PASTURE RESPONSE TO ORGANOPHOSPHATE INSECTICIDE TREATMENTS FOR GRASS GRUB

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Summary

Nine field trials including diazinon, parathion, fensulfothion and Dowco 179 insecticide formulations for grass grub (*Costelytra zealandica*) larval control are reported. All four compounds gave larval population reduction and subsequent pasture responses. Desirable conditions for application of the compounds are discussed and reference is made to an improved machine for broadcast distribution of granules.

INTRODUCTION

LIMITATION on the use of organochlorine insecticides for grass grub (*Costelytra zealandica*) control owing to persistent residues and the appearance of resistant strains of the insect, continues to stimulate the search for low-residue substitutes. Presented are data from three years' field trials of organophosphate insecticides for larval control.

EXPERIMENTAL

Plot size in all trials was 1/200 acre (15 ft × 14 ft 6 in.) except in Trials 1 and 2 where it was 1/400 acre. All granular treatments were applied using a salt-cellar type hand-shaker or a New Zealand manufactured modified precision granule applicator described by Henderson (1962). Spray treatments were applied with an Oxford Precision sprayer applying 30 gal of water per acre at 30 lb/sq. in.

Larval counts were made on three random soil samples per plot of 1/6 sq. ft to 6 in. deep. Visual rating of pasture yield was on a 0 to 10 scale where 0 = bare ground, and 10 = a very high producing sward of desired species. Dry matter yield is given in lb/acre, extrapolated from one 15 ft × 15 in. or two 288 sq. in. samples per plot.

TRIAL 1 — Mayfield, South Canterbury — laid on a moderately moist Lismore series loam on 21/3/68.

Despite no apparent serious pasture damage at treatment, sampling revealed 42 to 219 second and third instar larvae per square foot.

TRIAL 2 — Rakaia, Mid-Canterbury — laid on a Mayfield silt of the Lismore series on 17/4/68 with the soil moisture at field capacity.

At treatment, variable pasture damage was evident and counts of 75 to 150 third instar larvae per square foot were recorded. The trial area was topdressed with a 3:1 superphosphate:sulphate of ammonia mix at 4 cwt per acre, plus 20 lb per acre of a ryegrass/white clover seed mixture.

TRIAL 3 — Mayfield, South Canterbury — laid on a moderately moist, stony silt loam of the Lismore series on 21/4/67.

At treatment the pasture was showing 50% brown-off of grasses and clover with 42 to 132 third instar larvae per square foot present. The trial area was topdressed with 2 cwt of 2:1 superphosphate:sulphate of ammonia mix per acre plus 20 lb perennial ryegrass and 2 lb white clover per acre.

TRIAL 4 — Takapau, Hawke's Bay — laid on a fine, moderately moist Matamau silt loam on 30/4/68.

At treatment, 50% of the perennial ryegrass/white clover sward had been destroyed and sampling revealed 30 to 50 third instar larvae per square foot in the top 2 to 4 in. of soil. The trial area was topdressed with 3 cwt superphosphate and 1 cwt sulphate of ammonia per acre, 10 lb perennial rye and 5 lb white clover seed per acre.

TRIAL 5 — Takapau, Hawke's Bay — laid on a moderately moist Matamau silt loam on 30/4/68.

The site carried the same variation in larval population as Trial 4 and was topdressed with the same rate of fertilizer/seed mixture.

TRIAL 6 — Waitara, North Taranaki — laid on a dry New Plymouth black loam on 9/4/68.

This rough sheep pasture consisted mostly of weeds and dead matter and carried an even third instar larval population of 45 per square foot. The trial was topdressed with 2 cwt superphosphate plus 20 lb of a ryegrass/clover mixture per acre on 9/5/68.

TRIAL 7 — Takapau, Hawke's Bay — laid on a dry, fine Matamau silt loam on 13/11/68.

At treatment 40% of the pasture was seedling chickweed (*Stellaria media*). The site carried 30 to 50 pupae per square foot.

TRIAL 8A — Takapau, Hawke's Bay — laid on a fine Matamau silt loam at field capacity on 6/2/69 during light rain.

The only damage apparent at this site was attributable to the grass grub infestation of the previous year. At treatment, 50 to 60 first instar larvae were present per square foot.

