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POSSIBILITIES FOR CLONAL FORESTRY WITH *EUCALYPTUS GRANDIS* X *E. NITENS* HYBRIDS IN NEW ZEALAND

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EXECUTIVE SUMMARY

In South Africa and other subtropical areas such as Brazil, clonal forestry with *Eucalyptus grandis* and its hybrids with species like *E. urophylla, E. camaldulensis* and *E. nitens* is being practised with great success. Clones of the hybrid *E. grandis* x *E. nitens* are successfully grown in the eastern Transvaal highveld at altitudes of 1500m. outside the range of *E. grandis.*

E. grandis is easy to propagate from cuttings, either from juvenile seedling or coppice material and this attribute is passed to F_1 hybrids with other species in large measure.

It is proposed that hybrids between a southern provenance of *E. grandis,* and *E. nitens* from central Victoria and from southern New South Wales are tested as seedlings in a range of New Zealand sites, and if successful, clones are selected from these families, and rejuvenated by coppicing. Clonal testing would then lead eventually to clonal forestry.

POSSIBILITIES FOR CLONAL FORESTRY WITH EUCALYPTUS GRANDIS X E. NITENS HYBRIDS IN NEW ZEALAND

BACKGROUND

Eucalyptus grandis is one of the most widely planted eucalypts in the subtropics and shows extremely rapid growth, good form and easy vegetative propagation. Its utilisation properties are good for sawtimber, pulp and poles. It originates in northern New South Wales (NSW) and Queensland in subtropical, summer rainfall climates. It has been grown little in New Zealand and is highly susceptible here to attack by *Paropsis charybidis*, a paropsine beetle defoliator, and is poorly adapted to New Zealand climates. As Paropsis is now well-controlled by a parasite, *Enoggera nassaui*, it should not in future be such a serious problem.

E. grandis can be readily crossed with several members of the subgenus Symphyomyrtus. It is also easy to propagate by rooted cuttings taken from young seedlings and from young coppice shoots, and confers its good rooting ability to a large extent onto its interspecific hybrids. This has enabled commercial production of its hybrids with some species in South Africa, mainly by propagating hybrid clones from juvenile seedlings or coppice shoots from felling selected hybrid trees. These cuttings of different clones are then planted out in replicated clonal tests, and eventually the best selected for mass propagation.

In South Africa, the climatic range of *E. grandis* has been considerably extended by hybridisation. The hybrid with *E. nitens* shows increased cold and frost tolerance that permits its cultivation on the eastern Transvaal highveld, where it out-performs its *E. nitens* parents (and where *E. grandis* is severely damaged or killed by frost). The hybrid with *E. camaldulensis* can be grown on dry, infertile, low-altitude sites where *E. grandis* is killed early in life, and the hybrid with *E. urophylla* thrives on coastal low-altitude sites in Zululand, where it will out perform *E. grandis* (which is subject there to fungal diseases).

Crossing *E. grandis* with other species extends its adaptive limits, increases production over both parents on various marginal sites but otherwise results in intermediacy between the two species for most characters. Hybrid clones of *E. grandis* particularly with *E. urophylla* are being used commercially in the Congo and on a very large scale in Brazil.

WOULD THE E. GRANDIS X E. NITENS HYBRID GROW WELL IN NEW ZEALAND?

A major difference between the New Zealand climates and those of coastal NSW, Queensland, eastern Transvaal and Zululand, is that NZ has an evenly distributed rainfall, sometimes with winter peaks, whereas in the Australian and South African areas indicated there is summer rainfall and a distinct, sometimes very severe dry season in winter.

In South Africa, *E. grandis* and *E. nitens* provenances used for hybridisation come from summer rainfall climates; the preferred provenances of *E. nitens* are from the extreme north of the species range in NSW, at Barrington Tops and Ebor. By contrast, provenances from southern NSW especially from Tallaganda, have done well in NZ, as have the central Victorian provenances.

E. grandis provenance trials in South Africa have shown an indeterminate picture of provenance adaptation, and the local land race appears to come largely from Coffs Harbour, NSW. For any *E. grandis* x *E. nitens* hybrids used in NZ, the southern NSW provenances (so-called "green nitens") and those from central Victoria ("blue nitens") should be crossed with *E. grandis* which should preferably come from the southernmost part of its range, in coastal NSW. Crossing would be best done in South Africa, on *E. grandis* female parents, using New Zealand - collected pollen of the Victorian and southern New South Wales provenances.

It seems probable that an *E. grandis* x *E. nitens* hybrid assembled from the above material would perform well, at least on low to mid-altitude sites in the North Island.

A PRELIMINARY TEST OF E. GRANDIS X E. NITENS HYBRIDS

If the prospects for this hybrid are accepted as sufficiently good, a preliminary test on several sites needs to be established. Because this hybrid will be primarily grown for pulpwood, early evaluation will be possible.

