RESIDUES ON PASTURES TREATED WITH VARIOUS FORMS OF DDT

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Summary

The residual DDT contamination of pasture was determined after application of a range of commercial preparations including dry mix DDT-superphosphate, "wet" mix DDT-superphosphate, granulated DDT-superphosphate and DDT prills. Ten per cent. DDT marble prills were found to give much lower residues than the DDT-superphosphates. Short dry pasture retained less DDT than long wet pasture. Brush harrowing after treatment reduced the contamination levels significantly. In the trial where yield measurements were taken, the amount of DDT in the uncut pasture appeared to remain constant but the concentration fell as the grass grew.

INTRODUCTION

AFTER it had been established that animal products may contain DDT when stock graze pasture treated with this insecticide for the control of insect pests, the Department of Agriculture commenced a series of trials to investigate the residual DDT contamination of pasture. It was hoped that a method of application would be found which would considerably reduce the amount of residues.

This paper gives the results of trials carried out by the Rukuhia Soil Research Station to give some information about the amount and persistence of residual DDT on pasture resulting from the use of commercially available forms of DDT.

The amount of residues remaining on the grass was expected to diminish with time owing to physical factors such as wind and rain and to chemical decomposition of DDT. Dilution through growth of the herbage was also expected.

References to DDT quantities in the paper are in terms of active ingredient per acre.

TRIAL A

This trial was laid down on August 14, 1961, at Ruakura Animal Research Station. DDT was applied at 1 lb and 2 lb as dry mix DDT-superphosphate, "wet" mix DDT-superphosphate, and 10% marble prills (all previously analysed). The total superphosphate application was 2 cwt per acre in each case. A "superphosphate only" control was included. There were two replications of the 7 treatments applied both to long (6 in.) and to short (2 to 3 in.) pasture. The short pasture was dry but rather macerated (through the use of a rotary mower) and the long pasture was damp when the topdressing was commenced. The treatments were applied with a plot topdresser which gave an even spread.

Pasture samples were taken, 4, 14, 28 and 42 days after application of the treatments, a separate strip of the plot being mown at each sampling. Each plot was cut by hand at a height of 2 in. above ground level, then trimmed with a sickle-bar mower set at 2 in. A second sample was then taken using a drum mower set as low as possible ($\frac{1}{2}$ in.). The short grass did not grow sufficiently to allow this stratum sampling until the 28 day cut, so at the earlier cuts the plots were sampled once only with the drum mower set at $\frac{1}{2}$ in.

ANALYTICAL

A portion of the sample was chopped and a 100 g sub-sample placed in a half-gallon preserving jar. Redistilled isopropyl alcohol (150 ml) was added and the jars shaken by hand to ensure thorough wetting of the sample. After the addition of 400 ml of redistilled n-hexane the jars were covered and shaken mechanically for 30 minutes. The procedure then followed the "cleanup" method of Davidow (1950) and the nitration method of Schechter *et al.* (1945).

RESULTS

Comparison of Treatments

The results expressed as parts per million of the para para isomer of DDT in the dry matter (Tables 1 and 2), show that marble prills caused a very much smaller amount of residual DDT contamination than either wet or dry mix superphosphate. The difference was tenfold, and was highly significant at all cuts. The trend was for dry mix superphosphate levels to be higher than the wet mix superphosphate levels. The difference was significant for both rates in the first cut but not in later cuts. For the superphosphate mixes, doubling the rate of DDT approximately doubled the contamination. There was no statistically significant difference in contamination levels between the two rates of prills.

TABLE 1: MEAN LEVELS OF DDT COMBINING RESULTS FOR LONG AND SHORT PASTURE (p.p.m. in dry matter)

Treatment	lb DDT/acre	Days after application							
		4			14			28	42
Prills	1	35	d	C	7	c	B	1.0	c C 0.3 b B
	2	48	d	C	12	c	B	1.5	c C 0.3 b B
Wet mix super.	1	149	c	B	44	b	A	4.6	b B 1.7 a A
	2	279	b	B	83	ab	A	9.3	a AB 2.5 a A
Dry mix super.	1	238	b	B	75	ab	A	9.3	a AB 1.2 a AB
	2	594	a	A	131	a	A	12.5	a A 2.8 a A

Rainfall 0 to 4 days — nil; 4 to 14 days — 1.99 in.; 14 to 28 days — 2.49 in.; 28 to 42 days — 1.07 in.

