GRASS WEED CONTROL AND HERBICIDE TOLERANCE IN CEREALS

M.P. ROLSTON¹, W.J. ARCHIE¹, K. REDDY¹ and F. DASTGHEIB²

¹AgResearch, PO Box 60, Lincoln, New Zealand

²IWM Consultancy, Lincoln, New Zealand

Corresponding author: phil.rolston@agresearch.co.nz

ABSTRACT

Field trials were undertaken over three years to determine herbicide options for grass weed control in cereal crops (wheat and barley). The susceptibility of phalaris, perennial ryegrass, Italian ryegrass, prairie grass and soft brome to a range of herbicides were evaluated at fixed rates and with a logarithmic sprayer. Wheat and barley damage and grain yield were also assessed and in general good tolerance was found in the 11 cultivars evaluated. The trials identified a number of control options for grass weeds in wheat and barley, in particular pre-emergence mixtures of cyanazine + terbuthylazine; chlorsulfuron + terbuthylazine; or metribuzin alone. Brome species were the most difficult to control and further research is required.

Keywords: grass weeds, cereals, herbicides, brome, ryegrass.

INTRODUCTION

Grass weeds are becoming an increasing problem in cereal crops both in New Zealand and internationally. Good herbicide options exist for the control of wild oat (*Avena fatua*), lesser canary grass (*Phalaris minor*), gnawed canary grass (*P. paradoxa*) in wheat (*Triticum aestivum*), ryecorn (*Secale cereale*) and triticale (*X Triticosecale*) (Mitchell 1982, Welsh 1994). There are fewer options for the control of wild oat and phalaris in barley (*Hordeum vulgare*) and oats (*Avena sativa*). Other grass weed species including annual ryegrass (*Lolium multiflorum*), perennial ryegrass (*L. perenne*), annual poa (*Poa annua*), brome species (soft brome (*Bromus hordeaceus*), ripgut brome (*B. diandrus*), prairie grass (*B. willdenowii*) and barren brome (*B. sterilis*)) and barley grass (*Hordeum leporinum*, and related species) are not well controlled. These grass weeds either become competitive or contaminate successive crops in the rotation, e.g. ryegrass in ryegrass or tall fescue (*Festuca arundinacea*) seed crops. In winter wheat systems in Europe, weed species have been rated according to three competition groups: critical (includes wild oats and brome), priority (includes Italian ryegrass and annual poa) and largely acceptable (Blair et al. 1999). Some species, especially ripgut and sterile brome are spreading from fence lines into the cereal crops, particularly in cultivated, un-burnt firebreaks. Some grass weeds are also hosts for the fungal disease take-all (*Gaeumannomyces graminis*).

This paper reports on seven trials, undertaken over three years to evaluate herbicide options for control of six grass weed species commonly found in cereals. The tolerance of wheat and barley to these treatments was also determined.

METHODS

Herbicide screening trial

The screening trial was sown on 31 May 2000 at the AgResearch Lincoln farm with two wheat cultivars (Hussar and Regency), two barley cultivars (Optic and Fleet) and five grass species. The grass species sown were prairie grass (cv. Matua), Italian ryegrass (cv. Concord), and field collected seed of lesser canary grass, annual poa and soft brome. Individual species were sown in a double row 0.5 m apart by 2 m long with 1.0 m between each cultivars/species. The trial involved 19 herbicide treatments x 9 cultivars

or species), replicated three times in a randomised complete block design. Barley and wheat were sown at a depth of 4–5 cm and the weed grasses at 2 cm.

Pre-emergence herbicide treatments (Table 1) that needed soil incorporation were applied on 1 June and raked into the soil. Herbicides that did not need soil incorporation were applied on 9 June. All post emergence herbicides were applied on the 13 and 14 September. Herbicide rates are presented in Table 1. The post-emergence applications were delayed because of very wet conditions in late winter until the four-leaf to early tillering stage. The herbicides were applied with a compressed nitrogen gas sprayer using a 2 m wide boom with 220 litres of water/ha at 220 kPa pressure. The herbicide effects on damage to the cereals and control of the weed grasses were visually scored on three occasions (3, 17 and 26 October) for phytotoxicity in wheat and barley and percent control in the weed grasses. The means of the three scores are reported in Table 1.

