RESIDUAL EFFECTIVENESS OF CERTAIN GRASS-GRUB INSECTICIDES

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Summary

First and second season results from replicated field trials for the control of grass-grub (*Costelytra zealandica*) using both persistent and non-persistent insecticides are presented. A very high degree of control in the first season is shown to be necessary for second season effectiveness with transient compounds such as diazinon. A very high reduction in grass-grub populations occurred with heptachlor in the second season down to less than 1 lb/acre. Preliminary results with some newer insecticides are included.

INTRODUCTION

THE PROBLEM of organochloride residues in agricultural produce and the increasing incidence of DDT resistance in populations of grass-grub (*Costelytra zealandica*), New Zealand's major pasture insect pest, is forcing research workers to evaluate closely alternative insecticides such as the organophosphorus compounds. One of this group, diazinon, at 2 lb (all rates are expressed as active ingredient per acre) has given high initial kills of grass-grub when applied under specific site conditions (Rastrick and Mason, 1966). In only a few cases, however, has this high level of control lasted into the second season (Fenemore, 1964; T. M. Patterson, pers. comm.). In 1966, three replicated field trials were laid and grub control with diazinon at 2 lb varied from 0 to 94% in the same season. The next season, even in the case of the original plots with near complete control, reinfestation was at a pasture damaging level. Consistently, the most effective treatment in the second season was heptachlor at 0.5 and 1.0 lb.

EXPERIMENTAL

Plot size was 1/200th acre (15 ft×14 ft 6 in.). Treatments were randomized and replicated five to eight times depending on the variability of larval distribution. All treatments were made as granular formulations, applied with a New Zealand manufactured modification of the precision granular applicator described by Henderson (1962) and using the application technique of Fenemore and Fleming (1964). Larval counts were made on three random soil samples per plot of 1/6th sq. ft area 6 in. deep taken with a soil coring device. A visual estimate (0 to 10 scale: 0=no response; 10=complete response) of pasture growth was also made.

RESULTS AND DISCUSSIONS

Of the eight insecticides used in these trials (Table 1), five showed initial activity in reducing grub numbers in one or more trials. These were the organophosphorus compounds bromophos ethyl, diazinon, dyfonate and fensulfothion and the organochlorine heptachlor (Tables 2, 3, 4).

TABLE 1: INSECTICIDE TREATMENTS USED IN TRIALS

<i>Treatment (lb)</i>	<i>Treatment (lb)</i>
Bromophos ethyl 2	Endosulfan 2
Cyanamid 47470 2	Fensulfothion 1, 2
Diazinon 1, 2	Heptachlor 0.5, 1
Dyfonate 1, 2	Parathion 2, 4

Diazinon at 2 lb caused significant population reductions in two of the trials. Preliminary data from Trial 1 (Rastrick and Mason, 1966), showed an 89% population reduction of these DDT resistant larvae seven weeks after treatment with a marked response in pasture recovery. Sixteen weeks after treatment, the population was recorded as only three larvae per square foot, which was a 94% reduction compared with the untreated controls. Pasture growth was significantly greater than that produced by any other treatment. Larval counts the following season showed a grub population at least as heavy as that in the control plots (Table 2) while the pasture cover was comparable with the most effective treatment and significantly more dense than that in the untreated control. Assuming an equal sex ratio with each female adult beetle laying 20 to 24 eggs (Fenemore, 1965a), this would suggest a particularly high survival from egg to larvae in the improved diazinon treated plots compared with the less densely pastured untreated controls, assuming reinfestation from outside did not occur.

Significant reduction in larval numbers with diazinon 2 lb in the first season was also found in Trial 2 conducted on a pumice loam soil (Table 3). On this site, no visible differences in pasture growth could be detected between any treatments. Larval counts in the second season showed numbers in the diazinon plots equal to controls. Likewise, treatments of bromophos ethyl 2 lb and dyfonate at 1 and 2 lb which showed significant reductions of grub populations in Trial 1 the first season gave no control in the following season.

Fensulfothion used in Trials 2 and 3, at 2 and 1 lb, respectively, showed some activity into the second season. In Trial 2, a significant reduction in larval numbers was apparent after 3 months. In the following season it appeared that some residual control had been obtained but differences in larval numbers were not statistically significant. Kain and Christie (1966), however, obtained good control of larvae for two seasons on these problem pumice soils of the central North Island with 1 and 2 lb of fensulfothion. No significant reduction was found in Trial 3, three months after June application of fensulfothion at 1 lb, although counts the following season did indicate marginal control.

