Direct-seeding of Native Trees and Shrubs in South-West Victoria

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Introduction

Direct seeding of trees was first practised in Victoria in 1873, when belts of sugar gums were sown on ploughed belts on the basalt plains. In later years when improved pastures were sown the problem of weed competition with the tree seedlings made success with the old approach difficult. Very few trees were established by direct seeding after 1940, until a resurgence of interest in the 1980s.

The major advantages of direct seeding are the increased capacity to establish trees (10 km of belts can easily be seeded in a day) and the lower costs of the tree establishment (especially where high initial tree densities are needed).

Research in South- west Victoria

In 1987-89 a National Soil Conservation Program funded a direct-seeding project on 12 farms on four Land Zones of the SW Region of Victoria. The research had 3 main objectives:

(1) **Assessment of site preparation methods, seed bed factors and time of sowing on germination/establishment of trees.** Twelve treatments were tested, including 4 times of sowing (April, September, October & November) and 4 forms of ground preparation:
- Mouldboard treatment – a single pass of a 3-furrough plough over the ripline
- Scalping treatment – an off-set disk slicing off a strip of soil 10-20 cm wide and 3-7 cm deep, with disturbance to the furrow created by 3 narrow cultivator points
- Cultivation treatment – a single pass of a hand-driven rotary cultivator along the line
- Nil treatment – no disturbance to the sprayed strip

(2) **Assessment of residual herbicides applied before sowing for weed control in the early establishment phase.** Twelve herbicides were applied at 2 levels and with 2 methods of seedline protection (scalping *v.* shielding). Scalping involved using an off-set disc to slice out soil containing herbicide. Shielding involved using a guard to prevent sprayed residual herbicide from contacting the sowing line. The spray width was 0.6 m from each edge of the sowing line. Where a shielded spray was used the seedline had been prepared for seeding by a small rotary cultivator.

(3) **Assessment of overspray herbicides applied in autumn (residuals) or late winter (contact and systemics) on tree survival & growth in the post-establishment phase**. The twelve herbicides were assessed at two levels of application. The residual herbicides were applied at the autumn break and the contact herbicides in August. All of the herbicides were sprayed over the top of the plants.

All plots except the control were ripped in late autumn and all plots had a 1.5-m-wide strip sprayed with Glyphosate in August or September and again before sowing, to control weeds.

In each of the 3 years the work was done on 3 farms on each of Basalt Plains, Dundas Tableland, Glenthompson Rolling Hills and Wimmera Plains. The results are thus based on 12 sites.

Results were assessed from the numbers of 38 species of trees and shrubs sown that were present at 6 months and 16 months after sowing.

Results & conclusions from the research.

The full details were published in *Trees and Shrubs for South West Victoria* (1996) by PR Bird, GA Kearney and DW Jowett (Publ. Agriculture Victoria). A summary is given below.

Site Preparation: Scalping was generally the best way to prepare a seed bed but mouldboarding gave the best result on wet sites. Cultivation, or sowing on bare ground, was much less useful.

Time of sowing: Spring sowing (September or October) was much superior to April or November

sowing where, although some seedlings germinated, few survived to 16 months.

- In one year, results on the Dundas Tableland showed better germination in April than at any other time but the advantage was lost over winter and spring because few seedlings survived.
- Plots from spring-sowing having a dense germination invariably 'thinned out' by 16 months, due to competition for water.
- Direct-seeding results from the Wimmera Plains were poor in 2 of the 3 years, seemingly dependent on rainfall. There was no advantage in sowing there in autumn because no plants from the autumn sowing survived to 16 months, whereas sowing in spring was successful.

Seedbed covering: There was a small but not a significant benefit from 'smudging' in the seed by dragging a bag containing a little sand along the seed line after sowing.

Seedbed compaction: There was no substantial or consistent benefit from rolling a tyre (to simulate a 'press-wheel') along the seed line before sowing or after sowing. However, there may be some small advantage on sandy soil in using a press-wheel to compact the seedbed after sowing.

Pest control: We found no response, although slugs and red-legged earth-mite should be looked for on any site.

