MONITORING AND CONTROL OF PEAR SLUG (SAWFLY) IN AN ORGANIC NASHI ORCHARD

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SUMMARY

Adult pear sawflies (*Caliroa cerasi*) were trapped in an organic nashi orchard using yellow, orange and transparent flat and cylindrical traps coated with sticky compound. Sawflies were trapped over almost 7 months and peak flights occurred in December and February/March. Peaks in numbers of eggs also occurred at these times. Numbers of pear slugs peaked about 2 weeks later. A trial using organic insecticides acceptable in organic production revealed that control was best when pyrethrins were included in the formulation.

Keywords: *Caliroa cerasi*, control, monitoring, pear slug, traps

INTRODUCTION

In New Zealand, pear slug (*Caliroa cerasi*) (Hymenoptera: Tenthredinidae) is a minor pest in commercial orchards (Tomkins and Gouk 1987). Good control is possible because organophosphate sprays, applied for control of other pests, kill eggs and slugs (Carl 1972). Roitberg and Angerilli (1986) have highlighted the lack of monitoring systems for pear slug. It is likely that the success of organophosphates removed the necessity to monitor pear slug.

In organic orchards, "gate sale" orchards and private gardens, in the absence of blanket spraying, the two generations of pear slug can completely skeletonise trees such as nashi, European pear, flowering cherry, plum, hawthorn and june berry. Damage to trees can be extensive as effective defoliation can occur 6 months before natural leaf fall.

The life history of *Caliroa cerasi* begins in spring with the emergence of female sawflies which have overwintered in earthen cocoons in the soil (male sawflies are rare (Alford 1984)).

Female sawflies pierce leaves from the underside and deposit eggs under the upper cuticle. The eggs appear as small blisters which gradually increase in size. When the eggs hatch, slugs emerge and feed mainly on the upperside of the leaves. Slugs move to the lower side of leaves only when overcrowding or rain occurs. The slugs will skeletonise the leaves by eating the upper epidermis and mesophyll, thus causing browning and premature shedding of the leaves. After the last moult, the slugs are bright yellow and drop to the ground to form an earthen cocoon in the soil. After some time (dependent on temperature) adults emerge to give the second generation.

In this paper, we describe the further development of a monitoring system for flying adults (sawflies) using colour traps that was described by van Epenhuijsen and Carpenter (1990). Relationship between adult phenology and egg and slug numbers is shown as is the impact of aspect on pest levels. We also report on the use of natural pesticides for the control of pear slugs in organic systems.

METHODS

Research was conducted at the Levin Horticultural Research Centre. The organic nashi (*Pyrus serotina*) block consisted of 0.5 ha with 4-year-old 'Hosui', 'Kosui' and 'Nijiseiki'. The trees were 5.2 m high and rows were orientated northeast-southwest.

Sawfly trapping

Flat board and cylindrical traps were of two different colours or transparent perspex. Each type was replicated seven times. The flat boards (150 x 210 x 5 mm), were

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spray-painted on both sides with fluorescent "Dazzle yellow" (yellow green 154 B¹), a so-called 'markerpaint', or painted with Sun (orange 23A), or made of perspex (3.3 mm thick). The transparent cylindrical traps (205 mm high) were made of plastic glazing sheets (LEXAN-General Electric) 1.1 mm thick and 90 mm diameter. The painted cylindrical traps were made from 90 mm diameter polyethylene pipe and painted as for the flatboard traps.

Acetate sheets (297 x 205 mm) were attached to all of the traps and covered with sticky tacktrap to immobilise sawflies. The acetate sheets were changed every 3 weeks. The orange oil-based paint remained in good condition during the observation period. The yellow paint flaked off when the acetate sheets were removed, and traps had to be repainted twice. The transparent traps were cleaned twice during the trial, using kerosene, when the perspex became cloudy.

Traps were suspended from a horizontal wire running 2.6 m above ground level in one row of 'Kosui' and two rows of 'Hosui'. The row spacing was 5 m. The area was divided into seven blocks down the rows. Within each block the six different traps were placed, two in each row with a spacing of 2-3 m within rows. Shoots were kept at least 30 cm from the traps, as recommended by Wildbolz and Staub (1986), to allow the sawflies access to the traps. Trap positions were re-randomised between sites every 4 weeks.

Monitoring eggs and slugs

Eggs and pear slugs were counted on all leaves on 30 branches on a single row of 'Hosui'. Fifteen branches 1.2 m high with 6-60 leaves (mean: 30 leaves) were tagged on each side of the 'Hosui' trees to monitor first-generation pear slugs. During the season, many vigorous shoots were pruned back to a maximum of 120 leaves per shoot.

To monitor second generation pear slugs, 60 branches were tagged, 15 on each side of two rows of 'Hosui'. Each branch had 9-25 leaves (mean: 14 leaves) and some leaves had been partly skeletonised by the first generation of pear slug. This was the reason that more branches were used. The number of slugs and eggs on both sides of leaves was recorded weekly.

