Establishment and Spread of Released *Typhlodromus pyri* Predator Mites in Apple Orchard Blocks of Different Tree Size: 1997 Results

Ronald Prokopy, Starker Wright, and Jonathan Black
Department of Entomology, University of Massachusetts

Jan Nyrop, Karen Wentworth, and Carol Herring
Cornell University, NY Agricultural Experiment Station, Geneva

Pest mites are usually completely controlled by predatory mites on unmanaged apple trees that receive no insecticide or fungicide. Some commonly-used orchard pesticides (e.g., synthetic pyrethroid insecticides, EBDC fungicides) kill or otherwise harm predatory mites, leading to pest mite outbreaks and need for miticide application. In Massachusetts, the predatory mite *Amblyseius fallacis* is present in about 90% of commercial orchards (see 1994 Spring issue of *Fruit Notes*) but usually not in numbers sufficient for providing mite biocontrol until August. Studies in New York have shown that the predatory mite *Typhlodromus pyri*, where established, can be an extremely effective season-long biocontrol agent of pest mites. This is a result of their ability to endure cold winter temperatures and periods of short supply of pest mites as food much better than *A. fallacis*. Unfortunately, few Massachusetts orchards appear to harbor significant natural populations of *T. pyri*.

In the 1997 Spring issue of *Fruit Notes*, we reported that when *T. pyri* obtained from Geneva, New York were released in 1995 into blocks of apple trees in six commercial orchards in Massachusetts, they became established in all blocks save those in one of the six orchards. On average, after two years, they had built to greater numbers in blocks managed under second-level IPM practices (no pesticide of any type used after early June) than in blocks managed under first-level IPM (sprayed with fungicide and insecticide through summer). These findings stimulated us to conduct further research on the establishment of *T. pyri* released in Massachusetts apple orchards.

We report here first-year results of a study in which *T. pyri* were released in 1997 on single trees in the center of blocks comprised of small, medium, or large trees and managed under third-level IPM practices.

Materials & Methods

Our experiment was conducted in six blocks of apple trees in each of eight commercial orchards. Of the six blocks per orchard, two each contained trees on M.9, M.26, or M.7 rootstock, designated as small, medium-size, or large trees. One block of each pair received first-level IPM practices, wherein growers applied insecticide and fungicide materials of their own choosing and timing of application, which extended from April through August. The other block of each pair received third-level IPM practices, wherein the intent was that no synthetic pyrethroid insecticide was to be used at any time, use of EBDC fungicides was to be minimized, no insecticide of any type was to be used after mid June, and captan or benomyl were the only fungicides to be used after mid

June. *T. pyri* is known to be highly adversely affected by synthetic pyrethroid insecticide and also adversely affected by EBDC fungicide (when applied from bloom onward) but not by captan or benomyl. Each block was comprised of 49 trees (7 rows x 7 trees per row) and of the cultivars McIntosh, Empire, and Cortland. Third-level IPM is similar to second-level IPM in focus on using biologically-based pest management practices, but it embraces integration with horticultural concerns (such as tree size) as an added component.

In May, blossom clusters harboring *T. pyri* were picked from an orchard at the New York State Agricultural Experiment Station at Geneva, sent by overnight mail to Massachusetts, and within three days were distributed to orchard blocks. Each third-level IPM block recieved 100 clusters, which were attached to twigs on the center tree of the block using twist ties. No *T. pyri* were released in first-level IPM blocks. Every 3 weeks from late July through early September in each of the 48 blocks, we sampled 25 leaves from the center tree, 15 leaves from each of the two outermost trees in the center row, and 15 leaves each from the center tree in each of the two outermost rows. The leaves were sent by overnight mail to Geneva, New York for the identification and counting of pest and predatory mites. In all, about 2,600 leaves were sampled for each of the three sampling periods.

Results

As shown in Table 1, significantly more *T. pyri* were present on the center (release) tree on each sampling date in blocks of each tree size than on outer trees in center rows of blocks (that is, the fourth tree up row and the fourth tree down row from the center tree in a block) or on center trees in outer rows of blocks (that is, the fourth tree directly across row to either side of the center tree of a block). In fact, extremely few or no *T. pyri* were found on any tree except those on which they were released. In contrast, there were no significant differences among tree locations within plots in numbers of *A. fallacis* sampled on each sampling date in blocks of each tree size (data not shown). The same was true for European red mites (data not shown).

