nurseries using or contemplating the use of tissue cultures to experiment extensively with their propagating facilities to optimize their success. Those nurseries which have established good success rates with cultures should be analysing very carefully the factors responsible for that success, just as those who have not had success need to experiment to find out the source of their problems. I believe that in a short time tissue culture will become a conventional technique in the nursery industry in Australia and we must begin now to take the guesswork out of preparation of stock plants and planting out of tissue cultures.

SELECTION AND GRAFTING STUDIES OF *BANKSIA COCCINEA* AND *BANKSIA MENZIESII*

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INTRODUCTION

Banksia species are showing great promise as a plantation-grown cut flower crop in South Australia where currently 56 ha are under cultivation. Two species with outstanding flowers and high export potential are *Banksia coccinea* (the scarlet banksia) and *Banksia menziesii* (raspberry frost banksia). *Banksia coccinea* has a reputation of being difficult to grow and is currently grown commercially only in well-drained acid sands in South Australia and Victoria. The flower is recognized in overseas markets from the export of bush-harvested blooms from Western Australia. There has been little success in cultivation overseas.

In addition to the striking appearance of the bloom, *B. coccinea* is suitable for export due to its small to medium size, relatively fine straight stems, compact leaves, and terminal flowering habit without side breaks. Considerable variation exists in populations in relation to flowering period (May to December) and color of blooms (yellow, orange to deep scarlet). A selection program for this species should concentrate on the following criteria:

1) Selections to extend the bloom season to provide for continuity of supply in export markets.
2) Identification of colour variants.
3) Identification of an outstanding high yielding true red cul-

tivar with lightweight stems to lead as the species standard.

4) Disease resistance and tolerance of heavier soils.

Banksia menziesii is one of the slower-growing commercial species which deserves attention due to its highly desirable terminal flower. Again, seedlings can exhibit a range of growth habits which can greatly influence yields of marketable flowers.

Both a tree form (to 10 m) and a lignotuber-forming shrub (to 3 m) exist in natural populations, the shrub being most commonly grown in commercial plantings. Considerable colour and size variation occurs in blooms and there is often a tendency towards short stems. Again, this species would benefit from selection and clonal propagation for cut-flower production.

There has been considerable interest shown in grafting Western Australian banksias on to eastern species which are more tolerant of disease and poor soil conditions. Work in Western Australia (4) has defined *Banksia* species which have potential for use as rootstocks due to resistance to *Phytophthora cinnamomi*, the most important disease of banksias under cultivation. Of the species studied, *Banksia integrifolia* appears to have the greatest potential as a rootstock. It is a species tolerant of high phosphorus levels and poorly drained sites, shows high level of resistance to *Phytophthora*, and is easily propagated from cuttings. The S.A. native *Banksia marginata* deserves assessment as a rootstock for local plantations. This species occurs over a wide range of soil types and shows moderate resistance to *Phytophthora*.

Reported grafting work on banksia species has not clearly determined compatibility of desirable cut flower species with selected rootstocks. McCredie et al. (3) utilized a hot-callusing tube to facilitate graft unions of 8 scion species on 5 rootstocks. Greatest success was achieved with *Banksia hookeriana* (1 take on 18 attempts) on *B. integrifolia* rootstock. Final assessment at 4 months was inconclusive concerning long-term compatibility. McKenzie (5) in Victoria has reported grafting studies with a wide range of banksia species. Compatibility is assessed for most species but there are no notations of successful field establishment.

Grafting is widely practiced on macadamia, another member of the Proteaceae. It is standard nursery practice to girdle branches used for scionwood six weeks prior to collection (2). Girdling allows for carbohydrate accumulation in the stems which appears necessary for grafting success in this species. This technique deserves assessment on all proteaceous species suitable for grafting.

MATERIALS AND METHODS

Seedling rootstocks of *Banksia integrifolia* and *B. marginata* were grown in 2 litre bags to a stem diameter of pencil thickness at

approx. 12 to 15 cm height. Rootstocks were moved into a glasshouse 1 week prior to grafting and maintained at a temperature of 15 to 30°C during a 8 to 10 week period after grafting.

Scionwood was collected from mature, flower-producing plants of *Banksia coccinea* and *B. menziesii* grown on plantations in Millicent and Happy Valley, S.A. Four weeks prior to grafting, several branches that would provide scionwood were girdled by removing a 1 cm ring of bark. Scion sticks were prepared approximately 10 cm long with 2 or 3 leaves from hardened current season's wood of pencil thickness.

All grafting in these trials utilized a simple wedge graft, the unions being wrapped with budding tape or Parafilm and waxed. A loose plastic bag was placed over the scion to reduce desiccation.

The first trial commenced in late May 1985 and was evaluated at 8, 12, and 20 weeks. Several successfully grafted plants were then field planted in early spring (September). The second trial commenced in September and involved grafting 200 plants, utilizing the best treatments of the first trial. Faulty temperature controls in the greenhouse over a weekend led to loss of all grafts except the 75 reported in Table 2.

