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Biological mite control in Hudson and Champlain Valley Apple Orchards Through the Distribution and Conservation of *Typhlodromus pyri*

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Project location: throughout the northeast

Abstract Biological mite control is a feasible alternative to pesticide-based control that is sustainable, possibly of lower cost, and void of the concerns that use of chemical pesticides raise. The mite predator *Typhlodromus pyri* has been shown to provide complete and sustained control of European red mite in apples in a variety of locations throughout the northeast. While previous research has indicated that *T. pyri* can be an effective biological control agent in eastern New York, there has been no large-scale demonstration of this technology. Beginning in 2001, we undertook such a demonstration effort. *Typhlodromus pyri* were introduced into 11 orchards in the Hudson valley region and into 8 orchards in the Champlain valley region. We also surveyed for *T. pyri* in other orchard blocks and conducted trials to evaluate chemical pesticides that might be used to control tarnished plant bug and were not highly toxic to *T. pyri.* We found that *T. pyri* could provide control of European red mite in eastern New York and that the predator persisted in orchards in these regions. We also learned that *T. pyri* is indigenous to these regions and introduction of the predator into orchards is therefore unnecessary. Use of *T. pyri* will only require careful selection and use of pesticides that are not highly toxic to this natural enemy. The insecticides Avaunt and Actara are alternatives to pyrethroids for tarnished plant bug control and are not toxic to *T. pyri.*

Although efficacious miticides continue to be developed and made available, the costs of control using these materials are escalating during a period when many orchardists are attempting to remain viable by minimizing expenses. Furthermore, chemically-based mite control programs may be environmentally harmful and the potential for resistance to miticides by the pest mites is a concern. Biological control of mites is an economically and technologically feasible alternative to pesticides. Two species of predaceous mites predominate in commercial orchards in New York, *Amblyseuis fallacis* and *Typhlodromus pyri*. While these two phytoseiid mites look very similar, they have very different biologies and it is *T. pyri* that is the most effective biological control agent (Nyrop et al. 1998). In fact, when *T. pyri* is conserved in commercial apple orchards, it can eliminate the need for miticides (Walde et al. 1992, Hardman et al. 1991, Blommers 1994). Primary among the differences that lead to *T. pyri* being a more effective biological control agent are that it survives in apple trees year round and can achieve quite high densities on a variety of alternative food sources including pollen and fungal spores (Breadth et al. 1998, Nyrop et al. 1998). *Typhlodromus pyri* is common in western New York apple orchards, and was thought to be relegated to this geographic area. However, research has demonstrated that *T. pyri* can provide effective biological control in both the Champlain and Hudson valley apple growing regions. This research also suggested that *T. pyri* was indigenous to at least a few orchards in these areas. These results indicate that a mite biological control progam based on conserving *T. pyri* could be very effective in these apple growing regions.

Objectives The overall goal of this project was to demonstrate a reliable and effective mite biological control system in eastern New York apple orchards. To accomplish this goal three objectives were pursued:

1. Demonstrate the effectiveness of *T. pyri* in Champlain and Hudson valley orchards by documenting persistence and impact on European red mite (*Panonychus ulmi*) populations.
2. Compare the efficacy of Thiodan, Actara and Avaunt for tarnished plant bug (TPB) control. Control of TPB was identified as a potential constraint to adopting biological mite control because existing TPB control strategies rely on insecticides toxic to *T. pyri*.
3. Construct a spreadsheet to allow growers to compare the costs associated with the application of pesticides that conserve *T. pyri* and place this information on the web.

