Effect of early application of bromoxynil on the population dynamics of a regenerating pasture species mixture

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Summary An experiment was conducted to test the effect of broadleaf weed control using an early herbicide spray (bromoxynil) on the population dynamics of weeds and legume components in a 2nd-year regenerating pasture species mixture dominated by subclover (*Trifolium subterraneum* L.). Of particular interest was the capacity of legumes for compensatory growth once weeds were removed or suppressed. The results indicate that after removal of broad leaf weeds (mainly capeweed, *Arctotheca calendula* Levyns), the legume component had the ability to grow more to fill the gaps created. However, there was also an increase in the number and productivity of grass weeds. While chemical control of weeds in pasture may be an effective option, there should be a reasonable legume seed reserve in the soil for legume plants to fill the gaps that are left.
Keywords Broadleaf weed, species mixture, regenerating pasture, herbicide.

INTRODUCTION

Many newly developed annual pasture legume species have small seedlings that make them less competitive with weeds. As a result, the idea of a legume-dominant pasture based on a mixture of different legume species (Liu and Revell 2001) will be challenged. Broad leaf weeds such as capeweed that have a high relative growth rate early in the season are of particular concern (Thomson *et al.* 1995). While grazing may be an option to control weeds, there are limitations to this strategy as this will not effectively remove the weeds from pastures and grazing could be detrimental to those legumes with upright growth habits (Broom and Arnold 1986). The effect of chemical removal of weeds on the performance of pastures consisting of different legume species was tested in this experiment.

MATERIALS AND METHODS

The site The site is situated at Jennacubine, about 30 km from Northam (31°21'S and 116°40'E). The average rainfall at the site is 434.5 mm. The soil is a sandy surfaced duplex. A long-term pasture/crop rotation trial has been conducted at the site. The plot chosen for the chemical treatment (in 2001) was a 2nd-year regenerating pasture phase, which started in 1998 (sown pasture) and went into crop (wheat) in 1999. The mixture sown includes subclover (*T. subterraneum* L. cv. Dalkeith), pink serradella (*Ornithopus sativus* Brot. cv. Cadiz), yellow serradella (*O. compressus* L. cv. Santorini), biserrula (*Biserrula pelecinus* L. cv. Casbah), gland clover (*T. glanduliferum* L. cv. Prima) and arrowleaf clover (*T. vesiculosum* Savi. cv. Cefalu); the control is subclover sown at the same rate as the combined species mixture.

The total rainfall for the year was about 250 mm, well below the long-term average. The start (mid-May) was followed by a dry spell that put most seedlings under stress. However, most rain fell within the growing season (242 mm) and the season finished reasonably well.

Treatment A chemical strip (bromoxynil, 300 g a.i. L^{-1}) of 3 m wide and 100 m long was applied to the 2nd-year regenerating pasture mixture plot at a rate of 1.5 L ha^{-1} two weeks after emergence (12 June). The strip treatment was repeated in three different plots as three replicates. The site was infested heavily with capeweed and some volunteer wheat plants. Grazing started on 19 June 2001 at 12 sheep (weaners) per ha and then was reduced to nine sheep per ha until the end of the trial.

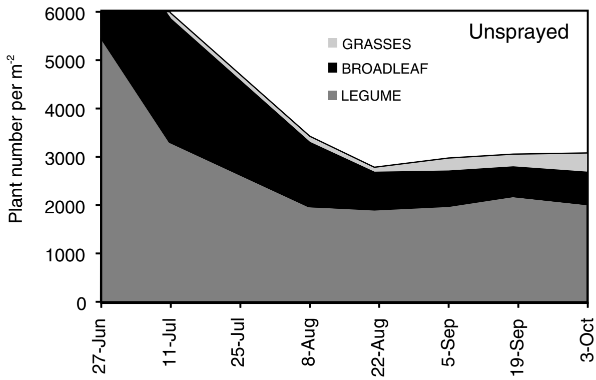
Sampling and measurement Assessments of plant densities and dry matter production were taken at fortnightly intervals commencing on 27 June. A corer with a diameter of 10.5 cm was used to take soil cores. Six cores were taken from within each of the chemical strips and in adjacent untreated area without chemical application. The cores were then carefully taken back to the laboratory, and plants within each core were separated into different species and counted. The plants were then oven-dried at 70°C for more than 48 hr to estimate dry weight.

Statistical analysis Data were analysed using Genstat (Release 4.2, 5th edition) based on a completely randomised block model for each sampling. Statistical information was only presented for the initial and final samplings.

