LUFENURON - AN INSECT GROWTH INHIBITOR FOR THE CONTROL OF LEAFROLLERS IN APPLES AND KIWIFRUIT

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SUMMARY

Trials to evaluate the efficacy of lufenuron, an insect growth inhibitor, against lepidopterous pests were carried out in apples and kiwifruit from 1991-1993. Multiple applications of lufenuron were made during the season at 2.5 and 5.0 g/100 litres compared with the standard insecticide programme for each fruit and an untreated control. In apples three spray intervals (14, 28 and 14-28 days) were also tested. Lufenuron at both rates was comparable with the standard insecticide programme in the reduction of fruit damage by lepidopterous pests, with no significant difference between the three spray intervals or the two rates. Lufenuron applied at 5 g/100 litres at a 28 day spray interval gave significant reductions in fruit damage on both apples and kiwifruit.

Keywords: lufenuron, apples, kiwifruit, leafrollers, codling moth

INTRODUCTION

Leafrollers are a serious pest of fruit crops in New Zealand. Current control practices are based on regular multiple applications of organophosphate insecticides. These practices may not be sustainable as the issue of pesticide residues becomes more significant (Stevens *et al.* 1993), and because current control levels may not continue (Walker *et al.* 1991).

Insect growth inhibitors and regulators are becoming more accepted and increasingly used for plant protection (eg. buprofezin, fenoxycarb and diflubenzuron). Their main advantage over other insecticides currently used is their low toxicity to vertebrates and specific activity confined to insects and other arthropods. Lufenuron (CGA 184699), an acylurea insecticide discovered by Ciba-Geigy, is an insect growth inhibitor. Lufenuron interferes with chitin biosynthesis, thus lethally disrupting the moulting process. It acts both by ingestion and contact against a range of insect pests. Due to its mode of action on immature stages, it is a potent larvicide with treated larvae failing to moult properly. The time taken for larval mortality to occur is dependent on the dose; if the dose is high they die before the moult but at lower doses they may survive until the next moult. Buholzer *et al.* (1992) reported that the delayed effect is not a drawback as larvae stop feeding well before having been lethally affected. The other action of lufenuron against lepidopteran pests is as an ovicide, noticeably so with codling moth (*Cydia pomonella*).

In this paper we report on eight trials carried out over two seasons under New Zealand conditions, on the evaluation of the efficacy of lufenuron against lepidopteran pests of apples and kiwifruit.

METHODS

Apples

A series of six trials of randomised complete block design were carried out in the Waikato, Hawkes Bay and Canterbury regions during two consecutive seasons from 1991-93. The treatments applied in each season were as follows.

1991-92: Lufenuron (Match 100 EC) was applied at 5 g/100 litres and compared with the standard programme of chlorpyrifos (Lorsban 50 WP) at 37.5 g/100 litres and an untreated control. The insecticides were applied at 14 day intervals. A total of seven

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applications were made on the early maturing variety Royal Gala (Waikato) and 11-13 applications on the later maturing variety Braeburn (Hawkes Bay, Canterbury).

1992-1993: Lufenuron was applied at three spray intervals (a) 14 days (2.5 and 5.0 g/100 litres) (b) 5 g/100 litres at 28 days and (c) three applications of 5 g/100 litres early season at 14 day intervals with the remainder at 28 day spray intervals. Comparisons were made with the standard treatment of chlorpyrifos applied every 14 days and an untreated control. A total of seven fortnightly applications were made on the early maturing variety Royal Gala (Waikato) and 9-11 fortnightly applications on the later maturing variety Braeburn (Hawkes Bay, Canterbury).

