PHEROMONE TRAPPING AND INSECTICIDE USE IN CANTERBURY APPLE ORCHARDS

D. M. SUCKLING and G. M. BURNIP

HortResearch, P.O. Box 51, Lincoln

SUMMARY

Pheromone traps were operated over three seasons on the borders of 8-10 Canterbury pipfruit orchards to determine whether any relationship was detectable between trap catch, insecticide use, or fruit damage from leafrollers and codling moth. *Epiphyas postvittana* was abundant at all orchards with *Planotortrix octo* catches highest at two South Canterbury sites. *Ctenopseustis herana* was caught in lower numbers at six sites, and was dominant at an organic orchard. Larval abundance at two organic orchards was reflected in trap catch after correction for trap effiency between species. No clear relationship between seasonal total trap catch and damage at harvest was found. Decreasing leafroller damage on fruit was significantly correlated with increased insecticide use.

Keywords: pheromone trap, apple, leafroller, codling moth, fruit damage, insecticides

INTRODUCTION

Pheromone traps are being used by a limited number of orchardists in Canterbury, to determine which leafroller species are present, to establish relative population densities, and to identify timing of population peaks. Three leafroller species are considered to be important in Canterbury orchards, with *Epiphyas postvittana* generally dominant. Previous collections of native leafrollers had shown that *Ctenopseustis herana* was present, while *C. obliquana* was essentially confined to Banks Peninsula (Dugdale 1990; Brown and Suckling 1993). Tai Tapu, near the Peninsula, is the holotype locality for *Planotortrix octo* (Dugdale 1990). Little information about regional variation in adult leafroller levels between Canterbury orchards has been reported previously, apart from a comparison of three Canterbury orchards by Tomkins *et al.* (1987) using bait traps, and a comparison of a further two orchards using pheromone and bait traps by Suckling *et al.* (1990a). Canterbury apple orchardists have been exporting apples for over 5 years, and more stringent standards of control have changed the pattern of insecticide use from earlier programmes designed for local market fruit (Hancox and Penman 1982). The aim of this project was to provide a sound basis for minimising insecticide use, while retaining insect control to the desired standards.

METHODS

Up to 10 Canterbury growers were involved in a leafroller trapping programme over three seasons from 1990 - 1993, in which the season's trapping data (including codling moth) were analysed, graphed, interpreted, and presented to orchardists. Harvest records of leafroller and codling moth damage were collected from packhouses, with the aim of evaluating the relationship between pheromone trap catch, number of post-bloom insecticides, and damage at harvest. Results from six conventionally managed orchards (orchards B,C,D,E,H,I; range 4-9 organophosphate insecticide applications) were compared with two gate sales orchards (A,G; range 3-4 organophosphate insecticides), and two organic orchards which used no insecticides at all (F, J). Orchard F was Winchmore Research Orchard in South Canterbury).

Pheromone traps

Traps for three leafroller species (lightbrown apple moth *Epiphyas postvittana*, brownheaded leafroller *Ctenopseusis herana*, and greenheaded leafroller *Planotortrix octo*) and codling moth (*Cydia pomonella*) were placed on 3 or 4 perimeters of each orchard (Suckling *et al.* 1990a). Traps were hung at 1.5 m above ground and spaced at least 5 m apart. The bases were changed every 3 weeks or as needed and pheromone lures changed 6 weekly. Traps were inspected weekly, moths removed and numbers recorded. Results from orchards with 2-3 seasons data (Nov 1 - March 31) were included in the analysis.

Fruit assessment

Packhouses were asked to save rejected fruit with suspected leafroller damage, and to record bin tallies. We confirmed fruit damage by leafrollers and other pests from each orchard, and converted the damage to percentages using a correction factor related to bin size and fruit size. Four varieties ('Royal Gala', 'Red Delicious', 'Braeburn', and 'Fuji') were included in 1990-1992, and 'Royal Gala' only were sampled in 1992-93. In 1992-93, larvae were sampled around harvest from 'Royal Gala' fruit on apple trees at the two organic orchards.