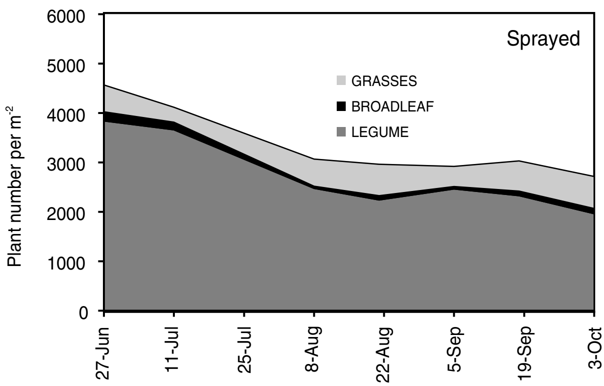
RESULTS

Plant number The total plant number declined quickly as the season progressed but stabilised by mid-August (Figure 1). Within the unsprayed treatment total plant number decreased from 8244 plants m^{-2} on 27 June 2001 to 3080 plants m^{-2} on 21 October 2001, a 63% reduction; while that for the sprayed plot was 41%. Although plant number was significantly lower initially after spraying (a decline of 3700 plants m^{-2}), the total plant number at the end of the season was similar for the two treatments (3080 vs 2714, ns). The pasture composition in the sprayed and unsprayed treatments was also different at the last sampling. After removal of most broad leaf weeds, the total number and proportion of grass weeds was higher in the sprayed treatment, while the difference in the total number of legumes was not significant.

At the beginning of the season, the legume plant population in the unsprayed treatment was mainly composed of gland clover (54%) and subclover (38%); at the end of the season, this changed to 30% and 39% respectively (Table 1), indicating that gland clover was more susceptible to competition and grazing. Serradella, arrowleaf clover and biserrula made up only a small portion of the legume population. The density of arrowleaf clover was so low that it was not recorded. Chemical spray significantly reduced gland clover plant density but had little effect of subclover and serradella at the beginning of the season. The higher plant number in biserrula after chemical spray cannot be explained based on data collected. At the last sampling the chemical effect on plant density of the legume components was not apparent.



a.



b.

Figure 1. (a) Plant number, unsprayed. (b) Plant number sprayed.
27 Jun: Legume, 1575; Broadleaf, 2486; Grass, ns; Total, 647.
03 Oct: Legume, ns; Broadleaf, 683 (P=0.071); Grass, 266 (P=0.056); Total, ns.

Table 1. Density of legume plants in unsprayed and sprayed pastures.

Date	27/6/2001					3/10/2001				
Treatment	unsprayed		sprayed		LSD*	unsprayed		sprayed		LSD*
	plants m^{-2}	%	plants m^{-2}	%	(P=0.05)	plants m^{-2}	%	plants m^{-2}	%	(P=0.05)
Subclover	2060	(38)	1649	(43)	ns	789	(39)	943	(48)	ns
Serradella	109	(2)	115	(3)	ns	417	(21)	308	(16)	ns
Biserrula	321	(6)	558	(15)	(192)	212	(11)	135	(7)	ns
Gland clover	2964	(54)	1514	(39)	(756)	597	(30)	577	(29)	ns

* unsprayed vs sprayed.

Food on offer (FOO) At the beginning of the season, the extra biomass produced in the unsprayed treatment was mainly attributed to broad leaf weeds, while the legume component was similar (Figure 2). At the end of the season, the sprayed treatment had a higher grass component and a higher legume component (percentage) than that of the unsprayed treatment. The total biomass between the two treatments was similar.

At the beginning of the season, legume plant biomass in the unsprayed treatment was mainly composed of subclover (63%) and gland clover (30%); at the end, this changed to 74% and 20% respectively (Table 2). A similar trend appeared in the sprayed plot, with subclover consisting of 86% of the total legume biomass at the end of the season. The proportion of both serradella and biserrula in the total legume biomass was negligible. Chemical spray resulted in reduced biomass production of gland clover at both the beginning and end of the season, but had little effect on the other species.

DISCUSSION

Plant number declined significantly during the season even without herbicide treatment. While part of the decline might have been caused by the dry spell at the beginning of the season, most of the mortality would be caused by competition from other plants and grazing pressure. The increase in plant number of serradella could be due to its delayed germination pattern (Revell *et al.* 1998). The significant decline in density and productivity of gland clover following herbicide treatment confirms its sensitivity to bromoxynil (Revell 2002).

