CHEMICAL CONTROL OF BROME GRASSES (*BROMUS* SPP.) IN CEREALS

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ABSTRACT

Ripgut brome (*Bromus diandrus*), prairie grass (*B. willdenowii*) and soft brome (*B. hordeaceus*) are becoming serious weed problems in arable farms of New Zealand. This paper reports results from three years of field experiments evaluating chemical treatments for brome control in cereal crops. Ripgut brome was shown to be very competitive, with moderate infestations reducing grain yields by 25-30%. A strong relationship ($R^2=0.96$) was found between seedling numbers of ripgut brome and final grain yield. The study found several promising chemical treatments that offer a good degree of control. These include pre-emergence applications of cyanazine + terbuthylazine, chlorsulfuron + terbuthylazine, and metribuzin. The same herbicides applied post-emergence were not as effective for brome grass control.

Keywords: barley, herbicides, weed control, weed competition, wheat.

INTRODUCTION

Brome grass is emerging as a major challenge for arable farmers because there is no effective herbicide for its control in cereals. Several species of brome grass have already established in cropping farms of New Zealand. Visits to farms in central Canterbury in the past few years have identified three species as the most common: ripgut brome (*Bromus diandrus*), soft brome (*B. hordeaceus*) and prairie grass (*B. willdenowii*). Ripgut brome is also a troublesome weed in Australia, where it is known as great brome (Cheam et al. 1992). A related species, sterile brome (*B. sterilis*), is troublesome in the UK, while downy brome (*B. tectorum*) and cheat (*B. secalinus*) are widespread in North America (Peters et al. 1993; Cussans et al. 1994; Koscelny & Peeper 1997).

Chemical control of brome grasses have been the focus of much research in the above countries, but an effective and reliable solution is still to be found. In the United States, a mixture of chlorsulfuron + metsulfuron is used pre-emergence or tank mixed with metribuzin and applied early post-emergence to control cheat (Stahman & Abd-El-Hamid 1994; Koscelny & Peeper 1997). In Australia and the UK, isoproturon, metribuzin and pendimethalin have been registered, and a new sulfonylurea herbicide, sulfosulfuron, is now also available for brome grass control in those countries (Zaicou & Gill 1992). The performance of most of these treatments is subject to edaphic and cultivar variations and limited by a narrow margin of crop safety. No published work on chemical control of brome grass in cereals has been reported in New Zealand.

This paper presents the results of three years (2000-2002) of field experiments on the performance of selected herbicides and herbicide mixtures on three species of brome grass, wheat and barley.

METHODS

First year

The first year trial was sown to wheat cv. Hussar, barley cv. Fleet, soft brome and prairie grass on 31 May 2000 at the AgResearch Lincoln farm. There were 54 herbicide treatments replicated three times in a randomised complete block design. Plot size was

2 x 1 m and all species were sown with a Planet Junior hand-push drill at a 0.5 m row spacing. Sowing rate was 50 kg/ha for cereal crops and 20 kg/ha for grass weeds. Pre-emergence herbicide treatments that needed soil incorporation were applied on 1 June and raked into the soil to a depth of 2 cm. Other pre-emergence herbicides were applied on 9 June. Wet weather delayed the post-emergence applications to mid September when plants were at the 4 to 5-leaf stage. Herbicides were applied with a compressed nitrogen gas knapsack sprayer using a 2 m boom delivering 220 litres water /ha at 220 kPa pressure. Visual assessments of grass control and crop damage were made for thinning, growth suppression and injury on a 0 to 10 scale with 0 as no effect and 10 as complete kill of plant. Assessments were made on three different dates during October and mean values are reported.

Second year

In the second year, eight post-emergence herbicide treatments were evaluated for their effects on soft brome, prairie grass, wheat cv. Hussar and barley cv. Regatta. Grass and cereal species were sown with a precision drill in 1.35 m wide plots at 15 cm row spacing. Sowing rate was 120 kg/ha for cereal crops and 25 kg/ha for grass species. The trial consisted of two blocks, with herbicide treatments randomised within each. Herbicides were applied when cereals and grasses had one leaf emerged with a logarithmic sprayer using a starting concentration of four times the label rate and a 90% dilution occurring at the end of 20 m long plots. This allowed the evaluation of grass and crop responses to a wide range of herbicide rates. The herbicide treatments were evaluated in the same way as described above on 29 October. Only the recommended and 75% rates are reported in this paper for brevity.

Third year

In the third year, fields with natural infestation of brome grasses were selected for experiments. Five field experiments were conducted in central Canterbury. The first one at Ashburton (site DF) was sown to barley (cv. Newgrange) infested with *B. willdenowii*. Three sites in Rakaia and one in Methven were all sown to wheat and infested with *B. diandrus*. Wheat cultivars were Domino (sites PW1 & PW3), Amarok (site PW2) and Savannah (site GR). All crops were drilled at 120–140 kg/ha.

