EVALUATING THE SUITABILITY OF SIXSPOTTED MITES AS PREY FOR COMMERCIALLY AVAILABLE MITE PREDATORS

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ABSTRACT

Sixspotted mites (*Eotetranychus sexmaculatus*) are serious pests of avocado in New Zealand. One of the potential options for managing this pest is by the release of commercially available biological control agents. There are two species of mite predators commercially available in New Zealand (*Phytoseiulus persimilis* and *Amblyseius cucumeris*). Adults of these two species of predators were set up on leaf arenas infested with sixspotted mites (ten replicates). The predators had no other choice of prey. The behaviour of the predatory mites was observed for 10 minutes using a stereo microscope immediately after introduction of the predator and again after three days. The numbers of mites on each leaf disc were recorded to determine whether the predators were consuming sixspotted mites during a three-day period of exposure. Observations and counts of the numbers of sixspotted mites indicated that neither of these species of predator mites feed on sixspotted mites.
Keywords: biological control, avocados

INTRODUCTION

Sixspotted mites, *Eotetranychus sexmaculatus* (Riley), are serious pests of avocado in New Zealand. High populations may lead to defoliation and subsequent decreases in tree productivity and yield. The reasons for the recent outbreaks of sixspotted mites in avocados are not clear as this mite has been present in New Zealand since at least 1953 (Charles, 1998). Although the most likely cause of sixspotted mite outbreaks is high levels of natural enemy mortality following the application of broad-spectrum insecticides used for controlling primary pests (e.g. leafrollers, armoured scale or greenhouse thrips), there are no clear patterns of outbreaks relating to historical pesticide use. The disruptive effects of copper fungicides may also be a contributing factor resulting in high levels of natural enemy mortality. Research investigating the effects of copper based fungicides on ladybird predation of soft wax scale insects show that these fungicides significantly lower predation levels and increase predator mortality when compared to non-copper fungicides (Lo and Blank, 1992; Lo, 2002).

There is an urgent need for effective ways to control sixspotted mites in avocados. There are no chemicals currently registered for the control of sixspotted mites but research is underway to evaluate the efficacy of several miticides. Controlling mites using chemicals is difficult, can cause undesirable residues, and there is risk of mites developing resistance to materials. If chemicals cause mortality of predators there is a risk that the pesticide treadmill will be invoked. This is the situation whereby control of pests becomes completely reliant on chemicals as natural ways of controlling populations (e.g. biological control) become non-functional.

Mites have good potential to be controlled through manipulation of predator populations. In California, research into the biological control of the persea mite *Oligonychus perseae* has been underway since the mite was first identified as a pest of avocados in the early 1990s. Predatory mites belonging to the Phytoseiidae family include some of the most effective mite predators known. Species such as *Phytoseiulus persimilis* are voracious consumers of twospotted spider mites capable of effectively controlling populations. Twospotted spider mite is controlled in many crops in New Zealand by *P. persimilis*, either as naturally occurring populations or as a result of augmentative releases.

There are two species of mite-feeding predators belonging to the Phytoseiidae family that are commercially available in New Zealand. These are *P. persimilis* and *Amblyseius cucumeris*. Enquiries of the commercial suppliers of these predators indicates that sixspotted mites are not used as prey. However, there appears to be a lack of data to support this conclusion. Before rejecting the use of these readily available mite predators it seemed prudent to check the suitability of sixspotted mites as prey.

MATERIAL AND METHODS

Avocado leaves that were infested with sixspotted mites were collected from a Whangarei orchard on 11 February 2002.

The mite predators *P. persimilis* and *A. cucumeris* were provided by commercial suppliers, Zonda Resources Ltd., on the 11th February 2002. *P. persimilis* were supplied on bean leaves infested with their preferred prey species *Tetranychus urticae* (two spotted spider mites) while the *A. cucumeris* were supplied in a bran-based medium.

Experiments were set out as no-choice so that the only prey available to predators were sixspotted mites. Leaf discs (15 mm diameter) were cut from the infested avocado leaves so that a natural 'colony' of sixspotted mites and associated webbing was included within the arena. The numbers and life stage of sixspotted mites on each leaf disc were recorded. To prevent escape of mites the leaf discs were floated in a Petri dish filled with water. A single predator was placed on each leaf disc. The behaviour of the mites was observed for ten minutes using a stereo-microscope and any interactions between the predators and the prey were recorded. After this initial observation period, the leaf discs were placed in an 18°C controlled temperature room (8 hours light, 16 hours dark) for three days. The behaviour of the mites on each leaf discs was observed for a further ten minutes after three days of predator exposure to sixspotted mites. The numbers of mites on each leaf disc was recorded to determine whether sixspotted mites had been eaten by the predator over the three-day exposure period. Ten replicates of each predator species were set up.

RESULTS AND DISCUSSION

P. persimilis

No probing, physical interactions or consumption of sixspotted mites was observed during the course of 100 minutes of continuous observations of *P. persimilis* after they were placed on leaf discs infested with sixspotted mites. The same result was

seen after *P. persimilis* had experienced three days of continuous exposure to sixspotted mites as their only source of food. The main behaviour observed was preening or walking. When *P. persimilis* touched sixspotted mites while walking, no probing, arrestment or anything more than casual contact was seen. After three days, leaf discs were still populated with sixspotted mites although the actual numbers varied slightly from those initially observed. If *P. persimilis* were feeding on the sixspotted mites it would be expected that almost all of the prey would have been consumed over the three days. During the three days some new eggs had been laid, some eggs had hatched and some of the mobile mites had escaped. However, overall the numbers of sixspotted mites on leaf discs did not decrease over the three day period of exposure (Table 1) supporting the behavioural observations indicating that sixspotted mites are not recognised as suitable prey by *P. persimilis*. By contrast, *P. persimilis* were observed to be very actively feeding on twospotted mites immediately before being provided with sixspotted mites.

