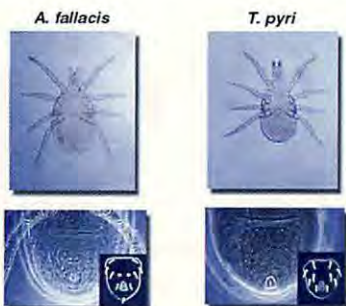


Achieving Biological Control of European Red Mite in Northeast Apples: An Implementation Guide for Growers

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European red mites (ERM), *Panonychus ulmi*, feed on leaves of apple trees and thereby interfere with photosynthesis and production of carbohydrates. At high levels, ERM damage to apple leaves reduces fruit yield and quality. As a general rule, keeping ERM numbers below 2.5 per leaf before July, below 5 per leaf during July, and below 7.5 per leaf in August will prevent economic losses from this pest.

Three strategies can be used to control ERM in apple orchards. First, protectant miticides (e.g., dormant oil or an ovicide) can be applied early in the growing season. Second, pest mite numbers can be monitored and miticides applied if densities exceed threshold levels. Third, natural enemies that feed on ERM can be encouraged and managed to constrain pest mite numbers. Strategies based solely on miticides are relatively expensive and eventually lead to the development of resistance by ERM to the miticides. With the help of natural enemies, the cost of managing ERM in apples can be greatly reduced and resistance delayed.



Pattern of setae on *T. pyri* and *A. fallacis*

Insect and mite predators, including several species of phytoseiid mites, stigmatid mites such as *Zetzellia mali*, and ladybird beetles, feed on ERM. Phytoseiid mites are the most effective of these predators in the Northeast. Several species of phytoseiid mites, including *Amblyseius fallacis*, *Typhlodromus pyri*, *T. occidentalis*, *T. vulgaris* and *A. cucumeris*, can be found in commercial orchards. Species cannot be identified in the field because they are so similar in appearance; they are only distinguishable through microscopic examination of the arrangement of the setae (hairs) on their bodies. *Typhlodromus pyri* and *A. fallacis* are the two most common species in Northeast

orchards. Of the two, *T. pyri* is better able to regulate ERM populations. This is the species that should be established and maintained for biological mite control in Northeast orchards. In this bulletin we answer two questions: First, why is it that *T. pyri* is such an effective predator? Second, how can you make use of this natural enemy to provide cost-free mite control?

Why is *Typhlodromus pyri* such an effective predator? For many years *A. fallacis* was promoted as an effective biological control agent for ERM. In truth, *A. fallacis* gives sporadic and unreliable ERM control, while *T. pyri* is highly effective in this capacity. Differences in effectiveness of *T. pyri* and *A. fallacis* as biological control agents are rooted in their biologies.

Typhlodromus pyri require approximately 32 days to complete a generation, and have 3 to 4 generations per year. They overwinter as mated adult females on trees wherever they can find a protective site (e.g., bark crevices, branches, spurs). Adult females emerge from overwintering sites on warm spring days before budbreak. The adults live about 20 days and lay an average of 20 eggs starting as early as tight cluster or pink bud growth stages. Eggs are usually laid on the undersides of leaves along the midrib. The eggs hatch in 1 to 3 days, and resulting immatures are nearly transparent and look like smaller versions of the adults. Immatures

and adults feed on a wide variety of food sources, including pollen and rust mites, along with ERM and two-spotted spider mites (*Tetranychus urticae*). An adult female will consume 1 to 2 ERM adults or 3 to 4 ERM nymphs per day. These predators do not concentrate on leaves with large numbers of ERM, unlike some other phytoseiids (e.g., *A. fallacis*). *T. pyri* are relatively winter hardy and remain in the tree even when ERM are scarce, feeding on alternative food sources.



Adult *T. pyri* (left) and *T. pyri* feeding on ERM

Amblyseius fallacis require 16 days for each generation, with 4 to 6 generations per year. These phytoseiids may also overwinter as adults in trees if prey are available to feed on in late summer and early fall; otherwise, they disperse from the trees and overwinter in the ground cover. Occasionally, they can be found in trees when ERM eggs start to hatch just before bloom, but are usually scarce until mid-July because of high winter mortality or lack of ERM as a food source before bloom. Adult *A. fallacis* lay twice as many eggs as *T. pyri*, immatures and adults consume nearly a third more ERM per day than *T. pyri*, and immatures develop into adults in a third of the time required by *T. pyri*. *Amblyseius fallacis* feed mainly on spider mites. Therefore, when prey mite numbers

are low in the trees, *A. fallacis* will disperse out of the trees to locate another food source, possibly in the ground cover. *A. fallacis* are more effective at reducing high red mite populations than *T. pyri*, but this is often after ERM have done considerable damage to the leaves.

