forest industry
research cooperatives

EUCALYPTUS NITENS FROSTING TRIAL – A POTENTIAL SEED SOURCE

S. Concheyro, R. McConnochie
and G. Vincent

Report No. 29 November 1998

forest research

EUCALYPTUS NITENS FROSTING TRIAL – A POTENTIAL SEED SOURCE

S. Concheyro, R. McConnochie & G. Vincent

EXECUTIVE SUMMARY

Two subsets of the *E. nitens* Breeding Population (25% of the total number of families) were established at Poronui and Wainui in 1990 as a frosting trial. Good and early flowering at Poronui opened the question whether this trial site should be thinned and converted into a seed stand which could deliver some genetically improved material without much effort.

Selections to be kept in the seed stand were made based on a selection index including diameter, straightness, form, and pilodyn. Breeding values estimates obtained from the combined-site analysis at Kaingaroa and Kinleith at age 6 were used for gain predictions. Estimates of genetic gains of 2% in diameter, 2.5% in straightness, 1.7% in branching and 4% in pilodyn after thinning to a stocking of 300 sph indicated that the conversion of the Poronui trial site into a seed stand is technically worthwhile, offering a readily available seed resource. Those levels of gain can also be improved through more intense selection and also by applying within-family selection.

Independent of the seed stand conversion, seed could be collected from 15 parents to provide an immediate supply. This seedlot is estimated to have 2% gain in diameter, 1.5% gain in straightness, 0.6% in branching and 1.9% in pilodyn, assuming equal contribution from each parent.

Strategic and economic considerations have to be considered by the Cooperative members to determine their interest in this seed source.

INTRODUCTION

In 1990, the *E. nitens* open-pollinated breeding population was established in a provenance/ progeny trial on two sites in the North Island, Kaingaroa Forest (Cpt. 1060) and Kinleith Forest (Podocarp Rd). The population consisted of 310 open-pollinated families, mainly from Macalister, Toorongo and Rubicon provenances in Central Victoria, and families from Northern New South Wales and Southern New South Wales plus some New Zealand seedlots. The breeding population included material with different degrees of genetic improvement. Some families were first- and others were second-generation selections. The trial design was sets-in replications with single-tree plots. The families were allocated to sets on the basis of their provenance.

After the establishment of the main trials, the remaining seedlings were divided into two independent groups of 72 families (representing 25 % of the families present in the breeding population) and were planted on two sites, Poronui Station and Wainui , primarily to study frost damage. Poronui is a harsh site, which provided good information on the frost tolerance of the families represented in that site (Cannon *et al.,* 1992). Poronui Station has fortuitously proved to be a good flowering site and at present, most trees are producing flowers and setting capsules. However, few flowers and capsules were observed at Wainui. In 1998, the Poronui trial was assessed to determine whether it was worthwhile to convert it into a seed stand for temporarily providing seed of some level of improvement to members of the Eucalypt Breeding Cooperative (EBC), until their seed orchards started production.

This report includes a discussion of the technical advantages of converting the Poronui trial into a seed stand. To promote flowering and to achieve some genetic gain it is necessary to selectively thin the stand to a third or less of its present density.

The level of genetic gain obtainable and the demand for improved seed will determine whether it is worth converting the trial to a seed stand.

The final decision on the need for or the relevance of this seed source rests with the members of the EBC and would be a cost independent of the cooperative programme.

PORONUI FIELD DESIGN

The design of this trial was a sets-in-replications design with single-tree-plots, and 24 replications of two sets at each site, each set including 70-72 open-pollinated families from the *E. nitens* breeding population. There was no overlap between the families present at Poronui and Wainui.

ASSESSMENT AT PORONUI

At Poronui diameter, straightness, form and flowering were assessed at age 8 years as shown in Table 1.

Table 1: Traits assessed at Poronui

Trait	Assessment
Diameter	Measured at 1.40 m height with diameter tape
Straightness	1-9 scale (1 = crooked, 9 = straight)
Form (including branching habit and malformations)	1-9 scale (1 = poor, 9 = excellent)
Flowering	1-3 scale (1 = poor, 3 = good)

CONVERSION OF THE TRIAL AT PORONUI TO A SEED STAND

The data from the assessment at age 8 years at Poronui was analysed. The number of families present at Poronui represented only 25% of the total number of families in the *E. nitens* breeding population. The site contributed no additional information to the estimation of breeding values done previously (Gea *et al.*, 1997) which was based on combined site analysis of the entire breeding population (at Compartment 1060-Kaingaroa Forest, and Podocarp Rd -Kinleith Forest). The combined-site breeding values were judged to be better estimated and therefore they were used to determine the families to be retained for seed production.

The estimation of genetic gain after thinning was also based on the combined-site breeding values.

