FRI/INDUSTRY RESEARCH COOPERATIVES

EUCALYPT BREEDING COOPERATIVE

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ROTORUA

OBSERVATIONS ON FLOWERING OF *EUCALYPTUS* SPECIES

TREVOR FAULDS

REPORT NO. 9 MARCH 1993

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EXECUTIVE SUMMARY

This report summarises many years of observations of factors affecting flowering and seed production for the main *Eucalyptus* species of current interest in New Zealand. Topics covered include grafting incompatibility, nutrition, light, insect damage, insect pollination, orchard siting, and seed production.

More specific information is given for *Eucalyptus nitens, E. regnans, E. fastigata, E. saligna, E. botryoides,* and *E. delegatensis*.

Experience with establishing eucalypt seed orchards is discussed and the important factors to ensure success are listed.

OBSERVATIONS ON FLOWERING OF *EUCALYPTUS* SPECIES

T. Faulds

General Observations on Grafts

Grafts of mature *Eucalyptus* spp. have been grown at NZFRI, Rotorua, Tairua, Woodhill and more recently in Canterbury.

Ramets have been grown up to 20 years of age from planting.

1. *Grafting incompatibility*

This appears one to two years after grafting and only appears serious in some species.

- *E. saligna* and *E. botryoides* – Serious in some clones but this can be rectified by the use of half-sib rootstock.
- *E. regnans* – No incompatibility except when *E. delegatensis* is used as a rootstock.
- *E. fastigata* – No incompatibility encountered on general rootstock.
- *E. delegatensis* – No incompatibility encountered on general rootstock.
- *E. nitens* (Blue) – No incompatibility encountered although related rootstock has been used in most cases.
- *E. nitens* (Green) – Serious incompatibility encountered when grafted onto blue strain *E. nitens*, but no incompatibility encountered when grafted onto green strain *E. nitens*.

Note: Grafting incompatibility is easily recognisable one year after grafting and therefore no incompatible graft should ever be planted in an orchard or archive.

2. *Nutrition*

Flower primordia production is greater and more readily retained on grafts that are in a good nutritional state, i.e. good leaf size, colour and retention (comparisons have been carried out on *E. delegatensis, E. regnans, E. saligna* and *E. botryoides* clones). An exception is incompatible grafts of *E. saligna* and *E. botryoides*. These grafts produce prolific flower primordia crops for up to two years from grafting before dying. Many flower primordia abort and flowers are usually small on these incompatible grafts.

3. *Light*

Full light is essential for flower primordia production. A single-leadered graft is more suitable than a pruned multi-leadered graft. Wide spacing is essential to achieve this. Species such as *E. regnans* and *E. fastigata* can take three years from flower primordia production to ripe seed and any shading in the first two years can cause abortion of the potential seed capsules.

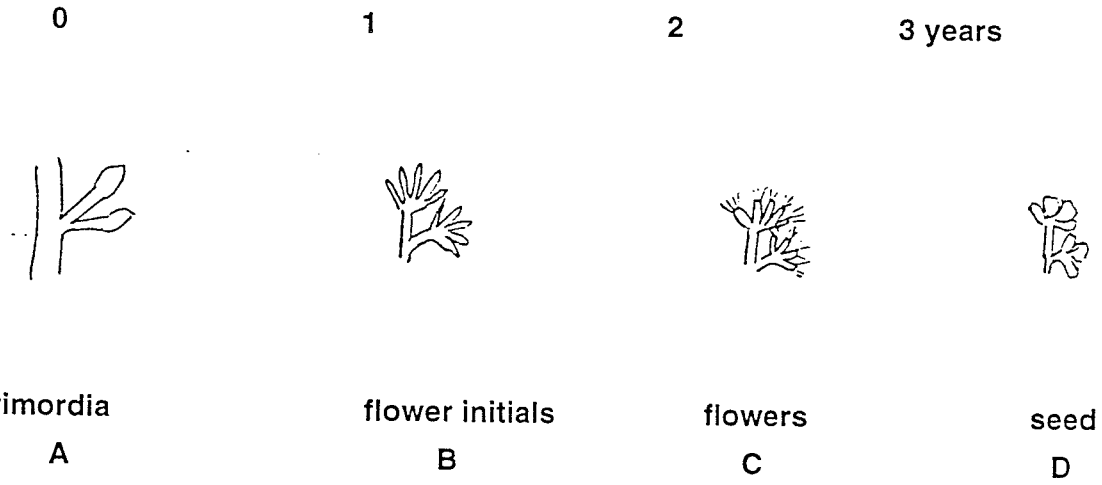


Fig. 1: Seed production sequence for *E. regnans*

Note: In some cases A→ C can occur in one year.

