THE EFFECT OF HERBICIDES AND SURFACTANTS ON TURF GRASSES AND ANNUAL POA

M.P. FINLAYSON¹ and F. DASTGHEIB²

¹Otago Polytechnic, P O Box 16, Cromwell

²Lincoln University, P O Box 2, Canterbury

ABSTRACT

The tolerance of browntop (*Agrostis capillaris* L.), perennial ryegrass (*Lolium perenne* L.), Chewings fescue (*Festuca nigrescens* Lam.) and annual poa (*Poa annua* L.) to twelve herbicides, with and without two organosilicone surfactants (Silwet L77 and Silwet S800), were assessed. Annual poa was controlled by haloxyfop and clethodim plus S800. Browntop was highly tolerant to chlorsulfuron and metsulfuron, and Chewings fescue to haloxyfop, fluzafop, clethodim and sethoxydim. Organosilicone surfactants affected the tolerance of some species to certain herbicides. For example, Silwet L77 reduced the tolerance of annual poa to glyphosate but S800 increased the tolerance of perennial ryegrass to terbuthylazine. The results have implications for the management of cool season turf.

Keywords: adjuvants, browntop, fescue, sportsfields, weed management.

INTRODUCTION

The main cool season turf species used in New Zealand are browntop (*Agrostis capillaris* L.), perennial ryegrass (*Lolium perenne* L.) and Chewings fescue (*Festuca nigrescens* Lam.). Grass weeds, more so than broadleaf weeds, are the major weed problems in cool season turf grasses as they are very similar to the main turf species in their tolerance to herbicides. Annual poa (*Poa annua* L.) has long been one of the main grass weed species of most New Zealand turf grounds (McLean 1978). Annual poa frequently invades, persists and becomes the major component of irrigated, close cut, intensely fertilised turf and is generally regarded as the main grass weed problem in cool season sports turf throughout the world (Beard 1973).

Over several decades various chemical treatments have been used to control annual poa in cool season turf. These include sulphur (Goss *et al.* 1975), arsenicals, DCPA, benefin, bensulide, paclobutrazol, endothal, ethofumesate, proflaminate (Vargas 1990; Baldwin 1993; Dernoeden 1998; Glasgow 1991) and different plant growth regulators (Johnson and Murphy 1996; Fagerness and Penner 1998). More recently a number of new herbicides have been developed for selective control of grass weeds in broadleaf crops. These include clethodim, fluzafop-butyl, haloxyfop and sethoxydim. These herbicides have label claims that Chewings fescue is a tolerant species (Fussell and Walton 1997), although little if any experimental work has been carried out on the tolerance of Chewings fescue sports turf cultivars in New Zealand to these herbicides.

It is known that surfactants affect the performance of herbicides and may vary the margin of selectivity between weeds and desired plants. The introduction of the organosilicone surfactants has opened up new opportunities for the efficient delivery of pesticide active ingredients into the plant (Field and Dastgheib 1996). It has been reported that the addition of Silwet L77 enhanced the uptake of glyphosate in pampas grass (*Cortaderia* spp.), gorse (*Ulex europaeus* L.) and perennial ryegrass (Dastgheib *et al.* 1994; Field and Bishop 1988; Gaskin and Zabkiewicz 1992). On the other hand Silwet L77 decreased glyphosate uptake in paspalum (*Paspalum dilatatum* L.) and couch (*Elytrigia repens* Beauv.) (Field *et al.* 1992).

This study was designed to investigate the effect of several herbicides with and without the addition of two organosilicone surfactants on the tolerances of four grass species. The aim was to find chemical treatments which selectively remove annual poa from browntop, Chewings fescue and perennial ryegrass turf.

MATERIALS AND METHODS

Three pot experiments were conducted in a greenhouse at minimum/maximum temperatures of 16/25°C to test the tolerance of browntop, perennial ryegrass, Chewings fescue and annual poa to different postemergence herbicide treatments. Plants were obtained from turf grounds using a core sampler 14.8 mm in diameter and 75 mm in length. The cores were planted into 50 x 50 x 80 mm pots at one core per pot filled with a Waimakariri silt loam soil. Plants were given sufficient time (between 4 and 6 weeks) to establish before receiving treatments. All plants were cut to a height of 75 mm one week before spraying. Plants were sprayed using a sprayer cabinet with a pressure of 320 kPa delivering 300 litres water/ha.

