Effect of low rates of flupropanate on selective removal of serrated tussock (*Nassella trichotoma* (Nees) Arech.) seedlings from a young improved pasture

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Summary

An 18 month-old improved pasture infested with 8–18 month-old serrated tussock (*Nassella trichotoma* (Nees) Arech.) seedlings near Berridale New South Wales was sprayed with rates of flupropanate from 0.19 to 1.12 kg a.i. ha^{-1} on 6 September 1995. Rates of 0.19, 0.37 and 0.56 kg a.i. ha^{-1} killed 53, 95 and 100% respectively of the serrated tussock seedlings without damaging sown pasture species (subterranean and white clovers, phalaris, fescue and cocksfoot). It is necessary to spray in spring or summer because subterranean clover, the improved species most susceptible to flupropanate, is more tolerant then than in autumn or winter.

Introduction

The best method of controlling serrated tussock (*Nassella trichotoma* (Nees) Arech.) on arable land is to cultivate and sow an improved pasture (Campbell 1985). Many serrated tussock seedlings establish at the same time as the sown pasture and at greater density in heavily cultivated than in lightly cultivated seedbeds; e.g. 6, 9 and 22 m^{-2} in seedbeds with one, two and three cultivations respectively (Campbell 1963). From 90 to 98% of these seedlings are killed by competition if the pasture is left ungrazed for a year after sowing (Campbell 1963). Seedling re-infestation also occurs after aerial spraying and sowing on non-arable land (Campbell 1974). Again, control of tussock seedlings depends on spelling the pasture for long periods after sowing (Campbell 1985). Despite recommendations to spell pastures after sowing (Campbell 1985), most are grazed in their first year which results in survival of tussock seedlings. If these seedlings could be selectively removed from the young pasture with an herbicide it would reduce the time necessary for spelling and prevent reinfestation and, ultimately, re-treatment and resowing. Serrated tussock seedlings have been shown to be susceptible to very low rates (0.095 kg a.i. ha^{-1}) of flupropanate (Frenock®) which may not affect sown pasture species (Campbell and Murison 1987). Therefore an experiment was set down where low rates of flupropanate were applied to a young pasture infested with serrated tussock seedlings in an effort to remove them without damaging the pasture.

Materials and methods

The soil on the experiment site near Berridale New South Wales was derived from slate with a pH ($CaCl_2$) of 5.0, an available phosphorous level of 4.2 μg g^{-1} (Olsen) and exchangeable cation levels (meq 100 g^{-1}) of 3.0 (Ca), 0.8 (Mg), 0.3 (K), 0.1 (Na) and 0.1 (Al).

In four of the six years prior to sowing an improved pasture, the paddock, which was heavily infested with serrated tussock, was ploughed and sown to grazing oats. In March 1994 subterranean clover *Trifolium subterraneum* cv. Goulburn, white clover *T. repens* cv. Haifa, phalaris *Phalaris aquatica* cvs. Australian and Sirosa, fescue *Festuca arundinacea* cv. Triumph and cocksfoot *Dactylis glomerata* cv. Currie, were sown at respectively 3, 0.5, 2, 2, 1 and 1 kg ha^{-1} with 30 kg ha^{-1} of Blackbutt oats and 70 kg ha^{-1} of mono ammonium phosphate fertilizer. The pasture was grazed through winter to late spring 1994 and again in winter 1995.

On 6 September 1995 flupropanate (sodium 2,2,3,3-tetrafluoropropinate 75% a.i.) was applied at rates from 0.19 to 1.12 kg a.i. ha^{-1} (Table 1) with a hand-held pneumatic sprayer in 500 L ha^{-1} water and no surfactant. At spraying the pasture was 2 cm high with a ground cover of 1% subterranean clover, 8% white clover, 10% sown grasses, 20% broadleaved weeds, 5% *Vulpia* spp. and 56% bare ground. It was infested with 6.4 serrated tussock seedlings m^{-2} from 2 to 10 cm high with, respectively, 20–80 leaves. The largest germinated with the sown species in March 1994 and the smallest germinated in response to heavy rain (148 mm) in January 1995. Tussocks higher than 10 cm were regrowth from plants only partly killed by cultivation. Small seedlings with 2–10 leaves that often establish in winter were absent.

Plots (5 × 4 m) were arranged in randomized blocks with three replications. Percentage kill of serrated tussock seedlings was calculated from whole plot counts at spraying and 15 months later. Measurements of the effects of flupropanate on serrated tussock and pasture species were made in November and December 1995 and November 1996 by visually estimating brown-out and ground cover (Table 1).

Results

Three months after spraying, brown-out of seedling tussocks increased with increasing rates of flupropanate (Table 1). The rates of brown-out occurred under rainfall of 47, 130 and 60 mm in September, October and November 1995 respectively and was faster than that of mature tussocks which normally take three months to register 25% brown-out when flupropanate is applied at the recommended rate of 1.5 kg a.i. ha^{-1}. Fifteen months after spraying, rates of flupropanate 0.56 kg a.i. ha^{-1} and above

Table 1. Effect of low rates of flupropanate on brown-out of serrated tussock seedlings three months after spraying and on kill of serrated tussock seedlings and ground cover of pasture species 15 months after spraying.

Rate of flupropanate		Serrated tussock seedlings		Ground cover of pasture (15 months)			
(kg a.i. ha^{-1})	(L ha^{-1} product)	Brown-out (3 months) (%)	Kill (15 months) (%)	Legumes[A] (%)	Sown grasses (%)	*Vulpia* spp. (%)	Bare ground (%)
0	0	0e[B]	3c	24ab	23b	26a	8d
0.19	0.25	13d	53b	21abc	30a	17ab	19c
0.37	0.50	40c	95a	24ab	32a	17ab	25bc
0.56	0.75	57b	100a	25a	36a	12b	27b
0.75	1.00	53bc	100a	18bc	32a	16ab	34a
0.94	1.25	70a	100a	19abc	32a	11b	38a
1.12	1.50	83a	100a	16c	35a	13b	36a

[A] Subterranean and white clovers and naturalized annual legumes.