Insecticide trial

For the insecticide trial, branches 40-60 cm length were chosen at random on both sides of 'Hosui' trees. Each of 10 treatments were replicated on 10 branches. Branches were sprayed to run-off on 23 February using a Cambrian CSP/15 compressed air hand sprayer. Slugs were counted on each branch 1 day later.

Chemicals tested were: Liquid Derris, which contains 30 g/litre rotenone, 3.7 g/litre pyrethrum and 15.1 g/litre piperonal butoxide; Multicrop, an insecticide with 150 g/litre garlic extract, 0.8 g/litre pyrethrins and 3.1 g/litre piperonyl butoxide; Safers, a natural insecticide concentrate containing a fatty acid with 477 g/litre potassium salts in the form of a soluble concentrate; Naturgro R-50, containing 0.11% ryanodine as an active ingredient; Naturgro Triple Plus W.P. containing 0.1% pyrethrins, 0.055% ryanodine and 0.75% rotenone; Neem, a neem seed oil extract with 5% azadirachtin; Bettacrop, containing 18 g/litre garlic extract, 12 g/litre pyrethrum oil and 3% potassium permanganate; and Coopers Pyrethrum, containing 14 g/litre pyrethrum and 56.5 g/litre piperonyl butoxide.

Statistical methods

The data from the monitoring trial is in the form of counts. Most theoretical model distributions for counts are skewed (Mead 1988), and the variance is likely to increase with increases in the mean value. Also it is reasonable to assume that our treatment effects are relative rather than additive. For the above reasons, and the fact that range in data is large, the data (x) was transformed into $\log_{10}(x + 1)$ to obtain a valid statistical analysis. To determine the effect of aspect on number of flies trapped, a paired t-test was done (west and east counts of a trap forming the pair), and the back transformed difference provided an estimate for ratio of (west/east) count. The significance of trap type and colour was determined by fitting a general linear model to data (using statistical package SAS) with trap type, colour and interaction of type x colour as model

¹Colours are defined by RHS Colour cards (1966)

parameters. Again the estimated means were back-transformed to give ratios that indicated relative effects.

For the insecticide trial, results were expressed as percentage mortality. Hypothesis testing was done by considering the normal approximation to the binomial random variable and computing the maximum standard error for difference as $100(0.5/N)^{1/2}$ where N = smallest total number of slugs, and then estimating the least significant difference at 95% confidence level.

RESULTS AND DISCUSSION

Sawfly trapping

The weekly record of sawfly catches is given in Figure 1. The yellow, orange and transparent traps gave broadly similar patterns of flight. There appears to be two major flight periods, in December and the end of February-March. This observation is consistent with there being two generations (Penman 1984), although more than two generations occur in Italy and U.K. as found by Golfari and Massee, quoted by Carl (1972).

Fig. 1: Mean number of pear slug sawflies per trap.day in yellow, orange and transparent flat boards and cylindrical traps at Levin H.R.C. 1990-1991. The bars represent standard errors and where missing are contained within the symbols.

Yellow traps usually caught significantly more sawflies than orange traps and both of these colours were more attractive to sawflies than transparent perspex during 8 weeks when the mean catch was greater than 10 sawflies per week (Table 1). Orange traps collected 3.8 times more flies than transparent traps and in half of the 8 weeks, yellow traps collected about twice as many flies as the orange. On 25 April recording was halted on all except the yellow traps from which 25 sawflies were collected. In the following 2 weeks only six and four sawflies were respectively caught in the 14 yellow traps. A total of 5726 sawflies were caught in the yellow traps.

More flies were trapped on the western facing sides of the traps (Table 1). Ovipositing females prefer sunny, wind sheltered areas (Carl 1972) and this may explain

TABLE 1: Comparison of catch of pear slug sawflies per trap.day in relation to aspect and trap type.

Period	Mean catch per trap/day	Mean yellow/orange count	Mean orange/ transp. count	Mean west/east count
30 Nov-6 Dec	3.57	2.37*	3.16*	1.24 NS
7 Dec-13 Dec	1.45	2.18*	3.06*	1.15 NS
18 Jan-24 Jan	1.65	2.30*	4.16*	1.16 NS
1 Feb-7 Feb	1.52	1.99*	3.51*	1.35*
22 Feb-28 Feb	5.88	1.50 NS	4.30*	1.53*
1 Mar-7 Mar	1.83	1.00 NS	3.73*	1.80*
15 Mar-21 Mar	3.40	1.41 NS	4.67*	1.72*
22 Mar-28 Mar	2.22	1.55 NS	4.24*	2.49*
Overall Mean	2.69	1.79	3.85	1.55

*Ratio significant ($P < 0.05$)

why more flies were trapped on the sunnier western side. By the end of the season, it was apparent that the western side of the trees had suffered more slug damage.