TRIAL 8B — laid at the same site as Trial 8A on a moderately moist soil on 6/3/69.

RESULTS

Table 1 summarizes grass grub larval counts, visual pasture response ratings, and total pasture yield data obtained from eight field trials in Canterbury, Hawke's Bay and Taranaki after insecticide application. Table 2 summarizes pasture analyses of selected trials in Canterbury and Taranaki.

DISCUSSION

Pasture response, as measured by visual ratings and dry matter yield, results not only from reduction of grass grub populations in the soil, but also weather conditions and management practices following treatment. The reduction of grass grub numbers from any insecticide treatment, more-

over, depends on management practice to some extent and, as Rastrick and Mason (1966) and Taylor (1968) note, weather conditions at and following treatment. In these trials maximum response has been obtained when diazinon, fensulfothion and parathion granules were applied to short pasture growing in moist soil, in which third instar larvae were close to the soil surface ($\frac{1}{2}$ to 3 in.) and when followed by $\frac{1}{2}$ in. or more of rain within 5 to 7 days of treatment. Where dry soil conditions occur at and following treatment, the effectiveness of parathion and diazinon appears reduced, parathion more so than diazinon.

At the rates used, pasture responses from fensulfothion treatments did not significantly differ from those of diazinon or parathion.

Where granular Dowco 179* was included in trials (Trials 7 and 8A), it out-performed diazinon and parathion in reducing larval numbers. It also apparently has greater reliability than the two latter materials when applied to dry soil in which only pupae were found at treatment (Trial 7).

Field experience has shown that, with many organophosphate insecticides, granular formulations are more effective for grass grub larval control than liquids or dusts. One example is given by results obtained in Trial 8A. Here, despite application in light rain to moist soil on which 1.18 in. of rain fell in the following 7 days, the emulsifiable concentrate formulation of Dowco 179 was much less effective in reducing grub counts than the 5% granule. This is presumably because larger amounts of toxicant are retained on the foliage with emulsion spray applications and should be most significant with insecticides possessing a short residual life. Pasture response following treatment with these organophosphates has been sufficiently rapid to obtain visual ratings at 5 to 8 weeks. This is somewhat faster than that of the more residual, slower acting organochlorines.

Pasture analyses of four trials (Table 2) show grass grub control not only resulted in significant dry matter yield increases, but also assisted to maintain pasture composition and to suppress weed ingress. Trial 6 suggests, however, that where a large weed population is present at treatment weed numbers are not significantly reduced in the season following, despite successful larval control. Other means would therefore be necessary to correct the pasture balance.

Larval samples from Trial 3 site showed DDT resistance in DSIR laboratory testing. Lack of apparent larval control following normal DDT applications over one or two years prior to laying Trials 1, 2, 4, 5, 7 and 8 indicate a level of DDT tolerance in these areas. However, the pasture responses following treatment with organophosphate insecticides on these sites show acceptable control was obtained.

Maclean (1968) emphasizes the difficulty of accurately applying granules through available broadcast applicators. Successful modification of a reciprocating-arm fertilizer and seed spreader now enables relatively even distribution of discrete granular particles over a 20 ft swath (Ivon Watkins-Dow Ltd., 1969).

CONCLUSIONS

Pasture yield data and larval counts (in one case pupal counts) show that significant control of grass grub larvae can be obtained from the treatment of pasture with organophosphate insecticides. Under favourable

*0,0-diethyl 0-(3,5,6-trichloro-2-pyridyl) phosphorothioate, Dursban (Dow Chemical Co.).

conditions as outlined in the discussion, parathion, diazinon, fensulfothion and Dowco 179 appear satisfactory. Under the less favourable treatment conditions of drought, and at the pupal stage of the grass grub life-cycle, Dowco 179 proved more reliable than diazinon and parathion. This is probably due to its longer residual life and greater adsorption on to the soil organic matter.

Future work will be concerned with development of better granular formulations of organophosphate insecticides for grass grub control and investigating the optimum application time.

These low-residue organophosphate insecticides have controlled both DDT susceptible and resistant grass grub larvae as indicated by satisfactory pasture response. Chemical control has now become a precision operation, however, demanding specialized application equipment and more precise timing of treatments than the New Zealand farmer has become accustomed to when using DDT.

