

LINDANE RESIDUES ON PASTURE AND IN THE FAT OF SHEEP FOLLOWING THE USE OF LINDANE PRILLS

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Summary

Sheep pasture was topdressed with lindane (20%) prills at the rate of 2 lb active ingredient per acre. Mean lindane residues in the fat of sheep grazed on the pasture after withholding periods of 0, 9, 17 and 27 days were 4.0, 1.8, 0.7 and 0.4 ppm, respectively.

When these stock were transferred to insecticide-free pasture, lindane was eliminated rapidly from the fat, all sheep having less than 0.5 ppm at one month and less than 0.1 ppm at two months after their last exposure to insecticide.

Significant lindane residues accumulated in the fat of sheep that were grazed during the period 16 to 20 weeks after topdressing on an area that had been grazed-off twice since lindane prills had been applied.

These results are discussed in relation to the present concept of withholding periods.

INTRODUCTION

INFORMATION is available on the storage of lindane in the body fat of sheep and cattle that were fed graded doses of the insecticide in a diet of hay and grain (Claborn *et al.*, 1960), and on residues in sheep, cattle and goats following the use of lindane for the control of ecto-parasites (Jackson *et al.*, 1959; Claborn *et al.*, 1960; Collett and Harrison, 1963; Egan, 1965). These data indicate that, in comparison with DDT, lindane accumulates less readily in the body fat of meat animals and that it is eliminated more rapidly from storage after exposure to insecticide ceases. In a replicated plot trial carried out at Wallaceville in 1963, dry or wet pasture was topdressed with DDT or lindane prills at the rate of 2 lb (all rates in active ingredient per acre). The amount and persistence of the resulting residues on the herbage were similar for both insecticides. However, the overall contamination was three to four times higher when the prills were applied to wet pasture than when the pasture was dry when treated (Anon., 1965).

As lindane has given promising results as a substitute for DDT for the control of DDT-resistant strains of grass-grub (*Costelytra zealandica* (White)), information was required on the residues likely to result in animal fats following the use of lindane prills on sheep and dairy pastures. This paper is an interim report of trials being carried out on sheep pastures. When the trials are completed a full account will be published elsewhere.

EXPERIMENTAL AND RESULTS

TRIAL 1

Four ¼-acre paddocks of established ryegrass/clover sheep pasture were heavily grazed by overstocking with sheep, chain harrowed, and

then allowed to recover to an average pasture height of 2 in. Lindane prills (Mapua 20%) were then applied at the rate of 2 lb using a rotary seed spreader. The date of treatment was November 15, 1966, and the ground was dry, and the pasture slightly damp.

Four groups of four ewe hoggets were used, one group for each paddock. Paddocks 1, 2, 3 and 4 were grazed successively after withholding periods of 0, 9, 17 and 27 days, respectively. Pasture was sampled just before topdressing and thereafter at intervals during the grazing periods. Omental fat was removed from each sheep two weeks before trial, again after each group had been exposed to lindane for 7 to 10 days, and subsequently at the end of the 36-day trial.

All sheep were then run together for two months on lindane-free pasture and omental fat was obtained by biopsy at the end of the first and second months.

Lindane residues on pasture and in fat were determined by gas chromatography. Recoveries of lindane added to these tissues was virtually complete and the limits of measurement of lindane in fat and pasture were 0.005 ppm and 0.10 ppm (dry matter basis), respectively.

TABLE 1: LINDANE RESIDUES ON PASTURE
(ppm dry matter basis)

<i>Days after Top- dressing</i>	<i>Paddock Number</i>				<i>Mean Residue Levels</i>
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	
Pre-trial	nil	nil	nil	nil	nil
0	(91.5)	54.4	195	215	139
6	28.3		9.7		19
9	10.3	(4.3)	9.1		7.9
13	4.9	2.8	2.4		3.4
17	5.0	2.0	(2.8)	1.4	2.8
22	3.0	2.6	5.2	1.5	3.1
27	1.0	1.5	1.1	(1.1)	1.2
31	4.6	1.3	1.3	0.8	2.0
36	1.6	1.0	0.9	0.8	1.1

Paddock 3, days 6, 9, 13—figures are means of Paddocks 2, 3 and 4.

Figures in parentheses in the table indicate the stage at which sheep were introduced on to the four treated areas. Figures below those in parentheses in each column, therefore, were the levels found on the pastures on which sheep were actually grazing.

TRIAL 2

Following Trial 1, one of the four treated paddocks (Paddock 1, Table 1), which had been free from stock for two months since the first period of grazing, was heavily grazed-off by stock from the station flock and the re-growth allowed to reach an average height of 2 in. Two sheep from each of the four original groups were then selected at random and these eight animals were grazed for one month on the re-grown pasture on paddock 1—this period corresponded to 16 to 20 weeks after topdressing with lindane prills. The remaining eight sheep from the original 16 were kept on lindane-free pasture and served as controls. After one month the 16 sheep were killed and their omental fat analysed for lindane.

A pasture sample taken from paddock 1 one day before the introduction of sheep in Trial 2 had 0.98 ppm lindane, and a further sample from this area, after being grazed for two weeks, had 1.42 ppm lindane (both figures on a dry matter basis).

Through the courtesy of J. M. Kelsey, samples of soil and pasture were made available for residue analysis from trials being carried out in Canterbury and details of these are as follows.

