SUSTAINABLE MANAGEMENT OF SIXSPOTTED SPIDER MITE (*EOTETRANYCHUS SEXMACULATUS* (RILEY)) ON AVOCADOS

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ABSTRACT

Sixspotted mite *(Eotetranychus sexmaculatus)* (SSM) has become more common in Whangarei orchards in recent seasons. Pesticide use and the abundance of SSM and potential natural enemies were compared to determine whether there was any relationship between them. The most commonly used pesticides were organophosphate and pyrethroid insecticides and copper-based fungicides. Spray practices differed considerably between orchards with some trees treated mainly with selective and others with broad-spectrum insecticides. Populations of SSM and potential natural enemies including ladybirds and predatory mites (*Amblyseius cucumeris, Amblyseius largoensis***)** also differed markedly between some orchards. On trees treated mainly with selective insecticides, there were more ladybirds and in some instances more predatory mites and less SSM. In situations where SSM populations were low, tydeid mites (*Orthotydeus* spp.) became more common. Some broad-spectrum insecticides appeared to have activity against SSM.

Keywords*:* sixspotted mite, avocados, biological control, predatory mites, Amblyseius cucumeris, Amblyseius largoensis)

INTRODUCTION

In 1998, sixspotted spider mite (*Eotetranychus sexmaculatus*) (SSM) caused serious premature leaf drop in some Whangarei avocado orchards. In subsequent seasons, this problem has also occurred in many other Whangarei orchards and more recently in orchards in the far North and northern Bay of Plenty. The reason why SSM suddenly became a problem in Whangarei orchards has not been established. To counter the SSM problem, growers are currently resorting to more aggressive spray practices. What is required is a better understanding of SSM in New Zealand avocado orchards to enable the development of more sustainable methods for control.

In Californian avocado orchards, SSM can become a pest when pesticide sprays applied against other pests disrupt biological control of SSM (Anon., 1999). In New Zealand avocado orchards, the presence and range of natural enemies of SSM and whether they are capable of regulating its numbers is unknown. However, a range of natural enemies attack closely related species of plant-feeding mites on other fruit crops. e.g. European red mite (*Panonychus ulmi*) (ERM) on pipfruit (Walker *et al*. 1989). It is therefore possible that changes in pesticide use in Whangarei orchards, may have triggered or contributed to the problems with SSM. For example, pyrethroid insecticides used to control greenhouse thrips (*Heliothrips haemorrhoidalis*) are known to be highly toxic to some key natural enemies of plant-feeding mites.

This project sought to try to establish what may have caused the SSM outbreaks and whether disruption of biological control is involved. Mite populations in Whangarei avocado orchards were monitored to determine whether natural enemies of SSM were present and if their abundance was affected by current spray practices.

MATERIAL AND METHODS

Whangarei orchards and packhouses were visited during December 2001 and spray programme and AvoGreen monitoring records were obtained. Data on orchard features (e.g. avocado cultivar, shelter and ground cover species) were obtained from 9 orchards, for comparison with the incidence of SSM on the same properties.

Nine orchards were then selected to monitor the incidence of SSM and potential natural enemies. These orchards used mainly broad-spectrum (i.e. ‘hard’) or selective (i.e. ‘soft’) insecticides. AvoGreen monitoring staff from packhouses or the orchardist assisted by sampling 10 leaves at 3-4 weekly intervals from February until May 2002 from each of 10 trees normally used for pest monitoring. Using a mite-brushing machine, mites were removed from the leaves for counting. The stage (egg, immature, mature) and numbers of SSM, tydeid mites (*Orthotydeus* spp.) and potential natural enemies were recorded. Adult predatory mites were collected, preserved in 70% ethanol and stored until identified.

RESULTS & DISCUSSION

Orchard spray practices

Analysis of spray programmes from 28 orchards showed that the most commonly used pesticides were copper-based fungicides, organophosphates, benomyl and insecticides based on pyrethroids alone or in combination with organophosphates (Table 1). Organophosphates were the most heavily used group of insecticides, both in terms of the percentage of growers using them and the average number of sprays applied by users. The frequency of use of different products varied considerably between orchards. For example, the numbers of organophosphates applied in each orchard varied from 1 to 8 between orchards over the period examined (Table 1).

