Collection and selection of natural enemies of twospotted spider mites for biological control

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ABSTRACT

Natural enemies of the twospotted spider mite, *Tetranychus urticae* (Koch) were surveyed (at three locations) in the lower Fraser Valley, British Columbia. Our objective was to identify predators that might be used for the biological control of spider mites in greenhouse tomato crops. Three to four pots of bean plants infested with spider mites were exposed each week at each of three locations from early April through to October, in both 1992 and 1993. Predators were collected from these trap plants, identified and tested as potential predators of spider mites. Twenty-two species were collected, more than half of them predatory Hemiptera. Two species, *Feltiella acarisuga* (Vallot) (Diptera: Cecidomyiidae), and *Stethorus punctum picipes* (Casey) (Coleoptera: Coccinellidae) were specialist predators of spider mites. *Feltiella acarisuga* was the most promising candidate for use in biological control of spider mites (on tomatoes) based on the frequency with which it occurred on trap plants, its cosmopolitan distribution, and its monophagous feeding habits.

Key words: biological control, British Columbia, greenhouse, tomato, *Tetranychus urticae*, *Feltiella acarisuga*, *Therodiplosis persicae*, predators.

INTRODUCTION

Biological control of twospotted spider mites, *Tetranychus urticae* (Koch) (Acari: Tetranychidae), by the predatory mite *Phytoseiulus persimilis* (Dosse & Bravenboer) (Acari: Phytoseiidae) is common on cucumber and pepper crops in greenhouses in British Columbia (Costello *et al.* 1992) and elsewhere (Lenteren & Woets 1988). Twospotted spider mites are also pests of greenhouse-grown tomatoes, and biological control using *P. persimilis* has been described (Hussey & Scopes 1985). Outbreaks of twospotted spider mites are common on greenhouse grown tomato crops in B.C. but attempts at biological control with *P. persimilis* have generally failed. The increase of populations of *P. persimilis* on tomato crops is reduced by mortality of motile stages through entanglement on glandular hairs on stems and leaf petioles (Haren *et al* 1987), and by reduced life span and fecundity of adults due to contact with tomato leaves (Gillespie & Quiring 1994).

As one of many possible solutions to this problem, a different natural enemy could be used either to replace or to supplement *P. persimilis*. Importation of exotic predators should be done cautiously, however, and potential endemic natural enemies should be screened first. Consequently, the predators of spider mites were surveyed at three locations in the lower Fraser Valley, BC, using trap plants baited with spider mites. We report here the results of that survey, and of the initial screening process used to select candidate species for further study.

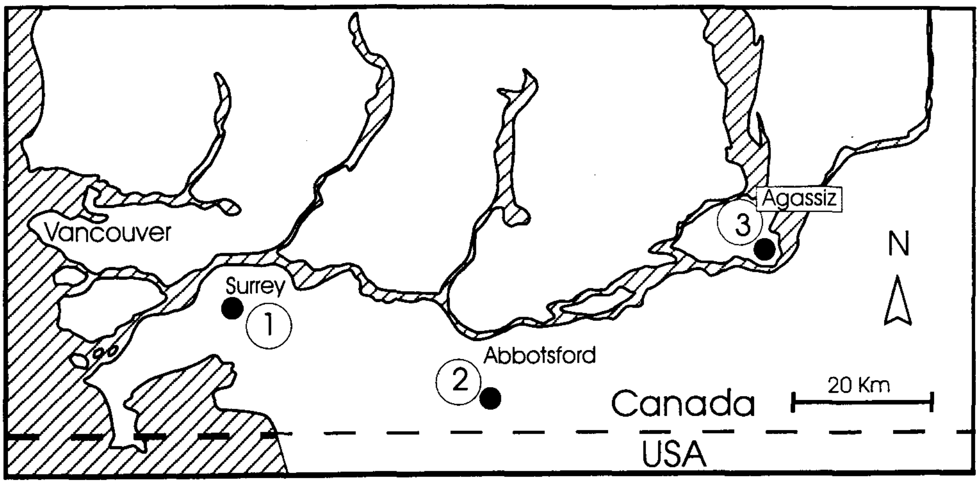

Figure 1. Map of the Lower Fraser Valley, B.C. Showing sample locations: 1. Green Timbers Nursery, Surrey, B.C.; 2. Agriculture and Agri-Food Canada Sub-Station, Abbotsford: 3. Agriculture and Agri-Food Canada Research Station, Agassiz.