Lindane granules (5%) were applied to 1 in. pasture at the rate of 2 lb lindane on April 15, 1966. Pasture and soil were sampled on November 14, 1966. The pasture was 3½ in. long and was cut to a stubble height of 1 in. The area had been grazed since topdressing but not within 6½ weeks of sampling.

DISCUSSION

Lindane residues on pasture followed the pattern found in similar topdressing trials with DDT prills on relatively dry pasture—that is, residues were high immediately after topdressing and there was considerable variation between samples from replicated paddocks (Table 1, 0 days), followed by the usual degradation and persistence pattern typical of organochlorine insecticide residues on growing pasture. Pastures sampled after the times indicated by parentheses in Table 1 were cut while sheep were continuously grazing on the treated areas so that any “secondary” contamination arising from the transfer of lindane from soil to the pasture by the action of stock (as distinct from the persisting residues from top-

TABLE 2: LINDANE RESIDUES IN SHEEP FAT

Sheep No.	Withhold- ing Period (days)	Residues (ppm) Grazing Periods (days) in Brackets		Residues (ppm) Periods on Lindane-free Pasture in Brackets	
		(0-9)	(0-36)	(1 month)	(2 months)
542	0	3.5	4.3	0.45	0.07
569		5.9	2.5	0.06	0.01
577		3.8	2.3	NS	0.06
586		4.6	3.2	0.27	NS
		Means 4.0	3.1	0.26	0.05
		(9-16)	(9-36)		
564	9	1.5	1.9	0.23	0.04
581		1.0	1.4	0.17	0.03
582		2.5	1.9	0.24	0.04
588		2.1	1.7	0.17	0.04
		Means 1.8	1.7	0.20	0.04
		(17-27)	(17-36)		
539	17	0.68	0.77	0.20	0.06
558		0.76	1.2	0.17	0.05
589		0.89	0.97	0.12	0.03
594		0.62	1.0	0.05	0.01
		Means 0.74	0.99	0.14	0.04
			(27-36)		
544	27		0.35	0.05	0.02
547			0.35	0.09	0.02
592			0.37	0.05	0.02
595			0.40	0.06	0.01
		Means	0.37	0.06	0.02

NS — denotes no sample.

dressing originally) would be incorporated in the figures shown in Table 1.

Sheep grazed for 36 days immediately after topdressing did not accumulate lindane residues in excess of 5 ppm. Maximum residues measured in individual animals that were grazed after withholding periods of 9, 17 and 27 days were 2.5, 1.2 and 0.4 ppm, respectively. Elimination of lindane from storage in fat was relatively rapid as, on average values, 84 to 92% was eliminated in one month and 95 to 98% in two months when the sheep were maintained on lindane-free pasture (Table 2). Four months after their last exposure to lindane, residues in fat were below the level of quantitative measurement (Table 3, control group).

TABLE 3: LINDANE RESIDUES IN SHEEP FAT (PPM)

CONTROL SHEEP		
Sheep No.	Residues one month before Trial 2*	Residues after two months on Lindane-free Pasture
569	0.01	<0.005
586	NS	<0.005
564	0.04	<0.005
582	0.04	<0.005
558	0.05	<0.005
594	0.01	<0.005
544	0.02	<0.005
547	0.02	<0.005
	Means 0.03	<0.005

SHEEP GRAZED ON Paddock 1 RE-GROWTH		
	Residues one month before Trial 2*	Residues after one month on Lindane-free Pasture and one month on Paddock 1
542	0.07	0.95
577	0.06	0.71
581	0.03	0.40
588	0.04	1.43
539	0.06	0.74
589	0.03	0.43
592	0.02	1.72
595	0.01	0.63
	Means 0.04	0.89

* These values correspond to figures given in last column in Table 2.
NS — denotes no sample.

TABLE 4: LINDANE RESIDUES IN SOIL AND PASTURE FROM CANTERBURY TRIALS

Sample	Plot Identification	Residue in ppm Dry Matter Basis
Soil	Control	Negligible
	Area 1	1.1
	Area 2	1.9
Pasture	Control	<0.1
	Area 1	0.24
	Area 2	0.24

The observed relationships between the residue levels attained in fat for the various grazing periods (Table 2, columns 3 and 4) indicate that maximum residue levels in omental fat were reached later in those groups that had the longer withholding periods. This phenomenon, believed to be related to the logarithmic depletion pattern of pasture residues with time, underlines the danger of trying to predict "safe" withholding periods for stock from extrapolation of limited experimental data. For example, a plot on semi-logarithmic paper of withholding periods against the appropriate residue levels found in fat (using data from Table 2) gives a straight-line relationship which suggests that lindane residues in sheep fat should not exceed 0.1 ppm after a 6 weeks' withholding period. The fallacy of this conclusion is evident from the results obtained in Trial 2. Significant contamination occurred in the eight sheep grazed on pasture that grew again 16 weeks after topdressing, despite the fact that the grass cover had been grazed-off twice previously by sheep (Table 3).

These experiments have shown that residues on pasture resulting from the use of lindane prills can persist for many months at levels that can now be determined readily by gas chromatography (0.98 ppm after 4 months at Wallaceville, 0.24 ppm after 7 months in Canterbury) and that pasture residues of this order can give rise to easily detectable lindane residues in sheep fat. These results are equally applicable to DDT and provide a logical explanation for the low-level but persistent residues of DDT and its metabolites that are being found in most animal fats.

It is intended to continue sampling and grazing the areas in these trials that were topdressed in November, 1966, for a period of at least one year.

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