An assessment of native tree susceptibility to the simulated aerial application of the herbicide flupropanate, for management of exotic unpalatable grasses

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Summary Re-afforestation is a management tool for long term control of exotic unpalatable grasses. Grass control is required at tree planting to maintain tree vigour and establishment. Flupropanate is a widely used herbicide for managing unpalatable grasses. The impact of a simulated aerial application of flupropanate at the recommended rate (1.49 kg a.i. ha^{-1}) and twice recommended rate (2.98 kg a.i. ha^{-1}) on a native tree trial located in the Rowsley Valley at Glenmore was conducted between 2004 and 2006. Results show that flupropanate does impact on tree survival with approximately 1 in 40 seedlings dying at 1.49 kg a.i. ha^{-1} and 1 in 20 dying at 2.98 kg a.i. ha^{-1}. Flupropanate substantially reduced height of black wattle and caused obvious leaf shrivelling/leaf deformation. Flupropanate reduced the height of varnish wattle but did not appear to affect leaf health. Flupropanate did not affect tree heights or cause apparent leaf damage to grey box, yellow gum or drooping sheoak. The use of flupropanate for wide scale unpalatable grass control in the establishment of native tree re-afforestation is discussed.

Keywords Serrated tussock, *Nassella trichotoma*, flupropanate, trees.

INTRODUCTION

Serrated tussock (*Nassella trichotoma* (Trin. & Rupr.) Barkworth) and Chilean needle grass (*Nassella neesiana* Trin. & Rupr.), which are unpalatable perennial grasses, are Weeds of National Significance (Thorp and Lynch, 2000). They cost Australia millions of dollars in lost agricultural production while they are also invading and replacing Australia's endangered native grasslands (McLaren *et al.* 1998). Despite years of research, there are still limited control options for managing weeds such as serrated tussock in Australia (Michalk *et al.* 1999). The only registered herbicides for control of serrated tussock in pastures are flupropanate, glyphosate and 2,2-DPA. Flupropanate is widely regarded as the most selective and effective herbicide for controlling serrated tussock while its residual action in the soil can prevent serrated tussock regrowing for three to five years (Campbell and Vere 1995).

Native trees are increasingly seen as a tool for long-term management of weeds such as serrated tussock, particularly on non-arable lands where management by more traditional methods can become difficult (Campbell and Vere 1995). Weed control to enhance tree establishment and growth during afforestation is an integral component of forestry operations. In steep and/or inaccessible situations this control may best be achieved by aerial herbicide application.

A large rehabilitation program 'Grow West' is aiming to reforest large areas (2000 ha) of the Rowsley Valley escarpment (Grow West Business Plan 2003), 20 km west of Melbourne. The Rowsley Valley escarpment is heavily infested with serrated tussock and is a major source of serrated tussock seed leading to continual re-infestation of surrounding land. This project aims to assess whether flupropanate can be used safely to control serrated tussock during reforestation. Registered for serrated tussock control, flupropanate is the only herbicide that might allow this type of integrated management without resultant damage to native tree species and without damaging adjacent pasture species. However, the effects of flupropanate on native tree species in the Rowsley Valley have not been documented and such information will be an important step towards improving current management of serrated tussock. This paper reports on a trial to assess the impact of flupropanate on the survival and growth of five native tree species considered as the most important rehabilitation species for this region.

MATERIALS AND METHODS

The trial was conducted on a 0.2 ha block of undulating pasture at 1342 Glenmore Road, Rowsley Valley, Western Victoria. Soil type is a fine sandy clay loam and the region receives an annual rainfall of 480 mm. Five native tree species were selected for this trial for their timber and local reforestation qualities. These were grey box (*Eucalyptus microcarpa* (Maiden)), yellow gum (*Eucalyptus leucoxylon* F. Muell.), black wattle (*Acacia mearnsii* De Wild.), varnish wattle (*Acacia verniciflua* A. Cunn.) and drooping sheoak (*Allocasuarina verticillata* (Lam.)). To aid survival of tree seedlings, the block was ripped and an application of glyphosate at 3.06 kg a.i. ha^{-1} (as Roundup™ Max) was applied one month prior to tree planting to eliminate competition from serrated tussock and other weeds. The planted block was fenced to prevent tree seedling damage from grazing animals.

Tree seedlings were planted in a randomised block design consisting of five tree species planted in 30 rows spaced 2 m apart. Rows were divided into six blocks (replicates) each containing five rows of 18 tree seedlings (one row for each of the five species). An individual row contained 18 tree seedlings of the same tree species spaced 1.5 m apart. Each row of tree seedlings was divided into three treatments (nil herbicide, 1X flupropanate (1.49 kg a.i. ha^{-1}) and 2X flupropanate (2.98 kg a.i. ha^{-1})) of six tree seedlings, with a 3 m spacing between plots.

