THE EFFECTS OF DIFFERENT TIMES OF INSECTICIDE APPLICATION ON DISEASE INCIDENCE IN GRASS GRUB POPULATIONS

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SUMMARY

Insecticide was applied to early first instars in December, to second instars in February and third instars in April to investigate its effect on populations and disease incidence of grass grub (*Costelytra zealandica*) at the Taranaki Agricultural Research Station. The three application times gave 77, 86 and 20% control of grass grub populations respectively. Disease incidence was significantly reduced immediately after each treatment. In the year after application, infection levels remained significantly lower in the first-instar treatment than in other treatments. The effects on disease incidence of different times of insecticide application depended on the pathogen species present.

INTRODUCTION

Naturally occurring pathogens of grass grub are capable of exerting some control on populations (Miln 1982a). The use of insecticide, however, can suppress these pathogens (Miln 1982b) because the recommended time for insecticide application, in February and March, may coincide with development of diseases in the population. Premature death of infected larvae and the prevention of new infections results in less inoculum in the soil to infect the next generation and, thus, a lower incidence of disease.

Two other times of insecticide application were investigated both for their effects on grass grub populations and on disease incidence. The first was an early application time (December) to first instars when few infections were apparent and the second, a late insecticide treatment (April) to third instars in early winter after infection levels in the population had reached their maximum. This paper reports the results of these investigations at the Taranaki Agricultural Research Station.

METHOD

The insecticide used was fensulfothion (Dasanit 5G) broadcast at 2.2 kg ai/ha using a Sisis lospread fertiliser spreader. The three times of treatment were: 17.12.80 to early first instars, 13.2.81 to second instars and 30.4.81 to third instars. Plot size was 6 x 6 m and there were eight replicates of each treatment in a randomised block design.

To assess disease incidence just prior to the first treatment, random spade squares were taken over the trial area, the grass grub collected and later examined for pathogens. Subsequent samplings were made on 5.2.81, 10.4.81, 2.7.81 and 11.3.82 by taking 6, 0.5 m mini-plough strips in each plot. Grass grubs were counted and later examined microscopically for presence of pathogens.

RESULTS

The effect of insecticide on grass grub numbers

The densities and percent control of grass grub at each sampling date are summarised in Table 1. Percent control is based on differences between control and treated plots at the time of sampling. The first two treatment times, in December, to first instars and February, to second instars, both gave significant reductions ($P < 0.01$) in grass grub numbers but the late treatment, to third instars, gave only 20% control.

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Numbers of grass grub in the untreated plots declined considerably over the course of the trial and, as a consequence, by July the percent control from the earliest treatment had declined by 16% but still remained significant ($P < 0.05$).

In the sample taken in March the following year, numbers of grass grub in the plots in which first instars had been treated was nearly twice that in untreated plots but this difference was not statistically significant. The other treatments differed little from the controls.

TABLE 1: No./m² of grass grub at each sampling date and percent control from each insecticide treatment.

Sampling date		untreated	Treatment date		
			17.12.80	13.2.81	30.4.81
5.2.81	No./m ²	104.8	24.4**	75.6	157.6
	% control		76.7		
10.4.81	No./m ²	50.4	16.4**	6.8**	41.2
	% control		67.5	86.5	
2.7.81	No./m ²	26.0	10.4*	3.2**	20.4
	% control		60.0	87.7	21.5
11.3.82	No./m ²	20.8	39.6	13.2	18.8

* Significantly different from untreated at 5% level

** Significantly different from untreated at 1% level

The effects of insecticide on disease incidence

Disease incidence in the December insecticide treatment was 15-20% lower ($P < 0.01$) than in the other treatments when measured in February (Fig. 1). The February treatment also caused a significant reduction in disease incidence ($P < 0.05$) but in the May application, although infection levels declined, this was not statistically significant.

In March the following year disease incidence in the early application treatment remained significantly lower than in the other treatments. In these other treatments percent infection level had climbed to levels similar to that which they had reached in February the previous year (Fig. 1).

