MONITORING LEPIDOPTEROUS PESTS AT TWO CANTERBURY ORCHARDS

D.M. SUCKLING, W.P. THOMAS, G.M. BURNIP
and A. ROBSON¹

DSIR Plant Protection, Canterbury Agriculture and Science Centre,
Private Bag, Christchurch

¹Canterbury Orchard Services, P.O. Box 5023, Belfast, Christchurch

SUMMARY

Pheromone and molasses bait traps were operated at the Lincoln and Styx Mill Orchards over the 1986/87 to 1989/90 growing seasons to trap leafrollers, codling moth (Tortricidae), and *Graphania mutans* (Noctuidae). There was a much greater abundance of native leafrollers and codling moth at Styx Mill Orchard, while *Epiphyas postvittana* and *G. mutans* were more abundant at the Lincoln Orchard. Land use, adjacent vegetation, and micro-climate may account for the differences. Total catches of Tortricidae declined over the four seasons at both orchards. *G. mutans* recolonised the Lincoln Orchard faster than did *E. postvittana*, according to the distribution of egg batches following cessation of insecticide use in autumn 1988.

INTRODUCTION

Leafrollers are key quarantine pests of the export apple industry, with a nil tolerance of live insects or recent damage. Two other key lepidopterous pests are codling moth (*Cydia pomonella* L.) and *Graphania mutans* (Walker) (Noctuidae: Hadeninae). Noctuid larvae can cause characteristic scar tissue damage on fruit at harvest, and damage apical shoots affecting tree vigour and shape. These insects are generally controlled by the application of insecticides from early November to 2 or 3 weeks before harvest. A minimal insecticide spray programme in Canterbury capable of meeting fruit quarantine standards would be desirable for reasons of cost, environmental impact, and human safety.

The short history of apple exports from Canterbury meant that only limited data was available on the status of these pests in export orchards although their biology has been studied in the region previously (Thomas 1965; Tomkins *et al* 1987). Recent progress in the systematics of leafrollers has identified the presence in Canterbury of *Planotortrix octo* (previously included in *P. excessana* (Walker), and called the green-headed leafroller (GHLR)), and *Ctenopseustis herana* (previously included in *C. obliquana* (Walker) and called the brown-headed leafroller, (BHLR)) (J.S. Dugdale pers. comm.). *Epiphyas postvittana* (Walker) (light brown apple moth, or LBAM) is also present.

The aim of this work was to evaluate differences in the composition of the lepidopterous pest fauna at two Canterbury export orchards, with very different surrounding land use characteristics, with a view to improving long-term pest management. A secondary aim was to investigate crop infestation by comparing orchard recolonisation rates by *E. postvittana* and *G. mutans* following insecticide use, in order to examine the relationship between dispersal and infestation risk. Demonstration of low recolonisation rates by tortricid moths could lead to management recommendations.

MATERIALS AND METHODS

The fauna at two large apple orchards on flat land (76 ha and 37 ha) was studied, one in an area predominantly surrounded by pasture (Lincoln), and the other in the vicinity of other well established orchards and urban dwellings (Styx Mill). Both were

Proc. 43rd N.Z. Weed and Pest Control Conf. 1990: 322-327

under the management of Canterbury Orchard Services Ltd. Land use near the Lincoln Orchard included extensive gorse hedges. At Styx Mill, a swamp with mixed shrubs bordered the orchard to the south. Both orchards were subdivided into 1 ha blocks, separated by shelter consisting of *Salix matsudana* (Koidzumi) and poplar *Populus* spp. cv. 'Flevo'.

Locally manufactured triangular ("delta") sticky traps (28 cm long x 20 cm base x 15 cm x 15 cm) were baited with rubber caps dosed with sex pheromone, with the loadings reported elsewhere in this volume (Suckling *et al* 1990b). In 1989/90, two types of sibling species of *G. mutans* (Frerot *et al* 1989) were trapped in plastic funnel pheromone traps (International Pheromone Systems Ltd., South Wirral, U.K.). The lures contained (Z)-7-14 acetate, (Z)-9-14 acetate, (Z)-7-14 alcohol, and (Z)-9-14 alcohol for *G. mutans* "S". For *G. mutans* "N", the lures contained (Z)-9-14 aldehyde, (Z)-7-14 acetate, (Z)-9-14 acetate, (Z)-7-14 alcohol, and (Z)-9-14 alcohol (Frerot *et al* 1989; Foster pers. comm.).

