LURE AND KILL AS A NEW CONTROL TACTIC FOR LEAFROLLERS

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ABSTRACT

An attracticide, based on sex pheromone and permethrin, was tested in an unsprayed apple orchard to determine the potential for *Epiphyas postvittana* male moth population suppression. Three treatments, control, attracticide and caged attracticide (both 450 droplets per ha) were placed in 0.3 ha plots (n = 6 replicates). Droplets were caged in one treatment to prevent access by male moths. Two traps, baited with attracticide droplets and placed on the centre row at 30 m from the opposite edges of each plot, were checked before, during, and after the treatment period. There was no significant difference among catches before treatment, but during the treatment with attracticide, a high level of suppression of trap catch (95%) was evident. Less suppression was recorded in the caged droplet treatment (63%). After the removal of caged droplets, catches returned to control levels indicating that the insects had been present, but were not caught during the treatment period. In sharp contrast, removal of the exposed attracticide droplets resulted in only a gradual loss of suppression in the next four days, indicating that moths in these plots had been killed. There is potential for control of leafrollers by attracticide, but more work is needed on biological and technical constraints to the approach.
Keywords: *Epiphyas postvittana*, Tortricidae, pheromone, attracticide, pyrethroid, lure and kill.

INTRODUCTION

Leafrollers, including the lightbrown apple moth (LBAM), *Epiphyas postvittana* (Walker), can cause significant problems for New Zealand's export horticulture industries. These insects can adversely affect market access, while resistance to insecticides such as organophosphates carbaryl (Suckling 1996) and tebufenozide (Wearing 1998), presents a threat to their successful management. A recently-developed attracticide (Sirene) consisting of pheromone and pyrethroid insecticide, could offer a new pest management solution. Based on the lure and kill tactic, the results of Sirene applications in apple orchards are encouraging (Charmillot *et al.* 1996; Charmillot and Hofer 1997), and the formulation is now registered by Novartis in Switzerland against codling moth, *Cydia pomonella* L. (Hofer 1997). Such a formulation appears to have excellent prospects for resistance management of leafrollers in New Zealand because pyrethroids are highly toxic to these species (Suckling *et al.* 1986) and there is no evidence of pyrethroid resistance.

Consumers may also find an attracticide more acceptable compared to the traditional approach of spraying crops. An attracticide need only be applied to non-crop parts of the plant, thereby avoiding insecticide residues on the crop. Laboratory and field tests show that LBAM is readily attracted to droplets containing its sex pheromone, and is not inhibited by the presence of pheromone for codling moth or green-headed leafroller (*Planototrix octo* Dugdale). This could permit a multiple-species blend (Brockerhoff and Suckling 1999). In this paper we summarise a field trial designed to test the level of male suppression by the attracticide against LBAM. Other aspects of this work have been reported elsewhere (Suckling and Brockerhoff 1999; Brockerhoff and Suckling 1999).

MATERIALS AND METHODS

Field trial

To test the potential for suppression of the male population of LBAM, a field trial was conducted with Sirene attracticide containing 6% permethrin insecticide (Novartis, Basel, Switzerland). LBAM pheromone [95% *E*11-tetradecenyl acetate and 5% *E*9,*E*11-tetradecadien-1yl acetate (Bellas *et al.* 1983) obtained from Sigma, St. Louis, Missouri, and Shin Etsu, Tokyo, respectively] was added to the attracticide. The trial was conducted near Lincoln, Canterbury, in an unsprayed apple orchard with 50 blocks of 1 ha separated by 7 m tall *Salix* sp. shelter trees. Eighteen 0.34 ha plots measuring 45 by 75 m (10 rows x 25 trees) were laid out each in the centre of a block and randomly assigned to one of three treatments: (i) control, (ii) 450 attracticide droplets per ha applied to plastic packing tape on a twig at ca. 1.5 m height, or (iii) 450 caged attracticide droplets per ha [on Mylar plastic bases covered with a hemisphere of aluminium mesh, placement similar to (ii)]. Droplets were applied to approximately every other tree. The cage treatment, which prevented moths from contacting droplets, was included to separate the effects of pheromone lure competition and mortality. The mean weight per attracticide droplet was 60 mg.

To assess treatment effects, six attracticide droplet-baited delta traps were installed in a transect down the central row. Two traps were placed at the outside edges of each plot (0 m), and 15 m and 30 m in from the edges. Traps were checked regularly from 4 May 1998. Droplets were deployed on 9 May and removed on 21 May, and trapping concluded on 16 June. We report only the salient data, from the plot centres, until 25 May (c.f. Suckling and Brockerhoff 1999). Hourly temperatures were logged in the tree canopy using a Campbell CR10 data logger (Logan, Utah).

Statistical analyses

Analyses of variance (ANOVAs) and Tukey tests were performed on total catch for each trap and time period (before, during and after attracticide treatment) to assess treatment effects. Catches in 2 traps located near the plot centres of each plot (30 m from the outside edges) were analysed for each treatment. Percentage suppression was calculated as 100 – [(Treatment Catch / Control Catch) x 100]. Linear regression was used to identify the threshold temperature at dusk of moth activity (i.e. trap catch). Best fit of the relationship between trap catches and ºC above a range of potential threshold temperatures recorded over dusk (the period of flight activity, at 18:00 hr) was assumed to occur at a minimum value of the intercept and a maximum value of r^2. All analyses were performed using SYSTAT (1992).

