INTEGRATED CONTROL OF APPLE PESTS IN NEW ZEALAND 11. THE INFLUENCE OF FIELD APPLICATION OF AZINPHOS-METHYL ON PREDATION OF EUROPEAN RED MITE BY *TYPHLODROMUS PYRI*

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Summary

The mite *Typhlodromus pyri*, a predator of European red mite (*Panonychus ulmi*) in Nelson apple orchards has, in laboratory tests, been shown to have a high resistance to azinphos-methyl. *T. pyri* under an azinphos-methyl spray programme has not always proved reliable in the integrated control of *P. ulmi*. The predation efficiency of *T. pyri* sprayed with azinphos-methyl was investigated in the field. It was found that resistant *T. pyri* were not as effective in the control of *P. ulmi* as a strain not receiving azinphos-methyl. It is suggested that sublethal effects of the chemical may exist which disrupt *T. pyri* distribution patterns thereby permitting damage by European red mite.

INTRODUCTION

The predatory mite, *Typhlodromus pyri*, has maintained European red mite (ERM) at low densities in England (Collyer 1964a) and New Zealand (Collyer 1964b) in situations where predator numbers were not reduced by spray chemicals. The use of many broad-spectrum insecticides has been associated with increases in phytophagous mites and the inhibition natural enemies is considered a primary cause of mite outbreaks. Large numbers of spray chemicals are highly toxic to predaceous phytoseiid mites and their use may severely disrupt attempts at integrated mite control (Croft 1976).

During the past decade widespread resistance to organophosphorus insecticides has developed in some predaceous phytoseiids (Croft 1976). Hoyt (1972) reported a strain of *T. pyri* from Nelson, New Zealand, to have an azinphos-methyl resistance factor of 9.7 fold when compared to a susceptible strain. Attempts to utilize this resistant strain of *T. pyri* in the integrated control of ERM were unseccessful, due to the resistance level of *T. pyri* being too low to survive continued applications of azinphos-methyl. Resistance to azinphos-methyl in *T. pyri* in Nelson has become much more widespread since the initial survey by Hoyt in 1972 (Wearing and Penman 1975). The levels of resistance to azinphos-methyl found in *T. pyri* (LC50 up to 0.3%) were considered sufficient to permit the predator to form the basis of an integrated mite control programme (Penman *et al* 1976).

The effectiveness of *T. pyri* in controlling ERM populations has seen considerable debate. Chant (1959) questioned the ability of phytoseiids in

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general to control ERM on apples. From studies with *T. pyri* Chant (1959) considered that the dispersion patterns of the predator and its prey were too dissimilar for effective predation. Furthermore, the predators lacked dependence on ERM as food. However, work by Collyer (1964 a,b) showed that *T. pyri* can be an effective predator of ERM on apple, despite its acceptance of alternative foods.

Collyer (1976) and Wearing *et al* (1978) reported the successful use of *T. pyri* in the integrated control of ERM in Nelson orchards. However, *T. pyri* has not always been consistent and reliable in the control of mite outbreaks under an azinphos-methyl spray programme. This study reports on the effectiveness of resistant and susceptible strains of *T. pyri* in the control of mite outbreaks.

METHOD

This study was conducted in 1976-77 on mature apple trees (cv 'Sturmer Pippin') at the Appleby Research Orchard, Nelson. The trees in Block 1 had a spray history of fungicides but no insecticides since 1968. The fungicides, dodine (80 g/100 litres) and colloidal sulphur (225 g/100 litres), were applied at fortnightly intervals. Block 2 received the above fungicides with azinphos-methyl (150 g/100 litres) applied simultaneously. Four of these trees also received DDT (100 g/100 litres) fortnightly applied by hand lance until runoff (15 litres/tree). Trees in Block 2 had had 15 years exposure to azinphos-methyl but no exposure to DDT in that time. Fungicides and azinphos-methyl were applied by a large capacity Konig airblast sprayer at 3X normal concentration (800 litres/ha). The treatments were:

	No. of trees sampled	
1. Fungicides alone	4	– Block 1
2. Fungicides, azinphos-methyl	26	– Block 2
3. Fungicides, azinphos-methyl, DDT	4	

At regular intervals 50-leaf samples were collected at random from each of the three treatments. Leaves were placed in plastic bags, sealed and chilled until mites could be brushed off onto a grass plate using a mite brushing machine (Leedom Engineering, Twain Harte, California). All live stages of ERM and *T. pyri* were recorded for each treatment.