Based on generation time, oviposition rate, and prey consumption, it would appear that *T. pyri* is a less effective biological control agent than *A. fallacis*. But the advantages *T. pyri* has over *A. fallacis* are its greater winter hardiness, its use of alternative food sources when ERM are not present, and its tendency to remain in trees when ERM are scarce. When ERM numbers are low, *T. pyri* will stay in the tree canopy feeding on pollen and rust mites, and will continue to be a presence as ERM numbers start to rise.

Because *A. fallacis* are often absent from trees or are in very low numbers in trees in early spring, ERM often build to damaging levels before *A. fallacis* exercise control. *Typhlodromus pyri* will consistently maintain ERM populations at low levels provided these predators are conserved. *Typhlodromus pyri* usually cannot control ERM populations in excess of 5 to 7 per leaf, and it can take 2 to 3 years for sufficient numbers of *T. pyri* to build in an orchard to realize biological control. Once predators are established, the benefits are great as the need for miticides can be eliminated.

How can *Typhlodromus pyri* be used to provide cost-free mite control? Achieving biological mite control using *T. pyri* is minimally a one-step process and may require two steps. First, an environment must be established in the orchard that will allow *T. pyri* to survive and flourish. This requires that pesticides that are toxic to these beneficial mites be excluded from the orchard. Second, if *T. pyri* are not already present in the orchard, they must be introduced.

[An environment conducive to *T. pyri*](#) *Typhlodromus pyri* have acquired resistance to some chemical pesticides used in commercial orchards and are innately tolerant of others. However, some pesticides are quite toxic to *T. pyri*. If biological mite control is to be achieved using this predator, these toxic materials must be avoided. Because *T. pyri* are resident in trees year round, and because these predators have a relatively slow growth rate, pesticides toxic to *T. pyri* cannot be used even intermittently (e.g., every other year) without serious disruption to biological control. A list of pesticides that can be used to control insects and diseases of apple while conserving *T. pyri* is provided as an insert in this bulletin. Be advised that estimates of toxicity to

T. pyri were obtained using predators from western NY, and there may be differences in susceptibility among predator populations indigenous to other regions of the Northeast.

Introducing *T. pyri* into an orchard There are situations where *T. pyri* might not be present in an orchard or where they are very scarce. This deficiency can be overcome by moving predators from an orchard where they are known to occur to a recipient site. Because phytoseiid species cannot be identified in the field, it is important that you be sure the source predators are, in fact, *T. pyri*. The best way of ensuring this is to have someone identify them for you. If this is not possible, you can be reasonably sure the predators are *T. pyri* if either of the following conditions are met: 1) The predators can be found in the trees either before or just after bloom and the predators are easily found even when ERM are scarce. 2) The predators in the source orchard were themselves introduced as *T. pyri* one or more years ago, and no pesticides harmful to *T. pyri* have been used since the introduction.

Typhlodromus pyri can be moved from a source orchard to a recipient orchard in one of four ways, each of which is described below. It is best to concentrate inoculation material in the recipient orchard rather than spreading it thinly over a site. If the predators are spread thinly, few animals may be introduced into each tree, which may allow for extinction of the populations. Once *T. pyri* are established in the receiver trees, they can be spread further in subsequent years. While *T. pyri* do disperse by themselves, assisting this process will hasten biological control throughout the planting.



Placing prunings in trees to transfer *T. pyri*

The first method of moving *T. pyri* from one orchard block to another is to place wood pruned from a source orchard in winter or early spring into a recipient orchard. Because *T. pyri* overwinter as adult females, prunings harbor predators, although numbers in each section of pruning are highly variable. We suggest placing all the prunings from one tree into another tree. It is probably not effective to simply spread the prunings beneath recipient trees. Pruned wood need not be placed in the recipient trees immediately after pruning, but should be placed there before or just when trees begin to produce green tissue the following spring.

