INTEGRATED CONTROL OF APPLE PESTS IN NEW ZEALAND

14. SEX PHEROMONE TRAPS TO DETERMINE APPLICATIONS OF AZINPHOS-METHYL FOR CODLING MOTH CONTROL

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Summary

Codling moth (*Laspeyresia pomonella*) populations in apple orchards in Auckland and Waikato were monitored for three seasons with traps baited with the sex pheromone of the species. Sprays of azinphos-methyl were applied to discrete blocks following a weekly catch of three moths in any trap in the block combined with a block mean of two moths/trap. In different seasons this permitted an average 50-66% reduction in the number of cover sprays required while maintaining codling moth damage well below 1%. Codling moth damage exceeded 1% only where monitoring and spraying were neglected by the grower. Leafroller fruit damage greater than 5 mm diameter rarely exceeded 2%. Grower response to the monitoring system was strongly positive and it is recommended for use in gate-sales orchards in northern areas.

INTRODUCTION

Sex pheromone traps can be used to monitor populations of codling moth in apple orchards and determine the need for application of insecticides against this pest (Madsen and Vakenti 1973; Vakenti and Madsen 1976). These traps are under investigation for this purpose in most of the apple-growing areas of the world (Audemard and Milaire 1975; Madsen *et al* 1974; Reidl *et al* 1976; Charmillot 1977) and are already in use commercially where codling moth dominates the design of spray schedules.

In New Zealand apple orchards insecticides are applied mainly for the control of codling moth, leafrollers (particularly *Epiphyas postvittana*, *Planotortrix excessana* and *Ctenopseustis obliquana*) and scales (particularly San José scale, *Quadraspidiotus perniciosus*). The relative importance of these pests varies between districts but in the key export areas of Hawkes Bay and Nelson, leafroller control dominates the design of spray programmes. Experiments in Nelson from 1973-75 (Wearing unpublished), where codling moth is univoltine, showed that the number of applications of azinphos-methyl required for codling moth control could be greatly reduced by using pheromone traps to monitor the population and guide spraying. However, leafroller damage, for which there is nil tolerance in export markets, rose to unacceptable levels in these experiments and negated any benefits from reduced spraying.

In orchards growing fruit for local consumption, especially for 'gate-sales', there is greater tolerance of insect damage. Low levels of leafroller damage can be tolerated without threatening the short or long-term sale of the crop. Under these conditions pheromone traps were considered potentially useful in permitting economic return from reduced

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insecticide schedules. The present paper describes trials with the traps at the DSIR Oratia Research Orchard, Auckland and at 'gate-sales' orchards in Auckland and the Waikato during 1975-78. In these areas codling moth is bivoltine with a partial third generation in warm seasons.

METHOD

The Traps

Pherocon ICP traps baited with standard Codlemone® rubber caps (Zoecon Corporation Ltd, U.S.A.) were used (Fig. 1). The aim was to place them at an approximate overall density of 1/0.4 ha by locating one trap every 150 m on the perimeter and one every 1.6 ha inside 2 ha blocks of mature full-bearing trees. However, blocks of only 0.8-1.6 ha were available in some orchards which resulted in slightly higher trap density.

FIG. 1: Sex pheromone trap for codling moth (Pherocon ICP trap, Zoecon Corporation Ltd, U.S.A.).

The traps were hung in the trees at a height of 1.5-2 m in mid-October (early-November 1976 due to late arrival of the traps) and remained there until harvest. Caps were changed every four (Research Orchard) or six weeks (commercial orchards) and the trapped moths were removed twice weekly.

Spraying

The thresholds for spraying were:

- three or more moths in any one trap in any calendar week and a block average for that week of two or more moths per trap, or
- an accumulated catch of ten moths in any one trap since the last spray (not used in 1977-78).

