RESIDUAL ACTIVITY OF TRIASULFURON IN SEVERAL NEW ZEALAND SOILS

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SUMMARY

Soil samples collected after harvesting cereals from 13 field trials throughout New Zealand were bioassayed in the glasshouse to determine the residual activity of triasulfuron. The biosassay species were mustard *(Sinapis alba)*, lentil *(Lens culinaris)* subterranean clover *(Trifolium subterraneum)* and annual ryegrass *(Lolium multiflorum)*. Visual damage and dry matter yields showed that a 15 g/ha rate of triasulfuron would not persist in toxic amounts at the end of the growing season under most conditions. Residues from 30 g/ha are likely to injure susceptible species planted in the autumn. The level of residual activity in the soil varied with trial location and soil type.

INTRODUCTION

The sulfonylurea herbicides have emerged as a major new class of herbicides representing an important advance in chemical weed control technology. Worldwide some eight sulfonylurea herbicides had been commercialised by 1987 (Beyer *et al* 1987). The herbicide triasulfuron (code number CGA 131'036) developed by Ciba-Geigy was first described by Amrein and Gerber (1985). It has been tested worldwide in the major cereal growing areas and good activity against a wide spectrum of weeds and good crop tolerance by small grain cereals have been reported (Amrein and Gerber 1985; Buchholz *et al* 1986; Gillespie *et al* 1985; Hobson and Ryan 1987).

Triasulfuron is amongst the more persistent sulfonylurea herbicides. It has pre-emergence activity which can provide season-long control of late germinating weeds (Amrein and Gerber 1985). Early experience has shown that it can be used in intensively grown cereals without affecting subsequent crops. However, its half life in the soil varies from 4 to 12 weeks and there could be some risks to broadleaf crops in the rotation (Gillespie *et al* 1985). As with other sulfonylurea herbicides, chemical hydrolysis and microbial breakdown are the principal modes of degradation of triasulfuron, with chemical hydrolysis being the main pathway in acidic soils, such as those commonly found in New Zealand. The degradation rate is controlled by various factors such as soil type, soil pH and climatic conditions, especially temperature and soil moisture (Beyer *et al* 1987; Duffy *et al* 1987).

This paper describes the residual activity of triasulfuron at the end of the growing season in soils from different cereal growing areas of New Zealand.

MATERIALS AND METHODS

Initial glasshouse studies were conducted between November 1986 and February 1987 to select the most suitable bioassay species and to establish 'standards' for the activity of triasulfuron in two local soils. One soil was a Horotiu sandy loam with 10.3% organic C, 16% clay, 61% sand, a pH of 5.7 and a field capacity of 42.8%. The other soil was a Hamilton clay loam with 4.5% organic C, 33% clay, 31% sand, a pH of 5.8 and a field capacity of 36.8%. The species included in the first experiments were soft turnip (*Brassica rapa* ssp *rapa*), swede (*Brassica napus* ssp *napobrassica*), beetroot (*Beta vulgaris* ssp. *vulgaris*), cucumber (*Cucumis sativus*) mustard, lentil, subterranean clover and annual ryegrass. From these, four species were chosen for later experiments and for the bioassays.

A range of concentrations between 0.1 and 10.0 g/ha was used for each experiment. The herbicide was sprayed by a glasshouse sprayer on to soil in a 5 cm deep tray and then mixed throughout before transferring it to pots. Bioassay species were planted at 1.5 cm depth in a 12 cm diameter pot and treatments were replicated four times. Pots were sub-irrigated to maintain the soil near field capacity. The plants were assessed visually and harvested after 4-5 weeks growth to determine the dry matter weight of shoots.

Thirteen field trials covering Waikato, Manawatu and Canterbury regions were carried out on commercially grown cereal crops during the 1986-87 growing season to test the efficacy and selectivity of triasulfuron. Treatments were replicated six times in a randomised latin square with a plot size of 2-3 x 10m. Triasulfuron was applied post-emergence to the crop at the 3-4 leaf stage (GS 22-32), as a mixture with bromoxynil in 200-250 litres/ha at 200-240 kPa using a CO_2 powered sprayer. These trials included both wheat and barley crops, with a range of soil types and varying rainfall (Table 1.)

