PYRETHROID INSECTICIDES FOR APPLE PEST CONTROL: II FIELD EVALUATION OF MITE AND INSECT CONTROL

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SUMMARY

Strains of synthetic pyrethroid (SP) insecticide-resistant *Typhlodromus pyri* Scheuten were evaluated for European red mite (*Panonychus ulmi* Koch) control in field trials. Once the SP-resistant predators were established within a block they provided effective control of European red mite. Control of lepidopterous pests with SP insecticides applied at four-weekly intervals was similar to a fortnightly organophosphorous (OP) insecticide programme. Control of homopterous pests with SPs was generally inferior to that with OP insecticides. SP insecticides offer significant advantages for leafroller control on apples, by substantially reducing insecticide use needed to meet export standards.

INTRODUCTION

The organophosphate (OP) insecticide-resistant predator mite, *Typhlodromus pyri*, is widely used in integrated mite control (IMC) programmes for European red mite (ERM) *Panonychus ulmi*, control in New Zealand. The continued benefits of this IMC programme are highly vulnerable to any major change to the existing, OP-based, insect control programme. To reduce the dependence of IMC on the continued use of OP insecticides, DSIR initiated a programme in 1978 to develop synthetic pyrethroid (SP) insecticide resistance in *T. pyri*. Previous field studies had indicated that SPs gave excellent control of tortricid leafrollers, the pest group for which control with OP's was considered most likely to fail. However, SPs were highly toxic to *T. pyri* (Wearing and Thomas unpublished).

Field and laboratory selection programmes to develop SP resistance in *T. pyri* are described by Markwick *et al* (1990). The strains developed were considered sufficiently resistant to cypermethrin by 1985 for field evaluations to commence in the 1985/86 season. These studies evaluated the ability of the SP-resistant strains of *T. pyri* to establish, disperse and control ERM under an SP spray programme. The acceptability of insect control with SP based programmes was also assessed throughout this research. This paper summarises trial results with the field-selected strain of synthetic pyrethroid resistant (SP-R) *T. pyri*.

MATERIALS AND METHODS

SP-based Integrated Mite Control

A four year study at the DSIR Research Orchard, Havelock North (1986-1990 inclusive), was typical of trials elsewhere in New Zealand on SP-R *T. pyri* establishment and ERM control with the field selected strain. In November 1986 SP-R *T. pyri* was released into a small (120 trees) block of apples (cv. Royal Gala) planted at 3 x 5 m spacings. It was released into every third tree in alternate rows immediately following application of esfenvalerate, at either 1.5 g or 2 g/100 litres to a divided block. Three applications of esfenvalerate were applied in the 1986-87 season, at 4-5 week intervals. In the 1987/88 season deltamethrin (1 g/100 litres) was similarly applied to the entire block. In subsequent seasons the block was again divided and either esfenvalerate or

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deltamethrin was applied (1.5 g and 1 g/100 litres respectively). Miticides were not applied to any treatment during the entire study period. A late winter oil (2 litres/100 litres), plus chlorpyrifos (40 g/100 litres), was applied in September 1989 and again (at 60 g/100 litres) in November 1989, to improve the control of mealybug (*Pseudococcus* spp.) and woolly apple aphid (*Eriosoma lanigerum* Hausmann).

To determine the impact of OP insecticides on SP-R *T. pyri*, the original SP treated block (cv. Splendour) at the DSIR Research Orchard, Appleby, was divided into two treatments for the 1988/89 season (Markwick *et al* 1990). The entire block received four-weekly esfenvalerate sprays (1.5 g/100 litres) but part of the block received two additional chlorpyrifos sprays (25 g/100 litres) on November 10 and January 20.

Mite populations in both studies were monitored by taking 50 leaf samples at two-weekly intervals from "release" and "non-release" trees. Leaf samples were brushed onto glass plates with a mite brushing machine and the mites counted using a binocular microscope.

SP-based insect control

Insect control using cypermethrin, deltamethrin, fenvalerate and esfenvalerate has been evaluated in numerous field trials. In the trials presented here the SP sprays were applied at 4-5 week intervals but the period between final application and harvest was variable, up to 57 days. Where standard OP spray programme data are provided, all sprays were applied at 2 to 3 week intervals until harvest. Chlorpyrifos and azinphosmethyl were applied at 38 g and 50 g/100 litres (Havelock North and Appleby respectively). Insect control was evaluated by inspecting 1000 fruit at harvest and recording the percentage of fruit infested or damaged by insects.

RESULTS

SP-based Integrated Mite Control

The development of ERM and SP-R *T. pyri* populations in 1986/87 and 1987/88 is presented in Figure 1. The numbers of mites on "release trees" are shown in 1a and 1c and on "non-release" trees in 1b and 1d. In 1986/87, ERM numbers were initially low in the block and OP-R *T. pyri* was rapidly eliminated following the first application of esfenvalerate in early November. SP-R *T. pyri* was released in November (after the SP spray) and was recovered regularly in leaf samples from late December. However, it did not prevent a rapid increase in the ERM population which reached damaging levels during February and caused premature defoliation.

SP-R *T. pyri* increased rapidly on the "release" trees throughout February (Fig. 1a) and appeared regularly in leaf samples from adjacent "non-release" trees (Fig. 1b) during March. Although SP-R *T. pyri* did not prevent another serious outbreak on "release" trees in March, ERM numbers were lower and leaf damage was less than on "non-release" trees.

