MANAGEMENT OF HERBICIDE RESISTANT ANNUAL RYEGRASS, *LOLIUM RIGIDUM*, IN CROPS AND PASTURES

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Summary. Herbicide resistant biotypes of annual ryegrass, *Lolium rigidum*, are controlled by few selective herbicides in crops. Strategic use of effective herbicides combined with alternative techniques will lead to more effective control. Cultivation stimulates germination of the resistant biotypes and when combined with a suitable herbicide is effective in manipulating the population numbers. Pasture manipulation by heavy grazing when combined with spraytopping reduced seed production of the resistant biotype.

INTRODUCTION

Annual ryegrass is a major weed of cereal and legume crops in southern Australia (1,4,6,7). It is, however, still considered a valuable component of pastures (in the absence of annual ryegrass toxicity).

Selective grass herbicides have provided satisfactory control of annual ryegrass in most situations. The successive application of these herbicides has resulted in the development of herbicide resistant biotypes of this weed (5). The failure of a range of grass herbicides on resistant biotypes has prompted a re-evaluation of control methods utilized prior to the advent of selective herbicides (9).

This paper reports the effects of cultivation in relation to control of herbicide resistant annual ryegrass (HRRG) in lupins and wheat and the effects of grazing and spraytopping in pasture.

METHODS

The experiments were conducted in 1989 on two properties in North-east Victoria where continuous cropping has been practiced from between 7 and 13 years.

Annual ryegrass seed samples that were collected in December 1988 were tested for resistance to diclofop-methyl using a similar technique as described by Heap (5). These tests confirmed resistance in both populations.

Pasture manipulation. This experiment was located on a property near Devenish. The experimental area was cultivated and sown to subterranean clover cv. Seaton Park (10 kg/ha) with superphosphate, lime and molybdenum (250 kg/ha) in autumn, 1989.

Heavy grazing was combined with spraytopping in the spring (8 replicates). One hundred wethers/ha grazed the plots from 2 October 1989 for 11 days and from 12 December 1989 for 10 days. Paraquat was applied at 100 g/ha with Agral 60 at 0.2% (v/v) on 20 November 1989 using an experimental plot spray unit with an output of 100 L/ha.

The number of seed producing heads was determined using 12 0.06 m^2 quadrats in each replicate. Ten seed heads were collected from each replicate when all the pasture had dried prior to the second grazing but before seeds had fallen to the ground. These figures were averaged for each treatment. The seeds were separated by hand and examined over a light table to determine if they had developed an endosperm.

Wheat. This experiment was conducted on the same biotype of annual ryegrass as the pasture experiment. The site was direct drilled using an experimental seeder which provided minimal surface soil disturbance. Wheat cv. Matong was sown at 85 kg/ha on 15 May 1989 with superphosphate (10.9 kg P/ha).

Cultivation treatments were applied on 28 April 1989 and 15 May 1989 using a two way disc plough to a depth of 10 cm. Glyphosate, 900 g/ha, was applied to all plots following the initial cultivation treatment to remove all annual ryegrass present. Chlorsulfuron, 18.75 g/ha, was applied to all plots with Agral 60 at 0.2% (v/v) on 20 June 1989. All herbicides were applied using an experimental plot spray unit with an output of 50 L/ha.

Annual ryegrass emergence was measured using 24 0.06 m^2 quadrats in all 8 replicates. Seed production was determined by measuring the number of seed heads and seeds on the soil surface in 12 0.06 m^2 quadrats in each replicate. The average number of seeds produced on each seed head in each treatment was determined from 10 seed heads selected at random from each replicate.

Lupins. This experiment was located on a property near Rutherglen. The site was sown to lupins cv. GeeBung at 89 kg/ha with 11 kg P/ha on 8 May 1989.

Cultivation treatments were carried out on 15 April 1989 and 5 May 1989. Glyphosate,563 g/ha, was applied to all plots after the first cultivation treatment. Paraquat, 250 g/ha, and diquat, 150 g/ha, were applied following sowing. Simazine, 2 kg/ha, was applied within 10 days of sowing. Carbetamide, 2.1 kg/ha, was applied to the site on 29 August 1989. The herbicides were applied using an experimental plot spray unit with an output of 50 L/ha or 100 L/ha when carbetamide was sprayed.

Emergence and seed production of annual ryegrass were measured using the same techniques as described for the wheat experiment.

RESULTS AND DISCUSSION

Pasture manipulation experiment. The combination of heavy grazing followed by spraytopping reduced annual ryegrass seed production by 92% from 25827 seeds/m^2 to 2047/m^2 (Table 1). Heap (2) reported a reduction of almost 100% by spraytopping without grazing. Heavy grazing was applied to reduce the number of seed heads produced by the individual plants and to control the flowering time of the population to maximize the effectiveness of spraytopping. The reduction in seed heads produced from 572/m^2 to 465/m^2 was not significant (P=0.05).

