SPECIES ESTABLISHMENT, EVALUATION AND REGENERATION:

Methods of establishing trees on non-arable land to control weeds

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In New South Wales some serious weeds have infested steep, rocky hill country which makes economic control by landholders using pastures impracticable. For example, Vere *et al.* (1993) have shown that it is unprofitable to control serrated tussock (*Nassella trichotoma*) by pasture improvement in non-arable areas with low rainfall and low soil fertility. In NSW 741,000 ha of land are infested with serrated tussock and 188,000 ha with St. John's wort (*Hypericum perforatum*). An average of 65% of this land is non-arable. At present the main method used to control weeds in these situations is repeated herbicide application which kills the weed for short periods but often eliminates associated useful species leaving bare ground which is vulnerable to erosion. The establishment of trees to control the weeds would be a more sustainable solution. Using aerial seeding or direct drilling large areas of weeds could be treated and sown to trees quickly and relatively cheaply. Thus this experiment was set down to examine methods of establishing trees to control weeds.

Methods

The site was an unploughed rocky hill 20 km south of Tuena, NSW heavily infested with serrated tussock and lightly infested with St. John's wort. The soil had a pH ($CaCl_2$) of 5.2 with an available phosphorous level (Bray No. 1) of 10.3 µg/g.

The experiment had 2 burning treatments (unburnt, burnt) x 3 herbicide treatments (nil, one, two sprays) x 3 methods of sowing (aerial, direct drilled, planted seedlings). Four tree species [ribbon gum (*Eucalyptus viminalis*), silver wattle (*Acacia dealbata*), river oak (*Casuarina cunninghamiana*) and radiata pine (*Pinus radiata*)] were sown on each plot. Serrated tussock was burnt on 6 June 1995 after nil, one spray (on 24 November 1994) or two sprays (24 November 1994, 23 May 1995). The November 1994 spray to kill serrated tussock and St. John's wort was a mixture of flupropanate (Frenock®) at 2 L/ha product (75% a.i.) and glyphosate (Roundup CT®) at 4 L/ha product (45% a.i.) and the May 1995 spray to kill annual weeds was Roundup CT® at 2 L/ha.

Seedling trees were planted (10 per $5m^2$ sub-plot) with a shovel and seeds sown on the aerial and direct drilled treatments by hand on 7 and 8 June 1995 (ribbon gum 2 kg/ha, silver wattle 3.6 kg/ha, river oak 2 kg/ha, radiata pine 8 kg/ha). The direct drilled furrow (8 cm wide x 3 cm deep) was dug with a mattock and soil firmed by walking on the furrow after the seed had been sown on the cultivated surface. Seeds were treated with permethrin to reduce losses due to seed harvesting ants. Superphosphate containing 0.02% molybdenum was applied at planting at 200 kg/ha.

Plots (4 x 5 m with sub-plots 1 x 5 m) were in a randomised block design, blocked for burning and spraying, with four replications.

Results were recorded in late March 1996 by counting the number of trees per $5m^2$ sub-plot and measuring their height.

Results

Aerial sown and direct drilled seed

Ten months after sowing, establishment of ribbon gum and radiata pine was higher from direct drilling than from aerial sowing (Table 1). Method of sowing had no effect on the establishment of wattle and sheoak failed to establish on any treatment.

Burning assisted the establishment of aerially sown ribbon gum but had no effect on the establishment of the other species (Table 1). Herbicide treatment asisted establishment of ribbon gum on the burnt treatment (two sprays giving better (P=0.05) establishment 41.0 plants/$5m^2$ than one spray 18.4/$5m^2$ or nil spray 18.8/$5m^2$) but did not assist establishment on the unburnt treatment nor on treatments with the other species. The surprising feature of herbicide effect was the establishment of ribbon gum on the unsprayed treatments (*i.e.* 15.9/$5m^2$ on the unburnt and 18.8/$5m^2$ on the burnt treatment, meaned for aerial sowing and direct drilling) despite heavy competition from serrated tussock. The different treatments did not influence height of trees,

Table 1. Effect of method of sowing on establishment of trees (number per $5m^2$) and height of the 3 species that established (cm) ten months after sowing.

