_4(2)	M_1(2) M_4(2)	M_0(2)	M_0(2)	M_0(1) M_1(2) M_4(2)	M_1(2) M_3(2) M_4(2)	M_0(2) M_4(2)	M_1(2) M_4(2)	"M_4"(5)
Number of entries	17	17	14	12	12	18	17	12	12	13
<u>5½ year data</u>										
mean height (m)	8.89 (8.88)[3]	8.13 (8.10)	8.55 (8.55)	7.67 (7.63)	7.32 (7.29)	8.25 (8.33)	7.92 (7.93)	8.30 (8.28)	6.68 (6.67)	9.44 (9.49)
mean d.b.h. (cm)	12.33 (12.35)[3]	11.82 (11.86)	12.75 (12.79)	10.34 (10.31)	10.27 (10.21)	12.29 (12.32)	11.86 (11.82)	12.72 (12.70)	10.65 (10.62)	14.97 (15.07)

[1] Number of months with rainfall less than 60 mm

[2] M_0 = Nil; M_1 = Superphosphate (P, Ca, S at 60, 44, 4 kg/ha); M_3 = M_1 plus N, K, Mg, S at 47, 113, 11, 73 kg/ha; M_4 = M_3 plus Cu, Zn, B, Mn, Mo at 4, 4, 4, 6, 1 kg/ha

[3] Bracketed value is the mean for set of 11 entries common to all trials

Table 2. Details of provenances of *P. caribaea* var. *hondurensis* established in multi-site trials in Queensland in 1973

Identifier	Collection site	Site code/2	Collection Number/2	Number of replications in Queensland trials/1									
				CAR	KES	CLR	PIR	PIS	BYR	BYS	ERR	TUS	BER
KUA	Kuakuil, Nicaragua	PC1	K18	5	6	4	-	-	5	6	-	-	5
KAR	Karawala, Nicaragua	PC2	K19	5	6	4	2	2	5	6	4	4	5
ALA	Alamicamba, Nicaragua	PC3	K20	5	6	4	2	2	5	6	4	4	5
PIN	Pinar, Nicaragua	PC4	(K21	5	5	-	-	-	-	-	-	-	-
			(K52	-	-	-	-	-	6	6	-	-	-
RIO	Rio Coco, Nicaragua	PC5	K22	5	6	4	2	2	5	6	4	4	5
BRU	Brus Lagoon, Honduras	PC7	K58	5	6	4	2	2	5	6	4	4	5
GUA	Guanaja, Honduras	PC8	K24	5	6	4	2	2	5	6	4	4	5
POP	Poptun, Guatemala	PC6	K29	5	6	4	2	2	5	6	4	4	5
BRI	Los Briones, Honduras	PC12	K54	5	-	-	-	-	5	-	-	-	-
LIM	Los Limones, Honduras	PC13	K56	5	6	4	-	-	4	6	-	-	-
CUL	Culmi, Honduras	PC14	K57	5	6	4	2	2	5	6	4	4	-
POT	Potosi, Honduras	PC17	K60	5	6	4	2	2	5	6	4	4	5
SCL	Santa Clara, Nicaragua	PC21	K61	5	6	4	2	2	5	6	4	4	5
SAN	Santos Pine Ridge, Belize	PC19	(K64	5	6	-	-	-	-	-	4	4	-
			(107N/3	-	-	4	2	2	5	6	-	-	5
MPR	Mountain Pine Ridge, Belize	PC20	K65	5	6	-	-	-	5	6	-	-	-
MEL	Melinda, Belize	PC23	K66	5	7	4	2	2	5	6	4	4	5
130	Byfield, Australia	PC22	R130R/4	-	6	-	-	-	5	6	-	-	5
125	Byfield, Australia	PC22	R125P/4	5	6	4	2	2	5	6	4	4	5

/1 Site identifiers as given in Table 1.

/2 Codes given by Greaves (1978).

/3 Queensland seed batch number for seed ex NewCaledonia originally from a French collection at this location in 1969.

/4 Queensland seed batch number.

rectitude du fût, sur tous les sites, on a remarqué, d'une façon générale, que les provenances d'origine côtière avaient en moyenne plus de rectitude. On a observé également, parmi les provenances, des différences concernant l'hypertrophie terminale, les déformations du fût dues au vent, les fûts fourchus, les branches déviées par le vent et la résistance efficace au vent.

Aucune provenance ne s'est montrée supérieure aux autres sous tous les aspects et les différences entre les meilleures provenances n'étaient généralement pas très importantes. Les provenances du Karawala, Guanaja, Poptun, Culmi, Brus lagoon et Santa clara ont, dans l'ensemble, une bonne croissance alors que celles de Melinda, Santos et Rio coco sont de mauvaise venue. Les provenances d'origine côtière (Karawala, Alamicamba, Brus lagoon, Pinar, Kuakuil et Melinda) ont généralement une meilleure rectitude de fût. Aucune provenance n'a présenté une amélioration génétique sensible de croissance ou de rectitude du fût.

Plusieurs provenances d'origine côtière semblent être suffisamment intéressantes pour faire partie du programme d'amélioration de Queensland.

INTRODUCTION

Provenances of *Pinus caribaea* Mor. var. *hondurensis* Barr. and Golf. are being evaluated under a wide range of environmental conditions in coastal Queensland as part of the international series of provenance trials coordinated by the Commonwealth Forestry Institute, Oxford. It is considered that the trial environments sample a major proportion of those available for or being planted with *P. caribaea* var. *hondurensis* in Queensland.

These multi-environment trials have several objectives. One major aim is to investigate differences between provenances in productivity and adaptation to Queensland conditions, and in particular to determine the extent of provenance-environmental interactions. This information will assist in choosing the best provenances for future breeding use, and in defining an appropriate breeding strategy for incorporating such material into the Queensland programme. This paper reports some early results of these trials.

MATERIAL AND METHODS

Ten trials, all in coastal Queensland, were established in the field early in 1973. Their localities are documented in Table 1. The trial sites range in latitude from 18°S to 27°S, and all are subject to periodic, destructive cyclonic winds. The trials sample a range of edaphic conditions including well-drained and poorly-drained soils of varying fertility status. Combinations of three fertilizer treatments were applied in seven of the trials to give a total of 21 site-fertilizer environments (Table 1). Nikles (1978) provides further details about the design, establishment and management of these trials.

A total of 16 provenances, drawn principally from the Kemp collections of 1970-71 (Greaves 1978), and two Queensland control seedlots derived from the Belize Mountain Pine Ridge provenance were established with a varying number of entries in each trial. The entries in each trial are detailed comprehensively in Table 2.

The trials were measured annually until 1976 (age 3½ years). These results have been summarized by Nikles (1978). All trials were remeasured in the cool, dry season of 1978 at approximately 5½ years of age. The diameter at 1.3 m (d.b.h.) and height of the interior 25 trees of each plot were recorded in each trial, apart from the Beerburrum trial where all ten trees of each plot were measured. In addition three trials were subjected to a standardized comprehensive assessment developed by an officer of the Commonwealth Forestry Institute with local assistance in early 1979 (age 6 years) (Barnes, Gibson and Bardey 1980). These were the trials identified as CAR, BYR and BER in Table 2. To supplement this, four of the remaining trials (KES, BYS, ERR and TUS) were assessed in mid-1979 (age 6½ years) for straightness (1-5 scale), presence of stem kinks, forks, and ramicorns and the incidence of 'foxtailing' (branch-free lengths of stem in excess of 2½ m). Three of the trials were also assessed for wind resistance (1-4 scale) at 6½ years (KES) or 7½ years (BYR and BYS). The results presented or discussed in this paper are restricted to the traits d.b.h., height, a derived volume index, straightness and incidence of foxtailing.

For the 5½ year data plot means were obtained for d.b.h. and height, and a volume index calculated for each plot by using these means in the equation

$$\text{Volume} = 2.47281\ (\text{d.b.h.})^2\ \text{height}.$$

Analyses of variance of this index, along with plot mean d.b.h. and height were conducted on the data from individual trials. Variation within plots based on data from individual trees was not obtained in these analyses, and provenance means were estimated from unweighted plot means. In two trials (CAR and BYR) the single replicate of the fertilizer treatment M_0 was not included in the analysis of variance.

Analyses of variance of data from the assessments made in cooperation with the CFI, Oxford were at the individual tree level where appropriate, as were those for the supplemental assessments at 6½ years.

To investigate provenance-site interactions, the data were pooled across trials to give several balanced arrays of provenances and sites, and analyses of variance were conducted

Table 3. Provenance means[/1] for 5.5 yr DBH (cms) ranked within each of 10 sites in Queensland

CAR[/2]		KES		CLR		PIR		PIS		BYR		BYS		ERR		TUS		BER	
125	13.14	125	12.97	GUA	13.93	125	10.95	125	11.16	125	14.67	125	12.78	125	13.62	ALA	11.36	SCL	16.13
BRI	13.07	GUA	12.51	SCL	13.41	KAR	10.85	GUA	11.15	GUA	13.96	POP	12.78	GUA	13.31	CUL	11.00	125	15.88
POP	12.81	CUL	12.46	125	13.31	POP	10.85	POT	11.13	BRI	13.47	MPR	12.48	POT	12.98	125	10.96	POP	15.83
POT	12.81	MPR	12.44	POP	13.12	POT	10.82	CUL	10.92	POP	13.35	130	12.38	CUL	12.91	POT	10.90	GUA	15.65
ALA	12.77	RIO	12.38	KAR	12.97	SCL	10.69	POP	10.64	CUL	13.27	CUL	12.28	ALA	12.85	POP	10.76	POT	15.50
KAR	12.72	BRU	12.13	POT	12.86	CUL	10.60	SCL	10.56	SCL	13.13	POT	11.98	SCL	12.72	SCL	10.66	BRU	15.12
MPR	12.66	POP	12.10	CUL	12.73	RIO	10.39	BRU	10.44	ALA	13.08	BRU	11.96	MEL	12.70	GUA	10.64	KAR	14.99
SCL	12.51	SCL	12.01	BRU	12.67	GUA	10.18	MEL	9.97	130	13.05	SCL	11.89	KAR	12.66	MEL	10.63	130	14.71
MEL	12.20	KAR	11.97	LIM	12.62	ALA	9.98	RIO	9.61	MPR	12.99	GUA	11.87	POP	12.65	BRU	10.48	ALA	14.49
KUA	12.19	KUA	11.81	KUA	12.45	MEL	9.75	SAN	9.25	POT	12.90	KAR	11.65	BRU	12.50	KAR	10.20	RIO	14.34
PIN	12.13	PIN	11.68	MEL	12.40	SAN	9.52	ALA	9.23	BRU	12.60	KUA	11.51	RIO	12.19	RIO	10.10	KUA	14.08
CUL	12.06	130	11.67	SAN	12.26	BRU	9.49	KAR	9.20	PIN	12.51	LIM	11.50	SAN	11.54	SAN	10.09	SAN	14.07
GUA	12.05	ALA	11.37	ALA	11.93					RIO	12.51	MEL	11.37					MEL	13.74
BRU	11.92	SAN	11.33	PIN	11.82					KAR	12.44	ALA	11.32						
LIM	11.72	MEL	10.93							SAN	12.19	RIO	11.22						
SAN	11.39	POT	10.79							MEL	12.14	SAN	11.18						
RIO	11.17	LIM	10.49							KUA	12.14	PIN	11.12						
										LIM	11.83								
MEAN	12.31		11.82		12.75		10.34		10.27		12.90		11.84		12.72		10.65		14.97
LSD 0.05	1.06		1.44		1.67		1.36		2.20		1.14		0.82		0.79		1.16		0.77
CV%	6.0		10.5		9.0		6.0		9.7		6.1		6.0		4.3		7.5		4.0

/1 Means are based on numbers of replications per site as given in Table 2.

/2 Site and provenance identifiers as given in Tables 1 and 2.

to test for the occurrence of provenance-site interactions. Consistency in the ranking of provenances across sites for individual traits was examined by calculating pairwise correlations between sites using the set of provenance means common to each pair of sites.

RESULTS AND DISCUSSION

Individual Trials

Differences in the growth of provenances were apparent in seven of the 10 trials. These are documented in Table 3 and Table 4 for d.b.h. and height respectively. Provenance means for volume index are not tabulated because it is thought the estimates may be rather imprecise for such small trees of diverse provenances. However, these data have been analysed and used in the correlation studies. The trials of lowest productivity (PIR, PIS and TUS) failed to differentiate the responses of provenances clearly although for the Pinnacle trials (PIR and PIS) this was partly a function of insufficient replication. Differences in height growth generally were most strongly expressed, judging from the relative sizes of the mean squares obtained in the analyses of variance. No clear pattern of the influence of sites in discriminating among provenances was apparent, except that low productivity at a site generally limited the expression of the potential of provenances.

Significant responses to fertilizer were obtained for d.b.h., height and volume index in the two trials at Byfield (BYR and BYS) and for height at Clemant (CLR). There was little indication of provenance-fertilizer interactions for growth, apart from their occurrence at Clemant. In this trial they occurred for d.b.h., height and volume index and were mainly attributable to marked positive growth responses to fertilizer M_4 for the coastal Karawala (KAR) and Alamicamba (ALA) provenances, and a corresponding negative response for the Los Limones (LIM) upland provenance. The cause of this interaction is unknown, but is regarded as unimportant since the weight of evidence from the other trials suggests a lack of such interactions in general.

Provenances differed in stem straightness in all trials assessed at age 6-6½ years (Table 5). Coastal provenances were straighter on average, and had a higher proportion of trees rating well for stem straightness. Differences among provenances were also present in some trials for incidence of wind kinks, ramicorn branching and forking. In three trials,differences among provenances for wind-resistance were also apparent, with coastal provenances generally more resistant. This aspect is documented fully by Nikles, Spidy, Rider, Eisemann, Newton and Matthews-Frederick (1980). Incidence of foxtailing also varied among provenances, and was prevalent in the most productive trials (Table 6), particularly at Beerburrum (BER) and Elliott River (ERR). In general coastal provenances had a higher incidence of foxtailing although Guanaja (GUA), Melinda (MEL) and Santos (SAN) tended to have an average or lower incidence.

Across Sites

The wide variation in growth across sites (Table 1) provides the opportunity to investigate the occurrence of provenance-site interactions. Analyses of variance for several subsets of provenances and sites are presented in Table 7. These indicate little evidence of provenance-site interactions for growth across the four most extensive trials

Table 4. Provenance means[/1] for 5.5 yr height (m) ranked within each of 10 sites in Queensland

CAR[/2]		KES		CLR		PIR		PIS		BYR		BYS		ERR		TUS		BER	
125	9.53	BRU	9.10	BRU	9.09	POP	8.19	125	7.99	KAR	10.02	125	8.49	ALA	8.89	ALA	7.43	SCL	10.02
KAR	9.47	125	9.04	125	9.03	125	8.18	BRU	7.71	125	9.56	BRU	8.42	125	8.80	125	7.05	BRU	9.89
ALA	9.40	MPR	8.64	GUA	8.89	CUL	8.11	CUL	7.69	GUA	9.06	MPR	8.24	BRU	8.68	CUL	6.84	125	9.84
PIN	9.14	RIO	8.59	SCL	8.84	SCL	7.86	POT	7.66	ALA	9.02	KAR	8.16	KAR	8.45	POT	6.78	KAR	9.79
BRU	9.12	PIN	8.55	CUL	8.69	KAR	7.79	GUA	7.59	BRU	9.00	POP	8.15	CUL	8.43	SCL	6.75	GUA	9.65
MPR	9.11	CUL	8.54	KAR	8.67	ALA	7.70	POP	7.57	POP	8.94	CUL	8.12	GUA	8.42	MEL	6.74	ALA	9.56
SCL	9.04	KAR	8.33	KUA	8.67	POT	7.68	MEL	7.47	CUL	8.92	ALA	8.03	SCL	8.35	GUA	6.73	POP	9.53
POP	9.02	KUA	8.32	POP	8.61	RIO	7.58	SCL	7.44	130	8.88	KUA	7.96	POP	8.34	BRU	6.66	POT	9.40
BRI	8.98	GUA	8.26	POT	8.52	GUA	7.53	RIO	7.01	MPR	8.80	PIN	7.94	POT	8.26	KAR	6.56	RIO	9.32
KUA	8.92	SCL	8.12	LIM	8.29	MEL	7.47	KAR	6.89	POT	8.69	GUA	7.91	RIO	7.94	POP	6.52	130	9.23
POT	8.80	POP	8.11	RIO	8.27	BRU	7.31	ALA	6.64	PIN	8.65	SCL	7.81	MEL	7.91	RIO	6.40	KUA	9.05
CUL	8.74	ALA	8.09	ALA	8.20	SAN	6.69	SAN	6.17	RIO	8.60	POT	7.79	SAN	7.04	SAN	5.73	MEL	8.79
MEL	8.63	130	8.04	MEL	8.08					SCL	8.51	RIO	7.76					SAN	8.61
GUA	8.59	MEL	7.26	SAN	7.88					KUA	8.46	130	7.75						
LIM	8.21	POT	7.16							SAN	8.31	MEL	7.64						
RIO	8.11	LIM	7.10							MEL	8.29	LIM	7.45						
SAN	7.74	SAN	7.00							BRI	8.16	SAN	7.10						
										LIM	7.87								
MEAN	8.86		8.13		8.55		7.67		7.32		8.76		7.92		8.30		6.68		9.44
LSD 0.05	0.74		1.13		1.46		1.10		1.49		0.78		0.48		0.57		0.71		0.58
CV%	5.8		12.0		7.9		6.5		9.3		6.2		5.2		4.7		7.2		4.8

/1 Means are based on numbers of replications per site as given in Table 2.

/2 Site and provenance identifiers as given in Tables 1 and 2.

Table 5. Provenance means[1] for stem straightness score ranked within each of 7 sites in Queensland[2]

CAR[3]		KES		BYR		BYS		ERR		TUS		BER	
125	14.65	125	2.30	125	10.13	125	2.22	125	1.95	MEL	2.03	KUA	8.38
PIN	11.56	BRU	1.86	MEL	9.72	KUA	2.16	MEL	1.89	KAR	1.90	125	8.07
MEL	10.41	PIN	1.86	KUA	8.07	PIN	2.12	KAR	1.78	125	1.89	ALA	5.32
KUA	10.29	KUA	1.84	BRU	7.97	RIO	2.08	BRU	1.75	RIO	1.85	MEL	5.20
ALA	9.46	130	1.82	SAN	7.80	BRU	1.98	SAN	1.74	BRU	1.84	KAR	5.15
KAR	9.09	RIO	1.67	RIO	7.05	KAR	1.92	ALA	1.69	ALA	1.77	RIO	5.00
BRI	9.06	KAR	1.66	ALA	7.01	SAN	1.92	SCL	1.61	SAN	1.73	GUA	4.65
BRU	8.97	POP	1.59	KAR	6.95	MEL	1.89	RIO	1.61	GUA	1.66	BRU	4.62
SCL	8.72	ALA	1.58	PIN	6.92	ALA	1.88	CUL	1.60	POP	1.66	130	4.34
POP	8.46	MEL	1.55	130	5.73	POP	1.77	POP	1.48	SCL	1.63	SCL	4.22
RIO	8.29	MPR	1.54	GUA	5.36	130	1.76	GUA	1.42	POT	1.52	SAN	4.22
LIM	8.28	GUA	1.51	POP	5.36	GUA	1.74	POT	1.32	CUL	1.46	POP	3.98
MPR	8.14	CUL	1.50	MPR	5.09	CUL	1.74					POT	2.86
GUA	6.97	SCL	1.49	LIM	4.72	MPR	1.74						
CUL	6.94	SAN	1.46	CUL	4.07	SCL	1.70						
SAN	5.08	LIM	1.40	SCL	3.85	LIM	1.56						
POT	4.91	POT	1.27	BRI	3.73	POT	1.49						
				POT	3.67								
MEAN	8.78		1.67		6.29		1.88		1.65		1.75		5.08
LSD 0.05	2.07		0.23		1.98		0.19		0.33		0.17		1.78

[1] Means are based on numbers of replications per site as given in Table 2.

[2] CAR, BYR and BER sites were assessed at 6.0 years using CFI, Oxford scoring system; KES, BYS, ERR and TUS sites were assessed at 6.5 years using Queensland Forestry scoring system.

[3] Site and provenance identifiers as given in Tables 1 and 2.

(subset I) at Cardwell, Kennedy and Byfield. Extending the range of sites to include trials at Elliott River and Tuan (subset II) did not result in provenance-site interactions, but inclusion of data for the Clemant and Beerburrum trials (subset IV) gave evidence of provenance-site interactions for d.b.h., height and volume index (Table 7). However, variation attributable to provenance-site interactions appeared small in relation to variation among provenances, based on a comparison of components of variance estimated from the mean squares in Table 7. Correlations between pairs of sites are presented in Table 8. These are generally positive in sign and appreciable in magnitude for all traits and indicate that the rankings of provenances were not altered substantially across sites. This was particularly so for the qualitative traits stem straightness and incidence of foxtailing, for which correlations were predominantly greater than 0.6. These data suggested that provenance-site interactions were generally unimportant in considering the performance of provenances across sites. This indication, coupled with the lack of provenance-fertilizer interactions, suggested that provenance-environmental interactions in general are not a significant factor in the adaptation of provenances of P. caribaea var. hondurensis to Queensland conditions. This should reduce the complexity of choosing appropriate provenances for breeding, although these findings need reappraisal as these trials mature.

No single natural provenance was superior across all sites, but differences in growth among top-ranking provenances were generally small at 5½ years of age. Provenances from Karawala, Guanaja, Poptun, Culmi, Brus Lagoon and Santa Clara generally grew best and were comparable (Tables 3 and 4). Those from Melinda, Santos and Rio Coco ranked relatively

Table 6. Provenance means[1] for percentage of foxtails ranked within each of 7 sites in Queensland[2]

CAR[3]		KES		BYR		BYS		ERR		TUS		BER	
BRU	49	BRU	36	PIN	32	BRU	35	BRU	55	RIO	41	KAR	51
PIN	41	RIO	32	RIO	32	RIO	31	RIO	54	ALA	37	ALA	48
ALA	33	PIN	28	BRU	26	ALA	30	ALA	52	POT	31	BRU	48
RIO	33	KAR	27	CUL	23	PIN	30	KAR	48	BRU	30	RIO	46
KAR	30	ALA	24	ALA	20	KAR	28	POP	45	MEL	29	POP	43
SAN	25	KUA	21	SAN	20	KUA	25	SAN	39	POP	24	KUA	41
KUA	24	CUL	20	KAR	19	SAN	24	CUL	31	KAR	22	MEL	35
MPR	23	MPR	19	POP	19	POP	23	POT	24	CUL	20	130	32
GUA	21	SAN	17	MPR	18	MPR	23	125	23	SAN	19	GUA	29
POP	18	MEL	16	KUA	15	CUL	22	GUA	22	GUA	17	SCL	26
POT	17	GUA	16	SCL	15	POT	20	MEL	21	SCL	17	125	26
CUL	15	POP	15	GUA	12	GUA	19	SCL	19	125	17	SAN	24
SCL	15	SCL	12	POT	12	MEL	17					POT	22
125	15	130	14	125	9	130	14						
MEL	13	125	9	MEL	8	SCL	12						
BRI	8	POT	9	130	8	125	11						
LIM	6	LIM	5	LIM	7	LIM	4						
				BRI	0								
Mean	23		19		16		21		36		25		36

[1] Means are based on numbers of replications per site as given in Table 2

[2] CAR, BYR and BER sites were assessed at 6.0 years using CFI, Oxford system. KES, BYS, ERR and TUS sites were assessed at 6.5 years using Queensland Forestry system.

[3] Site and provenance identifiers as given in Tables 1 and 2.

Table 7. Combined analyses of variance for d.b.h., height and volume index at 5½ years across sites and provenances for different subsets of provenances, fertilizers and sites: Subset I - 16 provenances across 4 trials CAR, KES, BYR and BYS[1]; Subset II - 12 provenances across 6 trials CAR, KES, BYR, BYS, ERR and TUS[2]; Subset III - 11 provenances across 7 trials CAR, KES, BYR, BYS, ERR, TUS and BER[3]; Subset IV - 11 provenances across 8 trials CAR, KES, BYR, BYS, CLR, ERR, TUS and BER[4]

Subset	Source of variation	df	Mean squares		
			d.b.h. (cm)	height (m)	volume index (dm^3)
I	Sites (S)	3	36.560	26.130*	Not available
	Reps/sites	12	22.943***	11.288***	
	Provenances (P)	15	4.600***	3.160***	
	P x S	45	0.828	0.450	
	Error	180	0.807	0.439	
II	Sites (S)	5	39.237	33.723*	2033.0*
	Reps/sites	18	15.998***	7.934***	724.2***
	Provenances (P)	11	5.385***	4.412***	331.5***
	P x S	55	0.722	0.428	35.6
	Error	198	0.691	0.347	32.0
III	Sites (S)	6	96.243***	40.596**	5496.5***
	Reps/sites	21	13.297***	6.598***	609.1***
	Provenances (P)	10	7.441**	5.373***	494.9***
	P x S	60	0.796	0.417	46.6*
	Error	210	0.620	0.308	32.5
IV	Sites (S)	7	67.046***	30.756***	4112.6***
	Reps/sites	24	5.986***	2.757***	318.7***
	Provenances (P)	10	8.280***	5.928***	595.7***
	P x S	70	0.914*	0.442*	56.5*
	Error	240	0.654	0.303	38.2

[1] M_1 and M_4 fertilizer levels only

[2] M_1 and M_4 fertilizer levels at CAR, KES, BYR, BYS and TUS; M_0 and M_4 at ERR

[3] As for Subset II plus 4 of 5 replications at BER

[4] M_1 and M_4 fertilizer levels at CAR, BYR and TUS; M_3 and M_4 at KES and BYS; M_0 and M_4 at CLR and ERR, and 4 of 5 replications at BER

poorly, as did provenances from Kuakuil, Pinar and Los Limones. The Alamicamba provenance was also slightly less vigorous than other top-ranking provenances. Mountain Pine Ridge provenance, the source of initial Queensland seed introductions, was included in four trials (Table 2) and was comparable in growth to the best provenances. A genetically-improved population (125), derived from Mountain Pine Ridge provenance in the Queensland programme and included as a control in all 10 trials, generally out-grew all other provenances.

Coastal provenances (Karawala, Alamicamba, Brus Lagoon, Pinar, Kuakuil and Melinda) generally showed better stem straightness across sites (Table 5). However, coastal sources such as Brus Lagoon, Karawala and Rio Coco also exhibited greatest incidence of undesirable foxtailing (Table 6). The genetically-improved population (125) ranked first for stem straightness at four and second at the other three trial sites. The mainland coastal provenances and 125 were superior to inland provenances in windfirmness at the three sites where this trait was assessed (Nikles *et al.* 1980).

The genetically-improved population 125 was top-ranking or nearly so for all traits at all sites and was thus the highest-yielding and best-quality material in the trials overall. It had been developed as a synthetic variety in Queensland during the 1960s through selecting parents (within a large population equivalent to provenance MPR of the present trials) and establishing them in a clonal seed production area. The same improved population is represented in the international trials in several other countries, and observations by one of the authors (Dr D.G. Nikles) in 1977, 1978 and 1980 showed that it maintains its superiority especially in stem quality at almost all test sites. This stability of superior performance of 125 across many sites further suggests that provenance-environmental interactions are of minor importance.

It is believed that the substantial genetic gain demonstrated in these trials by the difference between provenance MPR and population 125 could also be achieved through selection within large populations of one or more of the better natural provenances, particularly such promising mainland coastal provenances as Brus Lagoon and Karawala which were equal to MPR in growth but significantly superior in stem straightness and wind-firmness.

It appears, therefore, that there are a number of options for future breeding strategy with *P. caribaea* var. *hondurensis* in Queensland. These options would include advanced-generation breeding within the already-improved populations of MPR provenance, intensive selection within large populations of the better mainland coastal provenances, or combining superior genotypes from a range of desirable provenances.

CONCLUSIONS

Early results from these multi-site trials of provenances of *Pinus caribaea* var. *hondurensis* indicate that few provenances are outstanding in all respects. However, a few of the coastal provenances appear to have a higher frequency of gene complexes conditioning straightness and wind-resistance in combination with acceptable vigour. Differences between such provenances are generally small, and it appears that introduction of the best of these into the Queensland breeding programme provides a means for broadening the genetic base of the variety in Queensland, and possibly of obtaining extra gains in stem quality. The general lack of provenance-environmental interactions for this exotic material suggests that choices of provenances with satisfactory adaptability to most Queensland growing conditions can be made. This should simplify the breeding procedures required to incorporate new provenance material into existing breeding populations. The best means for achieving this may be to undertake intensive selection within large plantation populations of desirable provenances, followed by inter-crossing with the best local genotypes to introgress desirable genes into current breeding populations of MPR provenance as quickly as possible.

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Table 8. Pairwise interclass correlation coefficients for d.b.h., height, volume index, stem straightness and incidence of foxtailing, among 10 provenance trials at ages 5½, 6 or 6½ years, based on the subset of 11 to 17 provenances common to each pair of trials

Trial[1]	KES	CLR	PIR	PIS	BYR	BYS	ERR	TUS	BER
CAR	0.22[2] 0.60 0.32(16)[3] 0.86 0.91	0.58 0.65 0.46(14) - -	0.69 0.74 0.65(12) - -	0.47 0.48 0.33(12) - -	0.64 0.74 0.62(17) 0.60 0.81	0.69 0.86 0.67(16) 0.70 0.89	0.80 0.91 0.78(12) 0.72 0.84	0.68 0.77 0.60(12) 0.63 0.50	0.64 0.75 0.39(12) 0.80 0.68
KES		0.31 0.75 0.50(14) - -	0.35 0.48 0.40(12) - -	0.36 0.45 0.39(12) - -	0.71 0.71 0.70(17) 0.68 0.84	0.50 0.85 0.64(17) 0.81 0.92	0.37 0.68 0.51(12) 0.68 0.84	-0.04 0.37 0.11(12) 0.54 0.54	0.50 0.69 0.54(13) 0.76 0.82
CLR			0.45 0.52 0.48(12) - -	0.70 0.75 0.74(12) - -	0.58 0.63 0.67(14) - -	0.65 0.80 0.67(14) - -	0.61 0.70 0.62(12) - -	0.14 0.37 0.16(12) - -	0.81 0.81 0.83(12) - -
PIR				0.42 0.63 0.49(12) - -	0.57 0.67 0.63(12) - -	0.62 0.70 0.69(12) - -	0.54 0.69 0.59(12) - -	0.25 0.62 0.37(12) - -	0.68 0.64 0.69(11) - -
PIS					0.73 0.34 0.50(12) - -	0.76 0.65 0.74(12) - -	0.69 0.56 0.65(12) - -	0.42 0.45 0.37(12) - -	0.75 0.52 0.69(11) - -
BYR						0.70 0.78 0.75(17) 0.82 0.82	0.81 0.76 0.83(12) 0.86 0.82	0.58 0.49 0.49(12) 0.89 0.49	0.72 0.72 0.72(13) 0.70 0.61
BYS							0.62 0.90 0.72(12) 0.79 0.93	0.43 0.63 0.42(12) 0.74 0.64	0.73 0.77 0.72(13) 0.85 0.77
ERR								0.68 0.87 0.79(12) 0.77 0.59	0.60 0.83 0.67(11) 0.76 0.84
TUS									0.33 0.54 0.34(11) 0.66 0.54

[1] Site identifier as given in Table 1.

[2] Correlations in the order d.b.h., height, volume index, stem straightness and incidence of foxtailing

[3] Number of provenances on which the correlation is based.

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FAST GROWING TREES

AVALIAÇÃO DA VARIAÇÃO E DAS INTERAÇÕES FAMÍLIA x AMBIENTE EM TESTES DE PROGÊNIE DE *Pinus caribaea* MOR. VAR. *hondurensis* BARR. E GOLF., IMPLANTADOS EM VÁRIOS SÍTIOS DE QUEENSLAND, AUSTRÁLIA

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Resumo

A variação e as interações família x ambiente para populações constituidas por famílias selecionadas de *Pinus caribaea* var. *hondurensis*, vegetando como espécie exótica no litoral de Queensland, estão sob estudo em ensaios em vários sítios. Os resultados encontrados para duas séries de testes de progênie, um de famílias de meios irmãos, aos 7 1/2 anos, e outro de irmãos germanos, aos 4 1/2 anos, são examinados visando documentar os efeitos dos sítios, adubações, famílias e a importância das interações família x ambiente. Os resultados das duas séries de testes de progênies implantados em Fiji e no Território Norte da Austrália, foram considerados conjuntamente com as séries dos de polinização livre implantados em Queensland. No estudo das progênies de polinização livre encontraram-se diferenças geralmente amplas, em crescimento e retidão do tronco, entre sítios e famílias em todos os testes implantados. As interações família x sítio também ocorreram, mas estes efeitos geralmente contribuiram com menos de 50% da variação entre famílias (em média para os sítios). Correlações entre médias das famílias para pares de sítios, geralmente indicam boas associações entre o comportamento da família, o que determina que a classificação das famílias seja relativamente consistente entre os sítios. Estas correlações foram mais fortes para DAP e volume do que para altura. Porém, famílias e sítios parecem interagir mais significativamente para DAP e volume do que para altura. Os valores das correlações entre sítios para estes três caracteres, foram levemente inferiores quando os resultados dos testes de Queensland foram correlacionados com aqueles de Fiji e Território Norte.

Os resultados para os testes de irmãos germanos indicaram grandes diferenças em crescimento entre famílias e sítios. As respostas das famílias à adubação foram observadas, mas estas dependeram do sítio. Não houve evidência das interações família x adubação. As interações família x sítio foram observadas para D.A.P., altura e volume, mas a variância das interações família x sítio foi geralmente, em média, menor que 50% da variância entre famílias nos sítios envolvidos. Correlações entre pares de localidades para estas três características foram geralmente fortes. Este fato conduz à conclusão de que as interações família x sítio não alteraram substancialmente a classificação das famílias de um sítio para o outro. Comparações entre os resultados dos testes de polinização livre e de irmãos germanos sugerem que a magnitude das interações família x sítio foram similares em ambos estudos.

As indicações preliminares destes testes multi-sítios, são de que as interações família x ambiente não são um fator significativo dentro das diferenças entre famílias, para toda a amplitude de sítios e/ou tratos culturais. Essa conclusão, tem implicações para a estratégia do melhoramento e para produção de sementes. Elas não dão suporte significativo para a regionalização do programa de melhoramento em Queensland, e elas também sugerem que os pomares de sementes podem ser compostos com o objetivo de suprir uma grande amplitude de sítios. Os resultados indicam, também, que os programas de melhoramento utilizando material genético local e de intercâmbio internacional, pelo menos ao nível de famílias de polinização livre, podem ser incluidos, sem o risco de perdas sérias no comportamento do material através da perda de adaptação.

AN EVALUATION OF VARIATION AND FAMILY – ENVIRONMENTAL INTERACTIONS IN MULTI–SITE PROGENY TESTS OF *Pinus caribaea* MOR. VAR. *hondurensis* BARR. AND GOLF. IN QUEENSLAND, AUSTRALIA

Summary

Variation and family-environmental interactions for populations of selected families of Pinus caribaea var. hondurensis grown as an exotic plantation species in coastal Queensland are under investigation in multi-site trials. Results for two series of progeny tests, one of open-pollinated families at $7^1/_2$ years of age, and the other of full-sib families at $4^1/_2$ years of age, are examined to document the effects os sites, fertilisers and families and the importance of family-environmental interactions. Results for trials established in Fiji and the Northern Territory of Australia in conjunctions with the open-pollinated series in Queensland are also considered.

In the open-pollinated study, there were generally large differences in growth and stem straightness between sites and families in all tests. Family-site interactions also accurred, but these effects generally accounted for substantially less than 50 per cent of the variation among families on average across sites. Correlations of family means for pairs of sites generally indicated good associations of family performance and implied that the ranking of families was relatively consistent across sites. These correlations were stronger for d.b.h. and volume than for height. However, families and sites did not appear to interact more strongly for height than for d.b.h. and volume. The magnitude of correlations between sites for these three traits were only slightly reduced when the results of Queensland trials were correlated with those of comparable trials in Fiji and the Northern Territory.

Results for the full-sib study also indicated large differences in growth between families and sites. Responses of families to fertiliser were observed, but these depended on the site. There was no evidence of family-fertiliser interactions. Family-site interactions were observed for d.b.h., height and volume, but the variance of family-site interactions was generally less than 50 per cent of the variance among families on average across sites. Correlations among pairs of sites for these three traits were generally strong. This implied that family-site interactions were not substantially altering the ranking of families from site to site. Comparison of results from the open-pollinated and full-sib progeny tests suggested that the extent of family-site interactions was similar in both studies.

The early indications from these multi-site tests are that family-environmental interactions are not a dominant feature of differences between families across a range of

sites and/or cultural regimes. These findings have implications for breeding strategy and seed production. They do not strongly support regionalisation of the Queensland breeding programme, and they also suggest that seed orchards which cater for a broad range of sites, climatically and edaphically, can be composed. The results also indicate that breeding programmes utilising locally and some internationally exchanged genetic material can be adopted, at least for open-pollinated families, without suffering serious losses of performance through lack of adaptation.

ÉVALUATION DE LA VARIATION ET DES ACTIONS RÉCIPROQUES (FAMILLE – ENVIRONNEMENT) DANS DES TESTS DE PROGENITURE DE *Pinus caribaea* MOR. VAR. *hondurensis* BARR. ET GOLF., IMPLANTÉS EN PLUSIEURS SITES DE QUEENSLAND, AUSTRALIE

Resume

Dans plusieurs essais en différents milieux, on a entrepris des recherches sur la variation et les interactions, variété-milieu pour des populations de variétés sélectionnées du Pinus caribaea, var. hondurensis, poussant en tant qu'espèces exotiques sur la côte du Queensland. Les résultats de 2 séries d'essais de descendance portant l'une sur des variétés à pollinisation libre à l'âge de 7 ans ½, et l'autre sur des variétés consanguines à l'âge de 4 ans ½, nous permettent d'examiner les effets du lieu d'implantation, des engrais et des variétés, ainsi que l'importance des interactions variété-milieu.

Les résultats des premiers essais entrepris aux Fidjis et dans le Northern Territory en Australie, conjointement avec les séries à pollinisation libre du Queensland, sont aussi pris en considération.

INTRODUCTION

Breeding work with Pinus caribaea Mor. var. hondurensis Barr. and Golf. (Pch), which began in Queensland in 1955, has escalated rapidly over the last decade in response to a rapid increase in the planting rate of this variety. This has resulted in a vigorous, diversified programme of tree improvement which aims to evolve genetically broadly-based populations of Pch better adapted and higher yielding under Queensland conditions. Evaluating provenances and families is a major component of this programme, and at present this has multiple objectives which serve both to implement current breeding plans and to refine those plans.

In developing a breeding and seed production plan and in evaluating breeding populations, basic questions arise about the role of genotype-environment interactions. Their occurrence, which reflects differences in the adaptation of heterogeneous genetic material to variable environmental conditions, may influence the way in which better-adapted material is sought through breeding and seed orchards are designed. In particular, documentation of family-environmental interactions is important because selected individual clones (genotypes) generally are not used directly in reforestation but mated in some fashion for either commercial seed production or development of the breeding population. To achieve this, it is imperative that the performance of families be evaluated across a representative sample of environments.

Multi-site testing of progeny has been undertaken on a large scale in Queensland since 1972 to investigate variation in breeding populations and to assess the importance of family-environmental interactions for both half- and full-sib families. The aim is to acquire essential information on family-environmental interactions and the adaptation of breeding populations, particularly in relation to environmental variation across sites, for use in evolving seed orchards attuned to specific productive requirements, in refining breeding objectives, and in rationalizing progeny-testing itself. In some instances, the scope is broader, with the Queensland trials forming part of an international cooperative investigation of Pch (Nikles and Newton 1980). Such cooperative, albeit informal, ventures are a first attempt at exploring the question of family-environmental interactions on a continental or even global basis.

Nikles, Haydock and Ratcliff (1978) reported results for the growth of open-pollinated families of Pch at 4½ years of age in a series of progeny trials in Queensland, Fiji and the Northern Territory of Australia, and included an analysis of family-environmental interactions for 16 families across 6 sites using joint regression analysis (Freeman and Perkins, 1971). They found that such interactions occurred, but were small relative to differences among families across sites. This paper presents some further results for two series of progeny tests in Pch, one consisting mainly of open-pollinated families, part of which was considered by Nikles et al. (1978), and the other of full-sib

Table 1. Details of multi-site open-pollinated progeny trials of P. caribaea var. hondurensis established in Queensland, Australia in 1972.

Site	Cardwell (site 1)		Cardwell (site 2)		Byfield		Elliott River	Tuan
Material/1	Set A	Set B	Set A	Set B	Set A	Set B	Set (A+B)	Set (A+B)
Trial	CRA	CRB	CSA	CSB	BRA	BRB	ERR	TUS
Latitude (°S)	18°15'	18°15'	18°15'	18°15'	22°50'	22°50'	25°05'	25°40'
Elevation (m)	30	30	6	6	30	30	30	18
Soil group	grey podsolic	grey podsolic	lateritic podsolic	lateritic podsolic	granitic colluvial	granitic colluvial	lateritic podsolic	gleyed podsolic
Natural vegetation	dry sclerophyll	dry sclerophyll	sclerophyll	sclerophyll	wet sclerophyll	wet sclerophyll	dry sclerophyll	wallum
Annual rainfall (mm)	2030	2030	2030	2030	1697	1697	1471	1478
Site type	almost flat, well-drained		almost flat, swampy		slight slope, well-drained		flat, well-drained	sloping, swampy
Planting date	2/72	2/72	2/72	2/72	1/72	1/72	4/72	3/72
Site Preparation	plough	plough	high mounding	high mounding	double disc	double disc	double plough	mounding
Spacing (m)	3.3 x 3.0	3.3 x 3.0	3.3 x 3.0	3.3 x 3.0	3.3 x 3.0	3.3 x 3.0	3.3 x 3.0	3.6 x 2.7
Number of entries	24	34	24	34	30	54	50	20
7½ year data								
mean height (m)	13.14 (13.14)/2	11.91 (12.06)	11.30 (10.99)	9.31 (9.46)	12.53 (12.31)	11.86 (12.38)	8.19 (8.18)	10.04 (9.86)
CV%	5.0	6.0	5.9	7.7	6.8	7.8	6.4	5.6
mean d.b.h.(cm)	17.51 (17.45)	16.29 (16.18)	15.28 (14.89)	13.61 (13.70)	19.44 (19.46)	18.89 (19.60)	13.55 (13.59)	14.95 (14.66)
CV%	6.8	7.2	8.0	8.7	6.9	7.9	7.4	7.3

/1 Set number as given by Nikles (1973)

/2 Bracketed value is the mean for the set of 5 entries common to all trials

Table 2. Details of multi-site full-sib progeny trials of <u>P. caribaea</u> var. <u>hondurensis</u> established in Queensland, Australia in 1973

Locality	Cardwell		Byfield	Elliott River	Tuan
Trial	CR	CS	BR	ER	TS
Latitude (S)	18°15'	18°15'	22°50'	25°05'	25°40'
Elevation (m)	15	9	30	30	18
Soil Group	Red podsolic	Outwash sand	Red podsolic	Lateritic podsolic	Gleyed podsolic
Natural Vegetation	Tall eucalypt	Tall tea-tree	Tall eucalypt	Tall eucalypt	Low eucalypt
Annual Rainfall (mm)	2122	2122	1705	1071	1314
Site type	sloping, well-drained	flat, swampy	slight slope, well-drained	flat, drained	almost flat swampy
Planting Date	3/73	3/73	1/73	3/73	3/73
Site Preparation	plough	rip plough mound	plough	plough	plough mound
Spacing (m)	3.3 x 3.0	2.7 x 3.6	3.3 x 3.0	3.3 x 3.0	3.6 x 2.7
Fertiliser[1]	M_0, M_1, M_2, M_4	M_1, M_2, M_3, M_4	M_0, M_1, M_2, M_4	M_0, M_1, M_2, M_4	M_1, M_2 M_3, M_4
Number of Families	54	54	64	40	39
<u>4½ year data</u>					
mean height (m)	7.47 (7.38)[2]	6.32 (6.20)	8.40 (8.33)	4.65 (4.65)	5.84 (5.87)
CV%	5.3	6.4	5.8	6.6	6.3
mean d.b.h.(cm)	11.64 (11.49)	10.32 (10.17)	15.16 (14.99)	7.92 (7.90)	10.36 (10.37)
CV%	5.9	6.8	5.5	7.2	6.6

[1] M_0 - Nil; M_1 - Superphosphate (P, Ca, S at 60, 44, 4 kg/ha);
M_2 - M_1 plus N, S at 47, 58 kg/ha; M_3 - M_1 plus N, K, Mg, S at 47, 113, 11, 73 kg/ha;
M_4 - M_3 plus Cu, Zn, B, Mn, Mo at 4, 4, 4, 6, 1 kg/ha

[2] Value in brackets is the mean for the set of 35 entries common to all trials

families, both established on a broad range of sites in coastal Queensland. The effect of sites, fertilizers and families are documented, the importance of family-environmental interactions is investigated, and some implications of the results are discussed.

M A T E R I A L   A N D   M E T H O D S

O p e n - p o l l i n a t e d   P r o g e n y   S t u d y

Nikles (1973) reported the establishment of a series of open-pollinated progeny trials in Queensland, in conjunction with trials in Fiji and the Northern Territory of Australia. Some early results of these trials have been reported elsewhere (Nikles <u>et al</u>. 1978). Seedlots were obtained from ramets in clonal banks in Queensland, and from selected ortets in Queensland and Fiji. The series of trials established in the field in Queensland in early 1972 involved 76 entries consisting of 24 ramet seedlots, 46 ortet seedlots (Queensland 37, Fiji 9), 3 full-sib families and 3 broadly-based control seedlots. The entries were divided into two sets (Nikles 1973). Set A consisted of ramet-derived open-pollinated families plus several standard check entries, and Set B comprised ortet-derived open-pollinated families plus standard check entries.

Ten trials were planted at six sites in Queensland, but two trials on a poorly-drained site at Byfield were devastated by cyclone in January, 1976 and have been abandoned. The eight remaining trials are listed and briefly described in Table 1. All were established as randomized complete block designs with 48 replications of single tree plots with a varying number of entries per trial (Table 1). The blocks in each trial were stratified further into groups of six to provide an alternative randomized block design comprising 8 replications of 6-tree plots with the trees of each plot arranged non-contiguously.

All trials were measured in the cool, dry seasons of 1976 and 1979 at 4½ and 7½ years of age approximately. Height and diameter at breast height (d.b.h.) of all living trees were recorded, and trees were also assessed in 1979 for stem straightness (1-5 scale of increasing straightness) and other traits including windfirmness, incidence of foxtailing, forking and other branching characteristics. Basal area over bark of each tree was computed and also an estimate of tree volume under bark using the equation

$$\text{Volume} = 2.47281 \cdot (\text{d.b.h.})^2 \cdot \text{height}.$$

Analyses of variance of unweighted plot means (Yates, 1934) were conducted on the data from individual trials, based on a nominal plot size of 6 trees. An estimate of the average variance among trees within plots, adjusted by the harmonic mean of the number of trees per plot was appended to the main analysis. Family means were estimated from unweighted plot means.

A similar approach was adopted for combined analyses across trials and/or sites. To cope with imbalance in the set of entries across trials, analyses of variance were conducted on a number of balanced subsets of trials to test for the occurrence of family-site interactions. Consideration of all pairwise combinations of sites to extract maximum information on interactions was not feasible and analyses were limited to a few subsets of data covering the range of sites. Components of variance were estimated from these analyses by equating mean squares to their expectations under a model of random effects and solving the resulting sets of simultaneous equations. Pairwise correlations of trials for individual traits based on the set of family means common to each pair of trials were also calculated to quantify the nature of interactions of families and sites. Data from the trial at Nausori Highlands, Fiji and at Humpty Doo in the Northern Territory were also included in these correlation studies.

F u l l - s i b   P r o g e n y   S t u d y

A set of control-pollinated progenies obtained by crossing superior parent trees to some or all of a group of female testers were accumulated in a crossing programme in Queensland in the period 1967-1970. These progenies were established in multi-site trials in Queensland in 1973 over approximately the same range of sites as was used for the open-pollinated study.

A total of 63 full-sib families from 20 parents, 6 open-pollinated families and controls were established in six trials in an experimental design similar to that used for the open-pollinated progeny trials, except that four fertilizer treatments were superimposed across the blocking structure to give a split-plot arrangement of fertilizers and families in each trial. One trial at Byfield was destroyed by cyclone in 1976. Details of the remaining trials are shown in Table 2.

Height and d.b.h. were measured in 1977 at 4½ years of age. Tree volume under bark was also calculated using the equation given earlier. Analysis of these data paralleled that undertaken for the open-pollinated study. Correlations between trials were based upon the 35 entries common to all five trials.

R E S U L T S   A N D   D I S C U S S I O N

I n d i v i d u a l   T r i a l s

Open-pollinated progeny study

An indication of the growth of Pch in the open-pollinated trials is given by the trial means for d.b.h. and height in Table 1. Data for the set of 5 entries common to all trials is shown also to compensate for possible effects of varying numbers of entries per trial. The productivity of these trials is quite variable, with height growth ranging from about 8 m at Elliott River to 13 m at Cardwell. Comparative data from the Nausori Highlands, Fiji trial at age 6 years showed a mean height of dominant trees greater than 13 m and a d.b.h. greater than 20 cm (Wilcox, unpublished data) while data at age 6½ years from the two Northern Territory trials at Humpty Doo and Melville Island showed mean height growth of about 7 m and 10 m respectively (Brigden, unpublished data).

Despite the range of productivity exhibited in the Queensland trials, they are not a totally representative sample of planting sites in Queensland. In particular, there was a lack of sampling of vary swampy sites, particularly at lower latitudes. Therefore, environmental variation associated with changes in edaphic conditions across sites was probably somewhat less than that normally expected in multi-site testing in Queensland. The coefficients of variation in Table 1 indicate that relative microsite variation was comparable in all trials and not excessive for the growth traits.

Analysis of variance results for d.b.h., height, volume and straightness for individual trials are shown in Table 3. Transformation of data for volume was indicated in some trials to stabilize error variances, but this was not done. Differences among entries were highly significant for all four traits in all trials, clearly demonstrating the presence of substantial genetic variance among both ramet- and ortet-derived open-pollinated families. Family differences were well-expressed in all trials, and the ranking of parental breeding values afforded by these tests has already been used to assist in choosing clones of high breeding value for inclusion in a series of new seed orchards. Much more genetic information is available from these trials, but it cannot be presented here.

The range of family means was dependent on the trial, with trials of higher productivity at Byfield for example, exhibiting the largest range of entry means (Table 3), while less productive sites showed smaller differences among family means. All trials however, provided similar discrimination among families for growth and form, judging from the ratio of mean squares for entries and error for the four traits in Table 3. This may be influenced somewhat by the varying number of entries in each trial, but in part it appears to result from a positive association between the range of family means in a trial, and the within-trial variation (Table 3). These changes in the range

Table 3. Analysis of variance for d.b.h., height, volume and stem straightness data at 7½ years of age from eight open-pollinated progeny trials in coastal Queensland.

Trial /1	Source of Variation	d.b.h. (cm)		height (m)		volume (m^3) (MS x 10^3)		straightness score (1-5)	
		df	MS	df	MS	df	MS	df	MS
CRA	Blocks (B)	7	11.083***	7	9.054***	7	3.648***	7	0.369***
	Entries (E)	23	12.616***	23	1.927***	23	1.827***	23	0.320***
	E x B	161	1.431	161	0.431	161	0.272	161	0.070*
	Trees/plots	930	1.334	930	0.476	930	0.250	930	0.054
	Range of entry means	14.1-19.1		10.5-14.0		0.0720-0.1317		1.8-2.5	
CRB	Blocks (B)	7	13.576***	7	19.256***	7	3.960***	7	0.416***
	Entries (E)	33	6.936***	33	1.450***	33	0.952***	33	0.306***
	E x B	231	1.369	231	0.507	231	0.199	231	0.067
	Trees/plots	1258	1.321	1258	0.521	1258	0.206	1258	0.073
	Range of entry means	14.5-18.2		10.9-12.8		0.0622-0.1089		1.6-2.5	
CSA	Blocks (B)	7	164.329***	7	183.725***	7	25.367***	7	2.087***
	Entries (E)	23	9.498***	23	2.243***	23	1.239***	23	0.399***
	E x B	161	1.467	161	0.432	161	0.209	161	0.098
	Trees/plots	878	1.538	878	0.539	878	0.221	878	0.084
	Range of entry means	12.7-17.2		10.0-12.3		0.0541-0.1016		1.6-2.3	
CSB	Blocks (B)	7	81.903***	7	68.626***	7	14.149***	7	0.511***
	Entries (E)	33	6.634***	33	1.653***	33	0.461***	33	0.226***
	E x B	231	1.392	231	0.513	231	0.107	231	0.055
	Trees/plots	1267	1.575	1267	0.610	1267	0.130	1267	0.047
	Range of entry means	11.5-15.5		8.1-10.1		0.0326-0.0652		1.5-2.2	
BRA	Blocks (B)	7	6.008**	7	5.781***	7	2.385***	7	0.673***
	Entries (E)	29	9.139***	29	2.777***	29	1.955***	29	0.929***
	E x B	203	1.799	203	0.723	203	0.416	203	0.171
	Trees/plots	1072	1.671	1072	0.749	1072	0.398	964	0.180
	Range of entry means	17.1-20.9		11.1-13.4		0.0926-0.1479		2.3-4.0	
BRB	Blocks (B)	7	22.981***	7	44.449***	7	8.523***	7	3.102***
	Entries (E)	53	10.946***	53	3.354***	53	2.083***	53	0.679***
	E x B	371	2.237	371	0.840	371	0.446	370 /2	0.190
	Trees/plots	1779	2.182	1779	0.842	1779	0.423	1592	0.185
	Range of entry means	14.5-21.5		9.1-13.0		0.0615-0.1555		1.9-3.3	
ERR	Blocks (B)	7	19.423***	7	11.370***	7	1.704***	7	0.982***
	Entries (E)	49	4.132***	49	0.961***	49	0.203***	49	0.440***
	E x B	343	1.004	343	0.277	343	0.051	343	0.078
	Trees/plots	1729	1.052	1729	0.281	1729	0.055	1610	0.081
	Range of entry means	12.1-15.0		7.3-9.0		0.0302-0.0517		1.1-2.1	
TUS	Blocks (B)	7	19.684***	7	11.065***	7	2.583***	7	0.122*
	Entries (E)	19	4.547***	19	1.009***	19	0.379***	29	0.331***
	E x B	133	1.197	133	0.320	133	0.090	133	0.058
	Trees/plots	731	1.064	732	0.299	731	0.087	716	0.064
	Range of entry means	13.6-16.3		9.5-10.8		0.0473-0.0727		1.1-1.8	

/1 Mnemonic identifiers for trials as given in Table 1.
/2 One missin value.

Table 4. Analyses of variance for d.b.h. and height data at 4½ years of age from five full-sib progeny trials in coastal Queensland

Trait	Source of variation	CR df	CR MS	CS df	CS MS	BR df	BR MS	ER df	ER MS	TS df	TS MS
d.b.h. (cm)	Blocks	7	48.546***	7	59.166***	7	7.945***	7	34.499***	7	63.464***
	Entries	53	7.890***	53	7.078***	63	8.249***	37	3.226***	38	3.006***
	Error	371	0.484	371	0.448	441	0.692	259	0.406	266	0.460
	Trees/plots	2112	1.288	2127	0.406	2172	0.756	1490	0.433	1576	1.057
	Range of entry means	9.6 -	14.3	8.1 -	12.6	12.9 -	17.4	5.8 -	9.5	9.1 -	11.9
height (m)	Blocks	7	33.425***	7	28.563***	7	2.050***	7	10.056***	7	18.989***
	Entries	53	2.242***	53	1.941***	63	1.414***	37	0.804***	38	0.890***
	Error	371	0.163	371	0.168	441	0.235	259	0.094	266	0.124
	Trees/plots	2112	0.425	2127	0.152	2173	0.233	1490	0.111	1576	0.346
	Range of entry means	6.1 -	8.4	5.2 -	7.3	7.4 -	9.2	3.9 -	5.2	5.2 -	6.7

Trial headings marked with note 1 (Trial[1]).

[1] Mnemonic identifiers for trials as given in Table 2

of family means also suggest the presence of family-site interactions.

Full-sib progeny study

Trial means for height and d.b.h. in Table 2 indicate that growth in the full-sib progeny trials compares favourably with that of the series of open-pollinated trials at the same age (Nikles et al. 1978). The range of sites sampled is also comparable (Tables 1 and 2), but included one additional swampy site. Growth differences among sites are large and indicate the diverse levels of production under which the families in this study have been tested. Despite these large differences in productivity, the coefficients of variation in Table 2 show that relative microsite variation is acceptable in size and similar in all trials, and that the productivity of a site is not a factor which critically affects statistical efficiency in progeny-testing.

Analyses of variance for d.b.h. and height for the five full-sib progeny trials are shown in Table 4. Fertilizer effects are not considered because their inclusion in a combined analysis with entries provided only insensitive tests for fertilizer differences and block-fertilizer interactions. The result is that fertilizer effects are part of the variation among blocks in Table 4, and an entry-fertilizer interaction source of variation is not included.

Separate analyses of fertilizer effects suggested that there were variable responses to fertilizer treatments, masked somewhat by within-site variation, but indicative of a response to phosphorus at Elliott River, to nitrogen at Tuan, and to potassium and trace elements on the swampy site at Cardwell. Foliar sampling has been undertaken to investigate these effects fully.

Family-fertilizer interactions for d.b.h. and height growth were not apparent in these trials, apart from some inconclusive indications of their occurrence at Elliott River. Therefore the evidence suggests that the growth responses of the full-sib families under test have been consistent to age 4½ years across the range of fertilizer treatments employed. This implies that selection to exploit differences in the response of families to fertilizer ought to be straightforward, and that there is little scope or need to develop complex breeding or selection objectives aimed at developing populations better-adapted to a range of nutritional conditions. However, these are preliminary results and must be treated cautiously, because they have yet to be consolidated with foliar sampling data, and a closer investigation of site-fertilizer relationships and edaphic conditions in relation to the growth of families.

The analyses in Table 4 indicate significant differences among families for growth in all trials. The differences are substantial as shown by the range of means for d.b.h. and height. Variance among these full-sib families at each site was generally substantially greater than that for entries in the open-pollinated trials on comparable sites at the same age, despite the much narrower range of parents and the different family structure involved in the full-sib study. Therefore, there appears to be ample opportunity for effective selection for growth among full-sib families in Pch.

The less productive sites, Elliott River and Tuan, constricted the range of entry means (Table 4), with the result that they discriminated less clearly among families for d.b.h. relative to the three more productive sites. This relative lack of discrimination was less distinct for height, however. In contrast to the lack of family-fertilizer interactions, these changes in the ranges of means are indicative of family-site interactions.

Across sites

Open-pollinated progeny study

Estimates of the components of variance for sites, entries, and entry-site interactions for several subsets of entries and sites are presented in Table 5. Apart from those for sites, the estimates are generally greater than twice their standard errors, suggesting that they are adequately precise. The component for entries is significantly different from zero for all traits in all four subsets, indicating the existence of substantial genetic variance among half-sib families on average across sites. The component for sites shows much the same pattern, but is much larger than that for entries, although it is imprecisely estimated. Notable is the substantial variation in stem straightness across sites, despite a standard procedure of assessment.

The entry-site interaction component is significantly different from zero in all four subsets for d.b.h. and volume, in one subset for height and in two subsets for stem straightness (Table 5). Therefore, the evidence from these trials is that family-site interactions among open-pollinated families are occurring for both growth and form. However, the size of these interactions, expressed as a ratio of components in Table 5, is small in relation to differences among families on average across sites. The proportions in Table 5 indicate that the interaction component is usually less than 30 per cent of the entry component for d.b.h., height and stem straightness and around 50 per cent for volume, apart from subset III for height.

These data imply that family-site interactions are not a dominant feature of differences in the patterns of response of families across sites and the ranking of families for performance should be reasonably consistent across sites. The correlations between selected pairs of sites in Table 6 confirm this. For pairs of Queensland trials, these are generally strong and positive. For d.b.h. and stem straightness all are greater than 0.5, while for volume only 3 correlations fall below this level. Correlations for height are more variable, with relatively weaker associations between trials at southern sites (Elliott River and Tuan) and trials at northern sites (Cardwell and Byfield). The relatively large ratio of variance components for height in subset III of Table 5 reflects this also. Although the reason for higher interaction in this subset of sites is unclear from these results because only a subset of trials shows the lack of association, it appears that the weakest correlations for height are associated with largest differences in site productivity measured by height growth. However, level of site productivity appears too broad a criterion for classifying the interactive behaviour of families and sites because some correlations in Table 6 are stronger than expected on this basis. Furthermore, the interpretation of the correlations in Table 6 is complicated by the different number of entries in each trial. Values of rank correlations for all traits generally paralleled the interclass correlations in Table 6. However, the overall levels of correlation among sites do not preclude substantial re-ranking of particular entries across sites. Although this aspect requires detailed investigation, it is not considered further here.

Of additional interest are the correlations between trials in Queensland, the Northern Territory and Fiji in Table 6. These are all positive, and generally reflect the magnitude of correlations among the Queensland trials. The correlations with the Fiji trial in particular are comparable for d.b.h. and volume, and only slightly reduced for height. As was indicated by Nikles et al. (1978), family-site interactions at 4½ years of age were not sufficient to negate the benefits of transferring Queensland material to Fiji. Subsequent results at age 6 years for the Fiji trial (Wilcox, unpublished data) confirm this. The correlations in Table 6 imply in addition that the better material in Queensland should also perform best in Fiji. The lower correlation for height between the Queensland and Fijian trials indicates greater reactivity in the ranking of families for height growth across sites compared with d.b.h. and volume and parallels results from the Queensland trials alone. Further investigation of these data is needed before any substantial reasons for this can be advanced.

Full-sib progeny study

Estimates of the components of variance for sites, entries, and entry-site interactions for two subsets of entries and sites for d.b.h., height and volume are presented in Table 7. The standard errors of the components for entries and entry-site interactions are small in relation to the estimates indicating that these components are precisely estimated, and both components are significantly different from zero for all three traits in both subsets. Therefore, substantial genetic variance among full-sib families is expressed on average across sites, and the occurrence of family-site interactions is also indicated. However, the variance attributable to the latter as a proportion of the variance among entries is generally less than one-half. This implies that family-site interactions are not disruptive in the ranking of families across sites. The correlations in Table 8 strengthen this suggestion with generally strong associations for growth across sites. Thus these results parallel those for the open-pollinated study.

Two aspects require comment in comparing the results presented here for the open-pollinated and full-sib progeny studies. Firstly, their entries differ in genetic structure. More genetic differences are present within open-pollinated families, and this may result in greater divergence of performance of individual genotypes and condition more genotype-site interactions within families than for full-sib families. Therefore, performance at the open-pollinated family level has greater potential for both diversity of genotypic performance and populational buffering through averaging of the performance of individual genotypes within families. This should reduce family-site interactions more in open-pollinated families than in full-sib families. This contention is difficult to establish from data presented here, but preliminary comparison of 4½ year results from both studies suggests that family-site interaction variances are larger for the full-sib study. However, further investigation is required to consolidate this point.

Secondly, the genetic diversity of entries in the full-sib study is more limited because they relate to a total of only 20 select parents with 10 of these involved in over 80 per cent of the entries, whereas the entries in the open-pollinated study are much more diverse in origin. Presumably this restriction of diversity in the full-sib study will govern the extent of differences in performance among full-sib families, and particularly differences in their patterns of performance across sites. Because the assessment of family-site interactions is both family- and site-specific, such restriction of the genetic diversity of families may limit the extent of family-site interactions in the full-sib study.

Table 5. Components of variance and their standard errors for sites, entries and entry-site interactions for growth and form traits at 7½ years for a series of open-pollinated progeny trials, estimated for different subsets of entries and sites: (i) Subset I - 33 entries across trials CRB, CSB and BRB; (ii) Subset II - 23 entries across trials CRB, CSB, BRB and ERR; (iii) Subset III - 21 entries across trials CRA, CSA, BRA and ERR; (iv) Subset IV - 20 entries across trials ERR and TUS.

Subset	Source of variation	Variance components			
		d.b.h. (cm)	height (m)	volume (m^3) (component x 10^3)	straightness (score 1-5)
I	Sites (S)	7.777 ± 5.595***	2.225 ± 1.676***	1.113 ± 0.808***	0.157 ± 0.113***
	Entries (E)	0.545 ± 0.158***	0.111 ± 0.035***	0.071 ± 0.021***	0.030 ± 0.008***
	Entries x Sites	0.109 ± 0.055**	0.018 ± 0.016	0.023 ± 0.010***	0.002 ± 0.003
	E x S/E (%)	20.0	16.2	32.4	6.7
II	Sites (S)	6.858 ± 4.408***	3.572 ± 2.329***	1.161 ± 0.748***	0.210 ± 0.136***
	Entries (E)	0.599 ± 0.194***	0.104 ± 0.035***	0.064 ± 0.023***	0.023 ± 0.008***
	Entries x Sites	0.113 ± 0.051**	0.007 ± 0.013	0.024 ± 0.008***	0.006 ± 0.003**
	E x S/E (%)	18.9	6.7	37.5	26.1
III	Sites (S)	6.718 ± 4.410***	4.640 ± 3.103***	1.356 ± 0.885***	0.456 ± 0.291***
	Entries (E)	0.567 ± 0.197***	0.085 ± 0.035***	0.078 ± 0.029***	0.045 ± 0.016***
	Entries x Sites	0.158 ± 0.062***	0.061 ± 0.021***	0.040 ± 0.013***	0.012 ± 0.004***
	E x S/E (%)	27.9	71.8	51.3	26.7
IV	Sites (S)	0.763 ± 0.702**	1.583 ± 1.334***	0.162 ± 0.141**	0.001 ± 0.002
	Entries (E)	0.312 ± 0.139**	0.052 ± 0.026**	0.017 ± 0.009**	0.038 ± 0.013***
	Entries x Sites	0.102 ± 0.076*	0.016 ± 0.017	0.010 ± 0.006**	0.002 ± 0.003
	E x S/E (%)	32.7	30.8	58.8	5.3

Table 6. Pairwise interclass correlation coefficients for d.b.h., height, volume and stem straightness among 10 open-pollinated progeny trials (eight in Queensland aged 7½ years, one at Humpty Doo, Northern Territory (HTD) aged 6½ years, and one at Nausori Highlands, Fiji (FIJ) aged 6 years), based on the subset of entries common to each pair of trials for all pairs with more than 10 entries in common.

Trials/1	Number of entries	Correlation coefficient			
		d.b.h.	height	volume	straightness
CRA and CSA	24	0.82***	0.73***	0.78***	0.74***
CRA and BRA	24	0.80***	0.54***	0.75***	0.56***
CRA and ERR	21	0.59**	0.03	0.41	0.66**
CRA and TUS	14	0.67**	0.43	0.57*	0.51
CRB and CSB	34	0.69***	0.64***	0.71***	0.72***
CRB and BRB	33	0.60***	0.52***	0.59***	0.71***
CRB and ERR	24	0.73***	0.70***	0.73***	0.57**
CRB and TUS	12	0.79**	0.48	0.69*	0.68*
CSA and BRA	24	0.72***	0.72***	0.69***	0.70***
CSA and ERR	21	0.53*	0.40	0.39	0.68***
CSA and TUS	14	0.65*	0.55*	0.64*	0.56*
CSB and BRB	33	0.63***	0.46*	0.60***	0.62***
CSB and ERR	24	0.76***	0.63***	0.75***	0.50*
CSB and TUS	12	0.78**	0.52	0.72**	0.61*
BRA and ERR	23	0.58**	0.29	0.54**	0.66***
BRA and TUS	14	0.66*	0.19	0.53	0.73**
BRB and ERR	32	0.53**	0.39*	0.53**	0.49**
BRB and TUS	11	0.63*	0.17	0.47	0.64*
ERR and TUS	20	0.56*	0.50*	0.50*	0.80***
CRA and HTD	11	-	-	0.32	-
CRB and HTD	20	-	-	0.50*	-
CSA and HTD	11	-	-	0.39	-
CSB and HTD	20	-	-	0.62**	-
BRA and HTD	13	-	-	0.22	-
BRB and HTD	29	-	-	0.54**	-
ERR and HTD	29	-	-	0.37*	-
TUS and HTD	11	-	-	0.48	-
CRB and FIJ	23	0.63**	0.36	0.57**	-
CSB and FIJ	23	0.61**	0.33	0.56**	-
BRB and FIJ	29	0.58***	0.34	0.56**	-
ERR and FIJ	24	0.42*	0.17	0.30	-
HTD and FIJ	23	-	-	0.62**	-

/1 Mnemonic identifiers for trials as given in Table 1.

