THE EFFECT OF FENSULFOTHION ON GRAZING SHEEP

S. R. B. SOLLY

Wallaceville Animal Research Centre, Private Bag, Wellington

Summary

Ewe hoggets were allowed to graze pasture immediately after it had been topdressed with 5% fensulfothion granules at 2 lb active ingredient per acre. Four days later the sheep showed severe symptoms of organophosphate poisoning accompanied by loss of weight, and the average erythrocyte cholinesterase activity of the group had fallen to approximately 20% of the pre-trial level. Samples of omental fat removed after 6 days' grazing contained low concentrations (approximately 0.003 ppm) of fensulfothion. Other groups of sheep put on to pasture topdressed at the same rate, after withholding periods of 11, 20, 29 and 40 days, showed no clinical symptoms or weight loss. However, there was some depression of cholinesterase activity which became less as withholding periods were increased.

In a second trial, soil was treated with 5% fensulfothion granules at 2½ lb active ingredient per acre at the time of sowing new pasture. When the pasture was established, ewes and hoggets grazed on it showed no overt symptoms of poisoning, but their erythrocyte cholinesterase levels were reduced to about 80% of their pre-trial values.

It is concluded that the use of fensulfothion for topical application to pasture would probably be limited by toxic effects to stock rather than by residues in the edible tissues of stock. Incorporation of fensulfothion in soil when sowing new pasture would be unlikely to cause poisoning in sheep grazed on the newly established pasture.

INTRODUCTION

FENSULFOTHION is a highly toxic organophosphate with long residual effect. It shows promise for the control of grass grub, *Costelytra zealandica* White (Kelsey and Read, 1966, 1967).

The stability and toxicity of the compound suggest that its use as an insecticide on pasture might present hazards to stock grazing the pasture and hazards to man in the form of residues of fensulfothion in foodstuffs derived from such stock.

The trials summarized in this paper were designed to investigate possible hazards. A full report will be published elsewhere.

EXPERIMENTAL

All insecticide treatments are expressed as lb active ingredient applied per acre.

Liveweight records of experimental sheep were kept throughout the trials.

TRIAL 1: FENSULFOTHION RESIDUES AND ERYTHROCYTE CHOLINESTERASE
ACTIVITY IN SHEEP GRAZING FENSULFOTHION-TREATED PASTURE

Pasture Treatment

Five 1/4 acre paddocks were topdressed in July 1967 with 5% fensulfothion granules at the rate of 2 lb using a Cyclone seed broadcaster. A sixth 1/4 acre paddock was left untreated to serve as a control. The pasture was a ryegrass/white clover mixture. Pastures were short (1–3 in.) and slightly damp at the time of topdressing.

Grazing

The trial was divided into two phases. Phase (a) was to test the effect of length of withholding period (WP) on the health of sheep and on fensulfothion residues and erythrocyte cholinesterase activities in their fat and blood respectively. Phase (b) was to test for possible effects on sheep of fensulfothion that might be taken up systemically by pasture that grew again after completion of the first grazing period.

Phase (a).—Six groups of sheep, each group consisting of four one-year Romney-Southdown-cross ewe hoggets, were grazed on the treated paddocks after various WPs. Immediately after topdressing, one group of four sheep (the nil WP group) was put on to the topdressed paddock, and a second, control group, of sheep was put on the untreated paddock. Further groups of sheep were put on other topdressed paddocks after WPs of 11, 20, 29 and 40 days. Each group of sheep grazed its allotted paddock continuously until either insufficient pasture remained to support the animals, or phase (a) of the experiment was terminated.

Because of a shortage of pasture in the control and nil WP paddocks, the sheep were removed from them 25 days after topdressing. The other four groups of sheep were removed from the experimental paddocks 48 days after topdressing.

Phase (b).—The paddocks on which the control and nil WP groups of sheep had been grazed were spelled for 22 days after removing the experimental animals. Thereafter the regrown pasture was grazed continuously for three months by a group of four sheep confined to each paddock.

