GRAFTING *EUCALYPTUS DEGLUPTA*

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ABSTRACT

Approach grafting, top-cleft grafting, bottle grafting and patch grafting as applied to **Eucalyptus deglupta** Blume in Papua New Guinea are discussed. Repeated failure of the stock occurred in methods other than patch grafting. It is postulated that an inhibitor of the stock is caused by adult scion material. Lines of further research on incompatibility are suggested.

Patch grafting, when applied to seed orchard work, is sufficiently well developed and cheap enough to be used effectively.

INTRODUCTION

Grafting has been the most favoured method of vegetative propagation of forest trees for many years because it is generally more reliable than cuttings and less affected by ortet age. However, the time-consuming nature of the operation combined with increasing labour costs has resulted in a decline in the practice in Australasia. The completion of many seed orchards and the greater interest in rooted cuttings, with, if necessary, pre-severance treatment or air-layering of physiologically older material, have both contributed to this decline.

The only active practical breeding programmes for production of improved *Eucalyptus* seed in Australasia are located at Coffs Harbour, New South Wales (*E. grandis*), Traralgon, Victoria (*E. regnans*) and Bulolo and Keravat, Papua New Guinea (*E. deglupta*). In the tree improvement programme for *E. deglupta* (Davidson, 1968a, b, c; 1972) both clonal grafted seed orchards and seedling seed orchards are proposed.

This paper will report on the grafting of *E. deglupta* by various techniques, and on the incidence of incompatibility between stock and scion.

TECHNIQUES

a. Approach Grafting

In this method; a seedling in a pot supported on a platform is approach-grafted to a suitable scion on the selected parent tree (Fig. 1). Effective union takes place in four to six weeks. The scion is then severed some distance below the union and converted to a bottle graft for a further 6 to 8 weeks.

This method has little practical value in a tree improvement programme for

FIG. 1—An approach graft of **E. deglupta.**

E. deglupta as the parent trees in which we are interested are more than 45 m tall. Also the grafting must be carried out *in situ.* Scions cannot be transported to sites for clone banks or seed orchards.

b. Bottle Grafting

The bottle graft in which the scion is severed from the parent tree at the time of grafting is a simpler procedure than approach-grafting. The difficulty of access to the crown of tall trees is removed.

With *E. deglupta,* leaves on the scion are cut back to the top of the petiole before setting up the graft (for illustrations *see* Pryor and Willing, 1963; Davidson, 1968a). The petioles absciss after one to two weeks and growth is renewed from concealed axillary buds or from naked axillary buds (terminology of Jacobs, 1965).

Scions are easily shipped long distances in damp peat moss covered with polythene film and placed in polystyrene ("esky-type") containers with a cooling brick. The only disadvantage is that the scion is fairly bulky as 6-12 nodes are required.

This method showed early promise for establishment of seed orchards (Davidson, 1968a) but, when test grafting was carried out on a large scale, numerous stock failures occurred.

When large scions taken from the upper crowns of 15 to 20-year-old trees were used, a very low percentage take of about 10% resulted. In many of the failures, the stocks became moribund and died; some before decapitation and some after, even though they were growing vigorously before grafting and were kept well watered and fertilised after grafting.

When scions were taken from 1- or 2-year-old trees and grafted by the same technique, the percentage of successful takes was greater, averaging about 76%, and almost

no stock failure occurred. This behaviour was, at first, difficult to explain. It appeared that a relatively large volume of adult scion material (as much as a third of the volume of the stock) had an inhibitory effect on seedling stock 4 months old and about one metre in height.

The increased success when younger scions were used indicated the inhibition was caused mainly when adult material greater than 5 years of age was used.

When entire young seedling stem cuttings about six nodes and 15 cm tall were placed in the container of water at the base of the scion, they failed to root. This is contrary to expectation as seedling cuttings of *E. deglupta* normally root in water with better than 90% success (Davidson, 1974). After these tests were carried out at Keravat, New Britain in 1968, a similar effect was reported by Paton *et al.,* (1970) while working with *E. deglupta* in the Department of Botany, Australian National University.

These two independent trials suggested that a rooting inhibitor had leached from the adult scion material into the water in which the base of the scion was placed. After tissue union had begun it was likely that sufficient quantity of inhibitor could have passed into the young seedling stock to inhibit root formation.

After planting out in the field, further failures occurred. Almost all of these failures were due to lack of growth in the root stock. Of 2,000 bottle grafts carried out in 1968, only 9 have survived.

