CHEMICAL CONTROL OF WHITE-FRINGED WEEVIL IN LUCERNE

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Summary

In laboratory tests lucerne (*Medicago sativa*) seedlings were protected from white-fringed weevil (*Graphognathus leucoloma*) larvae by granular formulations of carbofuran, terbufos, parathion, phorate, isazophos, disulfoton and fensulfothion sowed with the seed. The effects of each material were not significantly different ($P > 0.05$) at 2 kg/ha and 10 kg/ha. Foliar sprays of fenitrothion (0.75 and 1.0 kg/ha), methomyl (0.50 kg/ha), oxamyl (0.50 kg/ha) and carbofuran (0.25 kg/ha) gave good short-term control of white-fringed weevil adults in established lucerne. Field trials with caged adults suggest that it may be possible to control infestations with three or four applications at 10-20 day intervals during the main period of adult activity.

INTRODUCTION

White-fringed weevil larvae can cause severe damage to both seedling lucerne sowed into land ploughed out of infested pasture and established lucerne stands (Eyles 1961; Todd 1964). Insecticides such as carbofuran, diazinon, ethoprophos, fensulfothion, isazophos, parathion, phorate and terbufos have little effect on white-fringed weevil larvae at application rates of 2.0-4.4 kg/ha when either soil-incorporated in pot trials (Todd 1969) or applied to pasture as surface broadcast granular formulations (East unpublished). Harlan (1974) found that root dips in solutions of temephos (4000 ppm), chlorpyrifos (5000 ppm) and fensulfothion (5000 ppm) gave 95-100% kill of white-fringed weevil larvae infesting nursery plants, but these treatments are equivalent to very high application rates. An application of 2 kg/ha of fensulfothion to pasture is equivalent to about 2 ppm in the top 7.5 cm of soil (Solly *et al* 1971). Despite the lack of activity of surface applications of insecticides against white-fringed weevil larvae, it may be possible to protect seedlings from larval damage by placing insecticides in the soil beside the seed at the time of sowing. Harlan and Gross (1976) reported that application of a band of carbofuran granules (2.5 kg/ha) 2.5 cm below the seed at planting increased the yield of peanuts by 11-22%, which they suggested may have been due to control of white-fringed weevil larvae.

In contrast to the larvae, white-fringed weevil adults are susceptible to a wide range of insecticides applied as foliar sprays (Todd 1969; East *et al* 1975). This approach offers some promise for controlling white-fringed weevil in established lucerne by destroying the adults

Proc. 30th N.Z. Weed and Pest Control Conf.

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before oviposition occurs but there is a need to determine the optimum application rates and the minimum numbers of sprays required. White-fringed weevil adults occur for 4-5 months in summer and autumn but it should not be necessary to spray more frequently than at intervals of 10 days, which is the average period between the commencement of adult feeding and the start of egg laying (East *et al* 1975).

METHODS

Protection of seedlings against larvae

Polystyrene peach trays (30 x 40 x 12.5 cm) were filled to a depth of 10 cm with Horotiu sandy loam soil and given a basal nutrient dressing. In late November 1976 each tray received 26 white-fringed weevil larvae (equivalent to 216/m²) collected from pasture at the Otakanini research area near Helensville. The larvae were divided into five weight classes and each tray received a representative sample of the field population. 'Wairau' lucerne seed was then sowed into each tray in two rows 15 cm apart at a rate equivalent to 5.4 kg/ha. Each tray received one of the insecticide treatments listed in Table 1 which was sown with the seed. There were four replicates of each treatment. The trial was carried out in a screenhouse and soil moisture was maintained at a level adequate for plant growth. Seedling counts were made and the surviving larvae extracted by a flotation and wet sieving process (Kain and Atkinson 1976) and counted 4 weeks after sowing.

Control of adults with foliar sprays

A major problem with field trials against white-fringed weevil adults is that small plots give misleading results because of adult dispersal. This problem can be overcome by either using large plots (East *et al* 1975) or caging weevils on to small plots. The latter approach was adopted in this study. Insecticides were applied to small areas of lucerne 15-25 cm high in 280 litres/ha at 200 kPa with a small plot precision sprayer to compare application rates (Table 2). Wooden-framed fly-screen mesh cages 0.5 x 0.5 m with metal bottoms sunk into the soil to prevent the escape of white-fringed weevil adults were placed on the sprayed areas at intervals of 0, 7 and 14 days after spraying and 10 field-collected adults were released in each cage. Mortality was assessed 10-14 days after caging. There were four replicates of each treatment. The insecticides tested (Table 2) were the most effective out of a wide range screened by East *et al* (1975 and unpublished).