A minimum of 10 hybrid crosses need to be made between select trees from each of the two *E. nitens* provenances and *E. grandis*. The same 10 *E. grandis* females should be used for crossing with each *E. nitens* provenance. In addition open-pollinated seed should be collected from each *E. grandis* and each *E. nitens* parent. Single-pair crosses with 10 *E. grandis*, and 10 *E. nitens* (s. NSW) and 10 *E. nitens* (Vic.) would give 20 crosses plus 30 open pollinated seedlots, 50 altogether, which should be planted on at least five sites. Additional hybrid seedlings can be used for propagation trials and sufficient seed of each of the 20 hybrid crosses to raise about 30 seedlings should be stored (see below).

This trial will indicate clearly:

- whether *E. grandis* x *E. nitens* (s. NSW) or x *E. nitens* (Vic) hybrids are best, and thus which provenance of *E. nitens* should be used for hybridisation.
- whether the hybrids grow better or worse than *E. nitens* of those provenances.
- whether or on what sites the hybrids and/or pure *E. nitens* outgrow *E. grandis*.

A decision can then be easily made about the future of these hybrids. Assuming that this is favourable, a plan for incorporating interspecific hybrids into the *E. nitens* breeding strategy, is developed below.

CLONAL FORESTRY WITH E. GRANDIS X E. NITENS HYBRIDS IN NEW ZEALAND

Clonal forestry could be said to be the ultimate development of a conventional recurrent selection breeding programme, but it is not feasible with *E. nitens* because this species is very difficult to propagate. However, the F_1 hybrids of *E. grandis* x *E. nitens* propagate well by cuttings. Clonal forestry, if it is to be more than a one shot effort, should be incorporated as part of a hybrid breeding strategy, which I believe should be one of recurrent selection for general combining ability(1) for each parent species. A breeding strategy is proposed that is analogous to the dual superline approach used for *Pinus radiata*, except that the two superlines are respectively *E. grandis* and *E. nitens* (Figure 1).

Each species breeding population is maintained normally using either open or control-pollination, with or without sublining. At the end of each breeding cycle a small production population is normally selected for grafting into clonal seed orchards. This production population, say 30 parents from each species, is also pair-crossed to give 60 *E. grandis* x *E. nitens* hybrid families. These families, about 10 to 15 seedlings per family, will be propagated by 10 to 15 cuttings each whilst still very juvenile.

Clonal tests will be planted with the resulting 600 - 900 clones on two or three sites, and seedling ortet stools will be maintained in the nursery until the first assessment at about age 3, when about the best third of the clones can be started on commercial propagation. With further assessments this can be reduced to about 50 clones which can be planted in further, more extensively-sited growth and yield trials. There should be no problems with aging, as felling trees in the clonal tests or cutting back nursery shoots effects rejuvenation through coppice shoots.

Meanwhile the breeding populations of each species are mated and the offspring out-planted in another cycle of recurrent selection within each species.

The theoretical basis for this strategy is that recurrent selection for general combining ability will raise the frequency of additively-inherited alleles in each species population. Crossing genotypes of the two species will result in intermediacy between species for some traits and some non-additive effects for others. Clonal selection within this hybrid population of clones then allows reselection for additively and non-additively inherited traits, utilising the total genetic variance for all traits.

In the New Zealand breeding programme, two populations of *E. nitens* are being run in tandem, for southern NSW and central Victorian provenances, and one or both populations could be involved in future hybridisation. Both are mated by open-pollination, and one (Victorian) is sublined. New Zealand has no *E. grandis* population, and rather than try to develop one, it would be best to get help from an already-advanced programme, such as in South Africa. Commercial or reciprocal arrangements (eg. with *P. radiata*) could be made to produce the modest number of

