EVALUATION OF ORGANICALLY-ACCEPTABLE PESTICIDES AGAINST THE GREEN PEACH APHID (*MYZUS PERSICAE*)

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ABSTRACT

Organically-acceptable insecticides were field-tested against the green peach aphid (*Myzus persicae*). An initial trial tested 11 products using single nectarine trees as plots. The four most promising treatments were then applied to larger plots by an air-blast sprayer in early November. Pyrethrum mixed with mineral oil was the most effective aphicide, reducing aphid populations from >20/shoot, to 0 and <5/shoot in the small and large plot trials respectively. Mineral oil alone and the fungus *Beauveria bassiana* had some effect in the small plots but not in the larger ones. Pyrethrum should be used only against severe infestations of *M. persicae*, until it is shown to be non-disruptive to biological control. Mineral oil was less likely to cause side effects, but needed to be applied early in the season to achieve complete spray coverage.

Keywords: *Myzus persicae*, organic insecticides, pyrethrum, mineral oil, stonefruit.

INTRODUCTION

The green peach aphid (GPA) (*Myzus persicae*) is one of the main pests of peaches and nectarines in New Zealand (McLaren *et al*. in press). Populations developing on leaves will stunt or kill young shoots if left unchecked. On nectarines in particular, feeding by GPA on fruitlets immediately after flowering causes fruit to abort or distorts their growth, resulting in misshapen fruit.

Aphids overwinter as eggs on trees and hatch during August (McLaren and Fraser 1996). Mineral oil with or without an organophosphate insecticide is routinely applied to smother overwintering eggs during the dormant, pre-blossom period up to late August. Aphid populations have short generation times and their numbers increase rapidly under favourable conditions. In Hawke's Bay, GPA populations can reach damaging levels from October through to December (Lo *et al*. 1995). From mid-December onwards, GPA populations decline naturally on summerfruit as they move to alternate hosts. The objective of this trial was to evaluate the efficacy of organically-acceptable insecticides against GPA, when applied post-bloom.

MATERIALS AND METHODS

Small plot trial

Eleven products were tested on 4-year old nectarine trees, cv. Fantasia, on 30 October and 5 November 1997 (Table 1). Pyrethrum, mineral oils and potassium soaps are known to have some efficacy against aphid eggs or active stages. The fungal entomopathogen *Beauveria bassiana* attacks several groups including Lepidoptera, Hemiptera and Coleoptera. The botanical insecticides from neem oil and ryania have activity against several important groups of insects. Cryolite is a stomach poison made from ground sodium fluorosilicate rock. Diatomaceous earth is an inert substance that acts as a desiccant on some groups of insects. One conventionally approved aphicide, the carbamate pirimicarb, was included for comparison.

One tree was used per treatment and 10 shoots per tree, each with more than 20 aphids were labelled before treatments were applied. Tightly curled shoots were avoided and there were one or two guard trees between plots. Treatments were applied

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with a 5 litre hand sprayer, using one litre of solution per treatment. Control shoots were sprayed with water. The shoots received a more thorough wetting than they would by an air-blast sprayer because of a higher water rate (approximately 2000 litres/ha) and because less water was lost to the surroundings. The treatments were assessed after five days when the numbers of live GPA per shoot were scored as follows: 0 = no aphids; 1 = 1-5 aphids; 2 = 6-20 aphids; 3 = >20 aphids.

Large plot trial

The four most promising products from the single tree evaluation were evaluated further on the same orchard. They were applied using an air-blast sprayer operated at 1500 litres/ha. The six treatments included an unsprayed control and two rates of pyrethrum and mineral oil, the recommended rate of 0.25% and double this rate (Table 2). The treatments were replicated six times in a randomised block design.

There were two nectarine cultivars, 'Red gold' and 'Fantasia', in seven rows, three of each variety and a mixture in the central row. Plots were three rows wide plus one side of the central row, by 7-8 trees long. Each treatment covered a total area of approximately 0.1 ha. In each plot, 20 shoots with more than 20 aphids, where possible, were labelled on the centre 6-8 trees in the two outermost rows. This arrangement allowed two guard rows between varieties and buffers of two trees around the labelled shoots between adjacent plots.

