AERIAL APPLICATION OF AN ORGANOPHOSPHATE INSECTICIDE FOR THE CONTROL OF GRASS GRUB

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Summary

Fensulfothion granules aerially applied at 2.2 kg/ha to hill country in the Rotorua area did not give satisfactory control of grass grub (*Costelytra zealandica*) 12 weeks after treatment. Compared with the flat areas, control was generally poorer on the steep and rolling contours where, in most instances, effective insecticide application rates were lower. This situation may have been further aggravated by run-off caused by heavy rain during the three days after application. A significant relationship was shown to exist between the mean and median effective application rates and percentage control.

INTRODUCTION

With the banning of DDT and the total reliance on organophosphates for the control of grass grub (*Costelytra zealandica*), it has become important to assess the efficiency of this group of insecticides applied from the air to hill country.

In view of the large expanse of hill country that is dependent on the aerial application of insecticides for the control of pasture pests, it is surprising that there is no published information on the biological efficiency of organophosphate insecticides when applied from the air.

It has been assumed that, to gain efficient control with organophosphates, application must be accurate and uniform if a population is to be reduced to a level from which it would be unable to cause appreciable damage in the following season. Rastrick and Upritchard (1967) have placed this level of control at 95% but the writers consider that this is a function of the numbers in the residual population, not the percentage killed.

In order to determine the efficiency of aerial applications of organophosphate and possible associated hazards to wildlife, a large-scale trial was initiated by the Agricultural Chemicals Board in the Waikite Valley near Rotorua. The topography of the trial is shown in Fig. 1.

The insecticide used was fensulfothion, formulated as a 5% granule and applied at 2.2 kg/ha. Previous work has shown that this insecticide applied to pasture gives efficient control of grass grub at 2.2 kg/ha over most soils and under a wide range of environmental conditions (Rough and Haeske, 1966; Rastrick and Upritchard, 1967; Kain and Atkinson, 1968). At lower rates control seems less consistent (Rough and Haeske, 1966). Field work suggests that the active residual life of fensulfothion for grass grub control may be in excess of three months (Kain and Atkinson, 1968).

The purpose of this communication is to report on the spread of an aerially applied insecticide to hill country and the degree of control obtained as measured by grass grub numbers and pasture responses.

FIG. 1: *Topography of trial site.*

EXPERIMENTAL

Application of fensulfothion was made with a "Swathe master" calibrated for 1.1 kg/ha, a device described by Taylor in 1963 as being the most effective aerial distributor being used at that time in New Zealand. The plane covered the area first in one direction and then at right angles to it, giving double coverage aimed at applying 2.2 kg/ha. The height of the aircraft varied depending on the contour and the surroundings.

Treatment was made on January 28, at which time most of the grubs were in the second instar stage, wind was minimal, pasture on the areas ranged in height from 5 to 10 cm, soil conditions were moist, and 5 cm of rain fell during the three days after application. Over the six-week period

immediately following application, approximately 23 cm of rain fell in the trial area.

Intensive observations were confined to two properties. Three topographic types on each property were chosen, the steep contour ranging from 28 to 37°, the rolling 15 to 17°, and the flat 0 to 2°. Plots 1.8 by 5.6 m were set out transversely across the slope. Each of these was divided into two 1.8 × 1.8 m sub-plots. Prior to insecticide application, one random sub-plot in each plot was covered with a polythene sheet. This sheet was removed immediately after application, giving a treated and an untreated sub-plot.

In order to monitor the application rate and spread of granules, tins each 25 cm × 25 cm × 7.5 cm deep, with a 1.3 cm layer of grease smeared on the bottom, were set out on the downhill side of each plot. Tins were set level to measure insecticide rates on flat relief in order to minimize variation caused by the microtopography. Counts were corrected for the overall slope of the contour which was measured using an Abney level. Granules embedded in the greases over a central area 10 cm × 10 cm were counted and recorded for each 10 cm².