Statistical analysis

Details of post-bloom insecticide applications (azinphos-methyl or chlorpyrifos) were obtained from orchardists, and compared with the frequency of leafroller damage, and pheromone trap catches. Applications of carbaryl were omitted from the analysis due to the poor efficacy of this insecticide against leafrollers (Suckling *et al.* 1993).

Catch per trap.day was calculated from the total number of moths caught, divided by the number of traps in use and the trapping interval for each species, at each orchard. Seasonal mean catch per trap.day was calculated from Nov. 1 - March 30, inclusive. Mean catches per trap.day over three seasons from orchards over 3 years (Table 1) were then subjected to cluster analysis (based on the Euclidean distance between orchards, CSS Statistica 1991), in order to group orchards with similar native leafroller pest pressure. This analysis was performed using the correction factor for lower trap efficiency of *P. octo* and *C. herana* traps, of 4 and 3 fold respectively (Suckling and Brown 1992) in order to make suitable comparisons. Analyses included the two native leafrollers alone and with *E. postvittana*.

A general linear model was used to compare trap catch or insecticide use with fruit damage. Leafroller damage was compared with the seasonal mean catch per trap.day of *E. postvittana*, the most abundant species recorded, and across the total leafroller population, using the correction factors for trap efficiency. Insect damage was transformed (log % damage + 1). Data from the first two seasons were used to generate the model, for comparison with the 1992-93 data.

RESULTS

Pheromone traps

Pheromone trap records from November-March each season from 1990-93 indicated that *E. postvittana* was generally present in higher numbers than native leafrollers in this period (Table 1). The corrected mean seasonal catch of the two native leafroller species was generally similar at most locations, according to cluster analysis (Fig. 1). The inclusion of *E. postvittana* did not greatly affect this comparison. At Orchards E (a conventionally managed orchard) and F (Winchmore Research Orchard) there were substantial catches of *P. octo* in traps, which separates these two from the rest of Canterbury orchards examined. In 1992-93, the relative abundance in traps at Orchard F, after correction for trap efficiencies (not shown in Table 1), was 59% *P. octo*: 32% *E. postvittana*: 9% *C. herana*. Dominance of *P. octo* was even more evident in the larval samples taken from apple trees there in 1993: 77% *P. octo*, 20% *E. postvittana*, and 3% *C. herana* (n=112). Traps operated in 1992-93 at a second organic orchard in mid-Canterbury detected a higher than usual seasonal mean of *C. herana* of 1.33 males per trap.day. When the correction factors for trap efficiencies were applied, the relative abundance of the species estimated from trapping became 33% *P. octo*, 17% *E. postvittana*, and 49% *C. herana*. Dominance of this species was also evident in larval sampling, with 12% *P. octo*, 18% *E. postvittana*, and 70% *C. herana* (n=36). The discrepancies between larval and adult sampling could be due to error in the correction factors, or real differences between the relative attractivess of apples and other hosts to these species. There was little difference in the relative proportions of each species caught in a season (above), or just in February and March (not presented), the two months preceding the larval samples.

TABLE 1: Uncorrected mean and standard deviation (s.d.) of three seasons catch per trap.day of leafrollers and codling moth at nine Canterbury orchards, for the periods November to March 1990-91, 1991-92, 1992-93.

