Propagation of seedlings of native trees and shrubs

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Some factors that were found to be important in a small nursery producing 10-50 species and more than 5,000 seedlings per year are discussed below.

Potting tubes
Most nurseries now produce seedlings in "plug" planting systems− trays of 40-50 seedlings in 25 mm x 25 mm x 50 mm plugs. However, for the non-commercial producer, it is probably best to use plastic 50 mm x 50 mm x 120 mm high 'forestry' tubes. Make sure that these tubes have internal ridges that direct roots downwards. Such tubes produce plants that have very little root coiling, a fault that can cause losses of trees several years after planting. Older tubes with smooth sides were deficient in that regard.

Tubes can be recycled. It is advisable, when using potting mixtures containing a high proportion of clay loam, to wash any soil from used tubes before re-use otherwise the new seedlings may be difficult to dislodge from the tubes. Washing can be expedited by packing tubes into wire trays and employing hot water and detergent applied through a spray-cleaning unit. This process may eliminate disease organisms but, if in doubt, also dip the tray in a hypochlorite bath (effective concentration 4% chlorine) to sterilise the tubes. Household bleach can also be used (*e.g.* 20 mL of bleach per litre of water) but at this lower concentration of chlorine the tubes must be allowed to soak for about 10 minutes.

Potting mixes
Seedlings may be readily produced by two methods:

- direct-seeding into 'forestry' tubes which have been filled with potting mixture
- sowing into seedling trays and then pricking out later into tubes (see below)

A potting mixture that has proved to be economical and successful consists of coarse sand (*e.g.* "Coleraine sand" or "river sand"), sandy loam (*e.g.* "fern sand") and old rotted manure in proportion of 2:2:1. Peat, rotted sawdust or crushed pine bark in commercial mixes can replace the rotted manure. Other 'complete' mixtures can be used, including those containing vermiculite, peat, compost and rotted sawdust. These contain few weed seeds but can be expensive and prone to 'damping off' problems with emerged seedlings as a result of poor drainage. One economical solution is to mix coarse sand into the commercial potting medium, as 50% of the mix.

Disease
Potting mixtures that contain a very high proportion of vegetable material will favour "damping-off" organisms that quickly infect the seedling, reducing the stem to a thin thread and ultimately killing it.

Be extremely careful that you do not introduce phytophthora (root-rot) into your nursery area by buying infected seedlings, soil or potting mixture. If 'fern sand' from bushland is used it is possible that it may have phytophthora – such sand may be 'pre-cooked' in an oven to destroy pathogens and weed seeds.

Nutrients−after the first month or so it is necessary to provide a regular supply of nutrients to seedlings grown in potting mixtures that contain little or no manure. Controlled release fertiliser, such as "Osmocote", supply the nutrients N, P, S and Ca. Low-P slow release fertilisers can be incorporated into the potting mixture in the proportion of 2 g/litre of mix. Micronutrients can be supplied at 1-2 month intervals by dissolving 8-16 g (1-2 level measures) of "Aquasol", "Thrive" or similar material in 10 L of water and applying via a watering can as a light spray.

Seed 'dormancy'
A few eucalypts and other genera have a requirement for cold stratification before germination will freely occur. Such seed needs a period of days in cold storage at 2-5°C.

Sweet Bursaria (*Bursaria spinosa*) sheds its seed in autumn and germinates naturally in mid-winter following frosts. It will not germinate freely in late spring or summer, the tubes standing empty until mid-winter. However, it can be tricked into germinating in summer if the seeds are first given a day or so in the freezer and then planted.

Hard-seeded species (e.g. Acacia and members of *Fabacea* pea-flower family) require their seeds to be scarified or heat-treated to promote germination. For all 10 Acacias tested (see Table 1), the optimum heat treatment to promote germination was to allow the seed enclosed in metal fly-wire gauze to stand for 1 minute in water that had been brought to the boil in a large pot. On a smaller scale, simply add boiling water to a cup and leave the seeds in the water until they swell. The seed can then be sown damp or air-dried on paper towel in mild sun and stored until required.

Direct-sowing the seed into pots

Sow the seed in summer or autumn. With large-seeded species such as acacia, banksia, casuarina, hakea and cypress, put about 3 seeds on the soil surface in each tube and, using a sieve, lightly cover with medium sand. For small seeds such as eucalyptus, melaleuca and leptospermum, you should aim to spread an average of about 5 viable seeds per tube, but allow for about 20% of tubes to fail. Estimate the number of viable seeds in a certain weight of seed plus chaff (see Table 1) and calculate what amount is needed to cover the surface of the packed box of tubes filled with potting mix. A little fine sand with the seed helps in the spreading through a sieve. Put a sheet of iron or paper under the box to collect any spilled seed and reapply it. Cover the seed lightly with fine sand, distributed through a sieve. It is usual to pre-soak the tray of tubes and soil mixture before sowing but thereafter water is applied from the top by fine spray. It is necessary to keep the surface damp until the seedlings germinate but thereafter the top 1-2 mm should be allowed to dry out each day, if possible, to prevent 'damping off'.

The direct-seeding approach gives better root development and should eliminate problems of constricted roots that can occur with seedlings that are pricked out. The direct-sowing approach allows greater flexibility in timing operations, as the thinning out to one seedling per pot can be made at convenient times over a long period. To avoid disturbing the roots of the seedling that is left in the tube it may be best to snip off other seedlings rather than pulling them out. The thinning process is initiated in early summer, after the stems have thickened a little and the plants are less susceptible to damping off, and the seedlings should be ready for spring planting.

