RESIDUAL HERBICIDES APPLIED TO A PASTURE BEFORE REGENERATION WILL CONTROL SOME ANNUAL WEEDS

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Summary An experiment conducted at three sites in Woodanilling, Western Australia, during 1995, has demonstrated that a number of residual herbicides can be applied to pastures prior to regeneration for the control of annual weeds. Eight herbicides were applied at various rates and in combinations to dry pasture before the break of the season. Due to the inability to accurately predict the break of the season, treatments were applied four weeks prior to rainfall and subsequent pasture germination.

Of the herbicides tested simazine and imazethapyr were the most effective. Simazine, applied at 0.25 and 0.5 kg ha^{-1}, reduced the density of *Vulpia* spp. by 95–98% relative to untreated pasture. The density of *Erodium* spp. was lowered by 33–82% following the application of imazethapyr at 0.024 kg ha^{-1} prior to the break of the season. Variations in control were most likely due to changes in soil type. These treatments have resulted in little damage to companion subterranean clover (*Trifolium subterraneum* L.).

INTRODUCTION

It is most economical to control weeds while they are young and vigorously growing. In pastures, controls applied during early growth are termed pasture manipulation (or winter cleaning). A wide range of herbicides are available for grass and broad-leaf control in pastures (Brewster and Spinney 1989, Peirce 1993). However, with few exceptions these herbicides must be applied following pasture regeneration and as a result pasture manipulation may coincide with other farm operations (i.e. crop establishment).

Simazine and diuron have proved useful for weed control in pastures post-emergence (Leys *et al*. 1991, Peirce 1993). Both of these herbicides are residual and are registered for use pre-emergence in some legume crops (Fua 1981, Gilbey and Bowran 1993).

If effective pasture weed control could be performed well in advance of weed emergence using less expensive, residual herbicides, it is likely that a greater proportion of farmers would carry out pasture weed control thereby improving pasture quality and the potential performance of pastures and following crops. Trifluralin is already registered for this purpose in lucerne.

This paper outlines the results of an experiment designed to assess the effects of a range of soil residual herbicides on pasture legumes and grass and broad-leaf weeds when the herbicides were applied to regenerating pastures prior to seedling emergence.

MATERIALS AND METHODS

Site details An experiment was conducted at three sites in the Woodanilling area of Western Australia (527250 mE, 6288800 mN) from April to December 1995. Soil descriptions for each site are presented in Table 1.

Table 1. A soil description and analysis is presented for each site. Sites are referred to by their paddock name.

Site name	Backshed	Dutchmans	Pembers
Description	Dark greyish brown (10YR 4/2) sand 10% gravel over yellowish brown (10YR 5/4) gravelly sand	Very dark greyish brown (10YR 3/2) loamy coarse sand over a light brownish grey (10YR 6/2) gravelly coarse sand	Dark greyish brown (10YR 4/2) clayey sand over a light yellowish brown (10YR 6/4) loamy gravel with 40% fine and 40% medium sub-rounded ferruginous gravel
pH ($CaCl_2$) at surface	4.8	4.9	4.6
pH ($CaCl_2$) at 30 cm	4.7	5.4	5.2
Nitrogen (mg kg^{-1})	24	30	25
Phosphorus (mg kg^{-1})	10	17	11
Potassium (mg kg^{-1})	76	65	78
Sulphur (mg kg^{-1})	5	10	4
Organic Carbon (%)	1.7	1.4	1.5
Reactive Iron (mg kg^{-1})	220	763	300

Table 2. The density (plants m^{-2}) of the major pasture components six weeks after the opening rainfall, (3 July 1995). Selected treatments from three sites are presented. Values in parentheses are transformed means (ln (x + 1)) and LSDs relate to the transformed means.