Application of residual chemicals pre-sowing: Scalping away chemicals applied over the sowing line was effective in improving survival of seedlings (compared with the control treatment of glyphosate only).

- Chemicals such as Glean (*chlorsulfuron*), Goal (*oxyfluorfen*), Kerb (*propyzamide*), *atrazine* and *simazine* showed positive effects at most sites over all years. The treatment that was generally the most effective was Glean (*chlorsulfuron*).
- Enide (*diphenamid*), Dual (*S-metalachlor*), Metribuzin ($C_8H_{14}N_4OS$) and Linuron ($C_9H_{10}Cl_2N_2O_2$) had some benefit in some years, at some sites.
- Care must be taken on very sandy soils where most chemicals can leach into the sown line. This probably occurred in one year in the Glenthompson area, where high applied amounts of most of the chemicals resulted in fewer seedlings surviving.
- As expected, the greatest impact of applied residual herbicides was observed in years when weed growth was worst.
- When applying any chemicals follow the label recommendations as to amounts of chemical to use and take care to provide protection against herbicide contamination of the body.

The herbicide scalping treatments overall were superior to the shielded herbicide cultivated treatments. The difference was probably due to the scalping away of weed seeds and excess nutrients rather than the way the herbicide was applied, since the control scalped plots gave significantly better results than the control cultivated plots.

Application of overspray herbicides post germination: Residual chemical were applied in autumn and the other herbicides, including *glyphosate*, in early August. The impacts were assessed on Eucalypt, Acacia, Melaleuca and Allocasuarina species:

- *Simazine, atrazine, propazine*, Devrinol (*napropamide*) and Surflan (*oryzalin*) mostly improved the survival of plants and had no significant negative effects.
- The 'grass' herbicides Sertin (*sethoxidim*) and Fusilade (*fluazifop-p*) mostly had little or no impact.
- *Glyphosate* (1 L/ha) had no significant negative effects and, at one site in one year where weed growth was prolific, a large positive effect on eucalypt, sheoak and acacia numbers at 16 months.

Recommended practice for direct-sowing of trees and shrubs in SW Victoria

Recipes are given for direct-seeding in **late-winter or spring:**

- planting in lines, using scalping or mouldboard methods
- planting at spots, using hand-tools.

Preparation

Proposed planting lines should be ripped in early winter before the subsoil becomes wet, but there is no point in ripping deep sandy soils or wide-cracking clay soil. Rip deeply but without bringing clay up. Lightly roll down the lines to compact the surface.

Graze the site heavily in early winter then apply the first application of a knock-down herbicide such as *glyphosate* (2-4 L/ha) in a 1.5 m band (or 1.5 m diameter spots, where the hand-sowing method is to be used). The pasture must be killed early in order to conserve the soil moisture for use by the trees in summer. Apply a second application (2 L/ha) about 6 weeks later, just prior to sowing, to eliminate difficult perennials and new germinants. A residual chemical such as Glean (*chlorsulfuron*) (10-30 g/L) could be included in this spray to prevent further germination of grass and other weeds following late spring or early summer rains, and should be effective until late summer.

Apply the recommended amounts – too much may kill the seed (or tree), especially on sandy soils. Too little will result in a poor weed kill or, with residual chemicals, too short an effective weed-free period.

Sowing in scalped lines

Scalping will remove weed seeds, herbicide and high fertility from the seed zone. The scalp line should be roughened with tynes behind the scalping disk, to give a good seedbed. Mix the seed with an equal part of sand, bran or sawdust and sow by hand (low to the ground so that wind does not blow away seed) or by machine. The seed could be "rubbed in" by dragging along the line a small bag weighted with a little sand, although there is no good evidence that it is needed. Do not bury any seed deeply – fine seeds must be left near the surface (2-4 mm is best, 15-20 mm is no good).

Apply an autumn overspray of *simazine* (2-6 L/ha) before autumn germination of weeds. This will keep the site relatively weed-free through to the next autumn. It is difficult to judge when to apply these residuals – for best effect the soil needs to be moist, but the weeds may germinate after one fall of rain. *Atrazine* has some knockdown effect on young weeds and may be the best choice if you have delayed spraying in the hope that early weeds would die without follow-up rain.