These thresholds were based on those of Madsen (pers comm) and on trials conducted in Nelson (Wearing unpublished). When spraying thresholds were reached, azinphos-methyl (0.037-0.05% a.i.) was normally

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TABLE 1: Description of monitored orchards, sprays applied and insect damage to fruit at harvest 1975-78.

to fruit at harvest 1975-76.										
Codling moth pressure	Orchard	Plot, Block No.	No. of sprays	Fruits re-corded	Codling moth entries		Leafroller		Bronze beetle and noctuid	
					Alive	Dead	< 5mm	> 5mm		
1975-76 Season										
Moderate	Oratia R.O.	Test 1	5	4749	0	0.31	0.13	0.05	3.2	
1976-77 Season										
Low	D	Test	2	1250	0	0	0.04	0.64	4.2	
		Control	3	2000	0	0	0	0.30	4.2	
	E	Test	3	1000	0	0	0	0.30	5.6	
		H	Test	2-3*	1865	0	0.62	1.87	2.35	13.6
	Control		5-6*	580	0	0.18	1.40	0	11.6	
	I	Test	1	8562	0	0	0.13	0.27	4.2	
		Control	5	780	0	0	0.51	0.12	13.1	
	J+	Test	3	2600	0	0	0.73	1.15	13.3	
		Control	5	1000	0	0.10	0	0	17.3	
	Light	Oratia R.O.	Test 2	3	414	0	0	0.24	0.48	28.3
			Test 4	2	480	0	0.21	0.83	0	23.1
		B	Test	1-2*	3337	0.02	0.17	0.22	0.92	2.5
			C	Test	2	1351	0.84	0.96	2.13	0.37
		Control		4	1056	0.32	0.31	0.87	1.27	4.9
G		Test	2	350	0	0	0	0	11.7	
		Control	4	827	0	0.12	0	0	6.2	
L		Test	2	820	0	0.11	3.70	6.71	1.0	
		Control	4	900	0	0.10	0.10	0.10	0.5	
M		Test	2**	750	0	0	0.28	0	3.6	
		Oratia R.O.	Test 1	4	566	0	0.18	0.18	0.18	9.9
Test 3			5	341	0	0.29	0.29	0	11.7	
Test 5			5	537	0	0	0.19	0.19	4.7	
Moderate		A	Test	2-4*	650	0	0	0	0	8.9
	N		Test 1	3	520	0	0	0.19	1.04	5.2
			Test 2	3	1040	0	0.10	0.67	1.54	3.4
High	F	Test 3	5	540	0.42	0	3.79	1.64	7.0	
		K	Test	5	950	0.80	1.68	0.13	0.18	31.2
			Test	3-4*	770	1.80	2.18	3.14	1.85	19.7
1977-78 Season										
Low	D	Test	2	300	0	0	0	0.33	2.0	
		Control	5	300	0	0	0	0	1.3	
Light	Oratia R.O.	Test 2	3	250	0	0	0.40	0.40	0.4	
		B	Test	3	750	0	0	0.30	0.30	1.4
			G	Test	4	800	0	0	0	0.38
Moderate	Oratia R.O.	Test 1	3	494	0	0	0.20	0.81	1.0	
		Test 3	3	400	0	0.25	0	0	0.5	
	N	Test 1	6	400	0	0	0	0	0.8	
		Test 2	5	700	0	0	1.45	0.20	0.1	
		Test 3	5	900	0	0	1.62	1.02	2.9	

* No. of sprays varied with cultivar

** Also 2 sprays before petal-fall for bronze beetle

+ azinphos-methyl at only 0.1 kg/ha

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applied in the following week. No spraying against codling moth was undertaken before the first week in November regardless of moth catch and sprays were never applied less than 2 weeks apart. Not all growers followed the recommended procedure rigorously and sprays were occasionally omitted. On the other hand many growers applied an October/November spray for bronze beetle (*Eucolapsis brunneus*) control and, rarely, a mid-season spray specifically against leafroller.

No changes were made to commercial spraying practices with other chemicals. Growers varied considerably in the volume of spray which they applied but this usually resulted in 1-1.2 kg azinphos-methyl per hectare (range 0.1-2.5).

