RAISING RADIATA PINE AND EUCALYPT SEEDLINGS BY AN INDUSTRIAL FORESTRY COMPANY IN GIPPSLAND, VICTORIA

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Australian Paper Manufacturers Limited requires both pine and eucalypt for pulp production. The eucalypt pulpwood mainly comes from forest residues following sawlog extraction and from sawmill chips obtained from natural stands in State Forests while pine pulpwood is obtained from Company plantations on a continuing basis of thinning, clear cutting and replanting.

We have been actively engaged in the reforestation of abandoned farmland in Gippsland since 1950. During this 25 year period, 41,000 ha. have been established, requiring some 75 million pine seedlings and 7½ million eucalyptus seedlings.

The two main species used for this programme have been *Pinus radiata* (D. Don) on the marginal or low rainfall sites, and *Eucalyptus regnans* (F. Muell.) in the Strzelecki Ranges where rainfall is higher. Planting sites are prepared at considerable cost so it is imperative that the site be fully utilized with high quality seedling stock.

To ensure successful establishment, a high seedling survival in the field is necessary together with a vigorous early growth. Seedlings must have specific qualities to withstand adverse conditions in the field. They must have a woody stem, hardened-off foliage, a fibrous root system in balance with the stock, and have an acceptable level of mycorrhizal infection.

Pine seedlings are raised in a Company nursery, situated at Longford (near Sale) and the eucalyptus seedlings at Traralgon, Victoria.

This paper deals with the basic procedures and material requirements of the nursery programmes from seed origin through to the end seedling product ready for field planting.

RADIATA PINE

Seed Origin. Seedlings for the Company's earliest pine establishment areas were raised from seed purchased mainly from New Zealand and South Australia. This seed source continued until the Company's plantations began producing a cone crop. During this time a tree breeding programme was started and seed orchards established (2).

A.P.M. Forests Proprietary Limited, together with C.S.I.R.O.

Division of Forest Research (formerly Forestry Research Institute) have been involved in a co-operative tree breeding programme since 1958. The aim of the tree breeding programme is to improve wood production per hectare based on form, branch characteristics, and wood quality of all parent trees; their progeny is evaluated for health, vigor and wood properties. Initially the clonal material for grafting onto seedling stock was imported from New Zealand and many areas in Australia after intense selection by Forestry Departments for superior or "plus" trees. More recently, assessment of progeny from locally selected "plus" trees indicates the importance of their adjustment to the Gippsland environment. The scions are grafted onto healthy seedling stock and planted at wide spacing in areas free of outside pollen contamination to form seed orchards. Seed from these orchards is presently used in the pine nursery, and seedlings have been raised from this source since 1968. The seed orchards are being constantly upgraded by the introduction of new genetic material. The Company places extreme importance on seed origin and its potential for improvement.

Cone Collection and Seed Extraction. Cones are harvested from the seed orchards during the early summer period each year. Seed is extracted from cones by thermostatically controlled hot air from an oil-fired unit passing through a mesh drum. The drum is rotated intermittently to free the seed which drops through the mesh onto a conveyor belt. This seed is de-winged, cleaned and graded into three size classes. It is checked for moisture content (maximum allowable 8 percent), packed in plastic drums and stored at 4^0 C for until required.

Seed preparation - Stratification. Seed is soaked in water in the plastic storage containers for 12 hours. All surplus water is then drained off and the drums are returned to 4^0 C for 28 days before sowing. Stratified seed gives a more rapid and even emergence and a higher germination percentage than does unstratified seed.

Soil preparation. The Longford nursery soil is a relatively fine sand with a pH of about 5.5. Clay content and humus are both low. Humus is increased by cultivating in a 5 cm layer of pulverised pine bark (to which nitrogen has been added to give the correct carbon-nitrogen ratio). This is not a routine operation having only been done twice in six years. The maximum benefit to seedlings was evident two years after application. Soil preparation for the new crop begins immediately after the previous seedling crop has been lifted (usually in mid-winter). The total nursery area is rake harrowed to level the site and to harvest any surface weeds.

Fertilizer. Fertilizer requirements are determined from chemical analysis of seedlings from the previous crop. If the previous crop was healthy and showed no major deficiencies, then the same fertilizer regime is applied for the new crop. Initial fertilizer application to the current nursery was 560 kg per ha of superphosphate with copper and zinc added at 1% each.