Sprays were applied on 12 November 1997 and the number of aphids was re-assessed five days later. Aphid populations were scored as before. Data were analysed using a Kruskal-Wallis test with the correction for tied ranks (H_c is the test statistic) (Zar 1996). Where treatment differences occurred, a Nemenyi test (a non-parametric equivalent to a Tukey test) was performed using Dunn's correction of the standard errors to allow for unequal sample sizes (Zar 1996).

RESULTS

Small plot trial

Products with the greatest effect on GPA were pyrethrum and oil, pirimicarb, mineral oil alone and *Beauveria bassiana* (Table 1).

TABLE 1: Mean post-treatment score[1] of live aphids per shoot on 10 shoots in the small plot trial.

Active ingredient	Trade name	Product rate/litre	Aphid score[1] Mean	SD
pyrethrum + mineral oil	Night-time	2.5 ml	0	0
pirimicarb[2]	Pirimor	0.25 g	0.9	0.57
mineral oil	Sunspray	20 ml	1.1	0.88
mineral oil	Sunspray	10 ml	1.3	0.67
Beauveria bassiana	BotaniGard ES	1 ml	1.4	0.52
pyrethrum & garlic extract	Bettacrop Garlic & Pyrethrum	25 ml	2.0	0.99
fatty acids (soap)	Yates Defender	20 ml	2.5	0.85
fatty acids (soap)	NuFarm soap	20 ml	3.0	0
neem extract	Neemix	0.5 ml	3.0	0
Ryania	Ryan 50	6 g	3.0	0
Cryolite	Cryolite	4 g	3.0	0
diatomaceous earth	Diatomaceous earth	11 g	3.0	0
control (water)			3.0	0

[1]Numbers of aphids per shoot were scored as follows: 0 = no aphids; 1 = 1-5 aphids; 2 = 6-20 aphids; 3 = >20 aphids. All shoots had pre-treatment scores of 3, five days earlier.

[2]Not organically-acceptable.

The two rates of mineral oil had similar post-treatment aphid scores. No phytotoxic effects from the 2% rate were observed after a week. Pyrethrum and garlic, and the Yates soap Defender killed some aphids, but did not reduce populations to the same extent as the above products. In contrast, the NuFarm soap, neem extract, ryania, cryolite and diatomaceous earth all had no observable toxicity against aphids in this trial.

Large plot trial

Aphid scores were similar amongst the plots before treatment ($H_c = 7.8$, df = 5, $P > 0.05$), but differed after treatment ($H_c = 206.0$, df = 5, $P < 0.001$) (Table 2). Pyrethrum and mineral oil was the only product to significantly reduce aphid populations and the higher rate was more effective than the lower standard rate. The mineral oil, soap and *Beauveria bassiana* all caused some mortality to aphids but most of the labelled shoots still had more than 20 live GPA present. Consequently, the aphid scores did not change and there was no significant difference between these treatments and the control.

TABLE 2: Mean score[1] (and standard error of mean) of numbers of live aphids on 20 shoots before and after treatment in the large plot trial.

Treatment	Rate	Pre-treatment Mean[2]	Pre-treatment SEM	Post-treatment Mean[2]	Post-treatment SEM
Night-time	0.5%	2.67 a	0.06	0.92 a	0.12
Night-time	0.25%	2.71 a	0.05	1.85 b	0.12
BotaniGard ES	0.1%	2.51 a	0.10	2.41 c	0.15
Defender	2%	2.49 a	0.11	2.45 c	0.14
Sunspray	1%	2.57 a	0.14	2.48 c	0.16
Control		2.62 a	0.08	2.65 c	0.06

[1]Numbers of aphids per shoot were scored as follows: 0 = no aphids; 1 = 1-5 aphids; 2 = 6-20 aphids; 3 = >20 aphids.

[2]Means in a column followed by the same letter were not significantly different ($P < 0.05$).

DISCUSSION

At the time the treatments were applied, the aphid population had already caused damage to shoots. Pyrethrum and mineral oil was the only product that effectively controlled this level of GPA. Research in Central Otago (McLaren and Fraser 1996; G. McLaren pers. comm.) found that pyrethrum was as effective as the organophosphate chlorpyrifos in reducing GPA damage to nectarine fruit, whereas fatty acids and ryania were ineffective. One disadvantage of pyrethrum is its rapid break-down when exposed to ultra violet light. In this trial, the mixture was applied during the day. It has since been found to be more effective against several other pests when applied at night (C. Henry pers. comm.).

