EVALUATION OF MATING DISRUPTION OF LIGHTBROWN APPLE MOTH IN NELSON

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SUMMARY

Mating disruption of lightbrown apple moth using Shin-Etsu pheromone dispensers combined with fewer insecticide applications was evaluated using pheromone traps and assessment of damage on apples at harvest. Complete disruption of pheromone trapping was achieved. Large scale trials in the Nelson area during 1989/90 showed significantly less leafroller damage under the pheromone programme with 2-3 fewer insecticide applications compared to orchard blocks treated with insecticides alone. Leafroller damage was highly dependent on cultivar: 'Sturmer Pippin' = 'Braeburn' > 'Red Delicious' > 'Granny Smith' = 'Cox's Orange Pippin'. Pheromone release rates from dispensers were similar throughout the Nelson area, and were apparently not affected by wind run.

Keywords: mating disruption, pheromone, *Epiphyas postvittana*, lightbrown apple moth, leafroller

INTRODUCTION

Lightbrown apple moth *Epiphyas postvittana* (Lepidoptera: Tortricidae) (LBAM) is a key pest of horticulture in Australia and New Zealand which has developed resistance to organophosphate insecticides (Suckling *et al* 1987). This species is the dominant leafroller in the Nelson district, although other species are present (Suckling and Shaw 1990). Mating disruption of this species has been under investigation as a possible tactic for resistance management (Suckling *et al* 1990a), as well as for reducing insecticide use and improving leafroller control in New Zealand apple orchards (Suckling and Clearwater 1990; Suckling and Shaw 1990).

The aim of this study was to investigate in large scale trials if a combination of a reduced insecticide programme and use of pheromone dispensers would reduce leafroller damage at harvest, compared to more conventional spray programmes. Several growers involved had already made spray savings to their fully conventional programme, by withholding at least one spray from the early season period, during troughs in moth flight activity (Walker *et al* 1989).

MATERIALS AND METHODS

Three large blocks of apple trees (4.5, 10.6, 32.2 ha) were used for six trials in 1989-90 to evaluate two basic treatments, namely a combination of pheromone dispensers plus a reduced number of insecticides, compared to insecticides alone. The trials are summarised in Table 1. Trials 1-4 were conducted on commercial apple orchards at Moutere Bluffs, with adjacent pheromone-treated areas of 4.5 ha, 3.2 ha, 15.0 ha, and 9.5 ha, respectively. These trials centered on the area with azinphos-methyl resistant LBAM, which has had a progressively increasing area treated with pheromone since 1986/87 (Suckling *et al* 1990a). Trial 5 (10.6 ha, Lower Moutere) had been treated with pheromone in 1988/89 (Trial 4 in Suckling and Shaw 1990). Trial 6 (4.5 ha, Lower Moutere) was treated with dispensers for the first time.

In all trials, blocks of trees were treated with pheromone and, with the exception of Trial 5, had two or three fewer insecticide applications (including 1-2 spray omissions in February-March), than similar blocks treated with 8-10 applications of insecticide

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TABLE 1: Number of post-bloom insecticides on pheromone and no pheromone treatments, with average time interval between applications.

Trial	Pheromone		No Pheromone	
	No. Sprays	Average interval (Days)	No. Sprays	Average interval (Days)
1	7	21	10	15
2	6	25	9	15
3	6	24	8	17
4	7	20	10	15
5	7	20	7	20
6	6	26	8	18

(Table 1), depending on variety. In Trial 5 the same reduced insecticide programme was used in both treatments. In Trials 1, 2, 3 and 6, growers adopted 1-2 early season spray reductions (Walker *et al* 1989) in the no pheromone treatment, which reduced the difference between treatments to two spray applications (Table 1).

