AN EVALUATION OF THE INSECT GROWTH REGULATORS DIFLUBENZURON AND TEFLUBENZURON FOR CONTROL OF LUCERNE FLEA (*SMINTHURUS VIRIDIS*)

N.R. WRENN and R.A. McGHIE

Ruakura Soil and Plant Research Station, Private Bag, Hamilton

SUMMARY

The effectiveness of two insect growth regulators diflubenzuron and teflubenzuron on lucerne flea (*Sminthurus viridis*; Collembola Sminthuridae) was studied in laboratory foliar bioassay and field experiments. Bioassay experiments indicated smaller nymphs to be more sensitive to the insect growth regulators than the larger older stages. Insecticidal action was delayed with peak levels of control in field trials being obtained 2 weeks to 2 months after chemical application. Lucerne flea damage to white clover (*Trifolium repens*) declined quickly following organophosphate application but more slowly following diflubenzuron application. Insect growth regulators may be most useful in the autumn when lucerne flea nymphs emerge and before significant damage occurs to white clover.

INTRODUCTION

Lucerne flea (*Sminthurus viridis* L.) is one of the few Collembola which is recognised as a pest species. In the North Island of New Zealand it has caused severe damage to white clover (*Trifolium repens*) in dairy pastures. The insect completes four to five generations per year and damaging infestations occur from April until December. Most of the population occurs as aestivating eggs over the hotter and drier summer months. Aestivation is broken in the autumn in response to declining temperatures and increasing soil moisture (Pottinger *et al* 1985).

Insecticidal control of this pest is obtained by the application of organophosphate insecticides to pastures in either spray or granule formulations (Wrenn *et al* 1983, Wrenn *et al* 1984). The more persistent insecticides when used during winter or spring gave 4-9 weeks control of lucerne flea. Repeat applications are therefore necessary. The effectiveness of an insecticide application timed to coincide with the breaking of aestivation was reported by Pottinger *et al* (1985). Following a single spray application in April, control till late winter or spring was obtained.

Pottinger *et al* (1985) presented two simple pest management programmes for lucerne flea control in dairy pastures. Farmers now have practical and cost effective strategies for lucerne flea control.

Wrenn *et al* (1985) demonstrated that a di-substituted benzoylphenyl urea, diflubenzuron, is effective in controlling a major pasture pest, porina caterpillar (*Wiseana* spp.; Lepidoptera: Hepialidae). As a result of those trials and subsequent testing there are good prospects for commercial introduction of diflubenzuron to New Zealand. It is therefore of some value to determine the activity of diflubenzuron against other pests occurring in New Zealand. Effects on white fringed weevil (*Graphognathus leucoloma*) and armyworm (*Mythimna separata*) have been reported by Henzell *et al* (1976, 1979).

This paper reports on the initial evaluation of two di-substituted benzoylphenyl urea compounds, diflubenzuron and teflubenzuron, for control of lucerne flea.

METHODS

Field trials

In autumn 1984 diflubenzuron and teflubenzuron each at two application rates (Fig. 1, Trial 1) were applied to pasture plots near Walton, central Waikato. Treatments
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Fig. 1: Lucerne flea population levels in pasture after spraying with insect growth regulators, (a) applied 6.4.84, (b) applied 11.5.84.

were applied on the 6th April and again to a separate set of plots on the 11th May. Subsequent lucerne flea population levels were monitored until December 1984.

Trial 2, also near Walton, commenced on the 31st May 1984. Treatments were maldison at 75 g ai/ha, diflubenzuron 10 g ai/ha, and teflubenzuron 30 g ai/ha, each sprayed separately. In addition, other plots were sprayed with maldison immediately followed by the application of either diflubenzuron or teflubenzuron, at the previous rates (Fig. 2). Lucerne flea population levels were monitored until October 1984.

Trial 3 commenced on 9th October 1985 near Kiwitahi, central Waikato and compared the effectiveness of maldison at 200 g ai/ha and diflubenzuron at 10 g ai/ha, applied to a juvenile and rapidly increasing lucerne flea population. Many egg clusters were observed on the soil prior to spraying the trial. Population levels were monitored till December 1985.

Treatments in all trials were replicated four times in randomised blocks, with plot sizes of 5 m x 10 m. Lucerne flea population levels were assessed at 1 to 2 week intervals in all trials by taking one, 6 metre long, pasture sweep per plot with a 300 mm diameter net. The sweep net catches were killed in 70% alcohol before counts were made using a binocular microscope. All insect counts from field trials were transformed ($\log_e x + 1$) before analysis of variance.

All chemicals were applied using a hand held 2.4 m boom fitted with spraying systems flat fan tips, no. 730154, and operated at 210 kPa. Application volumes were 300 litres/ha (1984) and 200 litres/ha (1985).

In Trial 3 assessments were made of white clover leaf damage caused by lucerne flea. Pasture was cut from ten points per plot using an electric shearing hand piece. Foliage was bulked within a plot. On return to the laboratory approximately 300 randomly selected leaflets per plot were assessed for the presence or absence of lucerne flea feeding scars. Analysis of variance was conducted on the proportion of leaflets damaged (no transformations used).

Laboratory bioassays

Three bioassay experiments were conducted during May and June 1985, each using a different size/age range of lucerne flea. On each occasion the lucerne fleas were collected in the field using a sweep net. On return to the laboratory head width measurements from a sample of insects (20-40) were made using a binocular microscope (magnification 20 times).

Fig. 2: Lucerne flea population levels following combined maldison and insect growth regulator application to pasture.