The second method consists of transferring flower clusters from a source orchard to a recipient site. *Typhlodromus pyri* move into flower clusters at tight cluster and remain there through bloom, probably to feed on apple pollen. As many as 2 to 3 predators can be found in each flower cluster and surrounding leaves. To transfer predators in this manner, at least 20 flower clusters (and associated wood and leaves) should be placed in each recipient tree. The flower clusters are easily attached with paper clips, staples, or twist ties. Flower clusters may be stored for several days in a cooler before being attached to receiver trees.



Placing flowers in trees to transfer *T. pyri*

The third method of transferring *T. pyri* consists of collecting leaves during the summer from trees where *T. pyri* are abundant, and placing them into recipient trees. Leaves are easily attached to the recipient trees using staples. The number of leaves to use depends on the density of *T. pyri* in the source orchard. As a guide, at least 50 predators should be released in each target tree.

The fourth method of transferring *T. pyri* is perhaps the easiest and does not carry the risks of also moving unwanted pests that the three prior methods have. Artificial overwintering sites for *T. pyri* can be created by

glueing burlap to the inside of tree wrap. These composite bands, approximately 12 to 16 inches in length, are then placed on source trees in early to mid-September by stapling them around the tree bole and/or large scaffold branches. In early December, these bands should be collected, tightly rolled with a rubber band used to hold them, and placed in a sealed plastic bag with a bit (1 cubic inch) of wet cotton. The bag should be placed in an insulated storage container, which in turn should be placed in a cold, though protected, environment that will buffer large temperature fluctuations. Ideally, temperatures should be maintained right at the freezing point. The following spring, the burlap bands should be placed around recipient trees at around the half-inch green bud growth stage. While the number of predators that overwinter in bands is variable, as many as 400 predators can be transferred in each band. We suggest placing a single band on each recipient tree if the bands were collected from trees that harbored moderate to high numbers of *T. pyri* (1 to 2 per leaf) the prior fall, and two bands in each tree otherwise.



Band used to collect *T. pyri* and hibernating *T. pyri*

After a receiver orchard is inoculated with *T. pyri*, it often takes 2 to 3 years for the predator population to become abundant enough to regulate ERM without the need for any miticides. During this time, additional control measures are often needed to keep ERM below damaging levels. There are two key aspects to any strategy designed to do so. First, early season dormant oil sprays should be used to reduce ERM populations in the spring. These oil applications have no deleterious effect on *T. pyri*. Second, ERM numbers should be monitored, and if densities exceed threshold levels, a miticide that is not toxic to *T. pyri* should be used to control the pest mites. Note that it is actually desirable to have some pest mites in the trees after inoculation with *T. pyri* because these plant-feeding mites provide a food source for the predators and foster faster predator population growth.

A commonly asked question is, "How do you know when there are enough *T. pyri* to result in biological mite control?" This question is difficult to answer. While predators can be seen in the field, they are easy to miss, when they are present in low numbers low densities, and their impact on ERM is dependent on which species they are. Guidelines have been provided for the ratio of predators to ERM needed to achieve biological control; however, estimating these ratios is not practical. All that is required to determine if biological control is working is to note whether pest mites remain below threshold levels. This can be determined without regard to predator abundance. A procedure for determining whether ERM exceed threshold levels is described in the insert in this bulletin. If pesticide regimes for all orchard pests can be followed that allow *T. pyri* to survive, these predators will become abundant enough to make miticide applications unnecessary.

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Insert for IPM Pub. 215

**“Achieving Biological Control of European Red Mite in Northeast Apples:
An Implementation Guide for Growers.”**

Supplemental information on monitoring European red mite,
and relative toxicity of pesticides to the mite predator, *Typhlodromus pyri*.

For an updated version of this insert, contact Deborah I. Breth, CCE, PO Box 150, Albion, NY14411.

Monitoring European Red Mite in Apples

Damage by European red mites (ERM) to apple leaves is best related to cumulative mite density, which is measured as mite-days. Apple trees with a normal crop load can tolerate approximately 500 mite-days before reductions in fruit yield or quality occur. Therefore, one goal of any mite monitoring program is to ensure that miticide treatments are recommended so as to prevent 500 mite-days from occurring. Another goal of a mite monitoring program is to allow biological control to take its course when mite natural enemies (phytoseiid mites) are present. So, a mite monitoring program should not recommend intervention with pesticides when treatments are not necessary. A final goal of a mite monitoring program is to indicate when the pest population should again be sampled to determine its status. If, at the time of sampling, mite densities are very low, then it is not necessary to sample the population again in a short period of time. On the other hand, if densities are currently close to but not greater than a treatment threshold, the population should be assessed again in a short period of time. The monitoring program described here meets these goals.