Log sprayer trial

The logarithmic sprayer trial was established in spring 2001 at AgResearch, Lincoln. Three cereal and five grass species were evaluated: barley (cv. Regatta), wheat (cv. Hussar), oat (cv. Massif), Italian ryegrass (cv. Concord); perennial ryegrass (cv. Nui), prairie grass (cv. Grasslands Matua), and field collected seed of lesser canary grass and soft brome. These were sown with a precision drill in 1.35 m wide plots (9 rows at 15 cm wide) and 20 m long. Seven herbicide treatments were evaluated (Table 2), applied either singularly or as mixtures, with two replicates in a completely randomised block design. Herbicides were applied with a two-nozzle logarithmic sprayer, with a start concentration that was four times that of the recommended rate and a finish rate that was 10% of the start rate. Treatments were applied on the 8 October (Rep 1) to a dry soil surface and on 9 October (Rep 2) to a moist soil surface; 50% of cereals and 20% of ryegrasses had just emerged. The metsulfuron treatment was applied on 26 October with most grasses at 2–3 leaf stage and the wheat, barley and oats at 3–4 leaf to 1 or 2 tiller growth stage. Tralkoxydim was applied on 2 November.

The herbicide treatments were evaluated on 29 October for the early post-emergence treatments and in late November for the late post-emergence treatments by scoring the level of control or crop damage (as described above) at 1 m intervals. The herbicide rate at each 1 m point was calculated from the log curve with the rate that gave the best balance between crop tolerance and grass control being presented in Table 2.

Tolerance yield trials

Five trials were used to assess the tolerance of cereals to various herbicides. Two adjacent trials at AgResearch, Lincoln, consisting of a winter trial of three wheat cultivars (Impact, Regency and Savannah) sown on 21 June 2001 and a spring trial with two barley cultivars (Dash and Optic) and one wheat cultivar (Otane) sown on 6 September 2001. Both trials were sown with 120 kg cereal seed/ha into 1.35 m wide and 6.5 m long plots. The crops were irrigated and received a total of 180 kg N/ha. Fungicides (Opus + Amistar) were applied by hand to avoid crop damage by tyres. Herbicides used in the trial and the rates applied are listed in Table 3. In the winter wheat, herbicides were applied pre-emergence on 2 July 2001 or post emergence 7 September 2001 (Zadocks Growth stage 31), and on the spring-sown cereals herbicides were applied pre-emergence on 13 September 2001 or post-emergence on 21 September 2001. There were three control plots per replicate and these received a post-emergence application of a commercial mixture (Combine) containing 200 g/litre bromoxynil + 200 g/litre ioxynil (both as octanoate ester in an emulsifiable concentrate formulation) on 21 September 2001 to ensure broadleaf weeds did not become competitive. Treatments were replicated four times using a split plot layout with cereal cultivars as main plots and herbicides as sub-plots. Visual observations were made for herbicide damage as phytotoxicity responses or stunting at 2 and 4 weeks after application. Broadleaf weed control was also assessed at harvest to determine if the grass control treatments provided an acceptable control of broadleaf weeds thus reducing the need for an additional herbicide application. The main weed species were fat hen (*Chenopodium album*), black nightshade (*Solanum nigrum*), cornbine (*Polygonum corniculatus*) and scarlet pimpernel (*Anagallis arvensis*). Plots were harvested on the 12 February 2002 using a Wintersteiger 'Elite' plot combine.

The grain from each plot was weighed and seed moisture determined to correct grain yields to 14% moisture content.

