Biological control of the two-spotted spider mite in raspberries with the predator mite, *Phytoseiulus persimilis*

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ABSTRACT

Phytoseiulus persimilis was released to control the two-spotted spider mite, *Tetranychus urticae*, in field raspberries at Agassiz, B.C. The mite predators became established and responded numerically to the prey in the treatment plots. For a period of 8 weeks after release, the numbers of *T. urticae* were consistently lower in the treatment plots than in the controls. Differences in numbers of *T. urticae* between the treatments and the controls were significant on two dates.

Key words: *Tetranychus urticae, Phytoseiulus persimilis, Rubus idaeus*, biological control, Fraser Valley

INTRODUCTION

The two-spotted spider mite, *Tetranychus urticae* (Acari: Phytoseiidae) Koch is a common pest of raspberries in British Columbia. A severe infestation can result in almost complete defoliation by August. Photosynthetic reserves necessary for cold hardiness are lost if premature defoliation occurs (Jennings *et al.* 1964). An infestation in the autumn can result in reduced bud survival during the following winter (Doughty *et al.* 1972). Weak plants leaf out earlier in the spring, and are thus more susceptible to late frosts than healthy plants (W.Peters, District Horticulturist, Abbotsford, B.C., personal communication).

Phytoseiids are widely used for the biological control of spider mites on various greenhouse crops (Costello and Elliott 1981; Mori *et al.* 1989; Tanigoshi 1982). Because of its high voracity, short developmental time, high fecundity (Laing and Huffaker 1969) and good dispersal ability (McMurtry 1982), *Phytoseiulus persimilis* Athias-Henriot is an important predator of *T. urticae* in greenhouses. In addition, *P. persimilis* has also been successfully used for mite control in field strawberries in England, California and New Zealand (Easterbrook 1988; Oatman *et al.* 1968; Waite 1988).

We describe the results of an experiment to determine the efficacy of *P. persimilis* as a biological control agent of *T. urticae* on raspberry crops in the Lower Fraser Valley.

MATERIALS AND METHODS

The experiment was done in a plot of nine rows of red raspberries, *Rubus idaeus* L., at the Agriculture Canada Research Station in Agassiz. Each row consisted of four eight meter sections separated by two meters of bare ground. Three treatments and a control were assigned at random within a row. This was replicated five times on alternate rows, leaving a buffer row between treatments. We released *T. urticae*, obtained from Applied Bionomics (Box 2637, Sidney, B.C. V8L 4C1), on 11 May, 1989 by placing three pieces of mite-infested bush bean leaf (*Phaseolus vulgaris* cv Provider) per stool (a group of five raspberry canes derived from the same root) onto the raspberry foliage in each plot. The procedure was repeated on 9 and 27 July because the mites did not become established owing to wet, cold weather. The predator *P. persimilis* was introduced on 2 August when a sample of 30 leaflets per treatment indicated density of 0.70 *T. urticae* per leaflet. The bean leaves on which the predators were supplied were stapled onto the raspberry foliage in the middle of the canopy in numbers according to the following ratios of adult females to predators: 1:50 (High); 1:100 (Medium); and 1:200 (Low); and a control.

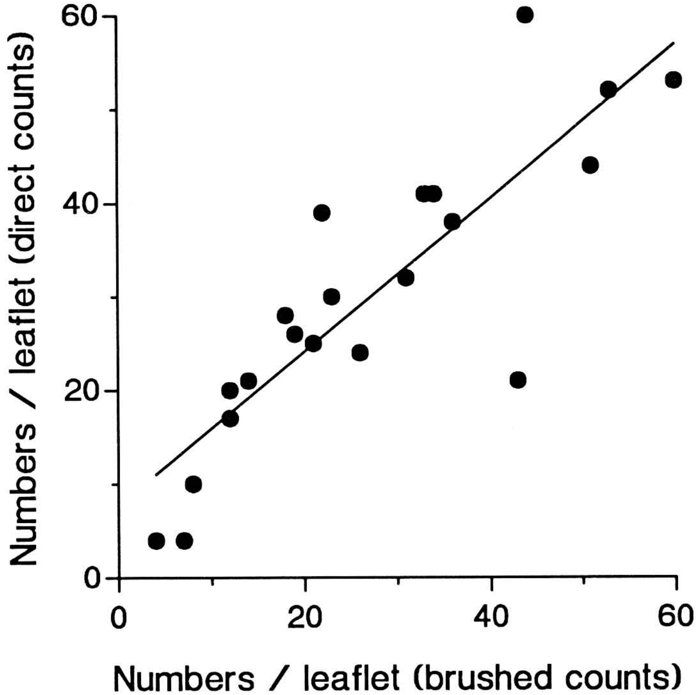

Figure 1. The relationship between estimated numbers of *Tetranychus urticae* on raspberry leaflets by direct counts and counts after removal with a mite-brushing machine.

