EFFICACY, PERSISTENCE AND MOVEMENT OF CLETHODIM IN TWO SOILS

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SUMMARY

Clethodim was very effective post-emergence against a mixed infestation of young annual grass weeds including smooth witchgrass (*Panicum dichotomiflorum*), summer grass (*Digitaria sanguinalis*) and barnyard grass (*Echinochloa crus-galli*). Of the perennial grasses, paspalum (*Paspalum dilatatum*), was more susceptible to clethodim than couch (*Elytrigia repens*). Damage symptoms from clethodim were similar to those from fluazifop-butyl and sethoxydim, but appeared earlier. Bioassay results show that clethodim has a short soil residual life. A rate of 960 g/ha dissipated below detectable levels from the 0-10 cm depth within 14 days. Large differences in persistence occurred between two soils. Clethodim did not move below a depth of 10 cm.

INTRODUCTION

Recent discovery of several post-emergence grass herbicides selective in broadleaf crops provides an effective alternative to traditional pre-emergence treatments. New materials with related chemistry and mode of action are still being developed. Clethodim is a very active post-emergence herbicide that has been reported to control both annual and perennial grass weeds, as well as volunteer cereals in a wide range of broadleaf crops (Baldwin 1987; Kincade *et al* 1987).

Clethodim is a systemic herbicide which is rapidly absorbed and readily translocated from the treated foliage to the root system and growing points of the plant. It is most effective as a post-emergence treatment in the early development stage of actively growing grasses. However, activity on annual grasses has been observed in many broadleaf crops when clethodim was applied pre-emergence or pre-plant incorporated (Kincade *et al* 1987).

This study reports on the efficacy of clethodim against some annual and perennial grasses and its persistence and movement in two soil types.

MATERIALS AND METHODS

Efficacy trial on annual grasses

This trial site was on a Hamilton clay loam soil. Treatments (Table 1) were arranged in a randomised block design with four replications and a plot size of 1 × 6 m. Herbicides were applied on 11 January 1986 with a CO₂ powered precision sprayer applying 300 litres/ha at 210 kPa. A white emulsifiable crop oil (BP crop oil) was added at 2 litres/ha to the clethodim (Select) and sethoxydim (Alloxol S) treatments. Fluazifop-butyl (Fusilade) had a wetting agent (Citowett) added to the solution at 450 ml/ha.

The average composition of grass weeds in the trial area at the time of treatment was : barnyard grass (560 plants/m²), summer grass (260 plants/m²) and smooth witchgrass (100 plants/m²). The grasses had 2-4 tillers and their height varied from 2-10 cm. Visual assessments of percent control were made at regular intervals over a 5 week period after treatment.

Efficacy trial on perennial grasses

This trial site was on a Horotiu sandy loam soil. Individual plots were 2 × 5 m in size and the treatments (Table 2) were arranged in a randomised block design with four replications. Application details of herbicides were the same as above with treatments applied on 15 December 1986.

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The site had a heavy infestation of established couch and paspalum which had been mown for the previous 3 years. At the time of treatment the sward had not been mown for 6 weeks and grasses had 10-20 cm of leaf. A visual assessment of percent control (brown off) was made 1 month after treatment and assessments of regrowth (0-10 linear scale) were made at 2 and 4 months after treatment.

Soil residue and movement studies

Two field trials were conducted to study the residual life and movement of clethodim in the soil. One trial was on a Horotiu sandy loam soil which had 10.3% organic C, 16% clay, 61% sand, a pH of 5.7 and a field capacity of 42.8%. The other trial was on a Hamilton clay loam soil which had 4.5% organic C, 33% clay, 31% sand, a pH of 5.8 and a field capacity of 36.8%. Both trial sites were on cultivated ground.

The trial on the Hamilton clay loam soil was treated on 11 November 1986 and had a plot size of 1.5 × 5 m while the trial on the Horotiu sandy loam soil was treated on 9 December 1986 and had a plot size of 1 × 6 m. Treatments (Table 4) were arranged in randomised block designs with four replications and applied with a precision sprayer in 300 litres/ha at 210 kPa. A white emulsifiable crop oil (BP crop oil) was added at 2 litres/ha to each treatment.

