INTEGRATED CONTROL OF APPLE PESTS IN NEW ZEALAND. 18. INTRODUCTION AND ESTABLISHMENT OF THE ORGANO-PHOSPHATE-RESISTANT PREDATORY MITE *TYPHLODROMUS PYRI* IN THE WAIKATO

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SUMMARY

The organo-phosphate-resistant predatory mite (*Typhlodromus pyri*), was introduced to a small area of a Waikato apple orchard in 1977 and 1978 for the control of European red mite (*Panonychus ulmi*). Establishment was monitored each summer by regular leaf sampling for both mites, and by 1981-82 the predators were common throughout the orchard. The main constraints to predator increase and spread were the fungicide programme used and low prey populations in some areas.

INTRODUCTION

Since integrated control of European red mite (ERM) was implemented in Nelson in the late 1970s (Wearing *et al* 1978), insecticide-resistant predators have become increasingly important for the control of both ERM and two-spotted mite (*Tetranychus urticae*) (TSM) in this and other fruit-growing districts (Wearing and Ashley 1982). In Hawkes Bay, for instance, *T. pyri*, the main phytoseiid predator of ERM, is now widespread and, of the introduced TSM predators, *Phytoseiulus persimilis* is well established and *Amblyseius fallacis* was mass reared and released in 1979-80 and 1980-81 (Walker pers comm).

In contrast, *T. pyri* occurs infrequently in commercial apple orchards in the Waikato. Both this area and the Auckland district experience particular disease problems, notably *Glomerella* sp., which demand special fungicide programmes. Many growers have used mancozeb and dinocap + mancozeb which are known to suppress *T. pyri* populations (Collyer 1980; Wearing and Shaw unpublished). Surveys of sprayed Waikato orchards from 1976-78 failed to locate indigenous organo-phosphate-resistant *T. pyri* and this predator was introduced to a commercial orchard near Hamilton beginning in autumn 1977. This paper reports the results of these introductions and records the release and occurrence of other phytoseiid predators in the area.

METHOD

Field releases of predators

T. pyri on apple leaves were collected at Appleby Research Orchard, Nelson, from a population highly resistant to azinphos-methyl (Penman *et al* 1976). Active stages of the predators were sucked from the leaves into 5 cm lengths of plastic straws (50 per straw) for despatch to the Waikato orchard (Fig. 1) (see Thomas and Chapman 1978). About 600 *T. pyri* were released on two ERM-infested Red Delicious trees (A and B) in February 1977 and a further 2000 on the same trees and two others in late November 1977 (A, B, C - 600) and in January 1978 (A, B, C, D - 1400). Trees A, B, C constituted plot 5 in Fig. 1, and tree D (Cox's Orange) was in plot 2. Following the establishment of *T. pyri* the grower spread the predators on foliage to many parts of the orchard, primarily in March each year when the populations reached peak numbers.

A. fallacis was mass reared on TSM on soya beans in the field (Walker pers comm) and was released in the orchard in March 1981. Many thousands of predators on bean foliage were placed in the crotches of Granny Smith and Golden Delicious trees in plots 6 and 8 respectively (Fig. 1).

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P. persimilis was not released directly in the orchard but was found to be present. This predator has been found recently in many sprayed orchards throughout the country following its introduction to New Zealand (Walker *et al* 1981).

Monitoring of predator establishment

To monitor predator establishment and prey populations during the growing seasons, 1- to 2-weekly samples of 50 leaves were collected from the trees and the mites were removed with a brushing machine for counting (for details see Wearing *et al* 1978). In 1977-78 and 1978-79 samples were collected from each of the release trees and in 1978-79 the spread of *T. pyri* was monitored by regular sampling of trees in plot 7 adjacent to plot 5 (Fig. 1) and by sampling of individual trees upwind and downwind from this release area (plots 6 and 7). In 1979-80 the mites were monitored separately on four plots (1 and 2 combined, 5, north side of 3 and 4, south side of 3 and 4). All eight plots, as shown in Fig. 1, were monitored in the 1980-81 and 1981-82 seasons.

Overwintering survival of *T. pyri* in 1977 was estimated from the occurrence of the predators sheltering in black velvet bands wrapped around small branches of the release trees in the previous March.

Fig. 1: Plan of study orchard, Hamilton. Plots of apples are numbered 1-8. Histograms show the seasonal mean No. of *T. pyri* per 100 leaves in 1979-80, 1980-1 and 1981-2. NA = not available. * Mean of 4 samples on trees with high ERM population. Dates record the first recovery of *T. pyri* in each plot.

Spray programmes

The spray programmes used were typical of commercial practice in the Waikato district except for the determination of miticide applications (azocyclotin, cyhexatin, dicofol) which was based on mite monitoring during the three seasons 1979-82 (for spray thresholds see Cook 1980). Insect control relied primarily on azinphos-methyl, applications of which were guided mainly by catches of codling moths (*Laspeyresia pomonella*) in pheromone traps (Wearing and Charles 1978). Other insecticides used were vamidothion, lindane (pre-bloom) and chlorpyrifos. Oil was applied at green tip each season to most plots.