TABLE 1: Soil details and rainfall for cereal trial sites.

Site	Soil Type	Organic C (%)	pH	Rainfall (mm)
	Waikato Trials			
1	Te Rapa peaty loam	11.8	5.8	290
2	Hungahunga peaty loam	8.4	5.8	195
3	Tirau sandy loam	7.5	6.2	236
4	Te Kowhai loam complex	5.4	6.5	204
	Manawatu Trials			
5	Manawatu silt loam	3.6	6.1	127
6	Manawatu silt loam	3.6	6.1	127
7	Manawatu silt loam	3.6	6.3	197
8	Takapau silt loam	2.7	6.7	41
	Canterbury Trials			
9	Templeton silt loam	3.1	6.0	229
10	Templeton silt/sandy loam	3.0	6.1	204
11	Templeton silt loam	2.5	5.9	134
12	Chertsey silt loam	3.1	5.6	167
13	Temuka silt loam	4.2	5.5	183

* Rainfall is for the period from treatment to sampling.

Soil samples for bioassay of herbicide residues were collected from 0-10 cm depth at, or soon after, harvest of each trial site in February. About 1 kg of soil was collected from each plot. In total, ten bags of soil samples were obtained from each trial — two rates of triasulfuron x four replicates plus two bags of untreated soil, collected from an untreated part of the field.

Upon receiving the samples, half of the untreated soil was placed in a 5 cm deep tray and sprayed with triasulfuron at 2 g/ha. The soil was then mixed to incorporate the herbicide thoroughly. This provided a 'standard' of known concentration to be used simultaneously with the treated soil from the field.

Each soil sample was transferred into four 12 cm diameter plastic pots which were planted with mustard, lentil, subterranean clover or annual ryegrass seeds at 1.5 cm depth. These bioassay species were assessed visually for any herbicide effects and harvested for dry matter determinations after 4-5 weeks growth in the glasshouse.

RESULTS

The effect of known concentrations of triasulfuron ('standards') on the four bioassay species is presented as approximate GR50 values, i.e. the concentration required to produce a 50% reduction in the growth of bioassay species compared with the untreated control (Table 2). These figures are based on the average of four series of 'standards' planted between November and February. Mustard was more susceptible than the other three bioassay species in both soil types. With all bioassay species the level of biological activity of triasulfuron was lower in the Hamilton clay loam soil than in the Horotiu sandy loam soil. The visual data on percent growth reduction were supported well by the actual dry matter yields from various treatments. In the initial experiments which included the additional test species, cucumbers were found to be the least susceptible to triasulfuron and beetroot the most susceptible. However, the growth of beetroot varied according to the time of the year and reliable results were difficult to achieve with this species.

TABLE 2: The concentration (g ai/ha) of triasulfuron required in the 'standards' series to give a 50% reduction in the growth of bioassay species compared to untreated controls (GR_{50}).

	Horotiu sandy loam		Hamilton clay loam	
Biosassay species	Based on visual damage	Based on DM yield	Based on visual damage	Based on DM yield
Mustard	1.1	1.4	1.7	2.2
Lentil	2.3	2.8	2.6	3.8
Subterranean clover	2.3	2.9	2.9	3.4
Annual ryegrass	2.6	2.9	3.1	3.6

The most common damage symptom of triasulfuron on the test species was a suppression or inhibition of growth. This stunting was due to different responses in different species. For example, in lentils triasulfuron caused branching from the lower stem, which gave the appearance of a stunted, more compact plant. The higher rates caused a reduction in the growth of the main stem and branches, resulting in very stunted and distorted plants. With mustard, the effects of the herbicide were first noticed as a reduction in the number of lobes on the leaves. In seriously damaged plants, leaves were reduced to small knobs around the growing point of the mustard. With both subterranean clover and annual ryegrass the main effect was a reduction in leaf size. The leaves appeared normal in other respects.

