Tolerance of four pasture legumes and a perennial ryegrass to pre-sowing applications of metsulfuron methyl on acid soil.

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Summary

On a podzolic soil of pH 5.4 (1:5 H_2O), metsulfuron methyl at rates up to 12 g ha^{-1} a.i. applied in November did not affect the germination or growth of five pasture cultivars sown the following May. The cultivars tested were subterranean clover (*Trifolium subterraneum* L.) cvv. Karridale and Trikkala, balansa clover (*T. michelianum* Savi var. *balansae* Boiss.) cv. Paradana, white clover (*T. repens* L.) cv. Haifa and perennial ryegrass (*Lolium perenne* L.) cv. Ellett. Consequently, metsulfuron may have a role on acid soils in providing effective control of some troublesome weeds on old pasture land in the year before resowing pastures. Although metsulfuron can be used for control of bracken (*Pteridium esculentum* (Forst. f.) Nakai) in summer–autumn, the registered rate of 36 g ha^{-1} a.i. applied in January to chemically fallowed pasture caused unacceptable reductions in the growth of all five cultivars sown in May. However, metsulfuron applied in January at 12 g ha^{-1} a.i., or in April at 6 g ha^{-1} a.i., was tolerated satisfactorily by May-sown perennial ryegrass.

Introduction

Direct drilling, the sowing of crops or pastures into uncultivated soil after some form of herbicidal weed control, is a recognized pasture establishment technique that is becoming popular in the higher rainfall areas of South Australia. Compared to sowing into cultivated ground, direct drilling of pastures has advantages in reduced labour requirements and erosion risks (Rowe and Johnson 1988) and in the reduced incidence of broadleaf weeds such as capeweed (*Arctotheca calendula* (L.) Levyns.) and perennial sorrel (*Rumex acetosella* L.) shoots after sowing (Mitchell *et al.* 1991).

Kloot (1986) drew attention to successive changes in weed flora in cropping systems with the evolution and use of different families of herbicides. We believe that similar events are occurring in permanent pasture systems in South Australia. For example onion grass (*Romulea rosea* (L.) Ecklon var, *australis* (Ewart) de Vos) and, to a lesser extent, sorrel (as seedlings) are prevalent weeds in newly sown, direct drilled pastures in the Mount Lofty Ranges region (P.D. Fairbrother personal communication). Here the use of phenoxy herbicides for 'spray-grazing', glyphosate or paraquat herbicides for chemical topping and the adoption of direct drilling provide the selection pressure favouring these harder-to-kill, perennial weeds.

The control of weed competition in newly sown pastures is critical, particularly for perennial pasture species (Campbell *et al.* 1987) and onion grass and sorrel are seen as weeds limiting the success of direct drilling.

We have recorded densities of onion grass of up to 2500 plants m^{-2} in direct drilled pastures in the Mount Lofty Ranges. Glyphosate has some activity on this weed but timing for effective control is around the two leaf stage (Duckworth 1984), precluding the direct drilling of pastures before the end of June.

Sorrel can be a competitive weed, with densities of only 50 plants m^{-2} able to significantly reduce cereal crop yields (Keys and Duncan 1989), and sowings of perennial grasses and clovers can fail unless it is controlled before sowing.

Metsulfuron methyl (under the trade name Ally®) is registered for the control of sorrel in cereal crops. It has also shown activity on bulbous weeds, including onion grass (Maslen *et al.* 1988, Mitchell *et al.* 1992). It has potential for the control of onion grass and sorrel in old pasture land in the year prior to direct drilling pastures (autumn sowing). Metsulfuron also controls subterranean clover and annual medics (*Medicago* spp.) (Anon 1987), and has also been used commercially for the control of salvation Jane (*Echium plantagineum* L.) and docks (*Rumex* spp.) in old pasture land.