	E. postvittana		*P. octo*		*C. herana*		Codling Moth	
Orchard	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
A	1.03	0.43	0.09	0.04	0.08	0.01	0.30	0.06
B	1.20	0.70	0.03	0.01	0.04	0.03	0.07	0.03
C	1.43	0.08	0.04	0.01	0.04	0.03	0.06	0.07
D	1.22	0.28	0.16	0.06	0.28	0.05	0.33	0.07
E	2.45	0.39	0.88	1.05	0.29	0.23	0.11	0.12
F	1.44	1.75	1.10	0.80	0.16	0.18	0.02	0.02
G	0.76	0.87	0.11	0.04	0.24	0.12	0.08	0.09
H	0.61	0.21	0.11	0.04	0.21	0.12	0.07	0.02
I	0.53	0.25	0.10	0.08	0.03	0.04	0.03	0.03
Ranges	5 fold		37 fold		8 fold		17 fold	

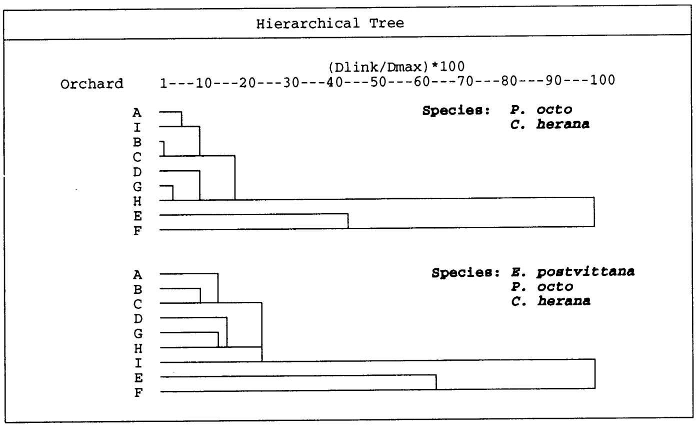

Figure 1: Hierarchical trees derived from mean catch per trap.day (corrected for trap efficiency) of leafrollers in Canterbury orchards, based on Euclidean distance between orchards along axes for each species; Dlink/Dmax is the distance that separates each orchard, relative to the maximum and minimum distances between orchards.

The catch at conventionally managed orchards was dominated by *E. postvittana* (Table 1). However, application of the correction factors derived from relative trap efficiencies indicated the importance of *P. octo* at a number of orchards of all types. *Ctenopseustis herana* was also important at some locations. Seasonal catches of all species were relatively stable over time, although *P. octo* showed the greatest variation in catch between orchards (37 fold).

Codling moth seldom exceeded 0.20 moths per trap.day in any week, although it was present at all orchards. The most relevant reported flight threshold (0.29 moths per trap.day for border traps of the 1CP type, Reidl *et al.* 1986) was rarely exceeded at these sites in the 3 years. Reidl's threshold was developed on a different sticky trap, so the comparison requires cautious interpretation. The use of three or more post-bloom insecticide applications generally provided excellent control of this pest, and damage was very rarely evident.

Leafroller damage

Over 1.5 million fruit was recorded at packhouses during this study. The level of leafroller damage observed was generally very low (0-0.1%) in the orchards with export-oriented production. This compared to a maximum of 17.8% leafroller damage in 1991-92 at Orchard J, where no control measures were used. Similarly, no insecticide treatment in 1992-93 at Winchmore Research Orchard led to over 25% fruit damage of 'Royal Gala' by leafrollers (Thomas and Burnip unpublished results), mainly due to *P. octo*. This species appears from trap catches to be frequently the most abundant leafroller in South Canterbury (W.P. Thomas pers. comm.) and Central Otago (McLaren and Suckling 1993), where it is found on stonefruit (McLaren pers. comm.) and apples (Wearing in prep.). One gate sales orchard showed a higher than usual level of leafroller infestation on fruit (4.5%), probably due to applying all three post-bloom insecticides pre-Christmas, without further control during the second larval generation.

There was no significant relationship between damage and seasonal mean catch of *E. postvittana*, *P. octo*, *C. herana*, or the combined sum (corrected for trap efficiency) of leafroller species (P>0.05).