In three of the eight periods analysed, the flat boards had significantly higher counts than the cylindrical shaped traps ($P < 0.05$).

From our data, some idea of the number of traps required can be obtained. This season 14 traps of each colour were used, and at times of peak catches, 30-70 flies were caught per trap. Assuming the frequency distribution of sawflies in traps followed a Poisson distribution, the number of traps required to give a 95% confidence limit equal to 10% of the mean is between six and thirteen. The lower number can be used during peak flight times. However, these traps need to be evenly distributed over the orchard block.

Monitoring eggs and slugs

Two generations of pear slugs and eggs are clearly seen in Figure 2. Peak numbers of pear slugs were found on leaves on 27 December.

Female sawflies live for 6-10 days and begin to lay a total of about 47 eggs each on the day they emerge from the soil (Carl 1972). Although large numbers of eggs were found on leaves during March, there was no corresponding increase in slugs (Fig. 2). It was observed that a proportion of the eggs remained flat and blackened, and did not hatch, while a significant number of slugs were found dead with symptoms similar to a protozoan disease reported by Hill and Valentine (1987) and Carl (1976). During February, females laid eggs on very young leaves, possibly due to the shortage of more suitable expanded leaves. The young leaves expanded before the eggs developed, leaving the eggs exposed to wind and rain. There may also have been a shortage of food. At the end of March, leaves were very severely damaged and more than 60% of tagged shoots were completely brown (skeletonised) and monitoring was stopped.

Branches on the west side of trees contained nearly three times as many slugs and eggs as branches on the east side. During eight periods when counts were high, mean ratios of west/east counts for eggs and slugs were 2.9 (range: 1.6-4.3) and 2.9 (range: 1.4-4.9) respectively.

The number of leaves per branch increased very little during the rapid buildup in slugs and eggs in the branches. Hence the trends seen for number of eggs/slugs per branch (Fig. 2), also reflect the changes in slug/egg density on leaves. With the increase in slug density on leaves one could expect a similar increase in percentage of damaged leaf tissue.

Control by insecticides

The mean slug count per branch (alive and dead, 1 day after treatment) varied from 21-35 and the natural death of larvae in the control was 2.8% (Table 2). Very good results were obtained with Bettacrop, Cooper's Pyrethrum, Multicrop and Naturgro R-50. All except Naturgro R-50 contain pyrethrins. Overall Bettacrop gave the best control, with a mortality of 98.4%. The high mortality using the lower concentration of

Fig. 2: Mean number of pear slug and eggs per branch for the first generation (hollow) and second generation (filled) on Nashi trees at H.R.C. Levin 1990-1991. Bars represent standard errors, and where missing are contained within the symbols.

TABLE 2: Effect of nine insecticides on percent mortality of second generation pear slugs.

Treatment/Solution	Total No. of slugs on 10 branches	Percentage mortality*
1. Control	353	2.8a
2. Safers Natural Concentrate 3.1%	257	4.7a
3. Neem 0.05%	211	27.5b
4. Liquid Derris 0.5%	253	30.0b
5. Naturgro Triple plus 1.25%	244	59.8c
6. Multicrop (Garlic) 2.5%	235	81.7d
7. Multicrop (Garlic) 10%	289	90.3de
8. Coopers Pyrethrum 0.5%	276	90.9de
9. Naturgro R-50 0.8%	247	91.9e
10. Bettacrop Insecticide Concentrate 2.5%	252	98.4e
Approximate LSD	—	10

*Estimates followed by the same letter are not significantly different at 5% level.

Multicrop is very encouraging and could offer a cost reduction. Liquid Derris, which we had previously found to give good control (van Epenhuijsen and Carpenter 1990) gave poor control. In another test with Liquid Derris in March, similar poor control was obtained. Liquid Derris has now been withdrawn from the market.

CONCLUSIONS

Pear slug sawflies are easily trapped and easy to identify. Peak numbers of slugs occur about two weeks after a major flight.

The decision to spray at the right moment with a "shortlived" organic compound should be based on the presence of a high number of slugs and an acceptable level of damage. At present we do not have enough data to develop a useful spray threshold density for pear slug but indications are that a slug density greater than 0.25/leaf (1 slug every 4 leaves) is likely to cause economic damage.

Pyrethrum-based insecticides appear to give good control of pear slug. Many of these insecticides need the synergist piperonyl butoxide. Unfortunately for organic growers, this compound is not always acceptable to the regulations on organic produce. Bettacrop does not contain this synergist. The chemicals, Bettacrop insecticide concentrate and Cooper's Pyrethrum, are not yet registered for commercial orchards. The other effective chemicals Naturgro R-50 and Multicrop are not registered in New Zealand.

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