All orchards were classified as being subject to low (no damage last year, no abandoned orchards within 1 km), light, moderate or high (moderate damage last year, abandoned orchard within 1 km) pressure from codling moth.

1975-76 season

Traps were placed throughout the DSIR Oratia Research Orchard and two traps in a 0.8 ha area of the orchard were used to determine spray applications to 'Jonathan' trees. At harvest insect damage was recorded on four cases of apples from each of ten trees using standard methods (Collyer and Geldermalsen 1975). Damage to windfall fruits from the same trees was also recorded. Damage to the fruits by leafrollers was recorded in two size classes, > and < 5 mm diameter.

1976-77 season

Pheromone traps were used to guide spray applications to discrete blocks (0.8-2 ha) within ten (A-J) commercial orchards in Auckland, four (K-N) commercial orchards in the Waikato and the Oratia Research Orchard (Blocks 1-5) (Table 1). The whole of orchard N was monitored. In seven of the commercial orchards half of the experimental block was sprayed according to the trap catches (test plot) and half was to be sprayed according to normal commercial practice (control plot). However, as the season progressed all growers also reduced their spraying on the control plot in response to the moth catches. Insect damage (see Collyer and Geldermalsen 1975) was recorded on 750-10000 fruits per orchard (depending on block size and cultivars present) selected at random either on the trees just before picking or in bins at harvest.

Sixteen cultivars were sampled from the plots including early-, mid-, and late-season apples which influenced the number of sprays applied. Where test and control plots were being compared, the harvest samples always contained cultivars common to both plots. Susceptibility to damage by leafrollers varied between cultivars but results cannot be presented here.

1977-78

Monitoring was continued in 1977-78 at Oratia Research Orchard, three Auckland commercial orchards (B, D, G) and one Waikato orchard (N). Trap catches remained the main determinant of spraying. However, on the basis of the results in 1976-77 all orchards were recommended to be sprayed once with azinphos-methyl in early November for control of codling moth, leafroller, and bronze beetle and to make special observations for leafroller damage in January/February. Insect damage to the fruit was recorded as in 1976/77.

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RESULTS

1975-76 Season

Two generations of codling moth were recorded by the traps. Five sprays were required mainly as a result of immigrant moths from a neighbouring abandoned orchard. The percentage of harvested fruit free of codling moth and leafroller damage was extremely high (Table 1), varying from 98.6-100% on individual trees. No deep entries by codling moth (i.e. live larvae) were recorded at harvest or in the windfalls and only four shallow (dead) entries were found on 514 windfalls examined. Damage to the crop by other insect pests was also low (San Jose scale 0.3%; woolly aphid (*Eriosoma lanigerum*) 0.5%; bronze beetle and noctuids 3.2%) with the exception of mealy bugs (*Pseudococcus* spp.) (25.4%). Insecticide for mealy bug control was deliberately omitted to avoid confusing the interpretation of the moth data.

1976-77 season

Two generations of codling moth were recorded by the traps, the second peaking at the end of February and being responsible for most of the spray applications (Figs 2 and 3). Codling moth pressure varied considerably between orchards and this was reflected in the moth catches and the number of sprays required (Figs 2, 3 and Table 1). The number of sprays applied also varied between late and early cultivars in the same orchard (Table 1), particularly in relation to the timing of the second generation of the moth. On the basis of the trap catches azinphos-methyl was sprayed from one to five times (see Table 1); four or five sprays were required only in plots which had been classified as subject to moderate or high codling moth pressure. Reduced insecticide schedules of 3-6 sprays were applied to the control plots.

FIG. 2:

Male codling moths trapped in orchards D (left) and H (right) in 1976-77. Arrow heads indicate applications of azinphos-methyl. Both orchards were subject to low codling moth pressure.

FIG. 3:

Male codling moths trapped in orchard N (test block 3) in 1976-77. Arrow heads indicate applications of azinphos-methyl. This orchard was subject to high codling moth pressure.

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Codling moth damaged much less than 1% of the fruit on all but three of the test plots (C, F, K Table 1). In these orchards trap monitoring and spraying were neglected and two were also subject to high codling moth pressure. In the remaining test plots live codling moth larvae (deep entries) were extremely rare (2 from 25,622 fruits examined).