Evaluation of provenances of Pch over a similar range of sites (Eisemann, Nikles and Newton 1980) gave results comparable with those given here. There was little evidence of provenance-fertilizer interactions, and although provenance-site interactions occurred for growth at 5½ years of age, these were small in magnitude relative to variation among provenances on average across sites, paralleling results obtained here for open-pollinated and full-sib families.

CONCLUSIONS AND IMPLICATIONS

The general indications from these studies are that family-environmental interactions, although identifiable, are not a critical influence on the growth of Pch. This implies that families relatively well-adapted to a broad range of sites and/or cultural conditions can be identified in both open-pollinated and full-sib studies.

Although these are preliminary findings and may alter somewhat in the light of further information from analyses yet to be done and additional data from subsequent investigations, some implications are as follows:

(a) Family-environment interactions do not appear important enough to warrant any subdivision into breeding or seed production zones, given a breeding strategy aimed at producing an improved synthetic variety from general combining ability orchards for the establishment of plantations. Use of such a bulk variety would also be expected to negate interactions through populational buffering enhanced beyond that of individual families, so that the influence of interactions would be minimized.

(b) The extent of family-environmental interactions, at least for open-pollinated families, does not preclude local and international exchanges of genetic material as a useful breeding technique for upgrading local programmes.

(c) No clear indication of an appropriate testing strategy in relation to the selection of test environments is yet apparent. More productive sites generally give better resolution of family differences, but multi-site testing is required to elucidate patterns of performance where interactions occur.

(d) These investigations do not indicate unequivocally a desirable pattern of response for families under varying environmental conditions. Because family-environmental interactions occur, several options which exploit patterns of family response differently are available both for development of the breeding population and commercial seed production. These differ in the use they make of populational buffering in responding to environmental change. For example, seed production may involve general combining ability orchards composed of broadly-adapted clones, diversion of seed of particular families to specified sites or orchards specifically producing seed for particular sites.

(e) Further work is necessary to determine the role of family-environmental interactions at later age and to consolidate the current investigation. In particular, examination of further sets of families over the broadest possible range of sites and determination of the influence of interactions on the form and quality of trees is required. Further studies along these lines are already in progress.

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Table 7. Components of variance and their standard errors for sites, entries and entry-site interactions for d.b.h., height and volume at 4½ years for a series of five full-sib progeny trials, estimated for different subsets of entries and sites: (i) Subset I - 35 entries common to all trials; (ii) Subset II - 48 entries across trials CR, CS and BR.

Subset	Source of variation	Variance components		
		d.b.h. (cm)	height (m)	volume (m^3) (component x 10^3)
I	Sites (S)	6.602 ± 3.880***	1.962 ± 1.162***	0.229 ± 0.134***
	Entries (E)	0.591 ± 0.149***	0.146 ± 0.037***	0.014 ± 0.004***
	Entries x Sites	0.139 ± 0.024***	0.040 ± 0.007***	0.008 ± 0.001***
	E x S/E (%)	23.5	27.4	57.1
II	Sites (S)	6.119 ± 5.069***	1.088 ± 0.805***	0.254 ± 0.182***
	Entries (E)	0.806 ± 0.174***	0.176 ± 0.039***	0.025 ± 0.006***
	Entries x Sites	0.099 ± 0.024***	0.033 ± 0.008***	0.006 ± 0.001***
	E x S/E (%)	12.3	18.8	24.0

Table 8. Pairwise interclass correlation coefficients for d.b.h., height and volume at 4½ years among five full-sib progeny trials in coastal Queensland, based on the set of 35 entries common to all trials

Trial[1]	CS	BR	ER	TS
CR	0.91[2] 0.89 0.93	0.80 0.74 0.78	0.72 0.75 0.69	0.75 0.81 0.71
CS		0.83 0.65 0.82	0.78 0.79 0.71	0.78 0.80 0.71
BR			0.74 0.59 0.70	0.79 0.64 0.70
ER				0.80 0.81 0.76

[1] Mnemonic identifiers for trials as given in Table 2

[2] Correlation coefficients in the order d.b.h., height and volume; all coefficients significant at the 0.001 level

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TESTES DE PROCEDÊNCIAS DE *Pinus caribaea* MORELET, EM BELIZE

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ENGLAND

Resumo

Dez procedências/variedades geográficas de *Pinus caribaea Morelet*, incluindo testemunhas locais, foram plantadas em ensaios com repetições em duas localidades, no ano de 1975 (uma localidade contém, também, uma variedade australiana melhorada). A sobrevivência avaliada em 1980, variou de 63 a 97% em um local e de 78 a 93% em outro. Os dados equivalentes de altura média variaram de 1,36 a 2,30 m, e 3,50 a 5,28 m, nas respectivas localidades.

As tendências ainda não são definidas, e é possível que a ampla variação inter e intra procedência, na altura das plantas, no estágio inicial das plantações, pode ter mascarado qualquer tendência que o comportamento posterior poderia ter mostrado.

A continuidade dos experimentos é necessária para se saber se tais tendências tornar-se-ão mais evidentes.

Pinus caribaea MORELET PROVENANCE TRIALS IN BELIZE

Summary

Ten provenances/geographic varieties of Pinus caribaea Morelet including local controls were planted in replicated trials on two sites in 1975 (one site also contained an Australian improved variety). Survival as measured in 1980 varied from 63 to 97% at one site and 78 to 93% at the other. Equivalent mean height figures varied from 1.36 to 2.30 m and 3.50 to 5.28 m at the respective sites.

Trends are by no means clear and it is possible that the wide inter- and intra- provenance range of seedling heights at the initial plantation stage may have masked any tendencies which subsequent performance could have shown. A continuation of the trial is therefore necessary in order for such tendencies to become more evident.

TESTS DE PROVENANCE DE *Pinus caribaea* MORELET À BELIZE

Resume

Au cours d'essais avec répétition, on a planté sept provenances de Cordia alliodora (RUIZ et PAVEN) CHAM., sur 2 parcelles. Sur l'une des parcelles on a obtenu un % de survivants de 47 à 84 %, et sur l'autre de 43 à 69 %. Les mesures en hauteur 12 mois après la plantation atteignaient respectivement de 0,61 à 0,90 m, et 0,55 à 0,81 mètres.

La provenance Honduras a eu une meilleure croissance dans l'un des sites seulement, alors que les 2 provenances Nicaraguan ont présenté un % élevé de survivants sur les 2 parcelles.

Introduction

Pinus caribaea Morelet occurs naturally in parts of Central America and certain Caribbean islands, having a latitudinal range from 27° 25' N in the northern Bahamas to 12° 13' N near Bluefields on the Atlantic coast of Nicaragua and a longitudinal range from 71° 40' W on Caicos Islands to 89° 25' W at Poptun in Guatemala.

Three varieties of Pinus caribaea Morelet are now recognised. In the northern part of its range, in the Bahamas and Caicos islands, Pinus caribaea var bahamensis is the variety occurring. In western Cuba and the nearby Isle of Pines P. caribaea var caribaea, the typical variety, is found; and in mainland Central America and the nearby island of Guanaja it is classified as Pinus caribaea var hondurensis.

In Belize, Pinus caribaea var hondurensis is found naturally occurring in two zones. In the coastal plain where before exploitation and the 1961 hurricane the total area of high and medium quality sites was estimated not to exceed 310 Km² (Lamb, 1973), pine occurs on alluvial sands and gravels as isolated pine stands and pine savanna interspersed with belts of hardwood forest. On Mountain Pine Ridge where the total area of pine forest is about 647 Km² Pinus caribaea var hondurensis occurs together with Pinus oocarpa Schiede on granite - derived soils, of which the most widespread is classified as Pinol coarse sandy clay loam (Wright et al. 1959).

Considerable interest in Pinus caribaea as an exotic plantation species as a result of promise in earlier trials has been shown by various countries; in Queensland, Australia, for example plots of Mountain Pine Ridge origin var hondurensis established soon after 1947 gave sufficiently good results for provenance trials of a wider species range to be initiated in 1955 (Nikles 1972).

In 1971 the FAO Panel of Experts on Forest Gene Resources listed P. caribaea as being one of the species of first priority for reconnais-

Table 1. Details of *Pinus caribaea* provenances

Local ident. No.	Seed lot No. (CFI number)	Country	Provenance	Latitude	Longitude	Altitude (m)	Mean annual precipitation (mm)
BZ-48	BR 20	Australia	Queensland improved	23°S	150°30'E	30	1700
BZ-54	BZE-54	Belize	Mountain Pine Ridge	17°N	89°W	500	1631
BZ-64	15/74 (K107)	Belize	Melinda Forest Reserve	17°05'N	88°20'W	10	2256
BZ-65	16/74 (K108)	Belize	Silver Creek	16°40'N	88°25'W	30-100	2297
BZ-66	17/74 (K109)	Belize	Las Lomitas	16°30'N	88°35'W	30	2398
BZ-67	69 7296	Bahamas	*	24°30'N	78°20'W	3	1665
BZ-68	59 7291	Cuba	Cajalbana	22°30'N	83°30'W	*	1523
BZ-69	37/71 (K57)	Honduras	Culmi	15°08'N	85°37'W	500-600	1325
BZ-70	28/70 (K24)	Honduras	Guanaja Island	16°27'N	85°54'W	50-100	2300
BZ-71	29/70 (K25)	Guatemala	Poptun	16°20'N	89°25'W	500	1600
BZ-72	6/74 (K106)	Nicaragua	Alamicamba	13°34'N	84°17'W	25	2900

* not recorded

ance and collection and the Commonwealth Forestry Institute, Oxford assumed responsibility for a programme of range-wide provenance seed collections. Leading on from these collections a series of international provenance trials has been initiated by the CFI in cooperation with various countries including Belize, in order to give more precise information on the performance of the species both within and outside its natural range.

This paper describes progress and performance up to date of two replicated provenance trials established in Belize in 1975, one at Mountain Pine Ridge, and the other at Melinda Forest Reserve, in the coastal plain.

Provenances

Details of the provenances and geographic varieties are given in Table 1. One of the provenances is of Mountain Pine Ridge origin and another of Melinda Forest Reserve (coastal plain) origin; both were included for comparison.

Nursery trial sites and experimental design

Seeds were sown at the beginning of the dry season (January and February) in lines spaced 5 cm. apart in beds, and covered lightly with sandy pine soil. Beds were shaded. Three weeks after sowing seedlings

Table 2. Details of *Pinus caribaea* provenance trial sites

	Trial site AE-12	Trial site MR-62
Location:	Mountain Pine Ridge	Melinda Forest Reserve
Latitude:	17° 01' N	17° 01' N
Longitude:	88° 56' W	88° 20' W
Altitude:	530 m	10 m
Site conditions:	Previously natural *Pinus caribaea*, burnt in 1974. Exposed flat ridge top.	*Pinus caribaea* forest and orchard savanna (broken pine ridge) burnt in May 1975 5% slope from SW-NE.
Soil:	Pinol sandy clay (52H) (Wright, 1959) humus destroyed by burning.	Puletan laomy sand and Silkgrass silty clay (Wright, 1959). Humus destroyed by burning.
Mean annual precipitation:	1631 mm.	2256 mm.

Table 3. Monthly rainfall distribution

	J	F	M	A	M	J	J	A	S	O	N	D	Total
Site AE-12 (Mountain Pine Ridge)	117	43	67	72	81	172	143	149	244	237	210	96	1631
Site MR-62 (Melinda)	142	77	45	67	111	277	248	284	202	239	253	146	2148

were transplanted into polythene pots measuring 15 cm. by 11.5 cm. (when full) which were filled with loamy clay topsoil and shaded. Seedlings were root pruned and hardened by the end of the nursery period. Watering was carried out daily and no fertilizers were applied.

Replicated trials were planted in September (MR-62) and November (AE-12) 1975 on two sites, details of which are given in Table 2. Mean monthly rainfall figures are given in Table 3.

Randomized block designs were used in both trials. At Melinda (trial MR-62) eleven provenances are replicated five times, each plot containing 49 (7 x 7) trees at 2.44 m spacing. At Mountain Pine Ridge (trial AE-12) ten provenances are replicated four times each plot containing 49 (7 x 7) trees at 2.44 m spacing.

Maintenance and assessment

Cleaning was carried out in February 1976, September 1976, August 1977 and May 1980 at the Melinda site and in March 1978 and June 1980 at the poorer Mountain Pine Ridge site.

Assessments were carried out in March 1976, March 1977 and May 1980 for trial AE-12 (Mountain Pine Ridge) and October 1975, October 1976, September 1977 and June 1980 for MR-62 (Melinda Forest Reserve).

Results

Measurements of height growth and mortality are summarized in Table 4.

Assessments of these results is complicated by the wide range in seedling heights (both inter- and intra- provenance) shown at the time of planting out. For instance at the time of first measurement of trial MR-62 (Melinda Forest Reserve) one month after planting out, mean provenance heights (table 4B) varied from 13 cm. (Bahamas) to 27 cm. (Australia). Intra-provenance seedling heights moreover ranged from 5 cm. to 43 cm. (provenance BZ-65, replicate E) and this is by no means an isolated example. Data for trial AE-12 is lacking in this respect as no measurements were carried out until after 12 months in the field; however the indications from first measurements are that a similar situation also existed here.

Table 4. Height growth and mortality, *Pinus caribaea* Morelet
Provenance trials at two sites, Belize

A. Mountain Pine Ridge (Trial no. AE-12)

Local ident. number	Seed lot no. (CFI number) Country of origin	Mean height (m)			Mean survival (% of original planted)		
		1976	1977	1980	1976	1977	1980
BZ-54	BZ-54 Belize	0.22	0.60	2.00	79	65	63
BZ-64	15/74 (K107) Belize	0.22	0.56	1.90	86	84	82
BZ-65	16/74 (K108) Belize	0.30	0.65	1.97	99	96	89
BZ-66	17/74 (K109) Belize	0.23	0.59	1.88	83	82	77
BZ-67	69 7296 Bahamas	0.13	0.51	1.63	83	80	80
BZ-68	59 7291 Cuba	0.10	0.38	1.36	98	91	91
BZ-69	37/71 (K67) Honduras	0.25	0.58	1.81	100	89	87
BZ-70	28/70 (K24) Honduras	0.25	0.72	2.25	99	99	97
BZ-71	29/70 (K25) Guatemala	0.27	0.70	2.12	93	92	89
BZ-72	6/74 (K106) Nicaragua	0.37	0.81	2.30	85	85	85

B. Melinda Forest Reserve (Trial no. MR-62)

Local ident. number	Seed lot no. (CFI number) Country of origin	Mean height (m)				Mean survival (% of original planted)			
		1975	1976	1977	1980	1975	1976	1977	1980
BZ-48	BR 20 Australia	0.27	0.89	1.86	4.89	100	98	97	93
BZ-54	BZ-54 Belize	0.26	0.99	2.04	5.28	100	98	96	89
BZ-64	15/74 (K107) Belize	0.19	0.72	1.68	4.62	99	98	96	84
BZ-65	16/74 (K108) Belize	0.23	0.79	1.65	4.57	99	96	95	89
BZ-66	17/74 (K109) Belize	0.22	0.85	1.89	5.10	98	96	93	89
BZ-67	69 7296 Bahamas	0.13	0.62	1.46	3.96	100	96	94	87
BZ-68	59 7291 Cuba	0.15	0.73	1.43	3.50	99	90	89	78
BZ-69	37/71 (K57) Honduras	0.23	0.80	1.68	4.30	99	95	94	82
BZ-70	28/70 (K24) Honduras	0.21	0.75	1.62	4.65	99	95	93	84
BZ-71	29/70 (K25) Guatemala	0.24	0.91	1.86	4.55	100	97	96	91
BZ-72	6/74 (K106) Nicaragua	0.19	0.82	1.89	4.90	99	96	95	87

Without knowing what precise effect this wide variation in seedling initial height caused to mortality and height growth it would be misleading to take 1980 height and survival figures in Table 4 at their face value.

In the Mountain Pine Ridge trial (no. AK-12) for instance the Mountain Pine Ridge provenance (BZ-84) appears to have the lowest survival of all provenances and even height growth is not apparently as good as for Honduras (BZ-70), Guatemala (BZ-71), or Nicaragua (BZ-72). Cuba (BZ-08) and Bahamas (BZ-67) have low height growth but initial seedling heights were also low, judging by the 1976 mean heights.

Similarly in the Melinda Forest Reserve trial (MR-62) the low height growths of Cuba and Bahamas as measured in 1980 may have been affected by the low initial heights as measured in 1976. The best height growth (and good survival) shown by the Mountain Pine Ridge provenance is also possibly a reflection of its earlier height advantage.

Trends are therefore still unclear and further measurements are required in order to show up tendencies which may have been masked by the unfortunate variation in initial heights.

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ALGUNS PROBLEMAS ESTATÍSTICOS E BIOLÓGICOS ENCONTRADOS NA INTERPRETAÇÃO DE ALGUNS TESTES DE PROCEDÊNCIAS DE *Pinus caribaea*

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Resumo

Sete problemas estatísticos e/ou biológicos, encontrados quando da análise e interpretação de três testes de procedências de *Pinus caribaea,* com repetições, e seis testes sem repetições, instalados na África do Sul são discutidos neste trabalho.

Concluiu-se que para *Pinus caribaea,* nas condições da África do Sul, as correlações com o lugar de origem não deveriam ser interpretadas antes de que uma série de medições, envolvendo vários anos, seja disponível, ou se somente para uma localidade do teste esses dados sejam disponíveis; a interação procedência por blocó, realmente existe, especialmente para altura média, porém os componentes da variância deveriam ser para estimar sua importância real; o erro de amostragem foi o mais importante fator na explicação da variação total das características de crescimento; a interação procedência localidade foi detectada para a altura, mas não para a produção volumétrica; os resultados dos testes de Duncan variam com as características de crescimento, anos de medição, localidades e que somente para a idade de exploração ou a metade da idade de rotação, os testes de Duncan deveriam ser usados para seleção, e que a produção volumétrica total, ou pelo menos o volume da árvore deveria ser empregado nesse trabalho.

No entanto, apesar desses problemas, a análise de regressão múltipla demonstra que é possível a seleção aos 8 anos de idade. Ensaios sem repetições são de valor duvidoso, exceto quando utilizados para seleção de árvores.

Em virtude do tipo de crescimento (sem período de paralisação) do *Pinus caribaea* Morelet, os ensaios deveriam ser medidos na mesma idade, e as características poderiam interagir com as idades das medições.

As propriedades da madeira deveriam ser selecionadas em função das regiões, como conseqüência da forte interação procedência x localidade em todas as propriedades da madeira estudadas, especialmente aquelas ligadas à resistência.

SOME STATISTICAL AND BIOLOGICAL PROBLEMS ENCOUNTERED IN INTERPRETING SOME PROVENANCE TRIALS OF *Pinus caribaea*

Summary

Seven statistical and/or biological problems encountered when analyzing and interpreting three replicated and six unreplicated provenance trials of *P. caribaea* in South Africa are discussed. It is concluded that in the South Africa conditions and for *P. caribaea*, the correlations with place of origin should not be interpreted before several years of measurement are available and if one test site is only available, that provenance by block interactions do exist, especially for average height, but that components of variance should be calculated to estimate their real importance, that sampling error was the most important factor in explaining total variation of growth traits, that provenance by site interaction was detected for height but not for volume production, that Duncan's tests results vary with growth traits, years of measurement and test sites and that only at age of exploitation or at mid rotation, the Duncan's tests (*) should be used for selection and that total volume production or at least tree volume should be used for selection.

However, in spite of these problems, multiple regression analyzes show that selection at age 8 years, is possible. Unreplicated trials are of doubtful value, except as source of single tree selection. Because of the type of growth (without dormancy period) of the Caribbean pine the trials should be measured at the same age and the growth traits may interact with years of measurements.

Wood properties should be selected on a regional basis because of strong site by provenance interactions for all the wood properties studied especially the strength properties.

QUELQUES PROBLÈMES STATISTIQUES ET BIOLOGIQUES RENCONTRÉS DANS L'INTERPRETATION DE QUELQUES TESTS DE PROVENANCES DE *Pinus caribaea*

Resume

En Afrique du Sud, on a examiné 7 problèmes statistiques et/ou biologiques rencontrés lors de l'analyse et de l'interprétation de 3 essais de provenance répétés du *Pinus caribaea* Morelet et de 6 essais non répétés.

On en a conclu que, pour ce qui est des conditions écologiques de l'Afrique du Sud, et pour le *Pinus caribaea* Morelet, aucune interprétation ne peut être envisagée quant aux corrélations avec le lieu d'origine, tant qu'un relevé des mensurations portant sur plusieurs années ne serait pas disponible ; que les erreurs d'échantillonnage expliquaient en grande partie les variations des caractéristiques de croissance ; que l'influence du lieu sur la provenance n'était perceptible que pour la hauteur et non pas pour la production en volume ; que le résultats des tests de DUNCAN variaient selon les caractéristiques de croissance,

(*) In fact, the Duncan's test should, for selection purposes, be abandoned and replaced by some ranking and selection test (Falkenhagen, 1979).

les années de mesurage et les lieux d'essais ; que ces tests ne devraient être utilisés pour la sélection qu'à l'âge d'exploitabilité ou à mi-révolution, et que le volume total de la production ou, tout au moins, le volume par arbre devrait être utilisé pour la sélection.

Malgré ces problèmes, cependant, des analyses multiples de régressions montrent qu'une sélection à l'âge de 8 ans est possible.

Les essais non répétés n'ont pas en soi une grande valeur, sauf comme source de délection d'arbres pris séparément.

Le *Pinus caribaea* ayant un type de croissance particulier (sans période de dormance), les essais devraient être menés à des âges semblables et une action réciproque peut se produire entre les caractéristiques de croissance et les années de mesurage.

Il serait bon de sélectionner les caractéristiques du bois par région, en raison d'une forte influence de la région sur les caractéristiques des bois étudiés, pour chaque provenance, spécialement en ce qui concerne les caractéristiques de résistance.

1. INTRODUCTION.

In 1957, the South African Department of Forestry sponsored an extensive survey of the natural range of *Pinus caribaea* and the collection of seed from 11 populations of this pine as well as from one population of *P. elliottii var. densa* in Florida (USA) and two populations of *P. oocarpa*. These 14 provenances were used to establish three replicated and six unreplicated trials in the Transvaal and Zululand, South Africa, in 1959. The growth of these provenances and the wood properties of three of them at age 16 to 17 years have been studied and reported on recently (Falkenhagen, 1979).

TABLE 1. Name and geographical co-ordinates of the provenances studied.

Abbreviation	Code	Name	Latitude (°,1/100)	Longitude (°,1/100)	Altitude (m)
		(a) *P. caribaea* provenances			
StCr	1	Stann Creek, Br. Honduras*	17,00	88,34	15
SaBa	2	Santa Barbara, Honduras	14,80	88,30	450
MPR	3	Mountain Pine Ridge, Br. Honduras	17,00	88,87	400
Cub	4	Pinar del Río, Cuba	22,22	83,81	350
NProv	5	New Providence, Bahamas	25,04	77,33	6
RPt	6	Riding Point, Grand Bahama	26,67	78,50	6
MPR-R	7	Mountain Pine Ridge (rough cones)	17,00	88,87	400
MPR-S	8	Mountain Pine Ridge (smooth cones)	17,00	88,87	400
Guat	12	Poptun, Guatemala	16,37	89,41	457
Hond	13	Guanaja, Honduras	16,42	85,91	50
Nic	14	Leimos, Nicaragua	14,66	83,79	105
		(b) Other pine species provenances.			
Ooc 1	9	*P. oocarpa* (Honduras)	15,12	88,73	600
Dens	10	*P. elliottii* var. *densa* (USA)	26,50	81,88	10
Ell	11	*P. elliottii* (local seed)	-	-	-
Ooc 2	15	*P. oocarpa* Br. Honduras	17,00	88,87	500

* British Honduras is now known as Belize.

It is proposed here to discuss some biological and statistical problems that I met while I was writing my report.

2. MATERIALS AND METHODS.

The basic data used in this paper come from the publication already mentioned (Falkenhagen, 1979 and from unpublished data and statistical analyzes).

Table 1 presents the name and geographical coordinates of the provenances.

3. RESULTS.

3.1. Instability of the correlations with latitude, longitude and altitude of place of origin of the provenances.

It was clear that the correlation coefficients of the growth traits studied (basically, average height (HT), diameter at breast height (DBH), tree volume, stand volume and total volume production (TVP) changed with year of measurements, with growth traits, sometimes disappearing totally; furthermore, the stability of the coefficients was different according to the trial considered. It was at Wilgeboom in the Eastern Transvaal, that the correlations were the rarest, with, for instance, 1 height significantly correlated out of 8 possible, .i.e. one year presenting a correlation out of 8 years possible, 3 DBH out of 6, etc.

Table II shows, without possible statistical comparisons of the percentages, the proportions of years showing significant correlations for some traits measured. It is obvious that Mpate and Wilgeboon present the most unstable and the least significant coefficients, while, Klein Australië shows significant correlations each year of measurement except for stand volume. There are no ready explanations for this instability, sampling error varying from year to year is not probable because the difficulty of measuring accurately, height, for instance, should increase with age of the stands, and there is no pattern in appearance of the significant correlations; more probably, there is some interaction between years of measurement and provenances. It must be also noted that two other pine species were used to calculate the correlations for Wilgeboom and that the coefficients of correlation must be very large to be significant because of the small number of provenances. Finally, Mpate is the most tropical of the three sites studied and is considered the most suitable for *P. caribaea*.

These interactions have been studied by Maugé, and his associates (1976) in progeny trials of *Pinus pinaster* and their implication for selection outlined.

Thus the type of growth of *P. caribaea* (continuous or without latent or prolonged dormant period, under most ecological conditions) may influence the results of one particular year of measurements.

Finally the coefficients can change in size with time. Therefore, the Caribbean pine should be measured for several years before using the correlation with place of origin and some interaction year of measurement by provenance and provenance by trial should be expected, affecting the size of the correlation-coefficients-although the sign did not change-at least when the number of provenances is not large. What remained stable was the tendency for height, volume, etc. to decline with increasing latitude of place of origin, and to increase with longitude of place of origin at any trial studied.

3.2. Instability of provenance by block interactions.

When plot subsampling existed, many block by provenance interactions were detected for HT and D.B.H. At Mpate these interactions were detected for all years, at Wilgeboon, for some years.

TABLE II. Proportions of the years showing significant correlation coefficients for some traits measured at three trials in South Africa.

	TRIALS		
	MPATE	WILGEBOOM	KLEIN AUSTRALIE
Total number of years of measurement	7	8	7
Degrees of freedom of the coefficient	8	8	6
Height	2/7 = 0,28 coefficients declining	1/8 = 0,125 ——	3/6 = 0.5 coefficients declining.
Diameter	4/6 = 0,667 coefficients increasing	3/6 = 0,5 coefficients declining	6/6 = 1.00coefficients constant
Standing volume	2/3 = 0,667 ——	2/6 = 0,333 ——	0/6 = 0.0 ——
Tree volume	0/6 = 0,000 ——	4/6 = 0,667coefficients constant	6/6 = 1,00coefficients constant
Total volume production	non applicable ——	1/6 = 0,167 ——	5/5 = 1.00 more or less constant.
Average proportion	0,405	0,358	0.700

However, as percentage of the total variance, the interaction effects explained only a small fraction of the total variation: at Wilgeboom it varied between 4 and 23% and was the highest for HT. At Klein Australië, the interaction variances, in percentage of total variance accounted for between 1,3 and 3,3% of the total variation and was therefore negligible. In all three trials, sampling error was always the largest component of variance (80 to 90%). Therefore, the years when tree interactions for HT and DBH existed, the Duncan's tests were slightly biased. Study of the rankings of the provenance on a block basis has shown that the four blocks could be grouped into two sets.

Therefore it seems clear, that in *P. caribaea* height growth can be very sensitive to small micro-enviromental but also to yearly and regional climatic variation. The trial of Wilgeboom (in a intermediate, temperate region) presents the highest interactions.

However, it is doubtful if these interactions, within trial, have practical consequences in a selection program, in South African ecological conditions. But their existence must be kept in mind.

Moreover, the growth pattern of *P. caribaea* should be studied in detail in different ecological regions of its distribution area.

3.3. Instability in the results of the Duncan's tests.

At all three trials, not only the ranking of the provenances changed somewhat from year to year of measurements bur the subsets of non significantly different provenances changed also.

As an example, we can take the evolution of the Duncan's tests with time for average tree height at Mpate (Table III).

You can see the blurring of the distinction between the three varieties except for the variety *caribaea*: Cub remains always the smallest provenance. The change in rank of the bahamensis provenance Rpt (Riding point). As mentioned before, large sampling errors have affected the height measurements throughout the years. Because of the weak or inexistant correlations between average height and DBH, in *P. caribaea* provenances, the ranking in tree volume and stand volume is different from that of the separate traits. The evolution for stand volume after thining at Mpate provides another example (Table IV).

It must be noted that however unstable is HT, HT has less influence on tree volume and stand volume than DBH.

TABLE III. Evolution of the rankings of the provenances and of the Duncan's tests ($\alpha = 0,05$) with time for average height.

Only height before thinning is presented. Ranks in decreasing order of magnitude.

Year	1961	1963	1965	1967	1969	1972	1975
	RPt	MPR-R	MPR-R	MPR	MPR-S	MPR	RPt
	MPR-S	MPR	MPR	MPR-R	MPR	MPR-S	SaBa
	MPR-R	RPt	Nic	MPR-S	MPR-R	Nic	StCr
	Nic	Nic	NProv	StCr	RPt	Hond	MPR
	MPR	NProv	MPR-S	RPt	Nic	SaBa	Hond
	NProv	MPR-S	Hond	Nic	StCr	StCr	Nic
	SaBa	StCr	StCt	NProv	NProv	MPR-R	MPR-R
	StCr	Hond	RPt	Hond	SaBa	Cub	Cub
	Hond	SaBa	SaBa	SaBa	Hond	RPt	MPR-S
	Cub	Cub	Cub	Cub	Cub	NProv	NProv

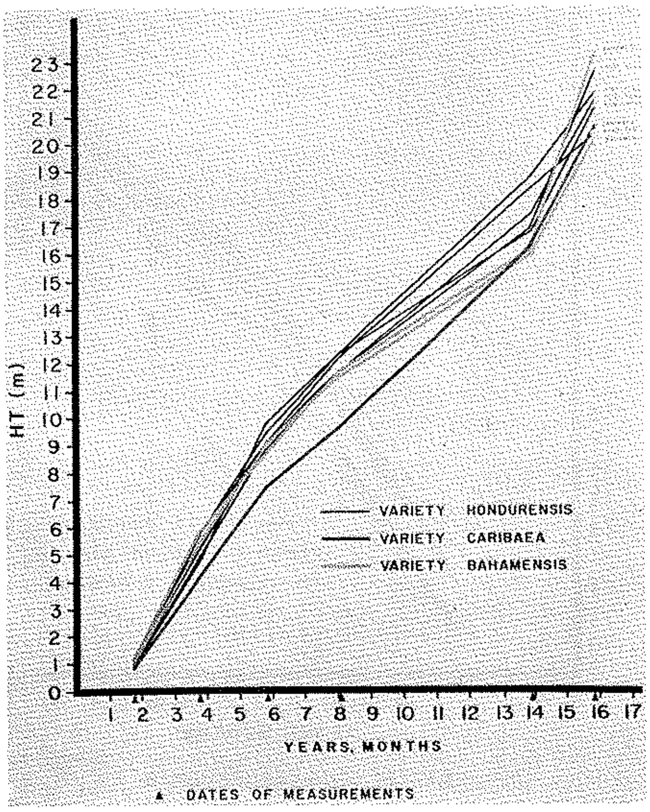

FIGURE 1: Height growth eight provenances of *Pinus caribaea* at Mpate.

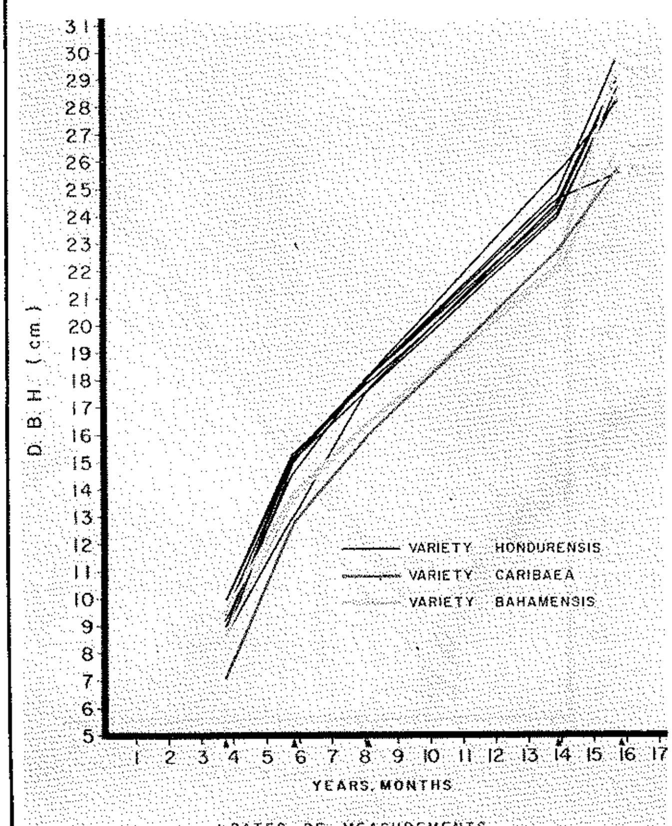

FIGURE 2: Diameter growth of eight provenance of *Pinus caribaea* at Mpate.

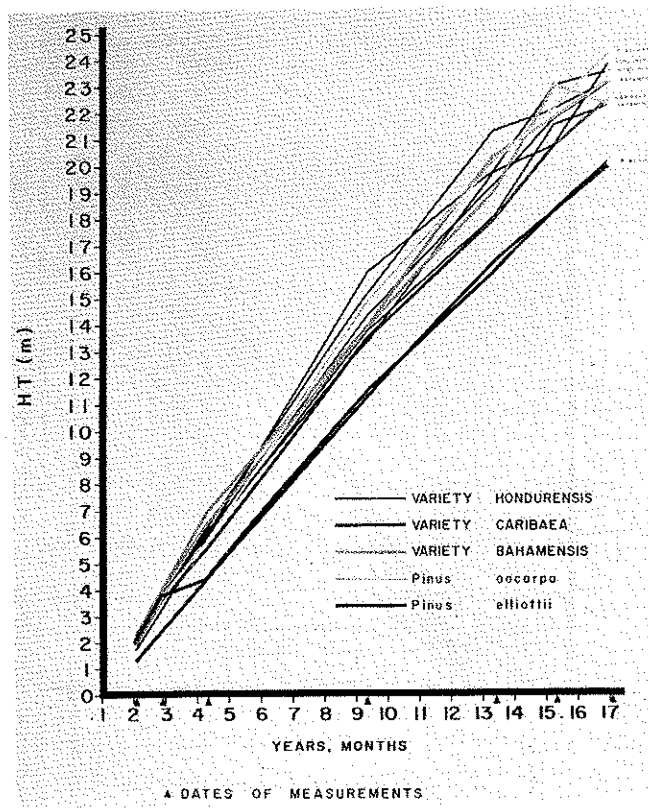

FIGURE 3: Height growth of *Pinus caribaea*, *P. elliottii* and *P. oocarpa* provenance at Wilgeboom.

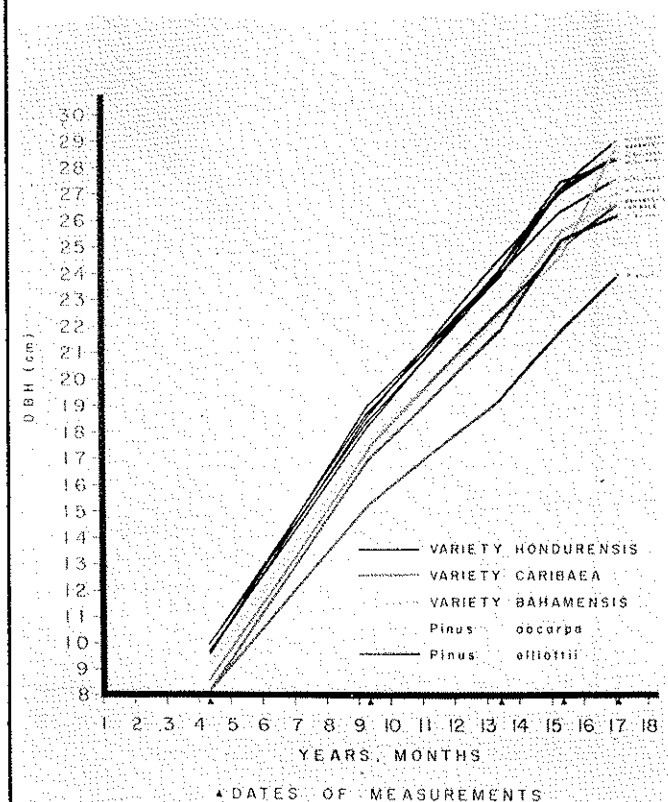

FIGURE 4: Diameter growth of *Pinus caribaea*, *P. elliottii* and *P. oocarpa* provenance at Wilgeboom.

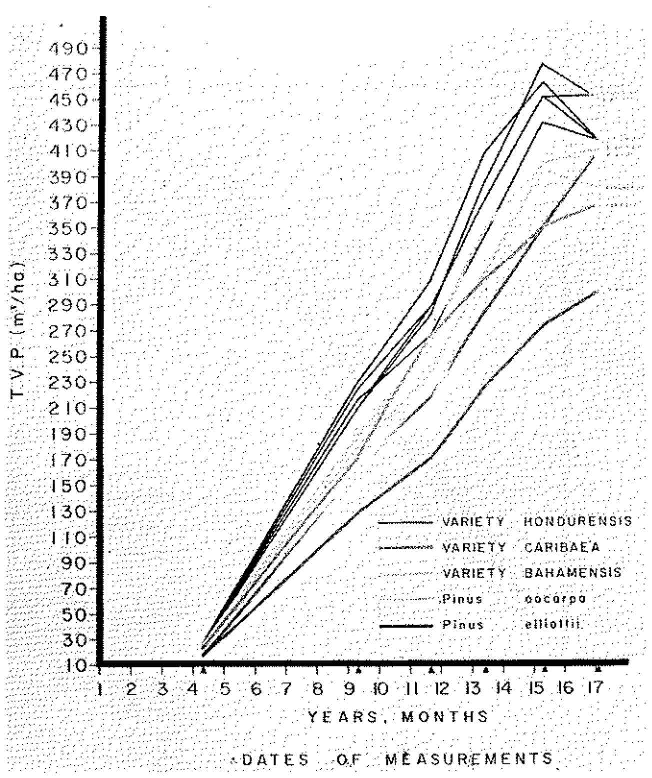

FIGURE 5: Total volume production of *Pinus caribaea*, *P. elliottii* and *P. oocarpa* provenance at Wilgeboom.

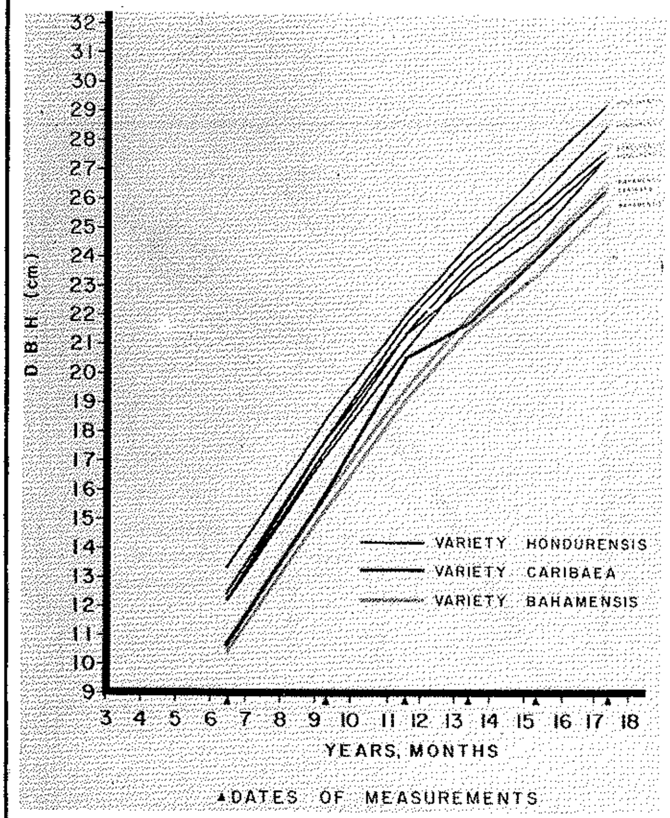

FIGURE 7: Diameter growth of *Pinus caribaea* provenances at Klein Australie.

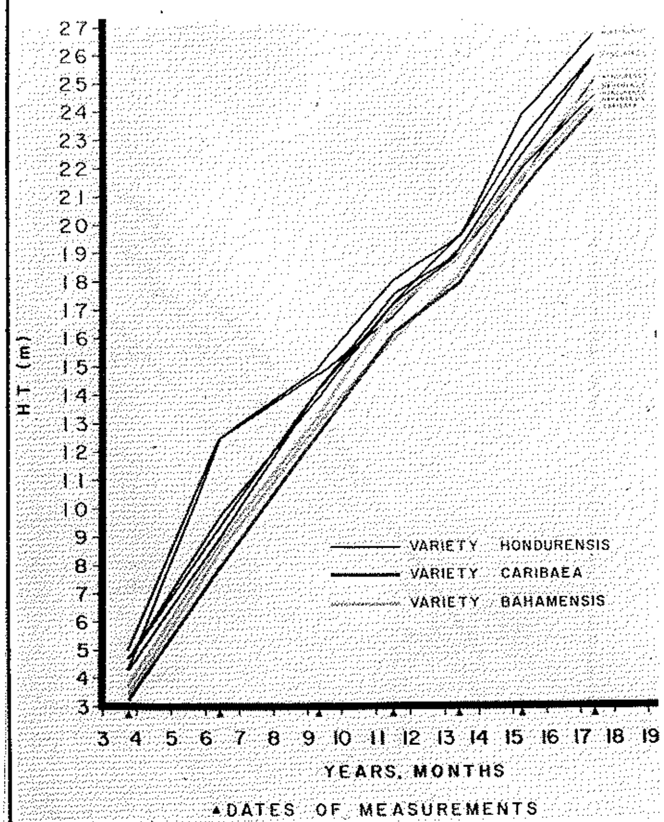

FIGURE 6: Height growth of *Pinus caribaea* provenances at Klein Australie.

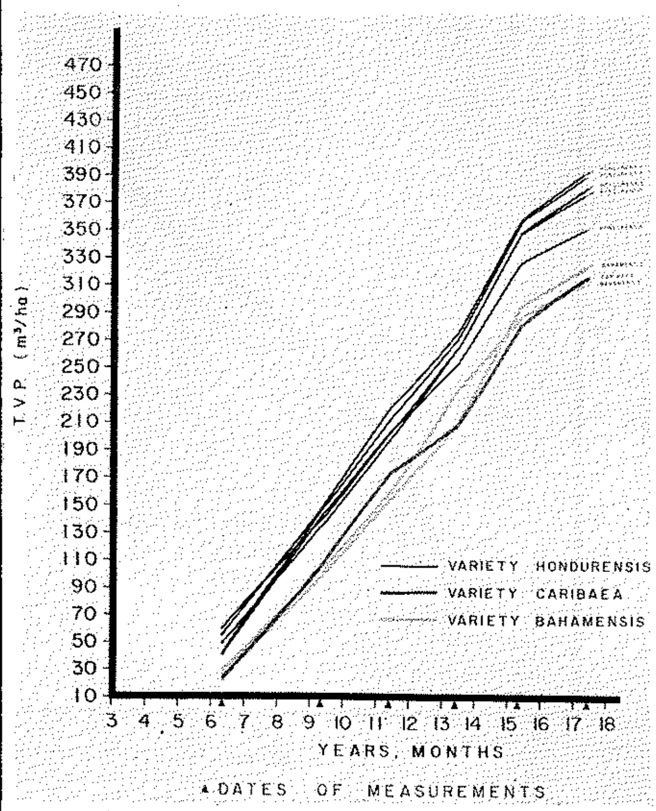

FIGURE 8: Total volume production of *Pinus caribaea* provenance at Klein Australie.

TABLE IV. Evolution of the ranking of the provenances and of the results of the Duncan's tests ($\alpha = 0,05$) with time for stand volume after thinning.

Year	1969	1972	1975
	MPR-S	MPR-S	RPt
	MPR	MPR	SaBa
	StCr	Hond	Hond
	MPR-R	StCr	MPR
	Hond	Nic	Nic
	Nic	SaBa	StCr
	SaBa	MPR-R	MPR-R
	RPt	Cub	NProv
	NProv	NProv	MPR-S
	Cub	RPt	Cub

Thus it is advisable to use average tree volume or better total volume production as criterion for selection. Multiple correlation and regression analysis indicated also that DBH and HT ought to be considered jointly if early selection is to be contemplated.

At Wilgeboom, the rankings for HT changed somewhat for 1961 to 1968, remained fairly stable from 1968 to 1972, changed in 1974 to become more similar in 1976 to those of preceding years. The shortest provenances remained the *P. elliottii* ones. The *P. oocarpa* provenance varied in rank, but stayed mainly in the upper class of provenances. In D.B.H. two groups of provenances could be distinguished: the continental provenances (variety *hondurensis*) with the largest DBH, and the Caribbean islands provenances of *P. caribaea*, indistinguishable from *P. oocarpa* & *elliottii var. densa* provenances, with the smallest D.B.H. The local *P. elliottii* provenance was well separated from the other provenances and always the smallest. In volume production, the distinction of the two groups of provenances was more blurred than for D.B.H. The same picture was true for the Klein Australië trial, but the distinction between the continental and the Caribbean island provenances was more constant that at the other trials. Thus, it can be concluded that, at least in *P. caribaea*, the results of the Duncan's tests can vary from year to year, without apparent stabilization and also somewhat from trial to trial. It is probable that the provenances of *P. caribaea* have their peculiar growth curve but also their rate of growth change with yearly variation in ecological factors and with regional ecological variation. Excluding varying sampling error, and interaction component, the Duncan's tests for one year of measurements, should not be interpreted too rigidly and only late measurements (at 15 - 20 years) should be used for selection although, multiple regression shows that it is possible to select the best provenances at age 8.

3.4. Evolution of a few growth characteristics with time.

In relation with the evolution or instability of the Duncan's tests, the graphical evolution of average HT, D.B.H. and total volume production (TVP) should be considered.

The figures 1, 2, 3, 4, 5, 6, 7, and 8 show this evolution for the three trials. At Mpate only HT and D.B.H. could be plotted. At Mpate, HT shows the most the change in ranking with the variety *bahamensis* first confounded with the provenances of the variety *hondurensis*, to be distinctly shorter from age 9 then to have RPt jumping at age 16 in the first position. Only, Cub (the variety *caribaea*) remained constantly and significantly shorter except in 1975, at age 16. In D.B.H., the contrast between the continental provenances and the Caribbean islands provenances is constant except in 1975 with RPt abnormally large.

At Wilgeboom, in height, only the *P. elliottii* provenances, remained constantly and significantly shorter, with Cub (variety *caribaea*) the shorter of the *P. caribaea* provenances but not significantly so. The *P. oocarpa* provenance remained indistinct from the other provenances of *P. caribaea*. In D.B.H. from age 9, three groups of provenances could be distinguished, more or less statistically, the group of the variety *hondurensis*, the group of the Caribbean islands provenances, of *P. oocarpa* and *P. elliottii var. densa* and the group of one provenance of *P. elliottii* (local seed of South Africa) the first group being the larger.

In total volume production, the same tendency could be seen but statistically, there was much overlap, except for the local *P. elliottii* (Fig. 5).

At Klein Australië, in height, although the relative position of the continental and Caribbean islands provenances remained constant, statistically the two groups overlapped much. In D.B.H. and total volume production the contrast was more striking and constant.

3.5. Use of the unreplicated trials.

The use of the unreplicated trials was disappointing. Is it worth the money and effort to establish and maintain these trials, I don't know. Perhaps not. I tried to analyse them objectively by calculating correlations between average plot values of one replicated trial and single plot values, but because of the very small number of provenances common to the trials, only very high correlation could be detected. Because of lack of replications, no conclusion could be drawn for the trials where there was no correlation detected. Except, as additional source for selection, these trials are of doubtful value.

3.6. Statistical comparison of the three replicated trials.

As *P. caribaea* is a pine with continuous growth, it is absolutely necessary to measure the trials at the same age, in months Except for HT, no significant interaction provenance by trial was detected.

3.7. Statistical study of the wood properties of three selected provenances.

It must be noted that for quasi all the wood properties studied (40 in total) provenance by trial interactions were detected. It was most noticeable for the strength properties, with probably some very important effect. Therefore it seems that the selection of the provenances of *P. caribaea*, in contrast with the growth characteristics, for wood properties, should be done a regional basis. For further details see the publication already mentioned. It is to be noted that probably for pulp and paper properties, interactions exist although no statistical evidence is available.

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FLORESCIMENTO E PRODUÇÃO DE SEMENTES DE *Pinus caribaea* VAR. *hondurensis* (RESULTADOS DE UMA PESQUISA MUNDIAL)

C. M. Gallegos
Central and South American Species
International Paper Company
U. S. A.

Resumo

Os resultados de uma pesquisa mundial em relação ao "florescimento" e produção de *Pinus caribaea* var. *hondurensis*, indicam que as condições ambientais ótimas para o crescimento reprodutivo situa-se entre as latitudes de 9° a 27° N e 9° a 27° S. Exceções a estas hipóteses são aparentemente as altas altitudes entre as latitudes de 18° a 27° N e 18° a 27° S, onde a espécie apresenta florescimento reduzido e pouca ou nenhuma produção de sementes. Em adição, as zonas altas entre as latitudes 9° N e 9° S do equador parecem ter climas que favorecem a produção de sementes viáveis. Abaixo de 27° N e 27° S o crescimento reprodutivo é altamente reduzido, provavelmente devido a modificações abruptas da temperatura e às geadas de inverno.

FLOWERING AND SEED PRODUCTION OF *Pinus caribaea* VAR. *hondurensis* (RESULTS OF A WORLDWIDE SURVEY)

Summary

The results from a worldwide survey concerning the "flowering" and seed production of *Pinus caribaea* var. *hondurensis* indicate that the optimum environmental conditions for reproductive growth of this tree lie between 9° to 27°N latitude and 9° to 27°S latitude. Exceptions to this hypothesis are apparently high elevations between 18° to 27°N latitude and 18° to 27°S latitude where these trees exhibit reduced "flowering" and little or no seed production. In addition, tropical highland zones between 9°N and 9°S of the equator appear to have climates which favor the production of viable seed. Beyond 27°N and 27°S latitude, reproductive growth is greatly reduced, probably due to abrupt temperature changes and winter freezing.

FLORAISON ET PRODUCTION DE GRAINES DE *Pinus caribaea* VAR. *hondurensis* (RÉSULTATS D'UNE RECHERCHE MONDIALE)

Resume

Les résultats d'une étude mondiale entreprise sur la floraison et la production de graines du Pinus caribaea, var. hondurensis, indiquent que les conditions optimum de milieu pour la production de graines, se trouvent dans des zones allant de 9° à 27° de latitude Nord, et de 9° à 27° de latitude Sud.

Des régions montagneuses situées entre 18° et 27° de latitude Sud semblent faire exception à cette hypothèse car on a constaté une diminution de la floraison de ces arbres, ainsi que très peu ou pas de production de graines. De plus, on a remarqué que les zones tropicales d'altitude situées entre 9° Sud et 9° Nord par rapport à l'Equateur, jouissaient de climats favorables à la production de graines viables. Au delà de 27° Nord et 27° Sud, la production de graines est sensiblement réduite; probablement à cause des changements brutaux de température et aux gels de l'hiver.

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

During the International Union of Forest Research Organization (IUFRO) Working Party S2.03.1 meeting, held in Brisbane, Australia, in April, 1977, the importance of *Pinus caribaea* var. *hondurensis* (PCH) as a plantation species in the tropics and subtropics was discussed at great length. The discourse regarding increased utilization of this species also brought to light the difficulties involved in acquiring the amounts of seed needed to establish plantations,

The author would like to express his gratitude to Dr. D. G. Nikles and Dr. J. M. Fielding of the Queensland Department of Forestry, plus Dr. B. J. Zobel and Dr. W. D. Miller of North Carolina State University, for their help in developing the questionnaire used in this study, and for providing the names and addresses of many of the people who supplied the information on which this paper is based.

Table 1. "Flowering" and Seed Production of *Pinus caribaea* var. *hondurensis* for Various Countries in AFRICA.

Country	Presence of Flowering/ Seed Viability	Plantation Age (Yrs)	Climate Type**	Latitude-Longitude	Elevation (m)
D.R. of the Congo	Yes/Yes(?)	7-8	Am (Monsoon Forest)	4°45'S-11°54'E	30
Ivory Coast	Yes/No	7	Am (Evergreen Seasonal Forest)	4°45'N-6°38'E	100
	Yes/No	11-12	Am (Evergreen Seasonal Forest)	5°02'N-4°01'E	25
Kenya	Yes/Yes(?)	21	Am (Monsoon Forest)	4°11'S-39°28'E	394
Nigeria	Yes/Yes	17	Tropical Highlands	9°50'N-8°40'E	1130
	Yes/Yes	10	Aw [Seasonally and Periodically Dry (Savannah)]	10°37'N-7°17'E	600
Rep. of So. Africa	Yes/No	12(S.O.)*	Cwa (Temperate Dry Winter & Hot Summer)	28°21'S-32°19'E	47
Rhodesia	No/No	15	Cwa (Temperate Dry Winter & Hot Summer)	18°40'S-32°50'E	900-1100
	Yes/No	5(S.O.)*	Cwa (Temperate Dry Winter & Hot Summer)	18°41'S-32°55'E	698
	No/No	9	Cwa (Temperate Dry Winter & Hot Summer)	18°40'S-32°40'E	700- 800
	Yes/No	3(S.O.)*	Bsh (Subtropical Steepe)	20°21'S-32°20'E	448
Tanzania	Yes/Yes	15	Am (Monsoon Forest)	6°53'S-38°55'E	80
	Yes/Yes	14-17	Am (Monsoon Forest)	2°01'S-33°03'E	1280
	Yes/No	18-19	Am (Monsoon Forest)	10°07'S-39°12'E	870
	Yes/No	20	Am (Evergreen Seasonal Forest)	2°30'S-32°00'E	1230
Uganda	Yes/Yes	17	Tropical Highlands	0°03'N-32°28'E	1135
Zambia	No/No	17	Am (Monsoon Forest)	12°45'S-28°10'E	1300

* S.O. = Seed Orchard

** After Koppen

plus the apparent lack of flowering and seed production that occurs when PCH is planted as an exotic, particularly in the low latitude tropics (Slee, 1978a and 1978b). Because of this situation, it was agreed at the meeting that the author would distribute a questionnaire to various parties throughout the world, who are engaged in growing Caribbean pine, to determine what environments are most suitable for cone and seed production in this species. The other varieties of this tree (i.e., *Pinus caribaea* var. *bahamensis* and *Pinus caribaea* var *caribaea*) were not included in this study because of the relatively lesser importance of these varieties for plantation establishment.

The natural distribution of PCH extends from 18°04'N latitude in northern Belize to 12°13'N latitude at Blue Fields, Nicaragua (Lamb, 1973). The longitudinal range is from 80°25'W at Poptun, Guatemala, to 89°25'W near Puerto Cabezas, Nicaragua. The altitudinal distribution varies from sea level to 1,000 m in Belize and to somewhat lower altitudes in Honduras and Nicaragua. The northernmost limit of Caribbean pine occurs in Grand Bahama and Great Abaco, where *P. caribaea* var. *bahamensis* (PCB) is found at 27°25'N latitude.

There is a large amount of physiographic variation within the native range of Caribbean pine, and climate varies from tropical and subtropical to tropical highland conditions as a result of this topographic diversity. Therefore, it seems logical that knowledge about the natural distribution of this species, and the environmental occurring within this region, should provide some insight into the climatic requirements for cone and seed production.

METHODS

In February, 1978, and again during July, 1978, the *Pinus caribaea* var. *hondurensis* "Flowering and Seed Production Questionnaire" (Appendix 1) was sent to 75 different parties located in 34 countries throughout the world. Eventually, 68 (88%) responses were received from 32 (94%) countries. Of these, 35 (47%) of the questionnaires that were returned yielded usable information concerning 56 plantations and 5 seed orchards (Tables 1-3).

Appendix 1. *Pinus caribaea* (var. *hondurensis*) "Flowering" and Seed Production Questionnaire. IUFRO Working Party S2.03.1 (Breeding Tropical and Subtropical Species).

1. The Plantation

Name: ________ Latitude: ______ Longitude: ______ Altitude(m): _____

Provenance (source of seeds): ____________ Year Planted: ______

2. The Climate

Type of Climate (check one):

Wet tropical lowlands (Af) *
(rain forest) : _____

Tropical lowlands with short dry season (Am)
(evergreen seasonal forest) : _____

Tropical lowlands with marked dry season (Am)
(monsoon forest) : _____

Seasonal and periodically dry (Aw)
(savannah) : _____

Humid subtropical lowlands (ca) : _____

Tropical highlands : _____

Monthly rainfall distribution (if available):

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Rainfall (mm)													

3. The Seeding

Period of female flower production:

(a) Produced during a particular period? ______ Month: ______
(b) Produced throughout the year? ______
(c) Not known ______

Period of pollen production:

(a) Produced during a particular period? ______ Month: ______
(b) Produced throughout the year? ______
(c) Not known ______

Do cones contain seed? Yes ____ No ____

Seed Viability: (a) Most of seed viable? ____ (b) Most of seed empty? ____
(c) Half of seed empty and half of seed full? ____
(d) Not known ____

Seed Production and Quality for Past Several Years:

Year	Avg. No. Seed Cones Per tree	Avg. No. Seed Cones Per ha.	Avg. No. Seeds/cone	No. Seeds/kg.	Seed Viability (%)	Weight of Seed (kg./ha)
1977						
1976						
1975						
1974						
1973						

Respondent

Name: ________ Signature: ________

Official Title: ________

Organization: ________ Date: ______

Address: ________

____

*Refers to Koeppen Climatic Classification System.

Table 2. *Pinus caribaea* var. *hondurensis* "Flowering" and Seed Production Information for Various Countries and Locations in AUSTRALIA/OCEANIA and ASIA

Country	Presence of Flowering/ Seed Viability	Plantation Age (Yrs.)	Climate Type**	Latitude/ Longitude	Elevation (m)
Australia (1)	Yes/Yes	4-11	Am (Evergreen Seasonal Forest)	18°15'S-146°00'E	7
	Yes/Yes	10-18	Am (Evergreen Seasonal Forest)	22°50'S-150°45'E	50
	Yes/Yes	10-18	Ca (Humid Subtropical Lowlands)	27°00'S-153°00'E	30
Australia (2)	Yes/Yes	12	Am (Monsoon Forest)	12°28'S-131°05'E	60
	Yes/Yes	13	Am (Monsoon Forest)	11°25'S-130°40'E	50
Fiji	Yes/Yes	5-6 (S.O.) *	Am (Monsoon Forest)	17°35'S-177°32'E	35
India	Yes/No	6-10	Cwa (Monsoon with Dry Winter & Hot Summer)	30°19'N-78°02'E	750
Indonesia (East Kalimantan)	Yes/No	1-5	Af (Wet Tropical Lowlands)	0°30'S-117°00E	50
Malaysia	Yes/No	7	Am (Evergreen Seasonal Forest)	5°10'N-116°15'E	350
	Yes/No	17	Am (Evergreen Seasonal Forest)	6°58'N-116°40'E	760
New Zealand	No/No	23	Cfb (Temperate with Cool Long Summer)	35°15'S-174°03'E	492
Papua New Guinea	Yes/Yes	7-8	Tropical Highlands	7°11'S-146°39'E	745
	Yes/Yes	10-11	Tropical Highlands	7°59'S-146°34'E	1333
	Yes/Yes	8-11	Am-Aw [Tropical Monsoon Forest-(Savannah)]	6°08'S-146°11'E	300
Philippines	Yes/No	7-8	Af (Wet Tropical Lowlands)	12°45'N-126°00'E	600
Thailand	Yes/?	7	Tropical Highlands	18°10'N-98°28'E	800
	Yes/Yes	13	Am (Monsoon Forest)	15°15'N-104°53'E	130
	Yes/No	13	Tropical Highlands	18°09'N-98°27'E	1095

* S. O. = Seed Orchard

** After Koppen

Statistical Evaluation

The data which was requested in the questionnaire (Appendix 1) included specific information concerning the quantity of seed production and its quality. However, very few of the individuals who responded were able to provide these facts. Because of this, and the resulting data limitations, it was impossible to derive meaningful results from conventional analysis of variance (ANOVA) regression and correlation analyses procedures. The approach ultimately used to evaluate these data was a one-way analysis of variance between the dependent variables (presence of flowering and seed viability) and the various independent variables including latitude, longitude, elevation, age climate and precipitation, plus time of flowering and pollination. In addition, non-parametric analyses for evaluating distribution-free populations (Snedecor and Chochran, 1972) were used for additional comparisons of these one-way evaluations between the dependent and independent variables.

The final data were analyzed on an IBM 370/158 computer using the Statistical Analysis System (SAS) NPAR1WAY procedure (Blair, et al., 1979). In addition, the SAS CHART procedure was used to develop plotted supplemental comparisions of this information.

RESULTS

Information derived from the one-way ANOVA showed that presence of "flowering" in *Pinus caribaea* var *hondurensis* is closely associated to latitude and elevation. The relation of "flowering" to elevation was found to be significant at the 96.9% level, and this result was borne out by the Chi-square analysis, which was significant at the 95.9% level. The relationship of "flowering" to latitude was slightly lower, being significant at the 93.7% level. However, the Chi-square test showed this association to be significant at the 96.0% level.

Production of viable seed, on the other hand, was found to be more closely linked with the month of the year when "flowering" and pollination occur. The level of significance for viability in relation to the time of female primordia initiation was 98.6% and 96.9% for the time of pollination. The Chi-square tests for the relation of "flowering" and pollination to seed viability were significant respectively at the 97.3% and 92.7% levels.

Examination of the plotted data indicates that, when *P. caribaea* var. *hondurensis* is grown as an exotic , it will "flower," but it will generally not produce viable seeds at low elevations and low latitudes (i.e., between 9°N and 9°S). This condition holds true for the Ivory Coast (Table 1), Indonesia, and Malaysia (Table 2), plus Surinam, French Guiana and Northern Brazil (Table 3). Initial evaluation of data obtained from the Democratic Republic of the Congo, Kenya and Tanzania (Table 1) indicated that these three locations could be exceptions to this hypothesis; however, closer examination of this information revealed that, although seed germination does occur, the production of viable seed is quite low for these three plantations.

The data also show that trees planted at high elevations in the low latitude tropics will produce good quantities of viable seed, which is an exception to the assumption stated above. It should be noted that the locations in Uganda (Table 1) and New Guinea (Table 2), where this phenomenon occurs, are found in Tropical Highland environments. Because of this occurrence, it seems apparent that higher elevations in the tropics have ameliorating effects on climate (notably temperature), which favors the "flowering" and seed production of PCH.

The most favorable latitudes for reproductive growth of PCH appear to lie between 9°N to 27°N and 9°S to 27°S. This theory is apparently borne out by the information obtained for Australia (Table 2), Brazil and Venezuela (Table 3). Furthermore, the natural distribution for PCB extends to 27°25'N latitude, which indicates that beyond this limit in the northern hemisphere reproduction of Caribbean pine is limited by unfavorable climatic conditions.

Apparently higher elevations within 18°S to 27°S latitude and 18°N to 27°N latitude do not have environments that are conducive to seed production. Plantations and seed orchards of PCH in Rhodesia (Table 1), Thailand (Table 2) and Brazil (Table 3) exhibit "flower" production, but little or no viable seed is produced at these higher elevations. It is interesting to note that within the native range, PCH does not occur further north than 18°04'N latitude, which might imply that ambient conditions at higher elevations limit reproduction and thereby the northward dissemination of this variety.

Beyond 27°N and 27°S latitude, "flowering" of PCH is reduced or absent (e.g., India, New Zealand, the Republic of South Africa, and Argentina), and there is apparently no production of viable seed. This phenomenon is comparable to what is observed at the northern limits of the natural distribution of PCB on Grand Bahama (27°25'N latitude), where the northward dispersion of this variety appears to be limited by physical barriers (i.e., the Caribbean Sea) and possibly climatic conditions. In addition, experimental introductions of PCH and *P. caribaea* var. *bahamensis* near Punta Gorda, Florida (27°55'N-82°02'W latitude) have shown that sudden changes in temperature and occasional winter freezing severely limit "flowering" and seed production of the species (Nikles, 1966; Squillace, Nikles and Saylor, 1977).

CONCLUSIONS

Despite the limitations placed on statistical evaluations by the data, there are certain practical deductions which can be derived from this investigation. In terms of seed orchard establishment, it appears that the best conditions for good seed production in *Pinus caribaea* var. *hondurensis* occur at lower elevations (below 800m-900m) at the mid-latitudes (between 9°N-27°N and 9°S-27°S). There are certain indications that in the tropical low latitudes (between 9°N and 9°S), some seed can be produced in orchards that are located at elevations exceeding 900m.

Table 3. The Production of "Flowers" and Seed of *Pinus caribaea* var. *hondurensis* for Various Countries and Locations in LATIN AMERICA

Country	Presence of Flowering/ Seed Viability	Plantation Age (Yrs)	Climate Type**	Latitude/ Longitude	Elevation (m)
Argentina	Yes/No	3-18	Aw (Tropical Savannah)	27°40'S-36°30'W	70
Brazil (1)	Yes/Yes	18	Aw (Tropical Savannah)	21°51'S-47°02'W	600
Brazil (2)	Yes/No	5	Am (Monsoon Forest)	13°00'S-38°30'W	45
Brazil (3)	Yes/?	1-3	Am (Evergreen Seasonal Forest)	12°00'S-38°00'W	60
Brazil (4)	Yes/Yes	7-15 2-3(S.O.)*	Cwa (Monsoon, Dry Winter and Hot Summer)	22°20'S-48°50'W	1070
Brazil (5)	Yes/No	1-8	Af (Rain Forest)	0°40'S-52°33'W	35
Brazil (6)	Yes/Yes	10	Af (Rain Forest)	19°24'S-40°04'W	30
	Yes/No	10	Tropical Highlands	19°37'S-43°13'W	826
Brazil (7)	Yes/Yes	4-8(?)	Ca (Humid Subtropical Lowlands)	27°30'S-48°30'W	50
Brazil (8)	Yes/Yes	17	Cwa (Monsoon with Dry Winter and Hot Summer)	22°22'S-49°44'W	500
	Yes/Yes	17	Cwa (Monsoon w/Dry Winter & Hot Summer)	21°40'S-47°49'W	550
	Yes/Yes	17	Cwa (Monsoon w/Dry Winter & Hot Summer)	22°18'S-47°13'W	600
Costa Rica	Yes/Yes	18	Am (Evergreen Seasonal Forest)	9°53'N-83°38'W	602
French Guiana	Yes/No	8-15	Af (Rain Forest)	5°05'N-55°00'W	10
	Yes/No	11	Af (Rain Forest	4°52'N-52°20'W	30
Puerto Rico	Yes/Yes	12	Ca (Humid Subtropical Lowlands)	18°21'N-67°12'W	150
	Yes/Yes	16	Ca (Humid Subtropical Lowlands)	18°09'N-65°50'W	110
	Yes/Yes	16	Tropical Highlands	18°12'N-66°35'W	820
	Yes/Yes	16	Ca (?)	18°21'N-65°49'W	480
Surinam	Yes/No	6-10	Af (Rain Forest)	5°05'N-55°00'W	200
Trinidad & Tobago	Yes/Yes	13-16	Am (Evergreen Seasonal Forest)	10°02'N-60°30'W	50
	Yes/Yes	13-16	Am (Evergreen Seasonal Forest)	11°21'N-61°56'W	50
Venzuela	Yes/Yes	7-12	Am (Evergreen Seasonal Forest)	9°40'S-63°10'W	90
	Yes/Yes	1-9	Aw (Tropical Savannah)	8°40'S-62°42'W	28
	Yes/?	1-5	Aw (Tropical Savannah)	9°02'S-63°16'W	40

* S.O. = Seed Orchard
** After Koppen

However, the ANOVA and Chi-square tests showed that seed viability is significantly associated with time of "flowering" and pollination. This indicates that climates with distinct seasonal variations favor the production of quality seed, but weather conditions at high elevations in the low latitude tropics are usually quite uniform throughout the year. The data also demonstrate that seed production and viability are generally quite low at higher latitudes (more than 27°N and 27°S). Indications are that, while certain lower elevations may be productive, it would probably not be desirable to establish a PCH seed orchard beyond the 27° latitudinal boundary.