As a large-scale technique, bottle grafting was discarded in favour of patch grafting (*see* Section d).

c. Top-Cleft Grafting

Top-cleft grafting (Pryor and Willing, 1963) has been used with some success in Papua New Guinea on *E. deglupta* (Fig. 2).

The ultimate success of grafts and later growth of clones is subject to wide variation. Many unions are not viable for long and a form of graft incompatibility is often displayed which leads to death after a few months. Most individual seedling stocks were not able to form a satisfactory union with particular scions and the deaths occur mainly from lack of growth in the stock.

A few successfully grafted plants are thriving following planting out in the field. These have grown as well as seedling stock planted in the same area.

The incompatibility was similar to that described in Section b above. Fig. 2b shows an incompatible top-cleft graft. The graft survived for only three months in the field. The stock remained the same size throughout the period while the scion made normal diameter growth.

Of some 2,500 top-cleft grafts made in 1968 only six have survived. One of the successful unions is illustrated in Fig. 2c. Failures of similar magnitude have occurred with at least one other species of *Eucalyptus*. In 100 grafts made from 20 selected trees of *E. grandis* at Coffs Harbour (P. Burgess, pers. comm., 1972), initial take was high at 93%, but subsequent field performance was very poor. Mortality in the field was last assessed at 70% and only one fully compatible union remained.

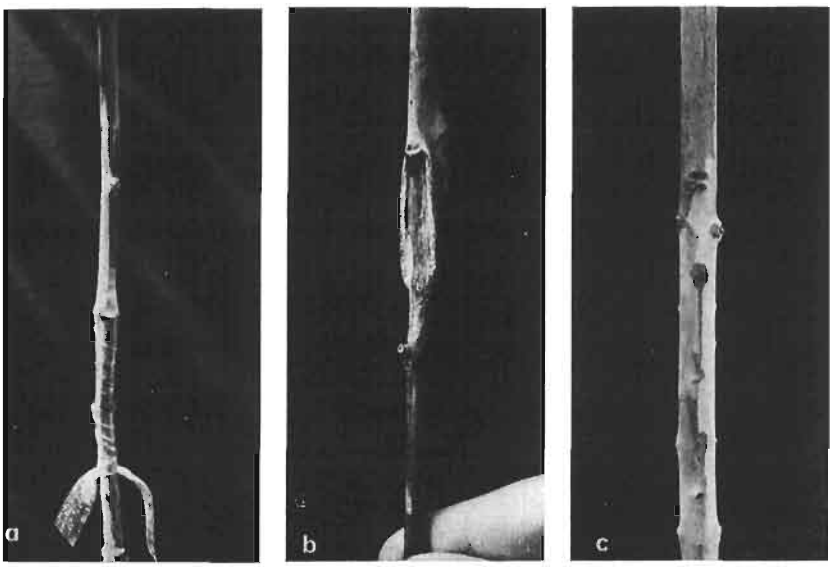

FIG. 2—a. A top-cleft graft, one week from grafting. Small shoots have just begun to develop from the axillary buds. b. Incompatible top-cleft graft. c. Compatible top-cleft graft.

d. Patch Grafting

The most successful method used for grafting *E. deglupta* in Papua New Guinea is patch grafting, a form of bud grafting.

The method is illustrated by the series of photographs in Fig. 3.

It is especially important that the stock used should be growing vigorously, yet the part of the stem on which the patch graft is made should not be too soft.

Potted plants about 1 m high and 1-1.5 cm diameter near ground level are normally chosen. Success is greatest (around 85% take) when grafting is carried out under the shade of high 30% sarlon. Grafting under high shade can be carried out all year round in Papua New Guinea. Several stages in the development of grafts are shown in Fig. 4.

No signs of incompatibility have been noticed in the unions while using this method with *E. deglupta.* In comparison with the previous two methods mentioned, the size of scion is very minute. If the postulated inhibitor is distributed throughout the adult tissues, it would be expected that the small scion would contain a great deal less of the critical substance as the patch is some 200 times smaller in volume than the smallest scions used in bottle or top cleft grafting.

Subsequent field performance is also excellent. No latent incompatibility symptoms have shown up in grafts 4 years of age.

An interesting feature of these open-grown grafts, set up as a trial seed orchard, is their habit (Fig. 4d). They do not show the marked apical dominance of saplings of the same age grown from seed. The crown shape and branching characteristics are similar to the top of the crown of the 15-year-old, 50 m-high tree from which the scion was taken—an excellent quality for seed orchard trees.