Bracken (*Pteridium esculentum* (Forst. f.) Nakai) is sometimes a problem perennial weed on lighter soils in the Mt. Lofty Ranges and metsulfuron also has activity on this weed. Metsulfuron is registered (under the trade name Brush Off®), for bracken control at 36 g ha^{-1} a.i. applied in summer-autumn.

A potential problem associated with metsulfuron applications before resowing pastures is its residual action in the soil. Information is lacking however, on safe recropping intervals for pasture species on acid soils when metsulfuron is used either in spring for weed control or specifically in summer-autumn for bracken control.

For application rates of metsulfuron of up to 4.2 g ha^{-1} a.i., a minimum interval of 9 months between application and the sowing of pasture legumes is recommended (Anon 1987), although most of the supporting research in South Australia was conducted on alkaline Mallee soils (D.J. McQuinn personal communication).

A field trial was established in 1989, to assess the effect of metsulfuron, at rates of 6 to 72 g ha^{-1} a.i., applied between November and the following April, on the establishment and herbage production of four pasture legumes and a perennial ryegrass sown in the following May.

Materials and methods

Site

The trial was conducted at the Flaxley Research Centre in the Mt. Lofty Ranges of South Australia (Latitude 34°52'S, Longitude 138°30'E). Flaxley has a Mediterranean climate with a mean annual rainfall of 800 mm. Monthly rainfall records over the duration of this experiment, along with long-term averages, are given in Table 1. The rainfall received between November 1989 and May 1990 was well below average (144 mm received versus 328 mm average), but rains received after May were slightly above average for this district.

Table 1. Actual and long-term average monthly rainfall (mm) for Flaxley.

Month	Actual	Average
November 1989	48	43
December 1989	11	35
January 1990	3	28
February 1990	20	27
March 1990	1	33
April 1990	35	66
May 1990	26	96
June 1990	141	110
July 1990	126	108
August 1990	118	107
September 1990	63	89
October 1990	80	70

The soil is a red podzolic with a classification Dr 2.21 (Northcote 1979). The 0 to 10 cm soil horizon has a pH of 5.4 (1:5 water test value). The top 20 cm is a grey sandy loam over a mottled red clay subsoil.

The site was occupied by a rundown subterranean clover-based pasture, comprised of capeweed, long storksbill (*Erodium botrys* (Cav.) Bertol.), perennial ryegrass (*Lolium perenne* L.) cv. Grasslands Nui, subterranean clover (*Trifolium subterraneum* L. var. *yanninicum* (Katz. *et* Morley) Zohary & Heller) cv. Yarloop and rat's tail fescue (*Vulpia myuros* (L.) J.

Gmelin). The entire site was chemically fallowed using glyphosate at 720 g ha^{-1} a.i. on November 20, 1989.

Herbicide treatments
Metsulfuron treatments were applied in 3 m wide strips, over two replicated blocks. Treatments were applied through flat fan, SS11001 nozzles mounted on a hand-held, 3 m wide boom, pressurized by carbon dioxide and applied at a rate of 100 L ha^{-1}. Metsulfuron was applied at 6, 12, 36 and 72 g ha^{-1} a.i. on November 20, 1989, at 12, 36 and 72 g ha^{-1} a.i. on January 16, 1990, and at 6 and 12 g ha^{-1} a.i. on April 4, 1990.

The entire site was sprayed with paraquat/diquat at 500/300 g ha^{-1} a.i. on May 1, 1991 to control emerging weed growth at the opening of the growing season. On the following day, five pasture cultivars were sown individually in four replicated strips across, and at right angles to the metsulfuron treatment strips. This layout produces a criss-cross pattern of cultivar rows and herbicide columns known as a strip plot design. This experimental design, explained and used by Evans *et al.* (1989), has been used frequently in evaluating the tolerance of crop and pasture cultivars to pesticide treatments in South Australia (Murrie and Stephenson 1985).