These conclusions are based primarily on climatic variables, and they do not take into account important characteristics such as soil physical properties, soil fertility, level of orchard management and other variables that must be considered in seed orchard establishment. In addition, this work should serve to emphasize the importance of maintaining accurate "flowering" and seed production records plus accurate and continuous weather records. This information is critical not only for the day-to-day management of a seed orchard, but it will also provide an accurate basis for locating future seed orchard sites.

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SITUAÇÃO DO TESTE INTERNACIONAL DE PROCEDÊNCIA DE PROCEDÊNCIAS MEXICANAS DE *Pinus oocarpa*, 1980

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Resumo

Foram distribuídas para 14 países, sementes de procedência mexicana de *Pinus oocarpa* Shiede, visando a instalação do teste internacional de procedência. Esse teste está sob a coordenação conjunta do Instituto Nacional de Investigaciones Forestales, México, e do Commonwealth Forestry Institute, Inglaterra.

STATUS OF THE INTERNATIONAL PROVENANCE TRIAL OF MEXICAN *Pinus oocarpa* PROVENANCES, 1980

Summary

Seed for the international provenance trial of Mexican Pinus oocarpa Schiede provenances was distributed to 14 countries. This trial is under the joint coordination of the Instituto Nacional de Investigaciones Forestales, Mexico, and the Commonwealth Forestry Institute, U.K.

SITUATION DU TEST INTERNATIONAUX DE PROVENANCE DES PROVENANCES MÉXICAINES DE *Pinus oocarpa*, 1980

Resume

Les graines du Pinus oocarpa d'origine mexicaine, destinées aux essais de provenance internationaux, ont été fournies à 14 pays.

L'ensemble des essais est coordonné à la fois par l'INSTITUT NATIONAL DES RECHERCHES FORESTIERES DE MEXICO et par l'INSTITUT FORESTIER DU COMMONWEALTH DU ROYAUME UNI.

INTRODUCTION

The exploration, evaluation and conservation of the genetic resources of Pinus oocarpa Schiede has been assigned first priority status in the Global Programme for Improved Use of Forest Genetic Resources (FAO, 1977). The international provenance trial of Central American P. oocarpa provenances has made a significant contribution to the programme (Kemp, 1972; Greaves and Kemp, 1978; Greaves, 1979; 1980a; 1980b) but this trial is concerned with less than one third of the species' natural latitudinal distribution.

During recent years the Instituto Nacional de Investigaciones Forestales (INIF), Mexico, has made provenance seed collections in the central part of the species' range (FAO, 1977). In 1979 these were distributed for an international provenance trial of Mexican P. oocarpa provenances in which INIF is responsible for coordinating the experiments in Latin America whilst the Commonwealth Forestry Institute (CFI) coordinates the work throughout Africa and Asia.

PROVENANCE SEED COLLECTIONS

Twenty seven P. oocarpa seed collections from sites between latitudes 15° and 21°N were made available by INIF (see Appendix 1). Special attention was given to sampling the stands in Chiapas as it was in this region that Mortenson acquired the fast-growing Jitotil provenance on behalf of the East African Agriculture and Forestry Research Organisation (Greaves and Dyson, 1977).

Four of the most promising Central American provenances were contributed by the CFI so that results from both series of international trials may be compared.

SEED DISTRIBUTION AND EXPERIMENTAL DESIGN

Seed allocations were made to 14 countries (see Appendix II). Each allocation comprised 16 Mexican and 4 Central American provenances.

It was recommended that the individual provenance trials should consist of all 20 provenances laid out in a randomised complete block design with 5 replications. This well-tried and robust design has proved to be very satisfactory for provenance trials of tropical pines. Rectangular lattice designs with six replications were offered as alternatives for trials that were to be established where there was pronounced site variation.

The advised plot size was 49 trees (7 x 7 rows) at 3 m spacing with the outside row used as a boundary and the assessments confined to the inner 25 trees (5 x 5 rows). The wide spacing delays the onset of competition and accentuates differences in crown form. The plot size is sufficient for thinning to be carried out without reducing the number of trees to an unacceptably low level thus prolonging the useful life of the trial.

INTERNATIONAL COOPERATION

Assessment data have not yet been published, but the CFI in cooperation with INIF will collate information as it becomes available on behalf of the international provenance trial collaborators, thus facilitating the rapid evaluation of the provenances.

Appendix I

SEED COLLECTIONS OF MEXICAN PINUS OOCARPA PROVENANCES

Site No.	Collector's No.	Site	Latitude	Longitude	Altitude (m)
PO 91	INIF353	Valle de Bravo	19°14'N	100°07'W	1,870
PO 99	INIF367	La Trinitaria	16°15'N	92°03'W	1,450
PO100	INIF378	Mazamitla	19°58'N	103°06'W	1,720
PO101	INIF379	Tzararacua	19°25'N	102°02'W	1,400
PO102	INIF392	Palos Altos	19°25'N	103°35'W	1,508
PO103	INIF398	Valle de Bravo	19°14'N	100°07'W	1,860
PO104	INIF399	El Llano	19°15'N	100°25'W	1,760
PO105	INIF417	Matanguaran	19°18'N	102°09'W	1,560
PO106	INIF481	Ziracuaretiro	19°18'N	102°09'W	1,500
PO107	INIF489	Los Sabinos	19°13'N	101°45'W	1,710
PO108	INIF490	Los Negros	19°13'N	101°45'W	1,710
PO109	INIF502	El Durazno	19°22'N	102°41'W	
PO110	INIF534	La Codicia	16°55'N	92°07'W	
PO111	INIF535	La Florida	16°55'N	92°53'W	
PO112	INIF554	Chinameca	20°45'N	98°39'W	1,550
PO113	INIF555	Cafeles	17°16'N	99°30'W	860
PO114	INIF556	Buena Vista	17°15'N	99°31'W	710
PO115	INIF582	Los Pinos Ranch	16°40'N	93°45'W	750
PO116	INIF575	El Durazno	19°27'N	102°05'W	1,600
PO117	INIF586	El Sanibal	16°50'N	92°55'W	1,180
PO118	INIF587	San Francisco	16°19'N	91°59'W	1,660
PO119	INIF588	La Cascada Ranch	16°50'N	93°50'W	900
PO120	INIF596	San Cristobal	16°50'N	92°36'W	2,220
PO121	INIF599	Cienega de Leon	16°45'N	93°45'W	1,100
PO122	INIF604	Santa Rita	16°07'N	92°00'W	1'640
PO123	INIF609	Toliman	15°16'N	92°20'W	
PO124	INIF627	Temascaltepec	18°57'N	100°05'W	1,650

Appendix II

COUNTRIES PARTICIPATING IN THE INTERNATIONAL PROVENANCE TRIAL OF MEXICAN P. OOCARPA PROVENANCES.

Australia, Brazil, Cameroun, China, Ecuador, Ghana, Honduras, Nepal, Nigeria, South Africa, Tanzania, Thailand, Uganda, Venezuela.

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TESTE DE PROCEDÊNCIAS DE *Pinus pseudostrobus*, HONDURAS – RESULTADOS AOS 31 MESES

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Resumo

Os resultados de um ensaio aos 31 meses, (26 meses no campo), comparando 15 procedências de *Pinus pseudostrobus* e uma procedência de *Pinus oocarpa* são apresentados. Uma tentativa de divisão foi feita na região Central de Guatemala, separando as populações de *P. pseudostrobus* em dois grupos taxonômicos bem diferentes. O grupo de procedências extendendo-se da área Central da Guatemala para Nordeste da Nicaragua, caracteriza-se como o grupo que cresce mais rápido do que o grupo que se extende da área Central da Guatemala para o Norte do México.

Dentro do Grupo da América Central nenhum padrão de variação geográfica na altura das árvores, aos31 meses, foi detectado, muito embora diferenças entre estas procedências, com relação a altura média, foram significantes. A única fonte de sementes de *P. oocarpa* cresceu significantemente menos que qualquer outra das procedências de *P. pseudostrobus* da América Central.

Pinus pseudostrobus PROVENANCE TRIAL, HONDURAS – 31 MONTH RESULTS

Summary

The results of a 31 month old trial (26 months in the field) comparing 15 provenances of *Pinus pseudostrobus* and one provenance of *Pinus oocarpa* are reported. A tentative division was made in central Guatemala separating the *P. pseudostrobus* population into two distinct taxonomic groups. The group of provenances extending from central Guatemala to northeastern Nicaragua as a whole grew much faster than did the group which extends from central Guatemala to northern Mexico. Within the Central American group, no pattern of geographic variation in 31 month heights was noted although differences among these provenances with respect to mean heights were significant. The single *P. oocarpa* seed source grew significantly slower than any of the Central American *P. pseudostrobus* provenances.

TEST DE PROVENANCES DE *Pinus pseudostrobus*, HONDURAS – RÉSULTATS APRÈS 31 MOIS

Resume

Les résultats d'un essai après 31 mois, (26 mois sur le champ), comparant 15 provenances de Pinus pseudostrobus et une provenance de Pinus Oocarpa sont présentés. Une tentative de division a été faite dans la région centrale du Guatemala, en séparant les populations de P. pseudostrobus en deux groupes taxonomiques bien différents. Le groupe de provenances s'étendant de la région centrale du Guatemala vers le Nord-est de Nicaragua, est caractérisé comme le groupe qui croît plus vite que le groupe s'étendant de la région centrale du Guatemala vers le Nord du Méxique.

Dans le groupe de l'Amérique Centrale aucun modèle de variation géographique dans la hauteur des arbres, à 31 mois, a été remarqué, bien que les différences par rapport à la hauteur moyenne, ont été signifiantes entre ces provenances. La seule source de graines de P. Oocarpa a grandi remarquablement moins que n'importe quelle autre provenance de P. pseudostrobus de l'Amérique Centrale.

INTRODUCTION

Pinus pseudostrobus Lindl. ranges from northern Mexico to northeastern Nicaragua (Critchfield and Little, 1966). Within Honduras and most of Central American, it is normally restricted to elevations above 1,100 m and forms a series of disjunct populations. It grows much faster than either *Pinus oocarpa* Schiede of *Pinus caribaea* var. *hondurensis* Barret and Golfari on its natural sites due to their higher moisture and deep, fertile soils. Although the wood quality of *P. pseudostrobus* is inferior to that to the other two pines[1], it is commercially logged, especially when found mixed with *P. oocarpa*.

In late 1976, a set of provenance seed sources was sent to the FAO forestry project (PNUD/FAO/HOND 71/511) in Tegucigalpa by the Commonwealth Forestry Institute (CFI). Responsibility for these trials was subsequently turned over to the National Forest Tree Improvement Program in Siguatepeque. In late 1977, two provenance trials were established on two widely differing sites within Honduras. This paper reports the 31 month results of one of these trials.

MATERIALS AND METHODS

Table 1 lists the provenance seed sources included in this trial.

[1] Unpublished results of the author.

TABLE 1. PROVENANCE SEED SOURCES

I.D.	Species	Country	Latitude	Longitude	Elevation m	Contributor
MP-1	*Pinus pseudostrobus*	Mexico	21.18°N	99.00°W	2,000	INIF*
MP-4	" "	"	17.33°N	97.67°W	2,000	"
MP-5	" "	"	19.50°N	102.10°W	1,634	"
MP-6	" "	"	16.48°N	97.08°W	2,200	"
MP-8	" "	"	19.12°N	97.62°W	2,400	"
GP-1	" "	Guatemala	14.72°N	90.67°W	1,800	CFI
GP-2	" "	"	14.83°N	91.08°W	2,200	"
HP-1	" "	Honduras	14.03°N	87.08°W	1.600	"
HP-2	" "	"	14.80°N	87.50°W	1,200	"
HP-3	" "	"	14.00°N	87.10°W	1,300	"
HP-4	" "	"	14.17°N	86.58°W	1,250	"
HP-5	" "	"	13.60°N	86.58°W	1,075	"
HP-6	" "	"	14.87°N	88.82°W	1,100	"
HP-7	" "	"	14.22°N	86.67°W	1,300	Bco.Sem.**
HO-1	*Pinus oocarpa*	"	14.50°N	85.00°W	1,200	"
NP-1	*Pinus pseudostrobus*	Nicaragua	13.25°N	86.18°W	1,300	CFI

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**Banco de Semillas, ESNACIFOR, Siguatepeque, Honduras, C. A.

Seeds were sown in the experimental nursery at ESNACIFOR on the 24th - 25th of June, 1977. Conditions and results of the nursery phase were presented in an earlier paper (Houkal, 1980), so will not be discussed here. However, it should be mentioned that the *P. oocarpa* seedlings were not included in the original nursery trial, but were the product of an additional sowing wich did receive a similar treatment.

A planting site was selected in the central part of Honduras at approximately 14.83°N longitude and 87.58°W latitude. The area is located at 1300 m elevation and was covered by a pure *P. pseudostrobus* stand. It was cleaned, burned and fenced in Oct-Nov. of 1977.

Seedlings were transplanted to the field in Dec. of 1977. A randomized complete block design using 5 blocks with plots of 36 plants (6 x 6) was employed. The area has been cleaned 5 times to date to reduce weed competition. Height measurements were taken to the nearest centimeter on all trees on Dec. 1977, Dec. 1978 and Feb. 1980; 6, 18 and 31 months following sowing, respectively.

RESULTS

Field Survival

Overall survival for the trial dropped from more than 99% following 1 month in the field to 73.5% after 12 months to 70% after 26 months. Survival percentages at 26 months vary greatly among provenances with the Mexican sources generally showing much lower values (Table 2).

TABLE 2. FIELD SURVIVAL/PROVENANCE AT 26 MONTHS

Provenance	Survival	Provenance	Survival
MP-1	69%	HP-2	81%
MP-4	52%	HP-3	75%
MP-5	60%	HP-3	71%
MP-6	35%	HP-5	85%
MP-8	59%	HP-6	86%
GP-1	79%	HP-7	77%
GP-2	73%	HO-1	67%
HP-1	75%	NP-1	74%

Three major factors are responsible for mortality. First, a small percentage of plants ($\sim$2%) were lost to insects such as the leafcutter ant which abound in the area. Secondly, the periodic cleaning of the plot with machetes has taken a heavy toll. Just prior to the latest height measurements in Feb. of 1980, the area was cleaned leaving 3% of the trees damages and over 1% dead. It is probable that during the prior 4 cleanings when the trees were much smaller, accidental cutting of trees would have been much greater. Therefore, it is estimated that 10% of the trees were killed during cleaning. Since adequate moisture seems to be present year around, the greatest cause of mortality appears to be competition with the surrounding vegetation. Growth of the underbrush on this site is rapid and even though *P. pseudostrobus* is a relatively shade tolerant pine, prolonged shade or dessication following rapid removal of shade (ie. during cleaning) can cause significant loses. A simple correlation coefficient comparing 31 month old average provenance heights with the survival percentages in Table 2 was calculated at 0.74** (tabular r = 0.623, p = .99 with 14 df), which also suggests that the slower growing provenances suffer increased mortality because they are more severely affected by the competitive factor.

Height Growth

Large differences exist among the provenances in terms of their 31 month average heights (Table 3). All Honduran sources of *P. pseudostrobus* and the one Nicaraguan source are similar and range from 2.5 to 3.0 meters average height, while the Guatemalan and Mexican sources are significantly shorter, ranging from 0.7 to 2.1 meters. The single *P. oocarpa* source is inferior to all the Honduran *P. pseudostrobus* sources.

TABLE 3. MEAN PROVENANCE HEIGHTS (cm)

Provenance	Heights $\bar{x}$	Heights s	No. obs.
MP-1	71.4	29.9	125
MP-4	90.6	36.8	94
MP-5	109.0	48.3	108
MP-6	86.5	38.1	63
MP-8	64.6	26.1	107
GP-1	215.0	77.2	142
GP-2	137.0	59.1	132
HP-1	275.5	78.6	135

Provenance	Heights $\bar{x}$	Heights s	No. obs.
HP-2	259.4	82.0	126
HP-3	302.4	75.2	135
HP-4	277.6	84.4	128
HP-5	294.6	75.1	153
HP-6	268.3	79.6	155
HP-7	251.3	93.6	120
HO-1	165.0	72.9	121
NP-1	245.2	80.4	134

A two-way analysis of variance was conducted using plot mean heights. The calculated F value for treatment effects of 44.2 is highly significant (tabular F = 2.35 for 15/60 df at 99% level) showing that real differences do exist among provenance heights (Table 4).

TABLE 4. ANALYSIS OF VARIANCE OF 31 MONTH HEIGHT

Source	df	SS	ms	f
Treatments	15	598972	39931	44.2**
Blocks	4	1578	394	
Error	60	54147	902	
Total	79	654697		

Subsequently, the new Duncan's multiple range test (DMR) was conducted in order to compare paired mean provenance heights. At the 95% confidence level, provenances HP-3 to HP-2 do not significantly differ and in factor all of the first nine provenances are related. However, this first group is significantly greater in mean height as compared with the final six provenances (HO-1 to MP-8).

TABLE 5. DMR OF PROVENANCE 31 MONTH MEAN HEIGHTS

Prov.	HP-3	HP-5	HP-4	HP-1	HP-6	HP-2	HP-7	NP-1	GP-1	HO-1	GP-2	MP-5	MP-4	MP-6	MP-1	MP-8
Mean Hgt.	302	295	278	275	268	259	251	245	215	165	137	109	91	86	71	65

Groupings

A simple correlation analysis was conducted comparing 31 month *Pinus pseudostrobus* provenance mean heights versus 18 and 6 month mean heights. Values of r were calculated to be 0.85*** and 0.99** (tabular r = 0.641 at 99% level with 13 df) respectively for 6 and 18 month comparisons indicating a considerable positive relationship between early growth rates.

Geographic Variation

An attempt was made to examine geographic patterns of variation within the *Pinus pseudostrobus* population. Correlation analysis of 31 month mean provenace heights versus their altitude, latitude and longitude yielded r values of -0.85*, -0.92* and -0.60* (tabular r = 0.514 at 95% level with 13 df) respectively. Apparently, strong geographic variation patterns exist. However, recent findings by Mittak and Perry (1979) and others seem to show that two distinct taxonomic entities may be involved in this study. According to these general guidelines the 15 *P. pseudostrobus* provenances were divided into two groups. Group A consists of all the Honduras, Nicaraguan and the GP-1 Guatemalan sources while Group B consists of all the Mexican and the GP-2 Guatemalan sources. Simple correlation analysis were then conducted again comparing 31 month mean provenance heights with altitude, latitude and longitude with the following results:

Group A	Group B
Height vs altitude = -0.59	Height vs. altitude = -0.28
Height vs latitude = -0.31	Height vs latitude = -0.67
Height vs longitude = -0.58	Height vs longitude = -0.51
(tabular r = 0.666 level, 7 df)	(tabular r = 0.811 95% level, 4 df)

None of the calculated r values are significant, suggesting that the prior significant geographic trend is simply a by-product of the fact that two distinct taxons are included in the trial.

Visual examination of the trial at 31 months revealed marked general morphological differences between the Group A and Group B provenances. Group A depicts the normal *P. pseudostrobus* phenotype found in Honduras which produces a symmetrical crown of fine branches with fine buds and covered by long, thin needles which tend to droop. Group B, on the other hand, has a long, thick, branchless leader and buds which are much thicker and longer coarser needles than those of Group A.

CONCLUSIONS

Of prime importance to this study and related studies around the world, is the fact that two separate taxonomic groups are probably involved. A recent paper by Mittak and Perry (1979) suggests a new classification for the *P. pseudostrobus* - *Pinus tenuifolia* complex and states that the southern extent for *P. pseudostrobus* is Central Guatemala. Both the height growth and survival data presented in this paper show a distinct division between provenances in Central Guatemala which is confirmed by field observations of the trial. It is therefore concluded that the Mexican and Guatemalan GP-2 provenances respresent one taxonomic group, while all Honduran, Nicaraguan and the Guatemalan GP-1 provenances represent a distinctly different taxonomic group.

With the aforementioned concept in mind, this study has demonstrated very little variation among provenances from the Central American *P. pseudostrobus* population. From the disjunct nature of the geographic distribution of this pine throughout Central America, it might be expected that both random genetic drift and genetic isolation would have combined to create a highly variable population. However, only initial growth rate was examined in this case and greater variation may be encountered when more cryptic characters are examined on nature trees. Of practical importance is the concept that it appears that a large number of different seed sources can be planted in this particular site.

Finally, this trial has shown that *P. oocarpa* is greatly inferior to *P. pseudostrobus* with respect to 31 month height growth on this site. Almost a two fold difference exists between the average height of the tallest *Pinus pseudostrobus* provenance and the one *P. oocarpa* source. The same *P. oocarpa* seed source is included in several other provenance trials in Honduras which are located on natural *P. oocarpa* sites. It is, however, growing considerably faster on the present site.

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PRODUÇÃO DE CONES E SEMENTES DE *Pinus oocarpa*

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Resumo

Em duas populações naturais localizadas em Honduras, o *Pinus oocarpa* Schiede produziu em média 35,8 sementes viáveis/cone. A eficiência da produção de sementes (produção atual/produção potencial de sementes viáveis) é relativamente alta, 25,5%, enquanto que a produção de sementes não viáveis é baixa 33,3%, evidenciando baixos níveis de endogamia e eficiente polinização.

Observou-se em média 80% de mortalidade dos conídeos durante as primeiras seis semanas após a polinização. Uma vez que a polinização é adequada e não existe evidência externa de danos, a perda parece ser devida à competição entre conídeos e/ou entre conídeos e crescimento vegetativo primário.

Foram registrados períodos de florescimento variando amplamente entre árvores da mesma população, significando que o melhorista deverá selecionar intensamente para conseguir homogeneidade nesta característica.

CONE AND SEED PRODUCTION OF *Pinus oocarpa*

Summary

In two natural stands in Honduras, *Pinus oocarpa* Schiede produced an average of 35.8 filled seeds/cone. Seed efficiency (actual/potential full seed production) is relatively high, 25.5%, while empty seed production is low, 33.3%, suggesting sufficient pollination and low levels of inbreeding.

An average 80% mortality of conelets was observed during the first six weeks following pollination. Since pollination is adequate and no external evidence of damage was noted, the loss appears to be due to competition between conelets and/or between conelets and primary vegetative growth.

Flowering times were found to vary greatly among trees of the same stand, signifying that the breeder will need to select heavily for homogeniety in this characteristic.

PRODUCTION DE CÔNES ET DE GRAINES DE *Pinus oocarpa*

Resume

Dans deux peuplements naturels, au Honduras, le Pinus oocarpa, SCHIEDE, produit, en moyenne, 35,8 % de cônes remplis de graines. La productivité en cônes de ce type est relativement élevée : 25,5 %, tandis que la production de cônes vides de graines n'est que de 33,3 %. On peut donc considérer que le taux de pollinisation est satisfaisant et que ceux de la consanguinité sont faibles.

La mortalité des infrutescences (conelets), durant les six premières semaines qui ont suivi la pollinisation, a été d'environ 80 %.

Puisque la pollinisation est satisfaisante et qu'aucune évidence de dommage externe n'a été constatée, il semble que cette mortalité est due à la compétition qui existe entre les infrutescences ainsi qu'à la concurrence entre infrutescences et pousses de jeunesse.

On a observé que la période de floraison est très irrégulière d'un arbre à l'autre du même peuplement. Pour obtenir une certaine homogénéité de cette caractéristique, le généticien devra faire une sélection rigoureuse.

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

Pinus oocarpa Schiede is the most important timber tree in Honduras and is developing into a widely utilized species throughout the tropics and subtropics. The forest tree improvement program begun in Honduras in 1977 has as its major goal the production of commercial quantities of genetically improved seed of this species for use in expanding national reforestation programs. Very little information concerning seed yields from *P. oocarpa* seed orchards is as yet available. Therefore, observations made on cone and seed production of trees in natural forests will provide useful initial information.

Two important problems concerning seed production of *P. oocarpa* have been identified in Honduras. The first of these is a relatively low average full seed yield per cone following extraction, estimated to be 18[1]. Hudson (1980) observed a very low full seed fall following two years of seed trapping in natural stands. Since these plots were composed of relatively dense stands of mature trees which exhibited an adequate production of cones, it is believed that the low full seed fall was due to a low seed production per cone. The second problem concerns a high level of conelet drop or abortion in naturally occuring stands. From several years of field observations and a controllolled pollination program, the author estimates that more than 80% of the developing conelets drop during the first 6 weeks following anthesis. For a large range of pine species, Sweet (1975) reported a 40% average drop of flowers following pollination.

Three separate studies conducted over the past few years are here reported which will hopefully help to clarify these two problems.

M A T E R I A L S A N D M E T H O D S

Phenology of Flowering

From Nov. 20th to Jan 24th 1976/77, a study to identify the flowering patterns of *P. oocarpa* was conducted within a relatively homogeneous natural stand in the National Forestry School's Forest in Siguatepeque. 15 well spaced, dominant trees were identified with a single observation point being asigned to each. Observations were made every 5 to 12 days at the same time of day with the aid of 16 x 50 power binoculars. The relative abundance of receptive female and dehiscing male strobili were subjectively quantified for each tree. Two trees were eliminated early because of foor visibility.

Controlled Pollination

In Nov. to Dec. of 1978, as part of a controlled pollination program, six crosses of *P. oocarpa* x *P. oocarpa* were made on three well spaced trees. Individual flowers were pollinated on two consecutive days. A local mixed pollen source was used and pollen quality was insured by periodic germination test. A bag and brush pollination technique was employed.

Cone Analysis

In early 1980, 50 cones from each of two natural stands of *P. oocarpa*, over 50km apart, were systematically sampled from commercial collections (ie. 1-2 cones/sack). The cones were subjected to a analysis similar to that describe by Bramlett, et. al. (1976) with the following data being recorded for each cone:

1) Number of developed seed extracted following drying in an oven at 100°F for 24 hrs.
2) Number of filled seed from (1)
3) Number of developed seed yielded following complete cone dissection.
4) Number of filled seed from (3)
5) Total number of scales
6) Number of fertile scales

[1] Personal communication (Marcus Robbins, Technical Advisor, Banco de Semillas, ESNACIFOR, Siguatepeque, Honduras).

R E S U L T S

Phenology of Flowering

Among the observed trees, pollen fall began on 4 trees prior to Nov. 20th, reached its peak around Dec. 14th and ended between Jan. 13th and 24 th. Receptive female strobili first appeared in two trees on Dec. 7th, attained maximum abundance between the 22nd and 28th of Dec. and terminated sometime after Jan 24th. Comparison of the two sets of data shows that pollen dispersal begins with some anticipation to female receptivity, a normal pattern in pines. However, it also appears that in the latter part of the flowering season a considerable number of receptive females are emerging while the pollen source is greatly diminishing, suggesting a possibility of inadequate pollination.

On any individual tree, pollen dispersal again began before female strobili receptivity. During the height of female flower receptivity for any tree, however, large quantities of pollen were still being released from the same trees. This, coupled with the proximity of the two types of flowers in the crown and on the same branch, could cause a large degree of natural inbreeding.

Of the 13 trees examined, two trees produced very few male flowers while three produced few, if any, female flowers. Two trees terminated pollen production by Dec. 7th, while one did not reach abundant production of receptive females until Jan 10th. It appears that *P. oocarpa* varies greatly in flower periodicity.

Controlled Pollination

All six conelets aborted during the first six weeks following pollination. No evidence of insect or pathogen infestation was noted.

Cone Analysis

Table 1 reports the results of the cone analysis.

TABLE 1. CONE ANALYSIS

	Extracted seed				Retained seed				Scales			
	Total		Filled		Total		Filled		Total		Filled	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Site I	37.5	23.5	24.1	17.1	19.9	18.7	12.6	13.6	147.7	18.9	81.3	12.5
Site II	40.2	22.1	29.5	18.7	9.9	10.1	5.5	6.0	148.1	19.1	59.4	10.8
Mean	38.8	22.8	26.8	17.9	14.9	14.4	9.0	9.8	147.9	19.0	70.3	11.6

The average total filled seed yield was 35.8 seeds/cone for *P. oocarpa* as compared with *Pinus elliottii* and *Pinus taeda* which yielded 27 and 37 filled seed/cone respectively in seed orchards (calculated from Bramlett, 1974). The average seed potential, calculated as 2 times the average number of fertile scales, is 140.6 for *P. oocarpa* while the seed efficiency, calculated as the total number of filled seed/seed potential, was found to be 25.5%. Bramlett (1974) found a 14% and 19% seed efficiency for *Pinus echinata* and *Pinus virginiana* respectively in natural stands, indicating a relatively high seed efficiency for *P. oocarpa*. An empty seed yield of 33.3% was obtained which is relatively low when compared with estimates of from 40% to 60% for pines (Bramlett, 1974).

C O N C L U S I O N E S

P. oocarpa produced a relatively high average production per cone of 35.8 filled seed while maintaining a low average percentage of empty seed of 33.3%. This suggests that adequate pollination is ocurring in the natural stands and that ovule abortion is also low. It also suggests that a low amount of natural inbreeding occurrs even though flowering time and flower position would tend to show the opposite.

P. oocarpa shows a 80% conelet abortion rate in natural stands during the first six weeks following pollination. Differences between pollen shedding and female stobili receptivity suggest that insufficient pollinization may be a primary cause, but the limited controlled pollination program and the high full seed/cone yield suggest otherwise. No insect predation was noted on the aborted conelets, although this can be difficult to determine. On the other hand, very active primary growth occures at the same time as early conelet development. It has been noted that competition between developing flowers and between developing flowers and vegetative shoots is an important causal factor in conelet drop (Sweet, 1975): The evidence presented have tends to favor this explanation.

Observations made on flowering demonstrated a high degree of variation between indivudual trees within the same stand as to the timing of male and female flower production. This does not create problems of insufficient pollination within these same stands as indicated by the high seed efficiency. However, serious problems may arise in seed orchards where few clones or families are utilized. Therefore, it will be of prime importance for the geneticist working with *P. oocarpa* to select breeding material which shows similar flowering patterns.

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RESULTADOS DO TESTE INTERNACIONAL DE PROCEDÊNCIAS DE *Pinus caribaea* VAR. *hondurensis*, AOS 5 ANOS E MEIO, NA RESERVA FLORESTAL DE BUKIT TAPALI, MALASIA PENINSULAR

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Resumo

Este trabalho destina-se a avaliar as variações devido às procedências, e identificar as procedências potenciais para plantações locais e estabelecimento do programa. Foram comparadas as taxas de crescimento entre procedências. Foram também discutidas as taxas de crescimento do ensaio e da parcela mais antiga. Quatro procedências foram identificadas como potenciais para o programa de plantações locais.

RESULTS OF 5 AND HALF YEAR OLD INTERNATIONAL PROVENANCE TRIAL OF *Pinus caribaea* VAR. *hondurensis* AT BUKIT TAPAH FOREST RESERVE, PENINSUALAR MALAYSIA

Summary

This paper is to evaluate the provenance variations, and to identify potential provenances for local plantation establishment programme. Growth rates between provenances were compared. Growth rates between the trial and the older established plot were also discussed. Four provenances were identified as the potential provenance for local plantation programme.

RÉSULTAT DU TEST INTERNATIONAL DE PROVENANCE DE *Pinus caribaea* VAR. *hondurensis*, À L'AGÊ DE CINQ ANS ET DEMI, À LA RÉSERVE FORESTIÈRE DE BUKIT TAPAH, MALASIE PÉNINSULAIRE

Resume

Cette étude a pour but d'évaluer les variations de provenances et d'identifier les provenances qui conviennent à l'établissement d'un programme de plantation local. Les taux de croissance des différentes provenances ont été comparés. Les taux de croissance de ces essais et ceux de placeaux plus anciens font l'objet d'une discussion. Quatre provenances sont retenues pour être utilisées dans le programme local de plantation.

Introduction

The introduction of Pinus caribaea Mor. in Peninsular Malaysia (then Malaya) extends back to 1936. This species has been grown under various ecological conditions all over the country. Its performance has been evaluated by a number of authors both foreign and local. Some of the important references are Barnard et. al. (1957), Mitchell (1962), Vincent et. al (1965), Freezaillah (1966), Franson (1970), Sheikh (1970, 1971) and Carmean & Chew (1974).

Among the tropical pines extensively tried in Peninsular Malaysia, Pinus caribaea var. hondurensis is most favoured. Beside of its fast initial growth and its ability to compete with Imperata cylindrica (Freezaillah, 1966), this variety was found to have a considerable potential to produce viable seeds (FAO, 1963). The first harvest of Pinus caribaea var. hondurensis was reported in 1979 (Razali & Ng, 1979).

In 1972, the Malaysian Forestry Department participated in the international provenance trail of Pinus caribaea var. hondurensis with the cooperation of the Commonwealth Forestry Institute. The purposes of this study are to evaluate provenance variations and to identify the most potential provenances for local plantation establishment programme.

Materials and methods

Plant materials

The seeds used in the provenance study were obtained from Central America through Commonwealth Forestry Institute. The description of seed origins is given in Table I.

Table I - Description of seed origins of Pinus caribaea var hondurensis included in the international provenance trail at Bukit Tapah Forest Reserve, Peninsular Malaysia.

Locality	Seed Lot No.	Longitude	Latitude	Altitude (m)	Mean annual Rainfall (mm)
Alamicamba, Nicaragua	22/70	84° 17'w	13° 34'N	20 - 30	2610
Rio Coco, Nicaragua	24/70	83° 55'w	14° 45'N	50 -100	2863
Brus Lagoon, Honduras	27/70	84° 40'w	15° 45'N	10	2840
Guanaja, Honduras	28/70	85° 54'w	16° 27'N	50 -100	2380
Poptun, Guatemala	26/70	89° 25'w	16° 21'N	500	1688
Santa Clara, Nicaragua	45/71	86° 12'w	13° 48N	700	1818
Potori, Honduras	40/71	88° 25'w	15° 20'N	600-700	1205
Mountain Pine Ridge, Belize	44/71	88° 55'w	17° 00'N	400	2064
+ Andros, Bahamas	69(7295)	78° 07'w	24° 53'N	10	N.A
++ Caya La Mula, Cuba	22/71	83° 48'w	22° 33'N	110	N.A
Melinda, Belize	47/71	88° 20'w	17° 01'N	10 - 15	2137
+++ Pueblo Caido, Guetamala	30/70	89° 18'w	13° 12'N	800	N.A

+ Pinus caribaea var bahamensis
++ Pinus caribaea var. caribaea
+++ Pinus oocarpa
N.A Not available.

Description of trial site

The trial site is located in the central western past of Peninsular Malaysia, at Bukit Tapah Forest Reserve. The description of trial site is given in Table 2.

Table 2: Description of the trial site of the international provenance trail of Pinus caribaea var. hondurensis, at Bukit Tapah Forest Reserve, Peninsular Malaysia.

Locality : Bukit Tapah Forest Reserve, Peninsular Malaysia
Longitude : 101° 18'E
Latitude : 4° 20'N
Altitude : 549 m
Parent Material : Granitie
Soil type : Sandy clay loam
Soil Series : Rengam series
Mean annual rainfall : 2435 mm
Mean annual maximum temperature: 23.5°C
Mean annual minimum temperature : 14.4°C

Climatic data are means over period of 1973 - 1978

Experimental design and establishment

Ten-month old potted seedlings of Pinus caribaea var. hondurensis from nine seed sources, raised at the Forest Research Institute Nursery were transplanted into the field in August 1973. The experiment was planted in lattice design with three replications.

The experimental unit (plot) comprises of thirty-six seedlings at 2.4m by 2.4m spacing. Pinus caribaea var. bahamensis from Andros, Pinus caribaea var. caribaea from Caya La Mula and Pinus oocarpa from Pueblo Caido were included in the trial as controls.

Field sampling

Since the establishment of the trial yearly survival count, height and diameter measurements were carried out. In Febuary 1979 both the parametric and non-parametric traits measurement and assessment were carried out by the Commonwealth Forestry Institute.

Statistical analysis

The compilation and analysis of data were carried out by the Commonwealth Forestry Institute. Sixteen traits have analysed on individual tree basis and thirty-seven traits by plot means.

Results and discussion

Table 3 shows a considerable difference in the performance of different provenances. In term of survival, Brus Lagoon maintained a 100% survival while Melinda suffered the most mortality, 17%. Among the nine provenances of Pinus caribaea var. hondurensis included in the trial, the volume production (under bark) per hectare ranges from 143.09 cu.m/ha (Santa Clara) to 95.95 cu.m/ha (Rio Coco) while their mean annual increment (volume under bark) ranges from 26.01 cu.m/ha to 17.62 cu.m/ha., a difference of about 1.5 times. For height and diameter growth, they ranges from 11.6m (Melinda) to 9.7m (Mountain Pine Ridge) and from 15.1 cm(Mountain Pine Ridge)to 13.2 cm (Brus Lagoon)respectively.

Table 3: Average survival percentage, height, diameter, volume (under bark) and mean annual increment (under bark) of Pinus caribaea var. hondurensis provenances at age of 5½ years old.

Provenance	Survival Percentage	Height (m)	Diameter (cm)	Volume (cu.m/ha)	M.A.I (cu.m/ha)
Alamicamba	95 (4)	11.34 (2)	14.16 (5)	135.70 (3)	24.67 (3)
Rio Coco	92 (7)	10.06 (10)	13.45 (9)	96.95(10)	17.62(10)
Brus Lagoon	100 (1)	10.73 (7)	13.19(10)	123.97 (6)	22.54 (6)
Guanaja	94 (5)	10.51 (9)	15.01 (2)	118.78 (8)	21.59 (8)
Poptun	97 (2)	11.24 (3)	13.77 (7)	126.24 (5)	22.95 (5)
Potosi	85 (10)	10.67 (8)	14.00 (6)	173.92 (9)	20.71 (9)
Santa Clara	96 (3)	11.18 (5)	14.63 (4)	143.09 (1)	26.01 (1)
Mountain Pine Ridge	90 (9)	11.03 (6)	15.05 (1)	132.24 (4)	24.04 (4)
+ Andros	91 (8)	9.73(11)	12.65(11)	95.50(11)	17.36(11)
++ Caya La Mula	84 (11)	8.81(12)	11.96(12)	56.37(12)	10.25(12)
Melinda	83 (12)	11.63 (1)	14.80 (3)	139.20 (2)	25.31 (2)
+++ Pueblo Caido	93 (6)	11.23 (4)	13.50 (8)	123.31 (7)	22.41 (7)
Overall Mean	91.7	10.68	13.85	117.11	21.3

\+ Pinus caribaea var. bahamensis
++ Pinus caribaea var. caribaea
+++ Pinus oocarpa

Figure in bracket denotes ranking

The analysis of variance in Table 4, shows that there are significant differences in the performance of different provenances, but mainly among the qualitative traits, describing stem form and branching habits. Though there are obvious differences in volume production and M.A.I., statistically the differences are not significant. The probable reasons are due to the inadequate number of replications and considerable heterogeneity of site within replications (Barnes, 1979). A large tree to tree variations within seed source were also observed.

Table 4: Analysis of variance of some of the traits in the international provenance trial of Pinus caribaea var. hondurensis at age of 5½ year old.

Trait \ Source of variations	Provenance	Replication	Residual	Tree
Volume u.b./ha	1.50 ns(9.04)	8.99**(36.35)	- (54.61)	-
M.A.I. u.b./ha	1.50 ns(9.04	8.99**(36.35)	- (54.61)	-
Total height	2.83 * (7.67)	16.18***(15.90)	2.95***(8.32)	-(68.11)
Diameter (b.h)	3.04* (4.47)	18.47** (10.16)	1.34ns (1.77)	-(83.34)
Stem straightness	13.78***(11.74)	11.78***(2.45)	0.55ns (0.00)	-(85.82)
Branch angle	4.12** (50.99)	0.49ns (0.00)	- (49.01)	-
Needleless shoot frequency	4.64** (53.54)	0.92ns (0.00)	- (46.46)	

Figure in bracket denotes coefficient of variation

In term of stem straightness, among the var. hondurensis, Alamicamba has the straighter bole and the poorest is Potosi. Melinda has the highest needleless shoot occurence while Rio Coco, Brus Lagoon and Guanaja have no needleless shoot.

Comparing the performance between species and varities included in the trail, there are significant differences observed. In term of volume production and M.A.I., Pinus oocarpa is slightly inferior to var. hondurensis, but var. bahamensis and var. caribaea are far below the var. hondurensis. In term of bole straightness var. caribaea is the best.This confirmed the finding made by Nikles et. al. (1973) that var. caribaea was the straightest population followed by var. bahamensis and var. hondurensis. Relatively there were little dieback observed in the trial. This is because of the location of the plot on a higher altitude and experincing a lower temperature.Slee et. al (1976) suggested that dieback is due to high temperature and its occurence decreases with altitude.

Comparing the growth performances of the international trial with the older established plots in Peninsular Malaysia, it seems that the trial perform better. This may be due to the better site quality on which the trial is located (Rengam soil series), and altitudinal effect. Carmean and Chew (1974), found out that excellent pine growth can be expected on Rengam soil series, a soil suitable for agriculture. Freezaillah (1966), found that growth is equally vigorous at elevations of about 600m as that obtained in the lowlands.The overall M.A.I of the trail (21.3 cu.m/ha) is about 1.2 times higher than the M.A.I. (17.6 cu.m/ha) of a 7 year old plot on a similar soil series i.e Rengam soil series, but at a lower elevation. With other plots (8 year old) on a different soil series, Gajah Mati and Sungai Buloh, the overall trial M.A.I exceed by 1.6 times and 1.3 times respectively.

Conclusion

The results of the 5½ year old international provenance trial of Pinus caribaea var. hondurensis indicate that there are variations in the performance of different provenances. Some of this variations are mainly due to genetics.

These variations are large enough to warrant selection of the fast growing provenances. The tree to tree variations within the seed source gives a considerable benefits in tree improvement programme in the selection of plus trees within the populations.

It may be concluded have that the most promising provenances are Santa Clara, Melinda, Alamicamba and Mountain Pine Ridge.

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Ectomycorrhizas EM PINHEIROS TROPICAIS DE BAIXA ALTITUDE

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Resumo

Uma breve abordagem é feita da anatomia e das funções dos fungos micorrízidos dos pinheiros, seguida por uma revisão das associações micorrízidas, para os quatro pinheiros tropicais, de baixa altitude, mais utilizados em populações naturais e cultivadas. Os dados encontrados sugerem que a ecologia e a fisiologia das micorrizas desses pinus são muito complexas, especialmente nas florestas naturais. Evidências experimentais, em outros pinheiros, têm demonstrado que um fungo particular pode variar na sua efetividade como micorriza associado a outro, ou com um determinado hospedeiro ou mesmo em condições particulares. O trabalho descreve como a micorriza pode ser manipulada, para se tirar vantagens dessas variações, e fornece conclusões através de uma discussão breve dos progressos efetuados no C.F.I., nesse setor.

Ectomycorrhizas OF LOWLAND TROPICAL PINES

Summary

A brief account is given of the anatomy and function of pine ectomycorrhizas, followed by a review of the mycorrhizal associations of the four most widely-planted lowland tropical pines in both natural and cultivated stands. The available data suggest that the ecology and physiology of the mycorrhizas of these pines are very complex, especially in the natural forests.

Experimental evidence from other pines has shown that particular fungi vary in their effectiveness as mycorrhizal partners, either with a particular host, or under particular conditions. The paper describes how mycorrhizas may be manipulated to take advantage of these variations and concludes by discussing briefly the work in progress at the C.F.I. on this topic.

Ectomycorrhizas DANS DES PINS TROPICAUX DE BASSE ALTITUDE

Resume

Après un bref aperçu de l'anatomie et de la biologie des ectomycorrhizes du pin ,l'auteur fait la revue des associations de mycorrhizes des 4 espèces de pins tropicaux de basse altitude les plus largement plantés, d'après les observations faites dans les peuplements naturels et les plantations. D'après les données obtenues l'écologie et la physiologie des mycorrhizes de ces pins sont très complexes, particulièrement dans les formations naturelles.

L'expérimentation montre à l'évidence chez d'autres espèces de pins que certains champignons présentent une variabilité dans leur rôle de partenaire-symbion comme micorrhize, soit en fonction d'un hôte particulier, soit par rapport à des conditions particulières. Cette étude indique comment agir sur les mycorrhizes pour tirer avantage de ces variations et, en conclusion, examine, brièvement les travaux en cours sur ce point à l'Institut forestier du Commonwealth d'Oxford.

INTRODUCTION

Most pines occur naturally in the North Temperate zone or the equable high altitude regions of the subtropical and tropical zones (Critchfield and Little, 1966), with very few being well adapted for growth in the lowland tropics. The latter include Pinus kesiya Royle ex Gord. and P. merkusii Jungh. and de Vriese from S.E. Asia and adjacent islands; P. caribaea Mor. (2 varieties), P. cubensis Grisenb., P. occidentalis Sw. and P. tropicalis Mor. from the Caribbean islands; and P. caribaea (1 variety) and P. oocarpa from Central America. They occur naturally in tropical savanna areas with poor acidic soils and subhumid/humid climates which are liable to severe seasonal fires. More rarely they are found on more fertile or alkaline soils, or under perhumid climates.

The mycorrhizal association of fungi with plant roots is common in Angiosperms, occurring on most plants grown in the wild, with two types of major importance to foresters. Firstly, there are the endomycorrhizas which predominate on herbaceous plants and many trees, especially those of the tropics, and which are formed by various fungi of the Endogonaceae, and secondly there are the ectomycorrhizas which occur particularly on trees in temperate regions and which are formed by various Ascomycete and Basidiomycete fungi. All pines form the latter type of association and are more or less dependent on it under natural conditions.

This paper reviews the information concerning mycorrhizas of lowland tropical pines, their functions, the possibilities for their deliberate manipulation, and briefly the work being undertaken at the Commonwealth Forestry Institute on this subject.

The anatomy and function of ectomycorrhizas

Ectomycorrhizas are specialized roots formed by the symbiotic association of a host plant with a fungus. In the case of pines these structures are in the form of modified roots which tend to become swollen and more or less branched in a dichotomous manner, and which lose their capacity for continual longitudinal growth and their ability to produce root hairs. The host root becomes enveloped in a continuous sheath of fungal hyphae, which may cause it to appear brightly coloured, and which often produces abundant hyphae extending well into the soil. Typically the fungus also produces a network of hyphae (Hartig net) between the cortex cells of the host root. In some cases this net may be very shallow, or the sheath may be very thin.

Ectomycorrhizas assist plants with relatively poor root systems, such as pines, to grow better in poor soils by providing an extensive network of fungal hyphae in the soil surrounding the roots, thus enabling the plant to exploit the nutrients and water from a greater soil volume (Harley, 1969). The fungal hyphae may also be able to compete more favourably with other plants and soil organisms for the available nutrients in a particular soil. In addition the sheath acts as a storage organ for nutrients, such as phosphates, in habitats with periodic nutrient availability (Harley, 1969), and as a barrier to infection by pathogens which normally infect fine roots (Marx, 1969).

In return the host passes to the fungus large quantities of organic carbon compounds formed during photosynthesis (Harley, 1969).

Infection of new host roots takes place by means of hyphae from existing active mycorrhizas of the same or neighbouring plants, or from dormant propagules, such as basidiospores, present in the soil. Ectomycorrhizas are fairly long-lived and can easily overwinter and become rejuvenated when soil temperatures rise; however they may be killed by high temperatures and drought. In the latter case the fungi may aestivate as mycelium inside the larger roots of the host or as dormant propagules in the soil.

The mycorrhizal associations of tropical pines in natural forests

The natural pine forests of the tropics have received little attention from mycologists and very few studies of their mycorrhizal associations have been attempted. Some collections of terrestrial macromycete fungi have been made, but few records have been collated with respect to host tree species. These are usually documented in herbarium records or taxonomic literature under their fungal identity and are difficult to trace using their plant associate as a reference source. These deficiencies are due, at least partly, to the complexity of tropical ecosystems and the taxonomic problems encountered with macrofungi from these regions.

A search of the literature for records of mycorrhizal fungi from natural forests of lowland tropical pines has yielded two records of a Suillus sp. with P. merkusii in Indonesia (Palm, 1930; Singer and Morello, 1960), one record of Pisolithus tinctorius with P. kesiya in the Philippines (Marx, 1977), but no records for the other pines listed on page 2. The paucity of such records does not reflect a scarcity of terrestrial fungi in these forests because a large variety of fungi were found by the author during two forays to the pine forests of Central America and the Bahamas in 1976. More than 50 species were found in forests of P. caribaea var. hondurensis, more than 30 in forests of P. oocarpa, and at least 10 in the forests of P. caribaea var. bahamensis. Preliminary identities for many of these fungi have been listed by Ivory (1980), but several have since been redetermined by specialist taxonomists. The limited data available from these forays suggests that a few of the fungi may be specific to particular Pinus spp. or to particular site conditions.

No one has studied the natural mycorrhizas of these pines in much detail, however, it was noted, during the above forays, that several mycorrhizal types can often be discerned in close proximity to each other on the roots of P. caribaea and P. oocarpa. This suggests that the ecology of mycorrhizas in these mixed age forests is likely to be very complex.

The mycorrhizal associations of cultivated tropical pines

Many general reports have been published concerning mycorrhizas of pines in tropical countries, but few give details of the host species, mycorrhiza morphology, or associated fungi. However, 21 fungi (Table 1) have been implicated as mycorrhiza formers with tropical pines under cultivation (Chaudhry, 1978; Ekwebelam, 1977, Ivory, 1975; Ivory, 1980; Lackham, 1972; Marx, 1977; Mikola, 1970; Momoh and Gbadegesin, 1975; Palm, 1930; Rawlings, 1951; Redhead, 1968 and Thoen, 1974). Several of these fungi have not been completely identified and others may be misidentified. Some other records quoted in the literature have been disregarded because of uncertainties regarding the identity of the host species.

Table 1 Terrestrial macrofungi associated with cultivated tropical pines

Amanita sychnopyramis	3
Amanita sp.	1
Boletus pernanus	2
Coltricia cinnamomea	1
Inocybe lanuginella	2
Inocybe sp	1, 4
Pisolithus tinctorius	1, 4
Porphyrellus sp.	2
Rhizopogon luteolus	2, 4
Rhizopogon nigrescens	1
Rhizopogon roseolus	1
Rhizopogon villosus	1
Rhizopogon sp.	1, 4
Russula brevipes	1
Scleroderma citrinum	1
Scleroderma geaster	1
Suillus granulatus	1, 2, 3, 4
Suillus sp.	3
Thelephora terrestris	1, 2, 4
Tylopilus spp	1

1 = P. caribaea 2 = P. kesiya 3 = P. merkusii 4 = P. oocarpa

Several of these and other fungi have been used to synthesize mycorrhizas on one or other of these pines under laboratory conditions. Most fungi appear to be non-specific with regard to their host under these artifical conditions, although some evidence of specificity has been noted with a few species in recent laboratory studies carried out by the author.

Possibilities for the manipulation of ectomycorrhizal associations

Trappe (1977), in a review of this subject, states that much evidence has been accumulated in recent years which suggests that all fungus species, or ecotypes within a species, can differ in their effectiveness as mycorrhizal partners with particular host species or ecotypes, especially when they are subjected to stress caused by environmental conditions. At the same time techniques have been developed which enable the grower to produce seedling trees with mycorrhizas formed by specific strains of fungi. In theory it is possible to produce trees with mycorrhizas adapted to any given situation, but in practice, too little is known about the ecology and physiology of mycorrhizas for this to be attained.

He concludes that inoculation with particular fungi may prove to be widely effective, but that the relative merits of any proposed system will ultimately depend as much on the practical limitations of the procedure as on the benefits it provides to the forester.

Research in progress at the Commonwealth Forestry Institute

Research on the mycorrhizas of tropical pines was begun in 1976 and has led to the collection of sporocarps of 78 putative mycorrhizal symbionts from natural forests of P. caribaea and P. oocarpa. Thirty-one of these have been fully identified, resulting in the determination of 9 new taxa.

Pure cultures were obtained from sporocarps of 24 fungi, and from 3 mycorrhizal root collections. Most are still maintained at C.F.I. in cold storage, and many have been used to synthesize mycorrhizas on laboratory seedlings of P. caribaea (15 spp.), P. oocarpa (13 spp.) and P. merkusii (7 spp.). Some differences in host specificity between the Central American pines and P. merkusii have been noted.

Cooperative studies are in progress with research officers in Antigua, Ghana, Kenya and Zambia to develop inoculation techniques suitable for tropical pines and to test the resulting pine/fungus associations for outplanting ability and subsequent growth.

CONCLUSIONS

The ecology and physiology of the mycorrhizas of tropical pines have received little attention until recently, however, the limited information available suggests that the situation is very complex in the natural forest, but somewhat simpler in even-aged plantations and nurseries. Some evidence, from work on other trees, suggests that inoculation of seedling stock with certain strains of fungi may be beneficial for particular host species or for particular environmental conditions. At present this information is insufficient for the sensible selection of desirable fungi, and techniques are not yet suitable for use with the majority of mycorrhizal fungi. Programmes of research, such as that in progress at C.F.I. may help to overcome these problems.

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TESTE DE PROGÊNIE DE MEIOS–IRMÃOS DE *Pinus caribaea* VAR. *hondurensis* BARR. ET GOLF. DE ÁRVORES SUPERIORES SELECIONADAS EM POPULAÇÕES DA AUSTRÁLIA

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Resumo

Um teste de progênie a partir de árvores selecionadas em populações da Austrália foi instalado em Agudos-SP, utilizando-se como testemunhas progênies de árvores selecionadas em populações do Brasil e um lote comercial proveniente da Guatemala. O delineamento estatístico utilizado foi o Latice com 64 tratamentos e 4 repetições, com parcelas lineares de 6 plantas.

Os resultados, obtidos aos dois anos de idade, mostram variações genéticas entre progênies para altura de plantas, ocorrência de "Fox-Tail" e sobrevivência, porém não para ocorrência de bifurcações. Não se detectou variações genéticas significativas entre as progênies derivadas da Austrália e do Brasil.

A partir da análise de variância foram obtidas as variâncias genéticas e não genéticas para altura de plantas, possibilitando a estimativa do coeficiente de herdabilidade no sentido restrito (0,36) e do coeficiente de variação genética (6,74%) para as condições do ensaio.

HALF-SIB PROGENY TRIAL OF *Pinus caribaea* VAR. *hondurensis* BARR. AND GOLF., FROM SELECTED SUPERIOR TREES OF AUSTRALIAN POPULATIONS

Summary

A progeny trial of plus trees of *Pinus caribaea* var. *hondurensis* selected on population from Australia were established in Agudos-SP. A sample of progenies from population of Casa Branca - SP (Brazil) and a commercial seed lot were utilized as controls. The lattice design was utilized involving 64 treatments and four replications, with a linear plots of 6 plants.

The results of progeny trial are showing, at the age of two years, genetic variation among progenies for height, fox-tail ocurrence and failure percent but no for double leaders. There was not significant difference for the performance between progenies selected from population of Australia and Brazil.

From the analysis of variance, genetic and environmental variances for tree height were obtained, wich permited an estimative of narrow sense heritability (0,36) and the genetic coeficient of variaton (6,74%).

TEST DE DESCENDANCE DE "DEMI-FRÈRES" DE *Pinus caribaea* VAR. *hondurensis* BARR. ET GOLF., D'ARBRES D'ÉLITE SÉLECTIONNÉS DANS DES POPULATIONS D'AUSTRALIE

Resume

On a mis en place, à Agubos - SP (Brésil), une expérimentation sur la descendance d'arbres d'élite de Pinus caribaea, var. hondurensis, sélectionnés dans une population se trouvant en Australie. On a utilisé comme contrôle , un échantillon de descendants issus d'une population de Casa Branca - SP (Brésil), et un lot de graines trouvées dans le commerce. Le protocole en lattice (en treilli) utilisé prévoit 64 traitements et 4 répétitions avec des placeaux linéaires de 6 plants .

Les résultats de ce test de descendance montrent, qu'à l'âge de 2 ans, il existe des variations génétiques parmi les descendants, pour divers pourcentages pour ce qui concerne la hauteur des tiges, l'apparition d'une hypertrophie terminale des tiges et les fractures, mais on n'a pas constaté de pousses apicales doubles. On n'a pas observé de différences significatives de développement entre les descendants sélectionnés des populations australiennes et brésiliennes.

Les répercussions des variances génétiques et dues au milieu sur la hauteur des tiges furent obtenues à partir d'une analyse de variance qui a permis une estimation de l'héritabilité, au sens limité du terme, de 0,36 et un coefficient génétique de variation de 6,74 %.

INTRODUÇÃO

A cooperação internacional tem sido bastante importante para um melhor desenvolvimento dos programas de melhoramento com espécies florestais, pois tem possibilitado o enriquecimento da base genética das populações locais, através da injeção de nova variabilidade, principalmente com a utilização de sementes provenientes de árvores selecionadas em outros países. A utilização de tal procedimento tem também possibilitado a aferição do valor das populações bases locais, assim como a checagem da eficiência da seleção executada.

O teste de progênie de polinização livre, apesar das desvantagens e restrições que o mesmo apresenta, é considerado ainda, segundo *SHELBOURNE e COCKREN (1969)*, o método mais barato e atrativo, e vem sendo utilizado com bastante frequência, principalmente nos programas iniciais de melhoramento.

Para uma estimativa ampla e sem restrições dos componentes de variância genética, conforme coloca *VENCOVSKY (1969)*, uma condição é essencial; tanto os indivíduos aparentados que constituem o material experimental, como os da população base, devem ser não endocruzados.

Segundo *NAMKOONG et alii (1966)*, os efeitos de interação de genótipos e ambientes não têm sido considerados na maioria dos trabalhos, sendo normalmente incluídos na componente genética, superestimando as estimativas de herdabilidades.

O presente trabalho tem por objetivo estudar o comportamento da variação genética entre progênies de *Pinus caribaea* var. *hondurensis* obtidas de árvores selecionadas em populações da Austrália, visando o seu possível aproveitamento no programa de melhoramento que vem sendo desenvolvido com a espécie no Brasil.

MATERIAL E MÉTODO

O ensaio envolvendo 64 tratamentos, segundo o delineamento em Latice (8 x 8), com 4 repetições e parcelas lineares de 6 plantas, foi instalado na região de Agudos - SP, em áreas da Companhia Agro-Florestal Monte Alegre, situada a uma latitude de 22º20'S, longitude de 48º50'W e altitude de 550 metros.

Os tratamentos constaram de 41 progênies de polinização livre originadas de árvores selecionadas de *Pinus caribaea* var. *hondurensis* Barr. et Golf. ("ortets"), 15 progênies de polinização livre de árvores selecionadas e propagadas em Pomares de Sementes ("ramets"), provenientes de populações da Austrália. Foram incluídas no ensaio uma amostra de cinco progênies de polinização livre de árvores selecionadas em uma população da espécie situada no município de Casa Branca - SP, além de uma testemunha comercial, repetida três vezes, proveniente da Guatemala.

RESULTADOS E CONCLUSÕES

Os resultados da avaliação preliminar efetuada aos dois anos de idade para os diferentes tratamentos são apresentados na Tabela 1.

Tabela 1. Dados de médias para os diferentes tipos de progênies, aos dois anos de idade, para as características: altura de plantas ($\bar{H}$), porcentagem de falhas (% F), porcentagem de "fox-tail" (% FT) e porcentagem de bifurcação (% BIF).
LOCAL: Agudos - SP

Progênies e Procedências \ Parâmetros	$\bar{H}$ (m)	%F	%FT	%BIF.	Nº Progênies
Byfield Area					
- "ortet"	3,33	5,15	23,09	13,11	21
- "ramet"	3,27	2,72	25,74	11,12	15
Kennedy/Cardwell (Inghand)					
- "ortet"	3,21	8,34	27,43	13,28	13
Beerburrum Area					
- "ortet"	3,39	5,17	19,71	13,86	7
Casa Branca - Brasil					
- "ortet"	3,34	11,09	20,82	12,24	5
Guatemala					
- comercial	3,17	9,11	30,72	13,35	-
Média Geral	3,28	6,93	25,58	12,83	-

Os dados obtidos para crescimento de plantas na localidade de Agudos-SP podem ser comparados aos obtidos em outros dois locais ensaiados, Romaria (MG) e Teixeira de Freitas (BA), à mesma idade de avaliação (2 anos).

Tabela 2. Dados de médias para os diferentes tipos de progênies e testemunhas, aos 2 anos de idade, para as características de altura de plantas (H) e porcentagem de falhas (%F).
LOCAIS: Romaria (Lat. 18º30', Long. 47º20', alt. 800 m) e Teixeira de Freitas (Lat. 17º45', Long. 39º32', Alt. 50 m).

Procedências	Tipo Material	LOCAIS: Teixeira Freitas(BA) idade = 2 anos			Romaria (MG idade = 2 anos		
		nº progênies	H(m)	%F	nº progênies	H(m)	%F
Byfield Area (Australia)	ortet	16	2,50	1,0	17	2,44	3,0
Byfield Area (Australia)	ramet	17	2,50	0	10	2,37	3,0
Kennedy/Cardwell (Australia)	ortet	5	2,48	0	7	2,38	1,0
Beerburrum Area (Australia)	ortet	4	2,66	0	2	2,35	0
Casa Branca (Brasil)	ortet	5	2,54	0	3	2,51	6,0
Guatemala	comercial	-	2,57	0	-	1,93	39,0

Neste estágio da experimentação, os dados coletados nos três locais revelam uma mesma tendência, com pequenas diferenças entre os diversos tipos de progênies, mostrando, principalmente, a pouca diferenciação entre as progênies da Austrália e do Brasil. O local Agudos apresentou maior crescimento comparativamente aos outros dois locais.

Os resultados da análise de variância em latice para crescimento em altura e ocorrência de "fox-tail", no local Agudos, são apresentados na Tabela 3.

Tabela 3. Resultados da análise de variância em latice (64 tratamentos) para altura de plantas (H) e porcentagem de "fox-tail" no local Agudos - SP.

Características	RESULTADOS DA ANAVA: Média	Teste F Tratamentos	Eficiência do latice	Coeficiente de variação %
Altura de plantas (m)	3,28	1,58**	104,6	12,82
"Fox-Tail" (%)	22,01	1,55*	100,8	48,44

* significativo ao nível de 5% de probabilidade

** significativo ao nível de 1% de probabilidade

Os resultados da análise de variância em latice revelam a existência de variações genéticas entre os tratamentos e uma pequena eficiência do latice, para as duas características analisadas. O coeficiente de variação experimental revelou-se bastante alto para "fox-tail", provavelmente devido à forma de avaliação subjetiva para essa característica.

De acordo com *SNYDER (1966)*, a análise de variância pode ser efetuada segundo o esquema de blocos ao acaso quando a eficiência do latice é inferior a 110%. Os resultados da análise em blocos ao acaso são apresentados na Tabela 4, desdobrando-se os tratamentos nos diferentes tipos de progênies e testemunhas.

Tabela 4. Resultados da análise de variância em blocos ao acaso, para altura de plantas e porcentagem de "fox-tail" (%FT), envolvendo as diferentes progênies ("ortets") e testemunhas.

Tratamentos (Progênies)	VALORES DE F DA ANAVA	
	Altura	% Fox-Tail
Byfield Area	3,11**	2,11**
Kennedy/Cardwell	0,62	1,82*
Beerburrum Area	0,71	1,13
Testemunhas	0,95	1,34
Entre grupos	1,32	1,76
Tratamentos	1,76**	1,78**
Coeficiente de Variação (%)	13,1	62,9

* significância ao nível de 5% de probabilidade

** significância ao nível de 1% de probabilidade

Os resultados da análise de variância, desdobrando-se os tratamentos nas diferentes procedências das progênies e testemunhas, mostram variações genéticas entre progênies de Byfield para altura de plantas e entre progênies de Byfield e Kennedy/Cardwell para ocorrência de "fox-tail". Não se detectou variações entre grupos, mostrando uniformidade para os diferentes materiais e testemunhas.

A estimação do coeficiente de herdabilidade a partir dos componentes de variância da análise de variância foi efetuada para altura de plantas, cujos resultados estão expressos na Tabela 5.

Tablea 5. Estimativas de variância entre progênies (σ^2p), da herdabilidade no sentido restrito (h^2) do coeficiente de variação genética (CVg%) para altura de plantas a partir de 41 progênies (ortets) da Austrália.

Caract.	σ^2p	$s(\sigma^2p)$	h^2	CVg(%)
Altura	0,0496	0,0034	0,36	6,74

$s(\sigma^2p)$ = desvio padrão da variância entre progênies

A estimativa da variância entre progênies e do desvio padrão dessa estimativa mostra a precisão para esse parâmetro. A estimativa da herdabilidade, equivalente a 0,36, revela boas perspectivas para a seleção dentro do ensaio, o que é corroborado pelo relativamente alto coeficiente de variação genética (6,74%).

A estimativa da herdabilidade obtida a partir da análise da variância, pressupõe a existência da relação de meios-irmãos para as progênies. Além disso, foi considerado que as 41 progênies de polinização aberta ("ortets") pertenciam a uma mesma população, o que pode não ser verdadeiro. Essa estimativa, no entanto, apesar dessas restrições, se presta para que tenhamos noção da variabilidade do material e do seu potencial para melhoramento.

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TESTE DE PROCEDÊNCIA DE *Pinus oocarpa* SCHIEDE EM CAMPOS DE SABAH

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Resumo

Um teste de procedências de *Pinus oocarpa*, Schiede, com 4 procedências de *P. oocarpa* e uma de *P. caribaea* var. *hondurensis* Golf. e Barr., foi instalado em Sook, em janeiro de 1973. Foram feitas medições anuais de altura e circunferência das árvores.

Após 7 anos foram medidos os seguintes parâmetros: retidão do tronco, características morfológicas, crescimento em "foxtail", sobrevivência e características dos ramos.

Determinou-se que as procedências Yukul e Nit. Pine Ridge são superiores em circunferência e crescimento em altura. Não há diferenças significativas na retidão do tronco, nas características morfológicas, "foxtail", comprimento e número de ramos. Mas as procedências MT. Pine Ridge têm, geralmente, maior diâmetro dos ramos.

PROVENANCE TRIAL OF *Pinus oocarpa* SCHIEDE IN GRASSLAND OF SABAH

Summary

A provenance trial of P. oocarpa. Schiede with 4 provenances of P. oocarpa and one provenance of P. cari-

baea var. hondurensis Golf. and Barr. was established at Sook in January 1973.

Annual assessments of height and girth were made. At year 7, parameters such as stem straightness, morphological characteristic, foxtailing, survival and branch characteristics were assessed.

It was found that the Yukul and Mt. Pine Ridge provenances are superior in girth and height growth. There is no significant differences in stem straightness, morphological characteristic, foxtailing, branch length and branch number. But the Mt. Pine Ridge provenance generally has larger branch diameter.

TEST DE PROVENANCE DE *Pinus oocarpa* SCHIEDE, À SABAH

Resume

Un essai de provenance de *Pinus oocarpa* Schiede comportant 4 provenances de *Pinus oocarpa* et une provenance de *Pinus Caribaea* de la variété *hondurensis* Barr. et Golf. a été mis en place à Sook, en Janvier 1973.

On a procédé à des mensurations annuelles de hauteur et de circonférence. Au cours de la 7ème année on a fait des observations suivantes : rectitude de la tige, caractéristiques morphologiques, hypertrophie terminale et caractéristiques et survivance des branches.

On a constaté que les provenances Yukul et Mt. Pine Ridge étaient supérieures quant à leur croissance en hauteur et en diamètre. Par contre, on n'a pas trouvé de différences notables en ce qui concerne la droiture des tiges, les caractéristiques morphologiques, l'hypertrophie terminale, la longueur des branches, ainsi que leur nombre. Cependant, la provenance Mt. Pine Ridge présente, en général, un diamètre de branches plus important.

1. Introduction

In Sabah, Pinus oocarpa Schiede was introduced in 1953. The first batch of seeds was of Guatemala origin. Shim (1970) reported that the growth of the species is comparable to P. caribaea var. hondurensis Barr. and Golf. but its form appears to be better with less incidence of foxtailing. However, the natural distribution of P. oocarpa covers a wide range in Central America and Mexico. Provenance trials are necessary to determine with seed sources give the optimum results under the conditions in Sabah.

2. Provenance Represented

Four provenances of P. oocarpa and one provenance of P. caribaea var. hondurensis were represented. Seed was supplied by the Commonwealth Forestry Institute, Oxford in 1972. Table A gives some details of the seed sources; additional information on them is given by Greaves (1979).

3. Site

Location : Sook
Longitude : 116° 17'E
Latitude : 5° 8'N
Mean yearly Rainfall : 2158 mm.

Mean Monthly:	J	F	M	A	M	J	J	A	S	O	N	D	
Rainfall:	234	157	97	203	234	183	218	127	143	177	244	142	mm

Mean yearly Temperature : 28°C
Soil : Red/yellow podzolic soil on raised alluvium.
Previous Vegetation : Imperata cylindrica, Pteridium aquilinum var. esculentum, Eugenia spp., Nepenthes spp., Lycopodium spp.

4. Design

The design used is a randomised complete block with 5 replications. Each plot has 11 x 11 rows of trees. The spacing is at 3 x 3 m.

5. Establishment and Management

The seed were sown in beds in March 1972 and seedlings transplanted into 10 x 18 cm. polythene bags in April 1972. NPK fertilizer were added to the potting mix.