The finding that, on average, numbers of European red mites were not significantly fewer on release trees than on non-release trees on any sampling date in blocks of any tree size suggests that *T. pyri* were not able to build to sufficient numbers to provide biocontrol of European red mites during the three months following release. This was not a surprising result because *T. pyri* populations grow slowly and usually are not capable of rapidly controlling moderate to high density red mite populations. Even so, there was one block of small trees in which *T. pyri* were released where every tree (save one) in that block (as well as every tree in each of the other five study blocks in that orchard) was heavily bronzed as a consequence of mite injury. The only tree that was not bronzed was the center tree on which *T. pyri* were released.

Data in Table 2 summarize information of all leaves sampled in a block and compare average numbers of *T. pyri*, A. fallacis and European red mites per leaf between first-level IPM blocks and third-level IPM blocks and among small, medium, and large trees within each sampling date. For each sampling date, there was no significant difference among blocks of small, medium-sized, and large trees in numbers of *T. pyri* found in third-level IPM blocks. In every case, third-level IPM blocks had significantly more *T. pyri* than first-level IPM blocks. For *A. fallacis* there were no significant differences in numbers found between first-level and third-level IPM blocks or among tree sizes for any sampling date. The same was true for European red mites.

Information on type and amount of insecticide, acaricide, and fungicide used before bloom, from bloom through mid-June, and after mid-June is given in Table 3. Blocks of small, medium, and large trees in the same orchard were treated in the same manner. With respect to insecticide, some Asana was used before bloom and some Lorsban after mid-June in first-level blocks. Both of these materials are known to be detrimental to *T.*

Table 1. Abundance of *T. pyri* mite predators on leaves sampled in July, August, and September in 1997 from first-level and third-level IPM blocks. *T. pyri* were released on the center tree in each block in mid-May 1997.

			Mean no. per leaf *	
Sample time	Tree size	Sample site	First-level IPM	Third-level IPM
Late July	Large	Center tree	0.00 b	0.34 a
		Center row, outer trees	0.01 b	0.01 b
		Outer row, center trees	0.00 b	0.00 b
	Medium	Center tree	0.03 b	0.54 a
		Center row, outer trees	0.00 b	0.00 b
		Outer row, center trees	0.00 b	0.00 b
	Small	Center tree	0.00 b	0.68 a
		Center row, outer trees	0.00 b	0.09 b
		Outer row, center trees	0.00 b	0.00 b
Mid-August	Large	Center tree	0.00 b	0.62 a
		Center row, outer trees	0.00 b	0.01 b
		Outer row, center trees	0.00 b	0.01 b
	Medium	Center tree	0.00 b	1.13 a
		Center row, outer trees	0.00 b	0.00 b
		Outer row, center trees	0.00 b	0.00 b
	Small	Center tree	0.00 b	0.97 a
		Center row, outer trees	0.00 b	0.00 b
		Outer row, center trees	0.00 b	0.00 b
Early September	Large	Center tree	0.00 b	0.87 a
		Center row, outer trees	0.07 b	0.01 b
		Outer row, center trees	0.01 b	0.00 b
	Medium	Center tree	0.00 b	0.67 a
		Center row, outer trees	0.00 b	0.01 b
		Outer row, center trees	0.00 b	0.00 b
	Small	Center tree	0.00 b	0.55 a
		Center row, outer trees	0.00 b	0.00 b
		Outer row, center trees	0.00 b	0.01 b

* For each size of tree at each time of sampling, numbers followed by a different letter are significantly different at odds of 19:1.

Table 2. Abundance of *T. pyri*, *A. fallacis*, and European red mites (ERM) on leaves sampled in July, August, and September in 1997 from first-level and third-level IPM blocks.

		Mean number per leaf *					
		T. pyri		*A. fallacis*		ERM	
Sample time	Tree size	1st level IPM	3rd level IPM	1st level IPM	3rd level IPM	1st level IPM	3rd level IPM
Late July	Large	0.00 b	0.12 a	0.04 a	0.04 a	3.6 a	7.2 a
	Medium	0.01 b	0.18 a	0.08 a	0.10 a	3.3 a	4.9 a
	Small	0.00 b	0.26 a	0.05 a	0.07 a	8.8 a	5.7 a
Mid-August	Large	0.00 b	0.21 a	0.06 a	0.15 a	9.9 a	9.0 a
	Medium	0.00 b	0.38 a	0.43 a	0.36 a	9.6 a	2.6 a
	Small	0.00 b	0.33 a	0.11 a	0.24 a	4.0 a	10.4 a
Early September	Large	0.01 b	0.21 a	0.15 a	0.17 a	2.9 a	1.3 a
	Medium	0.00 b	0.26 a	0.15 a	0.17 a	1.0 a	3.3 a
	Small	0.00 b	0.26 a	0.09 a	0.13 a	1.4 a	4.5 a