The third trial was sown at Lincoln with wheat cv. Claire at 160 kg/ha on 9 July 2002. Herbicide treatments (Table 4) were applied on 31 July (pre-emergence) or 12 September (post-emergence). The trial was in a randomised block with four replicates. Fertiliser, irrigation and fungicide management and harvesting (18 February 2003) of this trial was similar to the tolerance trials 1 and 2.

The fourth and fifth trials consisted of two dryland field sites on a farmer's property at Somerton. These were direct drilled with either cv. Domino or cv. Amarok wheat at 120 kg seed/ha. The herbicides (Table 4) were applied pre-emergence or post-emergence when the wheat had one tiller (GS 21). The trials were in a randomised block with four replicates. The Domino wheat was machine harvested and the Amarok was assessed by cutting two 0.25m² quadrats per plot, dissecting the wheat from the brome and oven drying samples to determine wheat biomass.

Statistical analysis

Data was analysed with a GenStat Release 6.2 Lawes Agricultural Trust (Rothamsted Experimental Station) package to generate LSD values.

RESULTS AND DISCUSSION

Herbicide screening trial

Both wheat and barley were tolerant to the herbicides evaluated with two exceptions; barley was susceptible to injury from clodinafop-propargyl and Hussar wheat to cyanazine+ terbuthylazine ($P < 0.05$) (Table 1). The effectiveness of the post-emergence herbicides in controlling grass weeds may have been reduced by the advanced growth stage at application. Annual poa was readily controlled by most of the herbicides evaluated. Italian ryegrass and canary grass were well controlled by acetochlor, clodinafop-propargyl and diclofop-methyl ($P < 0.05$). The two brome species were not well controlled by any of the treatments. Soft brome (but not prairie grass) was partially susceptible to acetochlor; while a mix of cyanazine + terbuthylazine was the most effective of the pre-emergence herbicides evaluated on brome species (Table 1).

Log sprayer trial

Wheat was more tolerant than barley, while oats was the most susceptible to herbicide damage (Table 2). In our experience the susceptibility of cultivated oats can be used as a guide to the susceptibility of wild oat to these herbicides. As in the screening trial, Italian ryegrass and canary grass were very susceptible to most treatments, but were only partially susceptible to tralkoxydim and tolerant to metsulfuron, while perennial ryegrass was susceptible to all herbicides (Table 2). In this trial better control of the brome species was achieved compared to Trial 1, with cyanazine + terbuthylazine and chlorsulfuron + terbuthylazine being most effective. However, these brome species were less susceptible than either the ryegrasses or canary grass to the herbicide treatments.

TABLE 1: Damage (%) of wheat and barley cultivars and control (%) of five grass species in the screening trial. Data are the mean of visual evaluations on three occasions.

Herbicide	kg ai/ha	Damage		Control				
		Barley	Wheat	Soft brome	Prairie grass	Italian ryegrass	Canary grass	Annual Poa
Control	0	0	0	0	0	0	0	0
Incorporated pre-emergence								
acetochlor	1.8	0	0	67	3	93	93	100
alachlor	1.9	0	0	10	0	30	7	100
trifluralin	1.2	0	0	0	0	33	63	100
triallate	2.6	3	0	10	7	43	3	0
Pre-emergence								
cyanazine	1	0	0	0	0	0	0	100
cyanazine								
+ terbutylazine	0.6+0.5	4	10	57	50	53	87	100
diuron	1.6	0	0	0	0	0	10	97
methabenzthiazuron	2.1	0	0	0	0	0	0	0
metribuzin	0.52	0	0	33	50	57	77	100
pendimethalin	1.1	0	0	0	0	0	20	77
simazine	1	0	0	10	27	20	53	100
simazine	1.5	0	0	53	30	43	70	100
simazine								
+ pendimethalin	0.75+1.1	0	0	13	0	0	73	100
terbutylazine	0.5	0	0	0	0	0	27	93
terbutylazine	1	0	0	13	0	0	57	100
Post-emergence								
clodinafop								
-propargyl+oil	0.024	62	0	0	0	100	93	40
diclofop-methyl	0.75	0	0	0	0	93	87	53
diflufenican								
+ isoproturon	0.1+0.5	0	0	0	0	0	0	0
fenoxaprop								
-P-ethyl+oil	0.052	0	0	0	0	17	77	0
LSD(P<0.05)		11	5	23	23	32	30	26