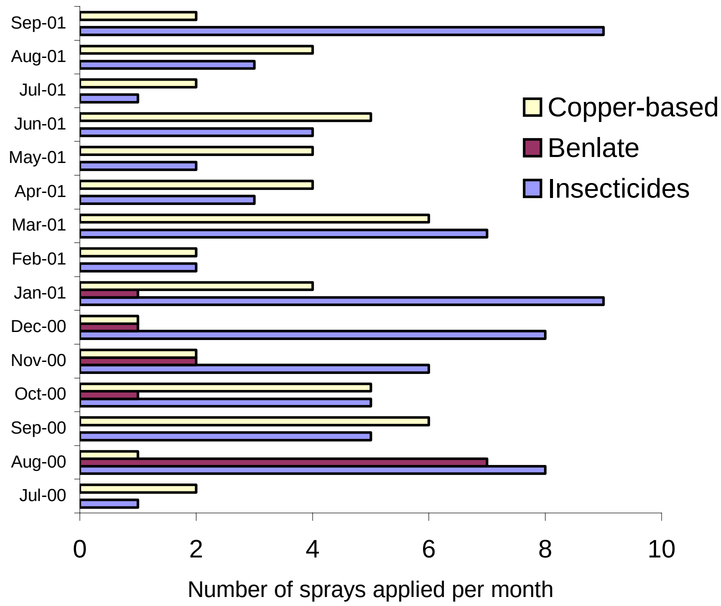
Some orchards were treated with insecticides that have more selective activity (e.g. products based on *Bacillus thuringiensis* (Bt) and Mimic) or relatively less adverse effects on beneficial organisms (e.g. Success). Generally these pesticides were used for part of the season, with broad-spectrum products for the remainder. This is because more selective products are only available to control some of the range of avocado pests. However, some orchards were treated with multiple applications of Bt-based insecticides, although these were not included in the analysis used to prepare Table 1. Although Avid has been shown to have activity against SSM when used with mineral oil (Stevens, 2000), it was used on only a small proportion of orchards and mostly without oil.

Table 1. Summary of pesticide use for 28 Whangarei avocado orchards between July/December 2000 and June/December 2001.

Chemical group/type	Products	% of orchards using	Mean number of sprays per user	Range in number of sprays per user
Insecticides				
Bacillus thuringensis (Bt)	Delfin, Dipel	14	1.5	1-2
Organophosphates	Basudin, Lorsban, Maldison	96	3.8	1-8
Pyrethroids	Mavrik	71	2.3	1-4
Organophosphate/ pyrethroid mixtures	Attack, Averte	64	2.2	1-5
Carbamates	Sevin	39	2.5	1-5
Naturalytes	Success	11	1.3	1-2
Avermectins	Avid	18	1.4	1-2
Moult accelerating compound	Mimic	14	1.0	
Mineral oils	Sunspray oil, Yates Excel oil	7	1.0	
Fungicides				
	Benlate	86	1.4	1-3
Copper-based	Blue Shield, Copper hydroxide, Kocide	100	7.1	3-11

Analysis of a small group (7) of orchard spray records for which complete sets of data were available for July/August 2000 until September 2001, showed that pesticides are applied throughout the year (Figure 1). Insecticide use was highest in early spring (August/September), late spring/early summer (November/ January) and early autumn (March).

Figure 1: Numbers of sprays applied per month for 7 Whangarei avocado orchards.



Abundance of mites in orchards

1. Sixspotted mite

All stages of SSM were found throughout the intensive monitoring of orchards between February and May 2002. Monitoring conducted by AvoGreen scouts (Figure 2) and during this project (Figure 3) both showed that the abundance of SSM varied considerably between some orchards.

2. Tydeid mites

In some orchards, the most common mites were tydeids (*Orthotydeus* spp.) (Figure 4), with both immature and mature mites found. Orchards with larger populations of SSM (Figure 3), tended to have relatively few tydeid mites on their leaves. Conversely orchards with smaller SSM populations often had more tydeids (Figure 4). There is also some indication in orchard U that as tydeid numbers fell there was a corresponding rise in SSM numbers (Figure 3). While it is unclear what tydeids feed on (Tomkins *et al.* 1997), there is no evidence that clearly shows they are plant feeders. Therefore, if tydeids and SSM compete, then it is probably because they can occupy a similar niche on avocado leaves, with both mostly found on the underside of leaves and frequently against the midrib.