The first experiment compared 12 herbicides each at two rates with and without the addition of each of the organosilicone surfactants Silwet L77 and Silwet S800 (hereafter referred to as L77 and S800, respectively) at 0.1% concentration. This made a total of 72 treatments and one untreated control in a split plot design (herbicides as the main plots) with three replicates. Herbicide names are given in Table 1. Plants were assessed visually at 3, 6 and 12 weeks after treatment (WAT) and given a score of 1 (healthy) to 10 (dead). Plants were harvested 12 WAT and their dry weights determined.

The second experiment studied the effect of five of the most promising herbicides on the same species as the first trial. Three herbicides namely isoproturon plus diflufenican, terbutylazine and haloxyfop were used at one rate, amitrole was used at two rates and glyphosate at three rates (Fig. 1). All herbicide treatments were used with and without the addition of the organosilicone surfactant S800 at 0.1%. This experiment had a randomised complete block design with five replicates.

The third experiment studied the effect of glyphosate and surfactants on the control of annual poa in more detail. There were three rates of glyphosate with and without each of the organosilicone surfactants L77 and S800 at 0.1, 0.25 and 0.5% concentrations. The experimental design was a randomised complete block with four replicates. All data were subjected to analysis of variance using Genstat 4.1 and means were separated by LSD ($P < 0.05$).

RESULTS

Experiment 1

Regular visual assessments of plants in the first experiment showed differential tolerance between grass species to the herbicides. As the response trend to treatments followed the same pattern, only the last assessment at 12 WAT is reported here (Table 1). Moreover, only the higher rate of herbicides is presented for brevity.

Chewings fescue showed high tolerance to haloxyfop, fluazifop, clethodim and sethoxydim while browntop and ryegrass were sensitive to them (Table 1). Annual poa was tolerant to fluazifop and sethoxydim but was controlled by haloxyfop on its own and by clethodim with S800. Perennial ryegrass was very sensitive to clethodim and sethoxydim either with or without the organosilicone surfactants. Chlorsulfuron and metsulfuron were reasonably safe on browntop but killed perennial ryegrass, although the addition of the surfactant L77 reduced the effect of metsulfuron on perennial ryegrass.

All grass species showed a high level of tolerance to amitrole at 200 g/ha and the addition of surfactants did not affect their responses (Table 1). Annual poa showed initial damage 3 weeks after application of amitrole (data not shown) but it had recovered by 12 weeks. The effect of ethofumesate was stronger on Chewings fescue than on annual poa irrespective of the surfactants. Terbutylazine on its own or with the addition of L77 killed all species tested. When S800 was added, the effect of

terbuthylazine on perennial ryegrass was reduced significantly while it provided complete control of annual poa. Similarly, isoproturon plus diflufenican with the addition of S800 gave good control of annual poa without significant damage to perennial ryegrass or Chewings fescue. These combinations may be promising for the control of annual poa in perennial ryegrass turf. All grass species with the exception of annual poa showed high tolerance to glyphosate at 180 g/ha. Glyphosate caused significant damage to poa either on its own or with the surfactants, although there was some regrowth after 12 weeks.

TABLE 1: Visual assessment¹ of turf grasses 12 weeks after treatment in experiment 1.