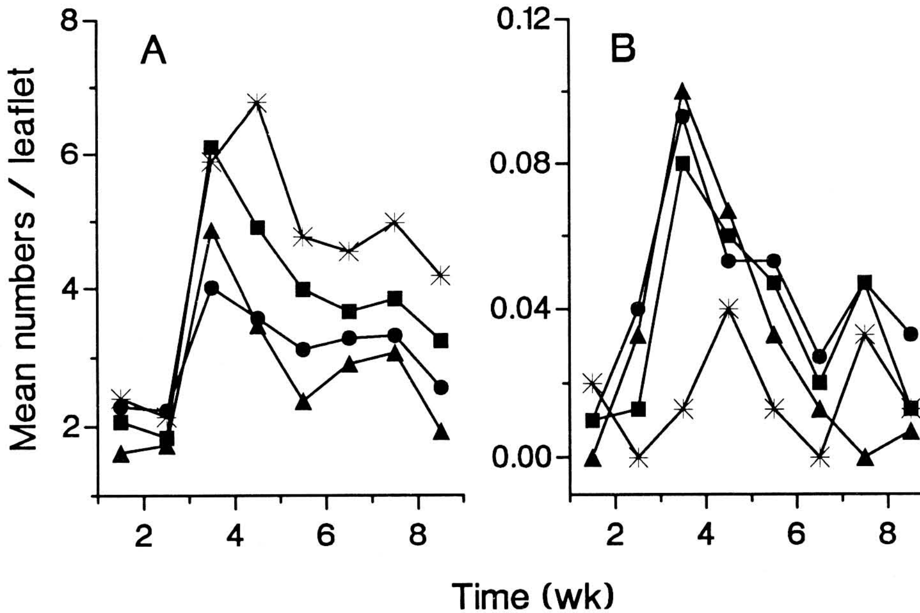

Figure 2. Population trends of *Tetranychus urticae* (A) and *Phytoseiulus persimilis* (B) in raspberry plots at Agassiz, B.C., 1989. Each point is the average of five replicates for the predator/prey treatments: 1:50,(●); 1:100 (▲) ; 1:200 (■); and control,(∗). One average standard error of a given mean density was 1.491 (A) and 0.03(B) mites per leaflet. Time zero was 2 August when *P. persimilis* was introduced.

Mites were sampled on 13 August and at weekly intervals thereafter until 1 October. Samples consisted of 30 leaflets per replicate, 10 leaflets picked equally from the top, middle, and bottom of the plant. The mites were removed from the leaves with a mite-brushing machine (J.G.H. Edwards, Llanfair Orchards, RR1, Okanagan Falls, B.C.), and all stages other than eggs were counted at 10X magnification under a dissecting microscope.

Brushed-mite counts were compared to direct counts of mites on leaves. Twenty-one leaflets were picked at random from raspberry plants that were infested with *T. urticae*. The mites were counted under a dissecting microscope. Each leaflet was then passed through the mite-brushing machine (Henderson and McBurnie 1943), and the *T. urticae* were counted again.

The data were analyzed using SAS® REG and GLM Anova procedure with repeated measures (SAS Institute Inc. 1985). The GLM analyses were performed on log- and square-root-transformed, and untransformed data with similar results. The results reported are from analyses of untransformed data.

RESULTS AND DISCUSSION

The regression of direct counts (y) on brushed-mite counts (x) (Fig. 1; $r^2 = 0.732$; $p < 0.01$; $y = 7.74 + 0.82\,x$) was linear since the addition of x^2 to the equation was not significant ($p > 0.05$). The x-intercept was not significantly different from zero ($p > 0.05$). The data obtained using the mite brushing machine were therefore analyzed without calibration.

The population trends for *T. urticae* in the three treatments and the controls followed a similar pattern during the first 2.5 weeks after release, then the numbers diverged (Fig. 2A). Overall differences between treatments were not significant ($p > 0.05$), but contrast analysis using Bonferroni's method showed significant differences between the High treatment and the controls at 4.5 weeks ($p < 0.05$), and between the Medium treatment and the control at 4.5 and 5.5 weeks ($p < 0.05$). Two-spotted spider mite population levels in the High and Medium treatments maintained the same position relative to the controls through the rest of the experiment but were not significantly different from the controls ($p > 0.05$).

Phytoseiulus persimilis became established in the treatment plots at low levels and followed a pattern of population fluctuations similar to that of *T. urticae* (Fig. 2B). Average *P. persimilis* numbers increased almost ten-fold within 3.5 weeks. The numerical response was analyzed by regressing average numbers of *P. persimilis* on average numbers of *T. urticae* for each treatment (High, $r^2 = 0.604$, $p = 0.023$; Medium, $r^2 = 0.608$, $p = 0.023$; Low, $r^2 = 0.857$, $p = 0.001$; and controls, $r^2 = 0.309$, $p = 0.153$). The data indicate that *P. persimilis* was able to find its prey and reproduce when prey were abundant.

The experiment shows that *P. persimilis*, which is not native to B.C., can establish and survive in a raspberry field during the summer, for at least 8.5 weeks, at a prey density of 0.7-6.0 *T. urticae* per leaflet. Significant treatment effects on two dates indicate that *P. persimilis* may reduce *T. urticae* numbers at both a 1:50 and 1:100 predator/prey ratio. The results are in agreement with other research showing that, in general, agents should be released at a predator:prey ratio of no less than 1:100 (Hoy *et al.* 1982; and Mori *et al.* 1989).

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