3. Beneficial insects and mites

A number of AvoGreen scouts and orchardists, have observed or recorded the presence of ladybirds on avocado trees. This includes both small black *Stethorus* ladybirds belonging to one or more species and larvae and adults of the larger steel-blue ladybird (*Orcus chalybeus*) have been observed. Other natural enemies of insects and mites that have been recorded during AvoGreen monitoring include spiders, whirlygig mites (*Anystis baccarum*), lacewings (larvae and adults) and *Orius* predatory bugs. During intensive monitoring, all stages of typhlodromid, one or more species of red-coloured *Agistemus* mites and a few ladybird larvae, mainly *Stethorus* were found. The typhlodromid mites were identified as *Amblyseius cucumeris* and *Amblyseius largoensis*. As with SSM, the abundance of these beneficial insects and mites varied considerably between orchards (Figure 5) as was found by the monitoring conducted by AvoGreen scouts (Figure 6).

Effects of spray programmes

The experience of orchardists and AvoGreen monitoring scouts was that organophosphate and pyrethroid insecticides, applied against key insects pests, were also providing some control of SSM. Comparison of the effects of sprays applied over the monitoring period provided some evidence to support these observations (Figure 7). This indicates that at present, SSM may still be susceptible to these products, although one person commented that after repeated spraying with malathion, later sprays seemed to be less effective. It also complicates trying to understand what is occurring in orchards sprayed with broad-spectrum insecticides as these products will be affecting the abundance of SSM and beneficial insects and mites that could be acting as natural enemies.

Comparison of mite abundance on the avocado trees from orchards using predominantly ‘soft’ or ‘hard’ spray programmes, showed that SSM were relatively less common in orchards using ‘soft’ programmes (Figure 8). In contrast, tydeid mite populations were higher in the same orchards (Figure 9). Predatory typhlodromid mites were initially more common in orchards using ‘soft’ spray programmes but this situation reversed later in the season from mid March 2002 onwards (Figure 10). This may have been due to the abundance of SSM and frequency of insecticide use at different stages of the season. Thus in orchards using ‘soft’ spray programmes, SSM numbers had fallen later in the season, which could have triggered a corresponding decline in the abundance of predatory mites. Whereas, on orchards using ‘hard’ programmes a decline in the frequency of spray application later in the season might allow a recovery in the number of beneficial insects and mites.

Figure 2: Percentage of monitor trees with low level of leaf infestation by SSM, 2001.

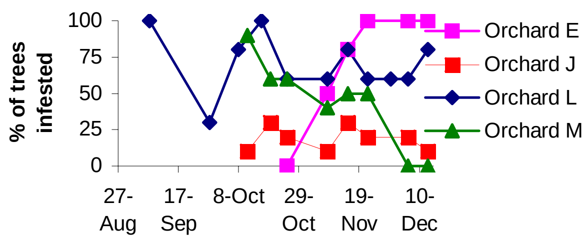


Figure 3: Mean number of mature sixspotted mites per leaf in different orchards, 2002.

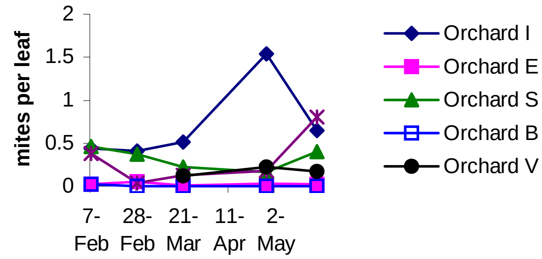


Figure 4: Mean number of tydeid mites per leaf in different orchards, 2002.

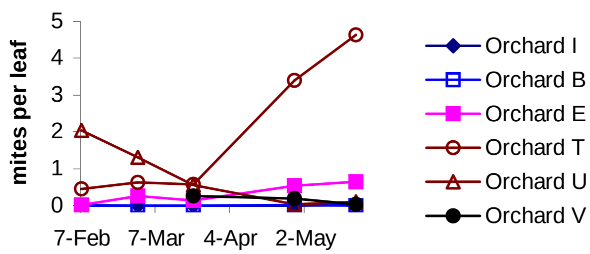


Figure 5: Mean number of mature typhlodromid mites per leaf in different orchards, 2002.