All experiments had four replicates and were laid out in completely randomised blocks. Plot width was 2.5 m and plot length ranged from 6 to 7.5 m. Application of herbicides was similar to the first year. Post-emergence applications were made when grass weeds had 1 leaf (site DF), 1–2 tillers (sites PW1 and PW2) or more than 6 tillers (sites PW3 and GR). Visual scores of grass control and crop damage were recorded by two independent observers, and plant density and dry weight data were taken in two randomly-placed quadrats (0.25 m²) per plot. Grain yield was measured using a Wintersteiger 'Elite' plot combine with 1.65 m swath and adjusted to 14% moisture. Data were analysed using Microsoft Excel ANOVA and where the F test was significant, LSD ($P < 0.05$) values were calculated for mean comparison.

RESULTS AND DISCUSSION

First year

From 54 herbicide treatments only the ones with significant effects on brome species are presented in Table 1. Ineffective herbicides included trifluralin and alachlor (as incorporated); cyanazine, diuron, pendimethalin and tribunil (pre-emergence); and diflufenican + isoproturon mix, diclofop-methyl, fenoxaprop-P-ethyl and clodinafop-propargyl (post-emergence).

Among the incorporated treatments, only acetochlor provided an adequate control of soft brome. Of the pre-emergence treatments, simazine gave good control of soft brome and simazine + pendimethalin gave satisfactory control of both soft brome and prairie grass. Simazine caused some damage in barley.

TABLE 1: Visual score (0=no effect, 10=dead; mean of three different occasions) after application of different herbicides to brome grasses, wheat and barley in 2000.

Herbicide treatment	Rate (g ai/ha)	Soft brome	Prairie grass	Wheat	Barley
Incorporated					
triallate	2625	3.3	1.8	0	0.3
acetochlor	3200	8.7	4.9	0.2	1.0
Pre-emergence					
cyanazine + terbuthylazine	620+500	6.3	6.1	1.2	2.2
terbuthylazine	1500	4.3	6.7	0.4	0.6
metribuzin	525	5.3	5.8	0.8	0.7
simazine	2700	7.1	4.9	0.2	2.2
simazine + pendimethalin	2700+2475	7.1	8.2	1.1	1.1
No herbicide					
LSD ($P < 0.05$)		2.1	2.4	0.7	1.3

Second year

In the second year, only post-emergence applications were compared. The most effective herbicide treatments on soft brome were cyanazine + terbuthylazine and chlorsulfuron + terbuthylazine (Table 2). The latter mixture was more effective on prairie grass. Isoproturon caused more damage to prairie grass than soft brome. The results reported in Table 2 are for the full rate of herbicides. At 75% of the recommended rate, chlorsulfuron + terbuthylazine still maintained good control (80%) of both grass species, while cyanazine + terbuthylazine and isoproturon maintained good control of soft brome (85%) and prairie grass (83%), respectively.

TABLE 2: Damage (% compared to the no herbicide treatment) caused by post-emergence herbicide treatments on brome grasses, wheat and barley in 2001.

Herbicide treatment	Rate (g ai/ha)	Soft brome	Prairie grass	Wheat	Barley
tralkoxydim	360	0	0	0	0
terbuthylazine	1000				
cyanazine + terbuthylazine	305+206	95	75	18	27
acetochlor	1800	75	70	0	32
chlorsulfuron + terbuthylazine	9+750	90	90	20	22
metsulfuron	6	5	25	0	0
clodinafop-propargyl + trifluralin	12+384	10	53	0	28
isoproturon	1500	75	95	25	18

Third year

Among the pre-emergence treatments (used only at two sites), chlorsulfuron + terbuthylazine and metribuzin gave better than average control at both sites, while cyanazine + terbuthylazine was effective only at one site (Table 3). Among the post-emergence treatments, isoproturon provided good control at one site only (DF), where the major grass species was prairie grass (*B. willdenowii*). Isoproturon did not have much effect on ripgut brome (*B. diandrus*) which was prevalent at the other sites. Application of herbicides at the PW3 site was made at tillering stage of wheat and ripgut brome. However, terbuthylazine + terbuthylazine gave reasonable control even on large ripgut brome at this site.

TABLE 3: Visual scores (1=no effect, 10=full control) at four sites (DF, PW1, PW3 and GR) and brome grass dry weight (g/m²) at one site (PW2) after application of herbicide treatments to brome grasses infesting cereal crops during 2002.