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Count: Grubs/sq. ft. Vis.: Pasture response (0-10 scale). Yield: Dry matter (lb/acre). All chemical treatments shown in lb a.i./acre, 6 replications, 1/200 acre plots. Rainfall: inches within one week unless otherwise stated.

TRIAL 1: Mayfield, South Canterbury 1/400 acre. Treated 21/3/68.

Site History

1964 — standard DDT/superphosphate 2 lb/acre. Fertilizer box application — control satisfactory.

1966 — extra strength granulated DDT/superphosphate at 2 lb/acre. Spinner application — no apparent control.

Rainfall: Nil. 1st 9/4/68 (6.7 in. for Apr.)

Treatment (lb)	8 wk count	8 wk vis.	22 wk vis.	23 wk yield (fresh wt.)
diazinon 5G 1	13.2 aAB	6.2	7.8	1603 bcAB
diazinon 5G 2	3.7 aA	7.6	8.4	2718 abAB
parathion 10G 2	8.2 aA	6.4	8.3	1986 abcAB
parathion 10G 4	2.3 aA	7.4	8.1	2997 aA
Control	62.0 cD	2.5	3.2	1359 cB
fensulfothion 5G 1	5.3 aA	6.9	8.0	3136 aA
	CV = 71.2%			CV = 39%

TRIAL 2: Rakaia, Mid-Canterbury 1/400 acre. Treated 17/4/68.

Site History

1967 — diazinon WP at 2 lb/acre. Spray application — good pasture response.

1967 — DDT prills at 2 lb/acre. Aerial application — no control.

Rainfall: 1.5 in.

Treatment (lb)	10 wk count	10 wk vis.	18 wk vis.	21 wk yield (fresh wt.)
diazinon 5G 2	18.6	7.1	7.0	3136
diazinon 5G 4	10.2	7.4	7.4	4495
parathion 20G 4	21.6	7.3	7.1	3311
Control	37.2	5.1	5.4	2457

TABLE 1 — *contd.*

TRIAL 3: Mayfield, South Canterbury. Treated 21/4/67.							
Site History							
1964 — Standard DDT/superphosphate at 2 lb/acre. Fertilizer box application — control satisfactory.							
1966 — Extra strength granulated DDT/superphosphate at 2 lb/acre. Spinner application — no apparent control.							
Rainfall: 0.50 in.							
Treatment (lb)	7 wk count	7 wk vis.	11 wk count	11 wk vis.	16 wk vis.	25 wk vis.	25 wk yield
diazinon 5G 1	38.6 aA	7.6	51.6 abABC	6.2	7.6	8.6	2794 abA
diazinon 5G 2	76.3 abcAB	8.9	20.3 aA	7.6	8.9	9.7	3109 aA
parathion 10G 2	106.1 bcB	6.2	49.3 abABC	4.5	6.2	8.3	2753 abA
Control	186.5 dC	6.0	150.2 eE	1.8	1.3	2.5	851 eD
fensulfothion 5G 1	62.4 abAB	8.3	46.7 abABC	6.8	8.3	9.2	2836 abA
	CV = 31.9%		CV = 37.7%				CV = 21.1%
TRIAL 4: Takapau, Hawke's Bay. Treated 30/4/68.							
Site History							
1966 — DDT/superphosphate at 2 lb/acre. Spinner application — poor control.							
Rainfall: 1.85 in.							
Treatment (lb)	7 wk count	13 wk vis.	21 wk vis.	25 wk vis.	25 wk yield		
diazinon 5G 2	15.0	7.3	7.0	6.0	1682		
diazinon 5G 4	6.0	8.6	8.8	6.8	2238		
parathion 20G 4	10.3	8.5	8.8	8.4	2398		
Control	41.3	4.6	4.5	4.6	1408		

TRIAL 5: Takapau, Hawke's Bay. Treated 30/4/68.

Site History

1966 — DDT/superphosphate at 2 lb/acre. Spinner application — poor control.

Rainfall: 1.85 in.

Treatment (lb)	7 wk count	21 wk vis.	25 wk vis.	25 wk yield
diazinon 5G 1	21.3	7.0	6.5	1564
diazinon 5G 2	13.6	8.3	7.9	2223
parathion 20G 2	16.6	8.4	8.2	2078
Control	41.6	4.2	4.9	970

TRIAL 6: Waitara, North Taranaki. Treated 9/4/68

Site History

Not available.