Pasture cultivars
The pasture cultivars sown were subterranean clovers (*T. subterraneum* (L.) var. *subterraneum* (Katz. *et* Morley) Zohary & Heller) cv. Karridale, (*T. subterraneum* var. *yanninicum*) cv. Trikkala, balansa clover (*T. michelianum* Savi. var. *balansae* Boiss.) cv. Paradana, white clover (*T. repens* L.) cv. Haifa and perennial ryegrass cv. Ellett. The cultivar strips were 1.3 m wide and were sown with a narrow-pointed seeder, so as to minimize soil disturbance. Sowing rates were 20 kg ha^{-1} for subterranean clover and perennial ryegrass, and 10 kg ha^{-1} for balansa and white clover. All legume seed was inoculated with the appropriate *Rhizobia* and lime pelleted immediately prior to sowing.

Table 2. Plant densities (No m^{-2}) for sown cultivars 72 days after sowing.

Metsulfuron treatment Application Date	Rate (g ha^{-1} a.i.)	Karridale	Trikkala	Paradana	Haifa	Ellett
Nil metsulfuron		170	173	191	99	147
November 20, 1989						
	6	189	156	161	116	187
	12	198	177	230	99	161
	36	193	128	255	173	153
	72	137	128	159	102	227
January 16, 1990						
	12	165	133	132	92	169
	36	65	16	19	38	115
	72	45	7	47	8	132
April 3, 1990						
	6	77	15	58	27	136
	12	12	4	7	13	133
LSD (p=0.05)		39	32	96	54	NS

Table 3. Herbage production (kg dry matter ha^{-1}) for sown cultivars 156 days after sowing.

Metsulfuron treatment Application Date	Rate (g ha^{-1} a.i.)	Karridale	Trikkala	Paradana	Haifa	Ellett
Nil metsulfuron		3438	3212	3177	628	3612
November 20, 1989						
	6	3906	2856	3069	938	3491
	12	3506	2838	3369	581	3382
	36	3550	2675	2763	669	5350
	72	2588	2088	2413	263	2603
January 16, 1990						
	12	2475	1063	1750	388	2981
	36	681	94	244	35	2048
	72	550	78	731	131	1851
April 3, 1990						
	6	444	125	644	81	3205
	12	115	64	81	50	2258
LSD (p=0.05)		1098	860	635	435	829

Management
Superphosphate and sulphate of potash were broadcast at 100 kg and 50 kg ha^{-1} respectively during the sowing operation. Redlegged earth mite (*Halotydeus destructor* Tucker) was controlled with omethoate insecticide ten days after sowing.

Measurements
Densities of sown cultivar seedlings were measured on July 13, 1990 (72 days after sowing). Counts were taken from three quadrats (each measuring 0.1 m^2) per plot.

The herbage yield from all plots was measured on October 5, 1990 (156 days after sowing). Because weeds were present in some plots, the proportion of sown plant material was assessed visually for each plot before cutting. Herbage samples were cut with a rotary mower down to a height of 2 cm from a 0.5 m^2 quadrat in each plot. Samples were then oven-dried for 24 hours at 100°C and weighed to determine dry matter production. The visual estimates were then used to determine the contribution of sown cultivars to herbage yield.

Statistical analyses
All field data were subjected to two-way analyses of variance.

Results

Trial conditions
Conditions were satisfactory for pasture establishment in May–June, and all sown species established well where metsulfuron was not used (Table 2). Onion grass and sorrel (seedlings) volunteered as weeds across the plots at densities averaging 130 and 21 plants m^{-2} respectively. The incidence of sorrel was lower in plots where metsulfuron had been applied in January or April. There were no other differences in the incidence of these weeds between metsulfuron treatments or pasture cultivars.

Seedling densities
Metsulfuron applied in November at rates up to 36 g ha^{-1} a.i. did not reduce the establishment densities of any of the sown species, except for Trikkala which recorded a 26% reduction in seedling density. Trikkala was also the only cultivar to record a significant ($p<0.05$) reduction in seedling density after the January application of 12 g ha^{-1} a.i. Higher rates applied in January, and all treatments applied in April, resulted in significant ($p<0.05$) reductions for all legume cultivars. The establishment of Ellett was not significantly affected by any of the metsulfuron treatments.