Pyrethrum has a broad spectrum of activity, however, which is potentially disruptive to biological control. For example, pyrethrum is toxic to predatory mites and can induce an outbreak of phytophagous mites, although no outbreaks had occurred at the trial site by harvest. The product tested (Night-time) has a lower concentration of pyrethrum than other brands, so it may have less side effects. Its compatibility with natural enemies needs to be determined before it could be fully recommended.

Pyrethrum and mineral oil, like most organic insecticides, are restricted materials under Bio-Gro regulations, but are permitted with special approval. Unlike other brands of pyrethrum, Night-time does not contain the synergist piperonyl butoxide. Piperonyl butoxide is permitted under the current Bio-Gro regulations, but is likely to be banned when these are re-drafted (M. Levick pers. comm.).

Mineral oil looked promising in the small plot trial, but effective control was not achieved on the large plots. This was probably because of the difficulty in obtaining complete coverage with the air-blast sprayer. Mineral oil is normally targeted against aphid eggs, but it also killed the active stage in this trial. Mineral oil should be most effective when applied early in the season before aphids cause the leaves to curl. Spray coverage should also be improved because the shoots are smaller at this time of year. Pest monitoring will be important in determining the best timing of spray applications. A spray threshold for GPA was developed for use with pirimicarb after bloom on process peaches (Lo *et al*. 1995), but a different threshold may be appropriate for oils and pyrethrum.

Potassium soaps (fatty acids) are one of the few insecticides permitted without restriction by the Bio-Gro production standards. In this trial, the efficacy of the two soaps was disappointing. After the trials were conducted, Yates New Zealand Ltd., the distributor of Defender, found that the wrong formulation of one ingredient had been inadvertently used in the product supplied for the trials. (P. De Jong pers. comm.). Yates New Zealand Ltd. believe that Defender manufactured with the correct ingredients would be more effective than the batch that was tested.

B. bassiana showed enough potential against GPA to be worth further evaluation. BotaniGard ES is not commercially available in New Zealand, but could be a useful alternative if presently available products provide insufficient control or are prohibited under new Bio-Gro regulations. In temperate climates, however, the effectiveness of entomopathogens outside glasshouses is limited by their requirement for high levels of humidity for spore germination and disease transmission (Quinlan 1988).

Several natural enemies attack GPA, including the eleven-spotted ladybird (*Coccinella undecimpunctata*) (Early 1984). This ladybird was numerous at the trial site by early December, but was still scarce in late October when aphid damage was already apparent. Increases in the populations of ladybirds and aphids were not sufficiently well synchronised to prevent aphids killing some shoots. Nevertheless, ladybirds could still be effective predators where a selective insecticide has previously reduced the aphid population. In this situation, an insecticide would not need to kill all the aphids. This could potentially allow a lower rate of pyrethrum to be used. Alternatives to pyrethrum such as oils, soaps or *B. bassiana*, despite their lower toxicity to GPA, could prove as effective if they were more compatible with natural enemies.

While organically-approved insecticides may have a low toxicity to beneficial insects, they are not necessarily completely benign. Lo and Blank (1992) tested mineral oil and Defender on the predation of scale insects by the steelblue ladybird (*Halmus chalybeus*). Although no ladybirds were killed, the oil did disrupt their feeding. An organic insecticide cannot be fully recommended for use against GPA until its compatibility with natural enemies such as eleven-spotted ladybirds has been determined.

CONCLUSION

Until natural enemies can be manipulated to give complete control of GPA, many organic growers will need to rely on chemical intervention. While pyrethrum could be recommended for GPA because of its efficacy, questions remain over possible side effects on natural enemies. Mineral oil alone killed the active stages of GPA, but was less effective than pyrethrum. This indicates that oil can probably control only lower aphid densities. Oil needs to be applied earlier in the season than in this trial, when better spray coverage is possible and before aphids damage shoots. One product (Night-time) combining a low rate of pyrethrum and mineral oil was highly effective. It had no apparent effects on predators although this was not specifically examined.

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