Table 1.The effect of heavy grazing and spraytopping on seed production of annual ryegrass at Devenish.

Treatment	Seed heads (number/m^2)	Seed Production[a] (seeds/m^2)
No treatment	572	25827
Heavy grazing + spraytopping	465	2047
Statistical significance	NS[b]	***[c]

[a]Seed production prior to the second grazing measured on 30.11.89.
[b]Not significant P=0.05.
[c]***Highly significant P=0.05.

Heavy grazing did however cause a delay in flowering of almost one month compared to the ungrazed plots. The delay in flowering would limit the possibility of regrowth following spraytopping. The second grazing removed all seed heads present at the time of spraytopping although some seed may have been trampled into the soil or passed through the animal gut.

Wheat experiment. Cultivation increased annual ryegrass emergence (Table 2). Chlorsulfuron reduced the initial population of annual ryegrass on both the cultivated and the direct drilled plots but the populations were still high enough to cause severe yield reductions. Reeves (10) has shown that 100 annual ryegrass plants/m2 can cause a 10% reduction in the yield of wheat. No late emerging annual ryegrass seedlings were observed.

Table 2. The effects of cultivation on annual ryegrass under wheat.

Treatment	Annual ryegrass density (plants/m^2)		Seed production (seeds/m^2)
	22.6.89[a]	15.11.89	6.12.89
Direct drilled	649	143	6000
Cultivated	1379	225	8888
Statistical significance	***[b]	**[c]	***

[a]Pre chlorsulfuron application.
[b]*** Highly significant at P=0.05.
[c]** Significant at P=0.05.

Lupin experiment. An emergence response to cultivation was also observed on the site sown to lupins before simazine began to act. The simazine provided effective control of the population that emerged immediately following sowing. Late emergence occurred on both cultivated and direct drilled treatments with significantly more annual ryegrass seedlings on the direct drilled plots (Table 3). Carbetamide was the only selective herbicide available to control these seedlings.

Table 3.The effects of cultivation on annual ryegrass under lupins.

Treatment	Annual ryegrass density (plants/m^2)		Seed production (seeds/m^2)
	18.8.89[a]	15.11.89	12.12.89
Direct drilled	443	41	3997
Cultivated	274	24	2528
Statistical significance	**[b]	NS[c]	NS

[a]Pre carbetamide application.
[b]** Significant P=0.05.
[c]NS Not significant P=0.05.

The cultivation treatment was responsible for an increase in emergence of annual ryegrass seedlings in May on both the wheat and lupin experimental sites. Contrasting results were observed between the two sites by August. The plots subject to cultivation on the wheat experiment maintained a higher population of annual ryegrass throughout the year compared to those plots direct drilled. On the lupin experiment, the higher populations were also observed to be on the cultivated plots in May, however, in August, populations were higher on the direct drilled plots compared to those cultivated. This difference between sites reflects the differences in time of sowing and herbicide application in relation to the germination pattern of annual ryegrass. The simazine, applied to the lupin experiment, controlled most of the annual ryegrass plants that germinated in May and June, following sowing. This resulted in a greater reduction in the seed bank on the plots that were cultivated and this was reflected in the plant population numbers in August. The chlorsulfuron was applied 5 weeks later to the wheat experiment, than the simazine to the lupin experiment, at which time a greater percentage of the annual ryegrass population would have germinated. The chlorsulfuron controlled approximately 80% of the emerged population present at spraying. A high residual population remained, however, with more on the cultivated plots, due to the higher numbers which emerged. No further emergence was observed due to the timing of the chlorsulfuron application.

Control of annual ryegrass has been examined in both the pasture and cropping phase of a rotation. In the pasture phase grazing and spraytopping are very effective in reducing seed set. Heavy grazing, following spraytopping, to remove any viable seed is a necessary procedure to improve the reliability of this technique. Reeves (9) has examined a number of alternative control techniques in the pasture phase which could also be utilized. In the cropping phase cultivation is effective in increasing germination of annual ryegrass. The effectiveness and timing of this operation is influenced by seasonal conditions. If the 'autumn break' is early it provides the opportunity to achieve a presowing germination of annual ryegrass. This population can then be removed using knockdown herbicides. Cultivation can also be used to manipulate the timing of germination within the crop to suit the herbicide. The use of cultivation, in the lupin experiment, increased the proportion of the population controlled by simazine. This decreases the reliance on the herbicides from the aryloxyphenoxypropionate and cyclohexanedione chemical groups which are normally applied to kill follow up germinations. Cultivation therefore reduces the selection pressure imposed on annual ryegrass by these herbicides. An understanding of the impact of cultivation on ryegrass germination and the use of appropriate herbicides will enable more effective control of annual ryegrass in the cropping phase. The strategies described form part of an integrated approach necessary to help prevent the development of HRRG and to control exiting herbicide resistant populations (8,11).

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