4. *Insects (damage)*

Flower primordia are produced in the tips of the growing shoots and an attack on these primordia-producing tips by insects could totally ruin a potential seed crop. If necessary, an insecticide can be given at this critical period. It should be noted that a

serious attack of this kind has never been encountered in the species mentioned in this report.

As the primordia case splits in readiness to expose the flower initials, a more serious type of insect damage occurs, especially in *E. saligna, E. botryoides* and *E. nitens*. The tortricid moth lays eggs inside the split primordia and the larvae consume the immature flower initials. Unfortunately, in most species this occurs at the time when flowering is taking place from the previous year's primordia and therefore insecticide cannot be applied without affecting the "pollination" insects.

5. *Insects (pollination)*

In the summer-flowering species, pollination appears to be mainly carried out by flies and bees during the day and moths during the night. Winter-flowering *Eucalyptus* species appear to be mainly pollinated by bees. Summer-flowering *Eucalyptus* species appear less attractive to bees in an orchard situation. Keeping flower heads mowed off the clover and other ground cover may attract the bees to the *Eucalyptus* flowers in summer.

6. *Siting*

This is of major importance (see individual species).

7. *Seed Production*

In a given species, flowering can take place over a period of up to three months (the older the grafts, the greater the flowering period seems to be). Flowers produced at the extremities of the flowering season have less chance of being cross pollinated than those in the middle of the season. The flowering trials at the Long Mile, NZFRI, Rotorua for various clones of *E. botryoides, E. obliqua, E. delegatensis, E. regnans* and *E. saligna* are give in Appendix 1.

The seed produced by early or late flowering may be smaller and have weaker germination capabilities than seed produced in the main flowering period (Chris O'Connor, pers. comm.). Chris O'Connor operates a seed collection business in Victoria, Australia. He has found that when seed is graded into three sizes, the smallest grade seed has poorer, later and less energy in germination than the two bigger grades. He now discards the smallest grade seed.

It has also been noted in FRI sowings, over a few thousand seedlots, that more deformed (selfed?) seedlings are produced by the late germinators. These observations are important to verify for future progeny and provenance trial work.

Observations by Species

E. nitens

This species appears to be very site and climate specific for good seed production to occur.

In a line from Rotorua to Waiouru, the colder the climate in winter, the greater the flowering (see Appendix 2 for a comparison between Rotorua and Waiouru sites). It has been noted that at the Rotorua site, short spurts of shoot growth occur if warm days are experienced during the winter. At Waiouru, no shoot growth is observed over the winter months and a more seasonal growth pattern is apparent than at Rotorua.

Production of flower primordia in *Eucalyptus* is usually associated with a growth pattern. An interruption to this pattern may adversely affect production of flower primordia. Stands of 10-13 year *E. nitens* at Waiouru that had side and/or top competition for light were assessed. Any sort of light suppression caused a fall-off in flower primordia production compared with "full light" trees (these suppressed trees had a greater number of flower primordia present on growing shoots than the *E. nitens* growing in full light at Rotorua).

E. nitens produces flower primordia only from the axillary shoot area.

If damaged or pruned, *E. nitens* produces shoots with a semi-juvenile appearance from the wounded areas (produced by accessory buds). This growth is capable of producing flower primordia (see Figure 2).

Fig. 2: Flower primordia formed on "juvenile" material following injury. Primordia are also found on the accessory shoots.

E. regnans and *E. fastigata*

Rotorua climatic conditions are suitable for these two species to produce large numbers of flower primordia which will successfully flower and set seed.

Observations on mature open-grown trees in the warmer coastal regions of the Bay of Plenty and on the colder Kaingaroa plateau area suggest that the Rotorua region is possibly the best choice of these areas if seed orchards are required.