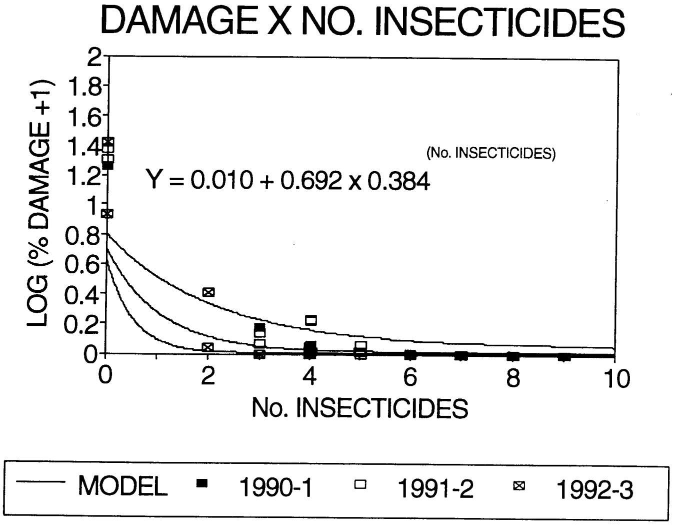

Figure 2: **Relationship between the logarithm of percentage leafroller damage [log(*x*+1)] on four varieties at harvest and number of post-bloom insecticides (model, ± SE). The model was generated from 1990-1992 data, while 1992-1993 data were from 'Royal Gala' only).**

Insecticide use

Conventional growers applied between 3-9 post-bloom insecticide applications. Average intervals between insecticide applications varied from 14 days for heavier spray programmes (e.g. 7-9 insecticides) to 26 days (3-4 insecticides), and showed little change over the 3 years. Fig. 2 indicates the significant relationship ($P<0.001$) between fruit damage on all varieties and number of post-bloom insecticide applications, with an exponential decay curve generated from 1990-92 and 1991-92 data, compared to the 1992-93 data for 'Royal Gala'. This model is truncated at 0% damage, and explains 79% of the variance in the data when the organic orchards are included, and 95% of the variance when these data are not included. Therefore the model presented did not include the organic orchards, although these were plotted (Fig. 2). 'Royal Gala' fruit examined in 1993 showed no significant damage on orchards that applied five or more insecticides (Fig. 2).

DISCUSSION

The lack of relationship between catch and damage could be due to the general similarity in seasonal abundance of leafrollers at these orchards (Fig. 1), which might provide a background of similar pressure, leading to a minimum baseline of damage. This lack of relationship places limits on the usefulness of pheromone traps in pipfruit orchards. However, the lack of a detected relationship between mean seasonal catch of leafrollers and damage at harvest does not preclude the possibility that traps could have a role in improved insecticide timing, apart from monitoring the effectiveness of mating disruption and other research applications.

The model shows that the major benefit from insecticide applications comes with the first three insecticides, while five insecticides should provide a good level of security against field infestation by leafrollers on all varieties. Pheromone traps have proved useful for defining the pest fauna in several types of orchards. Export-orientated orchards in Mid and South Canterbury had few codling moth, abundant *E. postvittana*, and generally few native leafrollers similar to Lincoln Orchard (Suckling *et al.* 1990a). While some year to year variation in trap catch was apparent, there was a general similarity in the fauna between years at a site. The groupings generated by cluster analysis reflect orchards with similar levels of pest pressure.

Orchard J has been unsprayed since 1989, and is undergoing a change in species complex and abundance (W.P. Thomas pers. comm.). During the study, there was evidence from phenological patterns at all orchards that potential improvements in timing could be made, particularly taking into account the two generations of native leafrollers. Apart from omitting sprays during a trough in activity (Suckling *et al.* 1990b), this would require growers to react to a threshold of some form, and further work would be needed to develop such an application of traps.

Growers recognise that every spray removed nearer to harvest represents an increased risk of damage (Fig. 2), and insecticide use patterns on these orchards reflected whether the fruit was for domestic or overseas markets. However, Canterbury pipfruit orchards using more than five post-bloom insecticides could seriously consider a reduction to five applications, based on this study, and local information about specific blocks. Blocks under high leafroller pressure might need to use more than five applications.

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