Samples

Pre-trial and post-exposure samples of blood for cholinesterase assay were taken from each sheep. For phase (a) of the trial, the results of these assays are shown in Fig. 1 as mean cholinesterase levels for each group of sheep, taking the mean pre-trial level for each group as 100 units of activity. In phase (b) of the trial, the erythrocyte cholinesterase levels in the group of sheep grazing treated pasture did not differ from those of the control group of sheep, and results are not shown.

Samples of omental fat were surgically removed from one sheep out of each group of four, three days before the start of the trial. Further samples of omental fat were taken from all sheep in the nil WP group after they had grazed the treated paddock for six days. Since these samples contained only traces of fensulfothion (Table 3), fat from all other groups of sheep (which were exposed to lower levels of fensulfothion on the pasture — Table 1) was not analysed.

One composite pre-trial pasture sample was taken from all paddocks, a sample was taken from each paddock immediately before sheep were put

on to graze, and samples were taken from all paddocks at the end of phase (a) of the trial. Control and treated paddocks were sampled at the beginning and end of phase (b) of the trial.

TRIAL 2: ERYTHROCYTE CHOLINESTERASE ACTIVITY AND BODY-WEIGHTS OF SHEEP GRAZING PASTURE GROWN IN FENSULFOTHION-TREATED SOIL.

Pasture Treatment

Two $\frac{1}{2}$ acre paddocks of established pasture were sprayed with diquat. When the herbage was dead, the ground was lightly disc-harrowed in preparation for sowing to pasture.

Twenty-five pounds of pasture seeds mixture containing mainly perennial ryegrass (*Lolium perenne* L.) and white clover (*Trifolium repens* L.) was mixed with 25 lb 5% fensulfothion granules. This mixture, together with mineralized superphosphate, was sown in drills 1 to 2 in. deep in one of the $\frac{1}{2}$ acre paddocks, using a Ferguson seed drill. The overall rate of application of active ingredient was $2\frac{1}{2}$ lb, but because the granules were applied in drills about 1 in. wide with 7 in. spacings between drills, the rate of application in the drills was approximately 16 to 18 lb.

The second $\frac{1}{2}$ acre (control) paddock was treated in a similar way to the first, except that no fensulfothion granules were added to the seed mixture.

Both experimental areas were rolled after seeding, and stock were excluded until the pasture was established. The seeds were sown in October 1967, in still, dry, sunny conditions. Heavy rain fell a few days after seeding and germination was rapid.

Grazing

Four ewes and four wethers, aged about 14 months, were put on to each paddock 7 weeks after seeding, when the pasture length was 4 to 6 in. The sheep were allowed to graze the pasture continuously until it was eaten right down, 25 days later.

Samples

Pre-trial and post-exposure samples of blood were taken from each sheep for erythrocyte cholinesterase assay.

Pasture samples were taken from both paddocks on the day the sheep were put on to the pasture, and at intervals subsequently, until the day they were taken off.

Analytical

Residues of fensulfothion in both pasture and sheep fat were determined by a cholinesterase inhibition method (Kramer and Gamson, 1958).

Results are expressed as parts per million (ppm) on a dry weight basis for pasture and on a raw fat basis for fat. The limits of sensitivity of the method were 0.25 ppm and 0.003 ppm fensulfothion in pasture and fat, respectively.

Sheep erythrocyte cholinesterase activity was determined by the Δ pH method of Michel (1949).

RESULTS AND DISCUSSION

For Trial 1, in which established pasture was treated with fensulfothion granules, results followed the pattern found in similar trials with DDT and lindane prills—high residues immediately after topdressing followed by the usual pattern of degradation and persistence of typical insecticide residues on growing pasture (Table 1). In comparison with other organophosphates, fensulfothion residues are unusually stable under field conditions, being similar in persistence to the organochlorine compounds, DDT and lindane. Residues associated with pasture were still detectable 8 weeks after application, and while a part of this may have been due to surface or soil contamination from the original topdressing, at least some could have been attributable to systemic uptake of insecticide from the topsoil (see Trial 2).