Soil samples for bioassay of herbicide activity were obtained from 0-10 cm depth from each plot 1, 3, 7, 14, 21 and 35 days after spraying. On days 7 and 14 after spraying, samples were also taken from the 10-20 cm depth to check the movement of herbicides in the two soils. Each sample consisted of 5 cores per plot using a 7 cm diameter soil sampler. All samples were thoroughly mixed and bioassayed in the glasshouse using maize (*Zea mays* cv. 'Pioneer' 3709) and annual ryegrass (*Lolium multiflorum* cv. 'Tama'). For comparison a series of 'standards' was established in the glasshouse for both soil types by using a range of concentrations of each herbicide (mixed with the soil throughout the pot) and determining the effect on plant growth and dry weight of shoots.

RESULTS AND DISCUSSION

Efficacy trial on annual grasses

Assessments made 2, 3 and 5 weeks after the application of herbicides are summarised in Table 1. The initial activity of clethodim on all three grass weeds was greater than with either fluazifop-butyl or sethoxydim. However, by the last assessment some regrowth of summer grass was evident in plots treated with fluazifop-butyl and the low rates of clethodim. This result supports the findings of Rahman *et al* (1983). There was no re-growth of either smooth witchgrass or barnyard grass in any treatment.

In this trial 120 g/ha of clethodim was sufficient for control of most annual grass weeds (Table 1). However conditions were good for herbicide activity, but a slightly higher rate may be required for reliable results under less favourable conditions such as when grasses are at a more advanced stage.

TABLE 1: Control of the annual grass weeds barnyard grass, summer grass and smooth witchgrass (treated 11/11/86).

Treatment	Rate (g ai/ha)	% control of annual grass weeds		
		25.11.86	3.12.86	17.12.86
clethodim	60	63	78	79
clethodim	120	88	96	96
clethodim	240	90	100	100
clethodim	480	97	100	100
clethodim	720	100	100	100
sethoxydim	400	83	97	98
fluazifop-butyl	500	75	91	91
untreated	—	0	0	0
LSD (P<.05)		15.2	12.1	13.0
(untreated excluded)				

Efficacy trial on perennial grasses

The level of couch and paspalum control achieved by different treatments is summarised in Table 2. One month after treatment clethodim at all rates of application was more effective on couch than either sethoxydim or fluazifop-butyl. In the case of paspalum, clethodim at 240 g/ha or above gave as good or better control than did sethoxydim or fluazifop-butyl. Sethoxydim was less effective than fluazifop-butyl for the control of paspalum.

Six weeks after the application of herbicides, considerable re-growth of couch had occurred in most plots and only two treatments viz. fluazifop-butyl and the highest rate of clethodim were providing reasonable control (Table 2). Both clethodim and fluazifop-butyl were more effective on paspalum. Little re-growth had occurred from clethodim treatments of 480 g/ha by 6 weeks after treatment and at nearly 3 months after treatment regrowth was still suppressed.

The results of this trial suggest that paspalum is more susceptible to clethodim than couch is, although the rates required for good control were much higher than those reported by Kincade *et al* (1987). It must be stressed, however, that our trial site had well established infestations of couch and paspalum. A higher level of control could be expected in cultivated ground, in which the rhizomes have been fragmented (Anon).

TABLE 2: Control of the perennial grass weeds couch and paspalum (treated 15.12.86).

Weeks after treatment	Rate (g ai/ha)	% Control		Regrowth Score*			
		(12.1.87)		(30.1.87)		(4.3.87)	
		4		6		12	
Treatment		couch	paspalum	couch	paspalum	couch	paspalum
clethodim	120	60	58	7.3	8.0	10.0	10.0
clethodim	240	67	81	5.7	6.0	8.5	10.0
clethodim	480	75	91	6.0	2.3	10.0	5.0
clethodim	720	87	96	3.7	0.5	8.5	1.5
sethoxydim	800	50	61	7.3	6.5	10.0	7.5
fluazifop-butyl	750	50	73	3.3	0	10.0	0
untreated	—	0	0	10.0	10.0	10.0	10.0
LSD (P < .05)		9.4	7.9				
(untreated excluded)							

* Regrowth score 0—10; 0 = no regrowth.