RESULTS AND DISCUSSION

There was no significant difference in trap catch among treatments before the attracticide was deployed (Fig. 1) (ANOVA; df = 1, 33; MS = 2.33; F = 0.11; P = 0.89). During the two-week period when the attracticide and caged attracticide treatments were in place, trap catches differed significantly among the treatments (ANOVA; df = 1, 33; MS = 86.92; F = 11.17; P < 0.001). Trap catches in the attracticide treatment were reduced by ca. 95% compared to the control (P < 0.001), whereas in the caged attracticide treatment, trap catches were reduced by ca. 63% (P < 0.012) (Fig.1, Table 1). For the four days after the attracticide was removed, trap catches remained significantly lower than in the control (Fig. 1, Table 1) (ANOVA; df = 1, 33; MS 305.3; F = 9.8; P < 0.001; Tukey test, P= 0.001). In contrast to this sustained impact, the plots treated with caged droplets recovered immediately after the removal of the competing point sources, to levels near the controls (Tukey test, P < 0.56) (Fig. 1, Table 1). Similar results were obtained for the other transect positions (0 m and 15 m from the plot edges), but the suppression of trap catch was slightly lower towards the edges of the plots, as reported more fully elsewhere (Suckling and Brockerhoff 1999).

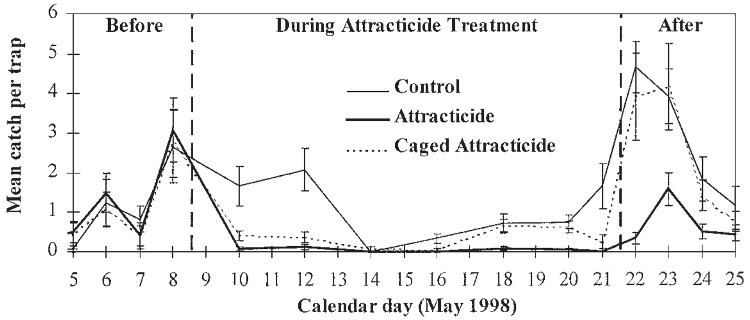

FIGURE 1: Mean ± SE catch per trap per day of *Epiphyas postvittana* near the centre of 0.3-ha plots in a Canterbury apple orchard before, during and after treatment with caged or uncaged attracticide, or in control plots (*n* = 6 plots). Caged attracticide droplets were enclosed in mesh cages to release pheromone but prevent moth mortality.

TABLE 1: Percent suppression of trap catch near the plot centres (30 m from plot edges) in the attracticide and caged attracticide treatments, compared with the control.

Treatment	During treatment (9 - 21 May 1998) (N = 217[1])	After treatment (22 - 25 May 1998) (N = 291)
Attracticide	94.8	80.0
Caged attracticide	63.4	19.3

[1]N, number of moths caught in all three treatments

There was considerable variation in trap catches from day to day, with catches in the controls ranging from 0 to 4.7 moths per trap per day (Fig. 1). Air temperature at dusk explained about 41% of this variation, when a threshold of moth flight of 9.5°C, which gave the best fit, was assumed (Fig. 2). The flight threshold reported from laboratory studies by Danthanarayana and Gu (1992) was 10°C. Rainfall and wind speed are also likely to have contributed to the variation in trap catch.

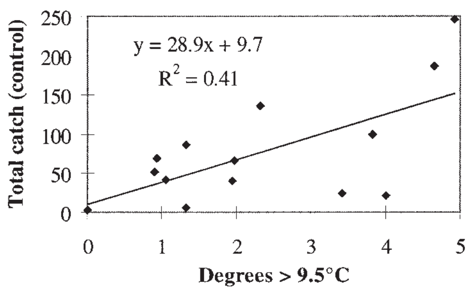

FIGURE 2: Relationship between catch of *Epiphyas postvittana* per trapping period and degrees above 9.5°C (the approximate threshold of flight) at dusk (18:00 hr).

The deployment of attracticide droplets was successful at reducing moth trap catch to very low levels, both during the presence of the attracticide and after its removal. This high level of suppression obtained by the attracticide formulation has demonstrated that there is considerable potential for suppression of male moth populations. The evidence for suppression is corroborated by the lack of an enduring effect from the caged attracticide. The suppressive effect during the presence of the caged attracticide is likely to be due to the competition between attractant point sources, sometimes referred to as “false trails” in the context of mating disruption (Cardé and Minks 1995). It is important to note that the lure-and-kill approach suffers from some of the same constraints as mating disruption, including the high pest selectivity, inverse density dependence, and risk of immigration of mated females. However, in contrast to mating disruption, males are removed during the treatment, and are therefore unable to mate. Much lower amounts of pheromone are required compared to mating disruption, although the blend purity needs to be high to attract males. Further work is underway to address the biological and technical constraints, including whether multiple species lures can be sufficiently effective at population suppression for sustained periods. This may be necessary in order for the approach to be cost effective.

ACKNOWLEDGEMENTS

ENZAFRUIT New Zealand (International) and FRST (CO6616) provided support for this work. We would also like to thank our colleagues Dr. G.F. McLaren, Dr. D. Steven and C. McKenna for constructive comments on the manuscript. Novartis supplied the base formulation of Sirene.

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