Pheromone traps were set up at eight sites in each orchard, with one trap for each species on each perimeter boundary of the orchard, and one trap for each species in an internal site, at ca. 200 m from the perimeter. Traps for different species were 10 m apart, mounted at 1.5 m height. In 1989/90, only four perimeter pheromone traps were operated at each orchard, as these were shown to trap the highest numbers of moths. Analysis of variance of trap catch ($\log(x + 1)$) was used to compare trap catch over time or by trap position for the first 3 years.

Bait traps, operated in 1986/87 and 1987/88, consisted of 1 litre pails, with a metal roof and support. The molasses was allowed to ferment for 3 or 4 days before being placed in the orchard, and was changed weekly.

Orchard recolonisation was investigated by weekly time searches along a southwest-northeast transect 460 m in length, at right angles across the 70 ha rectangular orchard. The transect comprised ten sites across the orchard, each approximately 50 m apart. The outside row of the perimeter blocks were the first and last trees sampled. Four 4-year old Braeburn trees were searched for 2 minutes each at each site, the presence of leafroller or noctuid egg batches was recorded and the eggs removed. The search was repeated weekly from 16/3/88 to 25/5/88 (11 occasions).

RESULTS AND DISCUSSION

There were major differences in the pest faunas of the two orchards, with a predominance of LBAM at the Lincoln Orchard, and a greater relative abundance of native leafrollers at the Styx Mill Orchard (Fig. 1). The numbers of male tortricid moths caught in pheromone traps declined over the 4 years at all trapping sites at both Lincoln and Styx Mill. For LBAM at Lincoln, the mean catch per trap.day (November to March) over the 4 years from 1986/87 to 1989/90 was 4.8, 1.9, 1.2, and 2.1 males per trap.day. At Styx Mill, the mean catches of LBAM were 3.0, 1.9, 1.0, and 0.9 males per trap.day over the same period. Analysis of variance of trap catch ($\log(x + 1)$) over the first 3 years, when both internal and external traps were used, indicated highly significant reductions in all species over time ($P < 0.001$).

At Styx Mill Orchard, bait trap catches of different leafroller species fluctuated more with time, and results from the two trap types showed a degree of divergence (Table 1). LBAM formed a much lower proportion, and GHLR and BHLR a much higher proportion, of the total catch in the bait traps compared with that in the pheromone traps. This difference was probably due to the relatively small catches in bait traps (e.g. total catch of 64 in eight traps during 1987/88, giving a mean of 8 moths per trap, Table 1). This seems a likely cause also of the differences between years seen in the bait trap but not in the pheromone trap results (Table 1). Tomkins *et al* (1987) reported relatively consistent results in proportions of leafroller species in bait traps and larval counts between 2 years elsewhere in Canterbury.

Both the bait and pheromone traps consistently indicated the importance of LBAM at the Lincoln Orchard (>90% of leafroller moths caught) (Table 1), which was a similar result to that reported by Tomkins *et al* (1987) for the orchard at Lincoln University (approximately 5 km away from Lincoln Orchard).

Fig. 1: Differences in mean seasonal catches (catch per trap.day, November-March) of leafrollers and codling moth in eight pheromone traps at the Lincoln and Styx Mill Orchards, Canterbury from 1986/87 to 1988/89 (eight traps of each type at each orchard, with odd numbers for external traps, even numbers for internal traps).

Bait traps catch male and female tortricids and are useful for catching some moth species for which there is no pheromone lure (e.g. *G. mutans*, until recently). However, bait trap efficiency is very low and varies according to the state of fermentation of the bait and stage of the insect. Very regular maintenance is also required, particularly under hot dry conditions. Pheromone traps are more reliable and effective, but cannot be assumed to have the same trap efficiency for all species. Any comparison of relative abundance of different species must therefore take this into account. However, Tomkins *et al* (1987) found that bait trap and larval collections generally reflected the same faunal composition and it seems probable that the differences in trap catches we report here reflect true differences in the fauna between the orchards. These differences are probably largely due to the greater diversity of vegetation and more moist environment in the vicinity of the Styx Mill Orchard, compared to the Lincoln Orchard.

TABLE 1: Composition of the total seasonal trap catch of pest leafrollers (mean per trap, and percentage of the total catch) in pheromone and molasses bait traps at the Lincoln and Styx Mill Orchards in Canterbury from 1986/87 to 1989/90.