As little information is available on the requirements of granules distribution for grass grub control, and in view of the fact that applications of insecticide to small plot screening trials in which fensulfothion has performed consistently well are usually made by hand, the distribution of hand applied granules was used as a standard. Insecticide was mixed with an inert filler (sand) and sprinkled at 2.2 kg a.i./ha over four flat plots, first in one direction, and then at right angles to it. The distribution was measured in the manner outlined above.

Grass grub numbers were assessed 6 and 12 weeks after treatment by taking four 15 cm on square spade spits from each sub-plot. A stratified random sampling of the trial area on which the plots were sited was carried out three days following application to give population assessments. All undecomposed larvae (less than 1%) were recorded as live. These areas were again sampled 14 weeks after treatment together with three paddocks from different properties which were treated at the same time. A minimum of 32 spade spits was taken from each contour in this general sampling and 42 from each farm paddock.

A visual assessment of pasture based on composition, vigour and damage was made 12 weeks after application. Plots were ranked from 0 to 5 with 0 being a completely undamaged plot and 5 a completely damaged plot.

RESULTS

DISTRIBUTION AND APPLICATION RATES

The number of granules per 10 cm² caught on each contour within each property is given in Table 1. Approximately 10 granules per 10 cm² is equal to 2.2 kg/ha.

The means and medians of the respective frequency distributions were compared using the χ^2 test. The results indicated that, apart from a higher application rate on the flat contour compared with the steep contour in property B ($P < 0.05$), and a difference between the steep contours on each property, application rates measured on flat relief were similar. However, application rates corrected for slope suggest that the overall rate decreases as slope increases ($P < 0.01$). Differences between properties were apparent on the rolling contours ($P < 0.05$).

TABLE 1: MEAN AND MEDIAN NUMBER OF GRANULES ON DIFFERENT CONTOURS WITHIN EACH PROPERTY

				No. per 10 cm ²		
				Uncorrected for Slope Mean	Corrected for Slope Mean Median	CV %
Property A Contour:						
Steep	....	....	11.3	8.4	7.2	54.7
Rolling	....	....	8.0	7.7	7.7	44.6
Flat	....	....	12.0	12.0	11.5	63.7
Property B Contour:						
Steep	....	....	7.3	6.0	5.4	53.8
Rolling	....	....	11.1	10.8	10.8	43.8
Flat	....	....	11.5	11.5	9.2	61.1
Hand applied	....	—	—	10	10.8	34.5

The spread of granules on all contours as shown by the CVs were less uniform than the hand-applied standards, with the flat contours showing the highest variability; uniformity of distribution is probably more critical at the lower effective application rates which the rolling and steep contours in general received.

TABLE 2: MEAN NUMBER OF GRASS GRUBS/m² TREATED (Tr.) AND UNTREATED (Untr.) AND PERCENTAGE CONTROL ASSESSED FROM PLOT SAMPLING

Contour and Property			6 Weeks			14 Weeks		
			Tr.	Untr.	% Control	Tr.	Untr.	% Control
Steep:								
A	....	....	176.5	312.0	43	82.9	204.4	59
B	....	....	66.7	86.0	22	50.6	66.7	24
Rolling:								
A	....	....	285.1	355.0	20	80.7	199.1	59
B	....	....	64.5	247.5	74	37.7	134.5	72
Flat:								
A	....	....	39.8	113.0	65	45.2	177.5	74
B	....	....	123.7	403.5	69	80.7	274.4	71

GRASS GRUB CONTROL

Plot Assessment

The result of plot sampling six and 14 weeks after treatment are given in Table 2.

General Sampling of the Trial Paddocks

The results of sampling of the trial area on which the plots were sited are summarized in Table 3.

Farm Survey

Assessments of grass grub populations 14 weeks after treatment were made in three paddocks on three other properties treated at the same time as the trial area (Table 4). The contour of each sample site was noted.

