Genetic parameter estimates for growth traits in *Eucalyptus grandis* and some implications for breeding and commercial seed production (in a TIP in Uruguay)

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IUFRO Congress. Forest Genetics For The Next Milenium

Durban, 9 October 2000

Outline

- Introduction
- Materials and methods
- Results
- Implications
- Conclusions
- Acknowledgments

Introduction

- *Eucalyptus grandis* in Uruguay: more than 130,000 hectares
- Forestry Program of INIA (National Institute of Agricultural Research)
- Tree Improvement Plan for *E. grandis* since 1992

- Tree Improvement Plan: simple and low cost
- Key features of the Breeding Strategy
  - Net of Progeny Tests
  - Multipurpose Population managed as Progeny Test; Breeding Population and Production Population (TBO)
  - Open-pollinated Breeding and Production Pops.
  - Short generation interval
  - Infusion of new materials each generation

- Short term Breeding Objective: to maximize productivity per unit area
- Genetic parameters for survival and growth traits were estimated
- and used to take decisions on both, the first and second generations, in the testing, breeding and seed production phases of the TIP

Materials and Methods

- 5 open-pollinated first-generation Progeny Tests (1993)
- 2 seed sources: Australian provenances
  Locally mass selected trees
- 2 sites: Zone 7 (deep, sandy soil)
  Zone 8 (medium depth, loamy soil)

Experimental design of Progeny Tests and TBO

Test code	RCB # of reps.	Trees per plot	# of families
P-7	6	10	80
P- 8	6	10	58
L-7	10	5	111
L- 8	10	5	85
TBO	30	1	180

Traits assessed and genetic parameters

- Height and Survival (8; 32 and 56 months)
- DBH and Tree Volume (32 and 56 months)
- Single-site heritabilities and standard errors
  - family for survival
  - individual tree for other traits
- Genetic correlations and standard errors
  - age-age for a given trait
  - between traits
  - between one trait on different sites (Type B)

Results

h_f^2 for survival

Age	S %	P- 7	P- 8	L- 7	L- 8
8	95.4	0.002	0.26	0.003	0.35
32	91.2	0.37	0.59	0.25	0.33
56	88.1	0.78	0.86	0.40	0.39

h_i^2 for growth traits (0.4 as c.r.)

Trait	P- 7	P- 8	L- 7	L- 8	TBO
H 8	0.10	0.25	0.10	0.17	0.27
H 32	0.13	0.38	0.17	0.13	0.29
H 56	0.22	0.28	0.13	0.12	-
D 32	0.10	0.33	0.16	0.08	0.43
D 56	0.29	0.29	0.12	0.08	-
V 32	0.08	0.25	0.17	0.10	0.38
V 56	0.24	0.26	0.13	0.10	-

r_g between growth traits at diferent ages

Trait (ages)	P- 7	P- 8	L- 7	L- 8	TBO
H (8-32)	0.63	0.72	0.68	0.91	0.72
H (8-56)	0.58	0.58	0.62	0.76	-
H (32-56)	0.92	0.88	0.78	0.84	-
D (32-56)	0.87	0.91	0.89	0.69	-
V (32-56)	0.91	0.90	0.88	0.80	-

r_g between different traits and tree volume at a given age

Traits (age)	P- 7	P- 8	L- 7	L- 8	TBO
S – V (32)	0.57	0.44	0.25	0.14	-
S –V (56)	0.54	0.57	0.26	0.09	-
H –V (32)	0.88	0.92	0.88	0.92	0.89
H –V (56)	0.92	0.92	0.90	0.85	-
D –V (32)	0.96	0.98	0.99	0.97	0.99
D –V (56)	0.98	0.98	0.99	0.97	-

Site-site r_g for tree volume

Australian provenances

Age	P7 - P8	P7 - TBO	P8 - TBO
V (32)	0.52	0.56	0.62
V (56)	0.72	-	-

Local selections

Age	L7 – L8	L7 - TBO	L8 - TBO
V (32)	- 0.01	0.68	0.22
V (56)	0.21	-	-

Summary of results and implications for INIA´s Tree Improvement Plan

- implications for testing and selection

- implications for breeding and commercial seed production

Implications of test design for testing and selection

- STP has higher h^2 and lower standard errors
  - better environmental control
  - higher precision on genetic parameter estimates
  - larger number of progenies in a single test
- STP was adopted in the 2nd generation

Implications for selection criteria

- low h_f^2 for survival
- moderate h_i^2 for growth traits

Breeding objective for 1st gen.: productivity

Tree volume was the selection criteria

Implications for selection age

- moderate r_g between 8 and 56 months
- high r_g between 32 and 56 months

To reduce the generation interval

3rd year data was used for selection pourposes

Implications for indirect selection

- r_g between survival and tree volume was low but positive
- r_g for height and diameter with tree volume was very high

To reduce measurement costs

DBH will be used in the 2nd generation as indirect selection criteria for tree volume

Implications for breeding unit delineation

- Type B r_g were low to moderate for volume
- Type B r_g increased with age

The level of G x E interaction should be taken into account on INIA´s TIP

Further analysis is required before any decision on breeding unit delineation is to be taken

Implications of test design for breeding and seed production

- STP favors outcrossing
  - increases genetic variability for the 2nd gen.
  - reduces inbreeding in commercial seed

STP is suitable for open-pollinated management of the TBO

Implications for TBO management

- high age-age r_g support the early deployment of the TBO
  - 1st low-intensity rogue at 3rd year (PT is transformed into BP)
  - more intense 2nd rogue at 4th year (BP is transformed into PP)

Implications for TBO management (cont.)

- G x E interaction could be exploited by
  - control-pollination on the BP
  - directed harvest on the PP

Conclusions

- For high survival tests family information for survival is of little help in order to improve productivity per unit area
- DBH at 3rd year is an efficient selection criteria, being a low cost alternative to maximize genetic gain per unit time

Conclusions (cont.)

- The STP design is well suited to the TBO strategy
  - As PT it provides good environmental control and allows to test a large number of families
  - As BP and PP it favors outcrossing which permits its open-pollinated management
- The TBO is a low-cost and simple strategy

Acknowledgments

- INIA´s Forestry Program staff
- JICA experts
- Ricardo Methol

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