Rainfall: 4.1 in.

Treatment (lb)	5 wk yield	9 wk count	13 wk vis.	18 wk count	21 wk vis.	21 wk yield
diazinon 5G 2	2390	4.7	8.1	1.7	8.9	3108 abAB
diazinon 5G 4	1934	3.2	8.1	1.7	9.1	2602 abcABC
parathion 20G 2	1834	1.7	7.9	1.0	8.8	2449 abcdABC
parathion 20G 4	2140	1.5	8.2	1.0	9.4	3380 aA
Control	1737	13.2	5.3	6.0	5.7	1685 dC
						CV = 32%

TABLE 1 -- *contd.*

TRIAL 7: Takapau, Hawke's Bay. Treated 13/11/68.

Site History

1966 — DDT/superphosphate at 2 lb/acre, spinner applied — poor control.

Rainfall: 0.46 in., 1.23 in. in 28 days.

<i>Treatment (lb)</i>	<i>6 mon count</i>
diazinon 5G 2	24.0
parathion 20G 3	17.0
DDT (super-phosphate) 2.4	35.0
Dowco 179 5G 1	14.8
Dowco 179 5G 2	8.2
Dowco 179 5G 4	4.6
Control	30.0

TRIAL 8A: Takapau, Hawke's Bay, 4 replications. Treated 6/2/69.

Site History

1966 — DDT/superphosphate at 2 lb/acre, spinner applied — poor control.

Rainfall: 1.18 in.

<i>Treatment (lb)</i>	<i>13 wk count</i>
parathion 20G 2	24.0
parathion 20G 3	15.6
Dowco 179 5G 1	15.3
Dowco 179 5G 3	11.4
Dowco 179 EC 1	22.8
Dowco 179 EC 2	29.1
Dowco 179 EC 4	20.4
Control	48.0

TRIAL 8B. Treated 6/3/69.

Rainfall: Nil. 1st 21/3/69 (0.12 in.). 2nd 30/3/69 (0.33 in.).

Treatment (lb)	8 wk count
parathion 20G 2	27.6
parathion 20G 3	28.2
Control	48.0

TABLE 2: RESULTS OF PASTURE ANALYSES OF GRASS GRUB TREATMENTS
(Yields in lb DM/acre)

Trial	Treatment (lb)	wk after Treatment	Visual Rating	Pasture Analysis			Total
				Grass	Clover	Weed	
1. Mayfield, South Canterbury 1/200 acre	diazinon 5G 1	23	7.8	873	158	176	1207
	diazinon 5G 2		8.4	927	182	172	1281
	parathion 10G 2		8.3	886	188	90	1164
	parathion 10G 4		8.1	914	175	91	1180
	Control		3.2	465	30	481	976
2. Rakaia, Mid Canterbury 1/400 acre						Misc. Dead Matter	
	diazinon 5G 2	18 (visual) 21 (yield)	7.0	Ryegrass	Clover	Weed	1532
	diazinon 5G 4		7.4	1131	169	21	211
	parathion 20G 4		7.1	1447	298	44	388
	Control		5.4	799	134	23	237
				682	146	170	162
	diazinon 5G 2	30	—	Grass	Clover	Weed	4567
	diazinon 5G 4		—	3985	354	228	4700
	parathion 20G 4		—	3926	489	285	4172
	Control		—	3230	550	393	3736
3. Mayfield, South Canterbury 1/200 acre						Misc.	
	diazinon 5G 1	25	8.6	Ryegrass	Clover	Misc.	2793 abA
	diazinon 5G 2		9.7	2115	75	603	3107 aA
	parathion 10G 2		8.3	2726	127	254	2752 abA
	fensulfothion 5G 1		9.2	2307	101	344	2836 abA
	Control		2.5	2430	173	232	849 eD
				130	90	630	CV = 21.1%
6. Waitara, North Taranaki 1/200 acre							
	diazinon 5G 2	21	8.9	Ryegrass	Grasses	Weeds	3106
	diazinon 5G 4		9.1	715	1532	197	662
	parathion 20G 2		8.8	461	936	417	787
	parathion 20G 4		9.4	691	1162	182	412
	Control		5.7	677	2213	201	288
				355	629	153	547