Flower primordia are produced 1-3 years after grafting (see Appendix 3). Flower primordia are produced in the November-January period from both accessory and

axillary shoot areas; the axillary flower primordia usually produced slightly earlier than the accompanying accessory flower primordia.

Both species develop from flower primordia to seed as in Figure 1.

1. *Insects*

There are no problems with insect damage at any stage of the seed producing process in the Rotorua area (observations over 15 years). Pollination is good, with night flying moths playing a major role. In an orchard, grass ground cover that supplies a habitat for moths is possibly better than bare soil.

2. *Light*

Both species can shed flower primordia, flower initials and even flowers if shading of branches takes place.

E. saligna and *E. botryoides*

A comparison between grafts (same age and clones), situated at the Long Mile area (Rotorua) and Coromandel peninsula showed that the latter produced 35-50% more flower primordia than the Rotorua area (flower primordia produced 1-3 years after grafting). Flower primordia are only produced in the axillary shoot area. Pollination and seed set are also more reliable at the Coromandel peninsular sites, i.e. Kauranga Valley and Tairua nursery.

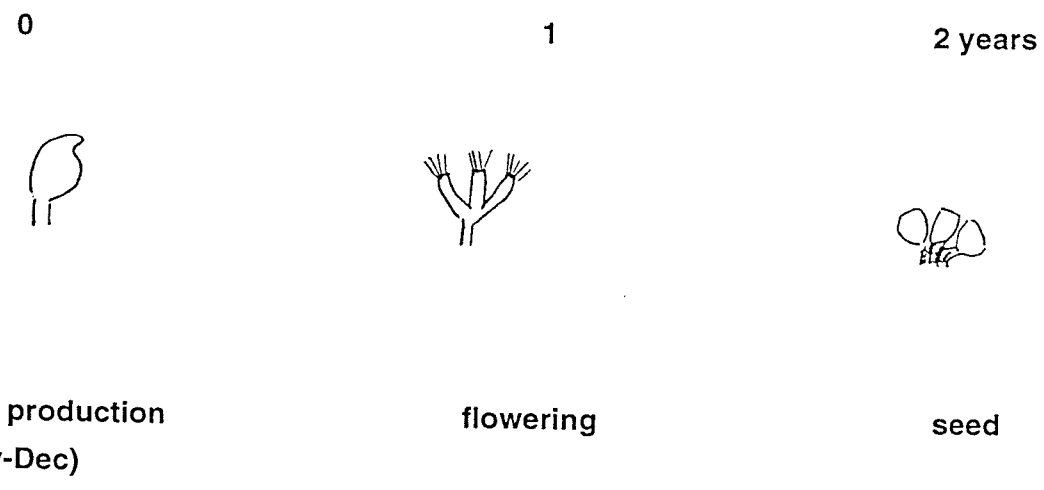


Fig. 3: Seed production sequence for *E. saligna* and *E. botryoides*

1. Insects

These can be a serious problem, especially at Rotorua, with tortricid moth larvae eating immature seed initials after the flower primordia case has started to split. No insecticide spraying can be carried out as flowering from the previous year's flower primordia is occurring.

E. delegatensis

Rotorua conditions are suitable for flower primordia production and seed set, although heavier production does occur at Kaingaroa and Waiouru (open-grown trees). Flower primordia are usually produced in the axillary area only, although a few clones will produce a few flower primordia in the accessory bud area.

From flower primordia to seed can take 2 or 3 years.