[B] Values in columns not followed by a common letter differ significantly at P<0.05.

completely removed serrated tussock seedlings and the 0.37 kg a.i. ha^{-1} rate removed all but the largest (Table 1) which were probably not seedlings but regrowth from plants not killed by cultivation. No new tussock seedlings were present at the end of the experiment as a result of establishment after spraying.

Ground cover of legumes was reduced ($P<0.05$) by the higher rates of flupropanate but the ground cover of sown grasses was not affected by these rates (Table 1). The lower ground cover of sown grasses on the control than on the herbicide treatments was possibly due to flupropanate killing most *Vulpia* spp. in spring 1995 and thus reducing seed production which resulted in less competition from *Vulpia* spp. on the herbicide treatments in 1996. The remaining ground cover not included in Table 1 comprised serrated tussock seedlings (18%, 12% and 2% respectively on the 0, 0.19 and 0.37 kg a.i. ha^{-1} treatments) and the few annual broadleaved weeds still alive.

Observations in November 1995 revealed that sown legumes and grasses treated with rates of flupropanate 0.56 kg a.i. ha^{-1} and above exhibited mild symptoms of flupropanate toxicity from which they had recovered by December 1995. No toxicity symptoms were observed on pasture plants treated with the 0.19 and 0.37 kg a.i. ha^{-1} rates.

Discussion

In this experiment rates of flupropanate 0.37 kg a.i. ha^{-1} and above selectively removed 8–18 month-old serrated tussock seedlings from an 18 month-old improved pasture. As a lower rate (0.095 kg a.i. ha^{-1}) will kill germinating seedlings (Campbell and Murison 1987) it is possible that by treating a pasture in its first year in spring, 6–8 month-old seedlings that established with the pasture in March will be removed with rates of flupropanate lower than 0.37 kg a.i. ha^{-1}. This may be the case on the Monaro where serrated tussock is very susceptible to flupropanate but in other environments rates higher than 0.37 kg a.i. ha^{-1} may be necessary. For example, at Mt. David on rocky basalt soil 0.75 kg a.i. ha^{-1} was needed to reduce ground cover of tussock seedlings from 53 to 11% (Campbell 1987b). In the latter case the seedlings were larger than those treated at Berridale (being 4–13 cm high with 30–150 leaves respectively) and were sprayed in March, factors that suggest a higher rate than 0.37 kg a.i. ha^{-1} was necessary.

In this experiment no new serrated tussock seedlings established in the fifteen months after spraying indicating that, once existing seedlings are removed, reinfestation will only occur in periods of well above average rainfall or after drought, cultivation or other disturbance.

It is important to spray in spring as the species most susceptible to flupropanate, subterranean clover, is more tolerant then than in autumn or winter when plants are smaller (Campbell 1987a). For example, well grown subterranean clover plants tolerated 0.75 kg a.i. ha^{-1} applied in September (Campbell 1987a) but germinating seedlings were severely damaged by 0.19 kg a.i. ha^{-1} (Campbell and Murison 1987). Spring application of flupropanate slightly restricts burr production of subterranean clover (Campbell 1987a). Flupropanate could also be applied in summer when subterranean clover is dead and other species tolerant (Campbell and Ridings 1988). The grasses sown in this experiment all tolerate low to medium rates of flupropanate (0.75–2.0 kg a.i. ha^{-1}) when mature and white clover is more tolerant than subterranean clover.

To ascertain whether spraying in the first spring of a new pasture is justified, it will be necessary to closely monitor the number of serrated tussock seedlings present. Similarly, in an established pasture, it will be necessary to closely observe the pasture to ascertain when tussock seedlings have re-invaded so that they can be sprayed when they are as small as possible. The danger in spraying very young seedlings is that further germinations may occur after spraying. However if germination occurs soon after spraying the new serrated tussock seedlings could be killed by residual flupropanate (Campbell and Murison 1987).

Very low rates of flupropanate will not harm improved species and will cost less than having to treat a heavily re-infested paddock by overall spraying at the recommended rate of 1.5 kg a.i. ha^{-1} or by intensive spot-spraying. Combined with spelling, a very low sub-toxic rate may be sufficient to kill serrated tussock seedlings due to the additive effects of flupropanate and pasture competition. For example, the 0.19 kg a.i. ha^{-1} rate used in this experiment killed 53% of seedlings, but if, in addition, there was strong pasture competition for light (clovers shading tussock seedlings) the percentage kill could have been much higher. In the experiment reported here there was little competition for light from the pasture due to low soil fertility and heavy grazing in winter, thus the removal of tussock seedlings was due almost entirely to flupropanate . The small reduction in tussock numbers on the control verifies this conclusion.

Although some native grasses (e.g. kangaroo grass *Themeda triandra*, redleg grass *Bothriochloa macra*, poa tussock *Poa labillardieri*) tolerate 1.5–3 kg a.i. ha^{-1} flupropanate, others (e.g. wallaby grasses *Danthonia* spp., weeping grass *Microlaena stipoides*) are killed by 0.75 kg a.i. ha^{-1} (Keys and Simpson 1993, Campbell and Van de Ven 1996). There is a need to ascertain whether the susceptible grasses can tolerate rates of flupropanate lower than 0.75 kg a.i. ha^{-1} which would then allow selective removal of serrated tussock seedlings from native grasses sensitive to flupropanate.

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