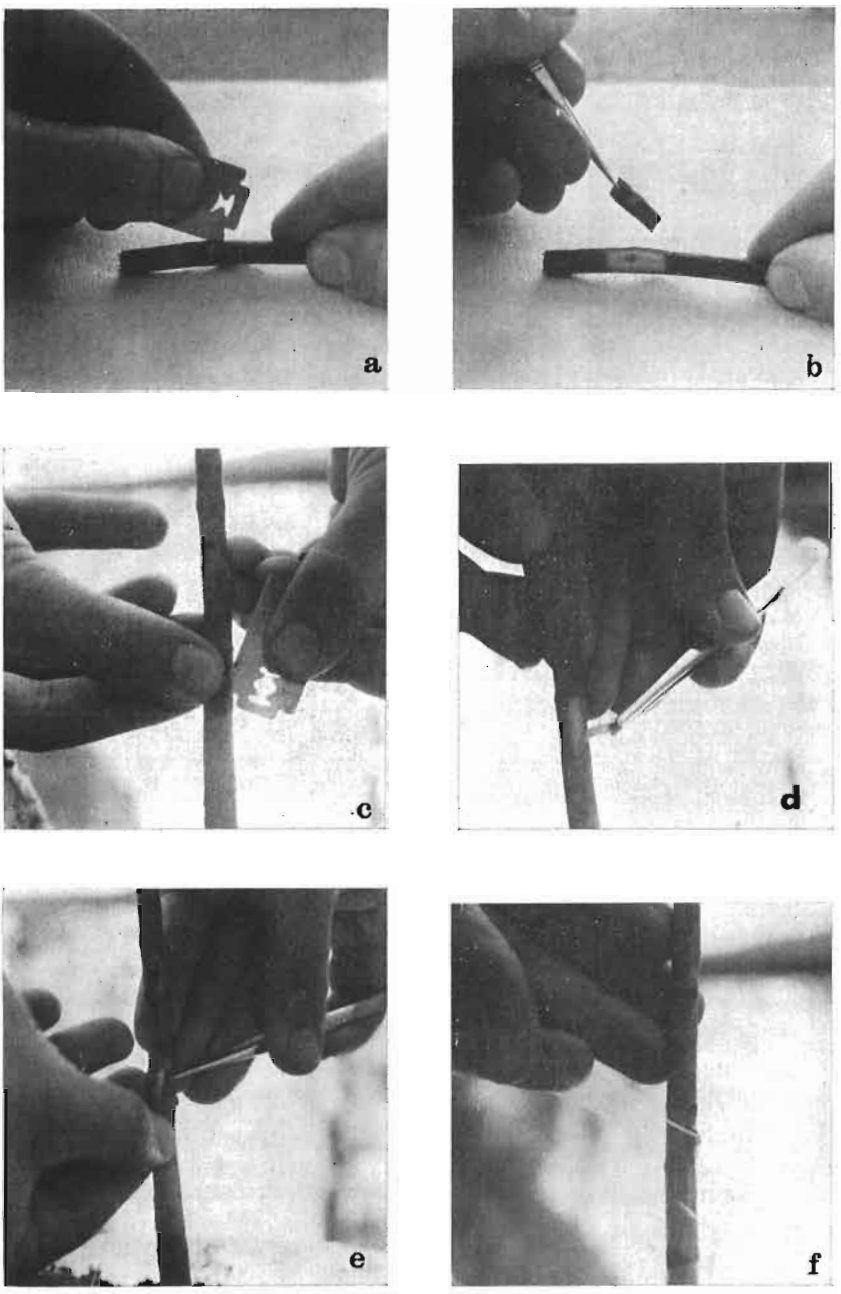

FIG. 3—a. Cutting the patch on the scion material; b. removing patch from the scion material; c, cutting bark on stock using the scion patch for size comparison; d, removing bark from the stock; e, placing the scion patch in position on the stock; f, taping the graft with non-adhesive clear tape. No mastic is used.