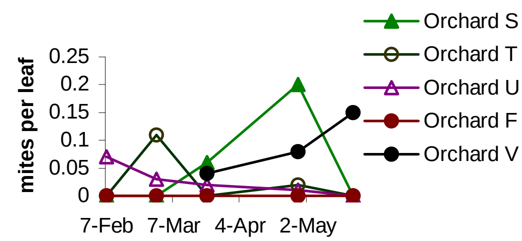


Figure 6: Percentage of monitor trees with adult ladybirds, 2001.

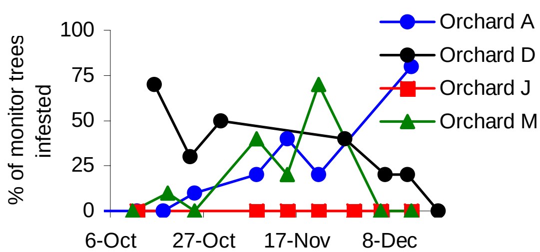


Figure 7: Percentage of monitor trees infested with eggs or low numbers of SSM in relation to sprays applied, Orchard B, 2001.

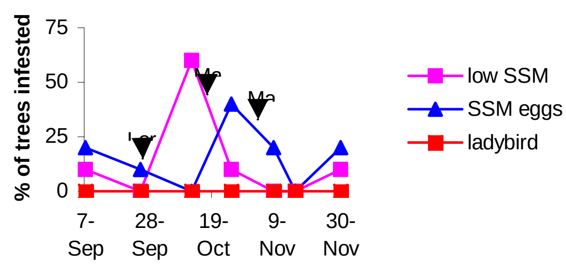


Figure 8: Mean number of mature sixspotted mites per leaf in orchards using hard or soft spray programmes, 2002.

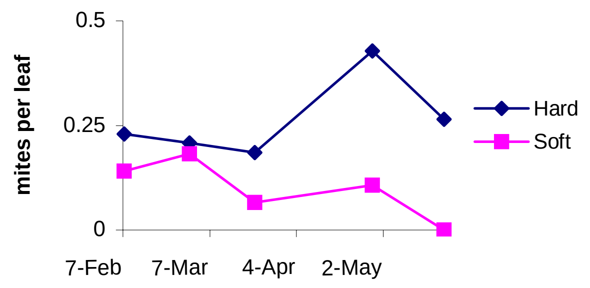


Figure 9: Mean number of tydeid mites per leaf in orchards using hard or soft spray programmes, 2002.

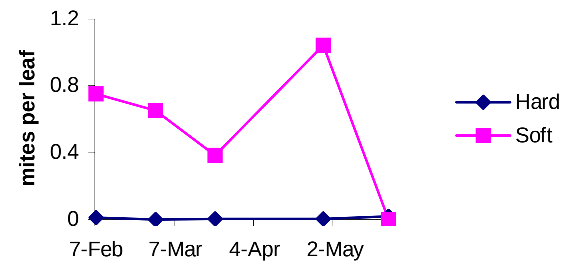
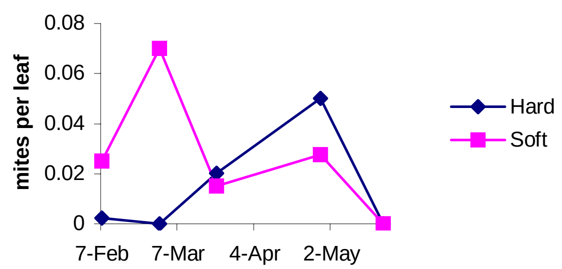


Figure 10: Mean number of mature typhlodromid mites per leaf in orchards using hard or soft spray programmes, 2002.



