Genetic Variation for Frost Tolerance in an Uruguayan Base Population of *Eucalyptus grandis*

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Outline

- Introduction
- Objectives
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Eucalyptus grandis for its fast growth; good form; good coppice ability and suitable wood for various uses

- Most widely planted eucalypt in the World (more than 2 million hectares)
- Most planted tree species in Uruguay (more than 100,000 hectares)

Susceptibility to frosts

Uruguay

- Between 30 and 35º S
- 30 frosts/year

- E. grandis is not planted in winter
  is not planted in frost prone areas

- Young plantations are severely damaged in some winters

Genetic variation for frost tolerance

- Among and within provenances
- Moderate to high heritabilities

Assessment of frost tolerance

- Visual scoring of damage after natural freezes (subjective and weather dependent)
- Artificial simulation of frosts (different methods)

Conductivity of diffusate method

- Based upon changes in conductivity produced by diffusion of electrolytes from damaged cells
- Cheap, quick, repeatable and nondestructive

General objective

Study genetic variation in a base population of *Eucalyptus grandis* for frost tolerance using the Conductivity of Diffusate Method

Specific objectives

- Estimate genetic parameters
- Rank genotypes
- Predict genetic gains

Materials and Methods
Lab Procedure

- Freeze tubes w/ 3.5 mL deionized water
- Single discs punched from leaves in tubes
- Racks held one hour in cold bath at desired test temperature
- 24 hours at room temperature
- First reading of electrical conductivity of diffusate (Ct)

Procedure cont.

- Autoclave for 20 minutes
- 24 hours at room temperature
- Final measurement of conductivity (Ck)

Relative Conductivity

Degree of tissue damage assessed as

Relative conductivity (RC)

$$RC = [Ck - Ct / Ck]^{1/2}$$

Plant materials

- 2.5-year-old 1st generation base population (180 families from Australia and Uruguay)
- Sampled 70 families from 14 provenances
- Samples shipped from Uruguay to Florida (storage period was 72 hours)

- Sample size

  5 families/provenance (70 fam.)
  9 trees/family (630 trees)
  2 leaves/tree
  2 discs/leaf

- Temperature -7 ^{o}C

Results
Genetic variation in RC

Source	Signif.	Var (%)
Run (R)	**	14.4
Provenance (P)		0.4
R*P		0
Family/P (F/P)		1.4
R*F/P	*	2.5
Tree(F/P/R)	**	28.4
Leaf(T/F/P/R)	**	13.6
Error (w/leaf)		39.3

Repeatability for RC = 0.35

Heritability for RC

$h^2 = 0.11 \pm 0.13$

$h_f^2 = 0.20 \pm 0.22$

In the literature h^2 for RC from 0.20 to 0.50

Possible explanations

- Storage of leaves
- Within-tree sample size
- Different mechanisms of hardiness
- h_i^2 for RC in *E. grandis* could be lower than in other species

Predicted genetic gains for RC

Selection strategy		Genetic gain (%)
Mass selection	180 best trees	2.4
Combined selection		
10 best families (18 trees per family)		2.0
60 best families (3 trees per family)		2.2
Within family selection		
180 families (1 tree per family)		1.7

Conclusions

- Low precision
- Small genetic variation for RC
- RC can be a valuable tool for TIPs but it must be refined and field verified

Future research

- Improve precision of RC method
  - lapse collection-freeze
  - sample size
  - test temperatures

- Relationship RC-natural frost damage