Procedures *Biological control evaluation*: *Typhlodromus pyri* were released in 8 and 11 orchards in the Champlain (CV) and Hudson (HV) valley growing regions, respectively. In each orchard, two blocks of approximately 1-5 ha consisting of nearly identical trees (same cultivar, 2-5m tall) were established. Within each block, single plots of 20 trees (4 rows, 5 trees per row) were marked and *T. pyri* released into one of these plots. Blocks were treated identically with insecticides and fungicides that are not toxic to *T. pyri*. Miticides were only applied if European red mite numbers exceeded treatment thresholds. Mite dynamics were monitored by collecting 25 leaves per tree from each of the 6 interior trees of the plots four times during the growing season. Mites on these leaves were brushed onto glass plates, counted, and phytoseiids identified.

TPB control evaluation: Several insecticides were evaluated for TPB control using small plot replicates in an orchard at the Hudson Valley Lab in Highland, NY. Six treatments and a control were compared (Table 1). Damage by tarnished plant bug, plum curculio (PC) and green fruit worm (GFW) was evaluated on 25 May, 2002. Tarnished plant bug control using Avaunt and variable growers' standards (organophospate and/or pyrethroid insecticides) was compared in 17 commercial orchards located throughout New York state. At each orchard one ca. 5 acre plot was treated with Avaunt at petal fall and a second plot was treated using standard grower practices. Plant bug damage was evaluated at harvest.

Spreadsheet of costs: A spreadsheet is being prepared and will be made available on the world-wide web.

Results *Summary of 2001 results*: Of the 11 orchards located in HV, 7 harbored *T. pyri* in both release and control plots, in two orchards *T. pyri* were found only in the release plots, in one orchard *T. pyri* was found only in the control plot, and in the remaining orchard no *T. pyri* were found. Of the 8 orchards in CV, *T. pyri* were found in all the release plots, but also in 7 of the control plots. These results show that *T. pyri* were indigenous to approximately 75% of the orchards that we worked in. However, samples from an additional 17 orchards revealed 9 with phytoseiids, but only in two of these orchards were *T. pyri* found. Clearly, *T. pyri* is indigenous to these apple growing regions and offers the potential for controlling European red mite. However, this predator is either lacking or at very low densities in many orchards. Average and maximum densities of European red mite were generally equivalent in release and control plots in both regions. For all but one site, densities of pest mites in release plots remained below a treatment threshold of 7-10 mites per leaf, even though miticides were not applied to these plots.

2002: The relationship between European red mite and *T. pyri* in release and control plots during 2002 is portrayed in Fig. 1. One important pattern revealed by these data is the limit imposed on European red mite numbers by *T. pyri*. Average seasonal densities of *T. pyri* in excess of 0.1 per leaf resulted in maximum European red mite densities of less than 5 per leaf. This pattern is portrayed by the smooth curve that was fitted by eye to the ridge of maximum European red mite densities. Because factors other than *T. pyri* influence European red mite abundance, densities of this pest mite were often below the upper limit imposed by *T. pyri*. The curve shows the likely upper pest mite density given the seasonal abundance of *T. pyri.* Note that in the absence of predators, European red mite attained densities of nearly 100 per leaf. A second important pattern revealed by this figure is that while densities of *T. pyri* were generally higher in plots where the predators were released, densities of this predator were also quite high in some control plots where the predators were not released.

The relationship between *T. pyri* abundance in release and control plots is more explicitly portrayed in Fig. 2 where patterns are shown for both 2001 and 2002. *Typhlodromus pyri* were more abundant in release plots than in control plots and, on average, were more abundant in the Champlain valley compared to the Hudson valley. The latter pattern probably reflects pesticide use rather than the influence of abiotic differences between the two regions because the maximum abundance of *T. pyri* in the two regions was similar; however, in the Hudson valley there were more locations with very low or no *T. pyri.* Pesticide records needed to verify that these differences can be attributed to erroneous application of pesticides harmful to *T. pyri* are still being collected from cooperators. In 2001 there was no correlation between the average densities of *T. pyri* in release and control blocks; however, in 2002 the correlation coefficient was 0.85. Because release and control plots were placed at least 100 m from each other, similarities in abundance between the two treatments can not be accounted for by movement of predators from release to control plots. A more plausible explanation is that use of selective pesticides in release and control blocks allowed indigenous *T. pyri* populations to grow in the control blocks. Numbers in the release blocks remained greater than in the control blocks because starting densities were higher.