Tolerance yield trials

Crop tolerance, assessed as crop phytotoxicity, and grain yield of three winter wheat cultivars, two cultivars of spring barley and one spring wheat, indicated good tolerance to the seven herbicides (Table 3). No phytotoxicity was observed following herbicide application. The yield of winter wheat cultivars averaged 10.1 t/ha, the spring barley 8.9 t/ha and the spring wheat 5.1 t/ha. In this trial two treatments reduced grain yield ($P<0.05$). Acetochlor at 2.4 kg/ha reduced cv. Regency winter wheat yield by 15%, but had no effect on the other three wheat cultivars evaluated. There was no difference in barley grain yield for any treatments averaged over both cultivars (Table 3). However, yield of cv. Dash barley was significantly ($P<0.05$) reduced (17%) by simazine at 1.5 kg/ha, but there was no effect of this treatment on cv. Optic barley (data not shown).

TABLE 2: Damage to wheat and barley (%) and control (%) of grass weeds in the log sprayer trial. Data are visual observations 21 and 28 days after treatment for pre-emergence and post-emergence treatments.

Herbicide	kg ai/ha	Damage			Control				
		Barley	Wheat	Oats	Soft brome	Prairie grass	Italian ryegrass	Perennial ryegrass	Canary grass
Pre-emergence									
acetochlor	1.44	10	0	35	50	50	97	95	98
chlorsulfuron	0.011+0.75	13	3	0	70	88	87	97	98
+ terbuthylazine									
clodinafop-propargyl	0.012+0.380	30	0	99	10	55	97	75	99
+ trifluralin	0.30+0.26	12	10	62	88	68	93	85	99
cyanazine +terbuthylazine	1.25	13	5	97	50	82	96	98	99
isoproturon									
Post-emergence									
metsulfuron	0.007	0	0	0	0	22	0	82	10
tralkoxydim	0.36	0	0	98	0	0	48	72	30

TABLE 3: Relative grain yield (control=100) of wheat (mean of four cultivars) and barley (mean of two cultivars), and broadleaf weed ground cover (%) at harvest.

	Rate (kg ai/ha)	Grain yield			Broadleaf weed cover		
		Winter wheat	Spring wheat	Spring Barley	Winter wheat	Spring barley	Spring wheat
control	0	100		100	3.8	3.4	19
Pre-emergence							
cyanazine							
+ terbuthylazine	0.25+0.25	98	100	98	5.3	4.4	16
cyanazine							
+ terbuthylazine	0.50+0.50	101	104	97	3.1	2.4	14
metribuzin	0.38	99	102	99	2.5	3.5	22
simazine	1.0	102	93	94	2.9	1.5	12
simazine	1.5	99	83	89	0.7	1.4	6
terbuthylazine	1.0	96	99	96	1.7	2.4	14
Post-emergence							
chlorsulfuron							
+ terbuthylazine	0.015+2.0	97	94	98	1.8	2.3	17
isoproturon	1.5	102	102	96	1.8	2.8	5
acetochlor	1.8	101	89	94	2.6	1.6	8
acetochlor	2.4	95	94	97	1.9	2.5	23
LSD (P<0.05)		5.7	12	14	1.8	2.5	8

There was a low level of broadleaf weeds following herbicide treatment in winter wheat and spring barley. In these crops and for the weed species present, the combined effect of the herbicides and crop competition suppressed the weeds to the same level as the control treatment which had a broadleaf herbicide treatment (Table 3). The cost of the grass weed herbicides could be off-set by savings from not having to apply a separate herbicide for broadleaf weed control. However, in spring wheat the same treatments did not provide an adequate level of broadleaf weed control and an additional broadleaf weed herbicide would be necessary following pre-emergence grass weed treatments.