Herbage production and pasture composition

Metsulfuron applied in November at rates up to 36 g ha^{-1} a.i. did not reduce herbage production of any of the species (Table 3). Applications of 72 g ha^{-1} a.i. at this time however, did cause significant ($p<0.05$) reductions in yield from Trikkala, Paradana and Ellett.

The majority of metsulfuron treatments applied in either January or April significantly reduced herbage yield of all pasture cultivars. The exceptions were 12 g ha^{-1} a.i. applied in January for Karridale, Haifa and Ellett; and 6 g ha^{-1} a.i. applied in April for Ellett.

November applications of metsulfuron up to 36 g ha^{-1} a.i. did not reduce the sown cultivar content (%) of any pasture swards, however the majority of January and April treatments caused significant ($p<0.05$) reductions in sown legume contents (Table 4). In general, the proportion of Ellett in swards sown with this cultivar was unaffected by the range of metsulfuron treatments.

Table 4. Sown cultivar contribution (%) to total sward herbage yield 156 days after sowing.

Metsulfuron treatment Application Date	Rate (g ha^{-1} a.i.)	Karridale	Trikkala	Paradana	Haifa	Ellett
Nil metsulfuron		82	80	77	18	85
November 20, 1989						
	6	85	74	69	25	79
	12	84	76	74	14	85
	36	87	71	73	20	88
	72	58	71	69	14	79
January 16, 1990						
	12	73	44	49	17	85
	36	26	5	14	2	71
	72	26	4	32	8	78
April 3, 1990						
	6	19	6	19	3	78
	12	6	2	3	1	76
LSD (p=0.05)		18	11	14	12	8

Discussion

November applications

For soils of pH less than 5.5 in the Mt. Lofty Ranges, metsulfuron can be applied at rates up to 12 g ha^{-1} a.i., as late as November of the preceding year, without the risk of residual herbicide damage to pasture species sown the following May. This represents a safe recropping interval of 5 months for applications of up to 12 g ha^{-1} a.i., compared to the currently recommended interval of 9 months for up to 4.2 g ha^{-1} a.i. The below average rainfall for the November–May period in this trial increases the degree of confidence in the metsulfuron rates demonstrated as safe for recropping at this site, as metsulfuron breakdown is slower in drier soil conditions (Anon 1987).

This conclusion may apply more widely across southern Australia. In a field trial in Victoria, metsulfuron applied at 12 g ha^{-1} a.i. in November to a soil of pH 4.8 did not affect the growth of subterranean clover, white clover or three perennial grasses sown the following May (D.J. McQuinn personal communication).

The proposed recropping interval may not apply to soils where liming materials have been applied to soils any time between the determination of soil pH and the resowing of pastures.

The safety of November applications up to 12 g ha^{-1} a.i. allows several potential roles for metsulfuron on acid soils to be explored. Metsulfuron may have a role in providing more effective weed control in old pasture land in the season before resowing, where either onion grass, sorrel, undesirable subterranean clovers, salvation Jane or docks are serious weeds. In preliminary field work on land infested with onion grass, significant increases in the establishment densities of cocksfoot (*Dactylis glomerata* L.) and phalaris (*Phalaris aquatica* L.) were achieved by controlling this weed with metsulfuron before sowing (Mitchell *et al.* 1992).

Further research is required to determine optimum timing for the control of these weeds, with a preference towards later timings to minimize herbage losses in that year.

Summer – autumn applications

Metsulfuron applied in January at 36 g ha^{-1} a.i. caused unacceptable reductions in herbage yields from all pasture cultivars, however this timing and rate corresponds with the registered use of metsulfuron for bracken control. It would appear that the sowing of perennial ryegrass / clover pastures in autumn is not feasible if bracken has been controlled with metsulfuron in the preceding summer, however the treatment was applied to chemically fallowed ground in this trial. It is not clear whether the same residual damage would occur where treatments are applied to heavy infestations of bracken, as dense stands would intercept far more herbicide before it contacted the soil.