Before planting in January 1973, the vegetation on site was cut by a tractor-driver slasher. The seedlings were hand-planted in the field at height of 50 - 60 cm.

The trial was weeded annually by running a farm-tractor between the rows to flatten the I. cylindrica and and P. aquilinum. Two hundred and seventy grams of NPK Blue were applied annually to all trees after weeding.

6. Method of assessment

All measurements were taken from the central 25 trees. Measurement of height and diameter were taken annually. Assessment of stem straightness, foxtailing, morphological characteristics and branch characteristics were assessed in April 1980 at age 7.

6.1 Height and diameter growth

Height and DBH (1.4m) had been measured with aluminium height sticks and diameter tape.

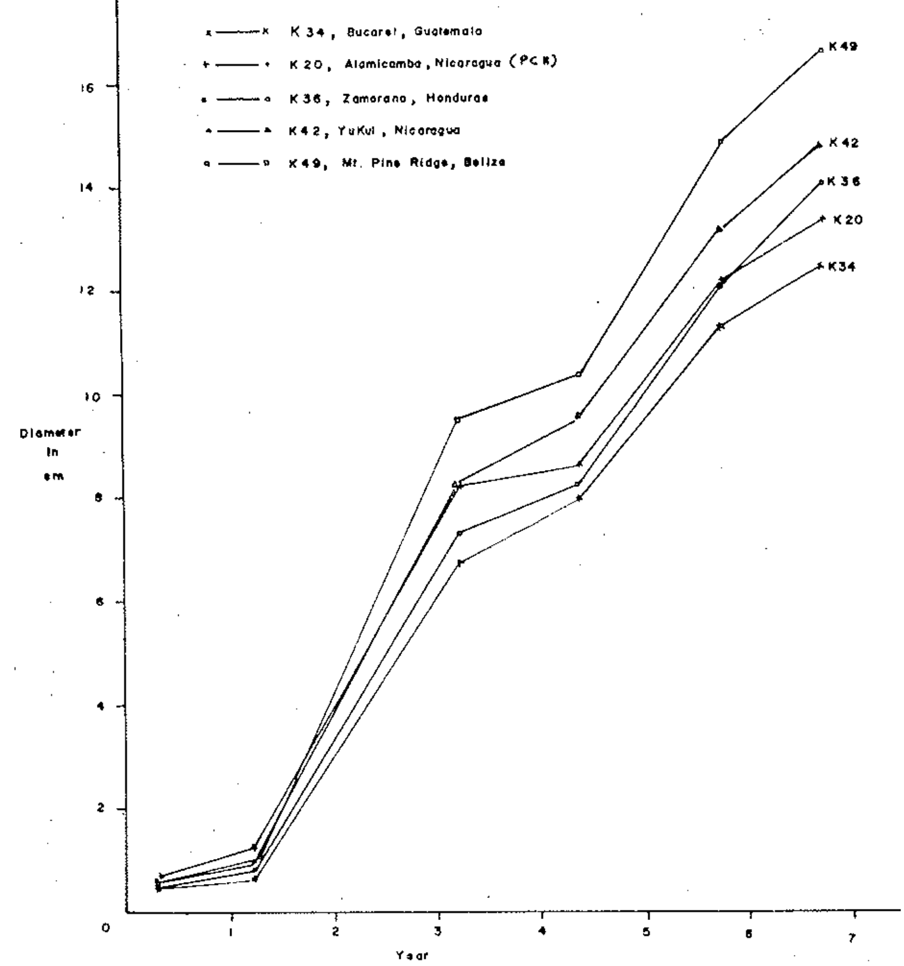
6.2 Stem straightness

The following schedule described by Nikles et. al. (1973) was adopted for used:-

Score	Definition
1	Does not contain two 1.2 m straight logs.
2	Not good enough for 3 - but contains two 1.2 m straight logs.
3	Contains two 2.7 m or one 3.6 m straight logs.
4	Has 3.6 m straight axis, but defects readily seen at a distance from the tree.
5	Has 3.6 straight axis; defects slight and seen only at arm's length from tree.
6	Has 3.6 m straight axis; defects very hard to see.

The lengths were estimated occularly.

Fig.1 Diameter growth of *P. oocarpa* provenances and *P. caribaea var hondurensis*



6.3 Foxtailing

In this assessment, a stem without branches for a length of 1.8 m or more was considered as a foxtail. The presence or absence was recorded.

6.4 Morphological characteristics

In the tropical lowland, Pines often exhibits abnormal and unhealthy growth. Needle, stem and branch dieback, needle less shoots, multiple branching, basket whorls and etc. are common.

The following schedule was used to assess the health of the vegetative structures.

Score	Definition
1	Stem and branch dieback, presence of multiple shoots and basket whorls. Needles short and scarce.
2	Stems and branch dieback; also presence of needleless shoots. Needle flushes few.
3	Presence of stem and branch dieback without needleless shoots.
4	Presence of branch dieback, dead needle accummulation on branches.
5	Crown thin. Needles in short flushes.
6	Crown dense. Needles in long flushes.

6.5 Branch Characteristics

Branch length, diameter, number and angles were assessed at a node nearest to 1.5 m height. Branch length was measured to the nearest 15 cm; diameter to the nearest 1 cm; and angle to the nearest 5° on all branches at the sample node. For measuring the angle, a card-board marked with 5° divisions was used. This was put against the tree and the branch angle read.

7. Analysis

Analysis of variance and Scheffe's test were carried out with a programmable calculator for all data. Arc Sin conversion was applied to percentage of survival and fox-tailing.

8. Results

The means of all parameter assessed and the significance of differences between the provenances and species are listed in Table B. Figure 1 and 2 illustrate height and diameter over a period of seven years.

8a Height and Diameter

The result showed that the Yukul K42, Mt. Pine Ridge K49 and Zamorano K36 provenances are significantly better than the Bucarel K34 in height growth. For diameter growth, the K49 provenance is best.

8b Stem straightness and Morphological characteristics

The analysis showed that there is not significant difference in stem straightness and morphological characteristic between the provenances.

8c Foxtailing

The incidence of foxtailing in P. oocarpa is

Fig. 2 Height growth of P oocarpa provenances and P. caribaea var hondurensis

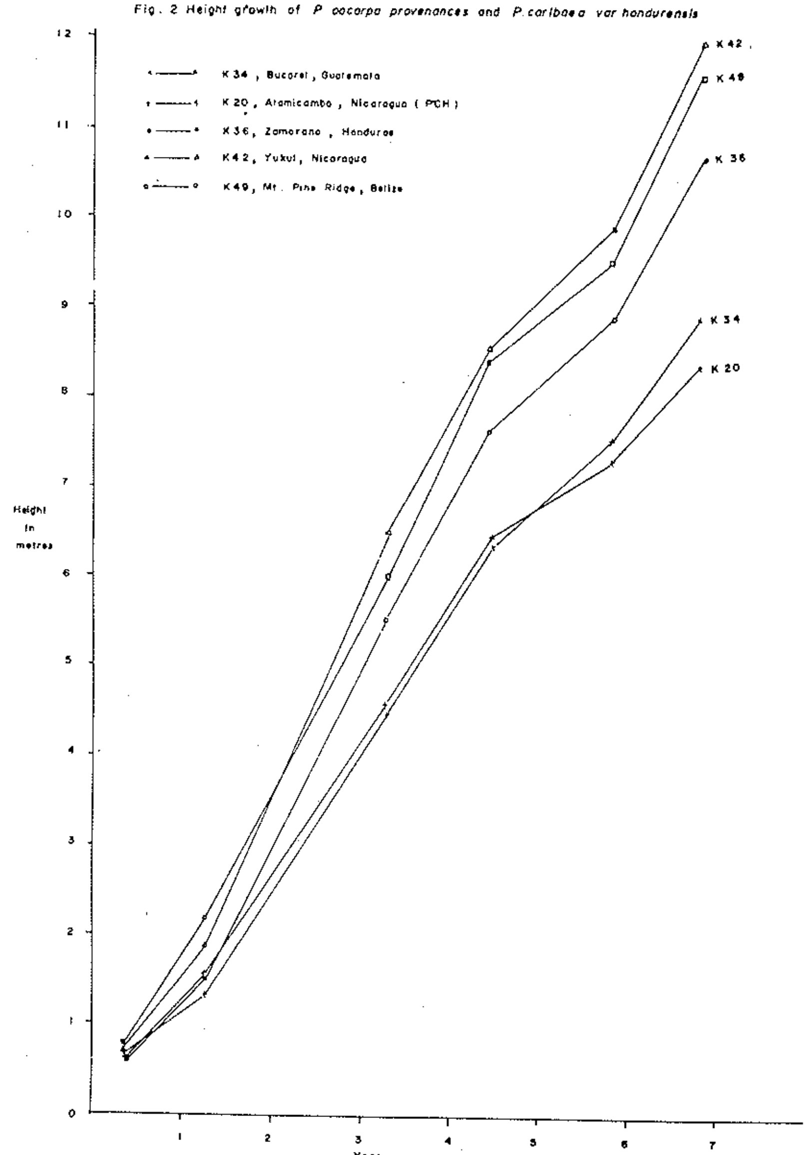


TABLE A SOURCES

Species	Country and site	Store No Provenance No.	Latitude Longitude	Approximate Altitude (m)	Mean Annual rainfall (mm)	No. of Seed Tree in collection
P. oocarpa	Guatemala/Bucaral	3/71 K 34	15° 01'N 90° 00'W	1,000-1,300	900	111
	Honduras/Zamorano	5/71 K 36	13° 58'N 86° 59'W	1,100	1117	120
	Nicaragua/Yucul	6/71 K 42	12° 55'N 85° 47'W	900	1394	46
	Mt. Pine Ridge/ Belize	30/71 K49	17° 00'N 88° 55'W	700	2064	-
P. caribaea var. hondurensis	Nicaragua/ Alamicamba	22/70 K20	13° 23'N 84° 17'W	20 - 30	2610	100

relatively small and there is no significant difference between the provenances.

8d Survival

Generally, the survival is good (over 90%) except K36 which has a survival percentage of 79%.

8e Branch characteristics

The result indicated that the provenances did not show any differences in branch length and number. But K49 has larger branch diameter than K42, K34 and K20. The branch angle of K42, K49 and K36 is also significantly steeper than K34.

Discussion and Conclusion

The Yukul K42 and Mt. Pine Ridge Provenance K49 are the best in diameter and height growth. Both of the provenances are also straight and with little needleless shoots and dieback. But the crown form is not as good as other provenances because the branch angle and branch number are high.

All the provenances of P. oocarpa tested originated from habitats above 700 m altitude. However, they are adaptable to lowland conditions in Sabah. Priority should be given to this species for planting in large-scale.

Table B. Provenance Means and Significance of differences by traits at age 7

Height (m)	Diameter (cm)	Stem straightness	Morphological characteristics	Foxtail %	Survival %	Branch Length (m)	Branch Diameter (mm)	Branch Number	Branch Angle°
K42 11.93	K49 16.54	K42 4.48	K42 4.02	K20 6.4	K20 95.4	K49 1.62	K20 16.3	K42 3.81	K42 28.65
K49 11.61	K42 14.71	K36 4.45	K49 3.98	K49 1.6	K49 96	K20 1.41	K49 14.2	K49 3.61	K49 28.26
K36 10.70	K36 14.02	K49 4.34	K36 3.93	K34 1.6	K34 92	K42 1.33	K42 10.9	K36 3.51	K36 28.05
K34 8.90	K20 13.31	K34 3.82	K34 3.58	K36 1.0	K42 92	K36 1.22	K36 10.7	K34 3.23	K20 25.5
K20 8.39	K34 12.40	K20 3.61	K20 3.09	K42 0.8	K36 79.2	K34 1.05	K34 10.7	K20 2.98	K34 24.8

K42 PO. Yukul/Nicaragua
K36 PO. Zamorano/Honduras
K49 PO. Mt Pine Ridge/Belize
K34 PO. Bucarel/Guatemala
K20 PCH. Alamicamba/Nicaragua

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Greaves A., (1979) Descriptions of seed sources and collections for provenances of Pinus oocarpa. CFI, Oxford. 144 pp.

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SELEÇÃO E MELHORAMENTO DE *Pinus caribaea* EM KALIMANTAN

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Resumo

Variabilidade genética em procedências, famílias, e clones de *Pinus. caribaea* e *P. oocarpa,* têm sido estudada desde 1974 em Kalimantan Leste, Indonésia. Mais são grandes as diferenças entre árvores de várias procedências de *P. caribaea* var. *hondurensis,* e a classificação das procedências varia em função dos locais. No entanto certas procedências deram origem a melhores parcelas que as outras (Mt. Pine Ridge, Alamicamba e Pinalako), com melhoramento de 5 a 7% em altura e diâmetro, em relação à média de teste. A variabilidade em relação à procedência é muito maior em *Pinus oocarpa,* e árvores de Jucul e Mt. Pine Ridge, são normalmente maiores que as árvores de qualquer procedência de *Pinus caribaea.* A variabilidade entre progênies de meio irmão oriundas de árvores "plus" foi mais distinta do que a variação entre árvores de diferentes procedências. A seleção na intensidade de 10% das melhores progênies de meio irmãos, resultaria num acréscimo de 12% para o diâmetro e altura, quando comparados com os valores da tesmunha. A incidência do crescimento "foxtail" foi enormemente reduzida através da propagação vegetativa — clonagem — de indivíduos selecionados com forma normal do tronco. Em todos os testes as diferenças entre locais foram a causa de variação mais importante, enquanto que as interações genótipo local foram não significativas.

SELECTION AND IMPROVEMENT OF *Pinus caribaea* IN KALIMANTAN

Summary

Genetic variability in provenances, families and clones of Pinus caribaea and P. oocarpa has been studied since 1974 in East Kalimantan, Indonesia. Differences among trees from various provenances of P. caribaea var. hondurensis are not large, and provenance ranks frequently vary across sites. Nevertheless, certain sources have consistently produced better stock than others (Mt. Pine Ridge, Alamicamba and Pinalako), with improvement of 5 to 7% in height and diameter over the test average. Variability according to provenance is much greater in P. oocarpa, and trees from the Yucul and Mt. Pine Ridge sources are usually larger than P. caribaea from any source. Variability among half-sib progeny of plus-tree selections was more distinct than among trees from different provenances; selection of the best 10% of the half-sib progeny would result in a 12% increase over controls in both diameter and height. Incidence of foxtailing was greatly reduced by cloning select individuals with normal stem form. In all tests, site differences were the most important cause of variation, whereas site x genotype interactions were negligible.

SÉLECTION ET AMÉLIORATION DE *Pinus caribaea, À KALIMANTAN*

Resume

Depuis 1974, on étudie en Indonésie, à l'Est de Kalimantan, la variabilité génétique qui existe entre les provenances, les familles et les clones de *Pinus caribaea* Morelet et de *Pinus oocarpa* Schiede.

Les différences entre les arbres de provenances diverses du *Pinus caribaea* var. *hondurensis* Barrett & Golfari, ne sont pas très importantes. Elles varient fréquemment suivant les sites. Néanmoins, on constate que certaines provenances produisent de façon régulière de meilleurs résultats que d'autres. (Mt. Pine Ridge, Alamicamba et Pinalako), avec des améliorations de 5 à 7% au-dessus de la moyenne des tests, en hauteur et en diamètre.

La variabilité, selon les provenances du *Pinus oocarpa* est bien plus importante et les arbres de provenance Yucul et Mt. Pine Ridge sont souvent plus grands qu'aucune des autres provenances du *Pinus caribaea*.

La variabilité rencontrée parmi les sélections d'arbres d'élite ayant entre-eux une demi-parenté (descendance uni-parental est plus distincte que parmi les arbres de provenances diverses. Si l'on sélectionnait 10 % des meilleures tiges ayant une demi-parenté, on aurait un accroissement de 12% sur les contrôles de diamètre et de hauteur.

La présence de l'hypertrophie terminale a été fortement réduite par la sélection individuelle de clones présentant une forme de tige normale

Dans tous les essais, la cause principale des variations était due aux différences de sites, tandis que la corrélation entre le site et le génotype était négligeable.

INTRODUCTION

In 1974 International Timber Corporation of Indonesia (ITCI) scientists initiated studies to (1) evaluate genetic diversity of Pinus caribaea Morelet and P. oocarpa Schiede according to provenance, family and clone, and (2) identify outstanding provenances and families that could be used as future sources for seeds or cuttings.

The ITCI concession area is 25 km northwest of Balikpapan, East Kalimantan. The climate is moist tropical forest with 2200 mm average annual precipitation. Although no dry season is recognized, rainfall decreases during June through October. Most soils are in the Ultisol order (Soil Survey Staff 1975), formed from Tertiary sediments. The topography is typified by short, sharply dissected hills and ridges.

Table 1. Characteristics at age 5 years for *Pinus caribaea* and *P. oocarpa* of various provenances planted in East Kalimantan, Indonesia.

Species	Variety	Provenance	Height Jan. 1980 (m)	Height Jan. 1980 ($s_{\bar{x}}$)	Height 1979 increment (m)	Diameter Jan. 1980 (cm)	Diameter Jan. 1980 ($s_{\bar{x}}$)	Diameter 1979 increment (cm)	Foxtails (%)
P. oocarpa		Yucul, Nic. (6/71)	9.7	(0.4)	1.7	14.5	(0.5)	3.1	1
P. oocarpa		Mt. Pine, Belize (30/71)	9.5	(0.8)	1.6	14.4	(1.7)	3.1	2
P. caribaea	*hondurensis*	Brus Lagoon, Hon. (38/71)	9.3	(1.0)	2.2	12.2	(0.5)	2.7	18
P. caribaea	*hondurensis*	Mt. Pine, Belize (44/71)	8.8	(0.6)	1.6	13.2	(0.5)	2.6	9
P. caribaea	*hondurensis*	Alamicamba, Nic. (22/70)	8.8	(1.5)	1.6	12.5	(1.3)	2.3	13
P. caribaea	*hondurensis*	Poptun, Guat. (29/70)	8.7	(1.0)	1.8	12.4	(0.9)	2.4	20
P. caribaea	*hondurensis*	Culmi, Hon. (37/71)	8.6	(1.1)	1.6	13.0	(1.1)	2.6	8
P. caribaea	*hondurensis*	Pinalako, Hon. (40/71)	8.6	(1.1)	1.9	13.0	(1.1)	2.8	5
P. caribaea	*hondurensis*	Guanaja, Hon. (28/70)	8.3	(0.4)	2.0	12.2	(0.3)	2.7	5
P. caribaea	*hondurensis*	Rio Coco, Nic. (24/70)	8.3	(1.0)	1.9	11.8	(0.6)	2.8	18
P. oocarpa		Zapatillo, Hon. (6/70)	8.3	(0.4)	1.8	11.6	(0.7)	3.0	3
P. oocarpa		Conacaste, Guat. (11/70)	8.1	(0.4)	1.5	11.7	(0.7)	2.7	1
P. oocarpa		Junguillo, Nic. (1/71)	8.1	(0.6)	1.7	11.7	(0.5)	3.0	1
P. caribaea	*caribaea*	(59/7291)	6.9	(1.1)	1.8	9.8	(1.5)	2.1	3
P. caribaea	*bahamensis*	(69/7296)	6.7	(1.4)	1.7	9.7	(1.2)	2.2	26

P R O V E N A N C E   V A R I A B I L I T Y

The oldest provenance trial was begun in March 1975, at four locations with different soils and cultivation histories. Fifteen sources of the two species were tested (Table 1), using seed provided by the Commonwealth Forestry Institute, Oxford, England. Field design used randomized blocks, replicated five times at three sites and twice at the fourth site. Spacing was 2.25 x 2.25 m, with 16 trees per plot. Most of this summary is based on that test; supplemental information is from additional tests begun in 1976 and 1978.

After 5 years, survival of *P. caribaea* var. *hondurensis* and *P. oocarpa* averaged 70 and 52%, respectively. Survival of *P. caribaea* var. *bahamensis* and var. *caribaea* was only 28%, and their growth was much less than var. *hondurensis* and *P. oocarpa* (*P. caribaea* var. *bahamensis* and var. *caribaea* will not be discussed further in this paper). Average height, by provenance, for both species across all sites varied from 8.1 to 9.7 m, the range for var. *hondurensis* sources being only 8.3 to 9.3 m (Table 1). Diameter at breast height averaged 11.6 to 14.5 cm, again with a sharply reduced range of 11.8 to 13.2 cm for var. *hondurensis*. *Pinus oocarpa* from Yucul, Nicaragua, and Mt. Pine Ridge, Belize, were tested on only two sites, yet grew signficantly taller than trees from other *P. oocarpa* sources. They had lower incidence of foxtails and were generally larger than *P. caribaea* from any source. Their superior performance was also clearly demonstrated in the 1976 and 1978 supplemental tests (Table 2).

Analyses of 5-year results for height, diameter, survival and foxtail occurrence all indicate that site and random environmental effects are far more influential than provenance or provenance x site interactions. In this study the two latter factors together accounted for less than 10% of the total variance for any of the traits listed. Nonetheless, several seed sources engendered consistently better products than the others (Mt. Pine Ridge, Alamicamba and Pinalako). The Brus Lagoon source has also produced individual trees with impressive height growth, but, like Alamicamba, it produces a high percentage of foxtails, a fact that affects average height of trees from this source (Tables 1 and 2).

Although provenance x site interaction effects were small, provenance ranks were dissimilar across all sites. Correlations of ranks at individual sites with the rank of the provenance averaged over all sites were significant only for height at one site and for diameter at three sites (Table 3). The site with lowest correlations was also the site with lowest productivity. Correlations for diameter were considerably larger than for height, suggesting that diameter may be a better criterion than height for selecting provenances to be used to provide stock for a variety of sites.

Correlations of provenance ranks from trees 3 to 5 years old indicate that tests should be made after age 3, and preferably age 4, to assure reliable ranking (Table 4).

F A M I L Y   V A R I A B I L I T Y

Installations of the International Progeny Study, coordinated by the

Table 2. Characteristics in 2- and 4-year-old tests of *Pinus caribaea* and *P. oocarpa* of various provenances planted in East Kalimantan, Indonesia.

Species	Variety	Provenance	1976 Test (4 years old) Height (m) ($s_{\bar{x}}$)	Diameter (cm)	Diameter ($s_{\bar{x}}$)	Foxtails (%)	1978 Test (2 years) Height (m)	Height ($s_{\bar{x}}$)	Foxtails (%)
P. oocarpa		Mt. Pine, Belize (30/71, 11/74)	8.2 (0.3)	12.0	(0.6)	11	4.1	(0.6)	8
P. oocarpa		Yucul, Nic. (6/71)					3.2	(0.8)	1
P. caribaea	*hondurensis*	Mt. Pine, Belize (44/71, 30/73)	7.4 (0.2)	10.9	(0.3)	13	3.2	(0.7)	11
P. caribaea	*hondurensis*	Alamicamba, Nic. (22/71, 6/74)	7.6 (0.2)	10.4	(0.3)	35	3.0	(0.6)	19
P. caribaea	*hondurensis*	Culmi, Hon. (37/71)	6.9 (0.2)	9.1	(0.4)	21			
P. caribaea	*hondurensis*	Pinalako, Hon. (40/71)	7.5 (0.2)	10.6	(0.3)	22			
P. caribaea	*hondurensis*	Brus Lagoon, Hon. (38/71)	7.1 (0.2)	9.5	(0.3)	43			
P. caribaea	*hondurensis*	Gruanaja, Hon. (28/70)	6.3 (0.2)	9.8	(0.4)	9			
P. caribaea	*hondurensis*	Rio Coco, Nic. (24/70)	7.3 (0.2)	10.2	(0.4)	19			
P. caribaea	*hondurensis*	Poptun, Guat. (29/70)	6.7 (0.2)	9.8	(0.4)	29	3.0	(0.9)	10
P. caribaea	*hondurensis*	Los Limones, Hon. (24/75)					2.6	(0.4)	4
P. caribaea	*hondurensis*	Melinda, Belize (15/74)					2.3	(0.5)	5
P. caribaea	*hondurensis*	Control-Guat.					3.3	(0.7)	17
P. oocarpa		Junguillo, Nic. (6/70)	7.4 (0.2)	10.1	(0.4)	0			
P. oocarpa		Conacaste, Guat. (11/70)	6.9 (0.3)	10.1	(0.6)	0			
P. oocarpa		Zapotillo, Hon. (1/71)	6.5 (0.3)	9.2	(0.5)	0			
P. oocarpa		Mal Paso, Guat. (4/75)	6.7 (0.2)	9.1	(0.4)		3.0	(0.7)	0
P. oocarpa		DiPilto, Nic. (6/75)					3.0	(0.5)	0
P. oocarpa		Pimientilla, Hon. (5/74)					3.0	(0.7)	0
P. oocarpa		Campamento, Hon. (12/72)					2.5	(0.5)	0
P. oocarpa		Pinalan Jalapa, Guat.	8.0 (0.2)	11.1	(0.4)	6			
P. caribaea	*caribaea*	(59/7291, 9/76)	4.1 (0.2)	5.4	(0.5)	0	1.5	(0.3)	0
P. caribaea	*bahamensis*	(69/72)	5.3 (0.2)	7.1	(0.3)	6	1.9	(0.2)	1

Queensland Department of Forestry, were repeated at ITCI in 1977, 1979 and 1980; results from the first test are described here. Basic field design for the 1977 test, which was done at only one location, contained single-tree plots in blocks, with 10 to 60 replications per family. Each family was represented by open-pollinated seed from plus-tree selections from plantations or by ramets from clone banks and seed orchards. A large proportion of the plus-tree selections were from the Mt. Pine Ridge provenance.

Among the 38 families, differences in height, diameter, percentage survival and foxtailing incidence were significant at 3 years of age (Table 5). Performance of a control seedlot of commercial origin (Guatemala) was very close to the average for all selected seedlots, and therefore was used as a baseline to estimate improvement in performance of the most vigorous families. The most successful five families in height averaged 6.3 m; the best five families in diameter averaged 10.2 cm; both groups showed an increase of 12% over the commercial control. However, family ranks for height and diameter were not strongly correlated (r_s = 0.59); several of the tallest examples ranked very low in diameter, and large-diameter examples ranked low in height. Family ranks for height were strongly correlated for ages 2 and 3 (r_s = 0.92). If this trend continues, selection in newer progeny tests might be feasible 3 to 4 years after planting.

CLONE VARIABILITY

Rooted cuttings of P. caribaea have been used in several small tests to evaluate (1) effect of site and site x genotype interactions on tree performance and (2) genetic control of foxtailing. Rooting techniques have included traditional air-layering methods (Lowery 1978) and a less cumbersome pregirdling procedure (Lowery, in press).

For our largest test, cuttings were collected from a representative sample of nonfoxtailed 3-year-old trees, and the rooted clones were planted on a variety of sites. Second-year height of P. caribaea was greatly influenced by differences among clones (3.4 to 4.7 m) and sites (3.3 to 5.5 m) (Table 6). Site differences are attributed not to general soil characteristics but to differences in cultivation and site preparation. Site x genotype interactions were negligible, as indicated by the small percentage contributed to total variance (Table 6). The foxtailing characteristic has not yet appeared on any trees in this study. Pinus oocarpa clones were also used in this test. Clone height means ranged from 3.0 to 5.3 m and site differences were again a significant factor.

In two smaller tests, clones from nonfoxtailed trees have produced only 2% foxtails after 2 years, whereas clones from foxtailed ortets are 63 and 100% foxtailed, 1 and 2 years after planting, respectively. These early results indicate that foxtailing can be reduced significantly by cloning nonfoxtailed trees.

Table 3. Correlation of Pinus caribaea provenance ranks at individual sites with provenance means across all sites (r); fifth-year results.

Site	r: Height	r: Diameter
km 6	0.74*	0.80*
km 21	0.70	0.82*
km 28	0.59	0.76*
2305	0.29	0.59

* Significant at p = 0.05.

Table 4. Correlation of Pinus caribaea provenance ranks at different ages.

Age	1975 Test Height	1975 Test Diameter	1976 Test Height	1976 Test Diameter
2-3			0.67*	
2-4			0.60	
3-4	0.92**	0.53	0.87**	0.91*
3-5	0.72*	0.51		
4-5	0.87**	0.98**		

* Significant at p = 0.05.
** Significant at p = 0.01.

Table 5. Third-year characteristics of 1977 Pinus caribaea progeny test, P.T. ITCI, East Kalimantan.

	Height (m)	Diameter (cm)	Survival (%)	Foxtail (%)
Progeny test average	5.7	9.3	72	11
Control (commercial)	5.6	9.1	96	25
Progeny test range	5.0-6.4	8.3-10.6	52-87	0-33
Best five families (for each parameter)	6.3	10.2		
Best five families (in height)	6.3	9.7	75	21

Table 6. Analysis of variance and variance components as percentages of total variance for second-year height of Pinus cariabaea clones planted on 4 sites.

Source of Variance	Degrees of Freedom	F	Variance Component (% of total)
Locations	3	20.0**	46
Replications in locations	24	3.0**	9
Clones	6	6.38**	10
Clones x locations	18	1.64	3
Error	136		32

* Significant at p = 0.01.

CLOSING REMARKS

Our tree-improvement program in Kalimantan was designed to capitalize on results from the tests described above. Local operating conditions precluded adopting a program as technically sophisticated as possible in other areas.

Plus-trees are being selected from provenance and progeny tests and from operational plantations. Selection is generally limited to individuals within the best provenances and families, to ensure superior genotypes and to counteract some of the effects of microsite variability. Rooted cuttings from plus-trees will be used for clone evaluation and for development of hedging orchards to supply future rooted cutting planting stock.

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CRESCIMENTO E AVALIAÇÕES DE CARACTERÍSTICAS SELECIONADAS DE TESTES DE PROCEDÊNCIAS DE *Pinus caribaea* E *Pinus oocarpa* EM PORTO RICO

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Resumo

São apresentados dados de crescimento de altura e diâmetro e 15 características adicionais de 16 procedências de *Pinus caribaea* Morelet e 15 de *Pinus oocarpa* Schiede, plantadas em uma localidade de Porto Rico. Os ensaios, aos 5, 7 anos de idade, são parte de um esforço mundial para avaliar as interações procedência x localidade para estas espécies, agora amplamente plantadas através das regiões tropicais e sub-tropicais.

O crescimento das procedências superiores foi similar, mas a melhor procedência de *P. oocarpa* suplantou levemente as procedências de mais rápido crescimento do *P. caribaea*, tanto em crescimento em altura como em diâmetro. As procedências de *P. oocarpa* tiveram as mais baixas sobrevivências, o mais inferior comprimento máximo dos internós, as mais baixas frequências de conídeos, e ao mesmo tempo, as mais altas frequências de bifurcações do que *P. caribaea*. As procedências de *P. caribaea* tiveram os maiores volumes de madeira com casca, mais altas áreas basais, e melhores pontuações em relação à retidão do caule do que as procedências de *P. oocarpa*.

GROWTH AND SELECTED ASSESSMENT TRAITS OF *Pinus caribaea* AND *Pinus oocarpa* PROVENANCE TRIALS IN PUERTO RICO

Summary

Data are presented for height and diameter growth and 15 additional traits of 16 Pinus caribaea Morelet and 15 Pinus oocarpa Schiede provenances planted at one location in Puerto Rico. The 5.7-year-old trials are part of a worldwide effort to assess provenance x site interactions of these species, now widely planted throughout the tropics and subtropics.

Growth for top ranked provenances of both species was similar, but the best P. oocarpa provenance slightly surpassed the fastest growing P. caribaea provenances in height and diameter growth. The P. oocarpa provenances had lower survivals, lower maximum internode lengths, lower conelet frequencies, but higher forking frequencies than P. caribaea. The P. caribaea provenances had higher overbark volumes, higher basal areas, and better stem straightness ratings than P. oocarpa provenances.

CROISSANCE ET ÉVALUATIONS DE CARACTÉRISTIQUES SÉLECTIONNÉES DE TESTS DE PROVENANCES DE *Pinus caribaea* ET DE *Pinus oocarpa*, À PORTO RICO

Resume

Présentation des résultats d'observations de la croissance en hauteur, en diamètre, ainsi que sur 15 autres points effectuées sur 16 Pinus caribaea, MORELET, et 15 Pinus oocarpa de provenances différentes. Ces essais, effectués sur un site de Porto-Rico, depuis plus de 5 ans et demi (5,7 ans), font partie d'un effort mondial d'appréciation des corrélations qui existent entre les différentes provenances de ces espèces et les sites d'implantation, car, maintenant, ces espèces sont très largement introduites dans les zones tropicales et subtropicales.

Les caractéristiques de croissance des meilleures provenances de ces deux espèces sont similaires, mais la meilleure provenance de Pinus oocarpa présente des croissances en hauteur et en diamètre qui surpassent légèrement les provenances de Pinus caribaea à croissance les plus rapides. Les provenances de Pinus oocarpa donnent des pourcentages de survivants plus faibles, les longueurs d'entre nœuds et les strobiles les plus élevés, mais aussi, pour les fourches, un taux de fréquences plus élevé que le Pinus caribaea.

De leur côté, les provenances de Pinus caribaea présentent des volumes sur écorce, des surfaces terrières plus élevées, ainsi que de meilleurs taux de rectitude du fût que les provenances de Pinus oocarpa.

INTRODUCTION

Puerto Rico has imported almost all of its wood products for many decades (Wadsworth 1971) and has no native commercial conifers. Important local hardwoods grow slowly and occur in secondary forests having mixed age classes and species composition (Weaver 1979). In 1939 the Institute of Tropical Forestry (ITF) began to identify fast growing exotic pines and hardwoods suitable for commercial plantations and local wood industries. Initial pine plantings failed until mycorrhizal fungi were introduced (Briscoe 1959; Hacskaylo and Vozzo 1967). By 1970 results from adaptability, spacing, and early provenance trials showed that Pinus caribaea Morelet and Pinus oocarpa Schiede had fast height growth and good survival on many sites (Geary and Briscoe 1972; Whitmore 1972). So, ITF established more extensive provenance trials of these two pine species between 1973 and 1975, in cooperation with the Commonwealth Forestry Institute (CFI) of the University of Oxford.

Over 40 countries have established similar trials since the early 1970's. Growth data from these have been analyzed and presented in various formats (Burley and Nikles 1972, 1973; Nikles et al. 1978). In 1978 CFI began collecting uniform data for assessment of some 50 traits (Barnes and Gibson 1980) from

Table 1. Site data for 5.7-year old Pinus caribaea and Pinus oocarpa provenance trials at Añasco, Puerto Rico.

SITE PARAMETER	PARAMETER DESCRIPTION
Latitude	18°19' 54" N
Longitude	67°06' 41" W
Elevation	150-200 m
Topography	0-35 percent slopes
Aspect	N-NE-E
Life Zone[1/]	Subtropical wet
Past land use	Minor crops and secondary forest
Soils	
series	Humatas clay (Typic Tropohumult)[2/] Consumo clay (Dystropeptic Tropudult)[2/]
acidity[3/] (1:1 in H_2O)	pH 4.6 at surface to pH 4.8 in lower horizons
structure[3/]	fine granular at surface to massive in lower horizons
depth[3/]	± 240 cm
organic matter (%)[3/]	8.3 at surface to 0.3 in lower horizons
base saturation (% of CEC)[3/]	12 percent at surface to 3 percent in lower horizons

1/ Using Holdridge (1967) classification of vegetational types.

2/ From Lugo-López and Rivera (1977), using nomenclature of Soil Taxonomy, developed by USDA Soil Conservation Service (1975).

3/ Data are for Humatas clay and taken from USDA Soil Conservation Service (1967).

Table 2. Provenances of *Pinus caribaea* and *Pinus oocarpa* planted at Añasco, Puerto Rico, in October 1973.

PINUS CARIBAEA			PINUS OOCARPA		
CFI NO.	SEED STORE NO.	ORIGIN	CFI NO.	SEED STORE NO.	ORIGIN
K 66	47/71	Melinda, Belize	K 1	1/70	Camelias, Nicaragua
	46/71	Byfield, Queensland Australia	K 6	6/70	Zapotillo, Honduras
K 61	45/71	Santa Clara, Nicaragua	K 11	11/70	Conacaste, Guatemala
K 65	44/71	Mountain Pine Ridge, Belize	K 16	16/70	Agua Fria, Honduras
K 60	40/71	Potosi, Honduras	K 20	22/70 1/	Alamicamba, Nicaragua
K 57	37/71	Culmi, Honduras	K 31	1/71	Junquillo, Nicaragua
K 54	34/71	Briones, Honduras	K 34	3/71	Bucaral, Guatemala
	24/71 2/	El Burén, Cuba	K 36	5/71	Zamorano, Honduras
	19/71 2/	Los Palacios, Cuba	K 42	6/71	Yucul, Nicaragua
K 24	28/70	Guanaja Island, Honduras	K 45	7/71	Siguatepeque, Honduras
K 23	27/70	Brus Lagoon, Honduras	K 43	8/71	Lagunilla, Guatemala
K 29	26/70	Poptun, Guatemala	K 47	10/71	San José, Guatemala
K 22	24/70	Río Coco, Nicaragua	K 44	27/71	Rafael, Nicaragua
K 20	22/70	Alamicamba, Nicaragua	K 48	29/71	Malacatancito, Guatemala
K 19	21/70	Karawala, Nicaragua	K 49	30/71	Mountain Pine Ridge, Belize
	69/7296 2/	Andros Island, Bahamas	EM 70	31/71	Jitotil, Mexico

1/ This *P. caribaea* var. *hondurensis* provenance included as a "standard" against which *P. oocarpa* growth could be measured.

2/ 24/71 and 19/71 are provenances of *P. caribaea* var. *caribaea* Morelet; 69/7296 is a provenance of *P. caribaea* var. *bahamensis*; the other 13 provenances are all *P. caribaea* var. *hondurensis*.

key trials that covered the range of climatic and environmental conditions under which the species were planted. This report summarizes findings on 17 traits from two *P. caribaea* and one *P. oocarpa* planting, selected by CFI for inclusion in its uniform assessment study.

STUDY SITE AND EXPERIMENTAL METHODS

The Añasco site is located in western Puerto Rico. Mean annual rainfall is 2090 mm, with driest months (50-80 mm) being December to March. Soils are deep clay Ultisols high in acidity and low in nutrients. Other geographical and soil features at the Añasco site (Table 1) are typical of large areas suitable for commercial plantations.

Two plantings (A and B) of the *P. caribaea* trial (Oxford No. 57) and one of the *P. oocarpa* trial (Oxford No. 37) were included in the CFI uniform assessment. Experimental design for each planting is randomized complete blocks with 16 provenances per planting (Table 2) and five replications of 7-tree row plots for each provenance (35 trees per provenance if none died). The known fast-growing Alamicamba provenance of *P. caribaea* var. *hondurensis* was included in the *P. oocarpa* trial as a "standard" against which *P. oocarpa* growth could be assessed. Field spacing was 2.7 x 2.7 m. There were no surround rows.

The site was cleared by bulldozer before planting in October 1973; profuse shrubby secondary vegetation precluded normal hand clearing. Nursery stock was 20 to 30 cm tall; individual seedlings were grown in polyethylene bags (10 x 23 cm) containing sandy loam soil. The trials were hand weeded three to four times a year for the first 2 years and once or twice thereafter.

Table 3. Analysis of variance F-test results for 14 traits of 5.7-year old *Pinus caribaea* and *Pinus oocarpa* provenances planted at Añasco, Puerto Rico.

TRAIT	*P. oocarpa*		*P. caribaea* A		*P. caribaea* B	
	F-test 1/	VC 2/ %	F-test 1/	VC 2/ %	F-test 1/	VC 2/ %
Height (m)	***	24	**	11	***	17
Overbark diameter (cm)	***	18	**	10	***	16
Overbark volume (m^3/ha)	***	64	**	27	***	38
Basal area (m^2/ha) 3/	***	54	***	30	***	6
Bark volume (%)	***	26	NS	2	***	6
Overbark form factor	***	20	***	11	*	4
Crown depth (%)	***	15	NS	0	NS	0
Stem straightness	***	16	***	11	***	11
Forking frequency (%) 3/	***	33	NS	9	NS	12
Maximum internode (m)	***	22	***	10	**	6
Number of whorls (From 1-6m)	***	19	***	26	***	19
Number of branches (per whorl)	***	17	NS	1	*	4
Number of branches (per 1m)	***	10	***	20	***	19
Conelet frequency (%) 3/	NS	8	***	52	***	51

1/ Significance levels: *** P.001, ** P.01, * P.05, NS-not significant.

2/ VC - variance component; the proportional variation (%) that provenances contributed to the total variation for any trait assessed by individual tree or plot mean analysis.

3/ Traits analyzed on a plot mean basis; other traits analyzed on individual tree basis.

Table 4. Height and diameter growth and survival of 5.7-year old *Pinus oocarpa* and *Pinus caribaea* provenances at Añasco, Puerto Rico. Studentized Range Levels at P.05; provenance means joined by same bar are not statistically different.

		Height[1] (m)		Overbark[1] Diameter (cm)
Pinus oocarpa	30/71[2]	11.4	30/71[2]	15.9
	6/71	10.9	22/70[3]	14.7
	22/70[3]	10.9	6/71	14.7
	1/70	10.5	1/70	13.9
	27/71	10.2	27/71	13.3
	5/71	9.7	5/71	12.9
	1/71	9.1	11/70	11.7
	10/71	9.0	10/71	11.4
	11/70	8.9	31/71	11.3
	8/71	8.5	3/71	11.0
	7/71	8.5	1/71	10.8
	3/71	8.3	29/71	10.5
	6/70	8.2	16/70	10.5
	31/70	8.1	8/71	10.2
	16/70	7.9	7/71	10.0
	29/71	7.4	6/70	9.6
OM[4]		9.2		12.1
CV[5]		4.7		7.1
Pinus caribaea A	22/70	11.2	46/71	15.4
	26/70	10.3	45/71	14.6
	21/70	10.3	44/71	14.5
	37/71	10.2	22/70	14.4
	44/71	10.1	26/70	14.1
	46/71	10.1	21/70	14.1
	40/71	9.9	40/71	13.8
	24/70	9.7	34/71	13.7
	34/71	9.7	28/70	13.7
	45/71	9.7	24/70	13.5
	28/70	9.3	37/71	13.3
	47/71	9.1	47/71	13.0
	24/71	9.0	27/70	12.6
	27/70	8.9	24/71	11.5
	19/71	8.0	19/71	10.4
	69/7296	7.5	69/7296	9.6
OM[4]		9.6		13.3
CV[5]		5.6		6.9
Pinus caribaea B	40/71	10.4	40/71	15.1
	26/70	9.7	46/71	14.1
	27/70	9.7	26/70	13.8
	46/71	9.6	37/71	13.7
	37/71	9.5	22/70	13.4
	22/70	9.4	44/71	13.3
	28/70	9.3	21/70	13.1
	45/71	9.2	27/70	13.1
	21/70	9.2	24/70	13.0
	44/71	9.2	28/70	12.8
	47/71	8.7	34/71	12.6
	24/70	8.6	45/71	12.5
	24/71	8.6	47/71	12.1
	34/71	8.5	24/71	11.3
	19/71	7.3	19/71	10.2
	69/7296	7.0	69/7296	9.6
OM[4]		9.0		12.7
CV[5]		4.1		4.3

1/ Individual tree analysis
2/ CFI provenance seed store number
3/ Alamicamba, Nicaragua provenance of *Pinus caribaea*
4/ OM-overall mean
5/ CV-coefficient of variation

Table 5. Overbark volume and basal area of 5.7-year old *Pinus oocarpa* and *Pinus caribaea* provenances at Añasco, Puerto Rico. Studentized Range Levels at P.05; provenance means joined by same bar are not statistically different.

		Overbark[1] Volume (m^3/ha)		Basal[1] Area (m^2/ha)
Pinus oocarpa	30/71[2]	211.5	30/71[2]	25.6
	6/71	186.8	22/70[3]	22.9
	22/70[3]	185.7	6/71	22.3
	1/70	176.9	1/70	21.6
	27/71	133.9	27/71	17.2
	5/71	109.6	5/71	16.7
	10/71	93.8	10/71	13.2
	11/70	85.2	11/70	12.8
	1/71	80.7	29/71	12.3
	8/71	73.7	1/71	11.6
	3/71	70.7	3/71	11.5
	31/71	68.0	31/71	11.5
	29/71	64.5	8/71	11.3
	16/70	63.2	16/70	10.9
	7/71	59.3	7/71	9.6
	6/70	45.6	6/70	8.0
OM[4]		107.7		15.1
CV[5]		16.2		14.4
Pinus caribaea A	46/71	191.7	45/71	24.7
	22/70	186.4	46/71	24.0
	45/71	178.5	21/70	23.4
	21/70	178.4	26/70	22.3
	26/70	166.4	34/71	22.0
	24/70	164.1	22/70	21.8
	34/71	162.5	40/71	21.6
	40/71	152.3	24/70	21.3
	44/71	151.4	44/71	21.0
	28/70	129.1	28/70	20.2
	47/71	126.3	47/71	19.0
	37/71	126.2	37/71	17.7
	27/70	109.5	27/70	17.4
	24/71	86.5	24/71	13.9
	19/71	62.7	19/71	11.4
	62/7296	41.5	69/7296	8.0
OM[4]		138.3		19.3
CV[5]		19.0		13.6
Pinus caribaea B	40/71	165.3	40/71	23.0
	46/71	142.2	46/71	21.4
	37/71	136.3	37/71	20.0
	26/70	126.3	44/71	18.6
	27/70	125.3	21/70	18.5
	44/71	119.8	26/70	18.5
	28/70	119.7	28/70	18.3
	21/70	119.2	22/70	17.5
	22/70	110.3	27/70	16.8
	45/71	108.4	45/71	16.5
	24/70	82.3	34/71	15.0
	34/71	80.8	24/70	14.9
	47/71	79.5	47/71	14.0
	24/71	79.4	24/71	13.8
	19/71	54.4	19/71	10.4
	69/7296	33.0	69/7296	7.6
OM[4]		105.1		16.5
CV[5]		14.8		11.0

1/ Plot mean analysis
2/ CFI provenance seed store numbers
3/ Alamicamba, Nicaragua provenance of *Pinus caribaea*
4/ OM-overall mean
5/ CV-coefficient of variation

Field measurements were made in June and July 1979, when the plantings were 5.7 years old. All measurements and observations were coded on field sheets prepared by CFI. For the 1508 trees assessed, total height was determined with a range pole, diameter at breast height with a plastic tape, and bark thickness with a bark gauge. Primary computer analysis of field data was done by CFI.

RESULTS

Overall growth and survival

The best *P. oocarpa* source, Mt. Pine Ridge, outgrew all *P. caribaea* provenances, but differences in height and diameter growth between it and the Alamicamba *P. caribaea* standard were not significant. Height and diameter growth varied more for *P. oocarpa* than for *P. caribaea* provenances (Tables 3, 4). Height growth in all three plantings surpassed 9 m in 5.7 years, representing a mean annual height increment (MAIH) of 1.6 m. The best provenances had MAIH's of or near 2.0 m. Overbark diameters averaged 12.1 cm for *P. oocarpa* and 13.0 cm for *P. caribaea*; corresponding mean annual diameter increments (MAID's) were 2.1 and 2.3 cm. Diameters of the top five provenances in all plantings exceeded 14.0 cm, or a MAID of 2.5 cm.

Overall survival for *P. caribaea* was 92 percent, slightly better than the 85 percent survival for *P. oocarpa*. Of the three plantings, only *P. caribaea* A had significant survival differences. No provenance had less than 71 percent survival. Provenances with the best height and diameter growth usually had the highest survivals, in both the *P. caribaea* and *P. oocarpa* trials.

The Mt. Pine Ridge *P. oocarpa* provenance had greater overbark volume (m^3/ha) and basal area (m^2/ha) than did the *P. caribaea* provenances. These two traits were also more variable for *P. oocarpa* than for *P. caribaea* provenances (Tables 3, 5). The top five provenances in the *P. oocarpa* and *P. caribaea* A plantings averaged 180 m^3 overbark volume; mean annual volume increment (MAIV) was 32 m^3. The top five provenances in *P. caribaea* B averaged 139 m^3 or a MAIV of 24 m^3. There were no significant provenance differences for bark volume (%) in *P. caribaea* A, few in *P. caribaea* B, but many in the *P. oocarpa* planting. In all plantings, provenances with greater MAIH and MAID growth and highest total overbark volumes usually had lowest bark volumes.

Stem form and straightness

There were many significant differences in form factor ratings and crown depth (%) for *P. oocarpa* but few or no differences for *P. caribaea* provenances (Table 6). For *P. oocarpa*, provenances with better height and diameter growth usually had large crowns and higher form factor ratings. There were many significant differences in stem straightness ratings for both *P. caribaea* and *P. oocarpa* (Table 6). Yet the top five *P. oocarpa* provenances in height and diameter growth did not have significantly different stem straightness ratings. The Jitotil, Mt. Pine Ridge, and two Guatemalan *P. oocarpa* provenances had lowest overall stem straightness. The Cuban and Bahaman P. caribaea provenances had the lowest form factors but the best stem straightness.

Forking frequency did not exceed 28 percent for any P. caribaea provenance; differences between provenances were not significant (Table 3). Forking was much higher for P. oocarpa. The range was 0 to 42 percent, with the maximum occurring for the Siguatepeque, Honduras, provenance. Maximum internode length[1] did not exceed 1.1 m in any P. oocarpa provenance. Provenance differences were not significant except for the Alamicamba standard; its internode length was 3.3 m and surpassed those of all P. oocarpa provenances. Internode lengths were more variable for and there were more significant differences for P. caribaea provenances. The Coastal Central American, Byfield, and Bahaman sources had greatest maximum internodes, from 2 to 4 m. The Cuban sources ranked lowest, with maximum internodes between 0.5 and 0.7 m.

Branching and Conelets

Number of whorls and number of branches per whorl or per meter were slightly greater for P. oocarpa than for P. caribaea provenances (Table 7). The two Cuban P. caribaea provenances ranked high for these traits and had significantly more whorls and branches per meter in the first 6 m than other P. caribaea provenances. The top P. oocarpa provenances in height growth generally had fewer whorls but more branches per whorl than the others.

Pinus caribaea provenances had fine-medium to medium-coarse branching and P. oocarpa had fine-medium to medium branching. The Cuban and Bahaman P. caribaea provenances had finest branching. Branch angles were slightly flatter for P. oocarpa than for P. caribaea provenances. Fastest growing provenances generally had coarser branches and more acute branch angles in both the P. caribaea and P. oocarpa trials.

Conelet frequencies (the percentage of all individuals having conelets) were greater for P. caribaea than for P. oocarpa provenances. The ranges were 4 to 37 percent for P. oocarpa and 0 to 55 percent for P. caribaea. The inland sources of P. caribaea had greatest conelet frequencies. Provenances with greater height growth in both trials did not always rank high in conelet frequency.

1/ This parameter was the mean length of the longest internodes recorded for all individuals of any provenance in each planting. It is therefore an index of foxtailing, i.e. provenances tending to foxtail have greater internode lengths.

DISCUSSION

Mean annual growth rates for the top five provenances of P. caribaea and P. oocarpa were similar, near 2.0 m for height and better than 2.5 cm for

Table 6. Stem form and straightness characteristics of 5.7-year old Pinus oocarpa and Pinus caribaea provenances at Añasco, Puerto Rico. Studentized Range Levels at P.05; provenance means joined by same bar are not statiscally different.

	Overbark[1] Form Factor (rating)		Crown[1] Depth (%)		Stem[1] Straightness (rating)	
Pinus oocarpa	22/70[2,3]	.68	27/71[2]	82	5/71[2]	9.9
	30/71	.68	6/71	80	8/71	9.7
	6/71	.67	1/70	77	27/71	9.6
	27/71	.66	30/71	76	6/71	9.5
	1/70	.65	22/70[3]	74	1/71	9.1
	5/71	.63	16/70	74	1/70	8.8
	11/70	.63	5/71	73	16/70	8.5
	1/71	.62	31/71	73	11/70	7.0
	8/71	.62	6/70	72	7/71	6.9
	10/71	.62	10/71	72	10/71	6.7
	16/70	.61	3/71	70	6/70	6.3
	7/71	.60	29/71	70	22/70[3]	6.2
	3/71	.60	8/71	69	30/71	6.0
	6/70	.58	1/71	69	3/71	5.4
	31/71	.58	7/71	68	29/71	3.1
	29/71	.57	11/70	67	31/71	2.8
OM[4]		0.62		73		7.2
CV[5]		2.03		3		11.4
Pinus caribaea A	22/70	.68	28/70	80	24/71	11.8
	46/71	.66	40/71	79	19/71	11.5
	21/70	.65	24/70	79	22/70	9.2
	44/71	.65	46/71	78	46/71	8.9
	24/70	.64	19/71	78	69/7296	8.7
	26/70	.64	24/71	78	44/71	8.5
	40/71	.64	37/71	78	24/70	8.4
	37/71	.64	26/70	77	34/71	7.9
	34/71	.64	44/71	77	28/70	7.3
	45/71	.63	47/71	77	47/71	7.3
	28/70	.62	21/70	76	21/70	7.0
	47/71	.62	45/71	76	27/70	7.0
	27/70	.62	27/70	75	37/71	6.5
	24/71	.61	69/7296	75	26/70	6.2
	19/71	.59	22/70	73	45/71	5.4
	69/7296	.56	34/71	73	40/71	4.7
OM[4]		0.63		77		7.9
CV[5]		2.33		3		11.4
Pinus caribaea B	27/70	.75	19/71	83	19/71	12.1
	46/71	.65	47/71	81	24/71	11.7
	40/71	.65	24/70	80	69/7296	10.4
	22/70	.64	24/71	79	44/71	10.3
	45/71	.63	34/71	79	46/71	10.1
	44/71	.63	44/71	79	45/71	10.0
	26/70	.63	69/7296	79	22/70	9.7
	21/70	.63	27/70	79	47/71	9.6
	37/71	.62	46/71	79	21/70	8.9
	28/70	.61	26/70	79	34/71	8.2
	24/70	.61	28/70	79	27/70	7.5
	47/71	.61	21/70	78	28/70	7.1
	24/71	.60	22/70	77	24/70	7.1
	34/71	.60	37/71	76	37/71	6.9
	19/71	.58	40/71	76	26/70	6.4
	69/7296	.56	45/71	74	40/71	5.1
OM[4]		0.62		79		8.8
CV[5]		4.28		3		11.6

1/ Individual tree analysis
2/ CFI provenance seed store numbers
3/ Alamicamba, Nicaragua provenance of Pinus caribaea
4/ OM-overall mean
5/ CV-coefficient of variation

Table 7. Branching and conelet traits of 5.7-year old Pinus oocarpa and Pinus caribaea provenance trials at Añasco, Puerto Rico. Studentized Range Levels at P.05; provenance means joined by same bar are not statistically different.

	No. of[1] whorls (From 1-6m)		No. of[1] branches (per whorl)		No. of[1] branches (per 1 m)	
Pinus oocarpa	29/71[2]	14.6	6/71[2]	3.9	6/71[2]	9.7
	31/71	14.0	30/71	3.8	1/71	8.5
	11/70	13.4	1/71	3.4	11/70	8.5
	3/71	13.4	27/71	3.4	27/71	8.3
	6/70	12.7	1/70	3.3	5/71	8.2
	8/71	12.7	5/71	3.2	8/71	8.0
	6/71	12.6	11/70	3.2	30/71	7.9
	1/71	12.6	8/71	3.2	31/71	7.8
	5/71	12.6	10/71	3.0	1/70	7.8
	7/71	12.5	7/71	2.9	29/71	7.7
	30/71	12.5	16/70	2.9	10/71	7.5
	27/71	12.3	22/70[3]	2.9	7/71	7.4
	1/70	11.9	31/71	2.8	3/71	7.2
	16/70	11.4	6/70	2.7	6/70	6.9
	30/71	10.4	3/71	2.7	16/70	6.7
	22/70[3]	9.8	29/71	2.7	22/70[3]	6.0
OM[4]		12.5		3.1		7.8
CV[5]		3.2		4.5		5.0
Pinus caribaea A	19/71	17.2	45/71	3.3	19/71	10.7
	24/71	16.2	24/71	3.2	24/71	10.4
	45/71	12.5	34/71	3.1	45/71	8.1
	34/71	12.5	19/71	3.1	34/71	8.0
	28/70	11.6	46/71	3.0	37/71	7.1
	37/71	11.5	28/70	2.9	28/70	6.8
	47/71	11.2	37/71	2.9	21/70	6.4
	21/70	11.0	44/71	2.9	40/71	6.2
	40/71	10.8	26/70	2.9	47/71	5.8
	44/71	9.7	22/70	2.8	44/71	5.8
	27/70	9.5	40/71	2.8	46/71	5.4
	69/7296	9.0	24/70	2.8	24/70	5.4
	24/70	8.8	69/7296	2.7	69/7296	5.2
	46/71	8.6	21/70	2.7	22/70	5.1
	22/70	8.2	27/70	2.7	26/70	4.9
	26/70	8.0	47/71	2.5	27/70	4.8
OM[4]		11.0		2.9		6.6
CV[5]		7.4		6.1		9.9
Pinus caribaea B	24/71	17.2	24/71	3.1	24/71	10.8
	19/71	16.5	46/71	3.1	19/71	9.9
	40/71	12.2	19/71	3.0	34/71	7.0
	34/71	12.0	44/71	3.0	40/71	6.9
	37/71	11.9	45/71	2.9	37/71	6.8
	69/7296	11.9	34/71	2.9	46/71	6.7
	47/71	11.7	37/71	2.8	45/71	6.6
	28/70	11.6	28/70	2.8	69/7296	6.6
	21/70	11.4	22/70	2.8	28/70	6.6
	22/70	11.1	40/71	2.8	22/70	6.5
	45/71	11.1	21/70	2.7	47/71	6.5
	46/71	10.9	47/71	2.7	21/70	6.3
	44/71	10.6	26/70	2.7	44/71	6.3
	24/70	10.4	69/7296	2.7	24/70	5.5
	27/70	10.0	24/70	2.6	27/70	5.1
	26/70	8.0	27/70	2.4	26/70	4.6
OM[4]		11.8		2.8		6.8
CV[5]		7.8		4.6		9.5

1/ Individual tree analysis
2/ CFI provenance seed store numbers
3/ Alamicaba, Nicaragua provenance of Pinus caribaea
4/ OM-overall mean
5/ CV-coefficient of variation

diameter. These rates equal or often surpass the best rates from 4-year or older provenance trials in other countries, as reviewed by Nikles et al. (1978) and Greaves (1980). Top provenances at other sites in Puerto Rico have performed even better than top ones at Añasco (ITF unpub. data, Study FS-SO-1152-2466). High growth rates reported here do not necessarily reflect "edge effect" in the absence of border rows. Rates of 1.5 m and 1.8 cm for MAIH and MAID growth have been measured in local 4- to 14-year-old unthinned *P. caribaea* var. *hondurensis* plantations where three or more border rows were present (ITF unpub. data, Study FS-SO-1152-2474).

Height and diameter growth of *P. caribaea* were apparently better on planting A than on planting B. Topsoil material shoved down from site B during initial land clearing could have improved inherent fertility of site A, thus promoting somewhat better growth there. But statistical significance of these differences has not yet been tested.

Most vigorous *P. oocarpa* provenances at Añasco, as in many countries (Greaves 1980), are those from Yucul, Rafael, Camelias, and Mt. Pine Ridge (Table 4). The most vigorous *P. caribaea* provenances are those from Poptun, Alamicamba, Culmi, and Byfield. Relationships between fast growth and important assessment traits are complex and did not follow similar trends for both *P. caribaea* and *P. oocarpa*. Study of other traits not yet analyzed, including resin and wood core samples and resistance to hurricane winds, is needed before we can choose the best provenances for reforestation in Puerto Rico.

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PRIMEIROS RESULTADOS DE TESTES DE INTRODUÇÃO DE PINHEIROS TROPICAIS, REALIZADOS EM MADAGASCAR, DESDE 1970

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Resumo

Nos últimos 10 anos, alguns testes comparativos envolvendo espécies de pinheiros tropicais, têm sido instalados em Madagascar, e despertado grande interesse pelas espécies: *Pinus caribaea* var. *Hondurensis, Pinus patula, Pinus oocarpa, Pinus greggii* e *Pinus Kesiya.* Posteriormente, testes comparativos de procedências foram estabelecidos para *Pinus caribaea, Pinus patula* e *Pinus oocarpa.* Os testes de procedência de *Pinus oocarpa* constituem assunto de um outro trabalho.

FIRST RESULTS ON TRIALS OF TROPICAL PINE INTRODUCTION CARRIED ON IN MADAGASCAR SINCE 1970

Summary

During these last ten years, some comparative trials on tropical Pine species have been carried on in Madagascar and have brought out all the interest for species as Pinus caribaea var. hondurensis, Pinus patula, Pinus oocarpa, Pinus greggii and Pinus kesiya. Furthermore, comparative provenance trials have been settled on concerning Pinus caribaea, Pinus patula and Pinus oocarpa. Provenance trials on Pinus oocarpa form the matter of a separate paper.

PREMIERS RESULTATS DES ESSAIS D'INTRODUCTION DE PINS TROPICAUX A MADAGASCAR REALISES DEPUIS 1970

Resume

Durant ces dix dernières années un certain nombre d'essais comparatifs d'espèces de Pins tropicaux ont été réalisés à Madagascar qui ont permis de mettre en évidence l'intérêt de Pinus caribaea var hondurensis, Pinus patula, Pinus oocarpa, Pinus greggii et Pinus kesiya notamment. Par ailleurs, des essais comparatifs de provenances ont été mis en place intéressant Pinus caribaea, Pinus patula et Pinus oocarpa. Les essais de provenances de Pinus oocarpa font l'objet d'une communication séparée.

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

Les pins tropicaux ont été introduits à Madagascar depuis 1914 et les reboisements, notamment en Pinus patula et Pinus kesiya, ont pris une très grande ampleur sur les Hauts Plateaux depuis les années 1950. Des opérations de reforestation de vaste envergure sont à l'heure actuelle en cours de réalisation.

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

Les caractéristiques des stations où sont réalisées les expérimentations citées 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.

Manankazo

18°08' LS - 47°13' lE - Climat tropical semi-humide d'altitude - Pluviométrie moyenne annuelle 1 828 mm - 5 mois secs (<50 mm) - Température moyenne 17° (minima 12, maxima 22) - Altitude 1 850 m - Sols ferrallitiques carencés.

Mangoro

18°38' LS - 48°14' lE - Climat tropical semi-humide type soudano-guinéen (Aubréville) - Pluviométrie moyenne annuelle 1 610 mm - 4 mois secs (<50 mm) - Température moyenne 19° (minima 12°, maxima 25°) - Sols ferrallitiques typiques très désaturés sur migmatiques schisteuses. Altitude 920 m.

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.

E S S A I S   C O M P A R A T I F S   D ' E S P E C E S

A u   M a n g o r o

Un premier essai (N° 25) a été mis en place en 1973 portant sur 25 espèces ou provenances. Il s'agit d'un essai selon un schéma de lattice carré équilibré avec 6 répétitions (64 plants par parcelle). La plantation a été effectuée sur labour en bande avec apport d'une fertilisation au potet (NPK) à la densité de 2 500 plants à l'hectare.

Les résultats obtenus sont les suivants (hauteur en m) :

Espèce ou provenance	Origine	Nov. 1973	Sept. 1974	Août 1975	Juil. 1976	Juin 1979
		1 an	1 an 1/2	2 ans 1/2	3 ans 1/2	6 ans 1/2
P. oocarpa	INIF N° 188, Mexique	0,46	1,55	2,53	3,63	6,98
P. oocarpa	INIF N° 185, Mexique	0,48	1,61	2,65	3,83	7,59
P. oocarpa	INIF N° 204, Mexique	0,38	1,40	2,32	3,19	5,99
P. oocarpa	INIF N° 269, Mexique	0,41	1,40	2,27	3,23	6,15
P. oocarpa	Guatemala	0,76	2,31	3,38	4,96	9,13
P. patula	INIF N° 281, Mexique	0,46	1,54	2,52	3,97	7,68
P. patula	Lot SN, Mexique	0,35	1,33	2,29	3,49	6,64
P. montezumae	INIF N° 258, Mexique	0,09	0,28	0,53	1,01	2,47
P. montezumae	INIF N° 143, Mexique	0,07	0,21	0,43	0,90	2,30
P. montezumae	INIF N° 132, Mexique	0,07	0,22	0,49	0,97	2,50
P. montezumae var macrocarpa	INIF N° 129, Mexique	0,08	0,25	0,57	1,15	2,86
P. michoacana var procera	INIF N° 154, Mexique	0,11	0,29	0,94	1,57	3,88
P. michoacana	INIF N° 252, Mexique	0,09	0,26	0,90	1,66	4,05
P. michoacana	INIF N° 267, Mexique	0,09	0,28	0,75	1,46	3,73
P. michoacana	INIF N° 264, Mexique	0,10	0,28	0,69	1,38	3,53
P. patula	N° 72086 Sambaina, Madagascar	0,46	1,61	2,73	4,04	7,29
P. pringlei	INIF N° 287, Mexique	0,13	0,80	1,65	2,49	5,12
P. pseudostrobus var oaxacana	INIF N° 242, Mexique	0,28	0,89	1,62	2,55	5,50
P. pseudostrobus	INIF N° 265, Mexique	0,09	0,26	0,68	1,36	3,57
P. pseudostrobus	INIF N° 266, Mexique	0,25	0,91	1,64	2,52	4,86
P. greggii	INIF N° 174, Mexique	0,46	1,58	2,79	4,24	7,63
P. kesiya	Andraimbe, Madagascar	0,46	1,46	2,74	3,65	7,14
P. caribaea var bahamensis	Bahamas	0,55	1,01	1,97	2,95	6,20
P. caribaea var hondurensis	Nicaragua	0,45	1,67	2,67	4,07	8,12
P. radiata	Nelle Zélande	0,64	1,63	2,49	3,46	5,76

Un second essai (N° 27) a été mis en place en 1974 portant sur 5 espèces ou provenances. L'essai est en carré latin (60 plants par parcelle). La plantation a été effectuée sur labour en plein avec apport de fertilisation de départ au potet (NPK) à la densité de 2,5 x 2,5 m soit 1 600 plants/ha. Les résultats obtenus sont les suivants (hauteurs en m) :

Espèce ou provenance	Origine	Sept. 1974	Juin 1975	Juil. 1976	Oct. 1977	Avril 1978	Juil. 1979
		6 mois	1 an 1/2	2 ans 1/2	3 ans 1/2	4 ans 1/2	5 ans 1/2
P. oocarpa var ochoterenai	Honduras	0,76	1,50	3,35	5,44	6,95	8,37
P. oocarpa var ochoterenai	Guatemala	0,61	1,12	2,77	4,54	5,98	7,39
P. kesiya	Madagascar (Maya-katompo)	0,40	1,01	2,29	4,06	5,22	6,25
P. caribaea var hondurensis	Guatemala	0,48	0,99	2,26	4,09	5,60	7,00
P. elliottii	Georgie, USA	0,16	0,38	0,94	2,07	2,89	3,88

S u r   l e s   a u t r e s   s t a t i o n s

Un essai de "triage" mis en place à Besakay qui mettait en comparaison 10 espèces ou provenances de : Pinus elliottii, Pinus taeda (2 provenances), Pinus caribaea var hondurensis (2 provenances), Pinus caribaea var caribaea, Pinus insularis, Pinus kesiya, Pinus canariensis, Pinus patula, en placeau de 25 plants à la densité de 4 400 plants à l'hectare, a montré la supériorité de Pinus caribaea.

A Mahela sur la côte Est les 2 essais qui comparaient, l'un 9 espèces ou provenances de Pinus taeda, Pinus caribaea var hondurensis (2 provenances), Pinus caribaea var caribaea, Pinus elliottii (2 provenances), Pinus kesiya, Pinus occidentalis, Pinus canariensis, l'autre 16 espèces ou provenances de Pinus caribaea var bahamensis (4 provenances), Pinus caribaea var caribaea, Pinus caribaea var hondurensis (4 provenances), Pinus elliottii (3 provenances), Pinus palustris, Pinus taeda (3 provenances), ont montré la supériorité de Pinus caribaea et surtout Pinus caribaea var hondurensis. Pinus taeda, Pinus occidentalis, Pinus canariensis et Pinus palustris ont disparu.

Dans un troisième essai mettant en comparaison 6 espèces, les meilleurs résultats sont obtenus avec Pinus oocarpa (provenance Nicaragua, Yucul), Pinus caribaea var bahamensis, Pinus caribaea var hondurensis (provenance Nicaragua), Pinus oocarpa (provenance Guatemala), Pinus greggii (provenance Mexique).

Enfin à Besakay, non loin du Mangoro, les deux essais mis en place et qui mettaient en comparaison 6 espèces de Pinus caribaea var hondurensis, Pinus elliottii, Pinus kesiya, Pinus oocarpa, Pinus patula, Pinus taeda avec ou sans apport de fertilisation de départ (NPK), ont montré tous les deux le classement suivant : Pinus caribaea var hondurensis, Pinus oocarpa, Pinus kesiya, Pinus patula, Pinus elliottii, Pinus taeda.