TABLE 3: MEAN NUMBER OF GRASS GRUBS ON THE TRIAL AREA FOLLOWING APPLICATION

Contour and Property					3 days	No. Grubs/m ² 12 wk	% reduction
Steep:							
A	....	....	....	....	145.3	82.9	42
B	....	....	....	....	72.1	49.5	32
Rolling:							
A	....	....	....	....	112.0	133.4	—20
Flat:							
A	....	....	....	....	167.9	33.4	86
B	....	....	....	....	362.6	49.5	82

Because of insufficient time, general sampling of the rolling contour on property B was omitted.

TABLE 4: MEAN NUMBER OF GRASS GRUBS ON THE DIFFERENT CONTOURS OF THREE PADDOCKS CHOSEN AT RANDOM FROM THOSE TREATED WITHIN THE DISTRICT

							Mean No. grubs/m ²	No. of Samples
Property C:								
Steep	....	....	....	....	....	....	104.4	30
Flat	....	....	....	....	....	....	63.5	12
Overall	....	....	....	....	....	....	93.6	42
Property D:								
Steep	....	....	....	....	....	....	165.7	20
Rolling	....	....	....	....	....	....	163.6	31
Flat	....	....	....	....	....	....	14.0	15
Overall	....	....	....	....	....	....	124.8	66
Property E:								
Steep	....	....	....	....	....	....	219.5	20
Rolling	....	....	....	....	....	....	285.1	22
Flat	....	....	....	....	....	....	72.1	7
Overall	....	....	....	....	....	....	178.6	49

Grass grub control appears less consistent on the rolling and steep contours than on the flat contour. This trend was substantiated by the general sampling on the study areas (Table 3). If it is assumed that the flat area in the farm survey paddocks contained at the time of treatment a similar population of grass grubs to the equivalent steep or rolling areas, then the results of that sampling (Table 4) also lend backing to this observation.

The percentage control for each contour in each property was significantly correlated with the respective mean ($r = 0.898$) and median ($r = 0.888$) corrected application rates (measured as granules per 10 cm²). In general, effective application rates decrease with slope. On the rolling and steep contours, the effectiveness of applied insecticide may have been further reduced by run-off resulting from heavy rainfall three days following application.

It is possible that insecticidal contamination of the untreated sub-plots on the rolling and steep contours may have occurred through run-off. In spite of this, it is felt that assessments of control are not biased against

the insecticide as relatively low percentage reductions were recorded from the general samplings of these contours within the trial area. A similar comparison of the flat contour suggests that the assessments of control in the sample plots are lower than the percentage reductions recorded outside these plots. This is an expected trend as the latter figures include both natural and insecticidal mortalities.

PASTURE RESPONSES

No consistent visible pasture responses were apparent from the plots 12 weeks after application even on the flat contour where control was highest. This was probably due to the high rainfall which has characterized the summer and autumn months in this locality and which may have masked the root-pruning activity of grass grub.

DISCUSSION

Grass grub control was unsatisfactory, particularly on the steep and rolling contours, following an aerial application of fensulfothion. This appears to be a result of the low effective application rates these areas received, a situation that may be corrected by increasing the rates to offset the diluent effect of slope, provided high rainfall does not wash the insecticide from the site.

On this class of country, 65 grubs/m² can be regarded as an economically important population. If populations are not reduced to below this level, then grass grub on these areas will be an important problem in the coming season. Work has shown that populations of this order are capable of increasing to high levels in the following generation. (Kain and Atkinson, 1968).

All surface-applied organophosphate granules require rainfall to wash the insecticide from the inert carrier into the soil. For the more transient insecticides, the interval between application and rainfall is extremely critical. To ensure reliable control on hill country, the rainfall requirements would be even more specific, in that sufficient moisture is needed to wash the insecticide into the soil but too much may wash the insecticide from the slopes or redistribute it in such a way that poor control results. Indeed, for certain areas, especially on the steeper slopes, these requirements may be too specific to allow reliable control of grass grub.

Further and more long-term work to investigate the relationship between granule distribution and the residual life of the insecticide on its biological efficiency would provide useful background information for assessing which organophosphate insecticides and formulations are likely to be efficient when applied to hill country by plane.

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