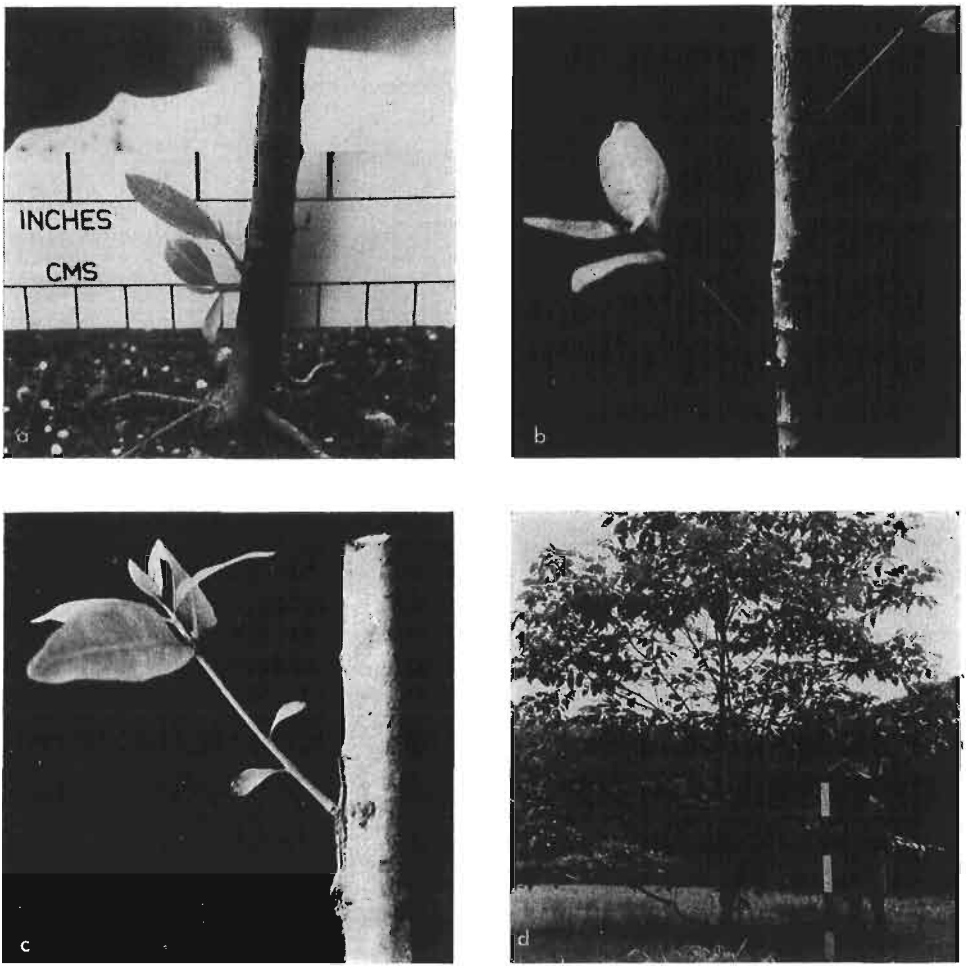

FIG. 4—a. Two shoots originating from a patch graft. b. Single shoot growing outwards and upwards from a patch graft. c. The stock after decapitation. d. A two-year-old patch graft at Keravat, New Britain, 1970.

DISCUSSION

There is increasing interest in the use of selected strains of *E. deglupta* in Papua New Guinea and of several *Eucalyptus* species elsewhere. The degree of graft incompatibility shown by some types of grafts of *E. deglupta* and *E. grandis*, for example, demonstrates the need to study, in detail, the nature of the stock-scion interaction as has been done with *Hevea braziliensis* (Buttery, 1961).

The physiological behaviour of the different types of *E. deglupta* grafts mentioned here indicates that some inhibition of the stock occurs. This inhibition can be overcome in *E. deglupta* by use of very small scions. More research is required on:

i. why there is a difference in graft compatibility between individuals as demon-

strated by the survival and normal growth of some individuals grafted by bottle and top-cleft methods and failure of the majority;

ii. the qualitative nature of the postulated inhibitor. This would appear to be a rooting inhibitor comparable to that found in cuttings by Paton *et al.* (1970), but in this present case appears to be translocated while that reported by Paton and co-workers was not;

iii. the quantitative nature of the inhibitor. It would be interesting to see, for example, if cuttings taken from successful top-cleft grafts would root in water;

iv. interspecific grafting trials of *Eucalyptus* to further determine compatibilities between species to attempt to explain the compatibility mechanism;

v. the part the root stock plays in graft compatibility, drought resistance, ability to withstand waterlogging (e.g., Boden, 1964), dwarfism and decay susceptibility.

These types of reaction between stock and scion have been studied in detail for plants of horticultural significance but not to any extent in forest trees.

The use of grafted clones in the establishment of plantations of *E. deglupta* for wood production is an uneconomic proposition because of the necessity of having adequate facilities for large scale grafting and since some measure of shading and means of forcing potted stock into a vigorously growing condition is required. Also, grafts of all types are tedious and time-consuming to prepare in large numbers.

However, the technique of patch grafting with *E. deglupta,* when applied to seed orchard work, is sufficiently well developed and cheap enough to be used effectively in practice.

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