METHODS AND MATERIALS

Ten to twelve lima bean (*Phaseolus lunatus* L.) seeds were planted in compost mix in standard "8 inch" plastic pots, weekly from early April to late September of 1992 and 1993. After three to four weeks in a greenhouse at 22°C the primary leaves had completed growth, and the first secondary leaves were maturing. The plants were then lightly infested with approximately 200 adult and immature twospotted spider mites per pot, and taken to three different locations. At each location (Fig. 1) three to four pots were placed in 30 cm diam., plastic saucers, filled with water, under a 90 x 90 x 90 cm, plastic-roofed shelter with open sides. These plants were left unattended for one week.

After each week the trap plants were replaced with pots of fresh plants. The pots of exposed plants were carefully placed in plastic tote boxes with tight fitting, screened lids, and returned to the laboratory. Any obvious herbivores were removed, and known predators of spider mites were preserved and catalogued. Predators with unknown prey preferences and species whose role in the food chain was not obvious (eg. nymphs of some Hemiptera) were provided with spider mites on pieces of bean leaf for 24 h. Any insects that did not feed on spider mites were discarded. Species of unknown identity were reared to adults on a diet of spider mites and preserved for identification.

At site 1, in Surrey, trap plants were placed on mowed grass at the interface between a large open grass field, and a mature second-growth coniferous forest. At site 2, in Abbotsford, plants were in a mixed grass and clover fallow field. The site was surrounded by a windbreak of deciduous and coniferous trees, and much of the surrounding land was dedicated to raspberry culture. At site 3, in Agassiz, plants were among long grass at the interface between grass pasture and an extensive blackberry (*Rubus* spp.) thicket. The wild area behind the blackberry was mixed deciduous and coniferous forest.

RESULTS AND DISCUSSION

More than 1500 specimens, representing 22 species of predator in seven orders and 14 families were collected from trap plants in 1992 and 1993 (Table 1). These species were either known predators of spider mites, or were observed to feed on them in the laboratory.

Most of the species (12 of 22) were Hemiptera and could be classed as generalist predators, feeding on spider mites and other small arthropods (see tables and citations in Chazeau 1985). With the exception of *Heterotoma meriopterum* (Scopoli) (Hemiptera: Miridae), all hemipterans were collected as adults. First instar nymphs of *H. meriopterum* were found on trap plants on several occasions. These were reared to adults on a diet of spider mites. It appears that adults of this species might lay eggs in or near to spider mite colonies.

Of the ten non-Hemipterous species, seven can be classed as generalist predators. Three species appeared to specialize as predators of spider mites. These were *Amblyseius sp.* (Acari: Phytoseiidae), *Feltiella acarisuga* (Vallot) (Diptera; Cecidomyiidae) and *Stethorus punctum-picipes* (Casey) (Coleoptera: Coccinellidae). Of these three, only *F. acarisuga* was collected at all three sites, and in virtually every month of the survey; it was the commonest predator. *Feltiella* spp. are predators of spider mites in many agricultural crops and are often considered the most important predators (Oatman *et al.* 1985, Pickett & Gilstrap 1986, Sharaf 1984). Moreover, *F. acarisuga* is virtually cosmopolitan (Gagne, 1995). In contrast, the other specialist feeder, *S. punctum picipes*, is restricted to western North America (Gordon 1985), and only 13 specimens were collected on 3 occasions.

Our objective was to select one or more natural enemies that might replace *P. persimilis* as a biological control for spider mites on greenhouse tomato crops. *Phytoseiulus persimilis* is ineffective on tomato plants, partly because motile stages are trapped on glandular hairs on stems and leaf petioles (Haren *et al.* 1987). Other phytoseiids and predators that walk between leaves to locate prey might also get trapped. Therefore trap plants were placed in water-filled saucers, in part to exclude such predators. This strategy was apparently successful, as only two species of predacious mites were found on trap plants. In a survey of spider mites on strawberry plants in the Fraser Valley, Raworth (1990) collected seven species of predacious Acari. All of the arthropod species found in this survey were collected either as winged adults, or as eggs, and first instars from eggs deposited by winged adults. The adults might therefore be able to avoid glandular hairs on stems and petioles when searching for prey.