Herbicide (Trade name)	Rate g ai/ha	Surfactant	Browntop	Annual poa	Perennial ryegrass	Chewings fescue
Haloxypop (Gallant)	300	0	10.0	10.0	9.7	1.0
		L77	8.7	6.3	10.0	1.0
		S800	9.7	7.7	8.3	1.0
Fluazifop (Fusilade)	375	0	4.7	1.0	8.7	1.0
		L77	8.7	1.0	10.0	1.0
		S800	4.0	1.0	2.3	1.0
Clethodim (Centurion)	240	0	8.3	2.0	10.0	1.0
		L77	7.7	6.7	10.0	1.0
		S800	9.3	9.0	10.0	1.0
Sethoxydim (Poast)	372	0	9.0	1.0	10.0	1.0
		L77	9.3	1.0	10.0	1.0
		S800	8.3	1.0	10.0	1.0
Chlorsulfuron (Glean)	30	0	2.0	2.0	10.0	2.7
		L77	2.0	2.0	10.0	5.3
		S800	2.3	1.3	10.0	2.7
Metsulfuron (Escort)	30	0	1.7	1.7	9.3	5.7
		L77	1.3	2.0	5.7	6.7
		S800	1.7	2.7	10.0	7.7
Amitrole (Amitrole)	200	0	2.7	2.3	2.0	1.0
		L77	2.0	2.0	2.0	2.0
		S800	2.7	2.7	1.7	1.3
Ethofumesate (Nortron)	2000	0	2.7	2.3	2.0	7.0
		L77	2.0	2.0	4.0	6.7
		S800	2.3	1.7	2.0	7.7
Terbuthylazine (Gardoprim)	1500	0	10.0	10.0	10.0	9.3
		L77	10.0	10.0	9.3	10.0
		S800	10.0	10.0	5.3	9.3
Isoproturon (Graminon)	390	0	5.0	5.3	4.0	1.7
		L77	7.3	7.0	9.0	1.7
		S800	4.0	3.0	1.7	2.0
Isoproturon and diflufenican (Cougar)	1000 and 200	0	7.0	6.0	7.0	1.3
		L77	6.0	9.0	10.0	1.0
		S800	6.7	9.0	3.0	1.3
Glyphosate	180	0	3.0	6.7	2.0	1.0
		S800	3.0	6.7	2.0	2.0
Control			1.0	1.0	1.0	1.0
Herbicide x species x surfactant			df=66	P<0.001	LSD=1.71 ²	

¹Visual assessment based on a scale of 1=no effect to 10= complete kill.

²LSD (P<0.05) is for comparing means within a column with the respective control.

FIGURE 1: Effect of different herbicides with and without the organosilicone surfactant S800 on the percent reduction in the dry weight of browntop, annual poa, perennial ryegrass and Chewings fescue in experiment 2. Herbicide rates given under the bars are in g ai/ha. Error bars are LSD ($P < 0.05$).

Experiment 2

Haloxypop markedly reduced the dry weight of all grass species except that of Chewings fescue (Fig. 1). It appears that haloxypop with or without surfactants may be a useful herbicide in a Chewings fescue lawn. Amitrole application at 600 g/ha caused only mild damage to the grass species tested. At 1000 g/ha this herbicide caused 74% reduction in the dry weight of annual poa with 35% and 43% reduction in the dry weight of browntop and Chewings fescue, respectively. The effect of isoproturon plus diflufenican on its own was more pronounced on annual poa than on perennial ryegrass or Chewings fescue (Fig. 1). However, the difference was not large enough to allow selective control of annual poa in these species. When S800 was added to isoproturon plus diflufenican all grass species showed more than 90% reduction in their dry

weights. Terbutylazine caused 93% reduction in the dry weight of annual poa but only 32% reduction in the dry weight of perennial ryegrass. In the absence of S800, glyphosate at 180 g/ha caused 70% reduction in the dry weight of annual poa compared with only 33% reduction in the dry weight of browntop and Chewings fescue (Fig. 1). At 270 g/ha, glyphosate damage to browntop increased to 75% whereas the reduction in the dry weight of Chewings fescue was only 28%. Annual poa was more sensitive to glyphosate compared to the other grass species and the highest rate of glyphosate caused more than 99% reduction in its growth. However, other turf grasses were sensitive to this rate as well. Addition of S800 to glyphosate at 180 g/ha increased its effect on all grass species except Chewings fescue. This species did not respond to S800 at the high rate (360 g/ha) of glyphosate.

Experiment 3

This experiment aimed to find the best combination of glyphosate rate and surfactant concentration for the control of annual poa. In the absence of surfactants, increasing glyphosate rate resulted in significant reductions in the dry weight of annual poa (Table 2). Glyphosate at 180 g/ha caused only 77% reduction in the dry weight of annual poa but the addition of L77 increased this to more than 94% irrespective of the surfactant concentration. Similarly, addition of S800 to the lowest glyphosate rate caused significant increases in the control of annual poa. However, with this surfactant there was a positive response to increasing surfactant concentration from 0.1 to 0.25%. Addition of organosilicone surfactants to glyphosate at 270 g/ha did not affect its efficacy. At 360 g/ha, there was a significant reduction in the control of annual poa when L77 was added and the addition of S800 did not affect the performance of glyphosate.

TABLE 2: Effect of glyphosate at three rates in combination with two organosilicone surfactants, L77 and S800, on the growth of annual poa in experiment 3. Values are percent reduction in dry weight compared to the untreated control.