Applications were made to run-off on multiple tree plots using the equivalent of 455-2400 litres of water/hectare depending on tree size, commencing at petal fall (October-November) and continuing until pre-harvest (January-March). All treatments were replicated four times and included a wetting agent at 0.025% v/v concentration. A standard fungicide programme was applied to all trials. Assessments for larval presence and feeding damage on the fruit (mean of 225 fruit/plot) were made at harvest (18-43 days after the last application). The species of lepidoptera present, the ratio of species, and peak flight times were determined on each trial site by pheromone traps. The traps were for light brown apple moth (*Epiphyas postvittana* Walker), codling moth, brown headed leafrollers (*Ctenopseustis obliquana*, *C. herana*) and green headed leafrollers (*Planotortrix octo* and *P. excessana*). At each trial site one trap for each of the lepidoptera species selected on the basis of current recommendations of species locality by HortResearch, was placed adjacent to the trial at least 1.5 m above ground level and a minimum of 5 m apart. Pherocaps and sticky bases were changed as recommended and the traps were assessed at weekly intervals over the trial period.

The data were subjected to ANOVA after either angular or square root transformation where necessary. The separation of means was according to Duncan's multiple range test. All results are reported as untransformed means.

Kiwifruit

Two trials were undertaken during the 1991-1993 seasons in the Waikato region for the control of leafrollers. The trials were randomised complete block designs using single vine plots with four replicates. Treatments of lufenuron at 2.5 and 5.0 g/100 litres were compared with an untreated control and either the standard diazinon/permethrin (Averte WP) in 1991-1992 or in 1992-1993 with a programme of diazinon/permethrin early season (petal fall-early January) and *Bacillus thuringiensis* (Agree 50 WP) for the remainder of the season. Applications commenced pre-blossom (November) in 1991 and immediately post-blossom (December) in 1992. A total of six applications were made in the equivalent of 2000-3000 litres of water/ha and included the addition of a wetting agent at 0.025% v/v concentration. The trials were assessed at harvest (31-35 days after the last application) by picking a minimum of 200 fruit/plot and assessing percent leafroller damage. The results were analysed using ANOVA and angular transformation was carried out where necessary. All results are reported as untransformed means.

RESULTS

Apples

The results from the 1991/1992 trials (Table 1) showed significant reductions in the level of leafroller and codling moth damage in the two insecticide treatments. Lepidopteran damage was lower in the insecticide treatments than in the untreated trees ($P < 0.01$). There was no difference in the level of damage between the lufenuron or chlorpyrifos treatments. Pheromone trap data showed that there were some differences in the lepidopteran species occurring at the three trial sites. The Waikato trial had codling moth as the major lepidopteran pest while in the Hawkes Bay and Canterbury trials light brown apple moth was the dominant species. There were only low trap catches of other lepidopteran species. Damage assessments at harvest reflected the leafroller and codling moth composition monitored by the pheromone traps. However, the trap catch data did not correlate with the damage levels. This was

also noted in work reported by Suckling and Burnip (1993). The pheromone traps were ideal to ascertain presence and the relative abundance of the pest species, although Suckling and Brown (1992) noted differences in trap efficiencies.

TABLE 1: Percentage of apples damaged by leafroller and codling moth at harvest (1991-92).

Treatment	Rate g ai/100 litres	Spray interval	Waikato codling moth	Hawkes Bay leafroller	Canterbury leafroller
lufenuron	5	14 days	0.0 A ¹	1.0 B	0.3 B
chlorpyrifos	37.5	14 days	0.0 A	1.2 B	0.3 B
untreated	-	-	4.7 A	9.9 A	4.7 A

¹ Any two means in a column without a letter in common are significantly different at $P < 0.01$

TABLE 2: Percentage of apples damaged by leafroller and codling moth at harvest (1992-93).