The occurrence of leafroller damage (Table 1) was regarded as insignificant by all the growers. It was recorded in all orchards except two and was low in all blocks (Table 1). In the test plots the damage < 5 mm and > 5 mm averaged respectively 0.89% (range 0-3.8%) and 0.94% (range 0-6.7%), the highest figures being recorded in the Waikato orchards.

Bronze beetle/noctuid scars were the commonest defects caused by insects on the fruit (Table 1). However, even very small scars were recorded and in practice the numbers of fruits discarded or even downgraded was negligible. Bronze beetle/noctuid damage was well-healed and occurred mainly before codling moth threatened the crop and the level of damage was not, therefore, dependent on the monitoring system. Mealy bug was a highly localised problem and occurred in low numbers in all but one of the commercial orchards.

1977-78 season

Two generations of codling moth were recorded, the second reaching peak numbers in mid-February. As a result of the modified spray recommendations an average of 0.5 extra sprays were applied to the test plots in 1977-78 compared with the same plots in the previous season. Codling moth damage was virtually eliminated (Table 1). Both leafroller and bronze beetle/noctuid damage were markedly reduced compared with 1976-77 confirming the benefit of the modified control procedures adopted in 1977-78.

DISCUSSION

The standard insecticide schedule for codling moth and leafroller control in gate-sales orchards in the Auckland/Waikato area involves 6-8 applications of azinphos-methyl depending on cultivar. The present work has confirmed that pheromone traps for codling moth can be used to design reduced yet effective spray programmes against this pest. Five or six sprays were required only where abandoned orchards were close to the monitored orchards.

Although consistently present the leafroller damage which occurred under the reduced insecticide schedules was commercially acceptable to all the growers because they were not bound by export quarantine regulations. Further analysis of the harvest data in 1976-77 indicated that a spray of azinphos-methyl in early November (at petal-fall) would be advisable on all orchards and this was done in 1977-78. This would be well timed for control of bronze beetle and noctuids. Thereafter spraying could be determined satisfactorily using the codling moth pheromone traps. Inspection of the trees in January/February for leafrollers would provide a further guide to spraying, particularly on shorter-stemmed or tight-clustered cultivars susceptible to these pests (e.g. 'Summerland', 'Sturmer Pippin', 'Red Delicious'). These techniques were adopted in 1977-78 and resulted in very low damage by leafrollers.

Damage to the crops by other insect pests, notably by bronze beetles and mealy bugs, was also acceptable to the growers but improvements could clearly be made in some orchards. Apart from the November spray already mentioned which appeared effective against bronze beetle in 1977-78, further measures could be taken independently of the moth monitoring system. Insect damage in the test plots was considerably less than that caused by birds or mechanical means.

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In 1976-77 parallel trials were conducted on ten gate-sales orchards in Canterbury where codling moth is univoltine. Although codling moth control was satisfactory in these trials, damage by leafrollers was unacceptable under the reduced spray programmes (Thomas pers comm). This difference between the regions may be related to the different species composition of leafrollers in Canterbury and Auckland. A DSIR/MAF survey recently completed (Wearing *et al* unpublished) showed that *E. postvittana* and *P. excessana* were dominant among larvae attacking fruit crops in Canterbury whereas *C. obliquana* was the dominant species in Auckland; in Waikato *C. obliquana* was dominant but with a higher proportion of *P. excessana* in the samples compared with those from Auckland.

In conclusion, the pheromone trap monitoring system appears well suited to commercial gate-sales orchards where slight insect damage, especially with respect to leafroller, can be tolerated and where codling moth dominates the design of spray schedules as in the northern half of the North Island. However, it should be noted that timing of spray applications is critical for optimum efficiency of the system and this requires a change in present attitudes to pest control in orchards.

The high catches of codling moths in orchards close to abandoned orchards suggest strongly that the regulations for the removal of these reservoirs of insect pests should be strengthened.

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