Overall, the residues on pasture resulting from soil incorporation of fensulfothion (Trial 2) persisted at much higher levels than in Trial 1 in which the bulk of the insecticide would be at or near the soil surface (*cf.* Tables 1 and 2). This suggests that pasture residues in Trial 2 were mostly systemic in origin rather than due to soil contamination, but this requires further study.

In Trial 1, four days after topdressing, the nil WP group showed typical symptoms of organophosphate poisoning, rles, salivation, scouring, frequent urination and loss of appetite. Loss of appetite was reflected in loss of body-weight during the first eleven days grazing topdressed pasture, but body-weight recovery was rapid after this time. Loss of appetite would limit uptake of fensulfothion during the critical period after topdressing

TABLE 1: FENSULFOTHION (ppm) ON PASTURE AFTER
TOPICAL TREATMENT (TRIAL 1)

Paddock No.	Sampling Time — Days after Topdressing							
	0	11	Phase (a) 20 29 40			54	Phase (b) 131 147	
1 (Control)	<0.25*	<0.25	<0.25	—	<0.25	<0.25*	<0.25	<0.25
2	43*	—	—	—	—	0.43*	<0.25	<0.25
3	—	9.2*	—	—	—	0.35	—	—
4	—	—	1.7*	—	—	0.39	—	—
5	—	—	—	0.4*	—	0.47	—	—
6	—	—	—	—	0.25*	<0.25	—	—

* Denotes levels of fensulfothion on pasture when sheep were put on to graze.
— Not sampled.

TABLE 2: FENSULFOTHION (ppm) ON PASTURE AFTER
SOIL TREATMENT (TRIAL 2)

Paddock Treatment*	Sampling Time — Days after Soil Treatment			
	49	56	63	74
0 (Control)	<0.25	0.26	<0.25	<0.25
2½ lb fensulfothion/acre	4.8	1.9	2.5	1.5

* 8 sheep were put on to each ½ acre paddock 49 days after the soil was treated and allowed to graze continuously until 74 days after the soil was treated.

TABLE 3: FENSULFOTHION IN OMENTAL FAT OF NIL WP
GROUP OF SHEEP 6 DAYS AFTER TOPDRESSING
PASTURE (TRIAL 1)

<i>Sheep No.</i>	<i>Fensulfothion (ppm)</i>
505	0.003
506	0.004
507	<0.003
508	0.005

TABLE 4: SHEEP ERYTHROCYTE CHOLINESTERASE ACTIVITY
(PRE-TRIAL ACTIVITY = 100) AFTER SOIL TREATMENT WITH
FENSULFOTHION (TRIAL 2)
(Sheep put on to trial paddocks 20/11/67)

Sheep Sex and No.		Date				
		23/11/67	27/11/67	4/12/67	15/12/67	
		52	56	63	74	
<hr/>						
EWES	CONTROL PADDOCK					
1258		119	106	103	106	
954		115	113	120	123	
2962		113	110	113	110	
2904		119	105	111	103	
Means		117	109	112	111	
<hr/>						
WETHERS						
463		118	97	108	105	
521		111	103	108	105	
583		100	94	106	100	
1139		95	95	89	89	
Means	106	97	103	100		
<hr/>						
EWES	PADDOCKS TREATED WITH 2½ LB FENSULFOTHION/ ACRE					
908		98	83	69	75	
2908		106	91	80	66	
1924		100	81	88	74	
1232		95	100	92	97	
Means		100	90	82	78	
<hr/>						
WETHERS						
443		112	83	85	78	
502		104	89	76	82	
569		98	77	84	84	
593		95	85	85	90	
Means	102	84	83	84		
<hr/>						

when pasture residues were high and was probably a major factor in the survival of this group.

