— POSTER —

Inheritance of Frost Resistance in F_1 and Advanced Generation Hybrids of *Eucalyptus globulus* and *E. gunnii*

A.F. Manson and B.M. Potts

Cooperative Research Centre for Temperate Hardwood Forestry and
Department of Plant Science, University of Tasmania,
G.P.O. 252C, Hobart, Tasmania 7001, Australia.

Abstract

Frost resistance of hybrids between the sensitive *E. globulus* and resistant *E. gunnii* is inherited in an additive manner in both F_1 and advanced generation hybrids. Variation in the F_2 is continuous and unimodel arguing that the difference in frost resistance between these two species is under polygeneic control. There was no association between frost resistance and seedling height within the F_2, suggesting that it may be possible to select fast growing, frost resistance genotypes from advanced generation hybrids.

Introduction

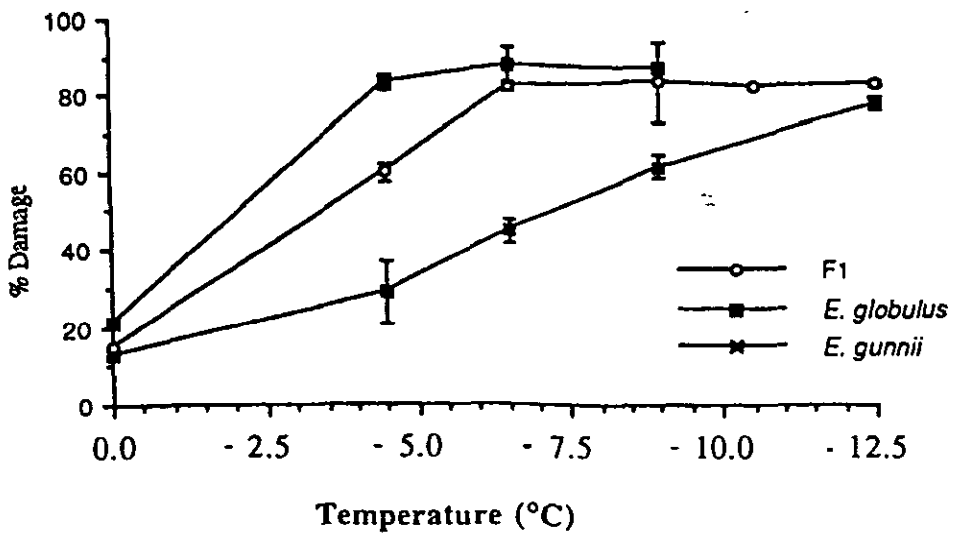
Eucalyptus globulus Labill. spp. *globulus* is one of the major plantation eucalypt species in temperate regions of the world. Poor frost resistance is one of the main factors limiting the ecological range of plantations of ssp. *globulus*, with hardened seedlings killed at approximately -4°C (e.g. Tibbits *et al.*, 1991). Hybridization of ssp. *globulus* and *E. gunnii* Hook. f. is of particular interest as this would allow the combination of genes from one of the most freezing resistant species of the genus with genes of one of the faster growing, high pulp yielding species (Cauvin *et al.*, 1987; Tibbits *et al.*, 1991; Vaillancourt *et al.*, 1995). This study examines the manner in which frost resistance is inherited in F_1 and advanced generation hybrids of these two species.

Methods

F_1 Hybrids

An incomplete factorial of F_1 hybrids was produced using 7 *E. gunnii* females from the most frost resistant provenances of the species (Central Plateau, Tasmania). Pollen was provided by North Eucalypt Technologies from 4 *E. globulus* trees selected from their Woolnorth seed orchard on the basis of high pulp yield. Plants from this factorial were grown in a randomized complete block design containing 6 replicates by North Eucalypt Technologies in a glasshouse at Ridgley. Each replicate contained 1 plant from each F_1 family as well as 1 plant from a pure species polymix family from each parent. The plants were initially used as mother plants for hardwood cuttings after which they were pruned to a

Figure 1. The mean (± s.e.) percentage electrolyte leakage following frosting of *E. globulus* and *E. gunnii* and their F_1 hybrid families.