Sowing into seed trays and pricking out into tubes

If you decide to germinate seed in small trays and then prick them out later into tubes, a few points are worth noting. Fine seeds may germinate best if the trays are kept wet using the "bog method" − the seed tray is stood in a container of wet sand but as soon as germination is observed remove the tray from the bath and water thereafter from the top. Failure to do this will usually result in "damping off" and loss of all of the seedlings.

Where seedlings are pricked out into tubes the best approach is to suspend the seedling over a partly filled tube and fill around the roots, rather than trying to put the roots down a dibble hole in the potting mixture. The latter action often results in roots being caught on the sides and badly kinked.

Controlling disease in the nursery

Many problems with fungal or mildew infection can be avoided by not using a hot-house (glass-house) or shade house. Provide protection from wind, and tackle the problem of heat-waves and lack of shade by regulating the frequency of watering on those days.

If problems with mildew are encountered then "Benlate" or similar fungicides should be applied and the seedlings isolated from other stock. Ensure that the foliage is allowed to dry off and that the pots are not kept continuously sodden.

Species of the fungus *Phoma* appear to be best controlled by Benlate; *pythium* and *phytophthora* organisms are best controlled with phosphorous acid (commercial products are "Alliette", "Foliar Fos 2000", "Phosgec 20" and "Fongarid"). Where problems occur use about 40 g of "Alliette" (or an equivalent amount of phosphorous acid) in 10 L of water and apply this monthly by watering can to wet the surface of the potting medium. With sensitive species, vermiculite could be used rather than peat.

Stowing the seedlings

Air-pruning of roots that emerge from the base of the tube is required and obtained by packing the tubes in wire or open plastic trays and keeping these clear of the ground. Seedlings cannot be satisfactorily stored in boxes that allow root growth in material outside the tube. Slugs and snails also find easy refuge in these boxes and are difficult to detect and control.

Watering system
The modern micro-irrigation sprayers, with programmable battery-operated timers, are very satisfactory for watering nursery stock. These systems remove a major labour/time impediment. Anyone wanting to raise large numbers of seedlings should make this small initial investment.

The ideal size of seedling to plant− the best seedlings are small (the shoot:root ratio should ideally be about 2:1) so the optimal size for seedlings grown in forestry tubes is about 20 cm.

Table 1. Guide to seed numbers and viability from assessments done in 3 years 1987-89 Agriculture Victoria, PVI – adapted from *Trees & Shrubs for South West Victoria* by PR Bird, GA Kearney & DW Jowett (1996)

SPECIES	Loc.	No. (N) seeds/g	Viable seed/g (or %N)	Loc.	No. (N) Seeds/g	Viable seed/g (or %N)	Loc.	No. (N) Seeds/g	Viable seed/g (or %N)
E. serraensis	1		21	2		30	3		45
E. camaldulensis	4		380	5		520	5		90
E. cladocalyx	6		230	6		90	6		206
E. globulus	7		83	7		109	8		50
E. kitsoniana	9		664	10		589	11		688
E. leucoxylon	12		161	13		174	14		300
E. maculata	15		85	16		68	16		100
E. melliodora	17		105	18		382	19		600
E. microcarpa	20		988	21		1004	22		560
E. ovata	23		225	23		624	24		336
E. occidentalis	25		236	25		156	26		256
E. polyanthemos	27		1148	28		961	28		352
E. sideroxylon	29		105	29		104	30		68
E. viminalis	31		472	31		560	32		396
Al. verticillata	33	229	48 (21%)	34	271	46 (17%)	34	271	49 (18%)
C. glauca	35	1781	606 (34%)	36	2033	262 (13%)	37	1422	640 (45%)
C. cunninghamiana	38	1881	113 (6%)	39	3127	1126(36%)	39	2366	1633(69%)
Al. luehmannii	40	165	81 (49%)	41	206	31 (15%)	42	256	59 (23%)
Al. muelleriana	43	459	115 (25%)	43	459	142 (31%)	43	459	151 (33%)
A. brachybotrya	44	36	8 (21%)	45	35	10 (29%)	46	36	19 (54%)
A. exudans	60	48	18 (38%)	61	49	26 (54%)	62	49	23 (47%)
A. howittii	47	141	82 (58%)	47	143	83 (58%)	47	143	
A. iteaphylla	48	32	25 (79%)	49	28	26 (93%)	49	28	25 (90%)
A. longifolia	50	73	57 (78%)	51	70	56 (80%)	51	70	
A. mearnsii	52	89	82 (92%)	53	85	77 (91%)	53	85	81 (95%)
A. melanoxylon	54	58	36 (62%)	55	59	36 (62%)	55	59	37 (62%)
A. pycnantha	56	42	39 (93%)	57	44	33 (76%)	57	44	
A. retinodes	58	73	48 (66%)	59	77	59 (77%)	59	77	
A. verticillata	63			64	121	81 (67%)	64	121	80 (66)
M. armillaris	65		2595	65		2470	66		2990
M. decussata	67			67		4670	68		4950
M. ericifolia	69		170	70		13845	70		13410
M. halmaturorum	71			71		2350	72		2720
M. lanceolata	73		1005	74		1207	75		1000
L. scoparium	76		285	77		1160	77		1420
L. lanigerum	78			78		1430	78		1240
C. rugulosus	79		8070	80		8820	81		8540
B. spinosa	82	435		82	435	204 (47%)	83	499	235 (47%)

Note – many of the germination tests for a given species apply to different seed collections made in the 3 years. The locations (Loc.) of the collections is indicated by numerals − within a row the same collections are given the same number (there were only 3 instances when the same collection was used in all 3 years of the direct-seeding project). Some seed was purchased but most was collected locally (e.g. Casterton Varnish Wattle – *Acacia exudans* and Sweet Bursaria – *Bursaria spinosa*).