Herbicide treatments were applied using a hand held Azo-Dutch 1 m boom sprayer with spray volume 176 L ha^{-1} to simulate aerial application. The site was monitored during August 2004 (prior to treatment), December 2004 (four months after treatment), March 2005 (seven months after treatment) and October 2005 (14 months after application). At each assessment records were kept on tree survival, tree height (cm), tree damage (1–5 scale – 1 = <10%, 2 = 11–25%, 3 = 26–50%, 4 = 51–75% and 5 = 76–100%) and type of damage (A = good condition, B = yellowing, C = browning, D = defoliated, E = leaf shrivelling or deformity, F = insect feeding).

RESULTS

Statistical analysis Angularly transformed survival to December 2005, the square root of tree height at appropriate times and indices of damage were analysed as a five tree species by three flupropanate factorial split plot analysis. Replicates consisted of five rows of 18 trees, main plots consisted of one row of 18 trees of the same species, and subplots consisted of six adjacent trees with the same rate of applied flupropanate. Since the data for survival and indices of damage had discrete values for many treatment combinations, P-values were calculated using exact permutation tests appropriate for the split plot design (Payne 2006).

Effect of flupropanate treatments on tree survival Results show that flupropanate did impact on tree survival with approximately 1 in 40 (2.5%) tree seedlings dying at the 1X rate and 1 in 20 (5%) dying at the 2X rate compared to the control (Table 1). However, there were no tree species interactions across the treatments.

Effect of flupropanate treatments on tree height and damage Flupropanate substantially reduced the height of black wattle (from 1160 cm to 440 cm at 1X rate) and varnish wattle (from 920 cm to 670 cm at 1X rate) compared to the control. It also caused some reduction in height of drooping sheoak but had no impact on grey box or yellow gum. It caused obvious leaf shrivelling/leaf deformation damage to black wattle but made no noticeable impacts on the other species.

Table 1. Effect of flupropanate on tree survival and damage.

Measurement	Transformed				Back transformed			P Value	
	0	1X	2X	SED	0	1X	2X	Flu	Sp × Flu
Survival									
Black wattle	86	83	77	7.5	1.00	0.98	0.97	0.026 Using perm test	0.51 Using perm test
Varnish wattle	90	83	82	7.5	1.00	0.98	0.98		
Drooping sheoak	90	74	72	7.5	1.00	0.92	0.91		
Grey box	90	80	75	7.5	1.00	0.97	0.93		
Yellow gum	78	86	82	7.5	0.96	1.00	0.98		
Damage									
Black wattle	1.0	3.0	3.8	0.26	–	–	–	<0.001 Using perm test	<0.001 Using perm test
Varnish wattle	1.0	1.0	1.1	0.26	–	–	–		
Drooping sheoak	1.2	1.0	0.9	0.26	–	–	–		
Grey box	1.0	1.0	1.1	0.26	–	–	–		
Yellow gum	1.2	1.2	1.3	0.26	–	–	–		

DISCUSSION

Flupropanate did not produce a significant species affect with respect to tree mortality for the five tree species tested. However, it did result in a 2.5% tree mortality at the recommended rate of 1.49 kg a.i. ha^{-1} and 5% tree mortality at 2.98 kg a.i. ha^{-1}. Increasing rates of flupropanate significantly increased stunting, foliage yellowing and deformity in black wattle. Flupropanate also affected the growth of varnish wattle and drooping sheoak but did not produce any noticeable leaf abnormalities to these species. Post emergent applications of flupropanate were specifically selective against black wattle (*Acacia mearnsii*). Previous studies have also found that hardwood species like acacia or ash are more susceptible to flupropanate than conifers (Kuo and Rin 1987). Flupropanate is known to be damaging to annual legume species such as subterranean clover (Campbell and Vere 1995) and this project shows it can be damaging to perennial *Acacia* legume species such as black wattle. Though the treated black wattle seedlings were damaged by the flupropanate treatments, most were still surviving 14 months after treatment.

Observations from a number of council weed officers and landowners during a recent series of national serrated tussock workshops (Fullerton *et al.* in press) suggest that *Acacia* species usually recover from flupropanate damage.

Flupropanate had no recognisable affects on growth of either grey box or yellow gum and supports previous studies that *Eucalyptus* species are relatively tolerant to flupropanate (Campbell and Nicol 1998).

The conclusion from this trial is that it is possible to use flupropanate for the selective control of serrated tussock amongst seedling *Eucalyptus* and sheoak species but care should be taken to select the lowest possible flupropanate rate to reduce the likelihood of off target impacts if spraying over *Acacia* species.

ACKNOWLEDGMENTS

The authors acknowledge the support provided by the Australian Commonwealth Government through the Natural Heritage Trust for this study. The authors would also like to thank Graeme Pritchard and Julio Bonilla for their advice and technical support.

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