RESIDUAL ACTIVITY OF ETHOFUMESATE UNDER DIFFERENT SOIL AND CLIMATIC CONDITIONS

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Summary

The residual activity of ethofumesate applied at 1, 2, 4 and 8 kg/ha at nine trial sites was studied in the glasshouse using red clover (*Trifolium pratense*) and barley grass (*Hordeum murinum*) as bioassay species. Trial sites located throughout New Zealand varied widely in their soil properties, daily temperatures and annual rainfall. Data show that at each rate the herbicide persisted at least twice as long in the Roxburgh site than in the trial site at Waihi. In general, the phytotoxic residues lasted longer under dry and cold conditions than under wet and warm conditions. Differences in the soil properties appeared to be important for ethofumesate persistence mainly within regions of similar rainfall and temperature.

INTRODUCTION

Ethofumesate has been extensively tested for control of barley grass in New Zealand (Allen *et al* 1974; Hartley *et al* 1974; O'Connor *et al* 1975). While barley grass control has been very promising and ryegrass (*Lolium* spp) has shown a high degree of tolerance to this herbicide, clovers (*Trifolium* spp) have been eliminated or severely depressed at optimum rates required for barley grass control. O'Connor *et al* (1975) reported no regrowth of white clover (*Trifolium repens*) after 5 months and Allen *et al* (1974) could find no regrowth after 10-12 months (with the exception of one trial) when treated with rates of ethofumesate as low as 1 kg/ha.

No data are available on the re-establishment of clovers in soil treated with ethofumesate under New Zealand conditions except the results of O'Connor *et al* (1975) who reported from visual observations that white clover established successfully when oversown into ethofumesate-treated plots 3 months after treatment. The work reported here monitored the residual activity of ethofumesate under the soil and climatic conditions of various areas of New Zealand to determine the period after which it would be 'safe' to establish susceptible species such as clovers in soils treated with different rates of this herbicide.

MATERIALS AND METHODS

Field trials were conducted at nine locations, all being located on sheep or cattle grazed pastures. The organic matter levels of the soils, determined by Walkley-Black method, and the rainfall during the experimental period at different locations are listed in Table 1. Rainfall figures were recorded between each sampling on the trial sites.

Ethofumesate was applied at rates of 1, 2, 4 or 8 kg/ha some time between late May and middle of June 1976. Individual plots were 15 x 30

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TABLE 1: Soil type, organic matter and rainfall records for the trial sites.

Location	Soil type*	Organic matter (%)	Rainfall (mm)		
			0 - 3 months	0 - 6 months	0 - 12 months
Waihi	Waihi s.l.	23.1	716	1367	2041
Hamilton	Horotiu s.l.	15.7	459	797	1358
Palmerston North	Tokomaru si.l.	6.9	425	776	1344
Gisborne	Matawhero heavy si.l	5.2	319	636	1072
Hastings	Waipukurau s.l.	7.4	349	521	992
Lincoln	Templeton si.l.	6.4	221	482	821
Waipara	Glenmark s.l.	5.2	190	364	707
Allanton	Clutha si.l.	6.0	177	314	672
Roxburgh	Struan fine s.l.	6.0	100	209	495

* s.l. = sandy loam; si.l. = silt loam

m² in size and treatments were arranged in a randomised block design with four replications. The herbicide was applied in a spray volume of 350 litres/ha at 210 kPa on the pasture mown down or grazed to a height of 2-4 cm before the application of treatments.

Soil samples for residue analyses were obtained from each plot at monthly intervals from the date of spraying until residues fell below the level of detection. All samples were collected to a depth of 5 cm and bioassayed in the glasshouse using the procedure described by Rahman and Cox (1975). The bioassay species used for measuring the residual activity were red clover and barley grass.

At the time of collection and until a few months after collection of soil samples data were collected on the re-establishment of resident clovers (white clover in each case) in field plots by point analysis at all trial sites.

RESULTS AND DISCUSSION

The data from 'standards' established with two clover species and barley grass using the Horotiu sandy loam soil are presented in Table 2. Damage from ethofumesate treatments was assessed on the basis of dry matter weight reductions in the case of barley grass. With the clovers, however, it was observed that unless the damage was severe, the green weights as well as dry weights of injured plants were similar to those produced by the untreated plants. Assessment of clovers was therefore made by means of the typical damage symptoms from ethofumesate – number of trifoliate leaves which failed to open (Fig. 1). At very high residue levels the total plant height was also reduced drastically. However, our assessments did not take this criterion into account and as long as all trifoliate leaves failed to open, the damage was assessed to be 100% regardless of the height of the plant.

Both the clover species were much more susceptible to ethofumesate than barley grass. White clover was slightly more sensitive than red clover from equal rates of application (Table 2). However, because of the more foliage growth of red clover the damage symptoms were more easily visible in this species, and it was selected, along with barley grass, as the indicator species for bioassay.