Sowing. In mid-September (early spring) the nursery area is rotary hoed and beds 1.8 m wide and 15 cm high are formed. The seed is removed from the refrigerator on the day of sowing and surface dried on hessian sheets to facilitate sowing. It is essential that the period of time between drying and sowing be kept to a minimum. Stratified seed is planted into 10 evenly spaced rows 15 cm apart with a Connor Shea combination seed sower, fitted with an adjustable roller at the front for bed compaction should the beds be too fluffy. Loose trailing "crowders" cover the seed, which is sown to a depth of 1.3 c.m.

The crop of 6 to 8 million seedlings usually takes a four-man crew two days to form beds and sow. The sowing rate is based on cabinet germination figures and the aim is 38 germinates per m for a potential recovery of 22 plantable seedlings per m.

Weed Control. Pre-emergent weedicides are applied by boom spray immediately after sowing is complete. Common summer grass (*Digitara sanguinalis*) has recently become a major problem and Tok E (Nitrofen) is being used to combat this. A rate of 4.5 kg ai per ha was applied immediately after sowing and will be repeated at regular intervals of six weeks. Tok E can be applied over developing seedlings without damage.

Propazine is applied at 0.8 kg per ha to control all other annual weeds but a second application may be necessary three months later. Persistent weeds can be controlled by spraying White Spirit (a petroleum distillate) through jets set close to the soil between seedling rows. Some hand weeding is necessary to check sorrel *(Rumex acetosella).*

Maintenance. An application of Pivot 400 fertilizer at 168 kg per hectare is applied through the Connor Shea combine six weeks after sowing or earlier should seedling development indicate. Later any slower developing areas will receive a further application. Added growth is induced when necessary by the application of "Aquasol" foliar fertilizer through a liquid fertilizer spreader.

The pine seedlings which should be plantable size by late summer (February), are then subject to regular root pruning to encourage a fibrous root system and to check further top growth. A secondary benefit is an increase in the mycorrhizal infection of the roots. Root pruning is initiated by undercutting 10 cm below the surface with a reciprocating blade. This is repeated four times

before lifting but each undercut is fractionally lower than the previous one.

Roots are vertically pruned along the rows by a set of coulter wheels fixed in front of a wheel tractor with the cutting wheels running in the centre of the row spacing. This lateral pruning is done twice during the nursery season. If seedlings become too tall, they can be topped with battery powered cutters, but this practice is avoided where possible. Wind is a constant problem at the Longford nursery as it lifts sand from the surface and virtually "sand blasts" the seedlings on the windward side. This can be overcome by applying clay slurry through the fertilizer spreader to seal the soil surface. Normal watering reduces the effect of the seal so the clay slurry may have to be applied several times whilst seedlings are small.

Lifting. Lifting of the seedlings begins after the first substantial rains (usually May). An angled blade equal to the width of the bed is passed under the seedlings at a depth of 15 cm. This action loosens the soil without altering the vertical position of the seedlings which suffer minimal root damage when lifted from the bed. Seedlings are lifted by hand, the roots are puddled in thick clay slurry, and are then heeled back into the soil until required for planting. The rate per man day is 25,000 which includes bypassing or culling out reject stock. As seed is graded and sown separately, the occurrence of suppressed individuals is reduced to a minimum. Culled seedlings are mainly double leaders, malformed or diseased.

The majority of seedlings are carried to planting sites in open tip trucks covered with tarpaulins to avoid wind dessication. Randomly selected despatches are followed to the field by nursery staff to assist in determining whether any future losses were the result of incorrect field handling or could be traced to any one nursery practice.

EUCALYPTUS REGNANS

From 1953 to 1960, we experimented with various species of Eucalypts for establishment both in the foothill forests and in the Strzelecki Ranges with mountain ash *(E. regnans F. Muell.)*. In 1960 it was decided to concentrate on planting mountain ash on abandoned and derelict farms on deep mountain soil as this species showed high volume production (1).

The annual seedling requirements can vary but the number raised is usually between 800,000 and 1,200,000. Approximately 80 percent of the crop is *Eucalyptus regnans;* the remainder consists of *E. globulus, E. viminalis* and *E. robusta* some of which are reserved for amenity and environmental planting and outside sales.

All seedling stock in the Traralgon nursery is raised in peat pots (Jiffy pot No. 517) (3).

