FIELD TRIALS WITH PHENOL FOR GRASS GRUB CONTROL

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Summary

Field trials were carried out on 0.4 ha areas to assess the feasibility of controlling grass grub (*Costelytra zealandica*) by disrupting normal mating behaviour with the sex attractant of the female beetle. Both high and low grass grub infestations were used. The average phenol release rate used, 5 g/h/ha, partially confused male flight behaviour but was insufficient to prevent mating from taking place.

INTRODUCTION

THE IDENTIFICATION of phenol as the sex attractant of the female grass grub beetle (*Costelytra zealandica*) (Henzell and Lowe, 1970) has made it possible to commence investigations into its use in control programmes. Phenol is cheap and readily available and the fact that the larvae are difficult to control by conventional insecticidal methods has stimulated efforts to develop alternative control procedures.

There are two possible ways of using phenol for direct behavioural control. First, male beetles can be attracted to areas and eliminated before mating takes place. Secondly, males can be disoriented in their search for females by permeating the atmosphere with sufficient phenol to prevent normal communication. In the Lepidoptera both these ways have been tested successfully (Shorey *et al.*, 1967; Roelofs *et al.*, 1971) but on lower infestations than those normally found with grass grub.

In this paper, results of field trials testing the male disorientation control method are discussed.

EXPERIMENTAL METHODS

TRIAL SITES

The trials were carried out at the Takapau Research Area in Hawke's Bay. Two sites about 5 km apart were selected, one with a high grass grub population and the other with a low population. Two plots (64 m × 64 m), spaced greater than 100 m apart were located within each site. Each plot was matched as far as possible for similarity in grub numbers, damage and history. On the low population plots, six sub-plots (4.6 m × 4.6 m) were placed on known pockets of infestation. These were set out at random on the high population plots.

SOIL SAMPLING

In order to assess likely beetle numbers, four hundred 10.2 cm diameter soil cores were taken at random from each plot at the pupal stage. During the flight season nine soil samples were taken daily, at random,

from each sub-plot. At the finish of the flight season, 12 soil samples were taken from each sub-plot to assess treatment effects by determining the resultant eggs and first instar larvae.

FLIGHT BEHAVIOUR

To record flight behaviour a mechanical rotary trap sampling at three heights (0.2, 1.7, 2.7 m) was placed on each plot. On the low population plots these were placed on known infested areas.

Treatment effects during flight were assessed with ten traps placed on each plot, each baited with five virgin female beetles. The females were held in soil at ground level and allowed to emerge naturally each evening. Control traps were placed alongside each baited trap.

Directional flight within each plot was measured with eight glass baffle traps, four at ground level, and four at 1 m above the ground. These traps were placed at random around the plot about 9 m from the fence line.

PHENOL DISPENSER

Phenol was released over the pasture at a reasonably controlled rate by sealing it into 3.2 mm PVC tubes and allowing it to permeate slowly through the polymer backbone. A total of 3 km of tube containing approximately 25 kg of liquefied phenol (90/10, phenol/water) was placed on each of the treated plots. Parallel lengths of tube (64 m) were spaced 1 m apart over each of the treated plots.

The phenol loss was monitored by measuring the weight loss from four 30.5 m lengths of tube placed on the pasture at the commencement of the trials. This loss was recorded over a 3- to 4-hour period around dusk.

RESULTS AND DISCUSSION

Prior to the commencement of the trial, the control and treated plots on the low population site contained 36.7 and 24.8 pupae per square metre, respectively. On the high population site, the control and treated plots contained 140 and 161 pupae per square metre, respectively.

On both sites, male flights were observed to commence on October 21 and the phenol tubes were laid out the following day. On the low population site, major flights took place between November 4 and 9 and the flight season was finished by November 15. Major flights on the high population site took place between November 7 and 15 and the beetle flights extended to November 25, 1971.

At Takapau, grass grub flight is usually dominated by males throughout the entire season. The percentage of the total males caught in the rotary traps at three heights is shown in Table 1.

TABLE 1: PERCENTAGE OF TOTAL MALES CAUGHT IN ROTARY TRAPS AT DIFFERENT HEIGHTS ON LOW AND HIGH POPULATIONS

<i>Treatment (Height)</i>	<i>Low Population</i>		<i>High Population</i>	
	<i>Control</i>	<i>Treated</i>	<i>Control</i>	<i>Treated</i>
Low			81.3	77.1
Medium			11.9	13.6
High			6.8	9.3
Total			1185	875
			$\chi^2_{(2)} = 6.2^*$	$\chi^2_{(2)} = 6.3^*$

* $P < 0.05$.

A significantly lower proportion of male beetles were caught in the lower rotary traps on the treated plots on both the high and low population sites. This was more marked in the baffle trap catches on the low population site (Table 2). On the high population site, differences were not significant, a result which remains unexplained.

