Improving Plantation Eucalypts: The Role of Vegetative Propagation©

Helen Smith
State Forests of NSW, Research and Development Division, PO Box 100, Beecroft NSW 2119

INTRODUCTION

State Forests of NSW reinitiated their tree improvement program for plantation eucalypts for the north coast of NSW in 1994. Previous work in the 1960s and 1970s resulted in the planting of a number of species and provenance trials (Johnson and Stanton, 1993) and one seedling seed orchard for *Eucalyptus grandis* Hill ex Maiden (flooded gum) near Coffs Harbour. Initial research on vegetative propagation of *E. grandis* was carried out by State Forests of NSW (previously Forestry Commission of NSW) in mid 1960s to early 1970s (Forestry Commission of NSW Internal File, 1964-1977). Cuttings were struck from seedlings, coppice on girdled and felled trees in the field and potted seedlings, and maintained as hedges in a glasshouse for up to 5 years. Although a small number of clones were used in the work, strike rates of between 67% and 100% were often achieved. Field trial plantings were established, with plants of *E. grandis* propagated by cuttings and micropropagation (plants provided by Ron de Fossard, University of New England, Armidale). Top cleft grafting and bottles grafts of *E. grandis* had variable success, with failure of many of the grafts after 1 to 2 years due to incompatability.

The current hardwood tree improvement program is in support of State Forests' Planted Forests Division, that has undertaken a plantation program primarily based on the species *E. grandis*, *Eucalyptus pilularis* Smith (blackbutt), *Eucalyptus dunnii* Maiden (Dunn's white gum) and *Corymbia* sp. (spotted gums) particularly *Corymbia citriodora* subsp. *variegata* (F. Muell.) A.R. Bean & M.W. McDonald (syn. *E. citriodora* subsp. *variegata*), and *Corymbia maculata* (Hook.) K.D. Hill & L.A.S. Johnson. Approximately 22,000 ha of hardwood plantations have been established by this Division in the north coast region over the past 9 years. The aim of the improvement program is to increase the productivity of any future plantations and develop improved pure species and hybrid genotypes suitable for specific north coast sites.

ROLE OF VEGETATIVE PROPAGATION IN STATE FORESTS HARDWOOD TREE IMPROVEMENT PROGRAM

Vegetative propagation techniques are becoming increasingly important in the current tree improvement program, as improvement trials established over the past 7 years are assessed and superior genotypes identified. Individuals with superior performance in growth characteristics, such as volume and form, field resistance to pests, diseases, or frost and more recently, wood quality, can be selected for these traits and captured by vegetative means. Vegetative propagation is used in the tree improvement program to capture interim gains from the program, while the traditional breeding populations are managed for long-term continuous improvement. It is used to develop new clones and bring new genetic material into the breeding program, multiply limited amounts of select material for field-testing, and establish facilities such as breeding arboreta to progress the breeding program. Vegetative propagation is also used to propagate plants to provide a means for rapid operational deployment of improved genotypes by seed or vegetative propagules.

The role of vegetative propagation in our eucalypt tree improvement program is summarised in Fig. 1.