Other features of orchards

During discussions with growers, one factor that was mentioned which could affect the incidence of SSM on orchards is dust. While this is unlikely to have been responsible for the overall SSM problem, it could affect where SSM outbreaks occur within orchards. Dust settling on fruit trees is well known to trigger outbreaks by a number of species of plant-feeding mites both in New Zealand and overseas. This appears to occur with SSM in California, as Anon. (1999) refer to the (rare) use of water trucks to prevent dust within orchards as a means of cultural control for SSM and the same approach is used in Florida for the avocado brown mite (*Oligonychus punicae).*

Some other features might possibly influence the abundance of SSM within avocado orchards. For example, spraying insecticides on shelter tree species that were SSM hosts might disrupt biological control by reducing predators and thereby, enabling SSM populations to build up and infest nearby avocado trees. This could occur if SSM had effective natural enemies and these were susceptible to some insecticides. Another potential factor could be the way in which the groundcover under the avocado trees is managed, such as whether groundcover is present or not and what weeds it contains, some of which could be hosts of SSM.

A small survey of orchards found that the main species of trees used to shelter the orchards were *Cryptomeria* and *Casuarina* with Leylandii cypress, Eucalypts, willow and pine also being used on some orchards (Table 2). Most orchardists (79%) did not spray their shelter, although spray drift onto shelter trees would occur when sprays are applied to nearby avocado trees. Therefore, unless spray drift onto shelter is extensive, then even if some shelter tree species are suitable hosts of SSM, in the absence of sprays of broad-spectrum insecticides being made directly onto the shelter, it is less likely to be acting as a major source of SSM.

Table 2. Summary of selected features of orchards (n=9).

Orchard feature
Orchard shelter- % of orchards with shelter species
Cryptomeria (66.7%), Casuarina (66.7%), Eucalyptus (33.3%), Leylandii Cypress (33.3%), pine (33.3%), willow (11.1%)
% of growers spraying shelter
Never (78.8%), generally not (11.1%), sprayed (11.1%)
Weed species beneath shelter
Inkweed, banana passionfruit, nightshade, barberry, Jerusalem cherry, kawakawa
% of orchards mowing ground cover – all
Ground cover species
Grass, clover, kikuyu, nightshade, puha, Jersusalem cherry
Weed species in ground cover
Woolly nightshade, dock, nightshade, wild strawberry, buttercup, couch, rye, clover
% of orchards using Roundup to spray beneath orchard trees - all
% of orchards using irrigation
None (22.2%), mini-sprinklers (78.8%)
% of orchards using air or ground spraying
Ground (78.8%), air (22.2%)
% of orchards treated by contractor or owner
Owner (22.2%), contractor (66.7%), joint (11.1%)

Although all of the orchardists managed their orchard groundcover with mowing and the ground beneath the avocado trees was frequently bare, the presence of some known hosts of SSM either beneath shelter trees and/or in the groundcover (Table 2) means that there is some potential for these areas to act as a source of SSM. However, most orchardists (79%) had irrigation which would reduce the likelihood that orchard groundcover would become water-stressed during summer, thereby forcing phytophagous mites such as SSM to move onto orchard trees.

Most (79%) orchards were sprayed from the ground (Table 2). The method of spraying will influence the deposition of spray residues within avocado trees and hence the level of SSM control that may occur. Without any data comparing actual within tree distribution of spray residues from the two methods of spraying it is not possible to speculate further.

SUMMARY

Most Whangarei avocado growers currently rely on organophosphate and pyrethroid insecticides for pest control, mainly against leafrollers, greenhouse thrips and armoured scale insects. Several of these products are also being used against SSM and at present some appear to provide control to an extent. This season growers have an increased awareness of SSM and at least some have modified their spray practices, for example by using more sprays or spraying earlier, in order to try to improve control. The introduction of monitoring practices under AvoGreen has assisted this process. However, where broad-spectrum insecticides are being used more frequently the numbers of the beneficial arthropods is considerably reduced. Amongst the beneficial insects and mites that are present in some orchards, are some that appear to be predating SSM. There is a need to determine what impact these natural enemies have on SSM populations and whether they have potential to manage this pest with or without some assistance.

ACKNOWLEDGEMENTS

I would like to express my gratitude to the staff of the packhouses visited for their willing co-operation, helping me to make contact with growers, sharing their experiences with SSM and providing me with information. Their assistance is vital to this project and will greatly benefit their industry in tackling this problem. Thanks are also due to Paul Brookbanks for his help in providing contacts.

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