Grain yield in Claire wheat was not depressed by any of the herbicides evaluated (Table 4), confirming the result with different cultivars in the previous trials (Tables 1, 2 and 3). In the presence of a natural population of riggut brome both wheat cultivars (Domino and Amarok) had higher yields for all the herbicide treatments compared to the untreated control (Table 4).

The trials suggest that there are a number of herbicide options for the control of a grass weed species in wheat and barley, especially to control annual poa, lesser canary grass, ryegrass, prairie grass and soft brome. Control of grass weeds in oats will be difficult. Although all the herbicides evaluated are commercially available in New Zealand, few are registered for use in cereals. With grass weeds increasing as a problem for arable farmers there is a need for the arable industry and agri-chemical companies to begin working together to address this problem.

TABLE 4: Actual yield (t/ha) and relative grain yield (RGY) or relative wheat dryweight (RDW) for three wheat cultivars: irrigated Claire (no weed competition) and dryland Domino and Amarok (with grass weed competition) following pre-and post-emergence herbicides.

Herbicide	Rate (kg ai/ha)	Claire		Domino		Amarok
		Actual	RGY	Actual	RGY	RDW
control	0	10.35	100	3.42	100	100
Pre-emergence						
chlorsulfuron						
+ terbutylazine	0.011 + 0.75	10.57	102	4.80	140	173
cyanazine+ terbutylazine	0.5+0.5	10.12	98	4.88	142	157
metribuzin	0.52	10.53	102	4.70	137	145
Post-emergence						
chlorsulfuron						
+ terbutylazine	0.011 + 0.75	10.27	99	3.92	115	158
cyanazine+ terbutylazine	0.5+0.5	10.68	103	3.82	112	128
isoproturon				3.56	104	119
isoproturon+cyanazine	1.0+1.75	10.35	100			
terbutryn+ terbutylazine	1.2 + 1.0	10.16	98			
LSD (P<0.05)		NS	NS	0.6	17	45

CONCLUSION

There are herbicides that can be used in wheat and barley that will control some grass weed species, especially oats, annual poa, canary grass and ryegrass. The control of brome species is more difficult. Of the herbicides evaluated mixtures of chlorsulfuron + terbutylazine or cyanazine + terbutylazine gave the best control of both ryegrass and brome. Further trials are needed on brome species, especially ripgut brome, a species not investigated in this study. Dastgheib et al. (2003) report on initial field trials with ripgut brome that build on the results obtained in the series of trials reported in this paper.

ACKNOWLEDGEMENT

Thanks to the Foundation for Arable Research for funding the trials referred to in this paper; Bede McCloy of New Zealand Arable for combine harvesting the tolerance-yield trials; Linda Reid and Fergus Rolston for technical assistance.

REFERENCES

- Blair, A.M.; Cussans, J.W.; Lutman, P.J.W. 1999: A biological framework for developing a weed management support system for weed control in winter wheat: weed competition and time of weed control. *Brighton Crop Prot. Conf. – Weeds*: 753-760.
- Dastgheib, F.; Rolston, M.P.; Archie, W.J. 2003: Chemical control of brome grasses in cereals. *N.Z. Plant Prot.* 56: 227-232.
- Mitchel, W.J.P. 1982: The tolerance of some bread wheats, durum wheats and triticales to herbicides used for wild oat control. *Proc. 35th N.Z. Weed and Pest Control Conf.*: 230-232.
- Welsh, R.D. 1994: Propargyl - a post-emergent herbicide for selective control of wild oats and canary grasses in wheat, triticale and durum. *Proc. 47th N.Z. Plant Prot. Conf.*: 27-28.