The nil WP group (Trial 1) showed a 70% loss of erythrocyte cholinesterase activity after 1 day, and an 80% loss after 4 days' exposure (Fig. 1). As expected, the recovery of erythrocyte cholinesterase activity was slow; the levels were still 67% below the pre-trial values when this group of sheep was removed from the treated pasture 25 days after top-dressing.

Despite the adverse effect of the absence of a withholding period on the health of the sheep and on their erythrocyte cholinesterase activities, samples of omental fat contained only traces of fensulfothion (Table 3).

None of the animals in the 11-, 20-, 29- or 40-day groups lost body weight or showed clinical symptoms of poisoning and depression of erythrocyte cholinesterase activity became less as the WP was increased.

In the 11- and 20-day WP groups, after an initial slight recovery of erythrocyte cholinesterase activity up to 35 days after topdressing, the activity declined slightly again in blood samples taken 48 days after topdressing (Fig. 1). This occurred during a period of vigorous pasture growth, and the depression at that time may have been caused by systemic uptake of fensulfothion from the soil. This effect was not observed in the 29- and 40-day WP groups of sheep which had much shorter grazing periods on treated pasture (Fig. 1).

Cholinesterase in the erythrocytes of sheep grazed on the re-growth of treated pasture on a treated paddock (Trial 1, phase (b)) did not differ from that of the control group, during a 13-week period of continuous grazing. It would appear, therefore, that, where fensulfothion granules are applied uniformly to established pasture at 2 lb, any systemic uptake of insecticide into the pasture from the soil would not present a hazard to sheep.

In Trial 2, no weight losses or clinical symptoms were noted in sheep, but a 20% depression of erythrocyte cholinesterase activity occurred in

Fig. 1: Mean erythrocyte cholinesterase activities (pre-trial activities = 100) of groups of sheep on fensulfothion-treated pasture (Trial 1).

Each point is the mean cholinesterase activity of erythrocytes from the four sheep in each group.

N — sheep removed from experimental paddocks.

both ewes and wethers over a 25-day period (Table 4). This cholinesterase depression was associated with pasture residue levels of between 1 and 5 ppm fensulfothion (Table 2). This is in accord with the results of Trial 1 (Fig. 1 and Table 1) from which it is apparent that depression of cholinesterase activity was associated with pasture residue levels higher than about 0.4 ppm. On the other hand, manifestations of poisoning were associated with pasture residues in excess of 9 ppm.

The trials confirm that considerable depression of erythrocyte cholinesterase activity (at least 30% below "normal") can occur with no effect on the general health, appetite or body-weight of sheep. However, depressions of this order could be predisposing causes of illness or death if stock were introduced to pasture topdressed with fensulfothion soon after medication with other organophosphates such as dips or anthelmintics.

It is concluded that the use of fensulfothion on established pasture at a rate of 2 lb is unlikely to lead to accumulation of high residues of fensulfothion in stock grazing the topdressed pasture. Nevertheless, some poisoning could occur in the absence of an adequate withholding period. Treatment of soil with fensulfothion before, or at the time of sowing pasture seeds would be unlikely to cause any residue hazards or poisoning in stock.

ACKNOWLEDGEMENTS

The author thanks B. F. A. Rough, Henry H. York & Co. (N.Z.) Ltd., for arranging the supply of fensulfothion granules.

REFERENCES

- Kelsey, J. M.; Read, P. E. C., 1966: *Proc. 19th N.Z. Weed & Pest Control Conf.*: 204.
———; ———, 1967: *Proc. 20th N.Z. Weed & Pest Control Conf.*: 155.
Cramer, D. N.; Gamson, R. M., 1958: *Anal. Chem.* 30: 251.
Michel, H. O., 1949: *J. Lab. Clin. Med.*, 34: 1564.