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FIG. 1:
Type of damage
from ethofumesate 6
weeks after
application. From
left to right: A, Red
clover — 0, 0.2, 0.4
and 0.6 ppmw
ethofumesate; B,
Barley grass — 0,
0.75, 1.0 and 1.0
ppmw ethofumesate.

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TABLE 2: Effect of ethofumesate on bioassay species in the glasshouse.

Ethofumesate (ppmw)	% damage		
	Red clover	White clover	Barley grass
0	0 d	0 d	0 d
0.1	40 c	45 c	0 d
0.2	65 b	75 b	8 d
0.4	100 a	100 a	14 cd
0.6			29 c
0.8			64 b
1.0			84 a

The lengths of time after which ethofumesate residues from various rates fell below phytotoxic levels in the nine trial sites are given in Table 3. Residues were considered non phytotoxic when the damage to clover plants was not significantly different from the untreated controls, which in most cases was found to be around 10% or less. Barley grass was more tolerant to ethofumesate as residue levels became non toxic to this species in much less time. However, the trend shown by the clover data in Table 3 was also obvious from the bioassay results obtained with barley grass. Data on the pattern of dissipation of ethofumesate from different rates of application will be reported elsewhere.

The above results clearly show that in general, phytotoxic residues of ethofumesate disappeared much faster from trial sites in the North Island than those of the South Island trial sites (Table 3). Differences in the initial activity of this herbicide between the two Islands have been recorded previously as higher rates have been required for satisfactory control of barley grass in the North Island regions compared to the South Island areas (Allen *et al* 1974; O'Connor *et al* 1975). It appears that similar or probably larger differences in the residual life of this chemical occur between regions and it is possible that better control of barley grass in the South Island could be partially due to the longer persistence of ethofumesate in that region.

TABLE 3: Months after application in which ethofumesate residues fell below phytotoxic levels to red clover at various locations.

Location	ethofumesate kg/ha			
	1	2	4	8
Waihi	3	4	7	9
Hamilton	3	4	7	9
Palmerston North	4	5	7	9
Gisborne	4	7	9	10
Hastings	4	7	9	11
Lincoln	6	8	10	13
Waipara	7	9	11	13
Allanton	7	9	11	16
Roxburgh	7	10	14	*

* After 20 months residues were still phytotoxic.

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An examination of the soil properties and rainfall data for trial sites in Table 1 shows a strong relationship of these factors with the residual life of ethofumesate reported in Table 3. Statistical analyses revealed that rainfall and soil temperature were the factors related most highly with the herbicide persistence ($r = 0.88^{***}$ and 0.92^{***} respectively) followed by the soil organic matter ($r = 0.66^{**}$). As rainfall and soil temperatures were strongly related with each other ($r = 0.87^{**}$), it is not possible to differentiate between the effects of these two factors. It can be said, however, that ethofumesate persists much longer under dry and cold conditions than under wet and warm conditions. Differences in the soil properties become important mainly within regions of similar rainfall or temperatures.

Data on the re-establishment of resident clovers showed that in most of the treated plots clovers had regenerated to comparable levels of those present in the untreated plots within 3-6 months after residues fell below detection levels in the glasshouse. One notable exception was the trial site at Gisborne where, even after oversowing, re-establishment of clovers in the plots treated with 2 kg/ha or more of ethofumesate was significantly below the level of control plots when the last observations were recorded 20 months after treatments were applied. No explanation could be provided for this abnormal behaviour of Gisborne soil.

As mentioned earlier, the assessment of clover damage was based only on the number of trifoliate leaves that failed to open. By taking some dry matter weights it was estimated that the damaged clover plants could produce dry matter similar to the normal plants when the damage assessments had fallen to between 20 and 35% levels, depending on the trial site. Thus if the damage was not taken into account, an area could be 'safe' to oversow clovers for normal dry matter production one or two months earlier than reported in Table 3. As the data are based on the residual activity in the top 5 cm of soil, these results would be applicable in the case of oversowing of clovers. Some of our later work has shown that the toxic residues of ethofumesate are confined in the top 5 to 10 cm of the soil. Thus if the area was cultivated to an average depth of 15 cm, the soil could be 'safe' earlier than shown here for the susceptible species.

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REFERENCES

- Allen, F. C., Hartley, M. J. and Meeklah, F. A., 1974. Control of barley grass by ethofumesate. *Proc. 27th N. Z. Weed and Pest Control Conf.*: 85-89.
- Hartley, M. J., Atkinson, G. C., Bimler, K. and Douch, G. A., 1974. Chemical control of barley grass under grazing conditions. *Proc. 27th N. Z. Weed and Pest Control Conf.*: 74-78.
- O'Connor, B. P., Logan, I. C. and Rowe, G. R. 1975. Effect of ethofumesate on barley grass and other pasture species. *Proc. 28th N. Z. Weed and Pest Control Conf.*: 12-16.
- Rahman, A. and Cox, T. I., 1975. Bioassay techniques for the determination of herbicide residues. *Proc. 28th N. Z. Weed and Pest Control Conf.*: 96-100.