Spraying over the top of seedlings in autumn with these and other chemicals has usually much improved survival and growth. Any damage done to the trees by the chemical is mostly far outweighed by the gains in weed control.

Control of weeds that have "escaped" in early summer. Do nothing and you may lose all of the trees – particularly if capeweed has grown vigorously. Capeweed cannot be controlled without affecting the trees to some degree. Its influence is minimised by using a very narrow scalp strip and a residual herbicide before scalping and sowing. If the trees become smothered by capeweed then use *oxyfluorfen* (2-4 L/ha) or *glyphosate* (1 L/ha) to release them. Most of the tree seedlings will be protected by the capeweed and will survive. In winter the trees will also not be growing actively and so will be less susceptible to herbicide toxicity.

Glyphosate (1-2 L/ha) can also be applied as a shielded spray at low pressure, working along each side of the row of trees. The trees, when older than about 4 months, will tolerate some *glyphosate* drift. Selective herbicides, such as *fluazifop-p* [*e.g.* Fusilade @ 4 L/ha], can be applied to control grass if that is the main problem. These chemicals do little harm to trees or broadleaved weeds.

Mouldboard method

This is the method of choice where the operator dislikes residual herbicides. It is also very suitable for wet soils that remain inundated for long periods. Growth on these mounds can be exceptional but do not expect good germination on saline soil (planting seedlings is then a better option). On drier sites, or in drier spring months, germination on mounds is poorer than obtained from sowing in scalped lines.

In early spring, at least a week or two after applying *glyphosate*, use a 3-furrow plough on sprayed strips to turn the sod and form a line free of weed-seeds (a mound may be formed by ploughing from the other direction onto the first mouldboard line).

The photo (right) shows a mound created by a 3-furough plough on a saline site where seedlings were planted.

Sow seed by hand along the selvage. Weed control should be acceptable for 15 months; if not, use oversprays (see above).

Sowing spots

This is a simple but effective method of direct-seeding.

- On the centre of a previously spray spot, use a mattock to remove 2-3 cm depth of topsoil from an area about 30 cm x 30 cm. Discard this soil.
- Use a hoe to make a seedbed
- Spread a pinch of the seed mix onto this area
- 'Rub' in the seed lightly and tap down with a boot or base of the hoe.

Follow-up weed control is the same as detailed above.

Sowing rates for direct-seeding

There is no satisfactory simple "rule of thumb" that will tell you how much seed should be sown. The amount of seed needed to establish the desired number of trees per km depends on:

Tree spacing – aim for double the desired final density to allow for less than optimal seasonal conditions; any excess plants can be thinned to leave the most vigorous seedling.

Seed viability – seed viability varies widely between species, as seen in Table 1
e.g. M. lanceolata (1,200 VS/g) – *M. ericifolia* (14,000 VS/g)

Viability of seed may also vary greatly within species, particularly if immature seed has been collected. Viability of small seeds, other than acacia and other legumes, may decline drastically after a few years storage.

Remember, too, that *Acacia* seed must be treated prior to sowing – we have found, for all 10 species tested, that the optimum treatment for sound seed is to enclose the seed in flywire and leave it for one minute in water that has been brought to the boil. It can then be kept damp for a few days and sown, or air-dried on paper and then stored until needed.

The seed of some species (*e.g. E. pauciflora and E. serraensis*) needs low temperature stratification to allow prompt germination. This can usually be provided by storage for a period of days in the

refrigerator (at 2-5°C). *Bursaria spinosa* germinates best only in mid winter. It is not suitable for direct-seeding in spring, although if the seed is put in the freezer for a day it can be sown in spring with some expectation of results.