	Lincoln Orchard				Styx Mill Orchard			
	Total (No/trap)	LBAM (% of total)	GHLR (% of total)	BHLR (% of total)	Total (No/trap)	LBAM (% of total)	GHLR (% of total)	BHLR (% of total)
1986/87								
Bait traps ¹	24	99	0.5	0.5	38	36	33	31
Pherotrap ²	772	95	4	1	696	67	18	15
1987/88								
Bait traps	5	97	3	0	8	11	48	41
Pherotrap	323	92	5	3	404	73	11	16
1988/89								
Pherotrap	196	92	6	2	235	65	14	21
1989/90								
Pherotrap ³	334	90	5	5	193	70	10	20

¹ Females only (n = 8 traps)² Males only (n = 8 traps)³ n = 4 traps

Trap position has an important influence on catch. Catches of LBAM in external traps (odd numbers) were significantly higher ($P < 0.001$) than in internal traps (even numbers) at the Lincoln Orchard from 1986/87 to 1988/89 (Fig. 1), but there was no difference between internal and external traps at the Styx Mill Orchard. In contrast, trap site was a significant influence at Styx Mill ($P < 0.05$), but not at Lincoln. Factors such as insecticide use, the proximity of surrounding host plants and shelter, and wind (direction and velocity) are all likely to be important factors affecting trap catch at particular sites. Lincoln orchard is larger and surrounding pasture environment more homogeneous than at Styx Mill which may explain these results. Catches of other species were too low at Lincoln to provide a valid comparison of trap position.

Improved pest management procedures probably account partly for the decline in catch over the 4 years, although an increase in warm dry conditions occurred simultaneously (Table 2). Danthanarayana (1983) noted the effect of hot dry conditions on LBAM populations, and Tomkins *et al* (1987) suggested that dry conditions in 1981/82 reduced LBAM numbers in Canterbury compared to the previous year. A reduction in leafroller pest pressure in dry years could lead to a reduced need for insecticide use in those years.

Female leafroller catches in port wine bait traps on orchard borders were shown by Tomkins *et al* (1987) to be significantly related to pheromone trap catches on orchard borders, suggesting that pheromone traps could provide useful information on pest pressure at particular sites. In our studies, the catch of LBAM females in bait traps on orchard borders was also significantly related to the catch of LBAM males in nearby pheromone traps (No. females = $-23.1 + 0.087$ (no. males), $r^2 = 67\%$, $P < 0.05$).

TABLE 2: Summary of meteorological conditions over the 4 years, at DSIR Lincoln.

Period	Mean daily temperature °C	Cumulative day degrees ¹	Mean daily evapotranspiration ² (mm)
1/11/86-30/4/87	13.4	1176.9	3.2
1/11/87-30/4/88	14.8	1421.6	3.3
1/11/88-30/4/89	15.9	1624.4	4.3
1/11/89-30/4/90	16.0	1520.0	4.3

¹ Threshold of 7 °C² Penman (1948)

The total seasonal catch per trap of both sexes of *G. mutans* (presumably both "N" and "S" types) in bait traps (n=8) during 1986/87 was very low (Lincoln 53.5 moths, Styx Mill 8.1), compared to pheromone trap catches of males alone in 1989/90 (2661 at Lincoln, 101 at Styx Mill), illustrating the much greater sensitivity of pheromone traps for detecting insect populations. In both cases, far more moths were caught at Lincoln than at Styx Mill. The low catches of *G. mutans* at Styx Mill possibly reflect the much lower proportion of pastoral land in the vicinity.

Pheromone trapping for the two "types" of *G. mutans* has not been possible previously, and it is evident that extremely high catches can be obtained using the pheromone lures identified by Frerot *et al* (1989). The close similarity of the phenology and abundance of the two pheromone "types" in Canterbury (Fig. 2) is of interest and may remove the need to trap for both species in future.

Fig. 2: Catch of two pheromone types of *Graphania mutans* ("N" and "S") at Lincoln orchard in 1989/90.

Codling moth was relatively rare at both orchards (Fig. 1) (mean seasonal catch of 0.1 males per trap.day at Styx Mill and 0.06 at Lincoln for the 4 years), although sources were identified near both orchards. Despite the low numbers, some fruit damage was observed in 1986/87 at both orchards, although a recurrence was prevented through improved management procedures.

At Lincoln Orchard eggs of both LBAM and *G. mutans* were present although their distributions across the orchard were very different (Fig. 3). The noctuid eggs were evenly distributed across the whole transect, while eggs of LBAM were not found further than 100 m from the orchard boundary. Substantially more LBAM eggs were found on the NE boundary, than on the SW boundary of the orchard, suggesting that the prevailing NE wind could have influenced the observed dispersion.