Time Comparison

The rate of reduction of DDT was about the same for the prills as for the other treatments (Table 2). For the long pasture the initial high levels dropped rapidly between the 4th and the 14th day, during the period when the first rain was recorded after the commencement of the trial. Much of the loss could be attributed to the action of wind and rain, but throughout the period of the trial the rate of growth of the pasture was considerable and this must have caused a large reduction in the concentration of DDT. The loss of DDT from the short pasture could not be followed satisfactorily throughout the trial because of the change in sampling technique after the second cut, and suspected contamination of the first two cuts explained below.

TABLE 2: DDT IN TOP PORTION OF LONG PASTURE (p.p.m. in dry matter)

Treatment	lb DDT/acre	Days after Application			
		4	14	28	42
Prills	1	19	4	1.5	0.3
	2	25	4	2.3	0.3
Wet mix super.	1	120	26	8.5	3.0
	2	204	67	17.5	6.5
Dry mix super.	1	191	59	20.5	3.0
	2	556	91	21.0	5.5

Comparison of Long versus Short Pasture at Time of Application

The average overall DDT level was much less for the short pasture than for the long pasture (Table 3). The difference,

although threefold, was not statistically significant, but if allowance were made for the widely differing yields the difference would be much greater and was probably real.

TABLE 3: COMPARISON OF TOP SECTIONS OF SHORT AND LONG PASTURE
(p.p.m. DDT in dry matter)

Mean of all treatments	Days after application	
	28	42
Long pasture	7.8	1.7
Short pasture	2.5	0.6

The early cuts cannot be included in Table 3 because the long pasture and the short pasture were not sampled in the same way until the third cut.

TABLE 4: DDT IN SHORT PASTURE
(p.p.m. in dry matter)

Treatment	lb DDT/acre	Days after Application			
		4	14	28	42
		Whole Samples (Mown)		Tops only (Handcut samples)	
Prills	1	33	5	0.7	0.3
	2	69	11	1.0	0.3
Wet mix super.	1	190	37	2.5	0.9
	2	340	65	4.9	1.0
Dry mix super.	1	306	49	4.2	0.5
	2	781	103	7.4	1.4

The change in sampling technique is reflected by the big drop in DDT levels in the short grass between the 14th and the 28th day (Table 4).

The results (Table 4) for the first two cuts of the short pasture were higher than would be expected from a comparison with the top section of long pasture (Table 2). The abnormally high levels were probably caused by contamination with soil containing high concentrations of DDT. There was visible evidence of soil contamination but this was difficult to avoid as the ground was uneven and the mower was set very low.

Comparison of Top and Bottom Sections

The bottom section of the long pasture in all cuts and of the short pasture in the last two cuts were affected by soil contamination. There was less evidence of contamination in the first cut where the grass was not so long and was less difficult to mow.

TABLE 5: COMPARISON BETWEEN TOP AND BOTTOM SECTIONS OF LONG PASTURE AT FIRST CUT
(p.p.m. DDT in dry matter)

Treatment	lb DDT/acre	Top Section	Bottom Section	"Difference"
Prills	1	19	77	sig. 1%
	2	25	45	N.S.
Wet mix super.	1	120	114	N.S.
	2	204	251	N.S.
Dry mix super.	1	191	180	N.S.
	2	556	363	N.S.

A comparison between the top and bottom sections of the long pasture showed that the distribution of the insecticide throughout the herbage was fairly even (Table 5).

TRIAL B

This trial was laid down on November 2, 1961. The main purpose was to test a wider range of DDT formulations. The technique of brush harrowing was used after application of the insecticide to brush off as much DDT as possible.

DDT was applied at the rate of 2 lb as dry mix DDT-superphosphate, wet mix DDT-superphosphate, salt prills, granulated DDT-superphosphate, marble prills mixed with superphosphate, marble prills alone, and a "superphosphate only" control. There were three replicates of each treatment, each plot was split in two sections lengthwise and one half was brush-harrowed. A visual examination of the plots showed that this succeeded in brushing off particles of superphosphate and DDT to the ground. The plot topdresser was used to apply the treatments to pasture mown to 2 or 3 in. in height several days before. The plots were sampled using a drum mower, and the yield from each mowing strip weighed.

RESULTS

Comparison of Treatments

The DDT levels are shown in Table 6.