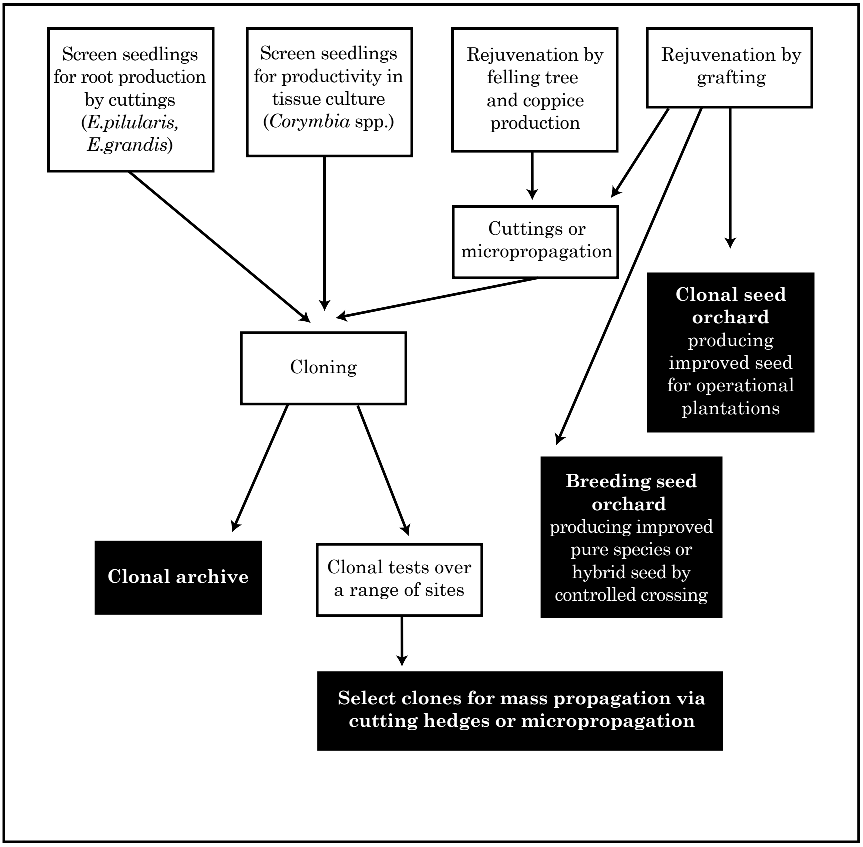

Figure 1. Role of vegetative propagation in our eucalypt tree improvement program, based on trees selected for superior growth and form.

PROPAGATION TECHNIQUES

A number of vegetative propagation techniques are used in tree improvement.

Cuttings. Cuttings cannot be used to propagate adult material of eucalypts. Shoots used for cuttings must be juvenile to be able to form roots. Cuttings are used to develop new eucalypt clones. There are two sources of material from which clones are developed — seedlings from seedlots of selected plus trees in native forests or plantations, or selected young plantation trees (field selects). Capture of field selects is achieved by taking cuttings from juvenile coppice shoots produced on stumps of the felled trees. Not all tree stumps will produce coppice shoots, but many will. Protocols have been developed for the propagation, by semihardwood cuttings, of *E. pilularis*, *E. grandis*, *E. grandis* based hybrids, and with limited success, *E. dunnii*.

Semihardwood cuttings are usually prepared as one internode in length, with an apical pair of leaves that have been cut to reduce transpiration. Some species and clones have better root development if a basal node is incorporated into the cutting. The cuttings are wounded on the base and a rooting hormone applied prior to setting. A powdered formulation of indole-3-butyric acid (IBA) is used, the concentration varying between 3000 ppm and 8000 ppm, depending on the species and source of cutting material (seedling vs. coppice). Cuttings are set in a propagation medium composed of peat and perlite in 40-celled trays (each cell of volume 93 cc) and placed in the propagating facility on heated benches (temperature of 23 °C in the root initiation zone), under intermittent mist. The time for the cuttings to strike varies with species and time of year. Under optimum conditions, it is generally 2 to 3 weeks, but may be up to 6 weeks with some species during cooler weather.

There is great variation between species and even between clones within families in amenability to the various stages of vegetative propagation. Prior to very recent work, cuttings have not successfully propagated *Corymbia* clones, so protocols have been developed for the micropropagation of *Corymbia* sp. However, in recent research into use of apical and semihardwood shoots for propagation of *C. citriodora* subsp. *variegata*, cuttings from 40% of clones have struck. Further screening is needed to ensure that cuttings from these clones will consistently form roots.

Clones are captured, screened for strike rate of cuttings, and those that reach the standard of 70% rooting are multiplied for field testing. The source of material for these cuttings are in-ground hedges in the clonal archive located on the NSW central coast. Cuttings are taken from the archive hedges during spring and summer. The better-performing genotypes are selected at 3 years after establishment of the field trials. Selected clones are then multiplied for further testing on different sites and for block plantings in operational plantations.