Treatment		Species		
		Ribbon gum	Silver wattle	Radiata pine
Method of Sowing				
Unburnt	Aerial	9.4 c	1.1 d	1.9 d
	Direct drilled	27.5 ab	1.1 d	10.0 c
Burnt	Aerial	18.8 b	1.0 d	1.1 d
	Direct drilled	33.4 a	2.8 cd	4.4 cd
Height[1]		24.8 a	20.3 a	11.1 b

Notes: [1] meaned for aerial and direct drilling; Means for method of sowing and for height followed by a common letter do not differ significantly (P=0.05).

tussock. The different treatments did not influence height of trees, the only difference being between species (Table 1). The slow growth of radiata pine was characterised by yellowish plants lacking vigour.

Planted seedlings

A high proportion of seedlings planted in June 1995 established and increased in height in the ten months after planting (Table 2). Treatments did not affect establishment or growth, the only difference being between species. Best establishment was achieved by ribbon gum and radiata pine whilst silver wattle attained the greatest height. The height of river oak was influenced by tree health, 23% being dark green and healthy with a mean height of 105 cm whilst the remaining 77% had unhealthy yellowish leaves and a mean height of 48 cm. The reason for the unhealthy trees may have been that their roots were not infected with the actinomycete *Frankia* and thus they were not able to fix nitrogen.

Discussion

All tree species established well from planting as seedlings. Ribbon gum and radiata pine established well from direct drilling whilst ribbon gum alone established well from aerial sowing. Growth of radiata pine from direct drilling and aerial sowing was very slow due, possibly, to the lack of micorhyza in the soil which leaves only ribbon gum as suitable for aerial sowing or direct drilling. The two spray treatment assisted the establishment of ribbon gum on the burnt treatment by controlling serrated tussock, St John's wort and annual weeds. The one spray treatment did not control annual weeds which smothered the tree seedlings in spring 1995. The beneficial effects of the two spray treatment was not evident on the other species at the time of measurement. The ability of ribbon gum to establish amongst unsprayed serrated tussock needs further investigation. Burning assisted the establishment of aerially sown ribbon gum by removing the horizontal mass of dead tussock leaves that occurred on the soil surface of unburnt treatments.

Table 2. Establishment (%) of planted seedlings ten months after planting, and height (cm) at planting and ten months later.

	Ribbon gum	Silver wattle	River oak	Radiata pine
Establishment (%)	98.3 a	70.8 c	89.2 b	97.5 a
Height (cm) at planting	36.4 a	13.5 c	40.4 a	28.4 b
Height (cm) 10 months	77.7 b	95.8 a	57.5 c	78.2 b

Notes: Means in rows followed by a common letter do not differ significantly (P=0.05). Methods of establishing trees on non-arable land to control weeds.

The best method of establishment was planting seedlings. However, the establishment achieved by direct drilling and aerial seeding of ribbon gum exceeded the recommended density of trees necessary for weed control (1 radiata pine/$10m^2$, Hans Porada personal communication) and for ground water recharge and agroforestry timberbelts /shelterbelts ($1/m^2$, Bird *et al.* 1990).

Of the species used here, only ribbon gum established well enough and grew sufficiently quickly to be considered for sowing by direct drilling or aerially seeding. Further research is needed to examine the establishment ability of other eucalypts and to reduce the costs of establishment by minimising herbicide, fertiliser and seed inputs. For radiata pine and sheoak to establish successfully from aerial sowing and direct drilling methods are needed to introduce, respectively, mycorhiza and Frankia with the seed at sowing. In addition, for planted seedlings of sheoak to establish successfully it will be necessary to sow them with *Frankia* already established on their roots.

Acknowledgments

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References

Bird, R., Cumming, K.N. and Kearney, G.A. (1990). Research in direct seeding of trees in the 500-800 mm rainfall zone of western Victoria. Proceeding Direct Seeding and Natural Regeneration Conference, Department of Agriculture and Rural Affairs, Victoria, pp.65- 74.

Vere, D.T., Auld, B.A. and Campbell, M.H. (1993). Economic assessments of serrated tussock as a pasture weed Weed Technology 7, 776-81.