Treatment	Rate g ai/100 litres	Spray int. (days)	Waikato codling moth	leafroller	Hawkes Bay leafroller	Canterbury leafroller
lufenuron	2.5	14	0.0 B ¹	0.6 B	0.5 B	0.6 B
lufenuron	5.0	14	0.0 B	0.3 B	0.9 B	0.9 B
lufenuron	5.0	28	0.0 B	0.5 B	0.0 B	0.6 B
lufenuron	5.0	14/28	0.0 B	0.4 B	0.3 B	1.2 B
chlorpyrifos	37.5	14	0.2 B	0.2 B	0.4 B	0.2 B
untreated	-	-	1.1 A	7.5 A	5.6 A	3.0 A

¹ Any two means without a letter in common are significantly different at $P < 0.01$

The three trials in 1992/1993 (Table 2) compared two rates of lufenuron at extended spray intervals to investigate the persistence of the compound on leaves. Pheromone trap data again showed that the dominant lepidopteran species present were either codling moth or light brown apple moth. Light brown apple moth was clearly the dominant leafroller species and codling moth damage and presence was again only recorded in the Waikato trial. Other Tortricids were trapped at a very low and erratic level. Lufenuron at the rates and the spray intervals evaluated, gave very significant reductions in the level of lepidopteran damaged fruit compared with the untreated control ($P < 0.01$). There was no significant difference between the two rates of lufenuron or the spray intervals used. Lufenuron treatments were comparable with the standard insecticide programme based on chlorpyrifos in the level of fruit damage recorded.

In these apple trials, lufenuron showed excellent reductions in fruit damage by leafroller and codling moth and was comparable with the standard insecticide programme. Lufenuron applied at 5 g/100 litres at a 28 day spray interval appears to be a viable alternative to the standard insecticides for the control of lepidopteran pests in the apple industry.

Kiwifruit

Multiple applications of lufenuron applied at 2.5 g/100 litres in 1991-1992 (Table 3) at intervals according to the Kiwifruit Authority spray programme gave very significant reductions in leafroller damaged fruit compared with the untreated ($P < 0.01$). There was no significant difference between the two insecticide treatments, although the diazinon/permethrin treatment had noticeably lower damage levels.

TABLE 3: Percentage of kiwifruit damaged by leafroller at harvest (1991-92).

Treatment	Rate g ai/100 litres	% damaged fruit
lufenuron	2.5	1.0 B ¹
diazinon + permethrin	50 + 2.5	0.2 B
untreated	-	11.4 A

¹ Any two means without a letter in common are significantly different at P<0.01

In the 1992/1993 trial (Table 4) all insecticide treatments reduced the level of leafroller damaged fruit compared with the untreated (P<0.01). The diazinon/permethrin/*Bacillus thuringiensis* programme gave the greatest reduction but this was not significantly different from the lufenuron treatments. There was no significant difference in the amount of fruit damage between the two rates of lufenuron although the 5 g rate had lower levels of damage than the 2.5 g rate.

Lufenuron used at 2.5-5.0 g/100 litres will give control of leafrollers in kiwifruit comparable with the current standard spray programme.

TABLE 4: Percentage of kiwifruit damaged by leafroller at harvest (1992-93).

Treatment	Rate g ai/100 litres	% damaged fruit
lufenuron	2.5	5.0 bcB ¹
lufenuron	5.0	2.5 bcB
diazinon + permethrin (x 2)	50 + 2.5	
+ <i>Bacillus thuringiensis</i> (x 4)	+ 100g	1.8 cB
untreated	-	41.6 aA

¹ Any means without a letter in common are significantly different at P<0.05 for lower case or P<0.01 for upper case.

CONCLUSIONS

Lufenuron shows considerable promise as a replacement for current organophosphate insecticides for the control of lepidopteran pests in apples and kiwifruit. Due to its high level of activity and lasting effect against lepidopterous pests, low use rates are possible. Lufenuron applied at 5.0 g/100 litres on a 28 day spray interval will give control of lepidoptera in apples and kiwifruit. Lufenuron offers a potential alternative to standard spray programmes, due to its selectivity and efficacy, for inclusion in integrated pest management programmes in the apple and kiwifruit industry. The control of secondary pests such as mealy bug (*Pseudococcus* spp.), woolly apple aphid (*Eriosoma lanigerum*) and scale insects also require consideration, due to the selectivity of this product.

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