To measure persistence of the *T. pyri* in the two regions, seasonal average densities in 2001 and 2002 were plotted (Fig. 3). If predators were persistent, plotted densities should fall along a line that bisects the graph at a 45 degree angle and a large number of observations fit this pattern. A linear model was fit to the data after omitting zeros in 2002. The plotted line is curvilinear because the axes are on a log scale. For *T. pyri* densities in excess of 0.1, the line is nearly linear. For 2001 densities less than 0.1 the line curves upward reflecting increases in *T. pyri* numbers in 2002 at sites where they were few in 2001. The persistence pattern was common to both Champlain and Hudson valley sites. These data show that in the absence of pesticides toxic to *T. pyri*, these predators can be counted on to provide control of European red mite.

Key to using *T. pyri* as a biological control agent is using pesticides that are not overly toxic to this predator. Historically, control of tarnished plant bug has relied on application of pyrethroid insecticides that are very toxic to *T. pyri*. Because some growers feel it necessary to control TPB, this is a potential obstacle to mite biological control with *T. pyri*. Results from our insecticide trials suggest this obstacle can be circumvented. Shown in Table 1 are the results from the small plot trials conducted at the Hudson Valley laboratory. Actara and Avaunt are both registered insecticides that have activity against TPB, though Actara would be preferred since it appears to control TPB better and is also efficacious against plum curculio (PC). Neither Actara or Avaunt are toxic to *T. pyri*. The organophosphates (Guthion and Imidan) and Thiodan showed less efficacy.

In the large scale trials a single application of Avaunt at petal fall provided less control than standard grower practices (Fig. 4). This was especially noticeable at one site where TPB damage in the Avaunt treated block exceeded 13%. Nonetheless, the differences between the Avaunt and conventionally treated blocks was, on average, small. Registration of Actara was not approved early enough to allow application of this compound in these blocks even though our experimental protocol had called for such. We feel that application of Actara at the pink bud stage will provide acceptable TPB control while also conserving *T. pyri*.

Summary This project has demonstrated that *T. pyri* can provide biological control of European red mite in Champlain and Hudson valley orchards. Furthermore, because this predator is indigenous to these regions, it should prove relatively easy to establish this beneficial mite by restricting pesticides to those that are at most, moderately toxic to this predator. The availability of Actara will allow a selective insecticide regime to be used while maintaining acceptable control of insect and disease pests.

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Table 1. Evaluation of insecticides for controlling early pest complex on apple N.Y.S.A.E.S., Hudson Valley Lab., Highland, N.Y.-2002

Treatment	Formulation amt./100 gal.	Timing	% Damaged fruit TPB	PC	GFW
Actara	1.4 oz.	P, PF-1C	0.0 a	0.5 abcd	0.0 a
Avaunt 30WG	2.0 oz.	P, PF-1C	0.1 a	3.9 abcde	0.0 a
Avaunt 30WG	1.25 oz.	PF -1C	0.4 abc	3.9 bcde	0.2 a
Asana XL	5.8 oz.	P, PF-1C	0.2 ab	0.0 a	0.0 a
Assail 70WG	0.6 OZ.	P, PF-1C	0.0 a	8.7 f	0.0 a
Imidan 70WP	12.0 oz.	PF -1C	0.2 ab	1.0 abcd	0.1 a
Lorsban 4E	16.0 oz.	P	0.5 abc	0.8 abcd	0.0 a
Guthion 50WP	10.0 oz.	PF-1C			
Thiodan 50WP	24.0 oz	P	1.0 bc	0.0 a	0.2 a
+ Guthion 50WP	10.0 oz.	P			
Guthion 50WP	10.0 oz.	PF-1C			
Guthion 50WP	10.0 oz.	PF-1C	0.5 abc	1.0 abcde	0.2 a
Untreated	-	-	3.9 c	70.8 g	3.9 b