* Each value represents the average number of individuals found on 55 leaves per block per sampling date (25 leaves from the center tree and a total of 30 leaves from four other trees in the blocks, all of which were four trees removed from the center tree). For each tree size at each time of sampling, numbers followed by a different letter are significantly different at odds of 19:1.

pyri. The fact that they were not used in third-level blocks undoubtedly aided in establishment of *T. pyri*. None of the acaricides used in either first-level or third-level blocks is known to affect *T. pyri* substantially. As hoped, none of the third-level blocks received any Manzate, Dithane, Mancozeb, or Penncozeb as fungicides, whereas first-level IPM blocks received substantial amounts of these materials up to mid-June. Third-level IPM blocks did, however, receive some Polyram before bloom and a small amount after bloom. Some data indicate that Polyram is just as harmful to *T. pyri* as the other four aforementioned EBDC fungicides, which are especially harmful when applied during or after bloom. In general, the profile of fungicides applied in third-level IPM blocks was quite (although not completely) conducive to establishment of *T. pyri*.

Conclusions

The data presented here show convincingly that *T. pyri* became established on trees in which they were released: the centermost trees in third-level IPM blocks of small, medium, and large trees. Growers participating in this experiment cooperated with its aims by not applying harmful insecticides or acaricides and by minimizing use of fungicides harmful to *T. pyri* in the blocks in which *T. pyri* were released. Interestingly, even more than three months after release, *T. pyri* failed to move (in detectable numbers) even as far as four trees

Table 3. Types and dosage equivalents of insecticides, acaricides, and fungicides applied per block in first-level and third-level IPM blocks in 1997.

Material		Before bloom		Bloom through mid-June		After mid-June	
		1st level	3rd level	1st level	3rd level	1st level	3rd level
Insecticide	Asana	0.06	-	-	-	-	-
	Dimethoate	0.08	0.08	-	-	-	-
	Gution	0.04	0.20	3.10	3.20	1.00	0.16
	Imidan	-	-	-	-	0.13	-
	Lorsban	-	-	-	-	0.26	-
	Provado	-	-	0.12	0.12	-	-
	Sevin	-	-	1.10	1.00	0.06	0.06
Acaricide	Oil	1.25	1.25	-	-	-	-
	Savey	0.50	0.38	-	-	-	-
	Silwet	0.13	0.13	-	-	0.67	1.2
	Agrimek	-	-	0.08	0.08	-	-
	Pyramite	-	-	-	-	0.15	0.13
	Omite	-	-	-	-	0.17	-
Fungicide	Benlate/Topsin	0.13	0.13	0.61	0.61	0.55	0.26
	Nova/Rubigan	0.42	1.54	0.34	1.28	0.04	-
	Manzate*	1.75	-	0.72	-	-	-
	Polyram	0.21	0.46	1.05	0.28	0.13	-
	Syllit	0.01	0.60	0.16	0.01	-	-
	Captec	-	-	0.73	1.7	1.15	0.88

* Includes also Dithane, Mancozeb, and Penncozeb.

away downrow or crossrow, regardless of whether blocks were comprised of small, medium-size or large trees. We saw no evidence of suppression of European red mites by released *T. pyri* in any trees (except one) in which *T. pyri* were released. In the lone exception (a block of small trees), the foliage of the release tree remained dark green throughout summer, whereas the foliage of all other trees in the block was decidedly bronzed by mid-July. For 1998 and 1999, we plan to sample the same trees sampled in each block in 1997. We expect that by 1999, *T. pyri* will have spread to all parts of each third-level IPM block and will have provided effective biocontrol of European red mites in such blocks, particularly in blocks of small trees.

Acknowledgments

We are grateful to the eight growers participating in this experiment and who made special effort to apply pesticide selectively to third-level IPM blocks: Bill Broderick, Dave Chandler, Dave Cheney, Dana Clark, Dave Shearer, Joe Sincuk, Tim Smith, and Mo Tougas. This work was supported by state/ federal IPM