Insect growth regulator solutions were prepared by diluting diflubenzuron (Dimilin 25WP) and teflubenzuron (CME 134-06) with water to obtain solutions of 10 and 100 ppm (ai). White clover leaflets were dipped in the growth regulator solution and left to dry in the laboratory for approximately 1 hour. Three white clover leaflets, 10 lucerne flea, and a disk of moist filter paper were placed together in a plastic pot (375 mls). A lid was used to prevent loss of moisture and lucerne flea. There were four replicates (pots) of each treatment, including water dipped, untreated leaflets. Lucerne flea mortality was assessed, treated clover leaflets replaced and filter paper remoistened at 2 to 5 day intervals.

TABLE 1: The estimated time in days at which lucerne flea mortality declined to half that of the untreated group, for three size categories of insects.

Mean headwidth and range (mm)		Estimated time (days after treatment) at which mortality reached half that of the untreated		
		0.29 (0.20-0.45)	0.42 (0.30-0.55)	0.6 (0.45-0.70)
Insect growth regulator	ppm			
diflubenzuron	10	7.2	7.6	14.6
diflubenzuron	100	5.9	7.2	11.5
teflubenzuron	10	*	14.2**	18.9
teflubenzuron	100	5.1	9.3	16.3
Pooled standard error		0.9	0.5	2.2

*When experiment was terminated after 11 days mortality had reached only 26%.

**Standard error for this figure is 2.3.

RESULTS AND DISCUSSION

Both the laboratory and field experiments indicated that the insect growth regulators (IGRs) diflubenzuron and teflubenzuron have activity against lucerne flea (Table 1, Figs 1-4). Laboratory experiments indicated susceptibility of lucerne flea to the IGRs varied according to their size/age (Table 1). Fifty percent of smaller lucerne flea (mean head width up to 0.42 mm) died within approximately 1 week of feeding or contact with white clover leaflets treated with diflubenzuron at 10 or 100 ppm, or teflubenzuron at 100 ppm. Larger lucerne flea (mean head width 0.60 mm) took approximately 2 weeks to suffer 50% mortality. Lucerne flea mortality in the untreated controls, 8 days after the experiment commenced, was 42% and 15% for the 0.29 and 0.42 mm sizes respectively. For the 0.60 mm size mortality in the untreated group was 25% at day 13. The increasing time till insect death occurs, is probably a function of the longer interval between moults (Mulder and Swennen 1973) for the larger insects. In addition, juveniles are often more sensitive to IGRs than mature insects (Grosscurt 1978).

In field trials maximum level of control was achieved some weeks after the insect growth regulator application. This occurred about 1 to 2 months after the application in Trial 1 (Fig. 1,a,b), at least 7 weeks after application in Trial 2 (Fig. 2) and 2 weeks after application in Trial 3 (Fig. 3). The generally slow population decline observed probably resulted from selective mortality of the smaller lucerne flea over 1 to 3 weeks, plus a natural decline of larger (adult) lucerne flea. In Trial 3 the relatively quick population decline following the diflubenzuron application was probably a result of mortality of recently hatched nymphs through residual foliar activity (Mulder and Swennen 1973) or through a direct effect of the IGR on the lucerne flea eggs present at spraying (Grosscurt 1977).

Fig. 3: Lucerne flea population levels following the October application of maldison and diflubenzuron.

Laboratory bioassay experiments and field trials evaluating the application rate of diflubenzuron (10 and 100 ppm or 10 and 100 g ai/ha) indicate only a small rate effect (Table 1, Fig. 1). With teflubenzuron (10 and 100 ppm or 30 and 300 g ai/ha) the rate effect was more marked (Table 1, Fig. 1).

When diflubenzuron and teflubenzuron were compared at equal application rates (laboratory bioassay experiments), diflubenzuron was usually more active (Table 1). Field trial data (Figs. 1 and 2) also indicated that teflubenzuron applied at 30 g ai/ha was relatively ineffective compared to diflubenzuron applied at 10 g ai/ha. Teflubenzuron at 300 g ai/ha was of similar effectiveness to diflubenzuron applied at 100 g ai/ha (Fig. 1).

Dual applications of maldison and insect growth regulators were no more effective than the organophosphate applied alone (Fig. 2). Reinfestation of the maldison alone treatment was slower than that generally reported elsewhere; e.g. 2 or 3 weeks of application (Townsend *et al* 1979 and Wrenn *et al* 1983). The timing of the application (late May) may have given the advantages of an autumn application, i.e., control through till August or September, reported by Pottinger *et al* (1985). Had the reinfestation pressure been greater, residual activity by the insect growth regulators, following the initial knockdown caused by maldison, may have been observed.

In Trial 3, maldison gave greater initial reductions in lucerne flea numbers (Fig. 3) and damage (Fig. 4) than diflubenzuron, but these effects had disappeared within 3 to 4 weeks of treatment because of reinfestation. In contrast, diflubenzuron continued to give significant reductions in lucerne flea numbers and leaflet damage for at least 7 weeks after treatment.

Fig. 4: Changes in frequency of feeding damage to white clover leaflets following the application of maldison and diflubenzuron.

CONCLUSIONS

The insect growth regulators diflubenzuron and teflubenzuron are slower acting than organophosphate insecticides against lucerne flea, and are also relatively ineffective against larger or adult lucerne flea. As insect population levels and pasture damage are slow to decline after insect growth regulator application, treatments directed against small lucerne flea, before excessive pasture damage occurs, will be the most effective. Autumn application times will reliably satisfy these conditions (Pottinger *et al* 1985). Later during the winter or spring careful observation of insect development status and pasture damage will be needed to ensure the age-structure of the population will allow effective use of IGRs.

Additional experiments are required to determine minimum effective application rates for IGRs and to directly compare their effectiveness with the organophosphate insecticides.

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