Herbicide treatment	Rate (g ai/ha)	Trial sites				
		DF	PW1	PW2	PW3	GR
Pre-emergence						
1.cyanazine + terbuthylazine	500+500		7.6	142		
2.chlorsulfuron+ terbuthylazine	11+500		8.0	106		
3.metribuzin	525		7.5			
Post-emergence						
4.cyanazine + terbuthylazine	500+500	8.5	3.8	193		5.8
5.chlorsulfuron+ terbuthylazine	11+500	6.5	2.0	147		6.5
6.isoproturon	1500	7.5	3.3	207		2.5
7.metribuzin	525	8.0		119		
8.terbutryn + terbuthylazine	1225+525				6.3	
9.isoproturon + cyanazine	1000+875				1.8	
10.No herbicide		2.7	1.7	204	1.0	1.0
LSD (P<0.05)		3.2	2.7	97.9	2.2	NS

Visual evaluations throughout the season (data not presented) showed that none of the pre-emergence treatments resulted in any obvious injury to the crop. Post-emergence application of metribuzin caused leaf burning and stunting of barley. All herbicide treatments at the site PW2 resulted in increases in wheat dry weight (Fig. 1), though some were not statistically significant. The increase ranged from 18% for isoproturon to 73% for the pre-emergence application of chlorsulfuron + terbuthylazine. This is an effect of brome grass control (Table 3), but also shows that the treatments did not result in any serious injury to wheat.

Grain yield data were obtained only at the site PW1. Wheat yield was the lowest in no herbicide plots where the competition from ripgut brome was severe (Fig. 2). More than 58 ripgut brome plants/m² were counted in no herbicide plots and the average yield in these plots was reduced by 30% compared to the highest yield in plots sprayed pre-emergence with cyanazine + terbuthylazine. All pre-emergence treatments resulted in significant increases in grain yield compared to the no herbicide plots with no difference between the herbicides. None of the post-emergence treatments used gave a significant increase in grain yield compared to the no herbicide plots.

DISCUSSION

The study showed variation between different species of brome grass in response to herbicides. Soft brome was more sensitive than prairie grass to acetochlor and cyanazine + terbuthylazine, while prairie grass showed more sensitivity to isoproturon. Ripgut brome was the most tolerant species to most herbicides tested but was reasonably controlled by pre-emergence applications of cyanazine + terbuthylazine, chlorsulfuron + terbuthylazine and metribuzin.

FIGURE 1: Relationship between mean dry weight of riggut brome (g/m^2) and mean dry weight of wheat (g/m^2) as measured in January at site PW2. Numbers on data points represent treatments as shown in Table 3. LSD ($P < 0.05$) for wheat dry weight = 319 g/m^2 .

FIGURE 2: Relationship between mean density of riggut brome (no. plants/ m^2) measured in September and final wheat yield (t/ha) at site PW1. Numbers on data points represent treatments as shown in Table 3. LSD ($P < 0.05$) for grain yield = 0.59 t/ha .

Timing is a critical factor in the success of brome grass control. Pre-emergence applications showed more efficacy in all our trials. This may not always be practical due to wet weather conditions in mid winter. It is ideal to have some post-emergence chemical options to control brome grasses. Overseas reports indicate that sulfosulfuron is an effective post-emergence herbicide for brome grass control (Blackshaw & Hamman 1998), but this is not available in New Zealand. The results from 2002 trials showed terbutryn + terbuthylazine as a promising post-emergence treatment. This mixture was applied at the tillering stage of wheat and gave more than 90% reduction in riggut brome biomass (data not presented). There was some early damage to wheat, but this was transitory and did not affect wheat biomass at harvest. This study and another report in this volume (Rolston et al. 2003) indicate that barley maybe more sensitive to herbicide treatments, and variation between cultivars needs to be considered when selecting a chemical option.

Although the study was not designed to determine threshold density for brome grass, the data showed strong competition between riggut brome and wheat. In two different trial sites, linear negative relationships were obtained between brome grass and wheat (Figs 1 & 2). The yield results (Fig. 2) underline the importance of controlling brome grass for farmers. Grain yield increases up to 45% were obtained with some of the more effective treatments. It would be desirable for farmers to have a model for predicting

their yield response based on weed competition. Both graphs show a linear model with high R^2 values and indicate an adverse effect of brome grass on wheat growth and yield.

At present, of the herbicides tested in this study, only chlorsulfuron and isoproturon are registered in New Zealand for use in wheat and barley; both of these are less effective on brome grass than some of the herbicides evaluated. Brome grass is a serious threat to cereal growers and more research on its management is required. Aspects of seed biology of different brome species are the subject of a parallel study by the authors and will provide background information for integrated weed management.

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APPENDIX: TRADE NAMES OF HERBICIDES REFERRED TO IN THE PAPER

Common name	Trade name & formulation
acetochlor	Trophy 400 S
chlorsulfuron	Glean 750WDG
clodinafop-propargyl	Topik 240 EC
cyanazine	Bladex 500 SC
isoproturon	Turonex 500 SC
metribuzin	Sencor 750 WDG
metsulfuron	Escort 600 600 WDG
pendimethalin	Stomp 330 EC
simazine	Simazine 900 WDG
terbuthylazine	Gardoprim 500 SC
terbutryn + terbuthylazine	Topogard SC
tralkoxydim	Achieve 400 WDG
triallate	Avadex 500 EC
trifluralin	Treflan 400 EC