RESULTS AND DISCUSSION

Table 1 summarizes the results of the first grafting trial on 60 plants each of the two rootstock species, *Banksia marginata* and *B. integrifolia*.

Table 1. Grafting trials commenced in May 1985 with four *Banksia* species.

Scion/Rootstock	Number/ treatment	Number plants alive at: 8 wk	12 wk	20 wk	Number plants showing scion development at: 8 wk	12 wk	20 wk
1. *B. coccinea*/ *B. marginata*	15	15	14	10	11	12	8
2. *B. coccinea*/ *B. marginata* (girdled)	15	14	11	6	7	10	4
3. *B. coccinea*/ *B. integrifolia*	15	14	10	4	5	5	4
4. *B. coccinea*/ *B. integrifolia* (girdled)	15	15	14	6	13	14	6
5. *B. menziesii*/ *B. marginata*	15	5	3	3	1	2	2
6. *B. menziesii*/ *B. marginata* (girdled)	15	14	14	13	6	11	8
7. *B. menziesii*/ *B. integrifolia*	15	4	4	3	1	2	3
8. *B. menziesii*/ *B. integrifolia* (girdled)	15	11	10	9	2	5	4

BANKSIA COCCINEA

The first assessment at 8 weeks showed that *B. coccinea* scions had started to develop in 60% of the grafted plants. This figure increased at 12 weeks and declined by 20 weeks when a final assessment of 36% successful takes was recorded. Girdling the scion wood of this species had no affect on success of graft take.

It is encouraging to note the rather rapid movement of *Banksia coccinea* scions after grafting, indicating quick callusing and union with the stock. *Banksia menziesii*, by comparison, showed development of scions in only 16% of the grafted plants at 8 weeks. The dieback of scions during the 12 to 20 week period corresponds with the period of unwrapping of the graft unions and movement of plants from the greenhouse outdoors into a nursery environment in winter. Scion loss can be attributed in some degree to premature unwrapping and possible desiccation of the graft unions which appeared to split or peel back at the narrow edges of the cut on the rootstock. Temperature changes to the grafted plants had the affect of arresting scion devleopment which may have been detrimental to continued graft healing.

In September, 30 additonal grafts made of *B. coccinea/B. integrifolia* with non-girdled scion wood survived and were assessed up to 6 months (Table 2). Results of survival at 6 months (31%) and scion development at 8 weeks (60%) were very similar to the first trial. Scions grew to an average of 15 to 40 cm in height.

Table 2. Results of grafting trial commenced September, 1985

Scion/Rootstock	Number/ treatment	Number plants alive at:		Number plants showing scion development at:	
		8 wks	6mo.	8 wks	6 mo.
B. coccinea/ B. integrifolia	30	30	15	18	11
B. menziesii/ B. marginata (girdled)	15	11	3	7	2
B. menziesii/ B. integrifolia (girdled)	15	5	0	0	0

BANKSIA MENZIESII

Results with *B. menziesii* showed significant differences between girdled and non-girdled scionwood on both species of rootstock. At 8 weeks, 70% of non-girdled grafts had failed, while only 17% of girdled material was lost. Scion development was slow in all treatments and at the end of 20 weeks, 73% of the girdled grafts survived but only 40% showed scion development at this time.

In the second trial (Table 2), only girdled scion wood was utilized and there were no surviving grafts with *B. integrifolia* rootstock. Low survival rates with *B. marginata* may also indicate that seasonal factors need to be thoroughly understood before optimal

conditions for grafting success can be recommended.

The results of these trials indicate that potential exists for grafting the species *B. coccinea* and *B. menziesii* onto rootstocks. It must be noted, however, that there was a trend towards graft failure apparent at 20 weeks. A number of developing scions were observed to wilt, the leaf margins browning and drying. When the graft of these scions was examined it was clear that the union between scion and rootstock was poor. Callus development was minimal in these cases and the graft union broke easily when twisted. This indicates either incompatibility of *B. coccinea* and *B. integrifolia*, or that insufficient time was allowed before the grafts were unwrapped and the scions subjected to environmental stress. Grafting studies with these species and several other banksias will be continued by the Department of Agriculture in 1986–87 at the Loxton Horticultural Research Station.

LITERATURE CITED

1. George, Alex. 1985. The Banksia Book. Kangaroo Press. 240p.
2. Hamilton, R. A. and E. T. Fukunaga. 1959. Growing macadamia nuts in Hawaii. Hawaii Ag. Expt. Station. Bull. 121. Univ. of Hawaii. 51p.
3. McCredie, T., K. Dixon, K. Sivasithamparam. 1985. Grafting banksias to avoid root-rot. *Austral. Hort.*, April, 1985. p. 75–79.
4. McCredie, T., K. Dixon, K. Sivasithamparam, and P. Watkins. 1985. Seeking *Phytophthora* resistant banksias. *Aust. Hort.* April, 1985. p. 48–49.
5. McKenzie, D. M., 1984. Grafting Australian native plants. *Proc. Inter. Plant Prop. Soc.* 34:135–141.