	Treatment (kg ha^{-1})	Backshed	Dutchmans	Pembers
Sub-clover	untreated	669 (6.49)	1147 (6.83)	481 (6.02)
(*Trifolium*	simazine 0.25	834 (6.69)	1509 (7.19)	398 (5.99)
subterraneum)	simazine 0.25[A]	881 (6.75)	900 (6.71)	564 (6.27)
	simazine 0.5	719 (6.49)	1759 (7.39)	498 (6.17)
	imazethapyr 0.024	747 (6.61)	1497 (7.24)	1025 (6.73)
	imazethapyr 0.018 + oryzalin 0.125	875 (6.62)	1547 (7.27)	826 (6.44)
	diuron 0.25	781 (6.54)	1088 (6.76)	494 (6.19)
LSD (P=0.05)		ns	0.49	ns
Capeweed	untreated	175 (4.75)	425 (5.76)	203 (4.68)
(*Arctotheca*	simazine 0.25	106 (4.42)	203 (5.17)	62 (1.38)
calendula)	simazine 0.25[A]	38 (2.78)	291 (5.55)	17 (1.05)
	simazine 0.5	25 (1.95)	138 (4.73)	4 (0.72)
	imazethapyr 0.024	184 (4.79)	425 (5.89)	199 (4.66)
	imazethapyr 0.018 + oryzalin 0.125	128 (3.8)	381 (5.72)	199 (3.57)
	diuron 0.25	69 (2.92)	353 (5.86)	37 (2.16)
LSD (P=0.05)		1.69	0.74	2.71
Erodium spp.	untreated	453 (6.01)	100 (4.39)	851 (6.73)
	simazine 0.25	297 (5.57)	156 (5.05)	896 (6.70)
	simazine 0.25[A]	338 (5.68)	88 (4.14)	842 (6.62)
	simazine 0.5	306 (5.59)	75 (3.73)	643 (6.44)
	imazethapyr 0.024	81 (4.10)	63 (3.89)	332 (5.46)
	imazethapyr 0.018 + oryzalin 0.125	266 (4.31)	25 (2.55)	253 (5.46)
	diuron 0.25	388 (5.85)	134 (4.75)	909 (6.79)
LSD (P=0.05)		ns	1.03	0.53
Vulpia spp.	untreated	613 (6.21)	3966 (8.27)	403 (3.32)
	simazine 0.25	241 (4.27)	1009 (5.34)	50 (3.10)
	simazine 0.25[A]	50 (3.11)	575 (6.24)	0 (0.00)
	simazine 0.5	9 (1.47)	194 (2.98)	12 (0.98)
	imazethapyr 0.024	788 (6.43)	3391 (8.10)	307 (3.18)
	imazethapyr 0.018 + oryzalin 0.125	178 (3.72)	2825 (7.92)	344 (3.20)
	diuron 0.25	159 (3.95)	2503 (7.80)	299 (4.16)
LSD (P=0.05)		2.29	1.72	2.36
Lolium	untreated	219 (5.29)	128 (2.60)	320 (3.22)
rigidum Gaud.	simazine 0.25	150 (4.88)	50 (3.70)	0 (0.00)
	simazine 0.25[A]	169 (5.07)	20 (2.61)	42 (1.28)
	simazine 0.5	66 (3.33)	31 (1.21)	0 (0.00)
	imazethapyr 0.024	216 (4.89)	169 (3.54)	461 (3.34)
	imazethapyr 0.018 + oryzalin 0.125	322 (5.61)	72 (2.46)	232 (1.71)
	diuron 0.25	306 (5.54)	184 (2.94)	37 (1.94)
LSD (P=0.05)		1.41	1.99	ns

[A] This treatment applied following rainfall, all others presented applied four weeks prior to rainfall.

Table 3. Seed head density (heads m^{-2}) of *Vulpia* spp. assessed in October of the treatment year. Selected treatments from three sites are presented. Values in parentheses are transformed means (ln (x + 1)) and LSDs relate to the transformed means.

Treatment (kg ha^{-1})	Backshed	Dutchmans	Pembers
untreated	131 (4.20)	1419 (7.01)	631 (4.85)
simazine 0.25	13 (1.56)	336 (5.30)	244 (4.62)
simazine 0.25^{A}	13 (0.98)	149 (4.40)	134 (3.76)
simazine 0.5	0 (0.82)	37 (1.94)	147 (2.49)
imazethapyr 0.024	134 (3.63)	1461 (7.06)	675 (6.42)
imazethapyr 0.018 + oryzalin 0.125	41 (1.28)	515 (5.87)	447 (4.74)
diuron 0.25	116 (3.35)	838 (6.71)	431 (6.00)
LSD (P=0.05)	2.38	1.24	ns

[A] This treatment applied following rainfall, all others presented applied four weeks prior to rainfall.

Treatments Herbicides applied to dry paddocks on 19 April 1995 were flumetsulam 0.016 kg ha^{-1}; diflufenican 0.05 and 0.1 kg ha^{-1}; diuron 0.125 and 0.25 kg ha^{-1}; simazine 0.25, 0.375 and 0.5 kg ha^{-1}; imazethapyr 0.024 kg ha^{-1}; oryzalin 0.25 kg ha^{-1}; oryzalin 0.125 + imazethapyr 0.018 kg ha^{-1}; oryzalin 0.125 + diuron 0.125 kg ha^{-1} and oryzalin 0.125 + flumetsulam 0.016 kg ha^{-1}. A further three treatments applied immediately following the first substantial rainfall, 21 May 1995, were simazine 0.25 kg ha^{-1}; diuron 0.125 kg ha^{-1} and oryzalin 0.25 kg ha^{-1}.