single leading shoot, and moved from the glasshouse to an outdoor nursery at Ridgley, 2 months prior to the commencement of the experiment. Plants were not fully hardened at the time of the experiment due to an unusually mild winter. The frost resistance of plants was tested (10/7/93) using a method based on the relative loss of electrolytes from 8mm discs of leaf tissue following frosting (e.g. Raymond *et al.*, 1986; Tibbits *et al.*, 1991). Plants with suitable foliage were tested over the temperature range of -4.5°C down to -12.5°C. Polyethylene glycol baths were programmed to cool from 2°C to the test temperature at a rate of -1°C every 5 minutes, maintain the test temperature for 60 minutes, and then return to 2°C at a rate of +2°C every 5 minutes. At each temperature, each plant was represented by 3 leaf discs taken from fully expanded leaves of the same maturity. The significance of male, female and male x female interaction effects on the percentage electrolyte leakage following frosting at -4.5°C compared to the heat killed sample was tested within the F_1 factorial using the GLM procedure of SAS (SAS, 1990). Replicates were treated as a fixed effect and other effects as random in this analysis.

Advanced Generation Hybrids

An *E. globulus* x *gunnii* F_1 hybrid individual was selfed (producing F_2 progeny; see Vaillancourt *et al.*, 1995), and backcrossed to its *E. gunnii* parent and 2 unrelated *E. globulus* parents. Open-pollinated and polymix progeny from all parents were included to act as controls. Plants of each family were split into 5 replicates and plants randomised within replicates regardless of family. The 7.5 month old plants were hardened in the Plant Science glasshouse (University of Tasmania) using a 16 hour cold night period (2-4°C) and an 8 hour warm day period (approx. 22°C) for 22 days. Replicate structure was maintained throughout. Plants were frost tested at -4°C as previously described. Analyses of variance testing differences between families and cross types based on block mean data were undertaken using the GLM procedure of SAS (SAS, 1988). Replicate, family and cross types were treated as fixed effects.

Results and discussion

On average the F_1 hybrids were intermediate between *E. globulus* and *E. gunnii* in their response to frost (Fig. 1). The temperature at which 50% electrolyte leakage occurs (T_{50} value) was -2°C, -3.75 °C and -7.5°C for *E. globulus*, F_1 hybrids and *E. gunnii*, respectively. These results confirm those of Tibbits *et al.*, (1991) who reported that freezing resistance was inherited in a predominantly additive manner in interspecific hybrids of *Eucalyptus* with a tendency for partial dominance toward the more frost sensitive species in some hybrid combinations, including *E. globulus* and *E. gunnii*. (of which only 3 F_1 hybrid families were screened). Male (P=0.061), female (P=0.114) and interaction (P=0.837) effects within our F_1 hybrid factorial were insignificant.

The intermediate inheritance of frost resistance was also observed in advanced generation hybrids, with families ranking in the order *E. globulus* > backcross to *E. globulus* > F_2 > backcross to *E. gunnii* > *E. gunnii* (from least frost resistant). At the temperature tested (-4°C), the families of *E. gunnii* and *E. globulus* were significantly differentiated, and the F_2 was intermediate but slightly bias towards *E. gunnii*. The distribution of individuals within the F_2 was continuous, unimodal and normal suggesting polygenic control of the difference in frost resistance between these two species. Several of the F_2 plants were as frost resistant as the *E. gunnii* seedlings at this temperature, but none were as frost sensitive as the *E. globulus* controls. However, the more resistant F_2 plants may also prove less frost resistant than *E. gunnii* at lower, more discriminating, frost temperatures.

Both frost resistance and growth rate are inherited in an intermediate manner in the F_1 hybrids between these two species which means that gains in frost resistance in F_1 hybrids may only be made at the expense of growth rate (Tibbits *et al.*, 1991). However, within our F_2, there was no significant correlation between the frost resistance and seedling height (Spearman correlation coefficient = -0.004; P= 0.98), which suggests that it may be possible to select fast growing, frost resistance genotypes from advanced generation hybrids.

References

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