TABLE 6: COMPARISON OF TREATMENTS
(p.p.m. DDT in dry matter)

<i>Treatment</i> (Mean harrowed and not harrowed)	<i>Days after application</i>		
	4	14	28
Marble prills	10 c C	7 d C	7 c D
Super. + Marble prills	23 b BC	6 d C	5 c D
Granulated super.	41 b B	14 c B	9 c CD
Salt prills	174 a A	36 b A	16 b BC
Wet mix DDT-super.	219 a A	43 ab A	29 a AB
Dry mix DDT-super.	234 a A	54 a A	45 a A
Rainfall	Nil	0.32 in.	1.21 in.

In this trial the insecticide contamination did not reach the high levels found in the earlier trial. The superphosphate + marble prill treatment gave one-tenth the amount of residues given by dry mix superphosphate, while the marble prills alone were still lower at the first cut. Salt prills proved to be unsatisfactory. In appearance the material resembled a rather heavy granular powder, and it behaved similarly to the wet and dry mix superphosphates. Granulated superphosphate reduced the DDT residues quite effectively compared with the superphosphate mixes and was comparable with the superphosphate + marble prill treatment.

Effect of Harrowing

Brush harrowing was successful in lowering the general DDT level significantly, particularly at the first two cuts (Table 7). There was no significant interaction between the treatment and harrowing.

TABLE 7: EFFECT OF HARROWING
(p.p.m. DDT in dry matter)

<i>Mean of all Treatments</i>	<i>Days after application</i>		
	4	14	28
Harrowed	35 b B	16 b B	12 b A
Not harrowed	50 a A	23 a A	15 a A

Time Comparison

The levels did not fall off as quickly as was expected from the results of Trial A, possibly because of the lower rainfall and lower initial levels of contamination. However, the rate of reduction of DDT concentration varied with the treatment. The marble prills initially gave low results which scarcely changed in 24 days, while the dry mix superphosphate treatment dropped to one-fifth of its original level. This may have been partly due to experimental variation. Replicate plots showed considerable variability, particularly at the first cut, possibly through contamination of the samples with sheep dung. This was present when the trial was laid down, and the DDT and superphosphate was still visible on top of the dung at the 4-day cut.

Recovery of DDT

A study of the recovery figures (Table 8) showed that the actual quantity of DDT remaining on the pasture between the 4th and the 28th day was fairly constant, suggesting that the main factor involved in the reduction in concentration was the growth of the grass. This pattern was complicated by the variation in the rate of reduction discussed above. In some cases it appeared that the total amount of DDT was increasing. A separate statistical analysis was made and this apparent increase reached statistical significance in the case of the "marble prills alone" treatment.

TABLE 8: LB/ACRE DDT RECOVERED

Treatment (Mean of harrowed and not harrowed)	Days after Application		
	4	14	28
Control	0.001 d D	0.002 e D	0.002 e D
Marble prills	0.004 e C	0.012 d C	0.021 d C
Super. + Marble prills	0.010 b BC	0.010 d C	0.015 d C
Granulated super.	0.017 b B	0.023 c B	0.022 d C
Salt prills	0.070 a A	0.060 b A	0.041 c BC
Wet mix super.	0.096 a A	0.073 ab A	0.070 ab AB
Dry mix super.	0.100 a A	0.091 a A	0.119 a A
Mean of all treatments:			
Harrowed	0.015 b B	0.019 b A	0.022 a A
Not harrowed	0.022 a A	0.023 a A	0.025 a A
Mean yield (lb DM/acre)	440	1700	2600

A possible reason for this increase in DDT could be that some DDT is picked up from the soil by the new growth. It is also possible that the sample was contaminated during the mowing as occurred in the first trial.

CONCLUSIONS

TRIAL A

Marble prills gave very much lower residues than either the wet mix superphosphate or the dry mix superphosphate, and the dry mix was worse than the wet mix. The concentration of the DDT in the pasture was reduced with time through the action of weather and the growth of the grass. The short pasture contained less DDT than the long pasture. The DDT was distributed fairly evenly between the top and bottom of the pasture.

TRIAL B

In this trial the value of marble prills in reducing the amount of initial contamination was confirmed. Granulated superphosphate also caused less residue than the DDT-superphosphate mixes. Brush harrowing the treated area immediately after application also helped to lower the levels.

The results, however, raised some doubts about the reduction with time, especially in the case of the marble prills. A third trial not yet completed investigates more fully the behaviour of marble prills towards irrigation and differing weather conditions.

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