Fig. 3: Comparison of orchard recolonisation between *Epiphyas postvittana* (Tortricidae) and *Graphania mutans* (Noctuidae), determined as counts of egg batches in a transect across the width of Lincoln Orchard from 16 March-25 May 1988.

Some noctuids are known to actively disperse over long distances (Johnson 1969), with flight speeds between 16 and 24 kph recorded in the laboratory for *Heliothis zea* (Boddie) and other moths (Callahan 1965), while LBAM has been shown to disperse over relatively short distances (Geier and Briese 1980; Suckling *et al* 1990a). Smaller insects tend to fly more slowly, and are more affected by wind (Johnson 1969), so the difference in orchard colonisation seen in Fig. 3 is not surprising. The evidence for limited dispersal by female LBAM suggests some possibility of reduced insecticide use in the centre of large orchards, provided that less than one generation is permitted between applications.

CONCLUSIONS

Pheromone and bait traps indicated important differences in the faunal composition of lepidopterous pests between two Canterbury orchards, which seem likely to be associated with surrounding land use. The scarcity of native leafrollers in Canterbury orchards surrounded by pasture may allow reductions in insecticide usage, with more careful targetting for control of LBAM. Some reductions in insecticide applications in the centre of large orchards may also be possible due to the limited dispersal capacity of females of this species. Tortricid infestation risk is likely to be greatest near orchard boundaries, while *G. mutans* is likely to have a more even distribution across large orchards.

ACKNOWLEDGEMENTS

We would like to thank the orchard managers at Lincoln and Styx Mill orchards for their cooperation in this research. We would also like to thank Dr S.P. Foster and Ms S.J. Muggleston (DSIR) for supplies of pheromone caps.

REFERENCES

- Bellas, T.E., Bartell, R.J. and Hill, A., 1983. Identification of the sex pheromone of *Epiphyas postvittana* (Lepidoptera: Tortricidae). *J. Chem. Ecol.* 9: 503-512.
- Callahan, P.S., 1965. A photoelectric-photographic analysis of the flight behaviour in the corn earworm *Heliothis zea* and other moths. *Ann. Ent. Soc. Amer.* 58: 159-169.
- Danthanarayana, W., 1983. Population ecology of the light-brown apple moth *Epiphyas postvittana* (Lepidoptera: Tortricidae). *J. Aust. Ecol.* 52: 1-33.
- Foster, S.P. and W.L. Roelofs., 1987. Sex pheromone differences in populations of the brown-headed leafroller, *Ctenopseustis obliquana*. *J. Chem. Ecol.* 13: 623-629.
- Frérot, B., Foster, S.P. and Dugdale, J.S., 1989. Preliminary results on pheromone identification in some noctuids (Hadeninae) from New Zealand. p 53-59. In: Bellas, T.E. (ed.) Applications of pheromones to pest control. Proc. Joint CSIRO/DSIR Workshop, Canberra July 8-11, 1988.
- Geier, P.W. and Briese, D.T., 1980. The lightbrown apple moth *Epiphyas postvittana* (Walker) 4. Studies in population dynamics and injuriousness to apples in the Australian Capital Territory. *Aust. J. Ecol.* 5: 63-93.
- Johnson, C.G., 1969. Migrations and Dispersal of Insects by Flight. Methuen & Co. Ltd. London. 763 p.
- Penman, H.L., 1948. Natural evaporation from water, bare soil and grass. *Royal Soc. (Lond.) A* 193: 120-145.
- Suckling, D.M., Shaw, P.W. and Rogers, D.J., 1990a. Disruption of lightbrown apple moth *Epiphyas postvittana* (Walker) (Lepidoptera: Tortricidae) trapping in Nelson, New Zealand. *Aust. J. Zool.* 38: In press.
- Suckling, D.M., Walker, J.T.S., and Shaw, P.W., 1990b. Reduced insecticide use in pipfruit: Nelson demonstration trials. *Proc. 43rd N.Z. Weed and Pest Control Conf.*: This issue.
- Thomas, W.P., 1965. Studies on *Epiphyas postvittana* (Walker) (Lepidoptera: Tortricidae) and its parasitoid complex. Unpublished M.Sc. thesis, Univ. of Canterbury. 130 pp and appendices.
- Tomkins, A.R., Penman, D.R. and Chapman, R.B., 1987. Use of traps for monitoring adult leafrollers in apple orchards. *N.Z. J. Exp. Ag.* 15: 91-95.