Enfin, un essai a été réalisé à Mahatsinjo (zone du Mangoro) avec 4 espèces (Pinus elliottii, Pinus kesiya, Pinus caribaea var hondurensis, Pinus caribaea var bahamensis).

E S S A I S   C O M P A R A T I F S   D E   P R O V E N A N C E S

Les essais concernant Pinus oocarpa font l'objet d'une communication spéciale.

Pinus caribaea

Une expérimentation visant à comparer 5 sous espèces ou provenances de Pinus caribaea a été mise en place en 1974 sur la station du Mangoro. Il s'agit d'un essai en carré latin avec parcelle unitaire de 144 plants, sur labour en plein avec fertilisation de départ au potet de plantation (NPK) à une densité de 1 600 plants à l'hectare.

Les résultats obtenus sont les suivants (hauteurs en m) :

Espèce	Origine	Juin 1972	Juin 1973	Juin 1974	Juil. 1975	Déc. 1976
		6 mois	1 an 1/2	2 ans 1/2	3 ans 1/2	5 ans
P. caribaea	Périnet A 10 d, Madagascar	0,16	0,62	1,72	3,10	4,88
P. caribaea var hondurensis	Belize, British Honras	0,26	0,93	2,34	3,76	5,42
P. caribaea var hondurensis	Pretoria, Afrique du Sud	0,25	1,01	2,54	4,16	6,23
P. caribaea var cubensis	Pretoria, Afrique du Sud	0,19	0,74	2,22	3,76	5,69
P. caribaea var hondurensis	Pretoria, Afrique du Sud	0,38	1,15	2,76	4,48	6,44

Pinus patula

Neuf provenances de Pinus patula ont été mises en comparaison en deux stations, Mangoro et Manankazo. L'expérimentation a été réalisée avec un dispositif en bloc complet totalement randomisé, avec quatre répétitions, des parcelles unitaires de de 100 plants à la densité de 2 500 plants à l'hectare, avec apport de fertilisation PK au potet. Les essais ont été implantés en 1972 et les résultats sont les suivants (hauteurs en m) :

Espèce	Origine	Au Mangoro Décembre 1976 5 ans 1/2	A Manankazo Mai 1977 5 ans 1/2
Pinus patula	Ranomainty, Madagascar	5,63	3,76
Pinus patula	Sambaina, Madagascar	5,60	3,49
Pinus patula	SN 24.477, Pretoria, Afrique du Sud	5,72	4,21
Pinus patula	Kiamwari 4 L, Kenya	5,67	4,07
Pinus patula	Old Moshi, Tanzanie	5,71	4,01
Pinus patula	Rangai, Tanzanie	5,67	3,99
Pinus patula	Shume Tanga, Tanzanie	5,58	3,59
Pinus patula	Lot SN, Mexique	5,14	3,78
Pinus patula	INIF N° 281, Mexique	5,83	3,95

C O N C L U S I O N

Les résultats obtenus dans ces essais d'introduction d'espèces ont montré l'intérêt d'un certain nombre d'espèces et notamment de Pinus caribaea var hondurensis. Les espèces et provenances donnant les meilleurs résultats sont présentées dans le tableau ci-dessous.

BESAKAY	MAHELA	MANGORO
P. caribaea var hondurensis (Honduras)	P. caribaea var hondurensis (British Honduras)	P. caribaea var hondurensis (Nicaragua)
P. caribaea var hondurensis (Guatemala)	P. caribaea var hondurensis (Alamicamba, Nicaragua)	P. patula (Mexique
P. oocarpa (Guatemala)	P. caribaea var hondurensis (Nicaragua)	P. greggii (Mexique)
	P. caribaea var bahamensis (Abaco)	P. oocarpa (Mexique)
	P. caribaea var caribaea	
	P. oocarpa (Guatemala)	
	P. oocarpa (Nicaragua)	

Concernant les provenances, les essais faits sur Pinus caribaea et patula ont montré la variabilité génétique de ces deux espèces et la nécessité de poursuivre les investigations dans ce domaine.

BREEDING SYSTEMS IN SOME CENTRAL AMERICAN PINE SPECIES : A PRELIMINARY ANALYSIS

Summary

The breeding systems of *Pinus caribaea* var. *bahamensis*, *P. caribaea* var. *hondurensis* and *P. oocarpa* were studied using seed samples collected from a total of ten stands in Central America. Genetic variation in enzymes of newly germinated embryos was used to estimate gene frequencies, outcrossing rates and other population parameters. Estimates of the outcrossing rate varied considerably for different enzymes due to small numbers of seeds assayed, but averaged between ten and twenty per cent overall. The implications of these preliminary findings are discussed briefly.

SISTHÈME DE REPRODUCTION DE QUELQUES ESPÈCES DE PINS DE L'AMÉRIQUE CENTRALE : UNE ANALYSE PRELIMINAIRE

Resume

On a étudié les méthodes d'amélioration génétique des Pinus caribaea, var. bahamensis, Pinus caribaea, var. hondurensis, et Pinus oocarpa en utilisant des échantillons de graines récoltées dans un ensemble de 10 peuplements d'Amérique Centrale. On a utilisé la variation génétique des enzymes d'embryons récemment germés pour apprécier la fréquence des gènes, les taux de croissement entre les variétés et les autres paramètres des peuplements. Les estimations des taux de croissement varient considérablement pour différents enzymes, ce qui est dû au trop petit nombre de graines sur lesquelles on a fait des essais, mais la moyenne se situe entre 10 et 20 % du chiffre global.

On examine brièvement les implications qui se déduisent de ces résultats préliminaires.

SISTEMAS REPRODUTIVOS EM ALGUMAS ESPÉCIES DE PINHEIROS DA AMÉRICA CENTRAL : UMA ANÁLISE PRELIMINAR

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Resumo

Os sistemas reprodutivos de *Pinus caribaea* var. *bahamensis*, *P. caribaea* var. *hondurensis* e *P. oocarpa* foram estudados, usando-se amostras de sementes colhidas de 10 povoamentos da América Central. A variação genética em enzimas de embriões, recentemente germinados, foi utilizada para estimar as frequências de genes, taxas de exocruzamentos e outros parâmetros da população. A estimativa da taxa de exocruzamentos variou consideravelmente para as diferentes enzimas, devido ao pequeno número de sementes testadas, mas foi em média geral de 10 a 20%. As implicações destes dados preliminares são discutidos sumariamente.

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

Knowledge of the basic biology of a species is essential before embarking on a domestication program. This applies whether the species concerned is a plant or animal. Often considered aspects of basic biology of trees are environmental requirements such as nutrition, day length, climate and rainfall; and silvicultural requirements such as nursery treatment and vegetative propagability. It is also necessary to know about seed yields, artificial pollination techniques and seed extraction. Only recently has it been possible to add the breeding system of trees to this list, largely because of the recent advent of biochemical methods of examining individual gene products. Before this, reliance was placed on the frequency of rare morphological variants such as chlorophyll mutants or other abnormal forms. The technique of electrophoresis allows the examination of proteins which vary in the electrical charge they carry. This has been shown to be due, in most cases, to single allelic differences within a gene locus. That is, instead of looking for morphological variants, we are now able to look at protein variants in much the same way. It turns out that this kind of variation is much more prevalent and widespread than qualitative morphological variation (i.e. qualitative variation controlled by single genes).

Consideration of breeding systems of economically important forest trees is important because different domestication and improvement strategies must be applied to outcrossing as opposed to inbreeding species. Among outbreeders, inbreeding usually results in loss of wood production, that is, inbred trees usually do not grow as well as outcrossed ones. Thus, a seed orchard of a species which is normally outcrossed but which does normally engage in some inbreeding may not be an appropriate seed production strategy.

For these reasons, and because seed was available from the Commonwealth Forestry Institute at Oxford, it was decided to study some Central American pine populations of species which have been the subject of many seed collections over the years. This paper reports the first results of these studies.

M A T E R I A L S   A N D   M E T H O D S

Seeds of *Pinus caribaea* var. *bahamensis*, *P. caribaea* var. *hondurensis*, and *P. oocarpa* were available for this study. Provenances used are listed in Table 1, and shown in Fig. 1.

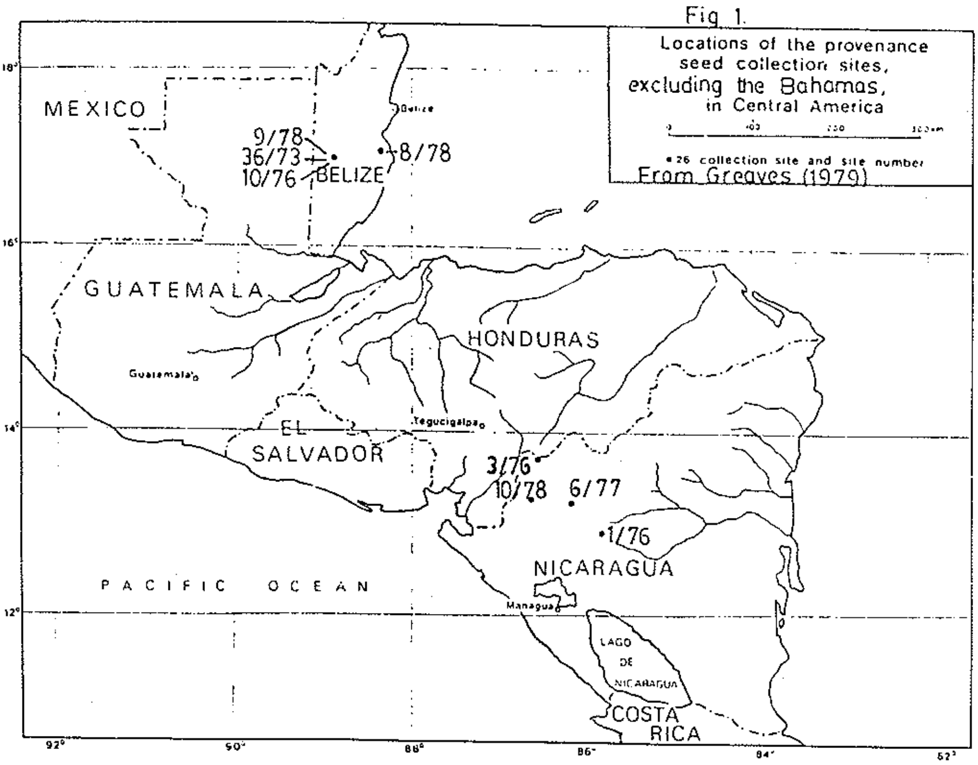

Fig 1.
Locations of the provenance seed collection sites, excluding the Bahamas, in Central America

From Greaves (1979)

Table 1. Details of provenances and species used

Species/variety	CFI ident.	No. trees	Origin
P. caribaea var. *bahamensis*	39/77	10	Little Abaco, Bahamas
P. caribaea var. *bahamensis*	7/78	9	Great Bahama
P. caribaea var. *hondurensis*	8/78	9	Melinda, Belize
P. caribaea var. *hondurensis*	36/73	8	Mountain Pine Ridge, Belize
P. caribaea var. *hondurensis*	10/76	5	Mountain Pine Ridge, Belize
P. oocarpa	6/77	10	Rafael, Nicaragua
P. oocarpa	3/76	10	Dipilto, Nicaragua
P. oocarpa	1/76	10	Yueal, Nicaragua
P. oocarpa	9/78	10	Mountain Pine Ridge, Belize
P. oocarpa	10/78	10	Cusmapa, Nicaragua

Seeds were germinated on petri dishes and grown until about one week post-germination. Five endosperms and ten embryos per mother tree were then ground singly in a buffer solution. The resultant mixture was then soaked up in a filter paper wick which was placed, with the individual ground mixtures of about thirty-four other such samples, on a starch gel slab across which a potential difference was applied. After about four hours the gel was sliced laterally and stained for the various proteins used. For this study the proteins were all enzymes and were:

6-Phosphogluconic dehydrogenase (6PGD)
Leucine amino peptidase (LAP)
Glutamic oxalacetic transaminase (GOT)
Glutamate dehydrogenase (GDH)
Phosphogluco mutase (PGM)
Malate dehydrogenase (MDH)

In several cases, the enzyme was produced by two different gene loci (e.g. 6PGD-1, 6PGD-2; LAP-1, LAP-2) and overall, variation in eight gene loci were available for use. Following the staining, the gels were scored for variation and the numbers of each genotype recorded.

The endosperm of pine seeds is haploid and so scoring them allows identification of the maternal genotype. Scoring of embryos allows identification of the paternal genotype and the number of detectable out-crosses can be counted. In general, the methods of Brown, Matheson and Eldridge (1975) were used to estimate the genetic statistics reported here. These methods assume two alleles per locus but for some populations there were, in fact, three alleles at some loci. For these loci, a computer program obtained from and using the methods of Clegg, Kahler and Allard (1978) was used.

RESULTS

Details of the estimate of the rate of outcrossing, gene frequencies, Wright's fixation index and the level of heterozygosity are given in Table 2. Gaps in the table are due to inadequate data resulting from poor staining on gels for some enzymes or too slow germination of seeds.

Table 2. Estimates of outcrossing rate ($\hat{t}$), most frequent allele frequencies in the pollen(p), Wright's fixation index (F), and heterozygosity (H) with their respective standard errors for each enzyme locus for each population (where available - see text). The alleles are identified by the letters F (fast), M (medium) S (slow), referring to the relative rate of movement of the proteins across the gel slab. Alleles given are in order of abundance.

Population	Locus	Alleles	$\hat{t}$	SE($\hat{t}$)	p	SE(p)	F	SE(F)	H	SE(H)
39/77	6PGD-1	MSF	0.51	0.20	0.69	0.11	0.34	0.16	0.30	0.07
	6PGD-2	M	-	-	-	-	-	-	-	-
Pinus	LAP-1	MS	0.43	0.12	0.73	0.10	0.54	0.15	0.22	0.07
caribaea	LAP-2	FMS	0.79	0.14	0.89	0.07	0.08	0.77	0.00	0.05
var.	GOT-2	MSF	0.94	0.11	0.86	0.07	-0.26	0.17	0.27	0.05
bahamensis	GDH-1	M	-	-	-	-	-	-	-	-
	PGM-1	MSF	0.71	0.12	0.48	0.10	0.15	0.15	0.39	0.07
	MDH-1	MS	0.67	0.20	0.44	0.09	0.16	0.13	0.42	0.12
	Average value of $\hat{t}$ = 0.68					Average value of F = 0.17				
7/78	6PGD-1	MS	1.02	0.27	0.72	0.07	0.03	0.25	0.29	0.07
	6PGD-2	M	-	-	-	-	-	-	-	-
Pinus	LAP-1	MS	0.31	0.11	0.95	0.05	0.75	0.16	0.09	0.05
caribaea	LAP-2	MS	1.05	0.04	0.98	0.02	-0.05	0.56	0.10	0.05
var.	GOT-2	MSF	0.94	0.14	0.82	0.05	-0.12	0.19	0.41	0.07
bahamensis	GDH-1	M	-	-	-	-	-	-	-	-
	PGM-1	MSV	0.84	0.30	0.62	0.09	0.11	0.19	0.37	0.08
	MDH-1	SM	0.65	0.15	0.62	0.11	0.14	0.13	0.43	0.06
	Average value of $\hat{t}$ = 0.80					Average value of F = 0.14				
8/78	6PGD-1	MSF	0.97	0.29	0.61	0.04	0.21	0.12	0.37	0.06
	6PGD-2	MFS	1.07	0.05	0.97	0.02	-0.09	0.67	0.07	0.05
Pinus	LAP-1	MSF	0.51	0.11	0.55	0.12	0.37	0.17	0.26	0.07
caribaea	LAP-2	MS	0.96	0.12	0.87	0.07	0.08	0.23	0.32	0.08
var.	GOT-2	MS	0.74	0.14	0.73	0.10	0.27	0.20	0.31	0.08
hondurensis	GOT-2	MS	0.74	0.14	0.73	0.10	0.27	0.20	0.31	0.08
	GDH-1	MS	1.04	0.26	0.84	0.05	-0.08	0.26	0.34	0.08
	PGM-1	MF	0.52	0.15	0.49	0.09	0.42	0.11	0.29	0.05
	MDH-1	M	-	-	-	-	-	-	-	-
	Average value of $\hat{t}$ = 0.83					Average value of F = 0.17				
36/73	6PGD-1	FMS	0.49	0.13	0.56	0.13	0.40	0.14	0.29	0.07
	6PGD-2	MF	1.13	0.06	0.94	0.03	-0.07	0.48	0.14	0.06
Pinus	LAP-1	MFS	1.30	0.18	0.80	0.05	-0.03	0.24	0.32	0.08
caribaea	LAP-2	MS	0.78	0.21	0.81	0.07	0.14	0.23	0.29	0.08
var.	GOT-2	MS	0.93	0.16	0.69	0.08	0.11	0.17	0.38	0.07
hondurensis	GDH-1	MS	0.88	0.28	0.85	0.07	-0.07	0.23	0.42	0.09
	PGM-1	MF	0.63	0.37	0.48	0.08	-0.01	0.19	0.45	0.08
	MDH-1	M	-	-	-	-	-	-	-	-
	Average value of $\hat{t}$ = 0.88					Average value of F = 0.07				
10/76	6PGD-1	MFS	0.67	0.17	0.46	0.13	0.34	0.19	0.31	0.09
	6PGD-2	MS	-	-	-	-	-	-	-	-
Pinus	LAP-1	MF	1.23	0.30	0.81	0.09	0.17	0.32	0.27	0.10
caribaea	LAP-2	MSF	0.32	0.13	0.57	0.21	0.25	0.20	0.34	0.09
var.	GOT-2	MSF	0.87	0.49	0.63	0.07	-0.16	0.24	0.50	0.11
hondurensis	GDH-1	MS	0.72	0.28	0.92	0.11	0.28	0.38	0.22	0.11
	PGM-1	MF	0.38	0.52	0.00	0.09	-0.12	0.21	0.56	0.11
	MDH-1	M	-	-	-	-	-	-	-	-
	MDH-2	MS	-	-	-	-	-	-	-	-
	Average value of $\hat{t}$ = 0.70					Average value of F = 0.13				
6/77	6PGD-1	MFS	0.88	0.24	0.93	0.03	0.13	0.55	0.08	0.05
	6PGD-2	MF	-	-	-	-	-	-	-	-
Pinus	LAP-1	MS	-	-	-	-	-	-	-	-
oocarpa	LAP-2	MFS	0.27	0.09	0.69	0.15	0.54	0.14	0.21	0.06
	GOT-2	MFS	0.82	0.18	0.78	0.08	0.01	0.26	0.27	0.07
	GDH-1	MS	0.79	0.15	0.61	0.09	0.27	0.13	0.34	0.06
	PGM-1	SV	1.04	0.03	0.98	0.02	-0.02	0.91	0.04	0.03
	MDH-1	M	-	-	-	-	-	-	-	-
	MDH-2	MF	-	-	-	-	-	-	-	-
	Average value of $\hat{t}$ = 0.76					Average value of F = 0.19				
3/76	6PGD-1	MFS	1.06	0.03	0.97	0.02	-0.03	0.70	0.06	0.04
	6PGD-2	MF	1.08	0.04	0.96	0.02	-0.03	0.68	0.06	0.04
Pinus	LAP-1	MS	1.07	0.04	0.97	0.02	-0.06	0.66	0.06	0.04
oocarpa	LAP-2	MFS	0.92	0.17	0.89	0.07	0.18	0.38	0.15	0.06
	GOT-2	MFS	1.14	0.17	0.88	0.04	-0.08	0.28	0.26	0.07
	GDH-1	MS	0.43	0.16	0.83	0.08	0.12	0.16	0.39	0.07
	PGM-1	SMF	0.20	0.07	0.84	0.15	0.66	0.16	0.13	0.06
	MDH-1	M	-	-	-	-	-	-	-	-
	MDH-2	MF	-	-	-	-	-	-	-	-
	Average value of $\hat{t}$ = 0.84					Average value of F = 0.11				
1/76	6PGD-1	MFS	0.70	0.14	0.77	0.09	0.39	0.25	0.18	0.06
	6PGD-2	M	-	-	-	-	-	-	-	-
Pinus	LAP-1	M	-	-	-	-	-	-	-	-
oocarpa	LAP-2	MFS	0.47	0.12	0.59	0.12	0.53	0.13	0.23	0.06
	GOT-2	MF	0.61	0.14	0.83	0.09	0.42	0.22	0.20	0.07
	GDH-1	SM	0.77	0.17	0.60	0.08	0.16	0.14	0.39	0.06
	PGM-1	MSF	-	-	-	-	-	-	-	-
	MDH-1	M	-	-	-	-	-	-	-	-
	Average value of $\hat{t}$ = 0.64					Average value of F = 0.38				

Table 2 (cont'd)

Population	Locus	Alleles	$\hat{t}$	SE($\hat{t}$)	p	SE(p)	F	SE(F)	H	SE(H)
9/78	6PGD-1	MFS	0.63	0.13	0.61	0.10	-0.05	0.22	0.34	0.07
	6PGD-2	MF	1.04		0.98		-0.02	0.87	0.04	0.04
Pinus	LAP-1	MF	-	-	-	-	-	-	-	-
oocarpa	LAP-2	MFS	1.17	0.24	0.75	0.09	0.24	0.19	0.32	0.08
	GOT-2	MFS	0.46	0.12	0.67	0.12	0.52	0.19	0.18	0.06
	GDH-1	SM	0.94	0.31	0.58	0.07	0.02	0.18	0.40	0.07
	PGM-1	MSF	-	-	-	-	-	-	-	-
	MDH-1	M	-	-	-	-	-	-	-	-
	MDH-2	MF	0.67	0.29	0.95	0.04	0.55	0.59	0.03	0.03
	Average value of $\hat{t}$ = 0.82					Average value of F = 0.21				
10/78	6PGD-1	MF	-	-	-	-	-	-	-	-
	6PGD-2	MF	1.08	0.04	0.96	0.02	-0.05	0.52	0.09	0.05
Pinus	LAP-1	M	-	-	-	-	-	-	-	-
oocarpa	LAP-2	MFS	0.89	0.13	0.94	0.05	0.11	0.32	0.19	0.06
	GOT-2	MF	1.18	0.06	0.92	0.03	-0.06	0.48	0.11	0.05
	GDH-1	FM	0.95	0.17	0.67	0.08	0.14	0.12	0.41	0.06
	PGM-1	MF	0.65	0.14	0.83	0.08	0.29	0.23	0.23	0.07
	MDH-1	M	-	-	-	-	-	-	-	-
	MDH-2	M	-	-	-	-	-	-	-	-
	Average value of $\hat{t}$ = 0.95					Average value of F = 0.09				

In general, the estimates of the rate of outcrossing ($\hat{t}$) are less than 1 and the averages for each population range from 0.64 (for 1/76) to 0.95 (10/78). Estimates above 1 usually have large standard errors and do not differ significantly from 1. The average values indicate that there may be a level of inbreeding of between ten and twenty per cent. There are several possible explanations which will be discussed below.

Values of p given in Table 2 refer to estimates of the frequency of the most frequent allele in the pollen. Since the pollen represents a larger sample of the population than the sample of mother trees, it is probably closer to the pôpulation allele frequencies. Estimates of t are generally most efficient for loci where the alleles are in approximately equal frequencies.

Wright's fixation index is calculated as 1 - (H/2p(1-p) for a two allele locus and represents the departure of the level of heterozygosity from that expected under Hardy-Weinberg panmixia. This can occur if there is inbreeding due to self-fertilisation or if the pollen gene frequencies are not constant throughout the population.

D I S C U S S I O N

Estimates of inbreeding and Wright's fixation index presented here suggest that there might be a moderate level of inbreeding in the species considered. The levels of heterozygosity (calculated independently of the outcrossing rate) indicate a similar conclusion. It is not possible, without a detailed analysis of each stand sampled, to decide whether the inbreeding is due to self-fertilisation or to heterogeneity in the gene pool. It seems likely that there could be both effects operating, i.e. a low level of self-fertilisation together with heterogeneity of the pollen pool.

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TESTES DE PROCEDÊNCIA DE *Pinus caribaea* MORELET EM ZIMBABWE

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Resumo

Testes de procedências das três variedades de *Pinus caribaea*, foram instalados em quatro locais de Zimbabwe, em 1968. Avaliações feitas entre as idade 8½ e 10½ anos, demonstrou haver diferenças significantes entre procedências para: altura, área basal, e forma do tronco das árvores, no entanto para a densidade básica da madeira, não foram significantes. A variedade *hondurensis* foi a que apresentou um crescimento mais rápido, embora com árvores de formas mais pobres. Houve uma interação significante entre procedência e localidade, para todas as características, excetuando-se forma do tronco. A densidade básica da madeira foi moderadamente alta, nas localidades de clima seco, porém muito baixa naquelas de clima úmido.

Embora seja dada atenção especial à var. *hondurensis*, não se deve descuidar das variedades *caribaea* e *bahamensis*, de crescimento mais lento.

PROVENANCE TRIALS OF *Pinus caribaea* MORELET IN ZIMBABWE

Summary

Replicated provenance trials of the three varieties of Pinus caribaea were established at four sites in Zimbabwe in 1968. Assessments made between ages 8½ and 10½ years showed significant differences between provenances in height, basal area, and stem form, but generally not in basic density. The variety hondurensis was the fastest growing, although the most poorly formed. There was significant provenance x locality interaction in all traits except stem form. Basic density was moderately high in dry localities but very low in moist ones. Although further attention must focus on hondurensis, the slower-growing caribaea and bahamensis cannot be dismissed.

TEST DE PROVENANCE DE *Pinus caribaea* MORELET À ZIMBABWE

Resume

Des essais de provenance avec répétition ont été entrepris sur les trois variétés de Pinus caribaea, MORELET, en quatre stations du Zimbabwe en 1968. Les observations effectuées sur les plants de 8 ans et demi à 10 ans et demi présentent des différences significatives entre les provenances sur la hauteur, la surface terrière et la forme du fût, mais, généralement,pas sur la densité basale. La variété hondurensis BARRET et GOLFARI a présenté la croissance la plus rapide, mais les caractéristiques de forme les plus mauvaises. La corrélation provenance x station s'est vérifié significative pour toutes caractéristiques, à l'exception de la forme du fût.

La densité basale est modérément élevée sur les stations sèches,et très faible sur les stations humides. Bien qu'une plus grande attention doit être accordée à la variété hondurensis, on doit continuer de s'intéresser aux variétés à croissance plus lente : au P. caribaea, var. caribaea, et à P. caribaea, var. bahamensis, BARRET et GOLFARI.

Introduction

Pinus caribaea Morelet occurs as three taxonomic varieties – caribaea, bahamensis (Griseb.) Barrett & Golfari, and hondurensis (Sénéclauze) Barrett & Golfari – widely separated from each other between latitudes 12° and 27°N in central America and some of the Caribbean islands (Lückhoff, 1964). Interest in the species in Zimbabwe began with the introduction of hondurensis from Belize in 1954 (Barrett and Mullin, 1968), and has been maintained by the good performance of later, wide-ranging seedlots of all three varieties and the selection within the resultant young plantings of 73 plus trees of caribaea,108 of bahamensis, and 42 of hondurensis. Localities where adequate flowering may be expected have recently been identified through clonal trials and it is hoped shortly to establish breeding orchards of all varieties.

This paper deals with the first replicated provenance trials which were planted in 1968 with seedlots of the three varieties.

Materials and Methods

Seed origins

The origins of the seedlots used for these provenance trials are shown in Table 1 but the precise localities of the natural stands in which the seed collections were made are not known. Locally allocated seed stock numbers (S/N) are given in the table.

Table 1. Origins of Pinus caribaea seedlots used in the provenance trials.

Stock No.	Variety	Seed origin
1892	hondurensis	Belize
2023	hondurensis	Belize; Mountain Pine Ridge
2024	hondurensis	Belize; coast
2028	hondurensis	Belize
1961	bahamensis	Bahamas; Great Abaco Island
2025	bahamensis	Bahamas; Grand Bahama Island
2026	caribaea	Cuba
2027	caribaea	Cuba

The experimental sites

Soil and climatic details of the experimental sites are given in Table 2. Climatic data for Chiwengwa, Gonye, and Martin came from meteorological stations located close to the sites but those for Tarka have had to be estimated from the records of several nearby stations.

Table 2. Descriptions of the provenance trial sites.

Trial No.	Locality	Mean temperatures °C	Mean annual rainfall, rain days, and evaporation	Soil
27	Chiwengwa Lat.18°41'S Long.32°55'E Alt.700 m	Max. 28,4 Min. 13,0 Annual 20,7	Rainfall 1 499,1 mm Rain days 110 Evap. 1 272,3 mm	reddish brown sandy clay loam to at least 1,0 m; doleritic.
28	Gonye Lat.18°42'S Long.32°55'E Alt.800 m	Max. 25,7 Min. 15,3 Annual 20,5	Rainfall 1 380,2 mm Rain days 99 Evap. 1 448,3 mm	granitic soil with much quartz gravel; shallow; poor drainage.
29	Martin Lat.19°43'S Long.32°56'E Alt. 1 250 m	Max. 22,9 Min. 12,6 Annual 17,7	Rainfall 1 081,9 mm Rainfdays 125 Evap. 1 479,0 mm	lower argillaceous shales/siltstones; deep but compacted; consisting of ferruginous bands.
30	Tarka Lat.19°58'S Long.32°57'E Alt.945 m	Max. 25,7 Min. 14,9 Annual 20,3	Rainfall 2 279,0 mm Rain days 150 Evap. 1 300,0 mm	doleritic sandy clay loam to 1,0 m or more; good drainage.

Field trial designs

The trials were planted between January 22 and 24, 1968, and each contained all eight provenances in a R.C.B. design with four replications of 81-tree, square plots spaced at 1,83 x 1,83 m. The nursery phase followed no statistical design but all plants were raised and distributed to the planting sites from one nursery.

In June, 1968, widespread, severe frosts killed virtually all the caribaea and hondurensis in Trial 29 but there was 21 and 42 percent survival in bahamensis S/Ns 1961 and 2025 respectively. This trial was replanted with surplus nursery stock in December, 1968, but plot size had to be reduced to 25 trees and one replication had to be omitted. There was slight frost damage, but no deaths, in Trial 27, while Trials 28 and 30 were unaffected.

Measurements and determination of wood density

Routine assessments of height, diameter, and stem straightness were assessed in Trial 29 at 8½ years, in Trials 27 and 30 at 9½ years, and in Trial 28 at 10½ years. Heights and diameters were measured in the 25-tree inner plots of Trials 27, 28, and 30, and in the 9-tree inner plots of Trial

Table 3. Pinus caribaea Provenance Trials 27, 28, 29 and 30. Summarized data of individual and combined trials, and Duncan multiple range tests (5%) for height, basal area, stem form, and basic density.

Trial No. and age / Trait	Trial 27 $9^9/12$ years			Trial 28 $10\ ^5/12$ years			Trial 29 $8\ ^7/12$ years			Trial 30 $9\ ^6/12$ years			Combined Trials 27 and 30		
	S/N	Var.	Mean DMRT	S/N	Var.	Mean DMRT	S/N	Var.	Mean DMRT	S/N	Var.	Mean DMRT	S/N	Var.	Mean DMRT
Height (m)	2023	hon	17,97	1892	hon	15,80	2028	hon	13,10	2023	hon	16,41	2023	hon	17,19
	2028	hon	17,75	2028	hon	15,41	2023	hon	12,93	1892	hon	16,14	2028	hon	16,89
	1892	hon	17,60	2023	hon	15,37	2025	bah	12,63	2028	hon	16,04	1892	hon	16,87
	1961	bah	15,96	2026	car	14,66	2027	car	11,84	2025	bah	16,03	1961	bah	15,96
	2024	hon	15,73	2024	hon	14,38	2026	car	11,61	1961	bah	15,97	2025	bah	15,77
	2025	bah	15,51	2025	bah	14,31	1961	bah	11,59	2027	car	14,22	2024	hon	14,61
	2026	car	14,64	2027	car	14,23	2024	hon	11,09	2026	car	13,72	2026	car	14,18
	2027	car	13,98	1961	bah	13,87	-	-	-	2024	hon	13,49	2027	car	14,10
$\bar{x}$ s.e. Sig. of F ratio Sig. of Interaction			16,16 0,4052 ***			14,75 0,3572 **			12,11 0,5361 N.S.			15,25 0,3659 ***			15,70 0,2730 * **
Basal area (m^2/ha)	2023	hon	68,96	2024	hon	54,63	2028	hon	78,93	1892	hon	70,19	2023	hon	68,63
	2028	hon	62,70	2028	hon	52,34	2025	bah	71,82	2023	hon	68,30	1892	hon	64,52
	1892	hon	58,85	1892	hon	52,19	2027	car	69,63	2028	hon	64,98	2028	hon	63,84
	2026	car	53,68	2023	hon	49,90	2023	hon	66,47	2027	car	60,85	2027	car	54,61
	2024	hon	52,02	2027	car	47,21	2026	car	65,97	2025	bah	56,33	2026	car	54,07
	1961	bah	49,10	2026	car	44,79	1961	bah	57,64	1961	bah	54,97	1961	bah	52,04
	2027	car	48,37	1961	bah	38,71	2024	hon	48,31	2026	car	54,47	2025	bah	49,33
	2025	bah	42,32	2025	bah	37,87	-	-	-	2024	hon	45,70	2024	hon	48,86
$\bar{x}$ s.e. Sig. of F ratio Sig. of Interaction			54,50 2,2146 ***			47,20 2,6385 **			65,53 7,3337 N.S.			59,47 3,0096 ***			56,99 1,8683 * **
Stem form	2025	bah	4,20	2026	car	3,81	2026	car	3,71	2025	bah	3,87	2025	bah	4,03
	1961	bah	4,02	1961	bah	3,68	2025	bah	3,41	2026	car	3,87	2026	car	3,86
	2026	car	3,85	2025	bah	3,66	1961	bah	3,28	2027	car	3,82	1961	bah	3,86
	2027	car	3,84	2027	car	3,44	2027	car	3,24	1961	bah	3,69	2027	car	3,83
	2024	hon	3,59	2023	hon	3,30	2023	hon	3,10	2023	hon	3,33	2028	hon	3,44
	2028	hon	3,58	2028	hon	3,27	2024	hon	3,07	2028	hon	3,30	2024	hon	3,43
	2023	hon	3,49	1892	hon	3,26	2028	hon	3,00	2024	hon	3,27	2023	hon	3,41
	1892	hon	3,46	2024	hon	3,08	-	-	-	1892	hon	3,24	1892	hon	3,35
$\bar{x}$ s.e. Sig. of F ratio Sig. of Interaction			3,75 0,0920 ***			3,44 0,1311 **			3,26 0,0994 **			3,55 0,1174 ***			3,65 0,0746 ** N.S.
Basic density (g/cm^3)	2025	bah	0,468	2025	bah	0,518	2024	hon	0,399	1892	hon	0,391	1892	hon	0,405
	1961	bah	0,442	2023	hon	0,497	2027	car	0,384	2023	hon	0,381	2023	hon	0,404
	2023	hon	0,426	2026	car	0,491	2023	hon	0,377	2024	hon	0,371	2025	bah	0,403
	2028	hon	0,421	1892	hon	0,490	2028	hon	0,376	1961	bah	0,358	1961	bah	0,400
	1892	hon	0,419	1961	bah	0,484	2026	car	0,372	2028	hon	0,350	2024	hon	0,389
	2027	car	0,411	2024	hon	0,473	2025	bah	0,364	2026	car	0,342	2028	hon	0,386
	2024	hon	0,408	2028	hon	0,473	1961	bah	0,346	2025	bah	0,338	2026	car	0,373
	2026	car	0,404	2027	car	0,459	-	-	-	2027	car	0,331	2027	car	0,371
$\bar{x}$ s.e. Sig. of F ratio Sig. of Interaction			0,425 0,0147 N.S.			0,486 0,0121 N.S.			0,374 0,0094 *			0,358 0,0121 *			0,391 0,0095 N.S. *

29. Stem straightness was assessed by the seven-point scale of Barrett and Mullin (1968). Immediately after these measurements each trial was thinned to 50 percent of original stocking and 10-cm-thick discs for 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).

R e s u l t s

The results of the latest assessments are shown in Table 3. Only Trials 27 and 30 could be combined for analysis because there were age differences in the other two.

There were significant differences between provenances for height and basal area only in Trials 27, 28, and 30. Significant differences were found for stem form in all four trials but, for basic density, only in Trials 29 and 30. Significant provenance x locality interaction was revealed by the combined analysis for Trials 27 and 30 and is reflected in the changes in rank for height, basal area, and basic density between the two sites. The D.M.R.T's for height, basal area, and stem form in the combined trials have separated the different entities of P.caribaea fairly clearly into hondurensis, on the one hand, and caribaea and bahamensis, on the other, except that in one seedlot of hondurensis (S/N 2024) the growth rate is more characteristic of the slower varieties; this can also be seen in the data for the individual trials except that it ranks first for basal area in Trial 28.

C o n c l u s i o n s

Hondurensis has emerged from these trials as the fastest-growing variety of P.caribaea, but the most poorly formed. Of the other two varieties, bahamensis generally has the best height growth and caribaea the greatest basal area; both are notably straighter than hondurensis. The much higher basic densities of all three in the drier Trials 27 and 28 support the earlier findings of Barnes et al.(1977) in six-year-old P.caribaea. They also indicate that the frequently expressed reservations concerning the density of P.caribaea timber in southern Africa would disappear with the selection of more suitable planting sites.

Only a fraction of the species' entire range has been sampled and it is not yet possible to dismiss any of the three varieties from further consideration. It is clear, however, that hondurensis should receive most attention in the proposed breeding programme.

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SELEÇÃO FENOTÍPICA INDIVIDUAL EM ESPÉCIES TROPICAIS DO GÊNERO *Pinus*

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Resumo

O presente trabalho tem como objetivo apresentar o que - foi realizado na seleção fenotípica individual em espécies -- tropicais do Gênero Pinus, nas dependências do Instituto Florestal do Estado de São Paulo, para o Programa de Melhoramento Genético e Produção de Sementes em desenvolvimento.

PHENOTYPIC INDIVIDUAL SELECTION IN TROPICAL SPECIES OF THE GENUS *Pinus*

Summary

The purpose of this work was to provide informations -- about phenotipic individual selection in species tropical of the Genus Pinus in the stations of Instituto Florestal - São Paulo State, for the Genetic Improvement Programme and Seed Productions in development.

SÉLECTION PHÉNOTYPIQUE EN DES ESPÈCES TROPICALES DU GENRE *Pinus*

Resume

L'objectif de ce travail a été de fournir des informations pour la sélection individuelle phénotypique d'espèces tropicales du genre Pinus, dans les stations de l'INSTITUT FORESTIER de São-Paulo, au titre du Programme d'amélioration génétique et de la production de graines, en cours.

Introdução

O Instituto Florestal iniciou em 1960 plantios homogêneos com espécies tropicais do Gênero Pinus, visando estudar seu comportamento sob diferentes condições edafo-climáticas.

Após a definição das melhores espécies para as nossas -- condições, a Instituição elaborou um Programa de Melhoramento Genético com as melhores procedências testadas, visando a obtenção de sementes melhoradas para implantação de novas populações.

Na seleção fenotípica individual, objetivo básico do presente trabalho, foram utilizadas inicialmente, as melhores populações existentes de cada espécie em condições de seleção, nos plantios tidos como comerciais e nas Áreas de Produção de Sementes, para implantação de Bancos e Pomares de Sementes Clonais.

Material e Métodos

Foram selecionadas árvores superiores das melhores populações de Pinus caribaea var. hondurensis (P.C.H.), Pinus caribaea var. caribaea (P.C.C.), Pinus caribaea var. bahamensis (P.C.B.), Pinus oocarpa (P.O.) e Pinus kesiya (P.K.), nas dependências do Instituto Florestal.

As árvores das populações selecionadas com idade acima de 8 anos já apresentavam um desenvolvimento satisfatório para coleta dos dados e análises das características desejáveis. Em grande parte destas áreas, já tinham sido executados pelo menos o primeiro desbaste seletivo.

Três métodos básicos de seleção são possíveis de serem utilizados numa seleção individual, segundo Hazel & Lush -- (1942): Níveis independentes de seleção, Seleção ordenada e Índice de seleção.

Em uma primeira fase foi efetuada a pré-seleção, onde foram marcadas árvores com características fenotípicas superiores à média da população original.

Na seleção e avaliação das árvores no campo foi utilizado o método de estratificação sugerido por Fletcher & Faulkner (1972), Keiding (1974), Dorman (1976), adotado por Fonseca & Kageyama (1978), onde comparou-se a árvore candidata com as cinco dominantes e co-dominantes ao seu redor num raio de 10 metros.

Os valores atribuidos às características desejáveis foram assim distribuidos: Vigor 30 pontos (Altura 20 pontos e Diâmetro 10 pontos); Forma do tronco 30 pontos; Espessura dos ramos 15 pontos; Ângulo de inserção dos ramos 15 pontos.

A fase final de seleção das árvores superiores foi efetuada com base no método de "Índice de Seleção", onde foram selecionadas e avaliadas para as seguintes características:

a-) Vigor - superioridade em altura e diâmetro.
b-) Forma do tronco e ausência de bifurcação.
c-) Habilidade de desrama natural.
d-) Ramificação: ângulo, espessura, comprimento.
e-) Comprimento dos internódios.
f-) Frutificação.

Os critérios de seleção, basicamente foram os mesmos para todas espécies estudadas, sofrendo pequenas variações levando-se em conta a tipicidade de cada uma delas.

Resultados e Discussão

Após a avaliação final das árvores tidas como superiores que atingiram número de pontos acima de 50 na somatória dos valores atribuidos às características desejáveis, o quadro a seguir apresenta os resultados obtidos para cada espécie:

Quadro 1 - Número de árvores superiores selecionadas nas dependências do Instituto Florestal.

Espécies	Área (Ha.)	Nº Árvores Iniciais	Nº Árvores Selecionadas	% Seleção
P.C.H.	2.761,50	5.585.700	874	0,02 ou 1:6000
P.C.C.	90,51	113.000	207	0,20 ou 1:500
P.C.B.	21,21	33.000	77	0,20 ou 1:500
P.O.	82,14	142.500	101	0,10 ou 1:1000
P.K.	597,79	1.131.200	514	0,05 ou 1:2000

As espécies de Pinus caribaea var. caribaea e Pinus kesiya já oferecem números de árvores superiores em quantidades suficientes ao início do Programa de Melhoramento de acôrdo com o preconizado por Fletcher & Faulkner (1972) e Burdon & Shelbourne (1973).

As espécies de Pinus caribaea var. caribaea, Pinus caribaea var. bahamensis e Pinus oocarpa tiveram um menor Índice de seleção, pelo fato de não se dispor de um maior número inicial de árvores em idade de seleção.

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OBSERVAÇÕES SOBRE O COMPORTAMENTO E O PROGRAMA DE MELHORAMENTO PARA *Pinus oocarpa* SCHIEDE – AGUDOS – SP

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Resumo

Os primeiros plantios comerciais de Pinus oocarpa Schiede iniciaram-se no Brasil a partir de 1.960. A instalação de testes de procedências - vieram posteriormente auxiliar em novas introduções de sementes.

A partir de 1.972 foram aplicadas novas técnicas de melhoramento - nos povoamento já estabelecidos visando a obtenção de sementes melhoradas para os programas de reflorestamento .

Novos testes de procedências devem ser realizados visando melhor - conhecer o potencial da espécie.

NOTES ON THE BEHAVIOUR AND IMPROVEMENT PROGRAM FOR *Pinus oocarpa* SCHIEDE – AGUDOS – SP

Summary

The first commercial plantations of Pinus oocarpa Schiede started in Brazil in 1960.

After that, the installations of provenance tests helped the new - introduction of seeds.

From 1972 on, improvement techniques were applied at the established sites trying to get improved seeds for the reflorestation programs.

New provenance techniques should be used for a better knowledge of the specie potential.

REMARQUES À PROPOS DU COMPORTEMENT ET DU PROGRAMME D'AMÉLIORATION POUR LE *Pinus oocarpa* SCHIEDE – AGUDOS – SP

Resume

Les premières plantations commerciales du Pinus Oocarpa ont commencé au Brésil en 1960.

Après cela, les installations d'essais de provenance ont aidé à introduire des graines.

Depuis 1972, les techniques d'amélioration ont été appliquées dans les sites de plantation en vue d'obtenir des graines améliorées pour des programmes de reboisement.

De nouvelles techniques de recherche de provenances devraient être utilisées pour obtenir une meilleure connaissance du potentiel de l'espèce.

INTRODUÇÃO

Pinus oocarpa Schiede foi mais significativamente introduzido no Brasil a partir de 1960 quando a CAFMA realizou as primeiras importações de sementes Oriundas de Honduras. Estas sementes foram provenientes de árvores estavam sendo abatidas para fins de semana, portanto de bons - padrões fenotípicos.

Após as observações dos primeiros plantios e confirmado o bom comportamento inicial da espécie, novas importações de sementes foram realizadas de Honduras, o que veio aumentar a base genética para os trabalhos de melhoramento hoje desenvolvidos.

Os plantios mais significativos de Pinus oocarpa no Brasil estão hoje situados nos estados de São Paulo, Minas Gerais e Mato Grosso do Sul. Apresenta a espécie um alto potencial para ser testada em outras regiões no Brasil, principalmente considerando-se a vasta área de ocorrência na região de origem,com variações edafo-climáticos significativo .

Comportamento Florestal do Pinus oocarpa Schiede

O comportamento do Pinus oocarpa varia significativamente de acordo com a procedência da semente utilizada, segundo estudos já realizados no Brasil e de acordo com Kajeyama, 1977 .

Os povoamentos implantados se basearam em sementes oriundas de Honduras e da Guatemala. De uma maneira geral temos que as sementes de Honduras proporcionam árvores com melhores formas do que as procedentes- da Guatemala. O rendimento médio obtido para a espécie nos povoamento - da CAFMA é de 25 m3 s/c por hectare por ano, em uma idade de 20 anos.

Os principais testes de procedencias introduzidas foram através de sementes fornecidas pelo COMMONWEALT FORESTRY INSTITUTE (C.F.I.) e Universidade de OXFORD.

No quadro abaixo teremos o comportamento de algumas procedências de Pinus oocarpa na região de Agudos - SP.

Quadro I - Procedências de Pinus oocarpa - Agudos SP.

Procedências	VALORES IDADE ANOS	DAP cm	H mts	VRC m3s/c	LAT. ºN	LONG. ºW	ALT. M	PRIC M
Angeles - Honduras	06	15,22	11,16	79,48	14º07'	87º04'	1300	950
San Marcos - Honduras	06	15,87	10,74	85,09	14º36'	87º00'	1100	1200
Zapotilio - Honduras	06	16,26	11,24	94,77	14º37'	87º02'	1100	1200
Siguatepeque - Honduras	06	15,09	10,82	71,35	14º32'	87º45'	1100	1250
Camélias - Nicaragua	06	17,94	12,06	117,31	13º46'	86º18'	1000	1500
Rafael - Nicaragua	06	17,83	11,72	115,09	13º12'	86º06'	1100	1500
Mt.Pine Ridge - Belize	06	18,16	11,94	126,00	17º00'	83º51'	700	1600
Lagunilha - Guatemala	06	16,10	12,95	91,74	14º42'	89º57'	1300	950
Pueblo Caido - Guatemala	06	15,31	10,89	99,44	15º12'	89º18'	800	1900
Bucaral - Guatemala	06	16,74	11,30	99,80	15º01'	90º09'	1100	800
San Jose - Guatemala	06	15,11	10,23	80,02	14º28'	89º28'	1000	1000
Huehuetenango - Guatemala	06	15,25	9,93	73,76	15º13'	91º32'	1700	1000
Lima - Guatemala	06	17,23	11,62	96,60	15º11'	89º21'	1000	1800
Pinalon Jalapa - Guatemala	06	15,69	11,10	83,69	-	-	-	-
Gramados B.Verapaz-Guatemala	06	16,31	11,39	97,02	-	-	-	-
Salama B.Verapaz-Guatemala	06	16,17	11,28	95,49	-	-	-	-
Mal Paso-Zacapa-Guatemala	06	16,36	11,11	95,94	-	-	-	-
Jacotan Chiquimula-Guatemala	06	15,41	10,97	81,15	-	-	-	-

* Material fornecido pela Universidade de OXFORD.

Programa de Melhoramento

De uma maneira geral o programa de melhoramento para o Pinus oocarpa se baseia em :

Observação dos testes de procedências existentes e introdução de novas procedências. Com referencia aos testes de procedências temos que as primeiras conclusões já estão sendo obtidas e novas procedências devem ser adicionadas aos testes - visando alem de cobrir as variações existentes na área de origem, assim como as variações existentes nas regiões de introdução da espécie no Brasil.

Aplicação de técnicas de melhoramento nos povoamentos já existentes se deu a partir de 1.972 quando as primeiras áreas de produção de sementes foram instaladas.

A seleção de árvores matrizes se deu a partir de 1.973 com as quais tornou se possível a instalação dos Bancos Clonais a partir de 1.975.

As sementes provenientes das árvores matrizes possibilitaram a instalação já em 1.979, de testes de progenies em uma vasta área do território nacional, testes estes que nos possibilitarão conhecer a variabilidade - genética e ambiental das matrizes envolvidas no programa.

A seguir teremos os quadros que esboçam a magnitude do trabalho de melhoramento genético conduzido para o Pinus oocarpa

Quadro II - Áreas de Produção de Sementes de Pinus oocarpa

Nº	Área	Localização	Data Plantio	Data Instalação	Nº Árvores Por Hectare
01	14,09	Agudos - SP	1.960	04/74	200
02	225,78	Agudos - SP	1.961	07/76	300
03	11,98	Agudos - SP	1.966	07/72	200
TOTAL	251,85	//////////	//////	//////	////////////

Quadro III - Nº de Árvores Matrizes Selecionadas de Pinus oocarpa

CONSIDERAÇÃO	ANOS PLANTIO	Nº MATRIZES
SELEÇÃO PARA FORMA E VOLUME	1.960	98
	1.961	37
	1.962	09
	1.965	36
	1.966	19
	1.967	01
	SUB - TOTAL	200
SELEÇÃO VOLUME	DIV.	50
T O T A I S	T O T A L	250

Quadro IV - Áreas de Bancos Clonais de Pinus oocarpa

Nº	ÁREA (ha)	Nº MATRIZES	TOTAL ENXERTOS	DATA INSTALAÇÃO	LOCAL
01	28,24	200	7.000	05/75	Agudos -SP
02	3,96	50	1.100	07/78	Agudos -SP
03 *	1,26	70	350	12/75	Agudos -SP
TOTAL	33,46	320	8.450	///////	//////////

*70 matrizes fornecidas pelo I.P.E.F.

Quadro V - Áreas de testes de progenies de Pinus oocarpa, matrizes C.A.F.M.A.

Nº	LOCALIDADE	LATITUDE ºS	LONG ºW	Nº MATRIZES	Nº REPET.	Nº MUDAS	ÁREA (ha)
01	Agudos 01 - SP	22	48	100	03	3.000	2,70
02	Agudos 02 - SP	22	48	100	05	3.000	2,70
03	Buritizeiro - MG.	17	44	81	03	2.430	2,19
04	Taquatinga - DF.	15	47	81	03	2.430	2,19
05	Águas Claras - MS.	20	52	64	03	1.920	1,73
06	Esplanada - BA.	11	38	64	03	1.920	1,73
07	S.José R. Preto - SP	20	49	49	03	1.470	1,32
08	Buri - SP	23	48	36	03	1.080	0,97
09	Pinhão Pr.	26	52	36	03	1.080	0,97
10	S.Fr. do Sul SC.	27	48	36	03	1.080	0,97
11	Teixeira de F. ES.	17	39	36	03	1.080	0,97
12	Petrolina PE.	09	40	36	03	1.080	0,97
13	Cairiras SP	23	46	36	03	1.080	0,97
14	Colombo PR.	25	49	25	03	750	0,68
15	Jarí PA.	01	53	25	03	750	0,68
15	T O T A L	//////	////	////////	//////	24.150	21,74

CONCLUSÕES

O potencial de 80.000 hectares de Pinus oocarpa já plantados no Brasil, auxiliados pelos testes internacionais de procedências estabelecidos a partir de 1.972 nos fornecem uma condição segura de implantação de técnicas de melhoramento visando a obtenção de florestas com melhores índices de produtividade.

A realização de novas coletas de procedências nas regiões de origem, coletas estas alicerçadas nas conclusões obtidas com os testes internacionais de procedencias, devem ser realizadas o mais breve possivel visando assegurar o material genético, material este que se encontra em risco de extinção.

As qualidades da madeira para o Pinus oocarpa tem-se mostrado excelente apresentado para uma idade de 13 anos uma densidade básicas da madeira emtorno de 0,45 gr/cm3.

A situação atual no Brasil de 4 65 hectares de áreas de produção de sementes, de 35,00 hectares em Bancos Clonais, envolvendo 10.000 enxertos oriundos de 400 árvores superiores nos dão a segurança de termos um material geneticamente superior para o desenvolvimento de um programa florestal para a espécie em questão no Brasil.

LINHAS GERAIS DE UM PROGRAMA PROPOSTO PARA MELHORAMENTO DE GERAÇÕES AVANÇADAS E POMARES DE SEMENTES PARA *Pinus caribaea* MOR. VAR. *hondurensis* BARR. E GOLF. EM QUEENSLAND, USANDO CRUZAMENTOS ENTRE PROCEDÊNCIAS

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Resumo

O melhoramento genético das procedências de Belize e Mountain Pine Ridge (B.M.P.R.), de *Pinus caribaea* var. *hondurensis*, em Queensland atingiu o estágio onde um complexo pomar de semente clonal está sendo implantado. Este irá prover as necessidades de sementes até o ano 2.004, quando um terceiro pomar complexo estará em produção. Uma das funções do programa de melhoramento é de completar o segundo e implantar o terceiro pomar complexo, com os complementos clonais mais adequados, levando em consideração as características desejáveis dentro dos testes de progênie, que serão utilizados como plantações para seleção e estão sendo implantados em 3 regiões. Estas regiões são: litoral norte e terras altas (em tôrno das latitudes 18° 30' S e 16° 45' S), litoral central (em tôrno de 22° 50' S) e litoral sul (25 - 27° 15' S). As características desejáveis da população principal são: ampla

adaptabilidade nas regiões, incluindo um alto nível de resistência aos ventos, alta taxa de crescimento, caules retos, copas sem defeito, e propriedades da madeira satisfatórias.

OUTLINE OF PROPOSED ADVANCED-GENERATION BREEDING AND SEED ORCHARD PROGRAMME WITH *Pinus caribaea* MOR. VAR. *hondurensis* BARR. AND GOLF. IN QUEENSLAND USING INTER-PROVENANCE CROSSING

Summary

Genetic improvement of the Belize, Mountain Pine Ridge (B,MPR) provenance of Pinus caribaea Mor. var. hondurensis Barr. and Golf. in Queensland has reached the stage where a second clonal orchard complex is being developed. This will cater for seed requirements until 2004 when a third complex will have to be in production. One function of the improvement programme is to complete the second and establish the third orchard complex with the most appropriate clonal complements, taking account of characteristics desired within the progeny which will be used to stock plantations being established in three regions. These are: northern coastal and upland (around latitudes 18°30'S and 16°45'S), central coastal (around 22°50'S) and southern coastal (25-27°15'S). The principal population characteristics desired are: region-wide adaptability including a high level of wind-firmness, high growth rate, straight stems, defect-free crowns and satisfactory wood properties.

LIGNES GÉNÉRALES D'UN PROGRAMME PROPOSÉ POUR L'AMELIORATION DE GÉNÉRATIONS AVANCÉES ET DE VERGERS DE GRAINES POUR *Pinus caribaea* MOR. VAR. *hondurensis* BARR. ET GOLF. À QUEENSLAND, EN EMPLOYANT DES CROISEMENTS DE PROVENANCES

Resume

Au Queensland, l'amélioration génétique du Pinus caribaea MORELET, var. hondurensis, BARR. et GOLF, provenance Mountain pine Ridge de Belize, a atteint le stade où un second ensemble de jardins grainiers, à partir de clones, est en train de s'établir. Il permettra de répondre aux besoins de graines jusqu'en 2004, année où un 3ème ensemble devra être mis en chantier. L'une des fonctions de ce programme d'amélioration est de compléter le second verger grainier et de mettre en place le 3ème à l'aide de compléments en clones les plus appropriés, tenant compte des caractéristiques que l'on désire retrouver dans les lignées qui seront utilisées dans les plantations établies dans les 3 régions suivantes :

- la zone côtière Nord et les plateaux (16° 45' de latitude Nord et 18° 30' de latitude Sud environ),
- le Centre (22° 50' Sud environ) et
- le Sud (25 - 27° 15' Sud).

Les caractéristiques principales à retenir sont : une grande adaptabilité au niveau des régions, ce qui implique une forte résistance au vent, un taux de croissance élevé, la rectitude des tiges, des houppiers sans défaut, et des caractéristiques du bois satisfaisantes.

The provenance of the large breeding population (over 350) is almost exclusively B,MPR. It includes 90 excellent second generation selections but these trace to only 30 first-generation parents. Many more second-generation selections will be added as current and future progeny trials, including many seedlots from overseas plus trees, are assessed.

The first cycle of selection, breeding and orchard development has given conspicuous gains in stem straightness, crown conformation and wind-firmness, but little in growth rate.

Recent, preliminary studies of 5.5 to 7.5 year data from the international provenance trials established on 10 sites at eight localities indicate that the eight mainland coastal provenances included are superior to the upland sources in stem straightness, windfirmness and percentage of superior butt logs. Most coastal provenances are taller also. The upland provenances include a B,MPR population which is considered to be typical of the original, local base population. Thus several provenances of equal growth rate but superior stem quality and windfirmness have been identified.

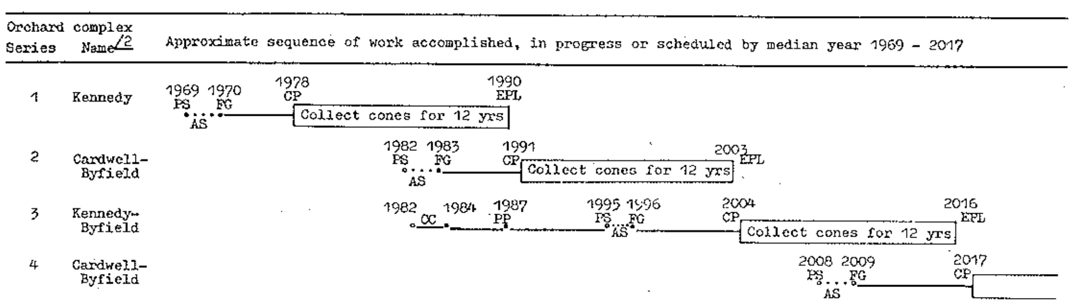
These findings suggest that several coastal provenances have a higher frequency of gene complexes conditioning stem straightness and windfirmness. These population characteristics are very desirable in Queensland where an important aim is to produce high-quality saw logs and where periodic cyclones can cause severe damage to pine plantations. Also indicated is the fact the coastal provenances themselves require improvement genetically before they could replace the seed orchard progeny derived from B,MPR provenance currently being planted in Queensland.

The second, breeding function of the programme for genetic improvement is (1) to develop more broadly-based populations, (2) to transfer gene complexes conditioning stem straightness and windfirmness from coastal provenances to the advanced-generation, local breeding population of B,MPR provenances, and (3) to develop a new breeding population with higher yield potential, e.g. an interpopulation showing hybrid vigour.

It is suggested that all three objectives might be achieved through a programme of inter-provenance crossing, using the best products of the first, local breeding cycle with B,MPR as seed parents, and pollen from plantation plus trees selected within the coastal provenances locally and at appropriate sites overseas. Such pollen importation is necessary because of the small coastal populations available locally. It would be carried out with strict adherence to quarantine requirements.

The logistics of such a breeding project are discussed and a schedule of activities, needed to discharge the breeding and seed-producing functions of the local improvement programme,

Figure 1. Chronological sequence of activities by median year for three cycles of orchard development and breeding in the programme for genetic improvement of var. hondurensis in Queensland (breeding and planting of progeny shown for Orchard Series 3 only)/1



/1 Based on the following known periods required for each activity: three seasons for controlled crossing (CC); three years from completion of CC until planting of progeny (PP); nine years from planting until completion of assessment (A) and selection (S) of superior individuals; field grafting (FG) the same year as AS; planting of seedling stocks (PS) done one year earlier; eight years from FG until appreciable cone production (CP); and twelve years until end of productive life (EPL) of each orchard section.

/2 The sites of the orchard complexes can be rotated between two locations. In fact, each complex comprises four or five discrete units as insurance against loss by fire, cyclone or other cause. The unit structure also permits orchard specialisation e.g. units could be culled, if necessary, to the clones yielding the best synthetic variety for particular target environments.

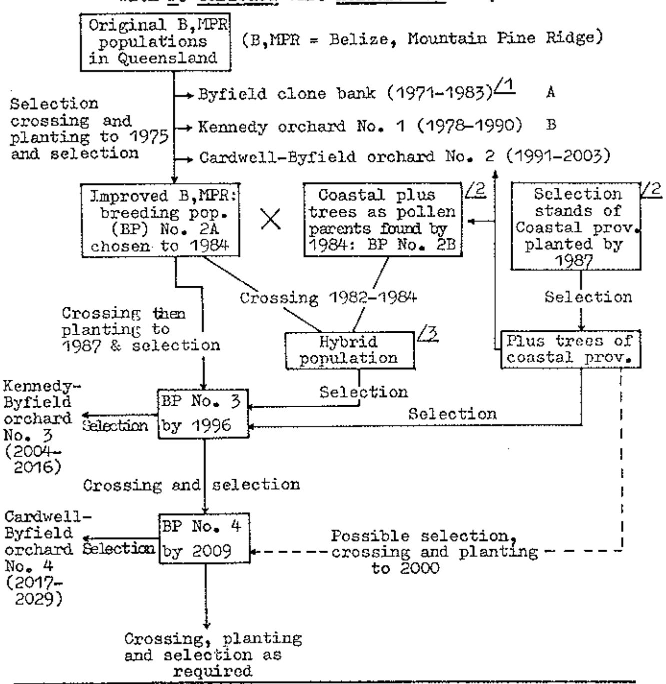
is described and illustrated. The form of the proposed mating design (N.C. Design I) is illustrated.

A plea and suggestions are made for international cooperation, by way of plus tree selection and pollen donation, in the proposed project. Selection would be carried out initially in the coastal populations within the international provenance trials (initiated by CFI in the early 1970s) and larger selection stands of known provenance. This work might be supervised and documented by an international coordinating agency.

Since there is no guarantee that the inter-provenance breeding project would succeed in achieving all its objectives, a complementary project is proposed. This would involve local establishment of perhaps 2000 ha of plantations using imported seed of coastal provenances (including seed available from plus trees) to enable intensive local selection of seed orchard and breeding populations for the improvement programme.

A diagramatic representation of the populations and activities that would be involved in such an advanced-generation breeding and seed orchard project is presented.

Figure 2. Outline of proposed long-term breeding programme with *P. caribaea* var. *hondurensis* in Queensland

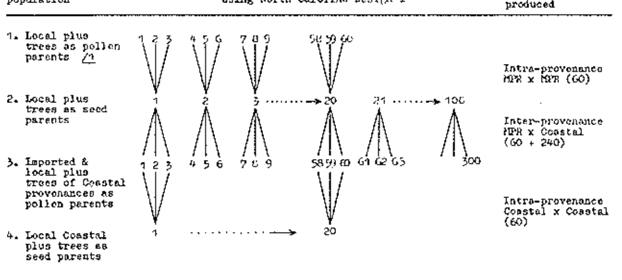


/1 Period in median years over which economic cone collection can be made in these already established clone banks and seed orchards; actual collection began 1966, 1975 in A, B.

/2 Provenances from coastal lowlands have equal growth but superior straightness and windfirmness to B,MPR. Breeding populations (BPs) 2A and 2B would be mated within themselves to provide control populations (see Figure 3). It is proposed to import selected pollen lots for inclusion in BP No. 2B.

/3 The hybrid population is expected to show increased vigour plus superior stem straightness and windfirmness.

Figure 3. Outline of crossing programme using N.C. Design I for proposed production of var. hondurensis provenance hybrids and control populations in Queensland



/1 The local breeding population totals over 350 plus trees of Belize, Mountain Pine Ridge (B,MPR) provenance.

INVENTÁRIO E USO DOS POVOAMENTOS IMPLANTADOS PARA CONSERVAÇÃO DE RECURSOS DE PROCEDÊNCIAS DE *Pinus caribaea* MOR. VAR. *hondurensis* BARR. E GOLF. EM QUEENSLAND

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Resumo

"Povoamentos implantados para Conservação de Recursos de Procedências" (P.I.C.R.P.) são definidos como plantações florestais de procedência conhecida, e ampla base genética, cujos limites são conhecidos e registrados em mapas oficiais, e que podem ser utilizados para a seleção de árvores "plus", coleta de sementes, conservação da procedência etc.; eles são especialmente úteis quando tem áreas de 50 ha, ou mais, das procedências desejáveis, quando então podem ser um recurso genético valioso para um programa de melhoramento.

Ensaios de procedências com várias repetições, são casos reais do conceito de P.I.C.R.P. Todavia as populações (parcelas) envolvidas são normalmente muito pequenas mas podem se constituir em recursos genéticos importantes.

Um inventário de tais populações de *P. caribaea* var. *hondurensis*, plantadas em Queensland no período de 1973 a 1979, incluindo também uma discussão dos seus usos é apresentado. Todos os melhoristas que trabalham com esta variedade são convocados a, igualmente, registrar suas P.I.C.R.P., e concordar em promover o intercâmbio de material genético selecionado entre eles.

INVENTORY AND USE OF "PROVENANCE RESOURCE STANDS" OF *Pinus caribaea* MOR. VAR. *hondurensis* BARR. AND GOLF. IN QUEENSLAND

Summary

"Provenance resource stands" (PRSs) are defined as forest plantations of known provenance and broad genetic base whose boundaries are marked in the field and recorded on official maps, and which may be used for plus tree selection, seed collection, provenance conservation, etc.; they are especially useful when they total 50 ha or more of desirable provenances, when they can be a valuable genetic resource for a breeding programme.

Replicated provenance trials are really special cases of the PRS concept. Although the stands (plots) involved are usually very small they can constitute important genetic resources.

An inventory of such stands of *Pinus caribaea* var. *hondurensis* planted in Queensland in the period 1973-1979 inclusive and a discussion of their uses are given. All breeders working with this variety are urged to similarly record their PRSs, and to agree to exchange selected genetic material from them.

INVENTAIRE ET USAGE DES PEUPLEMENTS IMPLANTÉS POUR LA CONSERVATION DE RESSOURCES DE PROVENANCES DE *Pinus caribaea* MOR. VAR. *hondurensis* BARR. ET GOLF. À QUEENSLAND

Resume

"Les peuplements d'approvisionnement en provenances" sont des plantations forestières dont la provenance est connue et qui possèdent une base génétique très vaste dont les limites sont

indiquées sur le terrain et reportées sur des cadastres officiels. On peut les utiliser pour la sélection des arbres d'élite, la récolte de graines, la conservation des provenances, etc. Ils sont tout particulièrement utiles quand leur surface atteint 50 ha ou plus de provenances intéressantes, quand il peuvent faire partie d'un programme d'amélioration grâce à leur réserve génétique. Dans le concept des "peuplements d'approvisionnement en provenances", les essais de provenances à répétitions sont un cas très particulier.
Bien que les placeaux d'essais en question aient en général une faible surface, ils peuvent constituer une importante réserve génétique.

On présente l'inventaire de tous"les peuplements d'approvisionnement en provenances"du Pinus Caribaea var. Hondurensis Barr. et Golf., plantés au Queensland entre 1973 et 1979 inclu, suivi d'un exposé de leur utilisation possible. Tous les Forestiers impliqués dans le travail d'amélioration du Pinus Caribaea sont priés de faire le même travail d'enregistrement pour de telles plantations,en vue de faire des échanges de matériel génétique sélectionné à partir de ces dernières.

INTRODUCTION

There has been an active tree breeding programme with Pinus caribaea Mor. var. hondurensis Barr. and Golf. in Queensland since 1955. Almost all of the plantations established and searched for plus trees in the breeding programme derive from many seed introductions from Belize, Mountain Pine Ridge (B,MPR). Provenance trials were planted in 1956, 1962, 1963, 1964, 1967, 1968 and 1969, but each planting comprised few provenances, and few of the non-B,MPR provenances showed promise. It was not until 1973, following the range-wide seed collections made by the Commonwealth Forestry Institute, Oxford (Greaves 1978), that comprehensive multi-site provenance trials were planted in Queensland (Nikles 1978).

Previous local experience with provenance studies and breeding of other conifers had shown that it was highly desirable to plant appreciable discrete areas of all available provenances at about the same time as the replicated provenance trials. These areas would constitute valuable genetic resources when superior provenances were identified through studies of the contemporary provenance trial plantings.