RESULTS

European red mite was the predominant species of phytophagous mite. Occasional specimens of two spotted mite, *Tetranychus urticae*, were observed during February and March. No predaceous insects were observed in the trees receiving insecticides. *T. pyri* was the principal predaceous mite occuring in all treatments. *Agistemus longisetus*, a stigmaeid, appeared on foliage in February but never exceeded a mean of 0.02/leaf. A predaceous mirid, *Sejanus albisignata*, was observed in low numbers in March on the trees receiving fungicides alone. During the sampling period, searches of trees receiving fungicides only failed to record the presence of the coccinellid predator *Stethorus bifidus*. As predators other than *T. pyri* were sporadic in appearance and small in numbers only ERM and *T. pyri* counts are presented in figures 1, 2 and 3.

Figure 1 shows population trends on the trees receiving fungicides only. ERM numbers did not exceed 1/leaf until mid-January and for the remainder of the season did not exceed 1.5/leaf. At this level no bronzing of leaves occurred throughout the season. *T. pyri* numbers nearly always exceeded those of ERM reaching a maximum of 1.7/leaf in lat February.

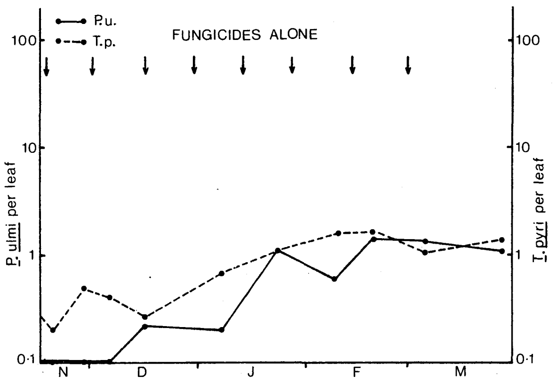

FIG. 1 Populations of ERM and *T. pyri* active stages on trees receiving fungicides only.

Figure 2 shows population trends on the trees receiving fungicides and azinphos-methyl. ERM numbers increased rapidly from early December reaching a peak of 68/leaf in mid-February, followed by a decline to 3.2/leaf by harvest in late March. *T. pyri* numbers steadily increased to a maximum of almost 8/leaf in early March, declining to 3.4 leaf in late March.

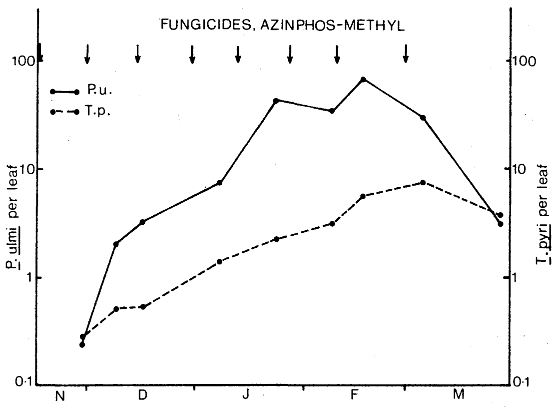

FIG. 2 Populations of ERM and *T. pyri* active stages on trees receiving fungicides and azinphos-methyl.

Figure 3 shows the impact of DDT as greatly restricting the development of *T. pyri* populations. *T. pyri* occurred at low levels throughout the season and never exceeded a mean of 0.4/leaf. Therefore, their predation probably did not influence the ERM population significantly which rose to very high densities; a mean exceeding 400/leaf. Extensive and uniform bronzing of leaves occurred on all four trees.

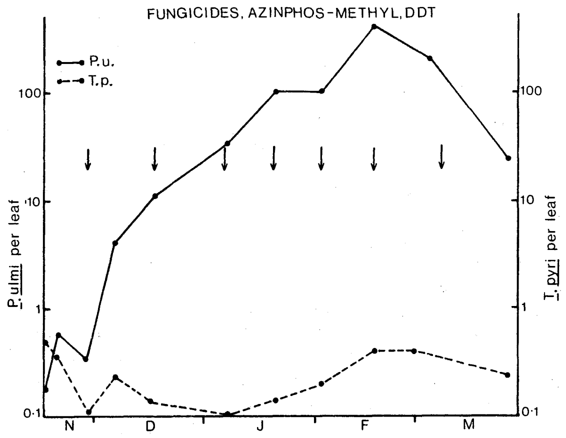

FIG. 3 Populations of ERM and *T. pyri* active stages on trees receiving fungicides, azinphos-methyl and DDT.