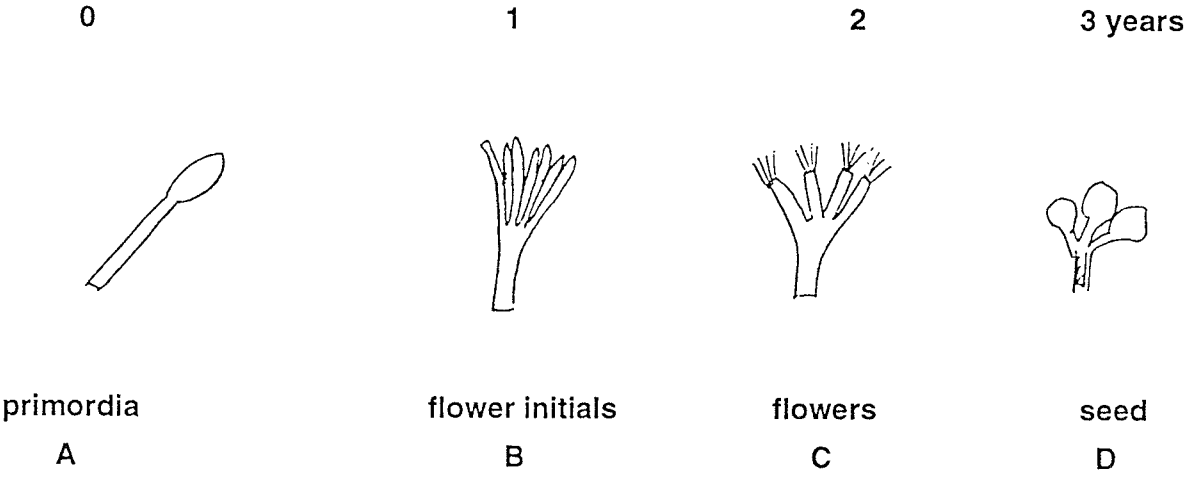


Fig. 4: Seed production sequence for *E. delegatensis*

In many cases A→ C can occur in 1 year.

Seed Orchards

In the last 30 years, seed orchards or clonal areas of *Eucalyptus* species have been planted in the following areas:

- *E. botryoides* – Woodhill, Kauranga Valley, Tairua nursery and FRI, Rotorua.
- *E. saligna* – Kauranga Valley, Tairua nursery and FRI, Rotorua.
- *E. fastigata* – FRI, Rotorua
- *E. regnans* – FRI, Rotorua
- *E. muelleriana* – Tairua Forest and FRI, Rotorua
- *E. pilularis* – Tairua Forest and FRI, Rotorua
- *E. nitens* – Canterbury, Waiouru and FRI, Rotorua
- *E. delegatensis* – FRI, Rotorua.

Expertise with these areas has shown the following points should be considered when choosing and establishing a seed orchard site.