This practice has been followed since 1973 with P. caribaea var. hondurensis in Queensland. An inventory and a discussion of the uses of such stands, which are here proposed to be called "Provenance Resource Stands" (PRSs) are given in this paper.

DEFINITION

PRSs are plantations of known provenance and broad genetic base whose boundaries are marked in the field and recorded on official maps; and they are maintained as possible future sources of plus trees, and for provenance conservation and seed collection purposes. Replicated provenance trials really are special cases of the PRS concept. The provenance identity of the seedlings must be kept at all stages and be maintained in the field through permanent pegging. The boundaries of the PRSs should be surveyed and mapped. This enables positive identification of the locations of the stands.

INVENTORY AND RECORDS

Details of the seed sources and of the resulting PRSs planted in Queensland between 1973 and 1979 are given in Table 1. This inventory does not include the thousands of hectares of operational plantations established with local seed, of various genetic histories, over the same period, but nevertheless records are held.

Additional provenance seedlots became available in 1979 and 1980 by which time 5- to 7-year results of assessments of the comprehensive, multi-site provenance trials were used, both to choose provenances for further attention and to select localities for their most appropriate future establishment. The seedlots were sown in 1980 and resultant PRSs will be added to the inventory in due course. It is intended to continue this practice until there is adequate local representation of desired provenances.

USES OF PRSs

PRSs can serve a number of purposes. When rather numerous and widely dispersed over plantation localities and sites, as in Queensland (Table 1), these stands extend the range of environments over which provenances can be observed and thus provide extra information.

Currently the most important use of these stands of desirable provenances in Queensland is as sources of candidate plus trees for broadening the local breeding population. Recently it has been determined that coastal, especially southern coastal, natural provenances are the most promising sources of plus trees for interbreeding with the local B,MPR population in Queensland (Nikles 1980). However, as mentioned already, the local breeding population is almost exclusively composed of selections of B,MPR provenance. A special effort is being made in 1980-81, therefore, to search for plus trees within the 40 ha of local plantings of 1973 and 1974 of desirable coastal provenances to permit early interbreeding.

Searching is also being extended to the provenance trials; details of their locations and composition are given in Nikles 1978. Although the provenance trials comprise only about 200 to 300 trees per provenance per locality (4, 5 or 6 replications of 49-tree plots) they are established at 9 localities and so constitute an appreciable genetic resource in total. And, in fact, plus trees have been found within them.

It is considered that selection within these stands is valid because all have broad genetic bases (Greaves 1978, Table 1). For example, seed collection K20 from site PC3A (Table 1) was derived from about 100 selected standing trees; the stand was chosen for good quality and high stocking; and collection was made from dominant and co-dominant trees every 100 metres to avoid related individuals as far as possible (Greaves 1978). If we assume (conservatively) that the seed of each of the 100 seed parents represents four different pollinators, then the K20 progeny population in total could derive from about 500 individual parents (counting both seed and pollen parents). Although some selections made within the K20 progeny population locally or elsewhere could be half sibs the risk is worth taking at this stage if K20 is a desirable provenance and available selection stands are limited.

Such PRSs can also serve as seed sources - if the cross pollination between them and the often-surrounding stands of locally improved B,MPR stock is acceptable. This would be so generally if the seed is required for purposes other than strict "conservation stands". In fact, if such PRSs are converted to Seed Production Areas (SPAs) through heavy, selective thinning, the resultant seed may include a proportion of well-formed provenance hybrids which may give superior growth.

PRSs can also serve as strict "conservation stands" if reproduction of the provenance is carried out by controlled crossing, or through natural crossing within a seed orchard comprising clones from a very large number of trees selected within the PRSs.

Finally, the total area (or more importantly, number of individuals) of a promising or proven provenance available to a breeder can be greatly enlarged if other breeders adopt the practice of establishing PRSs and agree to cooperate in provision or exchange of desired genetic material. All breeders working with this variety are urged to record their PRSs and to make the information available.

Table 1. Inventory of "provenance resource stands" of *P. caribaea* var. *hondurensis* planted in Queensland between 1973 and 1979

Seed collection details					Stand establishment details		
Locality	Country	Site no. /1	Collector's no. /1	No. of seed trees /1	Locality /2	Year planted	Area planted (ha)
Kuakuil	Nicaragua	PC1A	K18	40–50	Kennedy	1973	0.5
					Byfield	1973	0.2
Karawala	Nicaragua	PC2A	K19	>60	Kennedy	1973	0.3
		PC2C	K156	200	Kennedy	1979	4.7
					Byfield	1979	5.6
Alamicamba	Nicaragua	PC3A	K20	100	Kennedy	1973	1.4
					Byfield	1973	2.5
					Kennedy	1974	0.4
					Byfield	1974	1.0
					Kennedy	1975	0.6
					Byfield	1975	0.7
Alamicamba	Nicaragua	PC3C	K106	Bulk	Kennedy	1977	1.2
					Byfield	1977	0.9
					Byfield	1978	2.3
					Kennedy	1979	11.0
					Byfield	1979	18.1
Laguna del Pinar	Nicaragua	PC4A/C	K21/89	30–70	Byfield	1975	2.2
		PC4D	K123	80	Kennedy	1979	2.2
Slilma Sia	Nicaragua	PC5A	K22	Bulk	Kennedy	1973	4.5
					Byfield	1973	3.8
					Kennedy	1974	0.1
Poptun	Guatemala	PC6A	K29	Bulk	Kennedy	1973	0.5
					Byfield	1973	0.8
Brus Lagoon	Honduras	PC7A/B	K23/58	90–100	Kennedy	1973	0.2
					Byfield	1973	0.2
					Kennedy	1974	5.4
		PC7A	K58	100	Byfield	1975	4.5
					Byfield	1979	5.4
Guanaja	Honduras	PC8A	K24	Bulk	Byfield	1973	1.1
					Gregory	1973	3.8
					Kennedy	1973	5.0
					Byfield	1974	2.2
					Kuranda /3	1975	1.6
					Byfield	1975	2.9
Silver Creek	Belize	PC9A	K108	70	Kennedy	1977	1.8
					Byfield	1978	2.4
Las Lomitas	Belize	PC10A	K109	Bulk	Kennedy	1977	1.8
					Byfield	1978	3.8
Coastal Plain	Belize	–	–	–	Kennedy	1975	0.1
					Byfield	1975	0.4
Bermudian Landing	Belize	–	–	–	Kennedy	1974	1.2
					Byfield	1975	2.1
Los Limones	Honduras	PC13A	K56	67	Clemant	1973	0.1
Culmi	Honduras	PC14A	K57	60	Clemant	1973	0.1
Santos	Belize	PC19A	K64	Bulk	Kennedy	1973	0.2
Mountain Pine Ridge	Belize	PC20	K65	Bulk	Clemant	1973	0.1
					Byfield	1975	4.1
Santa Clara	Nicaragua	PC21A	K61	35+	Byfield	1973	1.5
						1974	0.6
						1975	5.2
					Kuranda	1975	8.7
Melinda	Belize	PC23A	K107	Bulk	Kennedy	1977	6.5
					Byfield	1978	11.0
							152.1

/1 See Greaves 1978 p. 20 and subsequently for details.

/2 See Nikles 1978 for some further details. Kuranda 16°45'S, Kennedy 18°10'S, Clemant 19°00'S, Byfield 22°50'S, Gregory 25°05'S.

/3 Elevation: ± 500 m

CONCLUSION

PRSs can serve several useful purposes, provided identity is strictly preserved and their limitations of size, isolation and genetic base are recognised. These uses include:

- a further check on provenance performance in addition to that of strict provenance trials
- a likely source of plus trees of desired provenances
- a seed source
- a conservation stand
- an extension of the population of a particular provenance if several breeders adopt the practice of establishing PRSs, reporting inventories and exchanging select material therefrom.

Therefore, it is recommended to breeders that the establishment, provision of inventories and exchanges of material from PRSs be practised widely.

ACKNOWLEDGEMENT

The authors wish to acknowledge the contribution of several research and operational staff of the Department for careful maintenance of provenance identity in nursery and field and for the planting and maintenance of the stands.

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FAST GROWING TREES

VARIAÇÃO GENÉTICA EM RESISTÊNCIA AO VENTO ENTRE PROCEDÊNCIAS DE *Pinus caribaea* MOR. VAR. *hondurensis* BARR. E GOLF. EM QUEENSLAND

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Resumo

Ensaios multi localidades de 15 procedências naturais e uma população local geneticamente melhorada, derivada de Belize e Mountain Pine Ridge, fontes de sementes de P. *caribaea* Mor. var. *hondurensis* Barr. e Golf., foram plantados no litoral de Queensland, no início de 1973, como parte dos ensaios internacionais coordenados pelo C.F.I. de Oxford. Em Byfield (22° 50', 30 m acima do nível do mar) dois sítios, um naturalmente bem drenado e outro hidromórfico, foram selecionados. Os sitios inundáveis foram convenientemente preparados para melhorar a drenagem.

A severa ação de ciclones nos sitios de Byfield, em janeiro de 1976 e janeiro de 1980, causou sérios prejuizos nos ensaios e nas plantações rotineiras. Um ciclone moderadamente severo ocorreu em Kennedy em 1979. A avaliação dos danos, a nível de árvores, foi efetuada em Byfield poucos meses após os dois ciclones, em duas repetições por sitio, dando-se notas para 49 árvores por parcela (idade 3,5 anos). As notas variaram de 1 a 4 (4 não apresentava dano algum), para inclinação da árvore, tombamento e quebra do tronco. Em 1980 (idade 7,5 anos) as árvores foram também classificadas de acordo com o potencial de uso da tora basal, 3 pontos para utilização como tora de serraria, 2 para madeira de polpa somente, e 1 para uso menos nobre. A avaliação da retidão do tronco foi efetuada na idade de 6 anos (solos bem drenados), usando o "Esquema de Oxford", e na idade de 6,5 anos (solos hidromórficos), usando uma escala de 1 a 5 pontos. Em Kennedy a resistência ao vento e a retidão do tronco foram avaliadas aos 6,5 anos nas mesmas bases dos solos hidromórficos de Byfield. A altura e diâmetro das árvores foram também mensurados em várias ocasiões. Análises das variâncias foram efetuadas em relação às médias das parcelas, a transformação dos dados foi efetuada quando necessária.

Houve diferenças significativas entre procedências em todos os critérios avaliados, dos danos causados pelo vento, para os três sitios e para um total de três avaliações envolvendo as idades 3,5, 6,5 e 7,5 anos. Encontrou-se, também, fortes correlações positivas das médias das procedências para resistência ao vento entre os três pares de sitios e entre as sucessivas avaliações em Byfield. As procedências mais resistentes incluem várias das mais altas e que foram portanto mais expostas e melhor testadas. Estudos locais prévios mostraram diferenças significativas entre várias procedências em relação à resistência ao vento. Os resultados mostram, também, que a resistência ao vento é uma grande componente da retidão do tronco.

Todas as observações indicaram que um grupo de procedências interiores da região litorânea, foram as mais resistentes, e as procedências mais interiores variaram de moderada a altamente suscetíveis aos danos pelo vento. A procedência M.P.R., localmente importante, demonstrou ser a melhor fonte de sementes interior. Uma população derivada da M.P.R.

e geneticamente melhorada, apresentou ganhos genéticos positivos para resistência ao vento e crescimento. Isto sugere que melhores resultados poderiam ser obtidos através do melhoramento das populações, envolvendo as altamente resistentes e vigorosas tais como Brus Lagoon, Karawala, e Almicamba.

As possíveis razões para a maior resistência ao vento das procedências litorâneas são mencionadas. As implicações desses resultados para o planejamento da futura estrategia são brevemente discutidas.

GENETIC VARIATION IN WINDFIRMNESS AMONG PROVENANCES OF *Pinus caribaea* MOR. VAR. *hondurensis* BARR. AND GOLF. IN QUEENSLAND

Summary

Multi-site trials of 16 natural provenances and a genetically-improved local population, derived from Belize, Mountain Pine Ridge (MPR) sources of Pinus caribaea Mor. var. hondurensis Barr. and Golf., were planted in coastal Queensland early in 1973 as part of the international trials coordinated by CFI, Oxford. At Byfield (22°50'S, 30 m a.s.l.) both naturally well-drained and swampy sites were sampled, while at Kennedy (18°15'S, 9 m a.s.l.) a swampy site was involved. The swampy sites had been prepared so as to improve drainage.

Severe cyclones struck the Byfield sites in January 1976 and January 1980 causing serious damage in the trials and routine plantations. A moderately severe cyclone occurred at Kennedy early in 1979. Assessments of damage to individual trees were carried out at Byfield a few months after both cyclones in two replications per site scoring 49 trees per plot in 1976 (age 3.5 years). Trees were scored on a one to four scale (four was equated to virtually no damage) for lean, stem bending and stem breakage. In 1980 (age 7.5 years) trees were also classified according to utilisation potential of the butt log, three points being awarded for sawlog quality, two for pulp wood quality only and one for useless. Assessments of stem straightness were carried out at age 6.0 years (well-drained site) using the "Oxford schedule" and at 6.5 years (swampy site) using a one to five points scale. At the Kennedy site windfirmness and stem straightness were assessed at 6.5 years on the same bases as at the Byfield swampy site. Tree heights and diameters were also measured on several occasions. Analyses of varianace were carried out on plot means, transformed where necessary.

There were significant differences between provenances in all criteria of wind damage assessed at the three sites on a total of three occasions involving trees aged 3.5, 6.5 and 7.5 years. Also, there were strong positive correlations of provenance means for wind damage between the three pairs of sites and between successive assessments at Byfield. The most resistant provenances included several of the tallest which were therefore exposed and well tested. Previous local studies had also shown significant differences among several provenances in windfirmness. Results also indicated that windfirmness is a large component of stem straightness.

All observations indicated that a group of mainland coastal provenance were the most resistant, and inland provenances were moderately to highly susceptible to wind damage. The locally-important MPR provenance was found to be the best inland source. A genetically-improved population derived from it showed a positive genetic gain for windfirmness and growth. This suggests that even better results might be obtained by means of population improvement within highly wind-resistant and vigorous provenances such as Brus Lagoon, Karawala and Alamicamba.

Possible reasons for the greater wind resistance of mainland coastal provenances are mentioned. Implications of these findings for planning future breeding strategy are discussed briefly.

VARIATION GÉNÉTIQUE EN RÉSISTENCE AU VENT ENTRE DES PROVENANCES DE *Pinus caribaea* MOR. VAR. *hondurensis* BARR. ET GOLF. À QUEENSLAND

Resume

Les observations effectuées sur les essais de provenances de Pinus caribaea, var. hondurensis, BARRET et GOLFARI, introduites au Queensland ont été entreprises peu de temps après avoir été endommagées par des cyclones. Elles montrent que les provenances de la région côtière sont plus résistantes au vent que celles des îles. La 2ème génération de la provenance Mountain Pine Ridge qui a été améliorée par sélection local se comporte comme la provenance de la région côtière.

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

Cyclones of varying intensity approach or cross the Queensland coast periodically and may destroy, defoliate or malform forest trees. For example, pine plantations have been severely damaged by cyclones at various places along the east coast in recent years: at Cathu (1970), Beerburrum and Tuan (1971), Elliott River (1976), Byfield (1976, 1980) and Kennedy-Cardwell (1979). Such damage also occurs periodically in Fiji, New Caledonia and other pine-growing areas in the south west Pacific at least.

The main forms of damage to pine trees are windthrow (which may range from a slight lean to complete toppling), stem bending or breakage. Their relative amounts are partly dependent on whether the soil is wet or dry at the time of wind occurrence. Wind damage causes economic losses through reduction of the volume and value of produce, and the added cost of attempts to repair the damage by re-erecting leaning trees.

The most susceptible height class of trees of Pinus caribaea Mor. var. hondurensis Barr. and Golf./1 is around 3 to 6 m, but much larger trees may be affected also, particularly if growing on shallow or swampy soils or in narrow valleys. This means that all plantations in hazardous areas have a long period of susceptibility and consequently a high likelihood of some economic loss during a rotation.

The best means for minimising wind damage to pine plantations probably involve integrated measures including careful selection of sites in relation to soil depth and type, appropriate design and location of boundaries, good thinning practices, use of strips of vegetation to act as windbreaks, use of planting stock with well-developed root systems, and selection of populations that are more resistant genetically.

Evidence of genetic variation among provenances of var. hondurensis grown in the Queensland plantings of the international provenance trials is given in this paper. It has already been found that there is considerable genetic variation for wind damage between varieties of P. caribaea and among families of Belize, Mountain Pine Ridge/2 provenance of var. hondurensis in Queensland. Implications of these findings for planning breeding strategy are also discussed briefly.

S I T E S , M A T E R I A L A N D M E T H O D S

Multi-site, replicated trials of 16 natural provenances, a genetically-improved population derived through selection within Queensland plantations of MPR provenance, and a Queensland commercial stock, also from local sources of MPR provenance, were planted at 8 localities in eastern coastal Queensland early in 1973 as part of international trials coordinated by the Commonwealth Forestry Institute, Oxford. Details of the localities, sites, provenances used and trial management are given in Nikles 1978 and Eisemann et al. 1980. Greaves 1978 reported on the seed collection localities and the composition of each provenance.

The two trials planted at Byfield (22°50'S, 30 m a.s.l.), and a third trial planted at Kennedy (18°15'S, 9 m a.s.l.), were struck by cyclones in January 1976 and 1980 (Byfield) and early 1979 (Kennedy) causing damage in the trials (and routine plantations) which was most serious in 1980 at Byfield.

The Byfield and Kennedy forests are in the generally flat coastal lowland, and the trial sites are typical of large areas of low-yield natural forest on which pine plantations are being established.

One Byfield site was naturally well-drained with a deep, lateritic podsolic soil and previously carried tall eucalypt forest. The other was a naturally, ill-drained slope classed as swampy due to poor internal drainage (soil type was gleyed podsolic). Natural vegetation comprised a low, open "forest" of scattered tea-tree (Leptospermum and Melaleuca species) and Banksia only a few metres high. Site preparation on the well-drained site consisted of mechanical pushing, windrowing and burning the remains of the natural forest after logging, followed by ploughing and chemical weed control just before planting. The swampy site at Byfield was prepared by clearing the very light woody vegetation cover and forming scattered heaps which were later burnt. It was ploughed, mounded and intensively drained artificially using a system of major drains (1.1 m deep) installed by back-hoe, plus auxiliary drains (0.5 m deep) formed by grader and set approximately at right angles to the main drains.

The Kennedy site carried tall tea-tree forest and the soil type was a gleyed sand/clay alluvium. On this swampy site preparation for planting was by pushing, heaping and burning followed by drainage and mounding, though less intensively than at Byfield.

/1 Hereafter referred to as var. hondurensis in this paper.

/2 Hereafter referred to as MPR in this paper.

Planting was carried out in January-February 1973 using normal, tubed stock at all three sites. (No root binding or coiling was evident or suspected). Espacement was 2.7 x 2.4 m. Plots were seven rows by seven trees and replicates of 18 plots each were established with five replications on well-drained and six on swampy sites. Each replicate had an isolation of at least two rows of experimental stock.

Three fertiliser regimes were applied on swampy and well-drained sites (two blocks each) with one missing replicate on the well-drained site, application taking place in the summer of 1974 some 13 months after planting and again in the spring (September) of 1974. Details are given in Eisemann et al. 1980.

Heights of the interior 25 trees per plot were measured annually in the cool dry season (August usually) until 1976 (age 3.5 years) and again in 1978 (age 5.5 years) when diameter (d.b.h.) was measured also.

At Byfield an assessment of cyclone damage to individual trees was carried out at age 3.5 years over two comparably fertilised replications per site by scoring each for windfirmness (lean), stem bending and breakage (using 1 to 4 point scales, the high scores signifying little or no damage). After the 1980 cyclone trees were again measured for d.b.h. and scored for wind damage (at age 7.5 years) and for "utilisation potential" of the butt log, 3 points being awarded for sawlog quality, 2 for pulp wood quality only, and 1 for "useless".

Stem straightness and several other traits were assessed in 1979 (6.0 to 6.5 years). On the well-drained Byfield site the assessment schedule devised by Commonwealth Forestry Institute, Oxford was used (Barnes and Gibson 1980). On the swampy sites stem straightness was scored at 6.5 years (one- to five-point scale with five points indicating the best class) and several other tree quality characteristics were similarly scored (Eisemann et al. 1980). Additionally, windfirmness was assessed (one to four scale as above) at the Kennedy site (six replications) at 6.5 years.

Analyses of variance were carried out both within and across Byfield sites and for the Kennedy site using plot means which were transformed where necessary.

RESULTS AND DISCUSSION

Presentation of Results

Survival was almost 100 per cent in all plots at all sites. Growth was normal, site means for height across provenances at 5.5 years ranging 7.92 m to 8.76 m (Eisemann et al. 1980).

Provenance means across the Byfield well-drained and swampy sites for several growth and tree quality traits measured, scored or derived are presented in Table 1. Observed rather than transformed values are tabulated, for the few traits where transformation was desirable, because both sets of data gave similar results in the analyses and observed values are more convenient to consider and discuss.

Only one trait, 3.5 year windfirmness score, showed a significant provenance x site interaction. This interaction was significant at the 5 per cent level only and it was due mainly to a relatively much better performance by the poor Culmi stock on the swampy site than on the well-drained site. Given the general lack of provenance x site interaction, results for individual Byfield sites are not presented. Instead, data were combined to give provenance means across sites.

The 3.5 Year Data

The 3.5 year data were obtained at Byfield only. There were significant differences among provenance means for all three traits reported (Table 1).

Only about 10 per cent of the trees suffered severe wind damage. (For example, Table 1 shows that 91.8 per cent of all trees suffered zero or very little windthrow damage). However all eight mainland, coastal provenances/3 were less affected than the six comparable inland provenances, the provenance mean scores for windfirmness ranging 3.87 - 3.69 (average 3.77) and 3.44 - 3.04 (average 3.23) for the former and latter groups respectively. The insular, Guanaja population was intermediate (3.55). And the mainland coastal provenances all suffered less stem bending than the inland provenances (respective group means were 3.65 and 3.15).

It is believed that wind damage to individuals within a population is dependent on height to some extent, with shorter trees at 3.5 years being less susceptible. Therefore some provenances might have suffered more damage because of greater height class and exposure. Examination by covariance analyses and graphical means, however, showed there was no consistent relationship between provenance mean height and windfirmness. Thus the more windfirm mainland coastal provenances included both the tallest (Brus Lagoon) and shortest (Melinda) provenances; and the generally wind-susceptible inland provenances included a short provenance (Los Limones) and moderately tall provenances (Santa Clara, Culmi, Potosi). This indicates that at least some provenances have genuine windfirmness.

The following five provenances were most notable for a combination of desirable tallness, windfirmness and resistance to stem bending at age 3.5 years: Brus Lagoon, Alamicamba, Karawala, Queensland select and Guanaja.

The 6.0 to 7.5 Year Data from Byfield and Kennedy

In considering the 7.5 year Byfield data it should be noted that 3.0 year wind damage (which was not repaired artificially by attempting to re-erect leaning trees) probably predisposed affected trees to damage at 7.5 years. Thus the accumulated damage, which was scored in 1980, is expected to be a very useful means for discriminating provenances and, when considered with growth parameters, for identifying promising provenances. This should be especially true in view of the fact that damage was very severe at Byfield in 1980/4 (age 7.0 years) thus providing a thorough test of any variation in wind resistance. Differences between provenances were highly significant for all four criteria of wind resistance - scores for windfirmness, stem bending, stem breakage and utilisation potential (Table 1).

The eight mainland coastal provenances as a group had higher means for all criteria of wind resistance than the six inland populations. For example, the ranges of provenance means and the group means for windfirmness score were: mainland coastal - 3.41 to 2.93 (3.20) and inland - 2.84 to 1.95 (2.395). As at 3.5 year, the insular Guanaja source was intermediate (mean of 2.78).

Provenance mean windfirmness scores across Byfield sites for the 3.5 year and 7.5 year assessments were highly correlated (r = 0.919***). This is illustrated in Figure 1 which also shows that all mainland coastal provenances, and the Queensland select population (125) had windfirmness scores exceeding the overall mean and the means of all inland provenances including MPR (K65).

The difference between MPR and Queensland select populations represents a positive genetic gain because the latter (and Queensland breeding populations) are derived from plus trees selected in plantations genetically equivalent to MPR natural provenance K65. Furthermore the difference between K65 and superior natural populations like Brus Lagoon (K58) indicates the latter has considerable potential for future breeding use in Queensland.

Provenance means for windfirmness and stem bending were well correlated (r = 0.886*** for Byfield sites combined). That is, for example, mainland coastal provenances also suffered less stem bending than inland sources. Stem breakage was also correlated, though less well, with each of the other two criteria of wind damage (with windfirmness, r = 0.695, with stem bending, r = 0.568). However this damage was of relatively rare occurrence except in Alamicamba, Potosi, Culmi, Poptun and Los Limones provenances, of which only Alamicamba is from the mainland coastal region. And provenance means for stem utilisation potential were highly correlated with windfirmness (r = 0.9785***). It should be possible, therefore, to select provenances which excel in all four criteria of wind resistance (see later).

Results of Kennedy Study

Wind damage was less severe than at Byfield, and the superiority of several mainland coastal provenances (of which Brus Lagoon was again the best) over MPR was not significant statistically. However, the other inland provenances (Culmi, Poptun, Santa Clara, Los Limones and Potosi) were significantly inferior to MPR and to all coastal provenances except Karawala and Alamicamba. The ranges of mainland coastal and inland provenance means for windfirmness were respectively 3.84 to 3.62 (average of 3.75) and 3.75 to 3.02 (3.33), and the only inland provenance with a mean within that of the range of mainland coastal provenances was MPR (3.75). Thus the results from the Kennedy trial paralleled those of the Byfield plantings. This was also indicated by the high and significant, positive correlation of provenance means for windfirmness between Kennedy and Byfield well-drained sites (r = 0.872***).

There was no consistent relationship between 5.5 year height and 6.5 year mean windfirmness score. Several provenances combined tallness and windfirmness including Brus Lagoon, Queensland select, MPR, Pinar, Rio Coco, Karawala, Kuakuil, Guanaja and Alamicamba. These and parallel results of the Byfield trials indicate that provenances combining superiority of both growth and windfirmness may be selected.

/3 Provenance groups are defined in Table 1.

/4 Some 70 per cent of all trees were severely damaged (Table 1).

Table 1. Provenance and provenance group means for growth, wind resistance and tree quality traits in Byfield and Kennedy trials planted in early 1973

Provenance name and code /1		Byfield well-drained and swampy sites: Ht. 3.5 yr (m)	Windfirm-ness score 3.5 yr /2	Stem bend score 3.5 yr /2	Ht. 5.5 yr (m)	Volume index 5.5 yr	DBH 7.5 yr (cm)	Windfirm-ness score 7.5 yr /2	Stem bend score 7.5 yr /2	Stem breakage score 7.5 yr /2	Stem potential score 7.5 yr /2	Sawlog class trees % /2	Kennedy swampy site: Ht. 5.5 yr (m)	Windfirm-ness score 6.5 yr /2	Straight-ness score 6.5 yr /2
I. Mainland coastal provenances															
Kuakuil	K18	4.29	3.69	3.69	8.09	280	14.68	3.10	3.56	4.00	2.10	38	8.32	3.83	1.84
Karawala	K19	4.86	3.78	3.64	8.97	326	16.01	2.96	3.71	3.94	2.05	35	8.33	3.71	1.66
Alamicamba	K20	5.00	3.74	3.54	8.43	312	14.83	2.93	3.50	3.78	1.85	24	8.09	3.62	1.58
Pinar	K21	4.50	3.70	3.65	8.13	281	14.94	3.24	3.79	3.97	2.27	49	8.55	3.73	1.86
Slilma Sia	K22	4.40	3.81	3.75	8.01	277	14.62	3.30	3.79	3.95	2.14	35	8.59	3.83	1.67
Brus Lagoon	K58	5.06	3.80	3.66	8.74	342	15.87	3.34	3.80	3.94	2.30	52	9.10	3.84	1.86
Santos	K64	4.15	3.87	3.67	7.61	257	15.09	3.41	3.72	3.97	2.22	42	7.00	3.72	1.46
Melinda	K66	4.02	3.75	3.63	7.93	275	15.18	3.32	3.63	4.00	2.21	42	7.26	3.75	1.55
	Mean	4.53	3.77	3.65	8.24	294	15.15	3.20	3.69	3.94	2.14	40	8.16	3.75	1.69
II. Insular provenance															
Guanaja	K24	4.65	3.55	3.48	8.35	351	15.87	2.78	3.38	3.94	1.77	26	8.26	3.78	1.51
III. Inland provenances															
Poptun	K29	4.85	3.44	3.19	8.51	367	16.11	2.81	3.58	3.83	1.82	24	8.11	3.41	1.59
Los Limones	K56	4.13	3.12	3.24	7.60	363	14.89	1.95	3.35	3.84	1.23	4	7.10	3.03	1.40
Culmi	K57	4.62	3.15	3.10	8.41	345	15.61	2.37	3.36	3.82	1.50	14	8.54	3.47	1.50
Potosi	K60	4.71	3.24	3.23	8.27	327	16.00	2.25	3.35	3.79	1.32	8	7.16	3.02	1.27
Santa Clara	K61	4.63	3.04	3.01	8.07	322	15.13	2.15	3.17	3.88	1.31	5	8.12	3.27	1.49
Mountain Pine Ridge	K65	4.75	3.37	3.15	8.43	344	16.01	2.84	3.46	3.91	1.69	21	8.64	3.75	1.54
	Mean	4.62	3.23	3.15	8.22	345	15.63	2.40	3.38	3.85	1.48	13	7.95	3.33	1.47
IV. Genetically-improved population derived through selection in Queensland plantations of Mountain Pine Ridge (Belize) sources															
Qld. Select	125	4.74	3.50	3.38	8.93	428	16.96	3.19	3.73	3.91	2.19	42	9.04	3.84	2.30
Expt. mean		4.59	3.51	3.43	8.28	319	15.49	2.87	3.56	3.91	1.88	29	8.13	3.36	1.67
LSD 0.05 /3		0.42	0.23	0.27	0.49	53	0.79	0.30	0.33	0.12	0.33	17	1.13	0.29	0.23
Signif. level		***	***	***	***	***	***	***	**	**	***	***	**	***	***

/1 For details of provenances see Greaves 1978

/2 See text for details of scoring schedules: high means are desirable

/3 LSD for comparison of individual provenances means

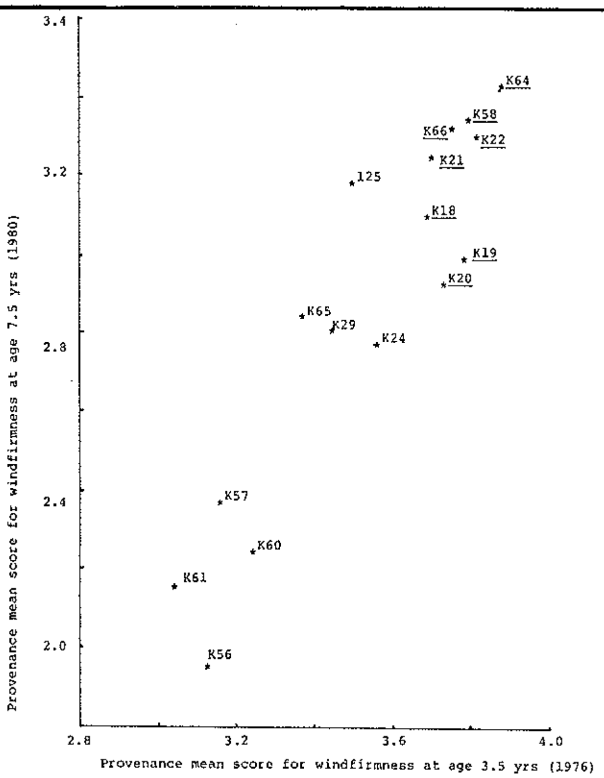

Figure 1. Relationship of provenance mean scores for windfirmness across Byfield well-drained and swampy sites at ages 3.5 and 7.5 yr (r = 0.919***). See Table 1 for provenance names and codes; mainland coastal provenances indicated thus: K58.

Relationship of Windfirmness and Stem Straightness

Provenance means for windfirmness scored soon after the cyclones were highly positively correlated with stem straightness scored 1.5 to 2 years before the cyclones occurred. The correlations for the three sites were as follows: Kennedy swampy site (0.654***), Byfield well-drained site (0.800***) and Byfield swampy site (0.807***).

This favourable relationship of stem straightness and windfirmness has also been observed at the levels of species, variety and individual-within-populations of the slash-caribbean pine complex grown in Queensland. Thus the relatively straighter north Florida slash pine (*P. elliottii* Engelmn. var. *elliottii* Little and Dorman) is more wind resistant than *P. caribaea* var. *hondurensis*; var. *bahamensis* and var. *caribaea* are more resistant than the relatively more crooked var. *hondurensis*; very straight ortets (plus trees) of all varieties of the slash-Caribbean pine complex are more resistant than their neighbours of ordinary or very inferior straightness; and families with the highest mean straightness also have the highest mean wind resistance rating (unpublished data).

It appears, therefore, that wind resistance is a major component or determinant of stem straightness. Superior resistance may be due to a very favourable interrelationship of crown and root systems in some genotypes. In any case the close and favourable relationship between stem straightness and wind resistance provides another good reason why stem straightness should be maintained as a primary selection criterion.

Most Promising Provenanances for Future Breeding

The most important criteria of future breeding potential of provenances are rate of growth, stem quality and their variability. Stem utilisation score or percentage of trees with butt logs suitable for sawlog purposes when considered together with 5.5 year provenance means for volume index or 7.5 year diameter are therefore useful criteria of the potential economic value of provenances. Variability within provenance has not yet been studied in detail but observations suggest provenances differ in this respect also.

Provenance means for 5.5 year diameter and height at Byfield were used to calculate provenance mean volume indices (Eisemann *et al*. 1980). The relationship of these indices and provenance means for stem utilisation potential is shown in Figure 2. To be of interest for future use in the Queensland breeding programme provenances must be at least equal to MPR (K65) in growth and equal, or preferably superior, in utilisation potential. This is because the current Queensland breeding population is of MPR provenance.

Of the natural provenances, none is superior to MPR in growth However Brus Lagoon (K58) and Karawala (K19) are significantly superior in utilisation score while being equal in volume production to MPR (K65), and so are the most promising provenances in the trials. On the criteria stated, another group of provenances, with growth and utilisation scores equal to MPR, are of some interest as sources of breeding material to broaden the current breeding populations. This group includes Poptun (K29), Guanaja (K24), Alamicamba (K20) and Culmi (K57). Several other mainland coastal provenances are superior to MPR in utilisation score but are significantly inferior in growth at Byfield. These are Kuakuil (K18), Pinar (K21), Rio Coco (K22), Santos (K64) and Melinda (K66). Clearly inferior provenances are Los Limones (K56), Potosi (K61) and Santa Clara (K61) which are all of inland origin.

The superior wind resistance of mainland coastal provenances and inferiority of certain inland sources demonstrated by the results of the Byfield and Kennedy trials planted in 1973, paralleled results of earlier, less comprehensive but wide spread trials. Thus a few coastal sources from Belize and/or Nicaragua included in trials planted in 1956, 1962, 1963, 1964 and 1969 at several localities have shown wind resistance superior to that of a few inland provenances of Guatemala and Honduras (Potosi). The latter have repeatedly shown very high susceptibility to wind damage relative to MPR and coastal provenances (Nikles 1972, unpublished data).

A further indication of the potential value of the mainland coastal provenances for future breeding purposes is provided by the results of a recent search of the Byfield material for superior phenotypes. Seventeen superior trees were selected among which all eight mainland coastal provenances except Santos were represented.

Superior individuals may be found within any provenance, though with expected low frequency in the relatively poor, inland provenances. Infact, the search of the Byfield trials and excess stock, giving most attention to coastal provenances, identified two acceptable plus trees within inland provenances (K54, K65) which have been added to the local breeding population.

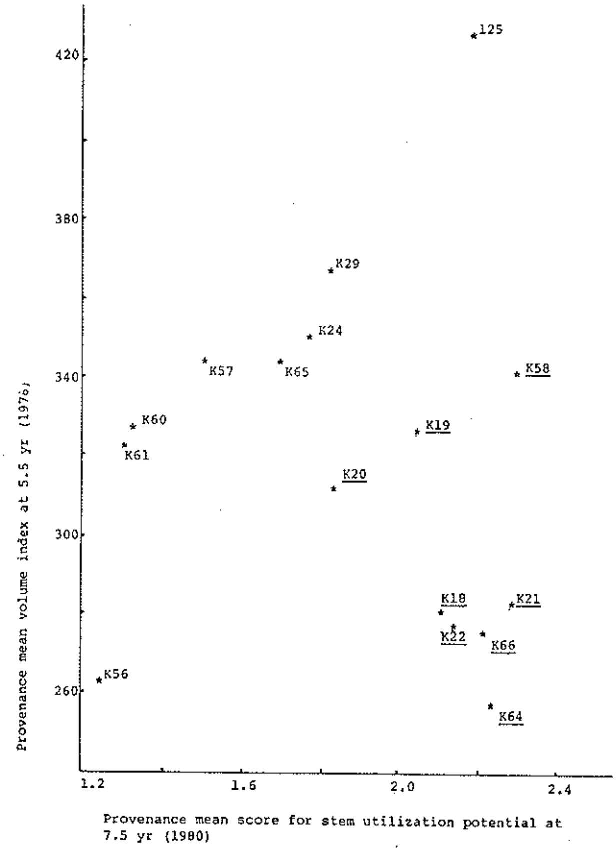

Figure 2. Relationship of provenance means for 5.5 yr volume index and score for stem utilisation potential at 7.5 yr across Byfield sites. See Table 1 for provenance names and codes; mainland coastal provenances indicated thus: K58.

Implications for Future Breeding Strategy

Results of the studies reported imply there are populations with greater genetic potential than the original MPR sources - on which the current breeding population in Queensland is based. These are certain mainland coastal provenances which have superior wind resistance and stem straightness combined with growth rate equal to that of MPR. They differ from MPR in some other respects also. For example, the mainland coastal provenances do not flower as early in life nor as abundantly as inland provenances, and they are less subject to "needleless shoots" when grown in tropical lowlands (Spidy et al. 1980; D.G. Nikles' personal observations during FAO Consultancies 1977, 1978).

The several differing traits of the two groups of provenances are each expected to be controlled by considerable numbers of genes. Therefore gene action, in both intra- and inter-provenance crosses, is probably largely additive and, if so, inter-provenance hybrids may be superior to parental provenances over a wide range of habitats intermediate between optima for parental provenances (Eriksson 1979).

These considerations suggest various possible future breeding strategies for var. hondurensis in Queensland. They include the following:

(i). To maintain the current, advanced-generation programme of population improvement within MPR populations while undertaking exploratory inter-provenance crossing to study the effects.

(ii). To concentrate efforts on population improvement within the most promising mainland coastal provenances, either as an alternative long-term strategy or as a prelude to future intercrossing.

(iii). To institute a planned programme of inter-provenance crossing[5] in order to test for hybrid vigour, and to extend the inter-provenance crossing on the assumption that this will prove to be the superior strategy (Nikles 1980).

Consideration is currently being given to these alternatives. Considerable constraints upon each of these options are the small populations of mainland coastal material planted locally (Nikles and Newton 1980) and the resources available for the work.

Possible Reasons for Superior Windfirmness of Mainland Coastal Provenances

All mainland, coastal provenances appear to have a high frequency of trees with sparse crowns, the sparse crowns often being due to long internodes resulting in relatively few whorls of branches per tree (unpublished observations; Barnes et al. 1980). There is a tendency for mainland coastal provenances to have a higher incidence of foxtailed trees (Eisemann et al. 1980) which certainly have much less crown per unit length of stem than do strongly multinodal trees. Also, mainland coastal provenances have a relatively high frequency of trees with narrow crowns made up of very numerous whorls of fine, short branches. These crown types appear to carry relatively less foliage than the multinodal crowns of long and thick branches common on trees of inland provenances. The latter may therefore present a larger surface area of foliage to buffetting winds.

There may also be inherent differences among groups of provenances in structure of root systems related to evolution of the populations in coastal and inland regions of the natural distribution differing in soil depth and moisture regimes. In view of this possibility, and the fact that cyclones periodically strike the coastal areas but less frequently penetrate inland, one may speculate that the superior windfirmness of the mainland coastal provenances may be due to natural selection in an environment that is more wind-prone, and with relatively higher water tables seasonally influencing root system development.

The intermediate windfirmness of the insular, low-altitude Guanaja provenance is, however, not explained on this basis. Rather, it is suggested here that its intermediacy may be due to a different genetic history from the mainland coastal provenances. The Guanaja stock certainly differs from the latter in several features of stem and wood quality (Eisemann et al. 1980, Barnes et al. 1980, Table 1) including branching habit which is thought to be directly related to wind resistance (see discussion above). On the basis of morphology (unpublished observations), it is hypothesised that Guanaja stock may have many genes in common with var. caribaea.

[5] And intra-provenance crossing to produce populations for comparison purposes.

CONCLUSIONS

There is genetic variation in wind resistance among P. caribaea var. hondurensis provenances which is important economically. The mainland coastal provenances are more windfirm than inland provenances on average. Some of the former provenances combine greater windfirmness with superior stem straightness and growth rate equal to that of MPR provenance. This is of importance in Queensland where current breeding populations are almost exclusively of MPR provenance. The best way to use this information may be to select superior phenotypes within plantations of coastal populations for breeding with the advanced generation MPR material developed locally, though other options are available.

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OBSERVAÇÕES DO COMPORTAMENTO DE ENXERTOS DE *Pinus caribaea* NO CAMPO

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Resumo

Cinco métodos de enxertia de *Pinus caribaea* Mor. foram utilizados. Os métodos de enxertia parecem ter pouco efeito nas falhas devidas à incompatibilidade tardia, todavia o método de fenda cheia originou uniões entre cavalo e cavaleiro mais saudáveis do que os outros. Os resultados indicam que quando os garfos são obtidos de árvores, nas idades de 7 a 9 anos, eles produzem mais cones do que garfos aos 10 - 11 anos. Essas observações seriam importantes para utilização na implantação de pomares clonais de *Pinus caribaea* na Nigéria.

OBSERVATIONS ON PERFORMANCE OF *Pinus caribaea* GRAFTS IN THE FIELD

Summary

Five methods of grafting Pinus caribaea Mor were used. Methods of grafting appeared to have little effect on later incompatibility failure although the splice method resulted in better healing of the union than the others. The indications are that, when scions are obtained from trees aged 7 to 9 years, they produce more cones than scions from 10 - 11 year-old trees. These observations would be of use in the establishment of clonal seed orchards of Pinus caribaea in Nigeria.

OBSERVATIONS DU COMPORTEMENT DE GREFFES DE *Pinus caribaea* DANS LE CHAMP

Resume

Cinq méthodes de greffe de Pinus Caribaea Mor. ont été employées. Les méthodes de greffe semblent influencer très peu les défauts dûs à l'incompatibilité tardive, toutefois la méthode des fentes pleines a originé d'unions plus salutaires que les autres. Les résultats montrent que quand les greffes sont obtenus d'arbres à l'âge de 7 à 9 ans, ils produisent plus de cônes que les greffes à l'âge de 10 - 11 ans. Ces remarques seraient importantes pour l'emploie dans implantation de vergers clonales de Pinus Caribaea en Nigéria.

INTRODUCTION

Grafting of Pinus caribaea Mor. has been carried out in the field in Australia and seedlings grafted in the nursery used to supplement the field grafting. The field grafts ranged in success from 34 to 80% - (Nikles, 1973). In Nigeria, grafting experiments in the field have not been successful. However, grafts kept under a partially controlled environment gave good results - (Oduwaiye, 1976; Okoro, 1976). The age of the trees and region of the crown from which scions were collected played major role in grafting success and cone development of grafts (Oduwaiye, 1978).

In this paper some observations are recorded on the effect of grafting methods on subsequent performance of the ramets, and upon the effect of age of the ortet on growth and flowering of ramets.

MATERIALS AND METHODS

Experiments were conducted under shaded polythene tent, in the open and under partially shaded environment. In one of the experiments, scions were collected from 7 to 10 year-old trees. They were grafted on 1½ year-old rootstock of Pinus caribaea. Four grafting-methods used were side veneer, splice, top cleft and bottle graft. In another experiment, the ages of rootstock ranged from one to four years while grafting methods used were side veneer, splice and top cleft. Pot graft was conducted in the Pinus caribaea plantation. Polythene pot containing rootstock was tied to the mother tree when scion was grafted onto it. After there was union, the scion was cut off the mother tree and pot untied.

Source of Scion Materials

The ramets were produced from scions collected in various experimental plots of the Forestry Research Institute of Nigeria. Sources and ages of scion materials were as follows:-

1. P. caribaea - 11 years (Ex-British Honduras)
2. " " - 10 " (Ex-Bahamas)
3. " " - 9 " (Ex-Holland)
4. " " - 8 " (Ex-Honduras Rep)
5. " " - 7 " (Ex-Honduras Rep)
6. " " - 9 " (Ex-Holland)

Field arrangements of ramets

The grafts, 9 months old when planted out, were arranged in systematically designed blocks, with respect to age of scion material as indicated above. Langner and Stern's (1955) systematic design was adopted. There were two blocks, each containing 3 plots. Each plot contained 36 grafts (Table 1).

Table 1. Plot systematic design containing ramets of different ages.

1	2	3	4	5	6
4	5	6	1	2	3
3	4	5	6	1	2
2	3	4	5	6	1
5	6	1	2	3	4
6	1	2	3	4	5

Method of Assessment

In 1978 and 1979, the following parameters were assessed:-

(a) Height of graft

(b) Diameter of rootstock (5cm below graft union)

(c) Diameter of scion (5cm above graft union).

The measurements permitted the determination of the correlation between the diameters of scion and rootstock at different stages of development. This make it possible to determine at what stage incompatibility setin.

Cone production of both female and male sexes on the grafts were observed and recorded at different times.

RESULTS AND DISCUSSION

Column I (Table 2) shows that the minimum average height of ramets with seven-year scions was 58cm in the first year of assessment; it increased to 91cm in the second year showing an average increase of 33cm. Ramets with 11 year scions had an average minimum height of 93cm in the first year and 153cm in the second year giving an average increase of 66cm. It can be observed, therefore that ramets with 11-year scions had developed more vegetatively but showed lower production of cones when compared with ramets formed with scions from younger trees (Column IV). Column VII (Table 2) indicates that the scion and rootstock were growing at the same rate within the period assessment.

Although the five methods of grafting mentioned in the paper did not result in incompatibility of grafts, some definitely appeared to be dwarfed. The healing of graft unions, however, did differ. The splice method was associated with the best healing of the graft union; the union points in the other methods of grafting were more visible in the first year but became less visible in the second year.

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Table 2. Growth, cone production and correlation between scion and rootstock of *Pinus caribaea* grafts of various ages in 1978 and 1979.

	I		II		III		IV		V		VI		VII	
	Av. Ht. of Graft (in cm)		Minimum Height (in cm)		Maximum Height (in cm)		Cone Production No of Graft		Av. Diameter of Rtstck (in cm)		Av. Diameter of Scion (cm)		Correlation between Scion and rootstock	
Scion Age	1978	1979	1976	1979	1978	1979	Male	Female	1978	1979	1978	1979	1978	1979
1. 11 years	93	159	59	94	129	201	1	2	1.3	2.4	1.2	2.0	r = + 0.9	r = + 0.95
2. 10 "	80	115	44	56	124	204	3	3	1.2	2.3	1.1	1.9	r = + 0.9	r = + 0.94
3 9 "	101	144	49	64	146	195	3	11	1.3	2.4	1.1	1.9	r = + 0.95	r = + 0.94
4. 8 "	92	137	53	80	137	181	6	8	1.4	2.8	1.1	2.1	r = + 0.95	r = + 0.95
5. 7 "	58	91	38	60	117	167	1	6	0.7	1.7	0.7	1.5	r = + 0.96	r = + 0.87
6. 9 "	102	152	74	109	130	214	4	11	1.9	2.9	1.3	1.7	r = + 0.96	r = + 0.9

O TEMPO DE FLORESCIMENTO DE CLONES DE *Pinus caribaea* MOR. VAR. *hondurensis* EM TRÊS LOCALIDADES DA AUSTRALIA

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Resumo

Os períodos de dispersão do pólen e receptividade do conídio, foram registrados em "ramets" de sete clones de *Pinus caribaea* var. *hondurensis*. Barr, e Golf. nas três localidades australianas – Darwin (latitude 12ºS), Cardwell (18ºS) e Byfield (22ºS). Os períodos de florescimento foram geralmente mais tardios nas localidades mais tropicais, sendo registradas diferenças, acima de seis semanas, entre Byfield e Darwin. A produção de conídios foi mais desorganizada em Darwin do que em outras localidades. As possíveis razões para tais fatos são discutidas neste trabalho.

THE TIMES OF FLOWERING OF CLONES OF *Pinus caribaea* MOR. VAR. *hondurensis* AT THREE LOCATIONS IN AUSTRALIA

Summary

The periods of pollen fly and conelet receptivity were recorded on ramets in seven clones of Pinus caribaea Mor var hondurensis Barr and Golf at three Australian locations - Darwin (latitude 12°S), Cardwell (18°S) and Byfield (22°S). The flowering times were generally later the more tropical the location with differences up to six weeks being recorded between Byfield and Darwin. Conelet production was more disorganized at Darwin than at the other locations. Possible reasons for this are discussed.

LE TEMPS DE FLORAISON DE CLONES DE *Pinus caribaea* MOR. VAR. *hondurensis*, DANS TROIS SITES D'AUSTRALIE

Resume

Les périodes de dispersion du pollen et de réceptivité des infrutescences (conelets) de sept clones de Pinus caribaea, MOR., var. hondurensis BARR. et GOLF. ont été observées sur des ramets, en trois stations australiennes : DARWIN (12° de latitude Sud), CARDWELL (18 N de latitude Sud) et BYFIELD (22° de latitude Sud). Généralement, plus la localité est tropicale, plus la période de floraison est tardive avec des différences allant jusqu'à six semaines entre Byfield et Darwin. Le déroulement de la production des infrutescences était moins confu que celui observé dans les autres localités. Un examen des causes possibles de cet état de fait termine cette communication.

INTRODUCTION

Flowering and seed production of Pinus caribaea Mor var hondurensis Barr and Golf vary markedly at different locations. In temperate regions and at high altitudes in the tropics flowering is very light, whilst in the humid tropics flowering may be plentiful but erratic, and seed production very poor (Chalmers 1962, Nikles 1973, Shim 1974, Spidy 1975). There are consequent difficulties in organizing local seed production and in locating seed orchards. This is a matter of major concern in so widely planted a species.

The need for detailed study of the controls of flowering of Pinus caribaea var hondurensis has been appreciated for some time and received emphasis at the Working Group meeting at Brisbane in 1977 (see, for example, Fielding 1978 and Burley 1978). However, few detailed studies have been possible to date, primarily because so many of the trees established around the world are still immature.

In Australia clone banks of selected trees used in the Queensland breeding programme have been established at several locations. In 1977 it was possible to co-ordinate observations of flowering in the same clones at three different locations. This study showed the times and patterns of flowering varied with location. The results are reported in this paper and possible climatic controls which could have induced the results are discussed.

MATERIAL

The observations were made on grafted ramets of seven clones established in clone banks at three Australian locations - Darwin, (latitude 12°27'S), Cardwell, (18°16'S) and Byfield (22°55'S) (Figure 1). All three locations are coastal and at altitudes below 50m. The grafts were aged between 10 and 12y at the time of the observations and clones included are shown in Table 1.

PROCEDURE

The development of the pollen and young seed cones (conelets) was observed closely during the flowering season (May - August) in 1977. Particular attention was paid to the times at which individual trees were shedding pollen or carried receptive conelets.

RESULTS

Pollen Fly

Most trees studied had pollen on at least 30% of the crown and all carried sufficient for the period of pollen fly to be reliably determined. The times recorded for the individual ramets are shown in Figure 2.

Where two ramets of the same clone were present the times of pollen fly of the two were very similar (Figure 2). Consequently if only one ramet of a clone was present then the time of flowering of this ramet was assumed typical for that clone.

TABLE 1. MEAN DATES (DAY/MONTH) OF COMMENCEMENT OF POLLEN SHED FOR EACH CLONE IN EACH REGION

Region / Clone	Darwin	Cardwell	Byfield	Mean
2/40	3/7	18/6	2/6	18/6
2/55	27/6	30/5	7/6	11/6
4/54	21/6	6/6	29/5	8/6
4/60	27/6	10/5	25/4	21/5
4/61	12/7	20/6	11/6	24/6
4/66	28/6	10/6	15/6	18/6
4/L	17/7	23/6	11/6	27/6
Mean	2/7	8/6	1/6	

Least significant difference - Region - 10 days (5% level)
- 21 days (0.1% level)
Clones - 16 days (5% level)

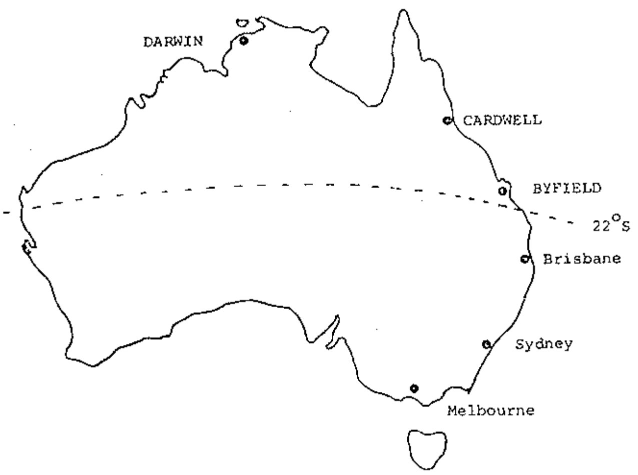

FIGURE 1. Showing the locations of the clone banks and also the major capital cities of Australia.

There was a trend for pollen shed to be later the lower the latitude. The average date of commencement of pollen fly at Darwin for the seven clones was 24 days later than at Cardwell and 31 days later than at Byfield. Analysis of variance of the dates of commencement of pollen fly showed the differences between Darwin and the other locations were significantly different at the 0.001 level. The difference between Byfield and Cardwell was not significant at the 0.05 level (Table 1).

There were also clear and significant differences in the times of pollen shed of individual clones (Figure 2, Table 1). Clones 4/54 and 4/60 were always amongst the earliest to shed pollen and 4/L and 4/61 amongst the last (Figure 2).

The performance of clone 4/60 was of interest and suggested some clone x locality interaction could exist. At Byfield and Cardwell grafts of this clone shed pollen much earlier than any of the other clones studied - at Byfield at least 32 days earlier than any other clone and at Cardwell 20 days earlier. However, at Darwin this difference was not present and clone 4/60 shed at the same time as the other early shedding clones (Figure 2).

Conelet Receptivity

Conelets were not produced by all ramets. At Darwin conelets were produced on only four ramets in three clones and at Byfield conelets were not produced on two ramets in separate clones. All ramets produced conelets at Cardwell.

Conelet production was earlier at Byfield than at Cardwell (Figure 2). At Byfield the overall period of receptivity for the seven clones was from 25th May to 6th July and at Cardwell from 9th June to 15th July - between one and two weeks later.

At Darwin conelet receptivity was more disorganized. Overall receptivity was slightly later than at Byfield and Cardwell - from 15th June to 29th July. However, comparisons of individual clones showed there was no clear trend to later receptivity. Two clones, 2/40 and 2/55, carried receptive conelets at Darwin before the same clones did so at Byfield or Cardwell. In contrast, the other clone (4/61) was receptive at Darwin much later than the same clone at the other centres.

There was some loss of coincidence of pollen shed and receptivity at Darwin. As the times of receptivity of clones 2/40 and 2/55 preceded pollen fly the early conelets in these clones would not have been pollinated by pollen from the other clones.

The receptive conelets on clones 2/40 and 2/55 were also present for a much longer period at Darwin than at the other locations - 34 and 26 days respectively compared with 22 and 6 days at Cardwell and 7 and 8 days at Byfield.

DISCUSSION

Differences in flowering times at different locations are usual and well known in many species (Kozlowski 1971). Clonal differences in flowering are also usual. It is, however, useful to know these same effects do occur in Pinus caribaea var hondurensis.

TABLE 2. MEAN MONTHLY TEMPERATURES AND DAYLENGTHS (SUNRISE TO SUNSET) RECORDED AT THE THREE CENTRES IN 1977.

Month	Darwin Temp	Darwin Dayl	Cardwell Temp	Cardwell Dayl	Byfield Temp	Byfield Dayl
	(°C)	(h)	(°C)	(h)	(°C)	(h)
Jan	28.3	12.5	27.8	13.0	25.4	13.2
Feb	27.8	-	27.2	-	25.7	-
Mar	27.8	12.1	26.7	12.2	24.6	12.2
April	28.3	-	25.0	-	22.5	-
May	26.9	11.4	22.8	11.2	18.8	11.0
June	24.9	-	20.5	-	16.1	-
July	24.8	11.3	19.9	11.1	14.9	10.5

These studies can be interpreted to provide some information on the flowering controls of the species. Pharis (1976) has summarized the information which indicates that development of pollen strobili through to shedding may require a period of low temperature and, possibly, short days. Our observations support this. The earlier development of the pollen strobili at the higher latitudes may have been due to the earlier occurrence of low temperatures (Table 2). The shorter days in the months immediately preceding flowering (Table 2) may also have had an effect.

Control of conelet development appears to be less well understood than the control of pollen strobili and low temperatures may not be so important (Pharis and Morf 1972). Receptivity at Darwin occurred early in two clones and late in the other. This suggests the factors controlling conelet development at this centre may be at marginal levels. Some clones respond in one way and others in another. The Darwin region may, therefore, be one of the more important areas in which to study Pinus caribaea flowering.

Darwin may represent a tropical limit beyond which flowering of Pinus caribaea var hondurensis becomes disorganized and seed production impaired. In more extreme conditions, in regions where low temperatures are rarely experienced, all control of flowering could be lost. Something approaching this situation appears to occur in Trinidad, latitude 10°N, where conelet production can occur all year round and pollen production over a nine month period (Chalmers 1962). Similar disorganization occurs in Malaysia at latitudes of approximately 5°N where pollen shed in a single cluster of strobili may be spread over many months (Spidy 1975). Establishment of seed orchards in more tropical locations than Darwin should, therefore, only be undertaken with care.

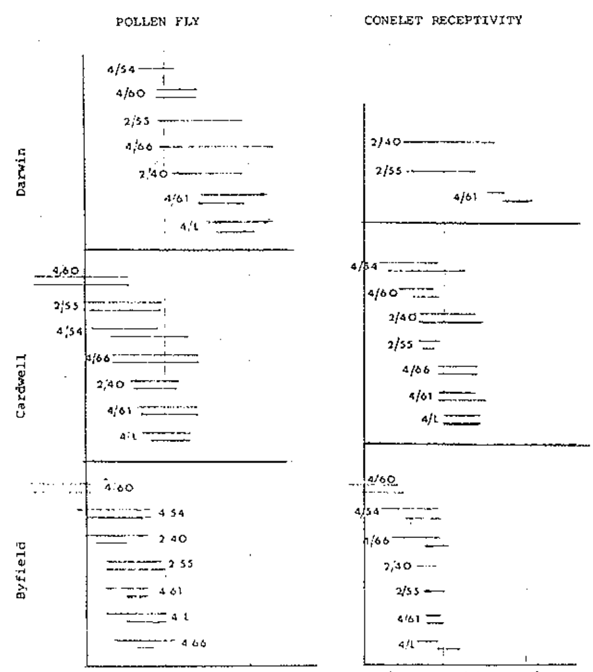

FIGURE 2. Diagrammatic representation of the times of pollen fly and conelet receptivity of each ramet in each clone at each location. (Each line represents the flowering time of one ramet.)

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IMPLANTAÇÃO DE ÁREAS DE COLETA DE SEMENTES EM FLORESTAS NATURAIS DE *Pinus oocarpa* E *Pinus caribaea* EM HONDURAS

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Resumo

A demanda de sementes de florestas naturais de *Pinus oocarpa* e *Pinus caribaea* dentro de Honduras é crescente tanto para exportação como para uso nacional.

A Corporação Hondurenha de Desenvolvimento Florestal, através da sua Escola de Ciências Florestais e do Centro de Sementes de Siguatepeque, é responsável pelo fornecimento e melhoramento dessas fontes de sementes. O melhoramento, a curto pDazo, envolve a definição das regiões de procedências das duas espécies, provisão de sementes de fontes identificadas e o estabelecimento de áreas de coleta de sementes.

O conceito original de uma Área de Coleta de Sementes foi desenvolvido para florestas manejadas e é difícil para ser aplicado às florestas naturais de Honduras, que são muito variáveis em função do fogo, pastagem, exploração, e até recentemente, inexistência de qualquer forma de manejo.

Pequenas áreas estão sendo implantadas em áreas naturais de tais florestas, mas considera-se que o melhoramento genético e físico das sementes destas áreas serão limitados devido à seleção baixa e ineficiente.

Outras áreas serão implantadas posteriormente em povoamentos jovens "candidatos", aos 10-15 anos de idade, para os quais o manejo adequado poderá ser efetuado antes da conversão a Áreas de Coleta de Sementes 5 a 10 anos mais tarde Tal fato irá resultar em uma seleção mais intensa e mais eficiente, mas irá atrasar a produção de sementes melhoradas.

ESTABLISHMENT OF SEED STANDS IN NATURAL FORESTS OF *Pinus oocarpa* AND *Pinus caribaea* IN HONDURAS

Summary

The demand for seed from natural forests of Pinus oocarpa and Pinus caribaea within Honduras is increasing both for export and national use.

The Honduran Forestry Development Corporation, through its School of Forest Sciences and Seed Centre at Siguatepeque, is responsible for the supply and improvement of these sources. Short term improvement involves the definition of provenance regions of the two species, provision of source identified seed, and the establishment of seed stands.

The original concept of a seed stand was developed for managed forests and is difficult to apply to the natural forests of Honduras which are very variable as a result of fire, grazing, explotation, and until recently, lack of any form of management.

Small stands are being established in mature areas of such forests, but it is considered that the genetic and physical improvement of seed from these areas will be limited due to low and inefficient selection.

Further stands will be established in young, "candidate" stands, 10 - 15 years old, so that proper management can be carried out before conversion to seed stands 5 - 10 years later. This will result in a higher and more efficient selection. but will delay production of improved seed.

IMPLANTATION DE CHAMPS DE RECOLTE DE GRAINES EN DES FORÊTS NATURELLES DE *Pinus oocarpa* ET DE *Pinus caribaea*, EN HONDURAS

Resume

La demande en semences de Pinus oocarpa et en Pinus caribaea provenant des peuplements naturels du Honduras va croissant, tant pour l'exportation que pour les besoins du pays.

L'Office de Développement Forestier du Honduras, par l'intermédiaire de son Ecole des Sciences Forestières, et son Centre de Semences de Siguatepeque, détient la responsabilité de la constitution de réserves de graines et de l'amélioration générale des lignées de ces espèces présentes dans ce pays. L'amélioration à court terme consiste à définir les zones de provenance de ces deux espèces, à constituer des stocks de graines dont la provenance est bien identifiée, et à établir des peuplements produisant des graines.

La notion de peuplement aménagé de porte graines ne peut s'appliquer aux forêts naturelles du Honduras qui jusque très récemment n'ont reçu aucune forme d'aménagement et qui sont plus ou moins endommagées par les feux courants, le pâturage et l'exploitation.

Dans ces forêts, dans les zones où les arbres sont à maturité, on délimite de petits peuplements susceptibles de fournir des graines grâce à des mesures génétiques et physiques appropriées. On considère que les résultats en seront limités en raison d'une sélection insuffisante et inefficace.

On procédera, ensuite, à la délimitation dans les populations de 10 à 15 ans, de peuplements pouvant éventuellement produire des graines lorsqu'un aménagement proprement dit sera appliqué dans 5 à 10 ans pour les convertir en peuplements grainiers. Ces mesures entraîneront une sélection plus intensive et plus efficace, mais les semences améliorées ne seront obtenues qu'après un plus long délai.

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

The natural forests of Pinus caribaea (Mor) var. hondurensis (Barr. et. Golf) and Pinus oocarpa (Schiede) that occur in Central America constitute the main seed source for reforestation programmes around the world that use these species.

Within the Republic of Honduras, there are several provenances that have been included in the Oxford international provenance trials, and which appear to be suitable for many of these programmes (see Greaves and Kemp 1977 for a general description of the trials). Examples are: P. oocarpa: Guaimaca; P. caribaea: Culmi, Mosquitia. Consequently, there is an increasing demand for the seed from these sources.

Given this situation, the Forestry Development Corporation of Honduras (COHDEFOR) has established a forest tree seed centre, whose main objectives are to supply to the international market high quality seed from these sources, and at the same time provide seed for the Corporation's own developing reforestation programme. The centre was started in 1975 as a British Technical Aid Project and is located in the National School of Forest Sciences (ESNACIFOR), Siguatepeque.

An important aspect of the centre's work concerns genetic improvement. The responsibility for this task is divided between the Seed Centre itself, and the Genetics Department of the school.

The Genetics Department is responsible for long term improvement of the principal seed sources (mainly for internal use), and has started detailed national provenance trials of the two pines, plus tree selection and establishment of seed orchards, amongst other work.

The Seed Centre is responsible for short term improvement, which involves: (1) ensuring that general collections of seed from the principal provenances - conform to the O.E.C.D. (Organization for Economic Cooperation and Development) guidelines for "source identified seed" (O.E.C.D. 1974); and (ii), the development of a programme of seed stand establishment within the existing forests, in order to improve their genetic quality and seed production. It is intended that seed produced from such stands should conform as nearly as possible to the O.E.C.D. "selected reproductive material" category.

P R O V E N A N C E   S T U D I E S

Since the seed Centre is concerned with seed export and supply for the national plantation programme, there are two distinct types of user whose provenance needs differ.

At the moment, the provenances required by the export market are mainly controlled by the results of the Oxford international provenance trials of P. oocarpa and P. caribaea. Although other provenances within Honduras may be equally good (or bad) as those tested by Oxford, there is no information available to prove this and so users prefer to obtain seed as near as possible to the original Oxford sources.

The provenances required by the national reforestation programme are dictated by the need to use sources that are in the same ecological zone as the proposed planting areas so as to ensure that the seed is at least properly adapted to the site.

Although the provenances required by the two types of user are quite distinct, the first step in their study and improvement has been common to both. This has been the study of the distribution, ecology, and phenotypic variation of the pine forests with a view to defining tentative regions of provenance for the two principal species.

The definition of these regions has now been completed (Robbins 1980) and will be further modified on the basis of the results of the national provenance trials, a process which will help to determine the degree to which those provenances tested by Oxford are similar or not to other provenances within the country and also assists in establishing the limits of appropriate collection areas for local use.

S E E D   S T A N D S

Priority is being given to improvement of seed sources within those provenance regions which are of most interest for export and internal use, and therefore it is within these that the establishment of seed stands is being contemplated, these being understood as defined by Barner (1973):

"A plus stand or young plantation, derived from a desirable source, which is upgraded and opened by removal of undesirable trees and then managed for early and abundant seed production".

There are various other definitions of Seed Stands (or seed production areas/selected stands as they are sometimes called), and all imply a degree of genetic improvement over regular sources. Firstly, the stand is supposed to be superior to the accepted mean of the surrounding forest within the provenance region considered, and secondly, there should be additional genetic improvement resulting from selection of the best phenotypes within the stand and thinning to remove the worst.

A P P L I C A T I O N   O F   T H E   S E E D   S T A N D   C O N C E P T

The concept of a seed stand has been developed mainly for, and applied to plantations and natural forests that have been under fairly intense management. In such forests, the comparison of genetic quality between stands or individuals is made relatively easy by uniform site conditions, age of trees and spacing. Selection on the basis of phenotype is therefore efficient and selection intensity can be high.

The natural forests of P. oocarpa and P. caribaea within Honduras are very different from this type. The two species occupy different altitudinal ranges with a small area of overlap (P. caribaea 0 - 700 M, P. oocarpa 500 - 1800 M), and generally grow as pure stands that are considered to be a fire disclimax, modified by mountainous topography, heavy grazing and dysgenic exploitation. Where the species overlap in range, there may be some hybridization. (Styles et al.1978).

The resultant forest is extremely variable. On the one hand there are small stands that are densely populated and almost even aged, originating from abundant regeneration, that has been able to establish itself in the absence of fires after the original forest has been almost destroyed by fire, hurricane o barkbeetle epidemic. In many areas, the forest is a sparsely populated and uneven aged savannah, where both fire and exploitation have been at work. In some areas, especially within the range of P. caribaea the complete destruction of the forest has occurred as a result of these agencies, leaving a treeless grassland.

The Forestry Corporation of Honduras was established in 1974 with the aim of managing such forests: however such management has hitherto been restricted to the control of fires and exploitation, so that, except for more abundant young regeneration in some areas, there appears little difference between the managed and unmanaged forests. A programme of thinning has been started, but has not yet been applied extensively.