Mean separation by Fishers Protected LSD (P=<0.05). Arc Sine transformation used for statistical analysis. Treatment means followed by the same letter are not significantly different

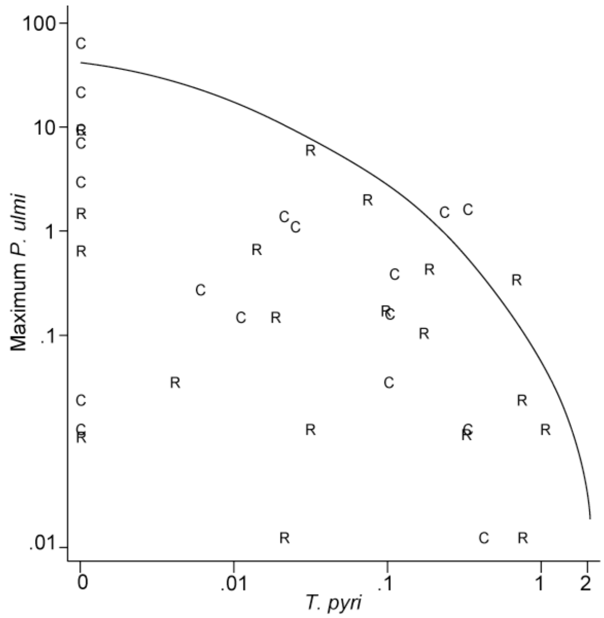


Figure 1. Relationship between average seasonal density of *T. pyri* and maximum density of *P. ulmi* in plots where *T. pyri* were released (R) and were not released (C). The smooth curve was fitted by eye.

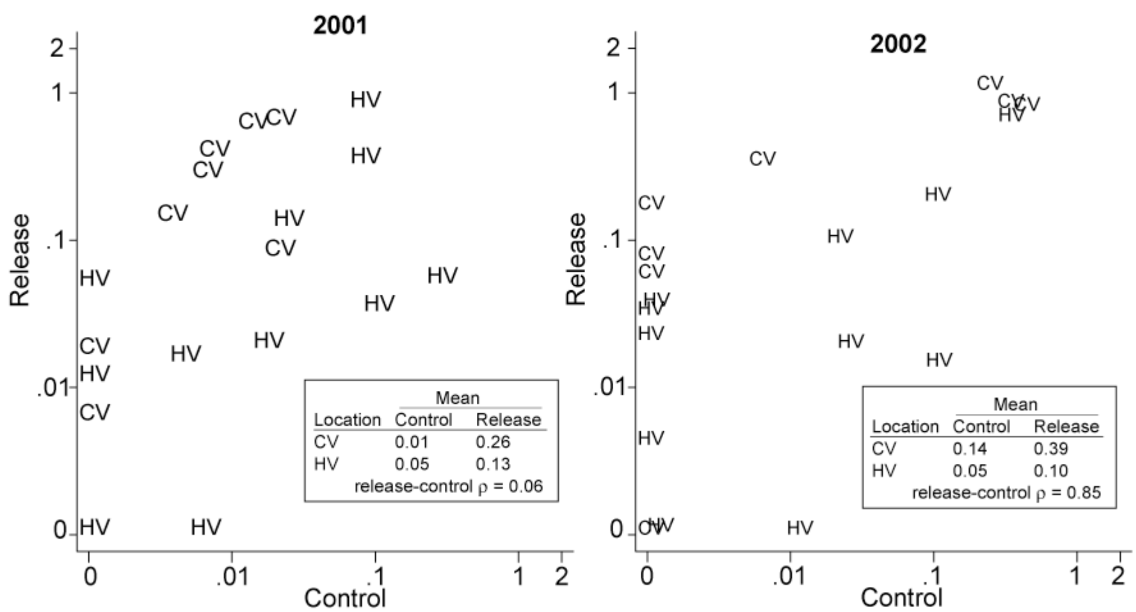


Figure 2. Average densities of *T. pyri* in plots where predators were (Release) and were not (Control) released in the Champlain (CV) and Hudson (HV) valley regions. Tables show average densities over all orchards in each of the two regions and correlations between densities in release and control plots.