Initial and residual activity was shown by heptachlor at 0.5 and 1 lb. In all three trials it proved to be the only really effective treatment in the second season. However, in contrast to the organophosphorus treatments, only in Trial 1 did it show significant reduction of larvae at both rates in the season of treatment.

CONCLUSIONS

It is evident that an exceptionally high level of control of larvae must be obtained with transient insecticides such as the organophosphates to prevent build up in the following season of a "damaging" population of grass-grub. As each adult female beetle lays 20 to 24 eggs it is evident that very few larvae need survive to produce a high population the next

TABLE 2
TRIAL 1: CAREW, CANTERBURY: TREATED APRIL 2, 1966 (DDT RESISTANT STRAIN)

Treatment (lb)	Larval Counts (Grubs/sq. ft) Months after Treatment				Visual Pasture Response Months after Treatment							
	2	3	4	12	2	3	6	13				
Diazinon 2	...	...	...	...	12.6	5.4	3.4	26.4	9.5	8.8	8.4	8.0
Heptachlor 1	...	...	...	...	55.4	37.0	25.2	4.8	5.5	4.2	4.6	7.5
Bromophos ethyl 2	...	...	...	...	62.6	37.4	15.8	24.2	5.6	4.6	5.6	7.6
Dyfonate 2	...	...	...	...	70.0	36.2	23.0	23.0	4.7	3.6	3.8	6.4
Heptachlor 0.5	...	...	...	...	72.2	44.2	29.8	11.0	3.9	3.3	3.6	8.0
Dyfonate 1	...	...	...	...	82.0	47.0	38.6	24.0	4.2	3.2	3.3	6.4
Endosulfan 2	...	...	...	...	115.6	72.4	41.4	21.2	1.7	1.6	1.9	5.2
Control	...	...	...	...	110.6	68.2	51.4	18.4	2.4	1.9	2.1	6.4
*					23.1	14.3	12.0	12.1				
**					31.1	19.3	16.2	16.4				

Rainfall — Overcast at treatment: 0.25 in. (1 day); 0.5 in. (7 days).

TABLE 3
TRIAL 2: REPOROA, TAUPO: TREATED MAY 11, 1966

Treatment (lb)	Larval Counts (Grubs/sq. ft) Months after Treatment	
	4	11
Fensulfothion 2	5.6	16.6
Diazinon 2	6.3	28.6
Dyfonate 2	11.3	29.6
Diazinon 1	11.6	25.3
Heptachlor 1	12.0	10.3
Bromophos ethyl 2	13.0	45.3
Heptachlor 0.5	14.6	8.0
Untreated	22.3	29.0
*	11.1	20.8
**	14.8	28.0

Rainfall — Fine at treatment: Nil (1 day), 0.22 in. (7 days).

TABLE 4
TRIAL 3: OKATO, TARANAKI: TREATED JUNE 16, 1966

Treatment (lb)	Larval Counts (Grubs/sq. ft) Months after Treatment	
	3	9
Heptachlor 1	8.0	2.75
Heptachlor 0.5	9.5	6.5
Fensulfothion 1	5.75	20.25
Cyanamid 47470 2	5.5	23.75
Diazinon 2	7.0	23.75
Parathion 2	10.5	27.75
Diazinon 1	5.5	28.25
Parathion 4	7.0	28.5
Bromophos ethyl 2	9.75	29.5
Dyfonate 2	8.0	30.0
Untreated	5.75	33.75
*		10.2
**		13.6

Rainfall — Fine at treatment, Nil (1 day); 1.01 in. (7 days).

season even without reinfestation from outside the plots. The results show, that to maintain second season control with diazinon, there must be an extremely high reduction of larvae in the first season. Examples of low populations in the second season following successful diazinon treatment have been reported by Fenemore at Riwaka, Nelson, and Patterson at Mangakino, Central North Island.

Dyfonate and bromophos ethyl both were clearly inferior to diazinon in larval control and in pasture response ratings. Under the conditions of a laboratory screening test, dyfonate had a higher initial toxicity rating than diazinon with an equivalent soil persistence after a 14-day test period (Fenemore, 1965b).

The results obtained with heptachlor, included as a standard of comparison, followed the pattern already established for this compound (Rastrick and Mason, 1966). Relatively slow control was achieved in the

first season but excellent results occurred in all trials during the second season. However, New Zealand studies on heptachlor residues may restrict its usage to non-agricultural situations alone.

It is now evident that grass-grub can be controlled either initially or residually with insecticides more effective than DDT. However, much further work is needed to establish under what conditions longer term control can be achieved with the residue-safe but transient insecticides such as the organophosphorus compounds.

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