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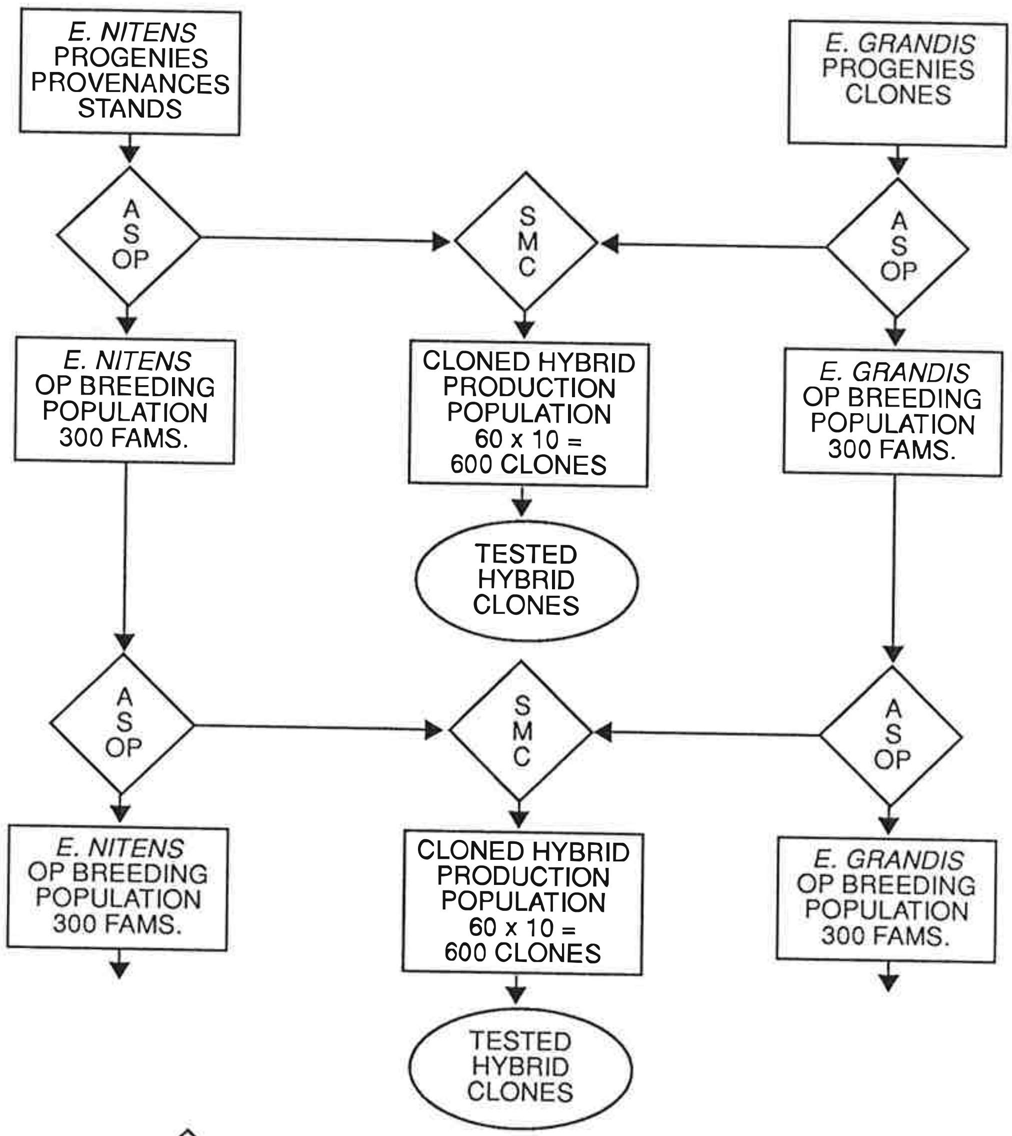
(1) An alternative strategy, Reciprocal Recurrent Selection, is more costly and requires much longer breeding cycles, and it is not discussed further in this report.

FIGURE 1 - INTERSPECIFIC HYBRIDISATION OF *E. GRANDIS* AND *E. NITENS* THROUGH OPEN-POLLINATED BREEDING POPULATIONS AND A CONTROL-POLLINATED, CLONED HYBRID PRODUCTION POPULATION



A S OP

Assess the progeny tests etc
Select best tree per family
OP - Collect open-pollinated seed from these

S M C

Select the best trees in the very best families of each species
M - Control-cross these in hybrid combinations, on parent ortets
Clone about 10 seedlings per hybrid F_1 family

NOTE : Breeding population of one or both species could be **control-pollinated**
Breeding population of *E. grandis* could be **cloned**

hybrid crosses required each generation using the best parents from the South African programme. All cloning and testing would be done in New Zealand.

Expected gains for clonal selection among interspecific hybrids, over those expected for *E. nitens* are impossible to predict. Mean gains of hybrids over pure species however will be estimated in the preliminary tests of the *E. grandis* x *E. nitens* hybrids. Gain predicted for the South African *E. grandis* breeding population and for a cloned production population (Shelbourne, unpublished) show that clonal selection gains were over double those from a clonal seed orchard, for narrow sense heritabilities of 0.1 to 0.4. However, these were gains from clonal selection in a pure species, based on an additive model.

RECOMMENDATIONS

There is a chance that New Zealand could capitalise on the features of *Eucalyptus grandis* that have resulted elsewhere in large gains in growth rate and site adaptation from clonal forestry with interspecific hybrids with this species. New Zealand selected clones of the hybrid *E. grandis* x *E. nitens*, a combination already used successfully in high altitude sites in South Africa, might out-produce *E. nitens*, the present best choice for short-fibred pulpwood production. To a lesser extent, gains of a vegetatively multiplied hybrid, without clonal testing, could exceed those of *E. nitens.*

It is recommended that a preliminary trial is made of crosses of 10 parents, from the southern NSW and from the central Victorian provenances of *E. nitens,* with 10 parents from *E. grandis* in South Africa. Open-pollinated progenies of each of the total number of 30 parents should be included for comparison and the trial planted on at least five sites.

If these hybrid crosses show superior growth, disease resistance and/or wood properties to *E. nitens*, then clonal selection within hybrid families might be expected to show much greater gains. If this is the case a hybrid breeding and clonal testing programme would be the logical outcome.