Minicuttings. Research has recently commenced on propagation of eucalypts by apical minicuttings. Potted mother plants are intensively managed, to optimise both shoot production and rooting of cuttings. In the initial experiments nutrient solutions were applied via a drip irrigation system, but more recently flood irrigation systems have been installed. Mother plants are maintained in celled trays or small pots and flood irrigated with well defined nutrient solutions 2 or 3 times per day. Apical cuttings are taken every 7 to 10 days, rooting hormone is applied to the base, and the cuttings are set in a propagating medium that has a high air-filled porosity. The aftercare of the cuttings is similar to semi-hardwood cuttings except more regular misting is required.

The advantages of this type of cutting propagation system, over the existing system, are that the plants produced have better form and a more robust and well developed root system, production time of plants is reduced as the juvenile apical shoot grows rapidly and the area required for mother plants is far less than for outdoor hedges (T. de Assis, pers. comm.). Research will continue on this propagation system as a potential method to strike cuttings from "difficult-to-root clones and species.

Micropropagation. *Corymbia* sp. are currently routinely propagated by micropropagation. Standard protocols have been developed for these species, although, once again, clonal variation is obvious in all stages of propagation. Explants are derived from aseptically germinated seedlings from plus tree seedlots, and clones developed from these seedlings. Propagation from field material, including coppice, has been limited in success due to contamination by endogenous fungi and bacteria. The system that has been successful for some eucalypt species is to graft scions from selected trees, and maintain grafts in an intensively controlled environment with routine spraying of systemic fungicides, followed by propagation of new shoot growth on initiation medium containing fungicides and antibiotics. Clones are screened for productivity in culture and rooting, and those reaching the 70% rooting with good multiplication rates are multiplied for field-testing. Clones are archived in vitro.

Grafting. Another use of vegetative propagation techniques is grafting ramets of superior genotypes to establish clonal seed orchards. Top cleft grafting has been found to be most successful for all species in the program. Scions are collected, by shooting or long handled pruners, from selected trees in trials, and grafted onto juvenile seedling rootstocks grown from related seed, to reduce incompatability between rootstock and scion. The scions are semihardwood, and may include the apical tip of the shoot. They are composed of between four and eight leaf axils, from which axillary shoots can develop. As material is collected under difficult circumstances, at field sites remote to the grafting site, it is often not possible to match the diameters of scions and rootstocks. Thus, it can be that the cambia on only one side of the stems will be placed in close contact with each other during grafting.

The grafted ramets are placed under intermittent mist. During the optimum time of year for grafting (spring, early summer, and early autumn), callus develops and a union is formed as early as 2 weeks after grafting. The mist is gradually reduced when shoots of up to 5 cm have grown on the scion. Grafted ramets are ready for planting the following spring.

Grafted ramets of superior clones are planted in clonal seed orchards to facilitate production and deployment of genetically improved seedlings into operational plantations. To date, two clonal seed orchards have been established in the hardwood tree improvement program, one each of *E. dunnii* and *E. pilularis*, with another of *E. pilularis* to be planted next spring. Ramets can also be used to establish breeding arboreta for manipulation of flowering and controlled crossing of superior genotypes to produce seed of specific hybrids or pure species. Clones can be developed from these seedlots for planting on sites with specific characteristics. The first breeding arboretum will be established at Grafton next spring.

LITERATURE CITED

De Assis, T. Aracruz Celulose S.A., Guarjuvira Street 54, Condominio Residencial Altos da Ale, 92.500-000, Guaiba, RS, Brazil. 13 April 2000.

Forestry Commission of NSW. 1964-1977. Internal file G3/8.4. Vegetative propagation of eucalypts. Wood Technology Division, Reseach Centre, Coffs Harbour, NSW, Australia.

Johnson, I.G. and **Stanton, R.R**. 1993. Thirty years of eucalypt species and provenance trials in New South Wales – Survival and growth in trials established from 1961 to 1990. Forestry Commission of New South Wales Research, Paper No. 20.