SELECTION OF FAMILIES

A selection index was constructed for each family as a linear combination of the combined-site breeding values for diameter, straightness, branching and pilodyn (this trait being an indirect measure of wood density). Emphasis was placed on growth and pilodyn, since *E. nitens* has shown relatively good straightness and branching. Thus, an economic weight of two (2) was allocated to diameter and pilodyn whereas the form traits were set to one (1). The selection index can be expressed as:

$$S.I. = (2 * BvDBH) + BvSTR + BvBR + (2 * BvPYL)$$

where

S.I.	Selection index
BvDBH	Breeding value for diameter
BvSTR	Breeding value for straightness
BvBR	Breeding value for branching
BvPYL	Breeding value for pilodyn

Families present at Poronui were ranked on their selection index value. The conversion of this trial to a seed stand offers the opportunity to obtain seed with improved pilodyn.

The present stocking of the trial is 952 sph. To encourage good crown development and flowering, an option would be to reduce the stocking to approximately 300 sph. That stocking can be achieved by keeping the top 24 families and culling the rest. The 24 top families selected are shown in Appendix 1.

The top 24 families at Poronui rank within the upper third of the total breeding population.

GENETIC GAIN

The percentage of genetic gain obtained by thinning the trial to a seed stand or by selective seed collection was calculated using the *E. nitens* Central Victoria Control at Kinleith as the baseline. This seedlot is a native population collection and can be consider to have minimal genetic improvement.

Thus, the formula used to calculate gain after converting the trial to a seed stand was:

$$\% gain = \frac{\overline{B}\,\overline{V}_{TRAIT(sd)} * STD}{\overline{X}_{TRAIT(CV)}} * 100$$

where

$\% gain$	Genetic gain expressed as percentage of the E.nitens Central Victoria Control at Kinleith
$\overline{B}\,\overline{V}_{TRAIT(sd)}$	Average breeding value of selected families for each standardised trait
STD	Standard deviation for each trait
$\overline{X}_{TRAIT(CV)}$	Mean of the trait for E.nitens Central Victoria at Kinleith

For seed collection from the top families the formula was:

$$\% gain = \frac{\left(0.5 * \overline{B}\,\overline{V}_{TRAIT(sd)Total} + 0.5 * \overline{B}\,\overline{V}_{TRAIT(sd)Selected}\right) * STD}{\overline{X}_{TRAIT(CV)}} * 100$$

where

$\overline{B}\,\overline{V}_{TRAIT(sd)Total}$	Average breeding value of all families for each standardised trait
$\overline{B}\,\overline{V}_{TRAIT(sd)Selected}$	Average breeding value of selected families for each standardised trait

RESULTS AND DISCUSSION

The genetic gain expected by converting the Poronui site into a seed stand limited to the top 24 families would be 2% in diameter, 2.5% in straightness, 1.7% in branching and 4% in pilodyn. If the physical distribution of the selected families in the field was heterogenous, families of lower rank would have to be included. As a consequence of this trade-off between adequate spacing and genetic gain, the latter could be reduced. To increase this genetic gain, it would be possible to reduce the stocking to 230 sph by selecting only ¼ of the total number of families. In that case, the gain would potentially be 3% in diameter, 3.4% in straightness, 1.5% in form and 4% in pilodyn. There is also the possibility to include some degree of within-family selection to enhance the genetic gain due to family selection.

Independent of developing a seed stand by thinning, seed could be collected from 15 parents to provide an immediate supply. This seedlot is estimated to have 2% gain in diameter, 1.5% gain in straightness, 0.6% in branching and 1.9% in pilodyn, assuming equal contribution from each parent.

These expected gains are predictions based on estimated genetic parameters at age 6 years from two test sites. Values may change if applied to different sites or to stands under different management.

CONCLUSIONS

Technically, it is worthwhile thinning the trial to convert it into a seed stand.

If the trial site is thinned, the seed stand will be a source of improved seed with genetic gain comparable to the gain currently offered by commercial seed orchards in production.

As selection emphasis has been placed on pilodyn apart from growth, a considerable gain in this trait is expected.

The use of this seed stand is seen as temporary until newly established seed orchards become productive. However, even after the onset of orchard seed production this seed stand could be considered as a back up seed source.

REFERENCES

GEA, L.; McCONNOCHIE, R.; HONG, M.; SHELBOURNE, C.J.A. 1997: Age 5 assessment of *E.nitens* progeny test (First and second generation) and forward selection of candidate for breeding and production populations. NZEBC. Report No. 21. ***Forest Research***.

CANNON,P.G. and McCONNOCHIE, R.M. 1992: Variation in Frost Tolerance in *Eucalyptus nitens*. Eucalypt Breeding Cooperative. Report No. 3. ***Forest Research***.

ACKNOWLEDGMENTS

We want to thank Drs Luis Gea, Paul Jefferson, and Tony Shelbourne for their comments and suggestions.

APPENDIX 1

Selection index of the best 24 families.

Code	S. Index
56*	2.69102
899*	1.91918
880*	1.84491
831*	1.83494
722*	1.63314
964*	1.54854
957*	1.52015
889*	1.49981
931*	1.1146
671*	1.04769
852*	0.98209
104*	0.92985
658*	0.87095
714*	0.75785
928*	0.73384
939*	0.73331
952*	0.71656
897*	0.67287
922*	0.66899
648*	0.66634
619*	0.59927
651*	0.54851
723*	0.54751
719*	0.54098