The residual activity of triasulfuron at different trial sites as assessed by the bioassay species is presented in Table 3. Visual damage scores show that significant residual activity from the low rate of the herbicide (15 g/ha) was present in only one out of thirteen field trials, viz. the Waikato trial, Site 4. Some minor damage symptoms were noted in six other trials, particularly in the most sensitive bioassay species (mustard), but these were present in only one or two plots of the four replications.

At the high rate of 30 g/ha, triasulfuron exhibited residual activity at all but one trial site, although the level of activity varied considerably between sites. In general, activity was lower in samples from Canterbury trials. Damage to annual ryegrass was often less than for the other three bioassay species.

Dry matter yields of the bioassay species (not statistically analysed due to low number of control pots) supported the visual assessments of damage (Table 3), although the extent of reductions in dry matter yields was usually lower than that shown by the visual damage levels. In most cases annual ryegrass was again more tolerant than other bioassay species.

It is difficult to assess the effect of soil factors on the persistence of triasulfuron from these trials. Under similar climatic conditions in the Waikato, residual activity was highest in the soil with the lowest organic C level (Site 4). However, the trial sites from Canterbury with much lower levels of organic C showed considerably less residual activity than the Waikato sites. The soil texture, type of clay mineral (which varies distinctly between Waikato and Canterbury sites), climatic conditions, cropping history and other similar factors would also have to be taken into account.

DISCUSSION AND CONCLUSIONS

These results show that the estimated level of residual activity in a soil can vary greatly depending on the bioassay species used. Susceptibility of bioassay species may also alter by changing the soil type. This is probably due to an inherent ability of one species to grow better in one soil than another. It is important, therefore, that the visual damage or dry matter figures for a particular trial or bioassay species are not taken as absolute but used, instead, to establish a trend.

It appears that the low rate of triasulfuron used in these trials would not leave toxic residues in the soil at the end of the growing season under most conditions. Where small residues are present, they should be dissipated by cultivation before planting the next crop. The level of residues present in the soil from the high rate of 30 g/ha could injure susceptible species in the rotation, if they are planted in the autumn. Growing conditions were quite favourable in thè glasshouse, so the damage levels could be even high under less favourable conditions of growth in the field. As these results are based on triasulfuron-sensitive bioassay species, a site could be 'safe' for earlier planting of less susceptible species, especially after cultivation and thorough mixing of the soil.

TABLE 3: Bioassay of triasulfuron residues in 0-10cm soil depth at cereal trial sites

Site	Rate (g ai/ha)	Visual score (% Damage)* Mustard	Lentil	Clover	Ryegrass	Dry shoot weight (% of untreated)* Mustard	Lentil	Clover	Ryegrass
					Waikato Trials				
1	15						94		
	30	33	11	8		78	83		
2	15					88	88		91
	30	46	20	20	5	76	71	86	79
3	15	8	3	3				90	
	30	55	30	38	23	61	77	75	
4	15	55	26	25		43	71	90	98
	30	80	33	23		22	63	79	94
					Manawatu Trials				
5	15	10				82		95	94
	30	10				77		91	98
6	15					83	86		96
	30	20	13	18	50	67	73	75	67
7	15	15	10	10		91		88	
	30	23	20	18	10	72		81	
8	15	10	13	8	5	87		81	92
	30	70	30	33	40	53	80	69	74
					Canterbury Trials				
9	15					92	87	94	95
	30					88	85	90	89
10	15						89	90	
	30	40	30	30		77	62	75	86
11	15	10		10		79	96	82	
	30	70	60	70	25	46	49	50	76
12	15	3	5	3		82		90	93
	30	15				78		90	95
13	15					83		91	
	30	27	10	20		74	82	85	

* Blank spaces indicate that no damage or no reduction in the dry weight of bioassay plants was recorded in those samples.

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