Selection of suitable areas within such forests for conversion to seed stands is difficult, if the original concept is to be adhered to. Either the forest is too sparse for there to be worthwhile selection and genetic improvement, and any thinning would probably not increase seed production significantly; or the stands are so dense that, although a fair degree of selection can be attained, seed production from the selected released trees may never be optimum since their crowns have been heavily suppressed.

The variability of the forests caused by age and environmental factors such as fire and exploitation, makes phenotypic selection between stands, and individuals within a stand, a very difficult task and, more often than not, the criteria for selecting a stand within a given region of provenance is that of age and stem density only.

Additionally, suitable areas of P. caribaea are limited due to the possible hybridization with P. oocarpa when the two species occur together between 500 and 700 M.

Because of these difficulties, two lines of approach are being taken to stand selection within Honduras.

The first is to select stands of about 15 - 20 years, which conform as near as possible to the phenotypic standards required, and that have an adequate density (eg. 500 stems or more/ha. over 10 cm d.b.h.). Since such areas are generally small (10 - 20 ha.) if necessary the total required area will be attained by selecting various stands which, although separate from each other, will be considered as one unit of production.

There are many disadvantages to such a method. Isolation of each individual stand from outside pollen requires at least a 100 metre wide thinned strip around each stand which means that disproportionately large areas will be managed but not used for seed production. Also stand demarcation and protection is difficult.

It is probable that seed collected from such stands will have limited genetic improvement over seed from nearby stands which have had no treatment, except for releasing suppressed trees, and where collection is restricted to the best phenotypes only.

The second line of approach will be to select candidate stands (as suggested by Keiding 1975, Barner 1973) within areas that are younger (10 - 15 years) and which are now surrounded by areas that have abundant regeneration (5 - 10 years) as a result of protection practiced by the Forestry Corporation. Although such stands are often dense and many trees are suppressed, thinning at this stage will give a better chance of crown recovery and will help final selection of the seed trees.

Unfortunately, the management of such stands will require a longer period before reasonable quantities of improved seed can be obtained (5 - 10 years instead of 2 - 5 years) and genetic superiority of the stand will only be apparent once the stand is older and its various characteristics have been expressed.

SEED STAND ESTABLISHMENT PROCEDURES

The procedures used for establishing seed stands are at present provisional and will be modified in the light of experience gained. The first stand established is located in Las Lajas, Department of Comayagua, and is around 20 - years old, with between 350 - 600 stems/ha. over 10 cm. d.b.h. It is typical of the older stands that appear to be most suitable for immediate conversion, but are without previous management and suppressed. The total area of the stand is 100 ha. of which 28 ha. have been managed so far (March 1980).

Inventory procedure

After determining and marking the limits of the stand, a systematic inventory is made by taking the required measurements at point samples (every 50 metres) along a transect decided in advance on the basis of the shape of the stand.

At each point along the transect, the following variables are measured. Height of nearest tree, diameter b.h. of the nearest 4 trees, and their phenotypic characteristics, and the basal area by means of a relascope count.

The phenotypic characteristics assessed and their classification is as follows: 1) Stem forking: none, present at ground level, present at higher level. 2) Form: Straight, bent. 3) Pruning: good, acceptable, bad. 4) Branch size: Thick, normal, thin. 5) Branch angle: normal, acute. 6) Other defects. 7) Seed production: unacceptable, sufficient.

These classifications are subjective and no figures have been applied yet to define the limits of the classes.

The data from the inventory are summarized giving standard information on height, stand density, etc. and the occurrence of each phenotypic characteristic is expressed as a percentage of the total No. of trees (eg 60% unforked, 30% forked at ground level, 10% forked at higher level).

Selection of final Crop trees

The final crop trees are selected by taking into account the characteristics already mentioned, ensuring principally that forked or wavy stems are eliminated. However, the selection possible is principally controlled by the distribution of the trees, their density, and their status in the stand as dominants, codominants or suppressed.

It was originally intended to leave a spacing of around half the mean height of the final crop trees. (eg 10 M for trees of 20 M tall, as in Lajas). However, the suppressed nature of the trees in older stands results in a smaller crown than would be found in a managed forest, and it is considered that an ideal spacing would be around a third of the height. In Lajas, thinning down to half - the mean height would permit a selection intensity of 1:4 trees (400 stems/ha. to 100 stems/ha), and to a third mean height, an intensity of approximately 1:2.

Basal area may be a better guide than height to thinning regimes and final crop spacing, since it is generally proportional to crown diameter, where as height is not. Studies will be made to see if suitable guidelines can be drawn up for spacing using this measurement.

Thinning procedure

Depending on the original stocking, thinning will be done in one or two stages, for older stands such as Lajas, or more in the case of young candidate stands, and will be done as heavily as possible provided that there is no danger of windblow or overexposure to the sun.

Isolation

So as to provide some degree of isolation from outside pollen management of the stand will extend to include a 100 metre wide strip around the stand and where possible advantage will be taken of treeless areas to increase the isolation area.

Further measurements

After each thinning, a further inventory will be made so that the changes resulting in the stand characteristics such as stocking, etc., and more importantly, phenological characteristics can be assessed.

Permanent Sample plots will be introduced so as to monitor the response of the trees to the various treatments applied, especially with respect to seed production.

As well as routine operations, experimental studies will be carried out. The most important of these have already been started, principally under control of the Oxford Pine Ecology Project which has just started in Honduras, (Project leader Mr. A. Wolffsohn). Part of this project concerns the study of thinnning and fertilizer regimes on the production of seed in the natural pine forest. The first studies on this subject have been established within the same stands as Lajas, so that the results can be directly compared with those obtained from this seed stand.

Further seed stand selection will continue with P. oocarpa in Guaimaca (Department Francisco Morazán) and with P. caribaea in Culmi (Olancho) and La Mosquitia (Cabo Gracias a Dios), putting more emphasis on selection in younger forests.

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TESTE DE PROCEDÊNCIAS DE *Pinus oocarpa* SCHIEDE EM TRES REGIÕES DO ESTADO DE SÃO PAULO

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Resumo

Foi instalado em três locais do Estado de São Paulo um ensaio competitivo entre sete origens conhecidas de *Pinus oocarpa* Schiede provenientes da América Central.

Sete anos após o plantio verificou-se grande variação genética entre as origens quando comparados estatisticamente, os dados de altura, diâmetro, porcentagem de sobrevivência, perfeição do fuste e características da copa.

As melhores origens foram as da Nicarágua e Guatemala, ao passo que as piores foram as de Honduras e Belize para as condições do experimento.

PROVENANCE TRIAL OF *Pinus oocarpa* SCHIEDE IN THREE REGIONS OF SÃO PAULO STATE

Summary

It was carried out in three localities of São Paulo State a research on competition among seven known provenances of *Pinus oocarpa* Schiede from Central America.

After seven years it was verified great genetic variation among the provenances when compared heights, diameters, percentage of survival, perfection of bole and characteristics of crown.

The best provenance were those whose seeds came from Nicarágua and Guatemala, while de worst came from Honduras and Belize.

TEST DE PROVENANCE DE *Pinus oocarpa* SCHIEDE DANS TROIS RÉGIONS DE L'ÉTAT DE SÃO PAULO

Resume

Des essais sur le *Pinus Oocarpa* Schiede ont été entrepris dans 3 localités de Sao Paulo sur 7 provenances connues d'Amérique Centrale.

Après 7 années, on a pu constater une importante variation génétique entre les provenances en ce qui concerne la hauteur, le diamètre, le pourcentage de survivants, la rectitude du fût et les caractéristiques du houppier.

Les meilleures provenances étaient originaires du Nicaragua et du Guatemala, alors que les pires venaient du Honduras et de Bélize.

I n t r o d u ç ã o

Com o crescente aumento das plantações de pináceas em São Paulo, houve necessidade de se promover seleção de espécies a serem introduzidas, bem como sua adaptação em regiões onde melhor se desenvolvessem relacionadas com produção de madeira com boas qualidades industriais (GURGEL FILHO 1970).

O *Pinus oocarpa* Schiede, segundo KAGEYAMA (1977) apresenta um potencial bastante grande de crescimento, mesmo quando plantado em áreas de baixa fertilidade. Esta conífera juntamente com o *Pinus caribaea* Morelet e o *Pinus kesiya* Royle ex Gordon são as espécies mais promissoras para as diversas regiões tropicais e subtropicais do Brasil. Mesmo sem uma definição quanto à origem das sementes utilizadas para a implantação destas plantações, as maiores plantações de *Pinus oocarpa* Schiede estão nos Estados de São Paulo e Minas Gerais.

As variações genéticas observadas entre as origens de *Pinus oocarpa* são grandes, justificando desta maneira o estudo de várias origens através de ensaios específicos relacionados com as variações geográficas dentro de uma determinada espécie (NICOLIELO e BERTOLANI 1978).

O Instituto Florestal vem conduzindouum teste de origens de Pinus oocarpa, implantado nas Estações Experimentais de Assis, Bebedouro e Moji Mirim, em convênio com a Universidade de Oxford (PIRES, 1973).

O presente trabalho tem por objetivo testar as variações genéticas entre as origens de Pinus oocarpa Schiede para as principais características silviculturais apresentadas nos três locais de instalação.

M a t e r i a l e M é t o d o

As sementes em estudo são originárias da América Central e foram fornecidas pela Universidade de Oxford através do Commowealth Forestry Institute (C.F.I).

Essas origens, em número de sete, são relacionadas a seguir:

TABELA 1 - Coordenadas geográficas, altitude e precipitação dos locais de origem das sementes.

Trat.	Local - País	Lat. (N)	Long. (W)	Altit. (m)	Precipit. (mm)
1	Sullates (Nicarágua)	13º51'	86º16'	1.100	1.700
2	Canas (Guatemala)	15º10'	98º23'	1.200	1.900
3	Zapotillo (Honduras)	14º37'	87º02'	1.100	1.200
4	Yucul (Nicarágua)	12º55'	85º47'	900	1.400
5	Zamorano (Honduras)	13º58'	86º59'	1.000	1.100
6	Zugunilla (Guatemala)	14º42'	89º57'	1.300	950
7	Mt Pine Ridge (Belize)	17º00'	88º55'	700	1.600

O experimento foi instalado em área do Instituto Florestal e apresenta as seguintes localizações e condições edafo-climáticas, (VEIGA 1975):

TABELA 2. Dados de localização e condições edafo-climáticas dos locais onde foram instalados os experimentos.

	ASSIS	BEBEDOURO	MOJI MIRIM
Latitude (S)	22º40'	20º57'	22º26'
Longitude (W)	50º25'	48º30'	46º57'
Altitude (m)	562	550	631
Precipitação (mm)	1.217	1.296	1.355
Clima	C w a	A w	C w a
Solo	L e a	L e a	L V a

As mudas foram produzidas em viveiro a partir de junho de 1971, sendo acondicionadas em torrão paulista e plantadas nos três locais em março de 1972.

O delineamento estatístico utilizado foi o de blocos casualizados sendo 7 tratamentos (origens) sob 5 repetições. O espaçamento foi o de 3,0 x 2,0 metros.

Efetuaram-se medições anuais de diâmetro e altura das plantas. Em 1979 calculou-se a porcentagem de sobrevivência e avaliaram-se a perfeição do fuste e características da copa. Para estes dois últimos parâmetros foram consignadas notas às plantas das parcelas e analisadas posteriormente.

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

Os dados obtidos para as alturas e diâmetros das plantas aos 7 anos nos três locais são os seguintes:

TABELA 3 - Altura (m) e diâmetro (cm) para os três locais aos 7 anos de idade.

Trat.	ALTURA (m)			DIÂMETRO (cm)		
	Assis	Bebedouro	Moji-Mirim	Assis	Bebedouro	Moji-Mirim
1 -	13,66	15,68	15,10	17,18	15,54	16,02
2 -	12,78	15,38	14,86	16,66	15,66	17,02
3 -	12,92	15,36	14,08	15,54	14,80	15,01
4 -	13,95	15,92	15,99	16,76	15,48	17,52
5 -	13,41	15,16	14,57	16,26	14,68	16,70
6 -	13,25	14,63	14,92	16,66	14,38	16,80
7 -	13,82	15,44	15,59	17,32	15,92	17,56
Média	13,39	15,36	15,01	16,62	15,20	16,66

a) Altura

A análise estatística revelou diferença significativa ao nível de 1% tanto para os locais como para as origens.

Em vista destes resultados foi aplicado o teste de Tukey para locais e procedências comparando-se as médias.

O ensaio localizado em Bebedouro foi o que apresentou melhor média de altura (15,36m) seguido de Moji-Mirim (15,01m) e Assis (13,39m) Os dois primeiros, estatisticamente, foram iguais, mas diferiram de Assis pelo Teste de Tukey.

Para origens a que melhor se comportou foi a de Yucul-Nicarágua que só diferiu estatisticamente da de pior crescimento, Zapotillo-Honduras. As demais não foram diferentes estatisticamente.

b) Diâmetro

A análise estatística revelou diferença significativa ao nível de 1% tanto para locais somo para origens.

Foi aplicado o teste de Tukey e o resultado revelou não existir diferença significativa entre Moji-Mirim (16,66m) e Assis (16,62m), que foram diferentes estatisticamente de Bebedouro (15,20m).

Entre as origens a melhor foi a de Pine Ridge - Belize que só diferiu da pior origem, de Zapotillo - Honduras. As demais origens não diferiram entre sí estatisticamente.

c) Sobrevivência

A análise estatística para porcentagem de sobrevivência não foi significativa tanto para locais como para origens, o que revela que todas as origens tiveram comportamento semelhante.

Com a interação locais x origens foi significativa ao nível de 1%, foram feitos desdobramentos que conduziram aos seguintes resultados:

Em Assis, apenas o tratamento 1 (Sullates-Nicarágua) foi diferente dos demais, sendo o pior deles.

Em Bebedouro, houve diferenças apenas entre o melhor tratamento 1 (Sullates-Nicarágua) e o pior, tratamento 2 (Canas-Guatemala).

Para Moji-Mirim não houve diferença significativa para sobrevivência entre as procedências.

d) Perfeição do fuste

Com relação a este parâmetro foram dadas notas subjetivas e os resultados foram altamente significativos principalmente entre os locais.

As melhores origens com relação à perfeição do fuste foram: Sullates-nicarágua e Lagunilla-Guatemala. As piores foram: Mt.Pine Ridge-Belise e Zamorano-Honduras.

Com relação aos locais, pela ordem, foram Assis, Bebedouro e Moji-Mirim.

e) Características da copa

A característica da copa apresentou também resultados altamente significativos e as melhores origens foram de Sullates-Nicarágua e Zapotillo-Honduras.

Os mais inferiores foram Mt. Pine Ridge-Belise e Zamorano-Honduras.

Entre os locais, os melhores resultados foram os de Moji-Mirim, depois vieram Bebedouro e Assis.

C o n c l u s õ e s

Os resultados obtidos, partindo da análise estatística dos dados coletados aos 7 anos de idade, apresentaram altas variações genéticas entre as procedências para altura e diâmetro das plantas. Para os dados de sobrevivência não houve diferenças significativas entre as procedências e locais.

Os resultados obtidos para perfeição do fuste e características da copa foram significativas, mas havendo coincidências nas melhores e piores procedências.

À vista dos resultados obtidos aos sete anos de idade pode-se concluir que as melhores origens para plantio nos locais do presente estudo são:

Sullates - Nicarágua

Yucul - Nicarágua

Lagunilla - Guatemala

As que apresentaram piores resultados foram:

Zapotillo - Honduras

Zamorano - Honduras

Mt Pine Ridge - Belise

Parece-nos que para Pinus oocarpa Schiede as procedências da Nicarágua e Guatemala são superiores às de Honduras e Belise, para as condições do experimento. As origens de Nicarágua e Guatemala evidenciaram uma superioridade, para os parâmetros analisados em relação às origens de Honduras e Belise.

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ESTIMATIVAS DE HERDABILIDADES E CORRELAÇÕES ENTRE CARACTERES DE CRESCIMENTO E "FOXTAILING" EM *Pinus caribaea* MOR. VAR. *hondurensis* BARR. ET GOLF.

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Resumo

Dezenove progênies de Pinus caribaea var. hondurensis, de matrizes selecionadas em Mountain Pine Ridge, Honduras Britânicas, foram avaliadas em cinco localidades ecologicamente distintas no Brasil.

As herdabilidades em sentido restrito para foxtailing variaram de 0,40 a 0,76; para alturas de plantas de 0,06 a 0,70; para diâmetro a 30 cm do solo de 0,13 a 0,71. As correlações genotípicas, fenotípicas e ambientais também são apresentadas.

HERITABILITIES AND CORRELATIONS ESTIMATIONS AMONG GROWTH CHARACTERISTICS AND FOR FOXTAILING GROWTH IN *Pinus caribaea* MOR. VAR. *hondurensis* BARR. AND GOLF.

Summary

Nineteen progenies of Pinus caribaea var. hondurensis from trees selected in Mountain Pine Ridge, British Honduras, were evaluated in five different locations in Brazil; one in Espirito Santo State, and four in Minas Gerais State, representing widely distinct environments.

Narrow-sense heritabilities for foxtailing varied from 0,40 to 0,76; for plant heights from 0,06 to 0,70; for diameter at 30 cm from the ground from 0,13 to 0,71. Genotypic, phenotypic and environmental correlations are also presented.

EVALUATIONS D'HÉRITAGES GÉNÉTIQUES ET DE CORRÉLATIONS DE CROISSANCE ET "FOXTAILING" SUR *Pinus caribaea* MOR. VAR. *hondurensis* BARR. ET GOLF.

Resume

On a entrepris 19 tests de descendance du Pinus caribaea, var. hondurensis, à partir de graines d'arbres sélectionnés dans le Mountain Pine Ridge - Honduras Britanique, dans 5 endroits différents du Brésil : l'un dans l'état de l'Etat de l'Espérito-Santo, et les 4 autres dans l'Etat de Minas Gerais, ce qui représente une grande variété de milieux.

Les héritabilités, au sens étroit du terme, de l'hypertrophie terminale varient entre 0,40 et 0,76 pour des tiges allant de 0,06 à 0,75 de hauteur. Pour le diamètre à 30 cm du sol, de 0,13 à 0,71. On examine également les corrélations génotypiques , phénotypiques et de milieu.

1. Introdução

A demanda por quantidade e qualidade dos produtos florestais é crescente. Uma das maneiras de se atender a essa demanda é através do uso de programas de melhoramento florestal, utilizando a variação genética existente.

O principal objetivo da maioria desses programas é obter-se maior incremento da taxa de crescimento e do valor das florestas através da melhoria da qualidade da madeira e da forma do fuste e hábito de ramificação, BALL(1973). A herdabilidade de características de ramificação, bem como da taxa de crescimento, são muito importantes, por influenciarem a qualidade da madeira, FIELDING(1960).

Os objetivos deste trabalho foram avaliação de mudas de matrizes selecionadas de Pinus caribaea var. hondurensis, de Mountain Pine Ridge, Honduras Britânicas, plantadas em quatro regiões distintas no estado de Minas Gerais e uma no estado do Espírito Santo; estimar a herdabilidade de "foxtailing" (hábito de crescimento sem formação de ramos, com aspecto de rabo de raposa); estimar a herdabilidade para altura da planta e para circunferência a 30 cm do solo, aos doze meses de idade; estimar as correlações genotípicas, fenotípicas e de ambiente para altura da planta, circunferência a 30 cm do solo e árvores "foxtailing".

Este trabalho faz parte de um estudo que deverá ser avaliado periodicamente até à idade adulta.

2. Revisão de Literatura

A maioria dos plantios existentes com Pinus caribaea variedade hondurensis no Brasil são de sementes coletadas na parte de sua distribuição natural, principalmente de Mountain Pine Ridge, ou de Poptun, GOLFARI (1973).

Segundo GOLFARI (1973), a área potencialmente apta para plantios com essa variedade é desde o norte do Paraná até a região amazônica.

Em alguns locais, a forma e crescimento das árvores são altamente variáveis; há árvores retas, tortuosas e outras com fuste fino e sem ramos, lembrando um rabo de raposa, BALL (1973). Esta forma foi chamada "foxtail" em 1941 por Lloyd,segundo KOZLOWSKI & GREATHOUSE (1970), e ocorre na maioria dos plantios onde a espécie é exótica, sendo extremamente raro sob condições naturais na variedade hondurensis.

Segundo SLEE & NIKLES (1968), em estudos realizados no estado de Quensland, Austrália, esta característica é fortemente influenciada pelo ambiente e pode ser melhorada por apresentar boa resposta à seleção.

Posey, citado por LAMB (1973), registra resultados de um teste de progênie, de polinização aberta, com trinta e oito fenótipos superiores de Pinus caribaea variedade hondurensis, selecionadas em Mountain Pine Ridge. O teste foi conduzido na Amazônia (lat.1° S), em abril de-1970. As diferenças foram marcantes em 1971, com algumas progênies totalmente afetadas e outras não, mostrando que "foxtailing" é fortemente herdável.

Frequentemente, as características do fuste e ramificação são de variação contínua, controladas por herança quantitativa, enquanto que características tais como bifurcação e formação de fascículos e redução na formação dos botões e ramos, são de herança mendeliana simples, EHRENBERG (1969).

BARNES (1977) estimando as herdabilidades em Pinus patula aos doze meses de idade encontrou valores de 0,45 para número de ramos e 0,63 para altura, sendo que esse último valor foi decrescendo com a idade do material; aos dois anos o valor passou para 0,50 e aos cinco anos para 0,35. Para número de ramos por metro do fuste, os valores foram de 0,92 aos dois anos e de 0,91 aos cinco anos.

As estimativas de herdabilidade para características de crescimento indicam que existe controle genético moderado na variabilidade encontrada, assim, STONECYPHER (1973) encontrou valores de 0,18 e 0,26 para altura e DAP e valor de 0,13 para área basal em Pinus taeda, mostrando que para o primeiro caráter, o controle genético é ligeiramente maior que para o segundo.

3. Material e Método

O material utilizado foi cedido pelo Commonwealth Forestry Institute, da Reserva Florestal de Mountain Pine Ridge, nas Honduras Britânicas. As áreas de coleta estão situadas entre latitudes de 16°53' N a 17°02'N, longitude entre 88°55' W e altitude entre 525 a 640 m.

3.1. Instalação e condução dos experimentos

Os dados foram coletados após doze meses do plantio, sendo tomados altura total da planta, circunferência a 30 cm do solo, porcentagem de sobrevivência e de árvores "foxtailing".

Para todos os caracteres tomou-se a média das seis plantas por parcela. Os dados referentes a porcentagem de sobrevivência e de árvores "foxtailing" foram transformados em arc sen $(p\%/100)^{1/2}$.

3.2. Análises estatísticas

Os dados foram analisados segundo dois diferentes modelos, considerando primeiramente cada local de plantio separadamente e em análise conjunta.

A partir da análise de variância dos dados das progênies estudadas, assumidas como sendo de "meio-irmãos", estimou- se os parâmetros genéticos da população.

A estimativa da herdabilidade para cada característica em cada local foi obtida pela relação: $H = \frac{1/4\ \sigma_A^2}{\sigma_F^2}$

H = coeficiente de herdabilidade no sentido restrito,

σ_A^2 = variância genética aditiva

σ_F^2 = variância fenotípica

A correlação entre dois caracteres foi estimada pelo quociente da covariância entre os caracteres e a raiz quadrada do produto das variâncias. As covariâncias foram estimadas a partir dos quadrados médios da análise da soma de dois caracteres, ou seja:

$$COV\ (X,Y)\ \frac{V\ (Z - V\ (X) - V(Y)}{2}$$

4. Resultados

As estimativas de herdabilidades, baseadas nas médias de famílias de"meio-irmãos" para altura da planta, circunferência a 30 cm do solo e árvores "foxtailing" foram para o local 1 de 0,70;0,71 e 0,51; para o local 2 de 0,45; 0,35 e 0,18; para o local 3 de 0,72; 0,54 e 0,76; para o local 4 de 0,70; 0,71 e para o local 5 de 0,06; 0,13 e 0,40, respectivamente.

Os coeficientes de correlação genotípica, fenotípica e de ambiente para os caracteres altura da planta e circunferência a 30 cm do solo, incluidos na análise conjunta foram altamente significativos.

Na análise por local, os caracteres altura da planta e árvores "foxtailing" foram altamente correlacionados em Viçosa e Perdizes, enquanto que em Linhares e Grão-Mogol não houve correlação significativa entre esses dois caracteres. Circunferência a 30 cm do solo e árvores "foxtailing" não foram correlacionados significativamente para a maioria dos locais. Alta significância para correlação genotípica entre esses dois caracteres foi encontrada apenas em Itabira e de ambiente em Perdizes.

5. Conclusões

As estimativas de herdabilidades encontradas foram, de modo geral, bastante altas com exceção de Perdizes para os caracteres altura da planta e circunferência a 30 cm do solo, provavelmente por apresentar maior coeficiente de variação dentro do local.

Quanto ao caráter, árvores "foxtailing", o local 3 (Viçosa-MG), apresentou as maiores médias, seguido pelos locais 4,2,5 e 1 respectivamente.

Nota-se que em Viçosa com maior média em altura e circunferência a 30 cm do solo, também houve maior incidência de "foxtailing" e em Linhares - ES,com as menores taxas de crescimento, houve menor incidência de "foxtailing".

Deve-se considerar algumas restrições quanto à análise para árvores "foxtailing", principalmente devido a idade do material e devido às mudanças que pode sofrer a sua forma com o aumento da idade. Por outro lado, é válida essa análise para diferenciação do comportamento das progênies, uma vez que o coeficiente de variação foi de baixa magnitude para todos os cinco locais,mostrando assim alta confiança quanto aos valores obtidos.

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PROPAGAÇÃO VEGETATIVA EM *Pinus spp.*

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Resumo

O objetivo deste trabalho é fornecer informações da influência de locais de procedência de ramos-ponteiro sobre a enxertia. Estudou-se através da garfagem em fenda de topo, em viveiro, o comportamento das espécies: Pinus caribaea var. hondurensis, Pinus kesiya e Pinus elliottii var. elliottii. O teste usado para comparação dos resultados foi o do qui-quadrado.

As diferenças existentes foram atribuidas as características genéticas do próprio material propagado.

VEGETATIVE PROPAGATION OF *Pinus spp.*

Summary

The purpose of this work was to give information about the influence of locals from wich the scions were taken, on grafting survival of Pinus caribaea var. hondurensis, Pinus kesiya and Pinus elliottii var. elliottii, using the cleft graft method. The test used to compare results was the qui-square method.

The differences that exists could be atributed to the genetic characteristics of the own material of propagation.

LA PROPAGATION VÉGÉTATIVE EN *Pinus spp.*

Resume

Le but de ce travail a été de donner des informations sur l'influence des sites d'où provenaient les greffons insérés sur les survivants des greffages de Pinus caribaea, var. hondurensis, de Pinus kesiya, et de Pinus elliottii, var. elliottii, en utilisant la méthode de greffe terminale.

On a comparé les résultats statistiquement.

Les différences existantes sont attribuables aux caractéristiques génétiques du matériel végétal de multiplication, lui-même.

I n t r o d u ç ã o

A implantação de florestas visando a produção de madeira e o aumento da produtividade destas, demanda o uso de sementes de qualidade superior. A formação de pomares clonais é o método que oferece a possibilidade de obtenção de sementes com maior grau de melhoramento.

O objetivo básico deste trabalho é fornecer informações sobre a influência dos locais de procedência dos ramos-ponteiro, sobre a enxertia, método utilizado na propagação de árvores superiores, para instalação de pomares. Desta forma, estudou-se o comportamento de matrizes provenientes de diversos locais, visando determinar sua influência sobre o índice de pegamento da enxertia de espécies do Gênero Pinus.

M a t e r i a l e M é t o d o s

Para porta-enxertos foram usadas mudas da mesma espécie do ramo-enxerto, sendo estes retirados de árvores superiores com mais de 8 anos de idade e a coleta feita no terço superior da copa.

O método de enxertia utilizado foi o da garfagem em fenda de topo, descrito por Mora et alii (1979), o qual, segundo Kageyama (1975) é um método que apresenta bons resultados, aliados à facilidade de operação do mesmo. As enxertias foram efetuadas em viveiro e as espécies utilizadas foram: Pinus caribaea var. hondurensis, Pinus kesiya e Pinus elliottii var. elliottii.

Os locais de procedência dos ramos-ponteiro constam do Quadro 1.

As análises estatísticas das contagens das sobrevivências foram feitas pelo método do qui-quadrado, conforme Pimentel Gomes (1976).

Quadro 1 - Localidades de onde procederam os ramos-ponteiro - (Estado de São Paulo).

M u n i c í p i o	Longitude (º ')	Latitude (º ')	Altitude (m.)
Assis	50º 25'	24º 40'	562
Batatais	47º 35'	20º 54'	880
Bento Quirino	47º 37'	21º 24'	640
Capão Bonito	48º 20'	24º 00'	588
Itirapina	47º 49'	22º 15'	760
Mogi Guaçu	46º 56'	22º 22'	588
Pederneiras	48º 44'	22º 22'	500
São Carlos	47º 00'	22º 21'	885
São Simão	47º 33'	21º 29'	640
Itapetininga	47º 57'	23º 42'	645

Resultados e Discussão

Os quadros de porcentagem de sobrevivência relativos aos locais estudados e as diferenças entre estes locais são expostos a seguir.

Quadro 2 - Enxertia efetuada em Bento Quirino - dezembro de 1978 - P. caribaea var. hondurensis.

Locais de procedência dos ramos-ponteiro	Nº de Matrizes Propagadas	% Pegamento
Batatais	50	66%
Bento Quirino	41	61%
São Simão	17	68%

Houve diferença estatística significativa, apenas entre o material procedente de Bento Quirino e São Simão, diferença esta que pode ser atribuida às próprias características das matrizes enxertadas, tendo em vista que as condições edafo-climáticas e as demais condições de operação são praticamente idênticas para os dois locais.

Quadro 3 - Enxertia efetuada em Bento Quirino - março de 1978 P. caribaea var. hondurensis.

Locais de procedência dos ramos-ponteiro	Nº de Matrizes Propagadas	% Pegamento
Assis	23	64%
Batatais	13	69%
Mogi Guaçu	10	55%
Pederneiras	28	59%

Houve diferença significativa entre Assis, Batatais, Pederneiras e Mogi Guaçu, excetuando-se estes dois últimos locais que não apresentaram diferença entre si. Pederneiras e Assis diferiram estatisticamente entre si. Tendo em vista que não há diferença entre locais de onde provieram os materiais, pode-se concluir que estes não interferiram nas enxertias efetuadas, apesar do material procedente de Batatais ter mostrado porcentagem de sobrevivência superior. Tal fato pode ser explicado por fatores de controle genético.

Quadro 4 - Enxertia efetuada em Itirapina - setembro de 1978 P. kesiya.

Locais de procedência dos ramos-ponteiro	Nº de Matrizes Propagadas	% Pegamento
Itirapina	70	88%
São Carlos	255	89%

Não houve diferença estatística significativa entre os dados de sobrevivência do P. kesiya, entre os dois locais estudados.

Quadro 5 - Enxertia efetuada em Itapetininga - fevereiro de 1979 - P. elliottii var. elliottii.

Locais de procedência dos ramos-ponteiro	Nº de Matrizes Propagadas	% Pegamento
Itapetininga	161	24%
Capão Bonito	100	19%

Houve diferença estatística significativa entre o material dos dois locais de procedência estudados. A superioridade da porcentagem de sobrevivência do material oriundo de Itapetininga deve ser atribuida às características genéticas do próprio material propagado.

Quadro 6 - Porcentagem de pegamento das espécies estudadas.

Espécie	% Pegamento
Pinus caribaea var. hondurensis	64%
Pinus kesiya	88%
Pinus elliottii var. elliottii	22%

Pelo quadro 6, observa-se que o P. kesiya apresentou as maiores porcentagens de pegamento. O valor de 88% a que se chegou para esta espécie, coincide com o elevado índice de pegamento descrito por Bertolotti et alii (1979), para a mesma espécie.

O P. caribaea var. hondurensis apresentou uma porcentagem de sobrevivência superior àquela mencionada por Pinto Jr. (1979) em seu trabalho com esta espécie.

Os baixos índices de pegamento obtidos para o Pinus elliottii var. elliottii, podem ser atribuidos à época da operação da enxertia, que não coincidiu com aquela indicada por Cândido (1967), ou devido à características da própria espécie.

Os programas serão repetidos, com o objetivo de tentar apurar as prováveis causas que contribuiram para os resultados a que se chegou.

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INCIDÊNCIA DE BROTAÇÕES COM POUCAS ACÍCULAS EM *Pinus caribaea* MOR. VAR. *hondurensis* NA AUSTRÁLIA CENTRAL

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Resumo

Brotações anormais do *Pinus Caribaea* Mor. var. *Hondureusis,* Barr e Golf, em Byfield, na Austrália Central, onde se observou que o crescimento das ascículas foi retardado. As avaliações mostraram que essas brotações são mais comuns em procedências de alta altitude.

O florecimento foi também mais comum nessas brotações. A relação entre essas brotações e as brotações que ocorrem nos trópicos umidos, e o florecimento, é discutida neste trabalho.

INCIPIENT NEEDLELESS SHOOTS ON *Pinus caribaea* MOR. VAR. *hondurensis* IN CENTRAL QUEENSLAND, AUSTRALIA

Summary

Unusual shoots on which needle development was delayed were noted in a provenance trial of Pinus caribaea Mor var hondurensis Barr and Golf at Byfield in central Queensland, Australia. Assessment showed these to be more common in the high altitude provenances from Nicaragua and Honduras. Flowering was also more common in these provenances. The relationship between these shoots, the needleless shoots prevalent in the humid tropics, and flowering is discussed.

OCCURRENCE DE BOURGEONNEMENTS AVEC PEU D'ASCICULES DANS LE *Pinus caribaea* MOR. VAR. *hondurensis* EN AUSTRALIE CENTRALE

Resume

A Byfield, dans le centre du Queensland (Australie), on a remarqué l'existence dans un essai de provenance de Pinus caribaea MORELET, variété hondurensis BARR. and GOLD, des rejets d'aspect inhabituel sur lesquels la croissance des aiguilles avait été retardée. Les mensurations ont montré que ce phénomène était plus courant lorsqu'il était question de provenances venant de haute altitude. La floraison se produit généralement bien chez les sujets de ces provenances.

On a examiné la relation qui existe entre ces rejets, les rejets sans aiguilles qui prévalent dans les zones tropicales humides et la floraison.

INTRODUCTION

Needleless shoots are an important phenomenon exhibited by Pinus caribaea Mor var hondurensis Barr and Golf in the humid tropics. They have been fully described by Slee, Spidy and Shim (1976). On needleless shoots the needle fascicles fail to develop over a portion of the stem. When a long length of stem is affected die back occurs and stem deformities develop. If a tree is severely affected main stem dominance is lost and the tree becomes multiple stemmed and grossly deformed.

The degree to which individual trees are affected varies from severe to very slight, when only short lengths of stem are needleless, and some stems are not affected at all. Slee et al (1976) estimated that approximately 30% of stems in lowland Malaysia were unaffected or only slightly affected.

The incidence of needleless shoots is reduced the further the locality is from the humid tropics. Slee et al (1976) estimated that the shoots were of negligible importance at latitudes greater than about 10°. However, occasional trees can be affected at much higher latitudes and have been noted in Queensland as far south as 27°.

In 1978 shoots on which needle development was disordered were noted in a provenance trial at Byfield in Central Queensland, (Latitude 22°S). These appeared to be an incipient form of needleless shoots and records were made of their incidence in each of nine provenances. In view of a possible relationship between needleless shoots and flowering (Slee 1977) the incidence of flower production was also recorded. The results, reported in this paper, suggest there are differences between provenances in the occurrence of the shoots and provide some additional information about their formation.

MATERIAL

The provenance trial was part of the large series established internationally in the early 1970's (Greaves and Kemp 1978) and has been fully described by Nikles (1978). Material from up to 18 different provenances was included and the trial was planted in 1973 on two sites at Byfield. One site was a freely drained lateritic podzolic soil type and the other a poorly drained gleyed podzolic. The latter site was mounded and permanent drains constructed before planting.

The layout on both types was a 4x4 lattice with with 49-tree plots.

DETAILS OF THE DISORDERS AT BYFIELD

Pinus caribaea shoot growth in Queensland is episodic. A bud forms at each stem tip and subsequently elongates to form a new shoot with the next bud in the process of formation before elongation finishes. Needle elongation commences during shoot elongation and it is usual for each bud therefore to be carried on a shoot with developing needles. These needles are usually clearly visible before the bud commences elongation to form the next shoot.

In the disordered shoots needle development was substantially delayed and two or more elongated shoots were present with no needles visible. Subsequently, however, needle elongation did occur and a few months later the trees appeared normal.

PROCEDURE

Trees were assessed in nine different provenances chosen to give a good coverage of the species range. The provenances used are detailed in Table 1 and provenance locations are shown in Figure 1.

Two rows of trees in each of four plots of each provenance on each site were assessed subjectively for the incidence of (i) shoot disorders and (ii) flowers (young cones) using the following scales :-

(i) Shoots with retarded needle development
- A - Nil
- B - 0-50% of upper crown shoots affected
- C - over 50% of upper crown shoots affected

(ii) Cones (current crop only)
- A - Nil
- B - Some cones, maximum of 10, present
- C - Cones abundant, over 10, present

Replacements were not introduced for missing trees and any poorly developed trees were ignored. Consequently the number of trees assessed in each plot varied between 11 and 14.

RESULTS

The provenances segregated into three distinct geographic groups for both the incidence of flowering and the incidence of the unusual shoots (Table 2). Flowering was light and the unusual shoots sparse on the three lowland provenances from Nicaragua and Honduras. Heavy flowering and the heaviest incidence of unusual shoots were evident on the high altitude sources from these countries. The other provenances - Poptun, Guatemala and Melinda, Belize were intermediate.

Flowering and the unusual shoots were more prevalent on the swamp site than on the ridge.

Table 1. Summarized details of the provenance material included in the trials (from Greaves 1978). (Nic = Nicaragua, Hond = Honduras, Guat = Guatemala)

Provenance Code No.	Location	Latitude (°N)	Longtitude (°W)	Altitude (m)
PC 1	Kuakuil,Nic.	14°12'	83°30'	20
PC 2	Karawala,Nic.	12°58'	83°34'	10
PC 6	Poptun,Guat.	16°21'	89°25'	500
PC13	L Limones,Hond.	14°03'	86°42'	700
PC14	Culmi,Hond.	15°06'	85°37'	500-600
PC 7	Brus Lagoon,Nic.	15°45'	84°40'	10
PC17	Potosi,Hond.	15°20'	88°25'	600-700
PC21	Santa Clara,Nic.	13°48'	86°12'	700
PC23	Melinda,Belize.	17°01'	88°20'	10-15

Table 2. Summarized results of the incidence of needleless shoots andthe presence of young cones by provenances. (Lines link all provenances which do not differ significantly at the 5%level)

Needleless shoots Provenance	% trees graded B+C	Cones Provenance	% trees graded B+C
High Altitude Nicaragua and Honduras			
PC14	62.9	PC21	67.6
PC13	60.1	PC14	66.8
PC17	59.1	PC13	44.9
PC21	59.3	PC17	43.1
Intermediate			
PC 6	41.8	PC 6	38.5
PC23	37.6	PC 7	12.6
Lowland			
PC 1	28.0	PC23	9.1
PC 2	25.4	PC 2	4.5
PC 7	19.1	PC 1	2.8

DISCUSSION

Early heavy flowering of the high altitude sources has previously been reported by Greaves (1980). These results are therefore in agreement with Greaves' findings.

The unusual shoots appeared to be associated with flowering. They were more common in the provenances which flowered most heavily and on the site type, the swamp, on which flowering was more prevalent.

At Byfield needle development was merely delayed. Presumably if flowering were prolonged, needle development might fail altogether. Flower production of Pinus caribaea is prolonged in the humid tropics (Chalmers 1962, Lamb 1972, Spidy 1975). The needleless shoots in this region may therefore result from extended suppression of needle development during flowering.

A different explanation for the occurrence of needleless shoots has been proposed previously (Slee 1977). Under tropical conditions the needles are replaced by pollen cones which later abort. The result is shoots without needles or pollen cones - the needleless shoots.

Both hypotheses could be correct. Both suggest reasons why the normal vegetative development processes of Pinus caribaea may break down in the humid tropics.

The relationship between the needleless shoots and flowering indicates a higher incidence of needleless shoots would be expected in high altitude provenances from Nicaragua and Honduras under tropical conditions. Greaves (pers comm) and Woessner (pers comm) have both reported a higher incidence of the deformity in some high altitude provenances in the tropics. These provenances should, therefore, not be used in the humid tropics.

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The study formed part of a series of trials established throughout Queensland by the Queensland Department of Forestry in conjunction with the Commonwealth Forestry Institute, Oxford,England. It represents part of a vigorous programme with many participants. The support received from these other participants, particularly D.G.Nikles and A.Greaves, and their permission to publish these results is most gratefully acknowledged.

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TAXONOMIA, VARIAÇÃO E EXPLORAÇÃO DE *Pinus caribaea* E *Pinus oocarpa* NO MÉXICO E AMÉRICA CENTRAL

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Resumo

Os resultados dos testes de procedência, utilizando-se sementes de populações naturais de *Pinus caribaea*, apóiam a manutenção das 3 variedades em que a espécie foi dividida, com base nas características morfológicas.

Os experimentos similares com *Pinus oocarpa* são ainda muito jovens para evidenciar diferenças que possam ser usadas taxonomicamente. Um experimento inicialmente classificado como *P.oocarpa* var. *ochoterenci*, levou a crer que o mesmo deveria ser reclassificado como *P. patula*, embora a fonte das sementes fosse, provavelmente, uma mistura das duas espécies.

TAXONOMY,VARIATION AND EXPLORATION OF *Pinus caribaea* AND *Pinus oocarpa* IN MEXICO AND CENTRAL AMERICA

Summary

Results from provenance trials with seed from naturally occurring populations of P. caribaea support the maintenance of the 3 varieties into which the species has been divided on morphological grounds. Similar trials of P. oocarpa are as yet too young to show any differences which may be of use taxonomically. One supposed trial of P. oocarpa var. ochoterenai supports views that this should be transferred to P. patula, although the seed-source was probably a mixture of two species.

TAXONOMIE, VARIATION ET EXPLOITATION DE *Pinus caribaea* ET *Pinus oocarpa* AU MÉXIQUE ET EN AMÉRIQUE CENTRALE

Resume

Les résultats des essais de provenance effectués avec des graines provenant de peuplements spontanés de Pinus caribaea confirment le maintien des 3 variétés que l'on a distinguées chez cette espèce d'après leurs différenciations morphologiques. Des essais semblables sont en cours sur le Pinus oocarpa. Les sujets sont trop jeunes pour présenter des différences de caractère taxonomique. L'un des essais supposé de Pinus oocarpa, var. ochoterenai, laisse penser qu'il s'agirait plutôt d'un Pinus patulan bien que l'échantillon de semence provenait probablement d'un mélange des deux espèces.

Introduction

Pinus caribaea Mor. and P. oocarpa Schiede are two of the most important tropical Latin-American and Caribbean pines under investigation by botanists and foresters at the present time. The former has been grown extensively in provenance trials since the early 1960s whilst interest in the latter began towards the end of that decade (Kemp, 1973, Greaves, 1978, 1979, 1980). As part of the overall research programme an urgent need for investigation into the distribution and variation of the two taxa soon became evident. This initiated programmes of exploration and collection of botanical material from trees in their natural distribution areas for subsequent taxonomic studies by staff of various institutions including that of the Unit of Tropical Silviculture, Oxford. As a result a large amount of herbarium material (vegetative branches, female cones), resin and ecological and phenological data have been accumulated, and a number of taxonomic conclusions have been based on their study and analysis. The present state of our knowledge is outlined below.

Pinus caribaea Mor.

P. caribaea was first discovered and described as a species by Morelet from the Caribbean Island of Pines (now renamed Island of Young People). It is a tropical lowland, usually 2/3-needled pine occurring from sea-level up to c. 800 m. Cones are cylindrical or barrel-shaped and early deciduous. Resin canals in the needles are usually medial or internal. Its subsequent very great confusion with the closely related P. elliottii Engelm. from the SE United States necessitated a thorough review of their variation and nomenclature by Little and Dorman (1954). They showed conclusively that the two are clearly defined species each with distinct areas of distribution, and separable on a number of sound botanical characters.

Isolated observations on the differences in morphology and rate of growth and behaviour of seedlings and young plants raised from seeds collected from different parts of the range in various exotic plantations suggested that considerable variation exists between populations. This prompted Barrett and Golfari (1962) and Lückhoff (1964) to investigate the morphology of mature trees by sampling populations throughout the range. They came independently to the conclusion that P. caribaea could be divided into three intraspecific groups, mainly on ecogeographical grounds, though they disagreed on the taxonomic rank of the taxa they proposed. Barrett and Golfari gave their taxa varietal status and as they published their conclusions first, their nomenclature must be adopted. It is this which if followed in all forestry literature concerning the Oxford and other trials involving the species. The following is a summary of their conclusions.

P. caribaea var. caribaea
Based on P. caribaea Morelet, Rev. Hort. Côte d'Or. 1: 107 (1851). Type from Isle of Pines (now Island of Young People), Caribbean.
Syn. P. recurvata Rowlee, Bull. Torr. Bot. Cl. 30: 107 (1903)

Needles on adult trees in fascicles of 3 (rarely 4), each with 3-4 resin canals. Female cones measure 7-10 cm with seeds 5.6-6.5 cm long. The wing of the seed is adnate (i.e. it is firmly attached or fused to the seed body and not easily separated from it). Most strikingly this variety has bright green, bushy seedlings of slow growth, in which the secondary (adult) foliage is formed relatively early, (after 3-4 months).

It occurs in NW parts of the Isle of Young People and locally in W. Cuba in the province of Pinar del Rio. It is strongly calcifuge, growing on acid lateritic and sedimentary soils, up to 400 m alt.

P. caribaea var. bahamensis (Griseb.) Barr. et Golf.
Based on Pinus bahamensis Griseb. Fl. Brit. West Ind. Is. : 503 (1864). Type from "Bahamas".

This is distinguished from the type in having needles in fascicles of 2-3, each with 3-4-(7-9) resin canals. Mature female cones are smaller, from 6-7 cm. long. The wing of the seed is articulate, i.e. easily separable from the main seed body. Seedlings are relatively slow growing, with early formation of secondary (adult) needles after 3-4 months. It is found on the NW islands of the Bahamas group (Andros, New Providence, Abaco and Grand Bahama) and on a few in the SE (Grand or Middle Caicos, N. Caicos and Pine Cay), in the Caribbean. It is strongly calcicole, growing on bare, often solid oolitic limestone, at sea level.

P. caribaea var. hondurensis (Sénécl.) Barr. et Golf.
Based on Pinus hondurensis Sénécl., Les Conifères : 122 (1867). Type from "Honduras".

It resembles the type variety very closely in the number of needles per fascicle on mature trees (but 4 or 5s also occur), in the number and position of the resin canals and in cone morphology and size. It differs principally in that the seedlings are very slender and quick growing. Development of the secondary needles occurs later, after 9 or more months. The seed-wing is articulate, thus resembling P. caribaea var. bahamensis.

This variety has a disjunct distribution alone the N. Atlantic slope of C. America. Its extensive range just extends into Mexico, Quintana Róo, W. of Rio Hondo (Stead and Styles, unpublished) with scattered populations in Belize, E. Guatemala, and the coastal areas of Honduras (including island of Guanaja) and Nicaragua as far as latitude 12°00N. In the latter two countries it also invades river valleys inland and an isolated population has been discovered as far west as La Union, El Salvador (Holdridge, 1975). It occurs mainly on acid soils derived from a variety of parent rocks, most commonly from sea-level to 750 m altitude, but populations have been found occasionally at 1000 m.

Of the three varieties the latter is the most variable. Naturally occurring populations from the drier inland sites in C. America differing in a number of morphological characters. Evidence from herbarium studies and provenance tests suggests that this variety is divisible into a coastal and an inland, more upland race. Where the distribution of this variety overlaps with that of P. oocarpa, between altitudes of 600-800 m, trees of intermediate morphology occur. These have been tentatively called hybrids (Styles, Stead & Rolph, in press). Successful artificial crossing of the two has been reported in litt. by Houkal (Honduras). Nikles (Queensland) reports (in litt.) that two-year old plants from the cross grow more vigorously than some of the best provenances of P. oocarpa.

Morphological differences between the three varieties are very slight, but their maintenance has been vindicated by information from behaviour in the provenance trials now being conducted, (Greaves, 1980). Analyses from 36 seed provenances grown in 40 countries show that young plants of P. caribaea var. caribaea have greener hypocotyls, are the most vigorous, but least resistant to frost, whilst those of P. caribaea var. bahamensis and var. hondurensis have purplish hypocotyls, slower growth but greater frost resistance.

Pinus oocarpa Schiede

This is a very common though as yet relatively little-known species with an extensive distribution in Mexico from latitude 26°N in Sonora state, and then ± continuously throughout Central America as far south as 12°40N in Léon, Nicaragua. It is normally 5-needled with coarse stiff leaves and pedunculate, ovoid cones which persist on the tree for several years. Septal resin canals are present in most needles. A subtropical species, it grows most frequently on well-drained soils along mountain slopes between 700 - 1500 m altitude, but in the N. part of the range it may be commonly found up to 2500 m. It thrives on a wide variety of substrates which are nearly always acidic and extremely poor in nutrients. Martinez (1948) has studied its variation in Mexico. Our work in Oxford has followed the normal procedure of sampling populations throughout the entire range, but with special emphasis in C. America. It in the main supports Martinez's division of the species.

P. oocarpa var. oocarpa
Based on P. oocarpa Schiede, Linnaea 12 : 491 (1838). Type from Michoacán, Mexico.

This has the most extensive distribution of any Latin American pine covering large areas of Mexico and Central America. Needles occur in fascicles of 5, rarely 4 or 6. Cones are extremely variable in size but are usually between 5 and 11 cm. In N. and C. Mexico most trees are of poor bushy form, the best stands occurring in the southern part of the range, particularly in Guatemala and Nicaragua. Almost all of the Oxford and Mexican seed collections are from provenances of this variety. Taxonomic studies show that further subdivision of it may be necessary, particularly with regard to populations in Belize, Guatemala and others at the extreme S. end of the range. Results will be published elsewhere. Information obtained from trials now being conducted is still too limited to be of any assistance in taxonomic work. At present provenances from the Belize and Nicaragua show the best growth.

P. oocarpa var. microphylla Shaw, Pines of Mexico : 27 (190).
Syntypes from Sinaloa and Tepic, Mexico.

A little-known variety which has a limited range in N. Mexico, mainly in the States of Sinaloa, Tepic and Nayarit. It differs from the type in having very short, narrow needles from 6 - 14 cm long. The female cone is similar in all respects to that of P. oocarpa var. oocarpa but the scales and peduncles are much more slender. Trees of this northern ecotype tend to be small and bushy, often of very poor form. No trials involving it are known to exist.

P. oocarpa var. trifoliata Mart., Los Pinos Mexicanos : 308 (1948).
Type from Durango, Mexico.

A distinct variety with a widespread distribution in the drier parts of Mexico (very common in Oaxaca) and perhaps in C. America. It is characterized by having rather glaucous foliage with the needles predominantly in fascicles of 3. The cones are somewhat smaller than the type, 2.5 - 5 cm. Trees are never very large and can be easily confused with P. lawsoni. The septal resin canals which are typical of P. oocarpa are always lacking in the latter. It has not yet been introduced into any trials.

P. oocarpa var. ochoterenai Mart., Anal. Inst. Biol. Mex. 9 (1) : 65 (1940).
Type from Chiapas, Mexico.

Styles (1976) has shown that this is conspecific with the closely related P. patula Schiede and Deppe and it has been consequently transferred to that species. It is showing excellent growth qualities in some trials. A Mexican provenance supposedly of this taxon may in fact be a mixture of this and P. oocarpa var. oocarpa. Young trees already show that the two are entirely different in morphology. An as yet incorrectly described species from Guatemala, P. tecumumanii Schwerdtf., which Standley and Steyermark (1958) claim is similar to P. oocarpa, is almost certainly the southernmost extension of P. patula in C. America and should be included in it. Similar red rough-barked trees with small cones and needles lacking septal resin canals occurring in Honduras and El Salvador may also be included in this taxon (Styles, Mittak and Perry, in press). Greater effort should be made to introduce populations of these magnificent trees into trials.

With regard to the limited biochemical taxonomic studies which have been undertaken so far on these species, Burley and Green (1977, 1979) report that it is possible to distinguish clearly between populations of P. oocarpa and P. caribaea on the basis of 12 terpenes from xylem oleoresins. P. caribaea var. bahamensis is very different from mainland var. hondurensis in having a low - pinene and high - phellandrine terpene content. Biochemical differences also support the division of the latter into high altitude/low rainfall and coastal/high rainfall races. A number of isolated populations of P. oocarpa var. oocarpa which are widely separated geographically also appear to be distinct from the other mainland sources. Such evidence also supports the existence of hybrids between the two taxa. Green states (in litt.) that analysis of two resin samples collected from trees in Guatemala named P. tecunumanii suggest affinities with P. patula in that they share a significant limonene content thus adding weight to the morphological evidence that the two are indeed closely related.

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TESTE DE ORIGENS DE *Pinus caribaea* MOR.

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Resumo

Foi instalado em dois locais do Estado de São Paulo, um estudo do comportamento de doze origens de Pinus caribaea Mor.

Após seis anos de observações, os dados mostraram variação entre os tratamentos quanto ao DAP, altura, característica da copa e perfeição do fuste.

PROVENANCE TRIAL OF *Pinus caribaea* MOR.

Summary

This paper deals with the study of DBH, height, crown characteristics and bole perfection of 12 Pinus caribaea Mor. provenances. In considering these phenotipic characteristics it was observed differênces among provenances.

TEST D'ORIGINE DE *Pinus caribaea* MOR.

Resume

Cette étude traite du diamètre à hauteur d'homme, de la hauteur, des caractéristiques du houppier et de la rectitude de fût de 12 provenances du Pinus Caribaea Morelet. On a observé des différences parmi ces provenances d'après ces caractéristiques phénotypiques.

I n t r o d u ç ã o

As variedades do Pinus caribaea Mor, despontam como as mais promissoras para o abastecimento do mercado de madeira mole em zonas de clima tropical do Brasil. Sendo pouco exigentes em solo, podem ser cultivados em locais não aproveitados para a agricultura e pecuária.

A introdução desta conífera foi de grande importância para a nossa economia florestal, estando a sua madeira, contribuindo nos dias de hoje, para substituir a madeira do pinheiro nacional, em fase de extinção no sul do Brasil.

Pires (1973) apresenta o esquema deste estudo, salientando a cooperação internacional da pesquisa da Universidade de Oxford junto ao Instituto Florestal do Estado de São Paulo. Greaves (1978) apresenta os dados dos tratamentos envolvidos.

Greaves (1980) faz uma revisão dos projetos Pinus caribaea Mor e Pinus oocarpa Sch. Internacional Provenance Trial, coordenado pela Universidade de Oxford e instalado em várias partes do mundo.

Sendo de âmbito mundial, este trabalho será de grande importância para os países onde está sendo conduzido e trará certamente, muitos subsídios para o conhecimento real da indicação das melhores procedências para as respectivas regiões, servindo ainda, para estudos de melhoramento genético.

M a t e r i a l e M é t o d o s

As sementes foram coletadas pelo Commonwealth Forestry Institute (CFI) cuja relação dos tratamentos é apresentado na TABELA 1.

TABELA 1 - Tratamentos, espécies e nº CFI

Tratamento	Espécie	Nº CFI
1	Pinus caribaea var. hondurensis Bar. et Golf.	22-70
2	Pinus caribaea var. hondurensis Bar. et Golf.	24-70
3	Pinus caribaea var. hondurensis Bar. et Golf.	27-70
4	Pinus caribaea var. hondurensis Bar. et Golf.	29-70
5	Pinus caribaea var. hondurensis Bar. et Golf.	36-71
6	Pinus caribaea var. hondurensis Bar. et Golf.	37-71
7	Pinus caribaea var. hondurensis Bar. et Golf.	39-71
8	Pinus caribaea var. hondurensis Bar. et Golf.	45-71
9	Pinus caribaea var. hondurensis Bar. et Golf.	44-71
10	Pinus caribaea var. bahamensis Bar. et Golf.	69(7296)
11	Pinus caribaea var. caribaea Bar. et Golf.	21-71
12	Pinus caribaea var. hondurensis Bar. et Golf.	47-71

Os locais de instalação do projeto (duas Estações Experimentais do Instituto Florestal), apresentam a seguinte localização e características edafo-climáticas, conforme TABELA 2.

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

Local	Lat. S	Long. W	Alt. m	Precip.	Temp. Média °C	Clima	Solo	Def. Hidr. mm
Bebedouro	20°57'	48°30'	550	1.296	21,9	Aw	LEa	73
Mogi Mirim	22°26'	46°57'	631	1.355	20,3	Cwa	LVa	19

As mudas foram produzidas em torrão paulista e plantadas com uma altura média de 20 cm, em janeiro de 1973.

O delineamento estatístico foi o de blocos, com 12 tratamentos e 5 repetições, utilizando 49 (7 x 7) mudas por parcela, com bordadura externa dupla, com espaçamento de 3,0m x 2,0m. Os dados foram coletados aos 6 anos das 25 plantas centrais de cada parcela.

Além dos dados de DAP e altura, procurou-se analisar outros parâmetros que são considerados importantes na avaliação de uma floresta. Kageyama (1977) adotou o sistema por notas, dadas subjetivamente em trabalho sobre o Pinus oocarpa Sch., considerando as características de forma do tronco, espessura dos ramos, ângulo dos ramos e comprimento dos internódios.

Segundo recomendações da IUFRO, neste trabalho, foram considerados as características de fuste e copa, dando notas subjetivamente, de acordo com o seguinte critério:

Perfeição do Fuste:
A - retilíneo sem tortuosidade
B - pequena tortuosidade
C - tortuosidade acentuada

Características da copa:
A - simétrica e fechada, ramificação regular
B - aberta, ramificação irregular
C - apresentando fox-tail

R e s u l t a d o s

O desenvolvimento em altura, DAP e a sobrevivência para os locais, são apresentados na TABELA 3.

TABELA 3 - Dados de altura, DAP e sobrevivência:

Tratamento	BEBEDOURO			MOJI MIRIM		
	Altura m	DAP cm	Sobrev. %	Altura m	DAP cm	Sobrev. %
1	11,92	15,54	79,2	9,73	12,94	95,5
2	11,45	14,72	71,1	8,89	12,60	94,4
3	10,95	13,68	88,8	9,27	12,42	95,2
4	11,69	14,22	92,8	9,91	13,44	96,0
5	12,31	15,04	74,4	9,77	13,22	90,4
6	11,98	14,96	82,4	9,35	13,12	89,6
7	11,60	15,62	87,2	9,63	13,58	94,4
8	12,46	16,18	73,6	9,62	13,06	88,0
9	12,15	15,44	82,4	10,39	13,74	92,0
10	10,03	12,34	68,8	8,82	11,74	80,8
11	9,90	12,16	76,0	9,24	12,34	73,6
12	11,49	14,84	74,4	9,15	13,10	92,0

A análise da variância revelou uma diferença significativa a nível de 1% entre os tratamentos para altura e DAP em ambos locais.

Na análise do Teste Tukey para os dados de altura e DAP, encontrou-se os seguintes tratamentos que se sobressaíram positivamente e negativamente dos demais.

Para altura em Bebedouro: melhores tratamentos - 1, 4, 5, 6, 7 e 8
pior tratamento - 11

Para altura em Moji Mirim: melhor tratamento - 9
piores tratamentos - 2 e 10

Para DAP em Bebedouro: melhor tratamento - 8
pior tratamento - 11

Para DAP em Moji Mirim: melhores tratamentos - 7 e 9
pior tratamento - 10

Os dados médios das notas dadas subjetivamente para perfeição de fuste e características da copa, apresentaram uma variação altamente significativa para ambos os locais.

Houve uma coincidência na classificação dos tratamentos por local de instalação do estudo, mas entre eles houve uma grande discrepância.

Numa análise sucinta, encontrou-se os seguintes resultados para os dois parâmetros considerados conjuntamente:

Bebedouro - melhores tratamentos: 11 e 5
piores tratamentos : 2 e 12

Moji Mirim - melhores tratamentos: 1 e 6
piores tratamentos : 2 e 9

C o n c l u s õ e s

Houve uma grande variação entre os tratamentos para os dados de altura e DAP, em ambos os locais, até o presente.

Na avaliação dos tratamentos que mais se sobressaíram positivamente e negativamente pelo Teste Tukey, houve uma certa coincidência, tanto para altura, como para DAP nos dois locais. Resumidamente, os melhores tratamentos foram o 7, 8 e 9 e os piores o 10 e 11.

Analisando os valores médios dos parâmetros dados subjetivamente (perfeição de fuste e característica da copa), constatou-se uma variação altamente significativa em ambos os locais. Houve coincidência dos parâmetros por localidade, mas quando comparados entre elas, os tratamentos que se sobressaíram não foram os mesmos.

Da mesma forma, as melhores médias de altura e DAP não coincidiram com as de fuste e copa em ambas as localidades.

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COMPORTAMENTO SILVICULTURAL DE DEZ ORIGENS DE *Pinus* TROPICAIS

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Resumo

Ensaio instalado em 3 regiões do Estado de São Paulo, com o objetivo de observar o comportamento de 10 procedências de Pinus de clima tropical, sendo 5 origens conhecidas e 5 lotes de sementes comerciais. São apresentados dados de altura, DAP, perfeição de fuste e característica da copa, aos 7 anos. Os resultados dos parâmetros analisados, mostraram diferenças em alguns locais.

SILVICULTURAL'S BEHAVIOUR OF TEN PROVENANCE OF TROPICAL *Pinus*

Summary

This trial was settled down in three areas of the São Paulo State, to study the behaviour of 10 provenances of tropical Pinus. The results of height, DBH, perfection of bole and crown characteristics were analysed showing differences.

COMPORTEMENT SYLVICULTUREL DE DIX ORIGINES DE *Pinus* TROPICAUX

Resume

Ce dispositif d'essais a été utilisé dans trois régions de l'état de Sao Paulo, pour étudier le comportement de 10 provenances de pins tropicaux. On a analysé les résultats concernant la hauteur, le diamètre à hauteur d'homme, la rectitude du fût et les caractéristiques du houppier. Ces résultats soulignent des différences.

I n t r o d u ç ã o

A utilização de sementes certificadas na introdução de espécies exóticas em um país, é de importância para o seu desenvolvimento florestal. Embora se possa presumir que determinada essência florestal terá êxito ou não quando introduzida de uma região para outra, baseando-se em determinados índices edafo-climáticos, somente pela pesquisa, após anos de observações é que se poderá confirmar ou não aquelas informações iniciais.

Em relatório sobre as suas impressões do estágio da silvicultura do Estado de São Paulo, ZOBEL (1965), recomenda as melhores origens de Pinus spp a serem pesquisados nas futuras introduções.

Após percorrer todas as regiões do Brasil onde houvessem povoamentos florestais, GOLFARI et alii (1978) classificou-as em zonas bioclimáticas, indicando as espécies e Pinus e Eucalyptus potencialmente aptas para cada região percorrida.

O objetivo principal deste trabalho, é comparar o desenvolvimento em três regiões do Estado de São Paulo, entre 5 origens de Pinus spp com 5 procedências de sementes comerciais, sendo uma colhida no Estado de São Paulo.

M a t e r i a l e M é t o d o s

As sementes dos tratamentos de número 1 a 5 foram provenientes do Commonwealth Forestry Institute(CFI) e as dos tratamentos 6 a 10, foram de sementes comerciais, importadas pelo Instituto Florestal do Estado de São Paulo, sendo que o tratamento 9, foi de sementes colhidas em Mogi Mirim - SP, conforme TABELA 1.

TABELA 1 - Relação dos tratamentos, espécie e origem das sementes

Tratamento	ESPÉCIE	Origem das Sementes
1	*Pinus oocarpa* Sch.	Nº CFI 69(7296)
2	*Pinus caribaea* var. *bahamensis* Bar. et Golf.	Nº CFI 10-70
3	*Pinus caribaea* var. *bahamensis* Bar. et Golf.	Nº CFI 66(7296)
4	*Pinus caribaea* var. *caribaea* Bar. et Golf.	Nº CFI 59(7291)
5	*Pinus kesiya* Royle ex Gordon	Nº CFI 66(597)
6	*Pinus oocarpa* Sch.	importadas
7	*Pinus caribaea* var. *hondurensis*	importadas
8	*Pinus caribaea* var. *bahamensis* Bar. et Golf.	importadas
9	*Pinus caribaea* var. *caribaea* Bar. et Golf.	colhidas em M. Mirim
10	*Pinus caribaea* var. *caribaea* Bar. et Golf.	importadas

Os dados e condições edafo-climáticos dos locais dos experimentos, se encontram na TABELA 2, segundo VEIGA (1975).

TABELA 2 - Dados geográficos e edafo-climáticos dos locais de instalação do projeto.

Local	Lat. S	Long. W	Alt. m	Precip. mm	Temp. Média ºC	Clima	Solo	Def. Hid mm
Assis	22°40'	50°25'	562	1.217	20,6	Cwa	Lea	4
Bebedouro	20°57'	48°30'	550	1.296	21,9	Aw	Lea	73
Mogi Mirim	22°26'	46°57'	631	1.355	20,3	Cwa	LVa	19

As mudas foram produzidas em torrão paulista e levadas para o campo com 20 cm de altura, plantadas num espaçamento de 3,0 x 2,0 m.

O delineamento estatístico foi de blocos ao acaso, com 10 tratamentos e 5 repetições, utilizando 4 mudas por parcela, dispostas linearmente. Utilizou-se bordadura externa dupla, ocupando uma área total de 0,24 ha.

Além dos dados de DAP e altura, foram considerados outros parâmetros na avaliação dos tratamentos. KAGEYAMA (1977) adota o sistema de notas, dadas subjetivamente no estudo do *Pinus oocarpa* Sch.

Baseado em informações de GREAVES (1980), foi adotado para este estudo, o critério de notas subjetivas para a perfeição do fuste e características da copa, dando nota A para os exemplares perfeitos, B para aqueles com pequenos defeitos e C para os com defeitos acentuados.

Resultados e Discussões

Os dados médios de altura e DAP para as 3 localidades aos 7 anos, são apresentados na TABELA 3.

TABELA 3 - Dados de altura e DAP dos locais de pesquisa

Tratamento	ASSIS		BEBEDOURO		MOGI MIRIM	
	Altura m	DAP cm.	Altura m	DAP cm.	Altura m	DAP cm.
1	11,1	15,4	13,0	14,9	12,8	15,7
2	11,1	16,0	13,7	17,0	14,8	18,3
3	11,5	17,5	13,4	15,4	13,5	17,3
4	10,7	14,0	13,0	14,3	11,9	15,5
5	11,2	14,2	12,0	16,6	14,4	18,2
6	11,7	16,6	13,8	15,4	14,9	17,5
7	12,2	19,1	13,3	17,2	15,0	20,5
8	11,3	17,7	12,7	15,0	14,1	17,1
9	10,0	12,8	11,0	13,0	11,9	14,6
10	10,6	14,4	12,3	14,5	12,2	15,9

Na análise da variância, encontrou-se para a altura, diferença não significativa entre os tratamentos de Assis, apenas significativa para Bebedouro e altamente significativa para Mogi Mirim.

Para os dados de DAP, a análise de variância revelou uma diferença entre os tratamentos, altamente significativa para Assis e Mogi Mirim e não significativa para Bebedouro.

Para o Teste Tukey, encontrou-se uma concordância na posição relativa dos tratamentos entre as localidades para altura e DAP, sobressaindo-se entre os demais tratamentos de forma positiva os de número 7, 6 e 2 de forma negativa, os de números 9, 10 e 4, por ordem de importância.

Analisando os dados das médias das notas dadas subjetivamente aos parâmetros de perfeição do fuste e características da copa, encontrou-se uma variação entre os tratamentos para ambos os fatores, havendo sempre uma concordância de copa e fuste, somente por localidade, mas entre elas os dados não coincidiram.

Sucintamente encontrou-se a seguinte classificação para o fuste e copa, por localidade, conforme TABELA 4.

TABELA 4 - Classificação dos tratamentos para fuste e copa conjuntamente:

Local	Melhores	Piores
Assis	6 e 10	7 e 1
Bebedouro	3 e 6	9 e 7
Mogi Mirim	8 e 10	5 e 3

Conclusões

Houve uma concordância dos dados de altura e DAP por localidade e entre elas, se destacando de forma positiva os tratamentos 7, 6 e 2 e de forma negativa, os tratamentos 9, 10 e 4.

No levantamento de perfeição de fuste e característica da copa, houve concordância entre estes parâmetros somente por localidade, mas entre elas os dados não coincidiram.

Comparando os dados de DAP e altura com os de fuste e copa, nos 3 locais, os resultados não coincidiram.