Glyphosate g ai/ha	Nil	L77 0.1%	L77 0.25%	Surfactant			
				L77 0.5%	S800 0.1%	S800 0.25%	S800 0.5%
180	76.9	97.2	99.3	94.4	82.5	98.6	98.6
270	92.3	90.9	91.6	94.4	94.4	99.3	88.8
360	97.2	86.7	88.8	90.9	99.3	99.3	99.3
LSD=4.1 ¹							

¹LSD (P<0.05) is for comparing any two means within the table.

DISCUSSION

The first experiment identified a number of herbicides with some degree of selectivity in turf. Haloxypfop, fluazifop, clethodim and sethoxydim belong to the aryloxyphenoxypropionate group and are developed as grass killers. Chewings fescue exhibited a high degree of tolerance to these herbicides irrespective of the rate or the addition of surfactants. For control of annual poa in Chewings fescue, haloxypfop would be the best option of the herbicides tested, although clethodim at 240 g/ha plus S800 was also an effective treatment (Table 1).

Ethofumesate damaged Chewings fescue more than other grass species tested. Perennial ryegrass and browntop showed tolerance to this herbicide, but annual poa was not controlled (Table 1). Ethofumesate has been used in parts of the United States and UK to manage annual poa where split applications and freezing temperatures following the application weaken annual poa (Baldwin 1993; Vargas 1990). In our experiment warm temperatures in the greenhouse probably helped the rapid recovery of annual poa from the herbicide damage. Moreover, it seems that ethofumesate kills only the annual biotype (*Poa annua* var. *annua*). However, in closely mown turf the

perennial form (*Poa annua* var. *reptans*) dominates and this biotype was used in our experiment.

All grass species exhibited high level of tolerance to the herbicide isoproturon and to the mixture isoproturon plus diflufenican at the lower rate used (data not presented), while at the higher rate promising differential tolerances were observed between species. Thus Chewings fescue was tolerant to the high rates of both these herbicides irrespective of the surfactant addition, perennial ryegrass was completely killed in the presence of L77 and annual poa was controlled by isoproturon plus diflufenican with the addition of either surfactant (Table 1). This is consistent with a previous report that the foliar activity of isoproturon was enhanced by adjuvants (Mathiassen *et al.* 1993). In the second experiment, there was not an adequate selectivity margin between the species to allow safe use of isoproturon plus diflufenican in turf (Fig. 1). On the basis of these results it appears that additional testing at intermediate rates with surfactants would be required.

Irrespective of the surfactant addition, browntop exhibited high tolerance to the sulfonylurea herbicides chlorsulfuron and metsulfuron while perennial ryegrass was sensitive to them (Table 1). While neither herbicide could be recommended for annual poa control, they could nevertheless be used to remove perennial ryegrass from browntop turf. This has application on many golf course roughs and fairways that have been developed from farmland where mowing costs would be reduced because perennial ryegrass grows much more quickly than browntop and thus needs more mowing.

In the first experiment amitrole was used at 120 and 200 g/ha and a high level of tolerance was observed with all species. In the second experiment, amitrole caused 54% and 74% reduction in the dry weight of annual poa at rates of 600 and 1000 g/ha, respectively (Fig. 1). At the high rate, damage to browntop and Chewings fescue was 35% and 43% only. This damage was further reduced when S800 was added to the herbicide. These results showed that amitrole might have potential in weed management in turf and further experiments are required to determine the optimum herbicide rate and surfactant concentration for selective control of annual poa.

The first and the second experiments showed that annual poa was more sensitive to glyphosate than the other species tested and that increasing glyphosate rate from 180 to 360 g/ha increased the damage to annual poa. At 360 g/ha glyphosate caused serious damage to browntop, perennial ryegrass and Chewings fescue (Fig. 1). It follows that only low rates of glyphosate (180 g/ha and less) should be considered for the control of annual poa in turf. When S800 was added to glyphosate at 180 g/ha there was 80% reduction in the dry weight of annual poa while Chewings fescue continued to show only 33% reduction in its dry weight. Previous work has also reported that the interaction between organosilicone surfactants and glyphosate is species dependent (Dastgheib and Field 1995; Field *et al.* 1992). The best control of annual poa at 180 g/ha glyphosate was obtained with the addition of L77 at 0.25% concentration (Table 2). It appears that further experimentation with organosilicone surfactants may determine the optimum treatment for selective control of annual poa in Chewings fescue and browntop turf.

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