This monitoring procedure classifies ERM density into one of three categories:

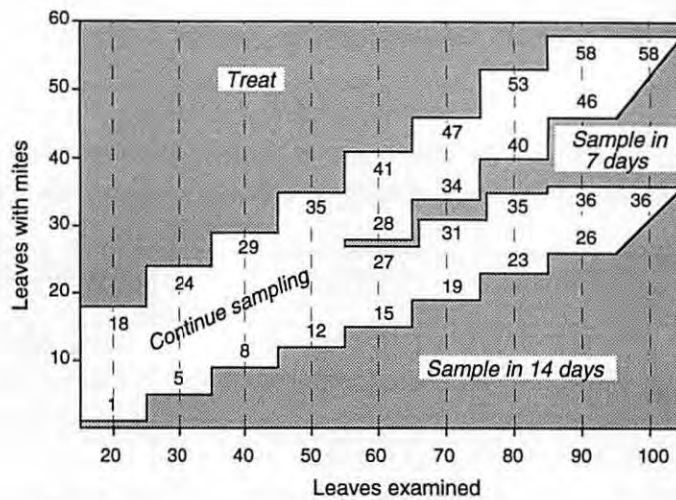
- 1) greater than treatment threshold, indicating application of a miticide is necessary,
- 2) less than treatment threshold, but requiring assessment again in about 7 days,
- 3) much less than a treatment threshold and not requiring assessment again for 14 days.

ERM are small and often numerous. This makes counting these pests a tedious and often difficult task. For monitoring purposes, it is only necessary to record the number of leaves infested with 1 or more motile mites. A mathematical relationship between the proportion of infested leaves and actual density can then be used to classify mite density. Because higher mite numbers can be tolerated as the season progresses, three sampling procedures are used at different times of the growing season; one each for June, July and August with treatment threshold of 2.5, 5, and 7.5 mites per leaf, respectively.

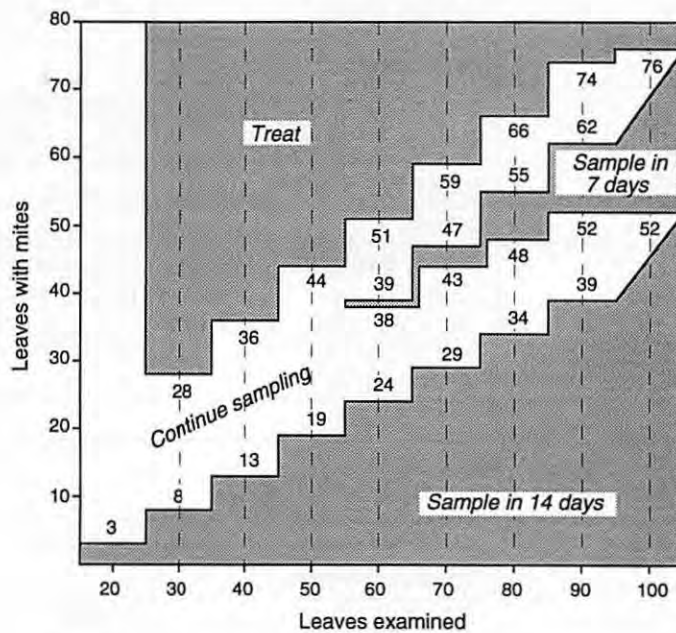
The sampling guides are used as follows:

- Sampling trees from throughout the orchard block, collect five intermediate aged leaves from each of four trees. To make sure the leaves are of an intermediate age, pick them from the middle of the fruit cluster before July and from the middle of fruit clusters or terminals thereafter.
- Using a magnifier, examine the top and bottom surface of each leaf for motile mites (anything but eggs), and keep track of the number of leaves with mites on them.
- When all 20 leaves have been examined, compare this number with the numbers on the decision guide. If the number of leaves with mites is equal to the values on the guide, the decision is shown in the area below the value. When the counts fall into any of the shaded regions, sampling is terminated and a decision to either "Treat", "Sample in 7 days," or "Sample in 14 days" is made.
- If the counts fall in the region labeled "Continue sampling" collect and examine groups of 10 leaves until the counts fall into one of the shaded regions.