In a trial which compared the effects of different frequencies of spraying, cages of the type described above were placed on 0.5 x 0.5 m plots surrounded by fibrolite to a depth of 25 cm in a lucerne stand known to be free of white-fringed weevil. Twenty field-collected adults were seeded into each cage over a 9-week period commencing on 1 February 1977, following the natural emergence pattern observed in lucerne and white clover in the 1975-6 summer at the Otakanini research area, *viz.*, 2 adults in week 1, 3 adults in each of weeks 2-6, and 1 adult in each of weeks 7-9. This pattern ignores the small proportion of the natural population (less than 15%) which emerged in

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subsequent weeks. Foliar sprays of fenitrothion (0.75 kg/ha) were applied at five different frequencies, giving six treatments:

- Treatment 1 – spray every 10 days commencing on 1 February (6 sprays)
- Treatment 2 – as for 1 minus the first spray (5 sprays)
- Treatment 3 – as for 1 minus the first and last sprays (4 sprays)
- Treatment 4 – spray at 20-day intervals commencing on 1 February (3 sprays)
- Treatment 5 – as for 4 minus the first spray (2 sprays)
- Treatment 6 – unsprayed control.

The trial was a randomised complete block design with four replicates of each treatment. The lucerne was cut with hand shears as necessitated by plant growth. The numbers of live and dead white-fringed weevil adults were counted weekly and the numbers of subsequent larvae assessed by digging up each plot in late May and extracting the larvae by flotation and wet sieving. The number of adult-days per plot was calculated by assuming that each weekly count of live adults represented the average number present for the preceding week.

RESULTS AND DISCUSSION

Protection of seedlings against larvae

All of the insecticide treatments apart from the lower rates of temephos and oxamyl caused a marked reduction ($P < 0.01$) in larval numbers below those in control 1 (larvae plus no insecticide) (Table 1). Within chemicals differences in larval numbers between rates were not significant ($P > 0.05$) except for temephos and oxamyl. There was a strong negative correlation between the number of seedlings and the number of surviving larvae ($r = -0.925$, $P < 0.001$) and in control 1 very few seedlings survived. All treatments apart from oxamyl, the lower rate of temephos and the higher rate of parathion (which was markedly phytotoxic) contained much greater numbers of seedlings ($P < 0.01$) than control 1, and there were no significant rate differences except for temephos and parathion. Seedling numbers in both rates of carbofuran and terbufos and the lower rates of parathion, phorate and isazophos did not differ significantly ($P < 0.01$) from those in control 2 (no larvae and no insecticide).

The difference between these results and those of Todd (1969) can be accounted for by the concentration of insecticides into a narrow band containing actively growing seedlings, which forced the larvae to come into contact with or ingest insecticide while feeding. This can be regarded as producing an effect equivalent to that of a completely weed-free seed bed. These results require confirmation under field conditions but they suggest that it may be possible to protect lucerne seedlings from white-fringed weevil larvae with insecticide granules applied at economically feasible rates.

Control of adults with foliar sprays

The comparison of application rates (Table 2) suggests that the optimum rates are 0.75-1.0 kg/ha for fenitrothion and 0.50 kg/ha

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for methomyl and oxamyl, considerably higher than the rates projected from pot trials by East *et al* (1975). Carbofuran (0.25 kg/ha) gave significantly better control ($P < 0.01$) 7 days after spraying than the other three chemicals, apart from the highest rate of fenitrothion, but no treatments were very effective 2 weeks after spraying.

TABLE 1: Effects of insecticide granules sown with lucerne seed on white-fringed weevil larvae and seedlings

Insecticide	Rate (kg/ha)	Average No. of larvae surviving/tray	Average No. of seedlings/tray
isazophos	2	4.00 deDE	13.75 bcdABC
isazophos	10	4.00 deDE	12.50 cdeBC
phorate	2	6.00 cdeDE	14.75 abcABC
phorate	10	3.00 eE	12.50 cdeBC
terbufos	2	5.00 cdeDE	15.00 abcABC
terbufos	10	4.00 deDE	14.00 abcdABC
carbofuran	2	6.75 cdDE	14.00 abcdABC
carbofuran	10	4.50 deDE	18.50 abAB
disulfoton	2	7.25 cdCDE	11.25 cdeBCD
disulfoton	10	4.50 deDE	10.50 cdeCD
parathion	2	6.50 cdDE	14.25 abcdABC
parathion	10	5.50 cdeDE	4.75 fgDE
fensulfothion	2	7.25 cdCDE	11.75 cdeBCD
fensulfothion	10	6.25 cdeDE	10.00 cdefCD
temephos	2	17.25 aA	1.00 gE
temephos	10	8.25 bcCD	9.25 defCD
oxamyl	2	15.50 aAB	5.00 fgDE
oxamyl	10	11.50 bBC	7.75 efCDE
*control 1		17.25 aA	0.75 gE
**control 2		—	19.25 aA