The fungicide programme comprised mainly Bordeaux, metiram + nitrothal-isopropyl, metiram, captan, dodine and captafol, with less frequent use of benomyl, thiophanate-methyl, fenarimol and folpet. However, each season some plots (notably 1 and 2 up to 1980-81) or trees were sprayed with dinocap + mancozeb instead of metiram + nitrothal-isopropyl. Other sprays used routinely were calcium nitrate for bitter pit and carbaryl and ANA as thinning agents.

RESULTS AND DISCUSSIONS

Early indications of establishment of *T. pyri* were obtained from low recoveries of over-wintering adult female predators in the black bands (July 1977, about 1 predator per band). This was confirmed in spring 1977 by *T. pyri* appearing on the first leaf samples from the release trees. However, normal commercial spraying of these trees through the 1977-78 season included the use of dinocap + mancozeb and miticides, and there were no further recoveries of predators, even following the November releases. Further releases were made in January 1978 and ERM populations were allowed to rise

Fig. 2: Population estimates of ERM and *T. pyri* in plot 5 for four of the seasons following release of *T. pyri* at the study orchard. Arrows indicate releases and miticide applications. (c = cyhexatin, a = azocyclotin).

to the end of the season (up to 16 active stages per leaf on tree A). Low numbers of *T. pyri* and their eggs were recovered in February and March from all four release trees (Fig. 2A).

More permanent establishment of the predators was obtained the following spring and summer in plot 5 when dinocap + mancozeb was not used and the populations rose to an average of almost 6 per leaf in March 1979 (Fig. 2B). This was assisted by high ERM numbers on the release trees which were deliberately allowed to increase in this and subsequent seasons. *T. pyri* reached a mean of 9 per leaf in March 1980 and almost 5 per leaf in 1982 (Fig. 2D) but in January 1981 high ERM numbers necessitated a miticide application which decimated the ERM population and prevented predator numbers exceeding 1.3 per leaf in that season (Fig. 2C).

Samples upwind and downwind from the release trees collected in March 1979 gave the following predator numbers on 50 leaves per tree:

3 upwind trees			3 release trees			5 downwind trees				
			A	B	C					
1	1	1	170	112	123	12	4	2	0	0
			12 (adjacent tree)							

These results suggested that the natural spread of the predators was slow and may have been assisted by wind (see Johnson and Croft 1976). Intensive manual distribution of predators on foliage each March was probably more important than natural spread in colonisation of the orchard. *T. pyri* was present in all blocks by autumn 1981 and was well established throughout the orchard (2100 apple trees in 4 ha) a year later (see histograms, Fig. 1). The use of an integrated mite control programme on the orchard in 1981-82 required one ($\frac{1}{2}$ strength) or two miticide applications on different blocks.

However, establishment and spread of the predators were strongly influenced by the spray programme. ERM and predator populations were consistently suppressed on trees and blocks sprayed with dinocap + mancozeb (Collyer 1980). ERM resurgence occurred after the dinocap + mancozeb applications became less frequent and ceased, but *T. pyri* was more seriously affected and was recovered only in low numbers at the end of the season (e.g. tree D Fig. 3, compare with Fig. 2B, no dinocap + mancozeb). Metiram has also been found to suppress *T. pyri* populations (Wearing and Shaw unpublished) but less severely than dinocap + mancozeb. This suppression was suggested during the first half of the summer in every season, even on the release trees, by a trough in numbers of *T. pyri* into January and rapid increase thereafter (e.g. Fig. 2D, metiram applied into December).

A. fallacis was not recovered in leaf samples since its release. This may have been due to the use of glyphosate on the ground cover (Hislop and Prokopy 1981). *P. persimilis* was first recorded at the orchard in March 1979 and in late summer on both

Fig. 3: Population estimates of ERM and *T. pyri* on release tree D in 1978-9. Arrows indicate miticide applications (c = cyhexatin, d = dicofol). Sprays of dinocap + mancozeb were applied during the period shown.

the trees and the ground-cover in all subsequent seasons. Its abundance and distribution were clearly correlated with TSM density which, because it reached a peak in very late summer, did not cause economic damage or require specific miticide applications. In autumn 1981 *P. persimilis* reached more than 5 per leaf in association with high TSM on some trees where it also fed on ERM. This predator and *T. pyri* remained actively feeding on the leaves into May. *Agistemus longisetus* and *Stethorus* sp. were recorded in late summer in some seasons, particularly after harvest.

OP-resistant *T. pyri* have been successfully established in the Waikato as a result of this work. In March 1982 a survey of 11 Waikato apple orchards showed low populations of endemic *T. pyri* present in two of them and very rare in a third. *P. persimilis* was found in two orchards. The release orchard was used as a source for distribution of *T. pyri* to apple orchards in the Waikato and Bay of Plenty in late March 1982. Waikato growers were advised through the press of appropriate dates for miticide applications against ERM in spring and early summer 1981. This technique combined with the predators will be a basis for future development of integrated mite control in the Waikato.

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