In early November 1989, polyethylene tubing dispensers (Shin-Etsu Chemical Co. Ltd., Tokyo) were placed in pheromone blocks (1000 per ha). Dispensers contained (E)-11-tetradecenyl acetate and (E, E)-9, 11-tetradecadien-1-yl acetate (56.5 mg and 2.8 mg per dispenser) (Bellas *et al* 1983) and 15.2 mg of (Z)-11-tetradecenyl acetate as an impurity. Growers paid \$160/ha for the dispensers, which was approximately equivalent to the cost of materials for three insecticide applications. Distribution of dispensers took approximately 4 h/ha.

Meteorological records (mean daily temperature and daily wind run at 6 m) were obtained at the DSIR Appleby Research Orchard. Wind run (6 m) was also recorded weekly at Riwaka Research Station, and at orchards at Waimea, Mouere Bluffs (Trial 4), and Lower Mouere (Trial 5) in order to examine variation in wind run around the district, and its possible impact on pheromone performance.

Pheromone traps (Suckling and Shaw 1990) were operated for pest leafrollers in and around the treated and untreated blocks.

Assessment of insect damage was done using random samples of 1500 fruit per block, and at packhouses by inspection and scoring of rejected fruit in relation to total fruit quantity. Fruit were scored for the presence of fresh (<1 week) or old leafroller damage, or other insect damage, and bins were assumed to hold 2500 fruit. Logistical regression was used to examine treatment, grower, variety and interactive effects, assuming binomial errors scaled to the observed dispersion.

The meniscus of pheromone in 10 dispensers was measured weekly (2/11/89-30/3/90) in order to estimate the release rate at Appleby Research Orchard. Meniscus measurements were also made approximately monthly from 6/12/89 to 26/2/90, on a sample of three dispensers placed at each of nine other orchards, in order to assess regional variation in release rates.

RESULTS AND DISCUSSION

Use of pheromone dispensers prevented pheromone trap catches of lightbrown apple moth inside treated orchard blocks in all trials, as previously observed (Suckling *et al* 1990a; Suckling and Shaw 1990). Pheromone release rates declined from 12 mg/ha.h in November 1989, to 4 mg/ha.h by the end of March 1990.

Logistical regression of Trials 1-4 at Mouere Bluffs indicated overall significant differences in leafroller damage in the pheromone treatments (with two or three fewer sprays) compared to the no pheromone programme ($P < 0.01$, Table 2), as well as major variety and site effects ($P < 0.001$) and a site x treatment effect ($P < 0.001$). Trial 4 had more damage in the pheromone treatment ($P < 0.01$), due to edge effects from immigration. Assessment of samples of 1500 fruit sampled from major varieties in the same blocks generally confirmed packhouse results.

TABLE 2: Percentage leafroller damage in Trials 1-4 at Moutere Bluffs, using pheromone + 6-7 insecticides, compared to the no pheromone programme (8-10 insecticides), from packhouse assessments subjected to logistical regression. N refers to the number of orchard blocks under each treatment at four orchards.

Treatment	N	Mean	Standard Error	No. Bins
Pheromone	15	0.061%	0.0097	2015
No Pheromone	14	0.1004%	0.0145	1299

In the 10.6 ha trial at Lower Moutere (Trial 5), the pheromone-treated blocks also averaged less fruit damage on 'Cox's Orange Pippin', 'Red Delicious' and 'Granny Smith' varieties (mean 0.0216%, 2003 bins) than blocks treated only with the insecticide programme (0.0391%, 0.001%, 1121 bins), but the difference was not significant ($t = 1.51$).

The only leafroller damage detected in Trial 6 (4.5 ha at Lower Moutere) was in cv 'Granny Smith', with no difference between treatments (both about 0.004% damage, 647 bins total). This site would seem promising for further reductions in insecticide use.

The results for cv 'Granny Smith' apples are shown in Fig. 1 (except for Trial 3, which had no 'Granny Smith' apples, so 'Braeburn' were substituted). The average interval between the final insecticide spray application and the opening date for harvest was 22 days, although harvest of cv 'Granny Smiths' can take over 3 weeks at these sites, extending this interval to a total of 5 weeks.