DISCUSSION

The azinphos-methyl programme prevented the establishment of insect predators. This allowed the effectiveness of an azinphos-methyl resistant strain of *T. pyri* as a predator of ERM to be evaluated. Trees not receiving azinphos-methyl demonstrated the performance of a susceptible strain of *T. pyri* without any observed insect predation.

It is evident that where *T. pyri* was not disturbed by the application of azinphos-methyl, it was successful in controlling ERM (Fig. 1). The fungicides, dodine and colloidal sulphur, have been reported as negligibly toxic to *T. pyri* in North America. In spite of possible mortality due to fungicides, *T. pyri* was very effective in the control of ERM throughout the season. A high proportion of *T. pyri* appeared not to be feeding on ERM shown by the absence of a coloured intestinal tract (Chant 1959). This suggested survival through the use of alternative food sources, e.g. pollen (Collyer 1964b).

DDT, when applied with fungicides and azinphos-methyl was responsible for high mortality of *T. pyri* which remained only in low numbers. DDT toxicity to *T. pyri* has been widely recorded (Collyer 1974b) and the application of DDT here illustrated the development of ERM populations when predation by *T. pyri* is low.

The application of fungicides and azinphos-methyl to a strain of resistant *T. pyri* did not prevent a numercial response to increasing numbers of ERM. Predation by *T. pyri* caused significant reductions in the peak numbers of ERM (Fig. 2) in comparison to trees where predators were almost absent (Fig. 3) but considerable leaf bronzing still occurred. The lower numbers of ERM in treatment 2 were probably due to predation as claims that DDT may stimulate ERM fecundity have largely been discounted. Although resistant *T. pyri* did not give satisfactory control of ERM when azinphos-methyl was applied, this failure was not entirely due to an inadequate number of predators. Peripheral areas of azinphos-methyl treated trees showed irregular bronzing becoming more apparent from February onwards. Isolated bronzing within trees implied that ERM was largely free of predation in these areas and could increase relatively uninhibited. Flaherty and Huffaker (1970) showed an insecticide-induced imbalance in a predator/prey interaction was not only due to predator mortality but also to the disruption of distributional patterns, a finding supported by this study.

Integrated Control

The failure of azinphos-methyl-resistant *T. pyri* to maintain low numbers of ERM questions the impact of this insecticide. Indirect effects of azinphos-methyl on predators by leaving ERM as a source of secondary poisoning were unlikely, since high resistance levels have been found in this strain of predator (Penman *et al* 1976). Sublethal azinphos-methyl effects in *T. pyri* may occur by affecting the survival or fecundity of the predators, or by affecting their genetic constitution. Despite a numerical response by *T. pyri* to increasing ERM numbers, these factors may have been sufficient to disrupt control by *T. pyri*. Alternatively, there may be a behavioural response to azinphos-methyl in the resistant strain. Collyer (1976) reported that in tests with resistant *T. pyri* from Appleby, Nelson, a strong azinphos-methyl avoidance reaction occurred which was not found in a susceptible strain. Avoidance reactions by resistant *T. pyri* could disrupt distributional patterns thereby affecting the predator/prey interaction. The isolated peripheral regions of the trees which suffered ERM bronzing damage in treatment 2 had greater exposure to airblast spray equipment applying azinphos-methyl. In contrast to the outer limb areas, the central regions of trees receiving the fungicide and azinphos-methyl treatment were consistently green suggesting little ERM damage. High numbers of *T. pyri* were found in this area. It appeared that azinphos-methyl induced isolated outbreaks of ERM as a result of an avoidance reaction by resistant strains of *T. pyri* to this insecticide.

ACKNOWLEDGEMENTS

We wish to thank staff of the Appleby Research Orchard for technical assistance, members of the Entomology Department, Lincoln College and Dr C. H. Wearing for critically reviewing the manuscript; and the N.Z. Fruitgrowers' Federation for financial support.

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