Try the following simple method to determine the viability of the seed to be used, especially if you intend to sow seed that has been stored for several years:

- Take a ¼ teaspoon measure to sample the seed and chaff mixture (*e.g.* 0.25 g of fine seed or perhaps 1.0 g for coarse seed) and put this amount on each of 3 or 4 pots of sand
- Cover very lightly with sand from a sieve
- Keep the sand damp by standing the pots in a shallow tray of water
- Find a warm spot for the pots (light is not important) to ensure that the seed can germinate.
- **C**ount seeds germinated in a month or more and average the results from the 3 pots. Express the result as viable seeds (VS) per gram of sample (if weighing facilities are available), or simply as viable seeds per sample spoon (a ¼ teaspoon measure is ideal).

Check your results against those in **Table 1**.

Quantity of seed to sow

Only a small part of the viable seed sown will survive in the field after germination; the percentage varies widely (*e.g.* 0.2-20% for eucalypts), depending on species, seasonal conditions and weed control. This loss factor must be allowed for when calculating how much seed is needed to sow each section.

Table 2 is a guide to likely seed requirements for 38 species sown on the Basalt Plains, Dundas Laterised Tableland and Glenthompson Hills. For some species the indicated seed requirement is much too high, suggesting that the seed quality was poor (low VS/g), or that the season was very difficult, or that the species was not suitable for direct-seeding at that particular site. Ignore those high values (e.g. 9990) and take the lower values as a guide.

A common error is the sowing of too much seed – particularly of acacias (and Black Wattle – *A. mearnsii* in particular). In some instances 10 to 20 times the appropriate amount of seed is sown, a huge waste of resource. Also, when sown with other species the wattles germinate at such a density that they suppress any other sown species.

The *quantity* of seed required (Q, weight in grams or number of sample spoonfuls) to give a specified number of established trees per m (S) over a given *distance* (D, in metres) is:

$$Q = S \times D \times 100/(\%VS \text{ establishing} \times VS)$$

VS = number of viable seeds per gram (or per sample spoon)
%VS establishing = percentage of viable seed *sown* that germinates *and survives* in the field.

If weighing facilities are not available (relatively cheap battery-operated scales are now available that weigh to a gram), establish how many ¼ teaspoons of the seed fill a larger scoop used in the field. Then divide Q by this number to give the number of scoops of seed required for the job.

Table 1. Guide to seed numbers per gram & viability from assessments in 3 years 1987-89 for sites on Basalt Plains, Dundas Tablelands and Glenthompson Hills.
Adapted from '*Direct Seeding of Trees*' by PR Bird, KN Cumming, GA Kearney, DW Jowett & EK Aldridge in '*Trees & Shrubs for South West Victoria'* by PR Bird, GA Kearney & DW Jowett (1996) Agriculture Victoria, PVI**,** Hamilton.

	1987			1988			1989		
SPECIES	Loc.	No. (N) of seeds/g	Viable seed/g (or %N)	Loc.	No. (N) of seeds/g	Viable seed/g (or %N)	Loc.	No. (N) of 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. tricarpa	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*).

Table 2. Guide to germination success and seed required for sowing various species for sites on the Basalt Plains, Dundas Tablelands and Glenthompson Hills: the data represent the highest and lowest values from the 3 sites in each of the 3 years 1987-89.

Adapted from '*Direct Seeding of Trees*' by PR Bird, KN Cumming, GA Kearney, DW Jowett & EK Aldridge in '*Trees & Shrubs for South West Victoria'* by PR Bird, GA Kearney & DW Jowett (1996) Agriculture Victoria, PVI**,** Hamilton.