The pathogen species present were a milky disease bacterium and three protozoan species; *Mattesia* sp, *Nosema costelytrae* and *Pleistophora* sp. Mixed infections of two or more pathogens in the one larva were common. *Mattesia* sp, the most prevalent disease, was the most affected by insecticide treatment. In the early first-instar treatment, incidence of this pathogen had reached 26% in February compared to 40-50% in the other treatments. Occurrence of mixed infections was also about 20% less in the early treatment. The second treatment reduced *Mattesia* levels from 50% to 17% by April, 2 months after insecticide application.

Of more interest, however, is the effect of the treatments on the pathogens in the year after treatment, summarised in Table 2.

In the plots in which first instars had been treated, occurrence of *Mattesia* sp and mixed infections were again considerably lower than in the untreated plots and other treatments. In the second treatment, levels of *Mattesia* sp were similar to that in untreated plots, but numbers of *N. costelytrae* and mixed infections were lower. The *Pleistophora* sp appeared to be less in all treated plots but numbers of this disease were too low to be important. Occurrence of milky disease was similar in all plots.

Fig. 1: Percent disease in each treatment at each sampling date.

TABLE 2: Percent occurrence of each pathogen and of mixed infections in grass grub in March 1982, the year following insecticide treatment.

Pathogen	untreated	Treatment time		
		17.12.80	13.2.81	30.4.81
<i>Mattesia</i>	46.1	23.2	51.5	59.6
<i>Nosema costelytrae</i>	19.2	15.2	6.1	27.7
<i>Pleistophora</i>	13.5	2.0	6.1	2.1
Milky disease	25.0	17.2	24.2	19.1
Mixed infections	25.0	4.0	12.1	23.4

DISCUSSION

As a general rule, any insecticide applied early in the life cycle of grass grub before disease incidence is fully expressed is likely to cause the greatest reduction in subsequent infection levels. The exact effect of insecticide, however, will depend on the species of pathogen present. *Mattesia* develops early in the life cycle of grass grub and was thus most affected by the early treatment of insecticide. Later developing diseases such as *N. costelytrae* are reduced by later treatments. The milky disease bacterium is a much more persistent pathogen than the protozoa and therefore less directly affected by insecticide use.

The second treatment time might appear to be the most satisfactory, giving good control of grass grub without reducing disease incidence. However, the change in composition of pathogens and in particular the reduction in the number of mixed infections, indicates that there was less inoculum in the soil than in the untreated plots. This may have resulted in a lower incidence of disease if pathogen levels, overall, had not been so high. Other work has shown that insecticide applied at this time, and especially successive applications, can reduce disease incidence (Miln unpublished data). The late application of insecticide had the least effect on diseases but, in this trial anyway, there was nothing to be gained from treating then either in terms of immediate control, or a reduction in populations the next year.

Although the protozoan pathogens of grass grub are unable to control populations by themselves (Miln 1982a) they could be used as part of an integrated control system which deliberately aims to conserve and make maximum use of them. By so doing, better long term control of populations may be achieved. There is a suggestion, although not statistically significant, that the reduction in disease levels in the early treatment of this study may have resulted in a higher population of grass grub in the next generation relative to the untreated (Table 1). Similarly, in Canterbury an increase in grass grub populations after insecticide use has been attributed to a reduction in the levels of a pathogenic bacterium (Trought *et al* 1982). A resurgence of grass grub populations after treatment with lindane which may also be associated with a reduction in pathogens has been recorded by East and Willoughby (1983) in the central North Island.

In conclusion, insecticide, perhaps, should not always be aimed at giving the greatest immediate kill. A compromise between a February application which gives highest mortality and a late application which makes optimum use of pathogens may be the best solution. However, more research is needed to determine this and other factors such as rates and types of insecticide used and methods of application which may help overcome the incompatibility of disease and insecticide.

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