Ellett perennial ryegrass had acceptable tolerance to metsulfuron at 6 g ha^{-1} a.i. applied 4 weeks presowing.

Comparison of pasture cultivar tolerances

Trikkala subclover was less tolerant than other tested cultivars to pre-sowing applications of metsulfuron. Seedling densities for Trikkala were significantly ($p<0.05$) reduced after a November application of 36 g ha^{-1} a.i. or a January application of 12 g ha^{-1} a.i., but not for other cultivars. The herbage production data also suggested that Paradana may be more susceptible to residual metsulfuron damage than Karridale or Haifa.

Ellett's tolerance to the April applications suggests some potential to use metsulfuron as little as four weeks before sowing ryegrass monocultures on acid soils, however further screening of a range of ryegrasses to short interval, presowing applications of metsulfuron is required. Particular emphasis should be given to screening Italian ryegrass (*Lolium multiflorum* Lam.) cultivars, which are more often sown as monocultures than perennial ryegrass.

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References

Anon. (1987). Ally Herbicide Technical Information Bulletin (DuPont Australia Ltd.)

Campbell, M.H., Hosking, W.J., Nicholas, D.A., Higgs, E.D., and Read, J.W. (1987). Establishment of perennial pastures. *In* 'Temperate pastures – their production, use and management', eds. J.L. Wheeler, C.J. Pearson, and G.E. Robards, (Australian Wool Corporation/CSIRO, Melbourne) p. 64

Duckworth, N. (1984). Onion grass. Proceedings of the 25th Annual Conference of the Grassland Society of Victoria, ed. M.E.J. Boyd, (Grasslands Society of Victoria, Parkeville). p. 86.

Evans, P.M., Smith, R.S., Carpenter, J.A., and Koen, T.B. (1989). Tolerance of subterranean clover cultivars and balansa clover to selective herbicides in Tasmania. *Australian Journal of Experimental Agriculture*. 29, 785-6.

Keys, M.J., and Duncan, M.R. (1989). Sorrel: a weed of crops and pastures. Agfact P7.6.47 (New South Wales Department of Agriculture and Fisheries, Orange).

Kloot, P.M. (1986). A review of the naturalized alien flora of the cereal areas of South Australia. Technical Paper No. 12 (South Australian Department of Agriculture, Adelaide). pp. 32-4.

Maslen, M.A., Mitchell, G.J., Matic, R., and Carter, P.A. (1988). Herbicide screening Group 1987 report. Technical Report No. 135 (South Australian Department of Agriculture, Adelaide). pp. 39-40, 89-91.

Mitchell, G.J., Chinner, S.R., Colman, P.V., and Prance, T. (1991). Flaxley Research Centre – pasture agronomy trials 1990. Technical Report No. 181 (South Australian Department of Agriculture, Adelaide). pp. 104-9.

Mitchell, G.J., Chinner, S.R., Colman, P.V., Fleming, N., Pearce, J.R., and Valentine, S.C. (1992). Flaxley Research Centre – pasture agronomy trials 1991. Technical Report No. 197 (South Australian Department of Agriculture, Adelaide). pp. 87-90.

Murrie, D.I., and Stephenson, D.W. (1985). The Agricultural Chemicals Evaluation Scheme 1978–1983. Technical Report No. 72 (South Australian Department of Agriculture, Adelaide). pp. 3, 5, 9.

Northcote, K.H. (1979). 'A factual key for the recognition of Australian soils'. 4th ed. (Rellim, Adelaide)

Rowe, B., and Johnson, T. (1988). Direct drilling for sustaining profitable pasture. Proceedings of the 29th Annual Conference of the Grassland Society of Victoria. ed. M. Dehnert, (Grassland Society of Victoria, Parkeville). p. 62.