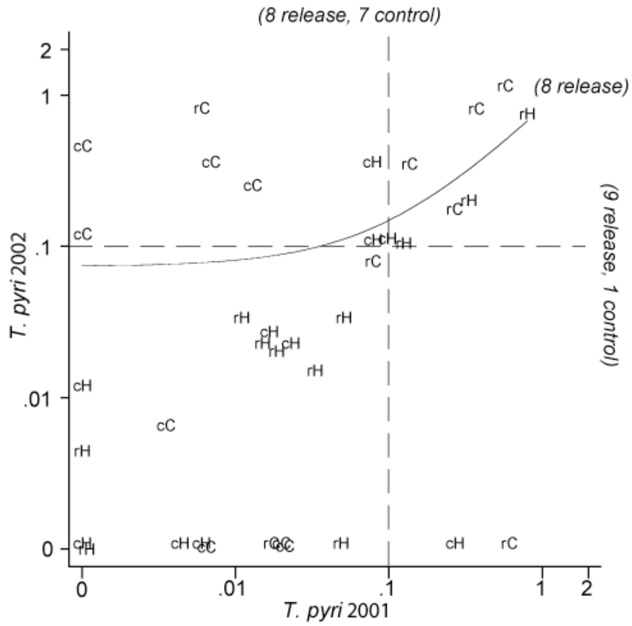
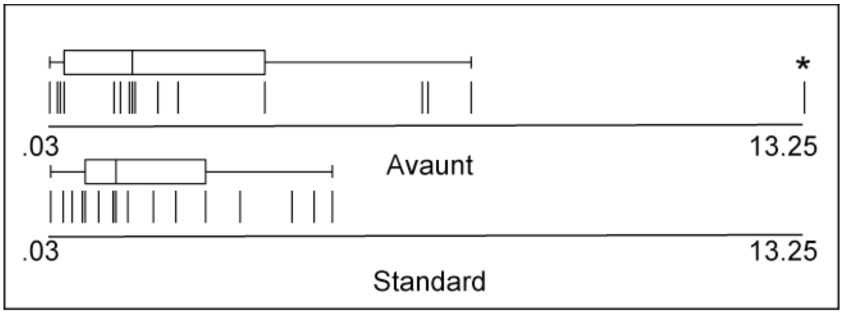


Figure 3. Average densities of *T. pyri* in each of two years in plots where predators were (rC and rH) and were not released (cC and cH) in two apple growing regions; Champlain valley (rC and cC) and Hudson valley (rH and cH). Dashed lines indicate the minimum average seasonal densities required to keep *P. ulmi* below 5 per leaf. Eight of 19 release sites had predator densities greater than this limit both years. The number of release and control with predator densities meeting these limits are indicated in parentheses. The smooth line is a linear model with intercept = 0.073 and slope = 0.75 ($F_{1,26} = 16.06$, $p < 0.001$).



Treatment	n	Mean	Std. Dev.	P > t [a]
Avaunt	17	3.04	3.54	0.06
Standard	17	1.84	1.57	
Avaunt	16 [b]	2.41	2.45	0.08
Standard	16	1.82	1.62	

Figure 4. Tarnished plant bug damage in 17 paired apple blocks in which Avaunt was applied to one block at petal fall and orchardists applied their standard insecticide in the other.

[a] P>t indicates the probability that damage in the Avaunt treated plots exceed that in the standard (paired t-test).

[b] Results after excluding the extreme value of 13.25 (*).