TABLE 2: TOTAL MALE BEETLES CAUGHT IN BAFFLE TRAPS OVER THE FLIGHT SEASON

Treatment (Height)	Low Population		High Population	
	Control	Treated	Control	Treated
0	496	153	1042	949
1m	486	317	937	737
	$\chi^2_{(1)} 40.7$ ($P < 0.001$)		$\chi^2_{(1)} 4.7$ ns	

To assess whether the treatment was disrupting normal communication between males and females, the attractiveness of females on the control and treated plots was compared. The results (Table 3) show that females on the control plots attracted a higher proportion of the total catch than those on the treated plots. Males on the treated plots, however, were not completely disoriented, for the traps containing females attracted significantly more males than the control traps alongside (low population $\chi^2 = 22$, $P < 0.001$; high population $\chi^2 = 93$, $P < 0.001$). Thus at the phenol release rate used, males were still capable of locating females.

The fact that males could be completely disoriented was confirmed by using a higher concentration of phenol in the air on an area adjacent to the high population treated plot. Phenol was released over a 0.1 ha area by covering the bottoms of eight open trays (39 cm $\times$ 53 cm $\times$ 10 cm) with liquefied phenol. The trays were spaced approximately 9 m apart and phenol was readily detectable over the area. Seven female traps, with controls alongside, were placed equidistantly between the phenol trays.

The test was carried out on a calm evening when a major flight took place. Female traps on the control area caught 197 males while, on the phenol area, they attracted only 14 males. Control traps on the control and phenol areas caught 30 and 18 males, respectively.

TABLE 3: MALE BEETLES ATTRACTED TO VIRGIN FEMALE TRAPS OVER THE FLIGHT SEASON

Treatment (Trap)	Low Population		High Population	
	Control	Treated	Control	Treated
Female traps	1026	317	1018	848
Control traps	361	209	415	493
Percentage caught in female traps	76.5 (52-94)† 60 (38-81)† $\chi^2_{(1)} = 33^{***}$		71 (50-100)† 63 (47-75)† $\chi^2_{(1)} = 19^{***}$	

†Day-to-day range in percentages.

*** $P < 0.001$.

Massive attraction of male beetles on to the treated plots was not observed to take place and this was verified by the soil sampling results in Table 4.

TABLE 4: MALE/FEMALE RATIO OBTAINED FROM SOIL SAMPLES FOR PERIODS THROUGHOUT THE FLIGHT SEASON

Treatment (Dates)	Low Population		High Population	
	Control	Treated	Control	Treated
Oct. 22-28	43/52	68/60	45/31	50/38
Oct. 29-Nov 4	97/129	116/163	224/181	169/149
Nov. 5-11	64/84	106/109	227/182	141/128
Nov. 12-18	3/30	7/20	102/108	38/56
Nov. 19-Dec. 1	Sampling terminated		23/32	1/6

In order to measure the effectiveness of the treatment at preventing mating, a comparison was made between the rates at which females were mated in the sub-plots on the control and treated plots. The results shown in Fig. 1 indicate that there was no difference on the control and treated plots for both the high and low populations. Thus, all the females on the treated plots were mated at the same time as those on the respective control plots. This was confirmed by the soil sampling results shown in Table 5 where a similar number of eggs/first instar larvae were found on the treated and respective control plots for the low and high populations.

FIG. 1: Percentage females mated on control and treated sites at two-day intervals.

TABLE 5: AVERAGE NUMBER OF TENERAL BEETLES AND RESULTANT EGGS/FIRST INSTAR LARVAE AND SUB-PLOTS

	<i>Low Population</i>		<i>High Population</i>	
	<i>Control</i>	<i>Treated</i>	<i>Control</i>	<i>Treated</i>
No. Beetles/m ²	105	139	171	175
No. eggs and first instar/m ²	514	484	603	475

One of the problems associated with the use of sex attractants in the field is the wasteful liberation of attractant during the day when it is biologically ineffective. In the case of the grass grub beetle, phenol needs to be present for only about half an hour at dusk when mating takes place.

In these trials the average phenol loss over the flight season of 4 weeks was 200 g/day/ha. During the hour at dusk, the average amount of phenol released was 5 g/h/ha. With the exception of three evenings, when the rate dropped to 1 g/h/ha, the phenol liberated at dusk varied between 3.5 and 10 g/h/ha.

CONCLUSIONS

On both the low and high grass grub populations, mating activity was not reduced by releasing phenol over the pasture at a rate of 5 g/h/ha. Flight behaviour appeared to be modified in that a greater proportion of males was flying higher over the treated plots than the controls. This phenomenon was not evident from the baffle trap catches on the high population site, however.

Insufficient phenol was released over the pasture in these trials to completely disorientate male flight behaviour and therefore males were still capable of locating females. This was tested by using a higher concentration of phenol in the air. The results clearly indicated that male flight was completely confused and provide a basis for further work on this aspect of grass grub control. In this respect, however, prevention of normal chemical communication may not be sufficient owing to the expected high probability of chance mating in the field.

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REFERENCES

- Henzell, R. F.; Lowe, M. D., 1970: Sex attractant of the grass grub beetle. *Science*, 168: 1005.
- Shorey, H. H.; Gaston, L. K.; Saario, C. A., 1967: Sex pheromones of noctuid moths. XIV. Feasibility of behavioural control by disrupting pheromone communication in cabbage loopers. *J. econ. Ent.*, 60: 1541.
- Roelofs, N. L.; Glass, E. H.; Tette, J.; Comeau, A., 1970: Sex pheromone trapping for red-banded leaf roller control: theoretical and actual. *J. econ. Ent.*, 63: 1162.