Seed Origin. It is believed that seed of *Eucalyptus regnans* harvested locally and planted back on the same site performs better than seed from non-local provenances. Local seed harvested from dominant trees is now used whenever possible.

In 1969, a tree improvement programme was started with *E. regnans* based on seed from local open-pollinated mother trees (4). These dominant mother trees were selected from even-aged, naturally regenerated stands arising from the 1939 and 1945 bush fires in the Strzeleckis. Seed was obtained from selected trees by shooting down limbs bearing capsules with a high-powered 0.222 sports rifle.

Seedlings from this seed were planted in family groups at 6 m centres to form seed orchards. Seedlings were also planted back on site in progeny trials so that differences between families could be assessed. Families which perform poorly will be culled from the seed orchards and progeny from the "better" families will later form the basis of improved seed orchards. It is anticipated that eventually all *Eucalyptus regnans* nurseries will be sown with improved seed.

Preparation and Sowing. Peat pots are placed into black plastic trays and set out on 2 m wide beds of metal aggregate. Paths between beds are 60 cm wide and alternate paths carry a water line for the sprinkler system.

Fine granulated MagAmp is broadcast into empty pots at the rate of 170 gm per 1000 pots. Pots are then filled en masse by hand with a fine grained sand which does not require sifting or sterilizing. The sand is then levelled to the top of the pot and lightly watered. This consolidates the sand slightly and the pots are retopped and levelled ready for sowing.

Seed Treatment. *Eucalyptus regnans* requires stratification to break seed dormancy. Dry seed is placed in fine muslin bags and soaked in water for 12 hours. Excess water is drained off and seed is stored in closed plastic containers at 4°C for 28 days.

Sowing. The sand-filled pots are watered lightly once more and the stratified seed (mixed 100 parts sand to 1 of seed) is broadcast over the pots. Nursery germination is usually about 80 percent of cabinet germination and the sowing rate is adjusted to achieve 3.0 to 3.4 germinates per pot. The seeded area is watered immediately then lightly covered with fine peat moss which is, in turn, watered lightly to complete the sowing programme. The nursery is sown in mid-summer over a two day period. Germination begins approximately 14 days after sowing and should be completed within a further 7 days. Germination, vigour and stems

per pot are determined by assessing small plots located in the nursery prior to sowing.

Maintenance. To lessen the dangers of losses through fungal development, the beds receive a weekly application of Difolitan until germinated seedlings reach the developed cotyledon stage, then Benlate (benomyl) is applied at regular intervals. The MagAmp applied in the base of the pots supplies the seedlings' basic nutrient requirements but "Aquasol" is applied fortnightly through the watering system after the second set of primary leaves are formed. Any small areas of retarded seedlings receive a light application of urea chips to bring them forward. One seedling per pot is desirable for field planting and all pots are thinned back to one seedling by removing surplus germinates and leaving one good seedling near the centre of the pot. This operation is done in the early post cotyledon stage.

Weed Control. The sand medium used is relatively free of weed seed but some weeds do result from wind-blown seed.

Watering. The pots require frequent light waterings because of the large surface area, shallow depth and the sand medium used. Water is delivered through butterfly sprinklers set 6 m apart on a 5 cm aluminium pipe.

Transportation. At planting time in May to June, the seedlings have reached and maintained a height of 20 to 25 cm and have become hardened off due to the colder autumn temperature and reduced nursery feeding.

Seedlings are transported to the planting site in a truck fitted with multiple decks to carry a total of 12,000 pots. The black plastic trays are used in the field as seedling carriers then returned empty to the nursery. The nursery staff endeavours to follow seedlings to the field to ensure that they receive correct handling and finally to assess seedling performance.

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LITERATURE CITED

1. Cromer, R. N. 1975. The potential for Eucalypt plantations in Victoria. *Austral. Science and Tech.* 12(6):6-9.
2. Eldridge, K. G. 1962. Improvement of *Pinus radiata* for forestry in Gippsland. APPITA Vol. 15-5.
3. Hall, M. J. and K. P. Richmond. 1966. Raising Eucalypts in peat pots. APPITA Vol. 23-1.
4. Richmond, K.P. 1971. A seed orchard of superior *Eucalyptus regnans*. *Inst. of Forest Austral. Newsletter* 12(3)13.