* contained larvae but no insecticide

** contained neither larvae nor insecticide

All spraying frequencies tested reduced adult numbers below those in the control ($P < 0.01$), with treatments 1-4 (3-6 sprays) giving reductions of 82-93% compared to 75% for treatment 5 (2 sprays) (Table 3). The greatest number of sprays (treatments 1 and 2) reduced the subsequent numbers of larvae by more than 90%, significantly greater ($P < 0.05$) than the reductions of 66-76% achieved by treatments 3 and 4, which in turn were superior ($P < 0.01$) to the 41% reduction of treatment 5 (Table 3). These results were obtained under somewhat artificial conditions, since the cages affected both insecticide breakdown and lucerne growth by reducing light incidence, as well as restricting adult movement. To test the effect of cages on residual activity of insecticide cages were placed on lucerne immediately before spraying with fenitrothion (0.75 kg/ha). White-fringed weevil adults

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were seeded into the cages at intervals of 7 and 14 days after spraying and mortalities of 90% and 10% respectively, were recorded. This shows greater residual activity than the same rate of fenitrothion under more natural conditions (Table 2) and is similar to a rate of 1.0 kg/ha and to carbofuran (0.25 kg/ha). The reduction in larval numbers achieved by spraying every 10 days (treatment 1) is of the same order as the 82% reduction obtained in a field trial by spraying with fenitrothion (1.0 kg/ha) every 6-12 days throughout the period of adult activity (East *et al* 1975).

TABLE 2 : Percentage mortalities of white-fringed weevil adults caged on lucerne at different intervals after spraying

Insecticide	Rate (kg/ha)	Interval (days after spraying)		
		0	7	14
fenitrothion	1.00	100 aA	90 aAB	20 abcA
fenitrothion	0.75	95 abAB	37 cC	5 bcA
fenitrothion	0.50	70 bcBC	7 deD	0 cA
fenitrothion	0.25	17 efE	0 eD	2 bcA
methomyl	0.50	100 aA	22 cdCD	0 cA
methomyl	0.25	55 cdCD	15 deCD	0 cA
oxamyl	0.50	100 aA	67 bB	30 aA
oxamyl	0.25	37 deDE	5 deD	7 abcA
carbofuran	0.25	100 aA	100 aA	25 abA
unsprayed		10 fE	5 deD	0 cA

TABLE 3: Effects of different spraying regimes on white-fringed weevil adults and subsequent larval populations

Treatment (see text)	Average total No. of adult-days/plot	Average No. of larvae/plot
1	33.7 dD	22.9 dD
2	56.2 cdCD	24.2 dD
3	71.2 cdCD	67.9 cCD
4	91.5 bcBC	98.3 cC
5	126.5 bB	169.0 bB
6	500.0 aA	286.1 aA

The results in Table 3 suggest that four sprays applied every 10 days during the main period of adult emergence (treatment 3) and three sprays applied at 20 day intervals from the first appearance of adults (treatment 4) may give worthwhile reductions in larval numbers, although not as great as those obtained by more frequent spraying (treatments 1 and 2). Little is known about the effects of different densities of white-fringed weevil larvae on lucerne production, but it is known that lucerne is able to tolerate larval root damage if soil moisture is adequate for plant growth. For example, a lucerne stand sown in mid-1974 at the Otakanini research area produced 16 800

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kg DM/ha in the calendar year 1976 despite the presence of 100-150 white-fringed weevil larvae/m² and extensive signs of larval feeding damage to most of the tap roots. This tolerance is attributed to good rainfall in the 1975-76 and 1976-77 summers, since several lucerne stands in the same area suffered a severe loss in production and considerable plant death due to white-fringed weevil in the summer drought of 1973-74. Chemical control of adults is best used as a preventive approach to reduce larval numbers before the lucerne is severely damaged. Since lucerne appears to be tolerant of white-fringed weevil in non-drought years it may be possible to hold larval populations below damaging levels by spraying infested stands every year at relatively low frequencies, as in treatments 3 and 4 or even treatment 5. These treatments require further evaluation in large-plot field trials.

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