Table1. Numbers and life stages of sixspotted mites provided to *P. persimilis***.**

Replicate	Number and life stage of sixspotted mites at day 0				Number and life stage of sixspotted mites at day 3			
	Eggs	Nymphs	Adults	TOTAL	Eggs	Nymphs	Adults	TOTAL
1	0	2	1	**3**	2	1	2	**5**
2	2	0	3	**5**	3	0	1	**4**
3	0	2	1	**3**	0	1	1	**2**
4	0	0	3	**3**	1	0	1	**2**
5	6	1	2	**9**	3	0	2	**5**
6	0	0	2	**2**	0	0	3	**3**
7	0	0	3	**3**	0	0	2	**2**
8	1	0	2	**3**	0	0	3	**3**
9	0	1	2	**3**	0	0	2	**2**
10	0	1	2	**3**	0	0	5	**5**

A. cucumeris

Very similar results were obtained for *A. cucumeris*. No probing, physical interaction or consumption of sixspotted mites was observed during the course of 100 minutes of continuous observations of *A. cucumeris* after they were placed on leaf discs infested with sixspotted mites. The same result was seen after *A. cucumeris* had experienced three days of continuous exposure to sixspotted mites as their only source of food. In several cases *A. cucumeris* was observed to actively move away from sixspotted mites that walked nearby. The numbers of sixspotted mites present on the leaf discs after three days did not suggest that sixspotted mites were being consumed by *A. cucumeris* (Table 2).

The results of these experiments indicate that sixspotted mites are not suitable prey for either *P. persimilis* or *A. cucumeris*. Future biological control of sixspotted mites will need to consider the potential of other species of mite predators that are not commercially available at this stage.

Table 2. Numbers and life stages of sixspotted mites provided to *A. cucumeris*

Replicate	Number and life stage of sixspotted mites at day 0				Number and life stage of sixspotted mites at day 3			
	Eggs	Nymphs	Adults	TOTAL	Eggs	Nymphs	Adults	TOTAL
1	0	1	1	**2**	0	1	1	**2**
2	0	1	2	**3**	3	0	2	**5**
3	0	0	2	**2**	1	0	2	**3**
4	0	0	2	**2**	0	0	2	**2**
5	0	0	1	**1**	0	0	2	**2**
6	0	0	1	**1**	0	0	1	**1**
7	0	1	1	**2**	3	1	1	**5**
8	0	0	1	**1**	0	0	1	**1**
9	0	2	0	**2**	0	0	2	**2**
10	0	0	3	**3**	0	0	3	**3**

Several species of predators are commonly observed to be associated with sixspotted mites in avocado orchards. However, they do not appear to be able to prevent unacceptable outbreaks of sixspotted mites. The poor control of populations of sixspotted mites may be because the predators are highly susceptible to insecticides used in the orchards, or because the biological parameters (e.g. reproductive ability, prey consumption rate, food preferences) of the predators are not sufficient to provide control. The main predators seen in association with sixspotted mites in New Zealand include several types of mites (unidentified Phytoseiidae); *Agistemis longisetus* (Stigmaeidae); the whirlygig mite *Anystis baccarum* (Anystidae) and the predatory ladybird *Stethorus* spp. Most of these predators feed predominatly on mites. The ladybirds, *Stethorus* spp., are obligate predators of spider mites.

The reality of commercial avocado production requires the application of insecticides and fungicides for control of primary pests and diseases. An evaluation of the direct and residual effects of products used in avocados against the predators of sixspotted mites, as is available for the predators *P. persimilis* and *A. cucumeris* used in greenhouses (Martin, 1993), would be extremely useful. The manual by Martin (1993) categorises chemicals according to their impact on predators and gives an indication of the longevity of toxicity against the predators following application.

Given the unsuitability of commercially available mite predators for control of sixspotted mite, the future direction of biological control research needs to focus elsewhere. It would be useful to survey and identify the species of predators found within avocado orchards. An evaluation of the potential for artificially manipulating populations of these predators to provide control of sixspotted mites would be prudent. Important factors to consider are ability to rear large numbers, reproductive rate relative to sixspotted mites, and rate of sixspotted mite consumption. Integrated mite control in combination with classical biological control is another option. However, the search and introduction of an appropriate new natural enemy is a very lengthy and costly process.

SUMMARY

Two species of mite-feeding predators are commercially available in New Zealand. These are *Phytoseiulus persimilis* and *Amblyseius cucumeris*. The results of these experiments indicate that sixspotted mites are not suitable prey for either *P.persimilis* or *A. cucumeris*. Future biological control of sixspotted mites will need to consider the potential of other species of mite predators that are not commercially available at this stage.

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REFERENCES

Charles, J.G., 1998. The settlement of fruit crop arthropod pests and their natural enemies in New Zealand: an historical guide to the future. Biocontrol News and Information 19(2): 47-57.

Lo, P.L., 2002. The effect of three fungicides on densities of *Halmus chalybeus* (steelblue ladybird) in a citrus orchard and toxicity of pesticides. *NZ Plant Protection* **55**: in press.

Lo, P.L. and Blank, R.H., 1992. Effect of pesticides on predation of soft wax scale by the steelblue ladybird. *Proceedings 45th NZ Plant Protection Conference*: 99-102.

Martin, N., 1993. *Integrated Pest Management: pesticides and natural enemies*. 2nd Edition. New Zealand Institute for Crop and Food Research.