Fig. 1: Packhouse result on incidence of leafroller damage to cv 'Granny Smith' or 'Braeburn' apples (Trial 3) treated with either insecticides, or pheromone and 2-3 fewer insecticide applications.

When all trials were combined, significant differences in the level of leafroller damage were evident between pheromone (0.039%) and no pheromone (0.061%) treatments ($P < 0.001$). There was a decreasing incidence of damage from late to early harvest and from short to long stems in the major varieties: cv 'Sturmer Pippin'. = 'Braeburn' > 'Red Delicious' > 'Granny Smith' = 'Cox's Orange Pippin'.

The level of fresh damage was significantly correlated with the level of older damage on fruit ($F_{1, 38} = 186.5$, $P < 0.001$). This suggests that growers with higher levels of leafroller damage are more likely to have fresh damage and presumably live larvae present. This could be due to local variation in pest populations, or orchard management. Reduction in insecticide usage should not be attempted on blocks subject to immigration of leafrollers, including native species, from high local populations.

Very little variation in average pheromone release rate was observed between the nine orchard locations over the December-February period (Table 3). This result confirms the validity of extrapolating release rates estimated from Appleby Research Orchard to other parts of Nelson.

Wind run was lower at Riwaka and Lower Moutere, than at Moutere Bluffs, Appleby and Waimea, which were all similar, according to t-tests on weekly readings between pairs of sites (Table 3). Weekly wind run was normally distributed over this period, and has been presented as km/day for standardisation. Wind speeds at 6 m height are likely to be a reasonable indicator of the wind speeds within the orchard canopy. The extent to which wind speed affects mating disruption is not yet precisely understood, although areas with higher wind speeds are probably less suited to this control tactic which relies on atmosphere pheromone concentrations being maintained above a threshold (Suckling and Shaw, unpublished data). The importance of local shelter in maintaining atmospheric pheromone concentrations has been demonstrated elsewhere (K. Ogawa, pers. comm.). However, wind speed alone has not been sufficient to explain a few matings of female LBAM which have been observed in pheromone-treated blocks in other trials. These matings also coincide with peak male activity nearby (Suckling and Shaw, unpublished data).

TABLE 3: Estimated pheromone release rate from dispensers and average wind run in the Nelson district (2/11/89/29/3/90) (Standard errors (sem) relate to weekly readings).

	Pheromone release rate mg/ha.h	Wind run (sem) km/day
Waimea 1	15.4	205.1 (7.3)a ¹
Waimea 2	15.0	
Appleby	14.4	211.7 (11.6)a
Moutere Bluffs	15.3	196.0 (9.4)a
Tasman	15.0	
Mariri	16.1	
Lower Moutere 1	15.4	155.1 (7.3)b
Lower Moutere 2	15.2	
Riwaka	14.7	135.7 (6.9)c

¹Column entries not sharing a letter were significantly different, t-test, $P < 0.05$.

Results on commercial orchards withholding two spray applications compared with the standard programme (Suckling *et al* 1990b) suggest that some reduction in insecticide use early season is possible without the addition of pheromone before January. Treatment with pheromone in January rather than November would offer the benefit of raising release rates over harvest (Suckling and Shaw 1990), and could improve efficacy. The chief innovation here is the saving of a third (or fourth) insecticide application in February.

Reductions in organophosphate usage are desirable for the apple industry, and it appears that the pheromone/insecticide combination may have a role to play in achieving this objective. However, reductions in residues would offer even more significant marketing advantages for the crop. The trials reported here indicate that reductions in insecticide use by up to three applications during the season did not result in greater damage at harvest. Further work is needed to determine if the final organophosphate insecticide applications can be safely omitted. The combination of insecticide plus pheromone was also useful for reactive insecticide resistance management of lightbrown apple moth, while a general reduction in organophosphate usage could be expected to reduce selection pressure against other pipfruit pests, particularly if adopted widely. There has been no evidence of secondary pest build-up in the 4 years of pheromone use at Moutere Bluffs, no doubt due to the continued use of 6-7 insecticides each season.

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