Soil residue and movement studies

Dry shoot weight data for the 'standard' series are presented in Table 3. Because ryegrass was more susceptible to clethodim than maize in both soil types, the persistence data presented (Table 4) are based on the ryegrass bioassay. The 'standard' series showed that the level of activity of clethodim was considerably lower in the Hamilton clay loam soil than in the Horotiu sandy loam soil. This difference in biological activity was also reflected in the bioassays from the field trials. In the Hamilton clay loam soil (data not tabulated) clethodim showed very little residual activity, with only the high rate (960 g/ha, showing a significant reduction (15%) in dry shoot weight of ryegrass on the day after treatment. Sethoxydim at 400 g/ha reduced yields on the first and third days after treatment.

Clethodim was more persistent in the Horotiu sandy loam soil. However even at the higher rates very little effect was present in the top 10 cm of soil 14 days after treatment (Table 4). When maize was the test species no significant residual activity appeared in the samples collected 7 days after spraying. Visual assessments of growth and vigour of both bioassay species showed trends similar to the reported data on dry matter yields.

At similar rates clethodim was slightly more active and persisted for longer than

TABLE 3: Effect of known concentrations of clethodim on two bioassay species, maize and ryegrass (average of three trials)

Clethodim (ppmw)**	Dry shoot weight* (% of control)			
	Horotiu sandy loam		Hamilton clay loam	
	maize	ryegrass	maize	ryegrass
0.0	100	100	100	100
0.1	97	87		
0.2	92	75		
0.3	85	45		
0.4	78	22		
0.5	64	9		
0.6	61	5		
0.8	50	0		
1.0	41	0	103	99
1.5	22	0		
2.0	17	0	101	100
5.0			92	81
10.0			85	69
20.0			73	54
40.0			59	33
50.0			51	28
LSD (P<0.5)	12.2	13.7	10.2	11.2

* Blank spaces indicate treatments not included.

** parts per million by weight of oven-dry soil.

TABLE 4: Bioassay, using ryegrass, of herbicide residues in 0-10 cm soil depth in the Horotiu sandy loam soil.

Treatment	Rate (g ai/ha)	Dry shoot weight of ryegrass (% of control)*					
		Days after spraying					
		1	3	7	14	21	35
clethodim	240	26	97				
clethodim	480	0	55	104			
clethodim	720	0	36	73	81	111	
clethodim	960	0	30	70	85	109	
sethoxydim	400	32	90				

* Figures in italics are not significantly different from untreated controls (= 100), P>0.05. The subsequent blank spaces also represent data not significantly different from controls.

sethoxydim in the Horotiu sandy loam soil while in the Hamilton clay loam soil the reverse was true. No detectable residues were found in any of the samples collected from the 10-20 cm depth 7 and 14 days after treatment. This shows that although the activity of clethodim in the top 10 cm of soil dramatically declined over this period it had not been leached into the 10-20 cm zone despite significant rainfall during this period. Rainfall at the Hamilton clay loam site at 7 days after treatment was 9 mm and for the Horotiu sandy loam site was 11 mm. By 14 days after treatment a further 18 and 84 mm had fallen respectively at the two sites. These results are similar to those achieved with a number of closely related grass weed herbicides used in earlier studies (Rahman *et al* 1985, Velovitch 1982).

In conclusion, the results of these studies show that clethodim is a highly active post-emergence grass herbicide. When used in the early growth stage, it is very effective on several annual grasses. Paspalum appears to be more susceptible to clethodim than

couch. Its mode of action i.e. disruption and decay of meristematic tissue, appears similar to the other related post-emergence grass herbicides, fluazifop-butyl and sethoxydim, but its effects were seen earlier. Clethodim has a short residual life in the soil and should pose little or no problem in the crop rotation.

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