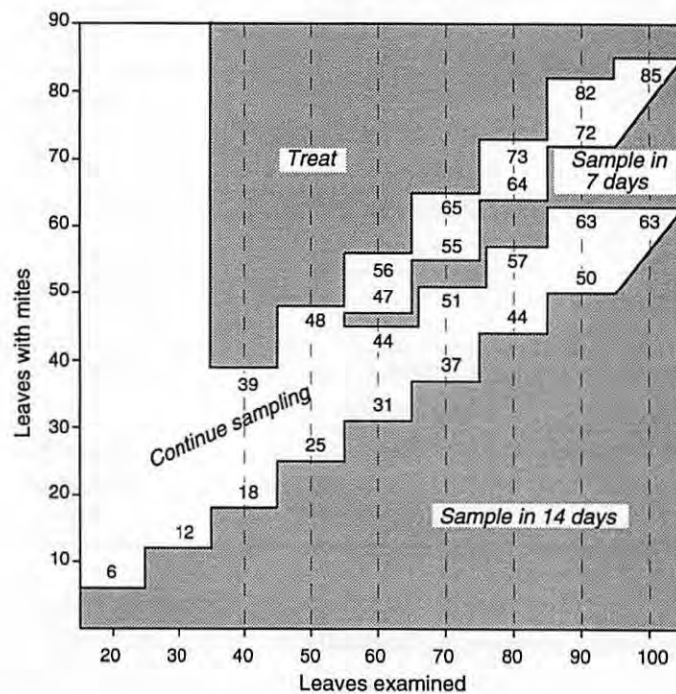
Use this sampling guide during June



Use this sampling guide during July



Use this sampling guide during August



Relative Toxicity of pesticides¹ to the mite predator, *Typhlodromus pyri*.

Materials with a low toxicity can be used when needed. Pesticides with moderate toxicity should be used sparingly. Those with high toxicity must be avoided. Refer to your State Extension Pesticide Recommendations for ratings of relative efficacy and application timing for specific target pests.

| Pest | Low toxicity | Moderate toxicity | High toxicity |
|-----------------------------|--|--|---|
| Apple scab | Nova, Rubigan, or Procure in combination with captan | mancozeb or metiram (EBDC fungicides) before bloom | mancozeb or metiram (EBDC fungicides), or Ziram after bloom |
| Powdery mildew | Nova, Rubigan, Procure, Bayleton, sulfur | | |
| Fire blight | Fixed copper, streptomycin | | |
| Black rot | captan, benomyl or Topsin M | mancozeb or metiram before bloom | mancozeb or metiram after bloom |
| Sooty blotch and fly speck | benomyl, Topsin M, captan | | mancozeb, metiram or Ziram after bloom |
| Rust disease | Nova, Rubigan, Procure, or Bayleton | mancozeb or metiram before bloom | mancozeb or metiram after bloom |
| Rosy apple aphid | Thiodan or Provado | Lorsban | Lannate, Vydate, dimethoate |
| Tarnished plant bug | | | pyrethroids |
| Spotted tentiform leafminer | Provado | | pyrethroids, Vydate, Lannate |
| Codling moth | azinphos-methyl, Imidan, Penncap M, B.t. | Lorsban | Lannate, dimethoate |
| Green fruitworm | Thiodan | Lorsban | pyrethroids, Lannate |
| Obliquebanded leafroller | B.t., Confirm, spinosad, Penncap M | Lorsban | Lannate, pyrethroids |
| Plum curculio | azinphos-methyl Imidan, Penncap M, carbaryl | Lorsban | pyrethroids |
| leafhoppers | Provado, Thiodan, carbaryl | | Lannate, dimethoate, Carzol, Vydate |
| Apple aphids, spirea aphids | Provado, Thiodan | Lorsban | dimethoate, Lannate, Vydate |
| Apple maggot | azinphos-methyl, Imidan, Penncap M | Lorsban | Lannate, dimethoate |
| European red mites | prebloom oil, Savey, Apollo, Pyramite, Vendex | Agri-mek, summer oil, Kelthane | Carzol |

¹ Check EPA and state registration status by contacting local Cooperative Extension representative. Registration status is changing annually and is not universal across all state lines. Use of product names does not imply endorsement of particular products. Read all labels for rates and timing.