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RELATÓRIO DOS TESTES INTERNACIONAIS DE PROCEDÊNCIAS DE *Pinus oocarpa* NA REPÚBLICA DA ÁFRICA DO SUL

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Resumo

Os resultados das últimas medições de DAP, na idade de 7 anos, dos 4 ensaios existentes são apresentados. A correlação entre as medições com as medições anteriores é geralmente muito boa. As procedências na Nicarágua parecem ser melhor adaptadas às condições Sul-Africanas. A correlação entre os ensaios é muito boa e a interação procedência x localidade é muito pequena.

REPORT ON THE INTERNATIONAL PROVENANCE TRIALS OF *Pinus oocarpa* IN THE REPUBLIC OF SOUTH AFRICA

Summary

The results of the latest dbh-measurements at age 7 years of the four existing trials are given. Correlation with previous assessments is generally very good. The provenances from Nicaragua seem to be best adapted to South African conditions. Correlation between the trials is very good and provenance x site interaction is very small.

RAPPORT DU TEST INTERNATIONAL DE PROVENANCE DE *Pinus oocarpa* EN ÁFRIQUE DU SUD

Resume

On présente ici les résultats des dernières mensurotion de diamètre à hauteur d'homme effectuées à l'âge de 7 ans dans 4 essais de *Pinus oocarpa* Schiede. La corrélation avec les mensurations effectuées précédemment est généralement bonne.

Les provenances du Nicaragua semblent les mieux adaptées aux conditions écologiques de l'Afrique du Sud. La corrélation entre ces essais est très bonne et l'influence réciproque entre la provenance et le site est très faible.

INTRODUCTION

Four field trials have been established in South Africa within the cadre of the International Provenance Trial of *Pinus oocarpa*, organised by the Commonwealth Forestry Institute, Oxford.

TABLE I : PROVENANCE SOURCE INFORMATION FOR P. OOCARPA

Stock No.	Country, Locality	Latitude N 0	'	Longtitude W 0	'	Altitude (m)	Mean annual rainfall (mm)
K2	Nicaragua, Camelias	13	46	86	18	1,000	1,500
K6	Honduras, Zapotillo	14	37	87	02	1,100	1,200
K7	Honduras, San Marcos	14	36	87	00	1,100	1,200
K9	Guatemala, Canas	15	10	98	23	1,200	1,900
K10	Guatemala, Lima	15	11	89	21	1,000	1,800
K11	Guatemala, Conacaste	15	10	89	21	650	1,900
K15	Honduras, Maraquito	14	30	86	50	1,000	1,200
K16	Honduras, Aqua Fria	15	16	87	06	1,100	1,100
K31	Nicaragua, Junquillo	13	42	86	35	1,000	900
K32	Nicaragua, Bonete	12	50	86	18	1,000	950
K34	Guatemala, Bucaral	15	01	90	09	1,100	800
K35	Honduras, Angeles	14	07	87	04	1,300	950
K36	Honduras, Zamorano	13	58	86	59	1,000	1,100
K42	Nicaragua, Yucul	12	55	85	47	900	1,400
K43	Guatemala, Lagunilla	14	42	89	57	1,300	950
K44	Nicaragua, Rafael	13	12	86	06	1,100	1,500
K45	Honduras, Siguatepeque	14	32	87	45	1,100	1,250
K46	Guatemala, Chuacus	15	02	09	16	1,300	800
K47	Guatemala, San José	14	28	89	28	1,000	(1,000)
K48	Guatemala, Huehuetenango	15	13	91	32	(1,700)	(1,000)
K49	Belize, Mt. Pine Ridge	17	00	88	55	700	1,600

P. car. — *P. caribaea* var. hondurensis (Poptun, Guat.)
P. ell. S.O. — *P. elliottii* local seed orchard mixture
P. tae. S.O. — *P. taeda* local seed orchard mixture
P. pat. S.O. — *P. patula* local seed orchard mixture
P. ell. C. — *P. elliottii* commercial seed ex Kwa Mbonambi
P. ooc. S.O. — *P. oocarpa* local seed orchard mixture

Full details of the provenances, test sites, design, lay-out and management of the field trials, as well as the results of early assessments have been given by van der Sÿde (1973) and van Wyk (1978), but for easy reference the main information on provenance sources is given in Table I.

Two of the trials have been selected for intensive assessment by a researcher from the C.F.I., Oxford, and will be fully measured and assessed during June/July 1980. For this reason a dbh-measurement only was done early in 1980 to enable a report on the trials to be submitted for the present symposium.

DATA COLLECTION AND ANALYSIS

The trials were all measured in March 1980 at an age of just over 7 years. The data were analysed and provenance means compared at the 5 % level using Duncan's New Multiple Range Test. The results are given in Table II.

The 1980 rankings for dbh were compared with earlier assessments of the same trial and the correlations evaluated using Spearman's Rank Correlation Coefficients. The between-trials correlations for the 1980 dbh-measurement were also calculated for those trials which had sufficient provenances in common.

The results of these correlation studies are presented in Table III.

Only in the Tweefontein trial was the number of forked trees noted during the 1980 assessment. Analysis of this information revealed highly significant differences between provenances.

RESULTS AND DISCUSSION

The high correlation between trials growing under widely different conditions (e.g. KwaMbonambi and Tweefontein with $r_s = 1,00$) confirms the finding that genotipe x environment interaction in *P. oocarpa* is very small (R.D. Barnes, pers. comm.).

The assessment at age 7 years supports the earlier conclusion that the provenances from Nicaragua are best suited to South African conditions (van Wyk, 1978). The correlation between successive assessments of the same trial is generally very good.

The *P. oocarpa* provenances had a better growth rate than the species planted commercially in the test areas except at Tweefontein, where the control species, *P. taeda* and *P. patula*, both outperformed *P. oocarpa*. However, the difference between the control species and the best two or three *P. oocarpa* provenances is not significant.

TABLE II : ASSESSMENT OF DBH (CM) IN FOUR TRIALS AT AGE 7 YEARS

SN	WILGEBOOM PLANTED 1/73	SN	TWEEFONTEIN PLANTED 3/73	SN	TIMBADOLA PLANTED 2/73	SN	KWAMBONAMBI PLANTED 5/73
P. CAR.	18,7	P. TAE. S.O.	15,6	K42	12,9	K2	15,5
K2	17,6	P. PAT. S.O.	15,6	K44	12,8	K49	14,8
K16	17,4	K42	15,4	P. ELL. S.O.	12,5	K9	13,5
K44	17,3	K2	15,3	K43	12,4	P. ELL. C.	12,8
K43	17,0	K49	14,7	K10	12,3	K36	12,2
K42	16,9	K43	14,5	K36	12,2	K34	12,1
P. ELL. S.O.	16,7	K32	14,5	K15	11,6	P. OOC. S.O.	11,8
K49	16,6	K35	14,3	K34	11,3	K15	11,4
K36	16,4	K46	13,7				
K35	16,4	K48	13,4				
K6	16,2	K15	13,4				
K47	16,2	K7	13,3				
K9	16,1	K34	13,3				
K31	16,1	K45	13,2				
K48	15,8	K10	12,5				
K45	15,6	K11	12,2				

BARS INDICATE DUNCAN'S NEW MULTIPLE RANGE TEST AT 5 % LEVEL.

TABLE III :

CORRELATIONS BETWEEN SUCCESSIVE ASSESSMENT AND BETWEEN TRIALS FOR THE 1980 ASSESSMENT (SPEARMAN'S RANK CORRELATION COEFFICIENTS).

						S.R.C. Coefficient
Kwamb.	dbh 1980	x	Kwamb.	ht	1976	0,98**
Timb.	dbh 1980	x	Timb.	ht	1976	0,93**
Wilg.	dbh 1980	x	Wilg.	ht	1976	0,58*
Tweef.	dbh 1980	x	Tweef.	ht	1976	0,82**
Timb.	dbh 1980	x	Timb.	dbh	1976	0,80**
Wilg.	dbh 1980	x	Tweef.	dbh	1980	0,82**
Kwamb.	dbh 1980	x	Tweef.	dbh	1980	1,00**
Timb.	dbh 1980	x	Wilg.	dbh	1980	0,50 N.S.
Timb.	dbh 1980	x	Tweef.	dbh	1980	0,71 N.S.

The poor performance of the local P. oocarpa (seed orchard mixture) in the KwaMbonambi trial is unexpected as the clones in the orchard had been selected in compartments of outstanding quality in the same area.

Although the incidence of double leaders was only investigated at Tweefontein, it seems as if P. oocarpa is prone to forking after repeated attack by Hylastus spp, for even the best provenances had 3 to 4 times as many forked trees as the control species, P. taeda and P. patula.

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RELATÓRIO DOS TESTES INTERNACIONAIS DE PROCEDÊNCIAS DE *Pinus caribaea* NA REPÚBLICA DA ÁFRICA DO SUL

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Resumo

Os resultados das últimas medições de OAP, aos $6^{2}/_{12}$ anos, para a localidade Mariti, e aos $6^{10}/_{12}$ anos, para KwaMbonambi, são apresentados e comparados com as avaliações prévias. A correlação entre os resultados atuais e as avaliações preliminares foi boa. Como era de se esperar, as procedências da var. *hondurensis* superam nesse estágio, as procedências da var. *caribaea*

REPORT ON THE INTERNATIONAL PROVENANCE TRIALS OF *Pinus caribaea* IN THE REPUBLIC OF SOUTH AFRICA

Summary

The results of the latest dbh-measurements at age $6^{2}/12$ years for the Mariti trial and at age $6^{10}/12$ years for the KwaMbonambi trial are presented and compared with previous assessments. The correlation between the trials and with early assessments was good. As could be expected, the var. hondurensis provenances at this stage outperform the var. caribaea provenances.

RAPPORT DES TESTS INTERNATIONAUX DE PROVENANCE DU *Pinus caribaea* EN AFRIQUE DU SUD

Resume

Les résultats des dernières mensurations du diamètre à hauteur d'homme effectuées à $6^{10}/12$ ans pour l'essai MARITI et à $6^{10}/12$ ans pour l'essai KwaMBONAMBI sont présentés et comparés aux résultats obtenus précédemment. La corrélation entre les essais et les mensurations antérieures était bonne. Comme on pouvait s'y attendre, les provenances de la variété *hondurensis* surpassent celles de la variété *caribaea*.

INTRODUCTION

Two trials were planted from seed received from the Commonwealth Forestry Institute, Oxford, as part of the international provenance trial of Pinus caribaea.

Full details of the provenances represented, test sites, design, lay-out and management of the two trials, and of the results of an early assessment have been given by van Wyk (1978). For easy reference, details of the provenances and of the two test sites are shown in Tables 1 and 2.

The trials have been selected for intensive assessment by a researcher from the CFI, Oxford, and will be fully assessed and measured during June/July 1980. For this reason only a dbh-measurement was done early in 1980 to enable a preliminary report on the trials to be submitted for the present meeting.

Table 1. Provenance source information

SN	Country, locality	Lat. (N)	Long. (W)	Alt. (m)	Mean Annual rainfall (mm)
20/70	Nicaragua, Kuakil	14°21'	83°30'	20	3 200
22/70	Nicaragua, Alamicamba	13°34'	84°17'	25	2 900
26/70	Guetemala, Poptun	16°20'	89°25'	500	1 700
28/70	Honduras Rep., Guanaja	16°27'		75	2 300
18/71	Cuba, Marabajita	22°50'		80	1 600
19/71	Cuba, Los Palacios	22°50'		50	1 50C
20/71	Cuba, Las Cabanas	22°50'		160	1 600
21/71	Cuba, Manuel	22°50'		150	1 600
22/71	Cuba, Cayo la Mula	22°50'		110	1 400
23/71	Cuba, Marabajita	22°50'		80	1 600
24/71	Cuba, El Buren	22°50'		300	1 600
37/71	Honduras Rep., Culmi	15°06'		550	1 500
38/71	Honduras Rep., Brus	15°45'		10	2 800
40/71	Honduras Rep., Potosi	15°20'		650	1 200
44/71	Belize, Mt. Pine Ridge	17°00'		400	1 600
45/71	Nicaragua, Santa Clara	13°48'		700	1 500
46/71	Queensland, Australia	Clonal reservoir			
47/71	Belize, Melinda	17°00'		20	2 000
17531	Belize, Mt. Pine Ridge	17°00'		700,	1 600
CAR	P. caribaea mixture ex seed Orchard				
ELL-S.O	P. elliottii var. elliottii ex Seed Orchard				
ELL. comm.	P. elliottii var. elliottii ex Plantation (KwaMbonambi)				

Table 2. Provenance trial site information.

Locality	Longitude E	Latitude S	Altitude (m)	Mean annual rainfall (mm)	Soil
KwaMbonambi	32°00'	28°45'	65	1370	Coastal Sand
Mariti	30°56'	24°54'	1000	1569	Granitic

DATA COLLECTION AND ANALYSIS

The trials were measured up when the Mariti trial was $6^{2}/12$ years and KwaMbonambi trial $6^{10}/12$ years old. The data were analysed and provenance means compared using Duncan 's New Multiple Range Test at the 5% level. The results are shown in Table 3.

The 1980 ranking for dbh were compared with those for the early height measurements of the same trials, using Spearman's Rank Correlation Coefficients. The between-trials correlation for the 1980 dbh-measurements was calculated the same way.

RESULTS AND DISCUSSION

In both trials the Pinus caribaea var. hondurensis provenances outperformed the var. caribaea provenances, which confirms the results of older provenance trials in South Africa (Falkenhagen, 1979) and elsewhere. At KwaMbonambi a locally-collected commercial seedlot of P. elliottii, the species normally planted in areas comparable to the test site, had the lowest dbh of all provenances at age $6^{10}/12$ years, while at Mariti a seed orchard mixture of the same species equalled the average for the group of var. caribaea provenances.

The correlations between the rankings for dbh in 1980 and for height in 1976 was significant for the Mariti trial and highly significant for the KwaMbonambi trial (Spearman's Rank Correlation Coefficients of 0,58 and 0,67 resp.). The rankings for dbh in 1980 of the nine common provenances in the two trials were highly significantly correlated (r_s=0,80).

Table 3: Assessment of dbh of Pinus caribaea at two test sites.

KwaMbonambi S.N.	KwaMbonambi dbh(cm)	Mariti S.N.	Mariti dbh(cm)
28/70	16,8	45/71	15.3
26/70	16,0	28/70	14.7
38/71	15,8	46/71	14.6
22/70	15.8	CAR.S.O.	14.6
20/70	15.6	44/71	14.6
CAR MT.P.R.	15.3	40/71	14.3
47/71	14.9	26/70	14.3
18/71(c)	14.6	38/71	13.8
23/71(c)	14.5	37/71	13.8
24/71(c)	14.3	20/71(c)	13.5
22/71(c)	13.7	22/70	13.4
20/71(c)	13.7	23/71(c)	13.3
19/71(c)	13.7	ELL.S.O.	12.9
21/71(c)	13.5	22/71(c)	12.8
ELL. Comm.	12,6	19/71(c)	12.8
		24/71(c)	12.5

Bars indicate Duncan's New Multiple Range Test at 5% level.

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MELHORAMENTO DE *Pinus oocarpa* NA ÁFRICA DO SUL

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Resumo

A situação passada e atual de um programa de melhoramento de *Pinus oocarpa* Schiede, é descrita neste trabalho. A seleção de todas as árvores "plus" foi efetuada em povoamentos com base genética muito restrita, e conseqüentemente, o progresso é dificultado pela ausência de uma população adequada com base genética ampla, e idade suficiente para os objetivos da seleção.

BREEDING OF *Pinus oocarpa* IN SOUTH AFRICA

Summary

The background to and present status of a breeding programme for Pinus oocarpa Schiede is described. All plus tree selections have been made in stands with a very restricted genetic base, and progress is hampered by the lack of a suitable, broad genetic population old enough for selection purposes.

L'AMELIORATION DU *Pinus oocarpa* EN AFRIQUE DU SUD

Resume

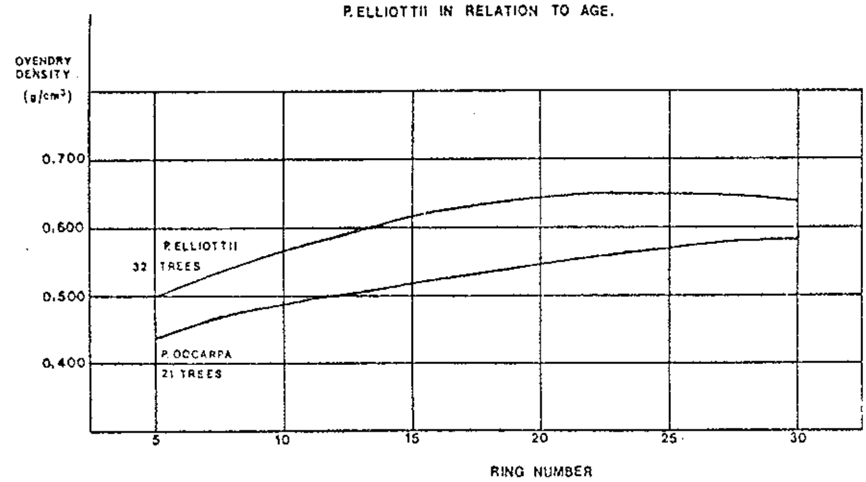
Généralités et état actuel d'avancement d'un programme d'amélioration génétique du Pinus oocarpa SCHIEDE.

Les sélections d'arbres d'élite ont été effectuées dans des peuplements dont l'assise génétique était très limitée. L'arrêt de progression de ce programme est dû au manque de population possédant une diversité génétique et un âge suffisant pour opérer une sélection.

INTRODUCTION

Pinus oocarpa Schiede was first introduced into South Africa from Mexico in 1911, when seed was obtained through a seed merchant. Between that year and 1915, further stocks were purchased from the same merchant. These stocks were widely distributed, chiefly to stations situated in the more humid parts of the summer rainfall area. Trees raised from these early

FIGURE: 1: OVEN-DRY WOOD DENSITIES OF P. OOCARPA AND P. ELLIOTTII IN RELATION TO AGE.



introductions were almost invariably crooked and heavily branched (Poynton, 1979). In 1934, seed of the extra-Mexican form of the species first reached the country from the Republic of Honduras. This seed was used to establish arboretum plots at Dukuduku, KwaMbonambi and Lottering. The stands at the first two stations, both situated in Zululand, are of exceptionally good quality, and contain many straight, and lightly branched trees. Further seed supplies of the extra-Mexican form have since been obtained from the Republic of Honduras and British Honduras. Seed collected in the arboretum plot at KwaMbonambi has also been used for further afforestation.

Although Pinus oocarpa was used only on a limited scale, the good performance of several plantings indicated its possibilities. P. oocarpa is best suited to conditions in the summer rainfall area, where it can be planted successfully in Silvicultural Zones B2-5 and in the most humid regions of Zones C2-5 (Poynton, 1971). The species is easily frosted and not particularly drought-resistant. It grows possibly best on deep, doleritic or granitic clay-loams yet succeeds also on infertile sandy-loams and even on deep marine sands along the coast.

The suitable area includes the warmer low-altitude (< 1000 m) sites in the Transvaal Forest Regions and the coastal area along the Zululand coast. The generally good stem form, light branching and very satisfactory wood density, (comparable with that of P. elliottii but with a flatter radial gradient) combined with a growth rate slightly lower than that of P. caribaea though about 40 % higher than P. elliottii (Falkenhagen, 1979) makes P. oocarpa an attractive alternative to P. elliottii in Zululand and to P. patula in the low-altitude regions in Transvaal, hence it was decided to include the species in the tree breeding programme of the Department.

Table 1 and Figure I give some detail of wood properties of P. oocarpa in comparison with those of P. elliottii, based on Zululand-grown material.

THE BREEDING PROGRAMME

The selection of plus trees started in 1961, taking into consideration stem form, branching, vigour, wood density, spiral grain and fibre length. Although all the available stands were searched, only 12 plus trees were found. All of these are in the arboretum plots at Dukuduku and KwaMbonambi, and no selections were made in plantings of Mexican origin, due to the high selection standard with regard to stem form and branching.

Plus tree selection continued over the years. Altogether 31 origin selections have now been made, to which must be added 17 F - selections made in unreplicated plots planted up with open-pollinated seed collected from the initial 12 plus trees. The new selections have not been used in the seed orchard, but are kept in a tree bank as part of the breeding population.

A start has been made with progeny testing. The first trial, planted in 1976, was, however, completely destroyed by chacma baboons (Papio ursinus) New trials are in the planning stage.

DISCUSSION

Progress with the breeding programme for P. oocarpa in South Africa is seriously hampered by the lack of a sufficiently mature and genetically diversified base population for the selection of plus trees.

TABLE I:

FIBRE LENGTH (IN MM.) OF ZULULAND-GROWN P. OOCARPA AND P.ELLIOTTII.

	5	10	15
P. oocarpa (21 Zululand trees)	4,01	4,85	5,07
P. elliottii (13 Zululand trees)	3,54	3,90	4,22

The total area under P. oocarpa in South Africa is at present only 313 ha, but the area will be increased as soon as seed orchard seed or seed of proven suitable provenances becomes available.

Of the 31 plus trees so far selected, 28 originated from one small seedlot of only 140 g imported from Tegucigalpa, Republic of Honduras, from which the Dukuduku and KwaMbonambi arboretum plots were planted. Notwithstanding the high quality of this provenance, a fact which is confirmed by trials in Uganda (Greaves, 1976), this population is too small to warrant further selection work. The source of the three remaining plus trees is uncertain, although they are also of extra-Mexican, probably Republic of Honduras, origin.

Young stands have recently been planted up with stocks imported from Mexico, Guetemala, El Salvador, Brazil and Zambia, and further selection work must be postponed until these and the local plantings of the International Provenance Trials organized by the Commonwealth Forestry Institute, Oxford, are old enough to permit a reliable assessment of the phenotypic quality (including wood properties) of individual trees.

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PROGRAMA DE MELHORAMENTO GENÉTICO DE PINHEIROS EM JARI

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Resumo

As atividades de melhoramento de pinheiros foram iniciadas em Jari, em 1971. Os primeiros experimentos informais indicaram que a var. *hondurensis* foi a mais produtiva dentre as três variedades de *Pinus caribaea*, plantadas em Jari. Experimentos de introdução de espécies demonstraram que o *Pinus oocarpa* também é potencial. Mais tarde, experimentos formais usando sementes fornecidas pelo CFI de Oxford, confirmaram esses resultados.

Um programa de seleção de árvores "plus" foi iniciado em Jari, com *Pinus caribaea* var. *hondurensis*, em 1978. O primeiro pomar de sementes está sendo instalado com 48 clones da procedência Alamicamba, Nicarágua; e 11 clones da procedência Mountain Pine Ridge, Belize. Esse pomar foi instalado no Estado de Minas Gerais porque as condições climáticas locais, durante a estação das chuvas, não favorecem a liberação do pólen e sua disseminação. Um maior número de clones será selecionado nas plantações em Jari, para o pomar de primeira geração. Acordos cooperativos com outras organizações interessadas no intercâmbio de material genético irão expandir a base genética das populações, que deverão ser empregadas para a seleção das gerações futuras.

O programa de experimentação com *Pinus oocarpa* está sendo ampliado. Os resultados atuais indicam que a espécie pode ser mais produtiva do que o *Pinus caribaea* var. *hondurensis*, em algumas localidades.

PINE GENETIC IMPROVEMENT PROGRAM AT JARI

Summary

Tree improvement activities of pine were initiated at Jari in 1971. Early informal trials indicated that var. hondurensis was the most productive of the three varieties of Pinus caribaea planted at Jari. Species trials indicated that Pinus oocarpa also showed promise. Later, more formal trials using seed supplied by the CFI of Oxford confirmed these results. A "Plus" tree selection program was begun at Jari with Pinus caribaea var. hondurensis in 1978. The first seed orchard is being established with 48 clones of an Alamicamba, Nicaragua, seed source and 11 clones from the Mountain Pine Ridge source of Belize. The seed orchard was located in the state of Minas Gerais because local weather conditions during the rainy season do not favor pollen shed and dissemination. More clones will be selected in Jari plantations for the first generation seed orchard. Cooperative agreements with other organizations interested in exchanging genetic material will expand the genetic base from which selections for future generations will be made.

The testing program of P. oocarpa is being expanded. Current results indicate that it may be more productive on some sites than P. caribaea var. hondurensis.

PROGRAMME D'AMELIORATION GÉNÉTIQUE DE PINS À JARI

Resume

L'amélioration des Pins a débuté à Jari, en 1971. Les premiers essais non systématiques indiquaient que la variété hondurensis était la plus productive des 3 variétés de Pinus caribaca plantées à Jari. Des essais d'espèces différentes indiquaient que le Pinus oocarpa était également intéressant. Par la suite, des essais plus systématiques faits à partir de graines fournient par le COMMONWEALTH FORESTRY INSTITUTE d'Oxford sont venus confirmer ces résultats.

En 1978, on a entrepris à Jari, un programme de sélection d'arbres d'élite pour le Pinus caribaea, var. hondurensis. Le premier verger grainier est en cours d'établissement constitué de 48 clones obtenus à partir de graines provenant d'Alamicamba, Nicaragua et de 11 clones de la provenance de Mountain Pine Ridge, Bélize. Il a été établi dans l'état de Minas Gerais, car le climat local, pendant la saison des pluies, ne favorisait pas la production et l'émission du pollen. On va sélectionner un plus grand nombre de clones dans les plantations de Jari pour créer la 1ère génération de verger grainier. Des accords coopératifs avec d'autres organisations intéressées par les échanges de matériel génétique permettront d'augmenter la base génétique à partir de laquelle sera effectué des sélections pour les générations à venir.

Le programme d'essais pour le Pinus oocarpa continue. Les derniers résultats indiquent qu'il peut être plus productif que le Pinus caribaea, var. hondurensis, dans certains endroits.

INTRODUCTION

Planting of PCH (Pinus caribaea var. hondurensis) began at Jari with a 3-ha trial of Belize origin seed in 1970. The excellent survival and juvenile height growth of this trial encouraged large scale commercial planting and by 1973 5,000 ha had been established. Since then about 4,500 ha have been established per year with an average annual seed requirement of 250 kg. This establishes an interesting scenario from a tree improvement perspective. Of necessity, the planting program was carried out with what seed origins could be obtained from commercial collectors. Even had improved seed of some type been available in commercial quantities in the early 1970's, there was little information on provenance variation available to assure the proper selection of the very best seed sources for the climatic and soil conditions at Jari.

Jari is situated in the Brazilian Amazon basin less than one degree south of the equator at 52° west longitude. The altitude ranges from about 5 to 240 m above sea level. The soils being planted to pine are Oxisols of good drainage but low natural fertility. Total rainfall averages 2200 mm with 85 percent of this falling from January through August. Pine growth practically ceases during the four driest months of September through December. Daily temperature extremes range from a high of 34°C to a low of 24°.

PROGRAM STATUS

Seed origins used and the future outlook

The approximate percentage of Jari plantations established with Pinus caribaea var. hondurensis from four Central American countries is shown below. There is a big disparity among countries since over two-thirds of the hectares have been

1/ In cooperation with SUDAM

planted with seed from Guatemala. Seed from Guatemala was rated very highly at one time and was also readily available. Recent information indicates this is not the best source for Jari; therefore, seed was bought from Australia, Brazil, Fiji, Guanaja Island, and Honduras. The 6-yr assessment of the CFI (Commonwealth Forestry Institute) provenance trial indicates that the four best sources for Jari would be Guanaja, Culmi, Santa Clara and Alamicamba (Woessner 1980). The best source (Guanaja) was producing 42 percent more fiber per year than Poptun, Guatemala. This amounted to 3.4 metric tons/ha/yr. Jari would be very interested in obtaining large commercial quantities of seed from all of these four best performing sources.

Percentage of Jari Lands Planted with seed of Pinus caribaea var. hondurensis from four countries.

Country of Seed Origin	Percentage
Guatemala	66
Honduras	23
Belize	10
Nicaragua	1
	100

Early tree improvement activities

Tree improvement activities on a small scale began at Jari in 1971 with the establishment of several informal trials comparing sources and varieties of Pinus caribaea and several other tropical conifers (Batista and Woessner, 1980). These early informal trials confirm the information now being obtained from the more rigorous CFI trial comparing the three varieties of hondurensis (Woessner 1980). Pinus caribaea var. hondurensis is producing 59 percent more dry wood/ha/yr than the other varieties. However, the form of the other two varieties is somewhat better than var. hondurensis. Also, the Manuel source of var. caribaea has the highest wood density. For pulpwood production the form and wood density advantages do not make up for the low volume yield.

Informal trials of some other conifers were established in 1971 and 1972. Those species tested were P. oocarpa, P. merkusii, P. insularis, P. pseudostrobus. Of these, only P. oocarpa was judged promising enough to warrant more formal trials (Batista and Woessner, 1980).

Current var. hondurensis improvement program

An active tree improvement program was begun with var. hondurensis in 1978. The older plantations were searched for "Plus" trees. In this initial selection phase, 150 trees were marked and graded. Of these, 59 were considered good enough to be used in the initial orchard establishment phase. Jari was especially fortunate in one respect regarding the selection program. Although seed from Alamicamba, Nicaragua, was used to establish less than one percent of the plantations, it was one of the first sources planted on a large scale in 1972. Based on the CFI trial results, this is one of the best sources for Jari. The initial orchard is being established with 48 clones of the Alamicamba source and 11 from the Mountain Pine Ridge from Belize.

"Plus" tree selection

The primary problem with PCH as a species when grown at Jari or other low altitude locations near the equator is tree form, principally crown deformities. Certain genotypes develop defects such as basket whorls and needleless shoots or develop into pure or partial foxtails.

These and other crown abnormalities lead to forking and stem degrade. The occurrence of basket whorls, needleless shoots and forking in the Jari CFI provenance trial at 6 years is shown in Table 1 (Woessner, 1980). Thirteen percent of the trees in the trial had these deformities. The best provenances had an incidence of only three percent while the worst averaged 31 percent. The positive aspects of the selection program are that growth and straightness of non-deformed trees is not a problem. Also, there are no serious disease problems such as Cronartium fusiforme which causes rejection of many candidate trees in tree improvement programs in the southern United States.

Table 1. Crown deformities found in the Pinus caribaea var. hondurensis CFI trial at Jari.

Characteristic	Percent of trees Range among provenance			mean	Best provenance
Basket whorls	5	-	32	18	Limones
Needleless shoots	0	-	20	5	Guanaja
Forking	4	-	40	16	Alamicamba
mean	3		31	13	

The goal of the improvement program was to select straight, healthy, multi-nodal trees of better than average growth which have well shaped crowns. This goal was implemented in five stages.

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

A grading sheet is filled in by the tree improvement forester when evaluating the candidate trees. The characteristics evaluated are:

a. total height
b. diameter
c. bark thickness
d. crown width, shape, density and color
e. stem straightness, pruning and roundness
f. branch angle, size, length and straightness
g. number of whorls and branches per whorl
h. flowering and fruiting
i. disease or insect attack
j. a wood sample is taken for determination of specific gravity
k. site characteristics are noted
l. tree age

For characteristics such as height, diameter and pruning, the candidate tree is compared with the largest five of the nearest eight neighbor trees. Other characteristics such as straightness, and the crown and branching characteristics are judged against an established scale independent of any comparison trees. A final score is arrived at by assigning points for each characteristic depending on the superiority of the candidate tree and the weight assigned to the characteristic. The grading system allocates 60 percent of the total score to growth, 20 percent to straightness and 20 percent to crown and branching characteristics.

In addition to the above described grading system, a tree also receives a ranking based on standardized scores. The candidate tree is rated for height and diameter against all the comparison trees of a given age class. A standardized score is given to each candidate tree by the use of this formula.

$$\frac{\text{Value for candidate tree} - \bar{X} \text{ for comparison trees}}{\text{Standard deviation for comparison trees}}$$

The average standardized score for height of the 59 accepted "Plus" trees was 2.4 as compared to 1.3 for the 91 candidate trees that were not accepted. The average standardized score for diameter for the "Plus" trees was 1.4 as compared to .7 for the trees that were not accepted.

The values for height, diameter and branch size and angle are shown in Table 2 for the "Plus" trees by age class. Height growth averaged 2.6 m per year and diameter growth 3.5 cm. Branch size was less than one-quarter bole size at the point of branch attachment to the bole and branch angle averaged about 45 degrees from the vertical in the middle of the crown.

Table 2. Height, diameter and branch size and angle of the 59 accepted Jari "Plus" trees.

Age	Height (m)	Diameter (cm)	Branch Size	Branch Angle	Number of trees
9	21.4	31.4	<1/4 2/	38°	3
8	19.5	27.1	1/4	56°	1
7	18.4	21.0	1/4	38°	7
6	17.6	23.4	<1/4	54°	48

No data are available to show the stand average for Jari. However, percentage superiority of the 59 accepted trees over the rejected 91 trees is shown in Table 3. These values range from a low of three percent for crown form to a high of 41 percent for stem straightness. These graded but not accepted trees are many times better in form than the average tree.

Table 3. Percentage superiority of 59 "Plus" trees over 91 rejected candidate trees.

Total height	Diam-eter	Stem stness	Crown form	Branch angle	Branch size	Prun-ing
9	17	41	3	14	6	38

2/ 1/4 diameter of stem at point of attachment or less than 1/4 the diameter of the stem

Orchard establishment

A seed orchard is being established in Brazil near the town of Morada Nova in the state of Minas Gerais. Scion material is shipped by air from Jari to Belo Horizonte where it is transported by vehicle to the orchard site. Grafting is done onto potted plants which are later set out at a 6 m X 6 m spacing. By the end of 1980, 25 hectares of orchard will have been established.

The seed orchard was not established locally in the Amazon because of the rainfall pattern. There is plenty of production of male and female flowers. Even at six years of age 37 percent of the trees of the PCH sources of the CFI trial had cones. However, the peak flowering period occurs during the peak of the rainy season. During April and May it can rain 20 days of each month while relative humidities range from a low of 55 percent to a high of 100 percent. Shedding of pollen and pollination are not very effective under these conditions. Some seed set does occur; young seedlings are found occasionally in the plantations.

FUTURE PLANS

Future tree improvement activities will be concentrated in three areas. First, the company will continue to select "Plus" trees of PCH from Jari plantations for the establishment of the first generation orchard. This orchard will be progeny tested by controlled crossing. These crosses will also serve as second generation selections.

Secondly, Jari will enter into cooperative agreements with other organizations interested in exchanging and testing of genetic material. This program will broaden our base for future selections. Currently, we are testing half-sibs supplied by Queensland, Australia, and Companhia Agro Florestal Monte Alegre of São Paulo. Also, the CFI has initiated a new program testing half-sibs from selected provenances. The Queensland Forest Service is also proposing a controlled crossing program among selected trees from various areas, a program with much promise in supplying material from which new selections can be made.

Thirdly, the testing program of *Pinus oocarpa* is being expanded. A recent trial testing four provenances of *P. oocarpa* and six provenances of PCH indicated that at some Jari sites the *P. oocarpa* has better height growth at 19 months than PCH. A larger *P. oocarpa* provenance trial will be planted in 1981 as well as half-sibs from selected provenances that are to be supplied by the CFI. It is very likely that the results from this trial will indicate that *P. oocarpa* should be planted on a commercial scale at Jari.

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CRESCIMENTO, FORMA E DENSIDADE DA MADEIRA DO C.F.I. – TESTE DE PROCEDÊNCIA DE *Pinus caribaea* AOS SEIS ANOS DE IDADE, EM JARI

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Resumo

Os resultados aos seis anos foram muito similares àqueles encontrados para os três anos de idade. O crescimento do *Pinus caribaea* var. *hondurensis* (PCH), como um grupo, foi superior às duas procedências de PCC (var. *caribaea*), e à uma procedência de PCB (var. *bahamensis*), quando plantadas em Jari, no norte do Estado do Pará. A procedência Santos de PCH, apresentou um crescimento um pouco mais rápido do que as outras duas variedades.

A procedência Guanaja de PCH, teve o melhor incremento anual de crescimento – 30,3 m^3/ha/ano. No entanto, esses vários casos, as características da forma do tronco e da copa das procedências de PCC e PCB foram melhores do que aquelas das procedências de PCH (aos 3 anos de idade). Não há dúvida que as melhores procedências de PCH são as mais produtivas em Jari.

Os valores da densidade da madeira de amostras não destrutivas, revelaram que a procedência Manuel de PCC foi a mais densa (0,40 g/cm^3). O grupo de procedências PCH teve densidade intermediária (0,37 g/cm^3). A procedência de Andros de PCB, apresentou a madeira mais leve (0,36 g/cm^3).

A amplitude de variação da densidade da madeira para PCH, foi de 0,36 g/cm^3, a 0,39 g/cm^3. Uma comparação em termos de toneladas métricas por ha/ano, entre as quatro melhores procedências de PCH (Guanaja, Culmi, Santa Clara e Alamicamba), com as quatro piores (Mountain Pine Ridge, Brus, Poptun e Santos), revelou uma diferença de 2,2 toneladas métricas por ha/ano. As quatro melhores procedências produziriam 26% a mais em fibra de madeira do que as quatro piores.

Essas melhores procedências são ou de Honduras ou da Nicarágua.

Dezoito dentre as vinte análises estatísticas efetuadas, revelaram diferenças significativas entre procedências, ao nível de 0,05 de probabilidade. Somente para os casos de porcentagem de sobrevivência, e freqüência da seca do ponteiro, não se encontrou diferenças estatisticamente significativos. A média geral de falhas foi menor que 2%, e da seca do ponteiro foi menor que 0,1%.

GROWTH, FORM AND WOOD DENSITY AT SIX YEARS OF THE C.F.I. *Pinus caribaea* PROVENANCE TRIAL AT JARI

Summary

Six year results were very similar to the three year results. Growth of PCH (Pinus caribaea var. hondurensis) as a group was better than two sources of PCC (var. caribaea) and one source of PCB (var. bahamensis) when grown at Jari in the north of the Amazonian state of Para. The Santos source of PCH was only a slightly faster grower than the other two varieties. The Guanaja source of PCH had the best mean annual increment 30.3 m^3/ha/yr.

Although in several cases the stem and crown form characteristics of the PCC and PCB sources were better than the PCH sources (just as at age three), there is no doubt that the best PCH sources are the most productive at Jari.

The increment core wood density values showed that the PCC source Manuel was the most dense (.40), PCH sources as a group fell in the middle (.37), and the Andros source of PCB was the lightest (.36). The range in wood density for PCH was from .36 to .39 g/cc.

A comparison in terms of metric tons/ha/yr of the four best PCH sources (Guanaja, Culmi, Santa Clara and Alamicamba) with the four worst (Mountain Pine Ridge, Brus, Poptun and Santos) revealed a difference of 2.2 metric tons/ha/yr. The four best would produce 26 percent more wood fiber than the four worst. These best sources are from either Honduras or Nicaragua.

Eighteen out of 20 statistical analyses showed significant differences among provenances at the .05 level. Only in the case of percent survival and dieback frequency were there no statistically significant differences. Mortality overall was less than two percent and dieback was less than .1 percent.

CROISSANCE, FORME ET DENSITÉ DU BOIS DU C.F.I. – TEST DE PROVENANCE DU *Pinus caribaea* À L'ÂGE DE SIX ANS, À JARI

Resume

Les résultats obtenus au bout de 6 ans sont les mêmes qu'après les 3 premières années. La croissance du groupe Pinus caribaea, var. hondurensis, planté à Jari, au Nord de l'état amazonien du Para, était meilleure que celle de 2 provenances Pinus caribaea var. caribaea, prov. bahamensis.

. La provenance de Santos du Pinus caribaea, var. hondurensis, n'était qu'un tout petit peu plus rapide dans sa croissance que les 2 autres variétés.

. La provenance Guanaja du Pinus caribaea, var. hondurensis, a eu le meilleur accroissement en moyenne annuelle avec 30,3 m3/ha/an. Bien que dans plusieurs cas, les caractéristiques de la tige et de la forme du houppier des provenances Pinus caribaea, var. caribaea et Pinus caribaea, var. bahamensis, étaient meilleures que celles du Pinus caribaea, var. hondurensis (seulement à l'âge de 3 ans), il n'y a pas de doute que les meilleures provenances du Pinus caribaea, var. hondurensis, sont les plus productives à Jari.

Les mesures de densité du bois extrait à la tarière ont montré que la provenance Manuel du Pinus caribaea, var. caribaea, avait la plus forte densité (0,40), que le groupe de provenances Pinus caribaea, var. hondurensis, se situait dans la moyenne (0,37) et que la provenance Andros du Pinus caribaea, var. bahamensis avait la plus basse (0,36).

L'éventail de la densité du bois pour le Pinus caribaea, var. hondurensis, allait de 0,36 à 0,39 g/cm3.

Une comparaison en terme de tonnes métriques/hectare/an entre les 4 meilleures provenances de Pinus caribaea, var. hondurensis

INTRODUCTION

The first planting of PCH (Pinus caribaea var. hondurensis) was done in the Brazilian Amazonia state of Para by the FAO in 1950 near the Curuá-Una river with seed from Belize. At 98 months of age, the production was 31.8 m^3/ha/yr (Correa and Luz 1976). A trial planting of the Belize source was made by Jari in 1970, and large scale commercial planting of several sources began in 1973. The CFI trial was also planted in 1973. An evaluation made at 40 months after field planting (Woessner 1978) indicated that the PCH was growing faster than the two sources of PCC (Pinus caribaea var. caribaea) and one source of PCB (Pinus caribaea var. bahamensis). The PCC and PCB had lower percentages of foxtail, were straighter, and had more uniform crowns. The five sources rated as best at 40 months were Guanaja, Santa Clara, Alamicamba, Limones, and Mountain Pine Ridge.

MATERIALS AND METHODS

The list of the 16 provenances is given in Table 1 along with the origin and a code used for each origin. The trial was planted as a randomized-complete-block of five replications on a well drained Latosol soil of medium fertility in March of 1973 at a 3 m X 3 m spacing. The site had been cleared of rainforest in July of 1972 and then burned in October of 1972. The planting was cleaned by hand twice a year through 1976, subsequently, minor cleanings have been done at the times measurements were taken. The trees were pruned to a height of 2.5 m in August of 1976 and then to 3.5 m in October of 1977.

Average annual rainfall is 2200 mm with 85 percent of the rain falling January through August. Daily temperatures range from a high of 34°C to a low of 24°C. The planting site lies less than one minute south of the equator at a longitude of 53 degrees west. The altitude is 76 m.

Table 1. Provenances included in the Jari trial

CFI CODE	COUNTRY	LOCATION	CODE NAME
K20	Nicaragua	Alamicamba	ALA
K22	"	Rio Coco	RIO
K24	Honduras Rep.	Guanaja	GUA
K25	Guatemala	Poptun	POP
K53	Nicaragua	Karawala	KAR
K56	Honduras, Rep.	Los Limones	LIM
K57	" "	Culmi	CUL
K58	" "	Brus	BRU
K60	" "	Potosi	POT
K61	Nicaragua	Santa Clara	CLA
K64	Belize	Santos	SAN
K65	"	Mt. Pine Ridge	MPR
K66	"	Melinda	MEL
69	Bahamas	Andros	AND
	Cuba	Palacios	PAL
	"	Manuel	MAN

An evaluation of growth and form characteristics of 16 trees of each 49-tree provenance plot was made in June of 1979 in all five replications by Mr. George Gibson of the CFI and Jari personnel when the trial was six years and three months old. Previously, in December of 1978 at 69 months of age, wood density samples were collected by Jari from the ten largest diameter trees of each 25-tree provenance measurement plot.

Of the 54 measured or derived characteristics subjected to an analysis of variance by CFI, only 19 are discussed in this paper. They are MAI (Whole tree volume increment under bark expressed as m^3/ha/yr), total height (m), diameter (measured in cm at 1.4 m), straightness rating (only the first six m were evaluated, the higher the score the straighter the stem), a rating of branch angle (a higher score indicates a more horizontal branch), branch coarseness (a higher score indicates the branch is large relative to the stem at the point of branch attachment), and branch order (a higher score indicates secondary branching on the main branches commenced further from the tree bole). Branch whorls (a count was made between one and six meters) and branch number (a count but excluding basket whorls) were assessed as counts. The maximum internode length was measured (a true foxtail tree would have this value equal to tree height). An overall index for best average tree was derived from volume, straightness, maximum internode length, number of whorls, ramicorn rating, basket whorl rating, branch number, angle, coarseness, and order. The characteristics forking, ramicorns, and basket whorls, were assessed by counting. These data were later expressed as a frequency of occurrence per tree and then transformed by the arcsin for analysis. The values shown are the transformed values. The characteristics kinky shoots, needleless shoots and cones were based on grades running from none (grade 0) to many (grade 3,5 or 6). These data also were later expressed as a frequency of occurrence per tree and then transformed by the arcsin for analysis. The values shown are the transformed values.

The percentage survival and percentage of trees with dieback were also converted by the arcsin for analysis. The untransformed values are presented in the paper.

The 4-mm increment cores were collected at 1.2 m height from bark to bark through the pith. The cores were split at the pith for determination of wood density. After storage in water for 24 hours, green volume was determined by displacement. Samples were then dried in a convection oven at 104°C until a constant weight was reached. Dry weights were obtained after cooling in a dessicator for 30 minutes. Wood density was calculated as oven dry weight/green volume. A mean for the core was obtained by averaging the value for the two sections. The plot mean was obtained by averaging the mean of the ten cores. The wood density data were subjected to an analysis of variance.

An estimated production in tons of dry wood per/ha/yr was obtained by multiplying the provenance wood density values in Table 2 by 1000 to get kg/m^3 and then multiplying this value by the provenance MAI values of Table 2.

Table 2. Volume, height, diameter, wood density, straightness, forking and branching ratings for the Jari trial a/

Source	MAI $m^3/ha/yr$	Ht (m)		Diam. (cm)		Wood Density g/cc	
Guanaja	30.3	ALA	12.9	GUA	17.2	MAN	.40
Culmi	27.8	GUA	12.8	CUL	16.8	PAL	.39
Sta.Clara	27.4	CLA	12.6	ALA	16.6	POT	.39
Alamicamba	27.0	LIM	12.4	LIM	16.6	GUA	.38
Limones	25.4	CUL	12.4	RIO	16.4	CUL	.38
Melinda	24.8	MPR	12.3	MEL	16.3	MEL	.38
Rio Coco	24.5	BRU	12.2	SAN	16.3	ALA	.37
Karawala	24.0	KAR	12.1	CLA	16.2	RIO	.37
Mt. Pine	23.8	MEL	12.1	MPR	16.2	SAN	.37
Brus	23.6	RIO	12.0	POP	15.8	CLA	.37
Potosi	22.6	POT	11.6	KAR	15.7	MPR	.37
Poptun	21.8	POP	11.6	BRU	15.4	KAR	.37
Santos	21.8	PAL	11.0	POT	15.3	POP	.37
Palacios	17.6	SAN	10.8	PAL	14.5	LIM	.36
Manuel	13.0	MAN	9.7	AND	13.1	BRU	.36
Andros	11.8	AND	9.5	MAN	13.1	AND	.36
	23.0		11.8		15.7		.37

Straightness		Forking b/ Percent		Rating of Branches: Angle		Coarseness		Order	
MAN	10.4	ALA	11.4	POT	3.3	AND	2.2	AND	2.0
AND	9.9	SAN	16.4	CLA	3.1	PAL	2.3	GUA	2.2
PAL	9.5	MAN	18.0	SAN	3.1	MAN	2.4	PAL	2.2
ALA	9.2	GUA	21.6	CUL	3.1	GUA	2.6	MAN	2.4
BRU	8.6	BRU	22.2	POP	3.1	MPR	2.6	CUL	2.5
LIM	8.5	RIO	22.2	RIO	3.0	MEL	2.7	LIM	2.5
KAR	8.5	KAR	22.4	KAR	3.0	LIM	2.7	CLA	2.5
GUA	8.0	AND	22.4	ALA	3.0	CLA	2.8	BRU	2.7
RIO	8.0	CLA	22.9	LIM	2.9	POP	2.8	RIO	2.7
CLA	7.6	CUL	23.7	MPR	2.8	BRU	2.8	MPR	2.7
CUL	7.0	MEL	23.9	GUA	2.8	KAR	2.9	ALA	2.8
MEL	6.9	PAL	25.5	BRU	2.8	RIO	2.9	POP	2.8
MPR	6.7	LIM	26.6	MEL	2.8	CUL	2.9	MEL	2.8
POP	6.1	POT	30.1	MAN	2.7	ALA	3.0	POT	2.8
SAN	5.9	MPR	34.6	AND	2.7	POT	3.0	KAR	2.8
POT	5.8	POP	39.4	PAL	2.6	SAN	3.3	SAN	3.0
	7.9		23.9		2.9		2.8		2.6

a/ Provenance means connected by the same line are not significantly different by the Duncan test at the .05 level.

b/ This is the actual percentage transformed by the arcsin.

Significant differences among provenance means were judged by use of the Duncan test at the .05 level for only those characteristics which had a significant 'F' for provenances at the .05 level or greater.

RESULTS

Analysis of variance

Twenty characteristics were submitted to an analysis of variance. The only two which were not significant at the .05 level or greater were percent survival and percent dieback. Significant differences among provenance means for the 18 significant analyses were judged by the Duncan test at the .05 level. This is the least conservative of the multiple range tests so the probability is very likely somewhat greater than .05 .

Provenance means

Tree mortality in the trial was quite low. The average survival at 6 years was 98 percent. Dieback was also not a problem since less than .1 percent of the trees showed any symptoms of dieback.

The MAI (30.3) of the best PCH provenance from Guanaja (Table 2) was 157 percent greater than the poorest provenance of PCB from Andros. This amounts to 18.5 $m^3/ha/yr$. Comparing only the PCH provenances, there exists a 39 percent difference between Guanaja and Santos which amounts to 8.5 $m^3/ha/yr$. The Alamicamba provenance of PCH at 12.9 m was .1 m taller than Guanaja. The total height of the PCH provenance from Alamicamba was 3.4 m greater than the PCB provenance from Andros. In diameter, the PCH provenance from Guanaja was 4.1 cm greater than the PCB provenance from Andros. All the PCH provenances except Santos ranked higher in MAI, height, and diameter than the two PCC provenances (Palacios and Manuel) from Cuba and the one PCB provenance from Andros, Bahamas. The differences among the PCH provenances in MAI, height, and diameter were not statistically

Table 3. Raimicorns, branching characteristics, cones, best tree rating, production in Tons/ha/yr for the Jari CFI trial a/

Percent b/: Ramicorns		Basket Whorls		Kinky shoots		Needleless shoots		Cones	
GUA	31.0	PAL	9.3	SAN	8.7	GUA	0.0	MPR	50.4
PAL	31.8	LIM	12.9	AND	13.7	BRU	0.0	CUL	50.1
CLA	33.5	MAN	15.8	POT	19.2	SAN	3.0	CLA	48.8
CUL	34.2	CLA	19.4	BRU	20.0	RIO	5.9	POT	36.7
POT	35.9	AND	21.1	CLA	21.5	ALA	5.9	'LA	35.8
RIO	37.2	POT	23.1	POP	21.9	KAR	6.2	BRU	34.9
MAN	38.1	GUA	24.7	RIO	22.4	MEL	9.8	MEL	34.4
MEL	39.3	CUL	26.0	LIM	26.5	LIM	9.3	RIO	34.4
SAN	39.5	MEL	26.3	KAR	27.8	CLA	11.1	KAR	34.2
ALA	41.9	MPR	26.5	MAN	28.2	PAL	18.5	POP	33.2
LIM	42.1	KAR	28.6	CUL	28.3	POT	19.3	LIM	32.0
KAR	42.1	BRU	30.6	MPR	30.2	AND	19.5	SAN	27.5
BRU	44.5	RIO	32.2	ALA	30.3	MAN	21.8	GUA	26.5
MPR	45.2	SAN	32.7	MEL	30.3	CUL	22.2	MAN	16.3
POP	46.9	POP	33.9	PAL	33.8	MPR	22.6	PAL	14.2
AND	50.9	ALA	34.6	GUA	40.3	POP	26.5	AND	10.0
	39.6		24.8		25.2		12.5		32.5

Number: Branches		Number: Whorls		Maximum Internode Length (m)		Best average tree		Production TON/Ha/yr c/	
GUA	3.3	MAN	15.4	BRU	2.6	GUA	115	GUA	11.5
CUL	3.2	PAL	13.9	ALA	2.3	CLA	105	CUL	10.6
MAN	3.1	AND	13.2	KAR	2.1	CUL	103	CLA	10.1
RIO	3.0	LIM	10.8	MPR	2.1	LIM	103	ALA	10.0
CLA	3.0	CLA	9.6	RIO	2.0	ALA	100	MEL	9.4
PAL	3.0	GUA	9.4	POP	1.8	MEL	100	LIM	9.1
LIM	3.0	POT	9.4	GUA	1.8	MPR	94	RIO	9.1
MEL	2.9	CUL	9.3	CUL	1.6	KAR	93	KAR	8.9
KAR	2.9	NEL	8.7	CLA	1.6	BRU	93	POT	8.8
ALA	2.9	SAN	8.6	SAN	1.5	RIO	92	MPR	8.8
MPR	2.9	POP	7.9	MEL	1.5	POP	89	BRU	8.5
AND	2.8	MPR	7.8	POT	1.5	POT	89	POP	8.1
POP	2.8	KAR	7.6	LIM	1.1	PAL	84	SAN	8.1
POT	2.8	RIO	6.9	PAL	1.0	SAN	84	PAL	6.9
SAN	2.8	ALA	6.8	AND	.8	MAN	71	MAN	5.2
BRU	2.7	BRU	6.7	MAN	.8	AND	64	AND	4.2
	2.9		9.5		1.6		92		8.6

a/ Provenance means connected by the same line are not significantly different by the Duncan test at the .05 level.

b/ This is the actual percentage transformed by the arcsin

c/ Not analyzed statistically.

significant by the Duncan test. The best PCH provenance for these three characteristics was significantly better than the PCC provenance from Manuel and the PCB provenance from Andros by the Duncan test.

The Manuel provenance from Cuba had the heaviest wood density (.40) and the Andros PCB provenance from the Bahamas had the lightest (.36). This difference was statistically significant. The range for the PCH provenances is from .36 (Brus and Limones) to .39 (Potosi). This difference was also statistically significant.

The results for straightness rank the PCC and PCB provenances above the PCH provenances. The highest ranking PCH provenance for straightness is Alamicamba and the lowest ranking is Potosi. By the Duncan test, the straight provenances (Manuel, Andros, Palacios, Alamicamba and Brus) were significantly straighter than the more crooked provenances (Poptun, Santos and Potosi).

The PCH provenance from Alamicamba had the lowest percentage of forking (11.4) and the PCH provenance from Poptun had the highest (39.4). This difference was significantly different by the Duncan test.

The branch rating scores indicated the PCC and PCB sources tended to have steeper angled branches, less coarse branches, and a better branch order than the PCH sources. The Guanaja PCH provenance ranked with the PCC and PCB sources in terms of branch coarseness and order. By the Duncan test, the highest ranking provenances were significantly better than the lowest ranking provenances.

The ratings having to do with crown defects i.e., ramicorns, basket whorls, kinky shoots, and needleless shoots, indicated that the PCH provenance Guanaja had the best scores for ramicorns and needless shoots. Guanaja was about average for basket whorls and the worst for kinky shoots. Guanaja was also average in terms of number of whorls but ranked highest for number of branches. Guanaja was slightly above average for maximum internode length.

The index for best average tree ranked Guanaja as best and Andros as worst. The same ranking held true for production in tons/ha/yr. Guanaja was producing 7.3 more tons/ha/yr than Andros.

Throughout the whole experiment, 32.5 percent of the trees had cones. The heaviest cone bearing source was the PCH Mountain Pine Ridge source (50.4 percent). The PCB Andros source had the least number of cones (10 percent). This difference was significantly different by the Duncan test.

DISCUSSION AND CONCLUSIONS

The growth results obtained at age 6 conform very closely to those obtained at age three. The PCH sources as a group are growing better than the PCC and PCB sources. Although in some cases the form characteristics of the PCC and PCB sources are better (just as at age three) than those of the PCH sources, there is no doubt that the best PCH sources are the logical choice for Jari. Also, although the Manuel source of PCC has the highest wood density, it still ranks next to last in terms of tons/ha/yr. A comparison in terms of metric tons/ha/yr of the four best PCH sources (Guanaja, Culmi, Santa Clara and Alamicamba) with the four worst PCH sources (Mountain Pine Ridge, Brus, Poptun and Santos) revealed a difference of 2.2 metric tons/ha/yr. The four best would produce 26 percent more wood fiber than the four worst. These best sources are either from Honduras or Nicaragua.

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POVOAMENTOS PARA CONSERVAÇÃO *Ex Situ*

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Resumo

Povoamentos para conservação de espécies e procedências importantes podem ser mantidos *in situ* ou *ex situ* em ambientes exóticos. Mesmo quando há pequena pressão em relação à existência contínua da população original, os povoamentos de conservação *ex situ* são um valioso recurso de genes, tanto para os paises que os conservam como internacionalmente. Recomendações para a colheita de sementes e amostragem nas populações originais são fornecidas. A coleta de sementes deve manter a identidade dos progenitores individuais. A seleção dos locais de plantio é importante para assegurar a continuidade da população a longo prazo e a adequação à produção de sementes, embora outros propágulos, além das sementes, possam ser também produzidos.

A recente iniciativa da FAO/UNEP em relação aos pinheiros tropicais e eucaliptos originou diretrizes para manejo, objetivando implantação de áreas de 10 ha para conservação da população representada. Os regimes de desbastes visam a conservação da variabilidade genética e ao mesmo tempo fornecer material selecionado para os programas nacionais.

Ex Situ CONSERVATION STANDS

Summary

Conservation stands of important species and provenances may be maintained in situ, or ex situ in exotic environments. Even where there is little threat to the continued existence of the original population, ex situ conservation stands form valuable gene resources both for the host countries and internationally. Recommendations for Seed collection and sampling in the original populations are given. Seed collection should retain the identity of individual parents. The selection of planting sites is important with long term security and suitability for seed production being important, though other propagules in addition to seed may also be produced.

The recent FAO/UNEP initiative for tropical pines and eucalypts developed guidelines for management, aiming at 10 ha of conservation stand per population represented, with thinning regimes intended to conserve genetic variability and at the same time to provide select material for national programs.

PEUPLEMENT POUR LA CONSERVATION *Ex Situ*

Resume

Les peuplements permettant la conservation d'importantes espèces et provenances peuvent être maintenus et entretenus "in situ" ou "ex situ" en milieux exotiques, même lorsqu'on ne craind pas la disparition des populations spontanées, la conservation des peuplements créés "ex situ" permet de constituer une réserve génétique pour le pays d'introduction des espèces et internationalement. On fait

The choice of sites, if more than one, should include as wide a variety as feasible - clearly the species should be suited to them and presumably will be, as only species of economic importance will be selected. The cost of even a modest program of work is high, and international support and finance is involved (FAO/UNEP, 1975, 1976).

Most stands will be required to provide seed, and therefore climatic conditions should be such that seeding will be adequate. However, the supply of vegetative material for grafting in seed orchards, or as cuttings may be equally important. Nonetheless the well known reluctance of *Pinus caribaea* var. *hondurensis* to set viable seed at low altitudes and latitudes is an example of importance to be borne in mind.

Particularly where wind pollinated species are concerned, adequate isolation taking into account wind direction is most important in choice of site. Such sites may be less desirable from the viewpoints of security of tenure, ease of access, or effective protection, however.

APPENDIX 2

Summary of ex situ conservation stands planted under Danish/FAO/UNEP auspices in Thailand /1

	Huey Bong	Tha Tum	Total
A. EUCALYPTS			
Eucalyptus camaldulensis Petford (Q)	8.2	2.3	10.5
Eucalyptus camaldulensis Gibb River	9.2	1.6	10.8
B. PINES			
Pinus caribaea Alamicamba	4.7	10.0	14.7
Pinus caribaea Los Limones	8.3	4.0	12.3
Pinus caribaea Poptun	-	10.0	10.0
Pinus oocarpa Mountain Pine Ridge	14.9	10.0	24.9
Pinus oocarpa Yucul	10.7	10.0	20.7

Summary of areas planned in Thailand

	Huey Bong	Tha Tum	Total
E. camaldulensis (Petford)	-	10	10
E. camaldulensis (Gibb River)	-	10	10
P. caribaea (Alamicamba)	10	10	20
P. caribaea (Los Limones)	10	10	20
P. caribaea (Poptun)	-	10	10
P. oocarpa (M.P.R.)	10	10	20
P. oocarpa (Yucul)	10	10	20

/1 Data supplied by FAO

METHODOLOGY AND MANAGEMENT

It goes without saying that the highest silvicultural standards are essential for ex situ conservation stands, if only to minimise genetic loss at all stages. This applies equally to documentation and record keeping, especially regarding site and climatic data both of the origin, and of the plantation site. Detailed records of work done and dates, and the history of the stand are also vital. Each country will have its own norms in this respect, but the guidelines given by Burley and Wood (1976) for provenance trials have fairly general acceptance.

The most recent series of ex situ conservation stands of productive plantation species, carried out under the auspices of FAO and UNEP, have included *Pinus caribaea*, *P. oocarpa*, *Eucalyptus camaldulensis* and *E. tereticornis* (FAO/UNEP, 1976). More details of methodology clearly depend upon the biology of the species concerned, and the remainder of this paper concentrates on these species in this particular program. A list of the stands planted so far is given in the Appendices.

An arbitrary area of 10 hectares was chosen for both pines and eucalypts, mainly as a target but also to give reasonable yields of seed. The agreement between FAO/UNEP and the collaborating governments was that half the seed would be made available internationally, at cost, and a good seed stand of *Pinus caribaea* may be expected to yield about 20 kg per hectare (Nikles, 1977). Initial spacing for both genera was 3 x 3 metres, giving 1111 stems/ha, and allowing mechanical access for maintenance. Minimum spacing between plots was set at 330 m, and buffer plantations of different and non-hybridising species were recommended (FAO/UNEP, 1976).

Thinning before final spacing for seed production is the main management problem. Any removal of stems must reduce the total genetic content of the stand, so the objective of management must be to reduce the original genetic variability as little as possible. Any country setting up seed stands, however, will be interested largely in seed suited to its own conditions, and selection of superior phenotypes would therefore be the normal approach to thinning. The reconciliation of these opposing views led to the suggestion that each stand might be divided in half, each half managed differently (FAO/UNEP, 1976). However, field experience and discussions between field managers in Africa indicate that this may be complicating management unduly, and the following basic management guidelines were worked out for the African conservation stands.

(1) (Optional). Before first thinning select, and mark with metal or plastic tags, the best 1% of the standing trees for future or immediate use in national breeding programs.

(2) When dominant height reaches about 8.5 m, thin alternate diagonals, but leaving any trees marked in (1) above. Each of these should have four of their immediate eight neighbour trees removed. (N = 555 approx.).

(3) When dominant height reaches about 12 m, thin alternate vertical rows, still retaining the plus trees, each of which should have the remaining four immediate neighbour trees removed. (N = 277 approx.).

(4) When dominant height reaches 16 m, remove every second tree in every fourth diagonal row. Retain superior trees. (N = 207 approx.).

(5) When dominant height reaches 18 m, remove remaining trees in every fourth diagonal row, retaining superior trees. (N = 138 approx.).

The object is to reduce the stand to a stocking of 130/ha and, particularly with pines, to develop large crowns without suppression. The thinning program was designed with this in mind, and is heavier than would be normal in production plantations.

Reduction of weed growth as needed is of course normal management practice in seed stands; fertilisation may be necessary to increase flowering, and trials outside the conservation stands may be necessary to evaluate this.

SEED AND PROPAGULE PRODUCTION

When seed production begins, collection can take place in the normal way. It is desirable for further breeding as well as for better understanding of the genetic constitution of the conservation stand, that seed of individual parents be kept separate. This also indicates seeding potential of individuals for use in other seed orchards. For normal production plantations seed may subsequently be bulked by the user, but the extra expense of individual tree collection and record keeping is entirely justified for ex situ conservation stands.

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ici des recommandations pour l'échantillonnage dans les populations de l'aire d'origine et la récolte des graines. Cette dernière devrait mentionner l'identité des parents désignés individuellement. Le choix des emplacements de plantation est important pour obtenir une production de graines convenable et assurée à long terme ; par ailleurs, en plus des graines, on peut obtenir ainsi des propagules.

Suivant la récente initiative FAO/UNEP, concernant les prescriptions conseillées pour l'aménagement des eucalyptus et des pins tropicaux, on recommande la conservation d'un peuplement de 10 ha pour chaque population représentée, avec des traitements par coupes d'éclaircie qui tendent à conserver la variabilité génétique et en même temps à fournir des sujets sélectionnés pour les programmes nationaux.

INTRODUCTION

The need for *in situ* conservation in agriculture is abundantly clear, both as a source of genes for future breeding programs, and as a source of breeding material for current production. It is the recognition of the importance of provenance in forestry, and in particular that important provenances are endangered in their natural habitats, that has led to international efforts to ensure effective *ex situ* conservation stands of several important tropical species (FAO, 1975). Implicit in such plans is the need for countries to act as agents for others; for instance, where an important exotic provenance seeds poorly but is of great economic importance to a country, its seed supplies will have to be secured in a country where seed production is feasible.

THE NEED FOR CONSERVATION

Losses of, or changes in, tropical forests inevitably lead to risks of losing genes which could be of value in the future, even if species do not become extinct. Uncontrolled destruction of forests is rarely wanton, and in order to deal with the problem it is necessary to solve other problems in the societies concerned. This generally includes the development of high-yielding plantations to supply needed materials and thus reduce pressures on natural gene pools. The plantations themselves are usually of exotic species, and it is with these that we are currently principally concerned, especially as they form the most obvious *ex situ* reserves of genes (Burley and Namkoong, 1980). *In situ* conservation of important or as yet unknown species, in their natural ecosystems, is not considered in this paper which is principally concerned with the management of *ex situ* stands of species or provenances of recognised importance, generally for the production of seed. The distinction between a conservation stand and a national seed stand is not aways clear, and depends on the degree of risk to the natural population, or upon international importance of the populations represented.

SAMPLING FOR GENE CONSERVATION

Generalised information on the desirability of a species or provenance may be obtained from appropriate trials (see *e.g.* Burley and Wood, 1976) or from knowledge of indigenous cultural practices, as is the case with many species for community or agro-forestry. However, our knowledge of gene frequencies in natural forest populations is frequently non existent, and we are therefore principally concerned with the conservation of all genes present. The intensity of sampling needed is discussed by Burley and Namkoong (1980) and guidelines given for field operations, but it is clear that total conservation of all genes or gene complexes is impossible, and that the aim should be to retain characteristic frequencies of those genes and their complexes which affect economic traits (*ibid.*).

SITES FOR *EX SITU* CONSERVATION

From the time that the seed is collected, through its transfer, storage, sowing and establishment in a new environment, it is under continual natural selection, even without the intervention of the forest manager, and changes in the gene pool are therefore inevitable. The importance, therefore, of replicating *ex situ* conservation stands on a variety of sites, is considerable. *Ex situ* conservation methods involving the storage of seed, pollen or plant tissues are less liable to the effects of such pressures, but they are for the short term and are supplementary to the establishment of stands. In general terms, most *ex situ* conservation stands can be considered to arise from bulked seed collections from 50-200 individual trees.

APPENDIX 1

Summary of ex situ conservation stands planted under FAO/UNEP and national auspices in Africa

	Area (ha) as at November 1979					Totals	
	Nigeria	Ivory Coast	Congo	Zambia	Kenya	FAO/UNEP	National
A. EUCALYPTS							
Eucalyptus camaldulensis Petford (Q)	2.6	-	-	-	-	2.6	-
Eucalyptus camaldulensis Katherine (NT)	- (1.4)	-	-	-	-		1.4
Eucalyptus tereticornis Cooktown (Q)	- (1.6)	-	9.0	19.0	-	28.1	1.6
Eucalyptus tereticornis Mt. Garnet (Q)	- (3)	-	10.0	11.0	-	21.00	3.0
Total Eucalypts	2.6 (6.0)	-	19.0	30.0	-	51.7	6.0
B. CENTRAL AMERICAN PINES							
Pinus caribaea (Alamicamba)	1.4	7	16.4	-	-	24.8	
Pinus caribaea (Los Limones)		-	20.0	-	7.5	35.5	
Pinus caribaea (Poptun)	-	8	8.2	-	-	16.3	
Pinus oocarpa (Bonete)	- (18.4)	-	20.0	20.0	-	40.0	18.4
Pinus oocarpa (Mountain Pine Ridge)	14.7	9.4	10.1	20.0	-	54.2	
Pinus oocarpa (Yucul)	24 (6.3)	9	20.1	10.0	-	63.3	6.3
Total Pines	48.2 (24.7)	33.5	94.9	50.0	7.5	234.1	24.7

SUMMARY (hectares)

STATUS	EUCALYPTS	PINES	TOTALS
International	51.7	234.1	285.6
National	6.0	24.7	30.7
TOTALS	57.7	258.8	316.3