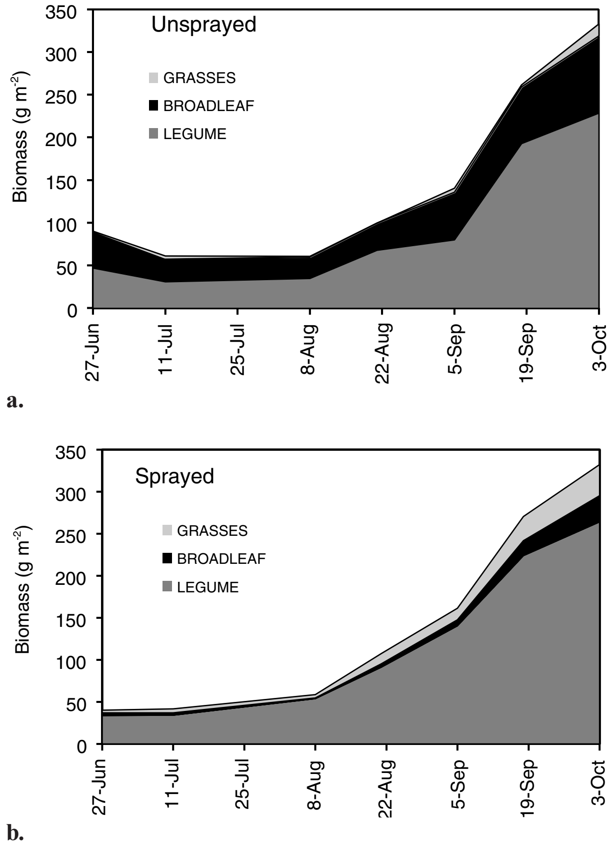


Figure 2. (a) Plant dry weight, unsprayed. (b) Plant dry weight, sprayed.
LSD (P=0.05) (unsprayed vs sprayed).
27 Jun: Legume, 16.0 (P=0.068); Broadleaf, 9.3; Grass, ns; Total, 18.3.
03 Oct: Legume ns; Broadleaf, 23; Grass, ns; Total, ns.

Table 2. Composition of legume biomass as affected by chemical spray.

Date	27/6/2001					3/10/2001				
Treatment	unsprayed		sprayed		LSD*	unsprayed		sprayed		LSD*
	g m^{-2}	%	g m^{-2}	%	(P=0.05)	g m^{-2}	%	g m^{-2}	%	(P=0.05)
Subclover	30	(63)	24	(72)	ns	171	(74)	228	(86)	ns
Serradella	1	(2)	1	(2)	ns	5	(2)	6	(2)	ns
Biserrula	2	(5)	3	(9)	ns	9	(4)	6	(2)	ns
Gland clover	14	(30)	6	(16)	8	45	(20)	24	(9)	11

* unsprayed vs sprayed.

At the site, the predominant broadleaf weed was capeweed. With its wide adaptation to the wheatbelt environment and competitive growth habit, capeweed has become a fixed feature in pastures (McIvor and Smith 1973, Arnold *et al.* 1985, Broom and Arnold 1986, Thomson *et al.* 1995, Dunbabin and Cocks, 1999). The removal of capeweed did result in a higher legume percentage at the end of the season. This is similar to the conclusion of Thorne and Perry (1987) that selectively controlling some species in the pasture population will improve the productivity of the desirable species.

The second aspect of this experiment was to test whether increased seed bank size and diversity of the legume species should give the legume component more stability (Liu and Revell 2001). In this experiment, the recovery in legume productivity was mainly attributed to subclover, which could be due to its competitive ability and large initial seed bank as indicated by the initial plant count. The large number of gland clover could have been attributed to its small seed size and high hard seed level. The low plant numbers of species other than subclover and gland clover could be caused by a low seed bank in the soil due to poor seasons experienced in previous years (as indicated by the low plant count at the beginning of the season). Constant grazing during the experiment could have disadvantaged aerial seeding species with an upright growth habit as indicated by the small contributions from other species to FOO. The soft seeded pink serradella did not appear in the regenerating phase after a crop, indicating that its seed bank has been exhausted through the cropping phase (which is as expected). The increase in grass weeds (mainly barley grass (*Hordeum leporinum* Link) and silver grass (*Vulpia* spp.)) in the pasture after removal of capeweed may be explained by a lack of competition and their low preference by sheep.

In conclusion, selectively removing broadleaf weeds can increase the legume percentage in pastures. However, grass weeds may become more significant especially when the legume seed bank is low. The contribution from alternative legume species after broad leaf weed control will be further investigated in 2002.

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