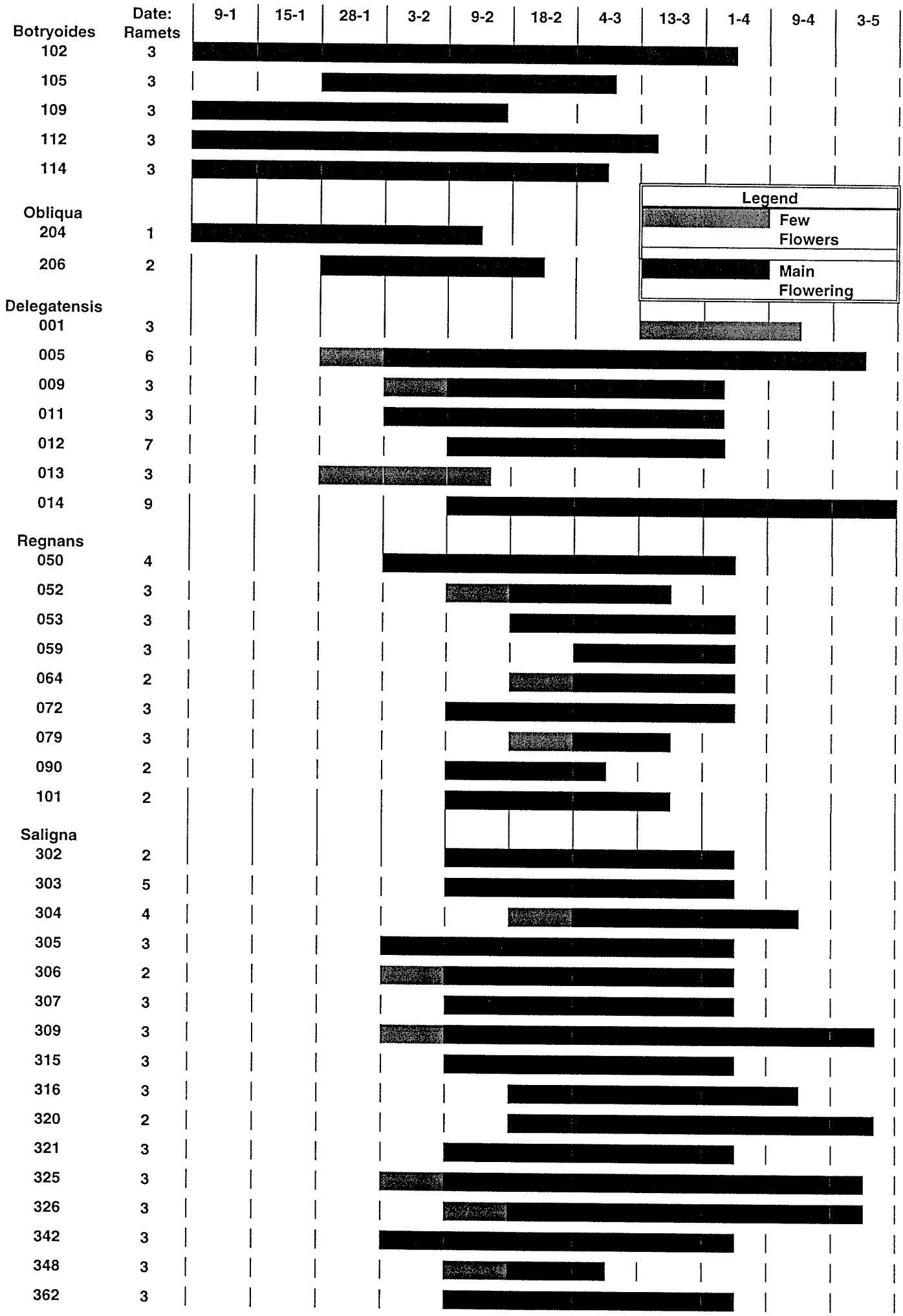
1. The site must be in a good seed producing region for the species being planted.
2. The area should not be subject to severe winds.
3. Wide spacing at planting should be used (up to 20 x 20 m) or single line planting as advocated by M. Wilcox.
4. If planting is done in a soil type different from potting mix of containerised grafts, then a ½ container: ½ regional soil mix method should be used for the planting holes.
5. Fertiliser suitable for the species and soil type should be used, and applied according to seasonal requirements.

6. No herbicides should be used for the first year after planting, but a cultivated area of 50 cm radius should be kept around each graft. This usually means 3 or 4 weed hoeings during the year (the rest of the area can be sown in a cover crop and kept mowed).

7. Grafts should be grown as single leaders and therefore the area selected should be suitable for the use of a cherry picker.

APPENDIX 1

ECALYPTUS FLOWERING 1980/81 - LONG MILE



APPENDIX 2

Flower Primordia Production on *E. nitens* (Blue Strain)

Source of Material

A. *E. nitens* clonal area (31 clones at 10 m x 10 m spacing).

Grafted 1988 from seed-producing trees at Rotoaira progeny test.

B. A single line of *E. nitens* approx. 13 years old. Open growth with no side competition. Flowering since approx. age of 6 years (every tree assessed).

Flower Primordia Production (Assessed Feb 1993)

	(A) FRI (Rotorua)	(B) Waiouru
Number of trees assessed	55	18
Number of trees bearing flower primordia (FP)	33	18
Average number of primordia/set (FP producing trees only)	2.7	5.5
Maximum number of primordia/set (FP producing trees only)	6	10
Minimum number of primordia/set (FP producing trees only)	1	3
% of branchlets bearing primordia	<5	>65

APPENDIX 3

Flower Primordia Production at the FRI Nursery

Species	Flower Primordia (yrs from grafting)	No. of clones	No. of clones (no. primordia within 3 years)
E. pilularis	2-3	10	1
E. muelleriana	2-3	10	1
E. saligna	1-3	25	1
E. botryoides	1-3	15	2
E. obliqua	2-3	2	0
E. regnans	2-3	20	2
E. fastigata	1-3	6	2
E. delegatensis	2-3	14	1
E. leucoxylon	1-2	3	0
E. ficifolia	1-2	3	0