All herbicides were applied using a four wheel drive mounted boom spray with an output of 100 L ha^{-1} at 180 kPa. Plots were 3 × 20 m and each treatment was replicated four times.

Measurements Pasture density and composition was assessed on each site six weeks after the opening rains (3 July 1995). Four 0.02 m^2 quadrats were counted per plot. The grass component was further evaluated in spring. Grass seed head density was measured by counting the seed heads present in four 0.02 m^2 quadrats on each plot. Sub-clover seed yield was determined after recovering burr from the soil to a depth of 2 cm in two 0.25 m^2 quadrats per plot.

Analysis An analysis of variance was conducted on the data using the Genstat 5 program (Payne *et al*. 1988). Data was transformed prior to analysis using a natural logarithm i.e. ln (x + 1).

RESULTS

Simazine and imazethapyr were the most effective herbicides applied (Table 2). Simazine especially at the 0.50 kg ha^{-1} rate reduced capeweed (*Arctotheca calendula* L. Levyns) and *Vulpia* spp. populations. The density of all the annual grass species present at each site was generally lower where simazine had been applied than following other treatments (data not presented). Imazethapyr applied alone at 0.024 kg ha^{-1} and combined with oryzalin (0.018 + 0.125 kg ha^{-1}) reduced the level of *Erodium* spp. present by approximately 60% compared to the density on the untreated plots.

Seed head density of *Vulpia* spp. was dramatically reduced following application of simazine at 0.5 kg ha^{-1} (Table 3). Imazethapyr plus oryzalin significantly reduced the density of *Vulpia* spp. seed heads at one of the three experimental sites and there was a reduction in seed head density at the other two sites when compared with the seed head density on the untreated plots.

Sub-clover density was not detrimentally affected by any of the treatments applied. Simazine, 0.25 kg ha^{-1}, applied immediately following rainfall did reduce the sub-clover density, but not to a significant level. Generally treatment of pasture pre-emergence with simazine, imazethapyr and imazethapyr plus oryzalin increased the density of sub-clover present, compared to the untreated controls. These increases were significant at the Dutchmans site (Table 2).

Sub-clover seed yield was assessed at two of the three sites (Pembers and Dutchmans) and there was no difference between treatments. However, when averaged over both sites sub-clover seed yield was 133% for simazine 0.5 kg ha^{-1} and 137% for imazethapyr 0.024 kg ha^{-1} of the yield from untreated plots (400 kg sub-clover seed ha^{-1})

DISCUSSION

The choice of herbicides for application prior to the regeneration of pasture will be limited to those herbicides which are activated by moisture and which are not degraded by UV light and/or heat. In dry conditions, imidazolinones (e.g. imazethapyr) are very stable under UV light. Where moisture and UV light are present these herbicides will degrade very quickly (Shaner 1989). Imidazolinones are primarily degraded by microbial breakdown, particularly under warm moist conditions. This group of herbicides would be suitable for application to pastures prior to regeneration.

It is likely that the effects of herbicides applied prior to pasture regeneration will vary from year to year depending on the length of time between application and the activating rainfall. Efficacy will also depend on the quantity of rain which may have fallen following application but which did not stimulate a germination.

The phytotoxicity of simazine is related to the amount of soil organic matter, clay content and cation exchange capacity (Day *et al.* 1968, Rahman and Matthews 1979). Species differences will also influence plant response to simazine applications.

The three sites in this experiment did not have appreciably high levels of soil organic matter (Table 1) and in nearly all other attributes measured, the soils at the three sites studied were similar.

The level of reactive iron was much higher at the Dutchmans site than the other two sites. The quantity of reactive iron present will determine the soils ability to remove and retain phosphates. It may be that the level of reactive iron in combination with other soil factors (clay content, organic matter etc.) could be having an influence on the amount of herbicide which is active in the soil. This would partially explain some of the variation found in the level of weed control on the three experimental sites.

A reduction in the competition between sub-clover with either *Vulpia* spp. or *Erodium* spp. following applications of simazine or imazethapyr probably led to the increase in sub-clover density measured. This effect is similar to previous research (Leys *et al.* 1991). Combining simazine and imazethapyr in the one application may prove the most effective for the control of grass and broad-leaf weeds.

There is certainly scope for the use of residual herbicides prior to the break of the season in pastures, particularly simazine and imazethapyr. More research is required to determine safety limits over a range of soil types. The optimum time interval between application and rainfall will also need to be studied closely.

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