	1987		1988		1989	
SPECIES	Trees at 7 mths as % of VS sown	Seed required (g/km) for 1 tree/m	Trees at 7 mths as % of VS sown	Seed required (g/km) for 1 tree/m	Trees at 7 mths as % of VS sown	Seed required (g/km) for 1 tree/m
E. camaldulensis	0.23-1.44	180-1150	0.11-2.37	80-1700	0.04-3.67	300-9990
E. cladocalyx	0.52-2.60	170-840	3.02-9.60	120-370	0.30-1.79	270-1610
E. globulus	2.69-8.01	150-450	4.58-8.24	110-200	0.46-3.16	630-4320
E. kitsoniana	0.05-0.75	200-3000	0.08-1.13	150-2030	0.08-0.30	480-1910
E. leucoxylon	0.07-0.66	950-9170	0.62-3.51	160-920	0.26-8.76	210-1280
E. maculata	4.60-12.50	90-260	11.31-19.50	80-130	0.67-8.76	110-1620
E. melliodora	0.07-0.39	2420-9990	0.11-1.36	190-2380	0.04-0.40	420-4200
E. microcarpa	0.05-0.24	420-2080	0.13-3.42	30-760	0.10-0.99	180-1830
E. ovata	0.09-1.06	420-4940	0.10-2.53	60-1560	0.16-0.51	590-1810
E. occidentalis	0.23-2.75	150-1810	1.56-7.65	80-410	0.16-1.61	240-2470
E. polyanthemos	0.07-0.56	160-1280	0.06-2.35	40-1780	0.07-0.61	470-4320
E. serraensis	0.41-1.74	2740-6400	3.13-5.83	570-1070	0.78-6.19	360-2830
E. tricarpa	0.23-1.39	690-4220	0.08-1.20	800-9990	0.16-1.07	1370-9180
E. viminalis	0.69-4.05	50-310	1.26-7.55	20-140	0.21-2.01	130-1200
Al. verticillata	3.04-10.87	190-690	16.8-29.21	70-130	0.91-11.34	180-2250
C. glauca	0.16-1.02	160-1070*	0.01-0.41	920-9990	0.15-1.18	130-1080*
C. cunninghamiana	0.01-1.39	640-9990*	0.01-0.09	1020-9990*	0.01-0.52	120-8640
Al. luehmannii	0.81-1.53	805-1540*	0.08-0.29	>9990	2.80-24.53	610-9990
Al. muelleriana	1.05-14.32	60-830	4.37-21.00	30-160	1.99-24.53	30-330
A. brachybotrya	11.78-32.29	390-1120	38.22-36.56	260-270	28.71-44.97	120-180
A. exudans	11.85-28.94	190-470	13.02-15.35	250-300	23.56-37.69	120-190
A. howittii	7.11-20.16	60-170	13.72-21.08	60-90	5.82-28.85	40-210
A. iteaphylla	18.97-27.13	130-150	15.49-19.77	200-250	12.42-33.41	120-320
A. longifolia	7.63-13.52	130-230	10.53-16.46	110-170	7.44-31.10	60-240
A. mearnsii	13.62-17.56	70-90	12.25-30.96	40-110	3.37-32.24	40-370
A. melanoxylon	15.15-21.79	130-180	3.41-6.92	400-820	6.65-26.82	100-410
A. pycnantha	14.40-28.41	90-180	15.66-22.33	140-190	23.06-51.57	60-130
A. retinodes	22.49-29.41	70-90	11.62-20.07	80-150	16.03-39.91	40-110
A. verticillata	-	-	6.40-22.23	60-190	7.38-35.10	40-170
M. armillaris	0.02-0.07	590-2190*	0.11-0.74	55-380*	0.02-0.67	50-1730*
M. decussata	0.01-0.13	170-2190	0.01-2.29	10-2160	0.07-0.96	20-280*
M. ericifolia	0.01	9990**	0.02-0.10	70-360	0.04	180**
M. halmaturorum	0.01	5120**	0.005	7890**	0.01-0.01	2830-3670*
M. lanceolata	0	***	0.01	7200**	0.01-0.07	1460-7830*
L. scoparium	0	***	0.02-0.21	410-5330*	0.01-0.18	400-6480
L. lanigerum	0	***	0.009	8060**	0.039	2070**
C. rugulosus	0	***	0.02-0.18	60-460*	0.01-0.05	250-1080*

* Denotes cases where none or less than 0.005% of the viable seed sown of a particular species germinated and/or plants survived to 7 months.

'9990' grams of seed required to establish 1 tree/m over 1 km – all such occurrences indicate that the conditions for germination and/or subsequent survival were not favourable that year. Ignore those high values and base estimates of seed required for sowing on the lower values in the table.

High values also indicate that direct-seeding can give very variable results, especially with small-seeded species and those with specific needs (e.g. Woolly tea-tree *Leptospermum lanigerum*).