The use of trap plants baited with target pest species and placed in areas where that pest is at a low density has been advocated as a way to select natural enemies for use in classical biological control (Pschorn-Walcher 1977). The natural enemies collected on such plants can presumably locate and feed on prey at low population densities. In this study, we placed trap plants baited with spider mites where spider mites were not obviously in outbreak, but might have been present naturally. At all sites, plants were placed in or near areas of mixed vegetation, separated from cultivated crops. Although spider mite density was not determined in surrounding vegetation, the lack of obvious damage on local plants presumably indicated low numbers. We therefore assumed that any natural enemies, particularly specialist natural enemies, that appeared on trap plants originated from nearby spider mite colonies that were not in outbreak or from distant outbreaks.

One of the desirable characteristics of natural enemies used for inundative biological control in greenhouses is their ability to locate hosts readily (Lentern & Woets 1988). Predators that discover spider mites on trap plants have either done so by chance or by some, presumably semiochemical, cues. It can be argued that those species that are known specialist predators of spider mites, and that also occur with regularity on trap plants probably have an efficient system for locating prey. In this context, *F. acarisuga* is an obvious candidate because of its consistently high numbers

Table 1.
Species of predatory insects collected on trap plants baited with twospotted spider mite, *Tetranychus urticae* (Koch).

Species	Common Name	Type	Stage Collected[1]	# Collected[2]
Acari: Anystidae				
Anystis agilis Banks	predatory mite	generalist	I, A	54
Phytoseiidae				
Amblyseius sp.	predatory mite	generalist	I,A	23
Hemiptera: Miridae	plant bugs			31
Heterotomma meriopterum (Scopoli)		generalist	I	
Dicyphus sp.		generalist	A	
Deraeocoris brevis Knight		generalist	A	
Campyloneura virgula (H.-S.)		generalist	A	
Lygaeidae	big-eyed bugs			
Geocoris sp		generalist	A	1
Anthocoridae	flower bugs			35
Orius tristicolor (White)		generalist	A	
Orius minutus (L.)		generalist	A	
Anthocoris antevoleus White		generalist	A	
Berytidae	stilt-legged bugs			
Neides muticus (Say)		generalist	A	1
Nabidae	damsel bugs			33
Nabis alternatus Parshley		generalist	A	
Nabis roseipennis Reuter		generalist	A	
Nabis rufusculus Reuter		generalist	A	
Diptera: Cecidomyiidae				
Feltiella acarisuga Vallot	predatory gall midge	specialist	E, I	1224
Syrphidae				
Scavaea pyrastri (L.)	flower fly	"generalist"	I	1
Thysanoptera: Aeolothripidae				
Aeolothrips fasciatus (L.)	thrips	generalist	A	32
Neuroptera: Chrysopidae				
Chrysopa sp.	green lacewing	generalist	I	40
Hemerobiidae				
Wesmaelius sp.	brown lacewing	generalist	E, I	3
Dermaptera: Forficulidae				
Forficula auricularia (L.)	european earwig	generalist	A	
Coleoptera: Coccinellidae				
Stethorus punctum picipes(Casey)	spider mite destroyer	specialist	E, I, A	13
Coccinella sp.	ladybird beetle	generalist	A	1

[1] stage collected on plants. E = egg, I = immature, A = adult
[2] total number collected at 3 sites during 2 years

A second important criterion for inundative biological control agents is that they should be able to complete their life history on the prey (Lentern & Woets 1988). Those predators found on infested baited trap plants as eggs and immatures probably meet this criterion. *Feltiella acarisuga*, *Wesmaelius sp.*, and *Stethorus punctum-picipes* all occurred as both eggs and immatures. In addition, we have seen *F. acarisuga* among spider mite colonies in greenhouses, apparently invading naturally. Our preliminary test release of *F. acarisuga* on tomato plants in a greenhouse became established and reproduced. On the basis of this evidence *F. acarisuga* was selected for further investigation as a potential candidate for inundative biological control of spider mites.

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