In 1987/88 *T. pyri* was present in "non-release" trees during November (Fig 1d) but the ratio of ERM:*T. pyri* was unfavourable (>10:1). ERM numbers increased rapidly causing severe damage. This contrasted with adjacent "release" trees (Fig. 1c) where ERM numbers remained low and no leaf damage occurred. In subsequent seasons SP-R *T. pyri* maintained ERM populations at low levels throughout the entire block; no significant leaf damage due to mite feeding occurred.

TABLE 1: The percentage of fruit infested or damaged by insects following pyrethroid-based insect control programmes over three seasons at DSIR, Appleby.

Year	Programme SP sprays	OP sprays	% fruit infested at harvest		
			Leafroller	Mealybug	W.A.aphid
88-89	esfenvalerate x 5	—	0.10	33.10	0.22
	esfenvalerate x 4	+ chlorpyrifos x 2	0.00	2.30	0.10
	—	azinphosmethyl x 9	0.00	3.50	0.60
89-90	esfenvalerate x 5	—	0.00	4.87	0.40
	esfenvalerate x 4	+ chlorpyrifos x 2	0.00	8.53	0.53
	—	azinphosmethyl x 9	0.00	8.52	0.40

Fig. 1: Mite monitoring of pyrethroid sprayed trees showing the number of European red mite (●—●) and SP-R *T. pyri* (+ +) active stages per leaf on “release” trees (Fig. a and c) and “non-release” trees (Fig. b and d) over two seasons.

The impact of chlorpyrifos applications on SP-R *T. pyri* is shown in Figs. 2a and 2b. ERM control was excellent throughout the season and there was no marked decrease in predator numbers following the chlorpyrifos applications. Numbers of *T. pyri* were similar to those in trees receiving esfenvalerate only.

SP-based insect control

Insect control with SPs as determined by fruit damage at harvest, is shown in Tables 1 (Appleby) and 2 (Havelock North). High levels of leafroller control were

Fig. 2: The number of European red mite (● — ●) and SP-R *T. pyri* (+) active stages per leaf on (a) trees treated with pyrethroid insecticide only and on (b) trees treated with both pyrethroid and organophosphate sprays (OP).

achieved with four-weekly applications of either fenvalerate, esfenvalerate or deltamethrin. Leafroller control in the Appleby trials with SPs was not significantly different to two-weekly applications of azinphosmethyl (Table 1). Both esfenvalerate and deltamethrin gave high and similar levels of leafroller control (Table 2). The presence of low levels of leafroller damage in pyrethroid treatments at either location was probably related to the extended interval between final application and harvest.

Control of mealybugs (*Pseudococcus* spp.) in the SP programme was inferior to that under the two-weekly azinphosmethyl programme at Appleby in the 1988-89 season (Table 1) but it had only reached this level after eleven consecutive seasons of only SP use. There was also an increasing problem with control of woolly apple aphid (*Erisoma lanigerum*) after just two seasons of an SP only programme at Havelock North (Table 2). Control of these pests was substantially improved at both sites by two applications of chlorpyrifos.

TABLE 2: The percentage of fruit infested or damaged by insects following pyrethroid-based insect control programmes over three seasons at DSIR, Havelock North.

Year	Programme SP sprays	OP sprays	% fruit infested at harvest		
			Leafroller	Mealybug	W.A.aphid
87-88	deltamethrin x 3	—	0.30	0.20	0.10
88-89	esfenvalerate x 3	—	0.00	1.10	12.70
	deltamethrin x 3	—	0.20	6.70	20.40
89-90	esfenvalerate x 3	+ chlorpyrifos x 2	0.20	2.13	0.10
	deltamethrin x 3	+ chlorpyrifos x 2	0.00	0.80	3.30

DISCUSSION

Once established, SP-R *T. pyri*, in the presence of an SP spray programme, provided control of ERM which was equivalent to that provided by OP-R *T. pyri* in a conventional OP-based pest control programme. High ERM populations occurred during the first season of SP use, while the SP-resistant predator mites established. This was an inevitable consequence of an adversely disrupted prey:predator ratio. Careful

management of mite control would therefore be necessary when establishing an SP-based IMC programme. Satisfactory mite control was achieved during the second season in this trial without the use of miticides and similar results have been achieved in other trials.

This predator has retained useful resistance to OPs (e.g. chlorpyrifos) (Markwick *et al* 1990) but is slow to disperse from release points. In these trials it spread only 5-10 metres in one season and this has been confirmed in other studies (Wearing and Proffitt 1982; Markwick, unpublished data). To minimise disruption to mite control during establishment it would be important to release SP-R *T. pyri* into every tree.

Control of homopterous pests under a four-weekly SP programme was inferior to a two-weekly OP programme. Specific control strategies, e.g. one or two chlorpyrifos applications would be required for an SP-based pest control programme.

The development of SP-R *T. pyri* at last makes the use of SP insecticides a practical option on pipfruit in New Zealand and elsewhere. The major advantages of such a programme include the possibility of improved leafroller control while reducing the frequency of insecticide application by as much as 50%. The real advantage could be in the availability of alternatives to OP insecticides should they fail to continue to provide adequate pest control.

REFERENCES

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