



Biological Control of Two-Spotted Spider Mites

The two-spotted spider mite (TSSM), *Tetranychus urticae*, is a common pest in greenhouses with a wide host range including specialty annuals and bedding plants, herbaceous perennials, vegetables and herbs.

Biology and Life Cycle

Adult female two-spotted spider mites can live for about one month. During this time, they may lay from 100 to 200 eggs. Mite eggs are small, spherical in shape and are laid on the underside of leaves. Eggs hatch in about three days and the young mite larvae begin feeding. After transitioning through two nymphal stages, mites become adults. The life cycle from egg to adult can be completed in as little as 7 days at temperatures greater than 85° F and low relative humidity levels of 30 to 50%.

Female mites are three times more abundant than males. Fertilized adult females produce both males and females. Unfertilized adult females only produce males. Males have only one set of genes, so mutations such as pesticide resistance, are immediately expressed. Incorporating biological control strategies into your pest management program can help slow down the development of resistance.

During adverse conditions of decreasing day length, falling temperatures and a decline in food supply, adult females enter a resting or overwintering stage known as “diapause”. Females turn bright orange- red and hide in concealed places within the greenhouse. Do not confuse this resting stage with the beneficial predatory mite, *Phytoseiulus persimilis*, which is a bright orange color without the two dark spots.



Figure 1: Bright orange diapausing spider mite (within circle) and round spider mite eggs.
Photo by L. Pundt

Scouting

Biological controls are best used preventatively, when spider mite populations are low. Weekly scouting and random plant inspections are needed to detect populations early. Carefully inspect plants in hot, dry areas of a greenhouse or on plants that have not been watered overhead with overhead irrigation that may wash some of the mites off the plant leaves. Regularly inspect the most susceptible cultivars or species, and look for signs of plant damage. As spider mites insert their stylet-like mouthparts into plant tissue, they suck out plant juices removing the chlorophyll. At first, you see a slight flecking or stippling (chlorotic spot) on the leaves.



Figure 2: Flecking or stippling on *Buddleia* leaf. Photo by L. Pundt

Thin-leaved plants such as garden impatiens may show injury more quickly than thick-leaved plants such as ivy geraniums. Mite feeding damage on ivy geraniums is also often mistaken for edema. As spider mite feeding continues, leaves turn yellow, bronzed and drop from the plant. When high mite populations develop, the fine webbing is extensive.

Tag pest-infested plants as indicator plants to determine the effectiveness of biological control measures. A 10x to 20x hand lens is helpful to detect all stages of the mites. Because mites are easily carried on workers or their clothing, one should do routine greenhouse tasks and scout in mite-infested areas at the end of the day.

Cultural Controls

Biological controls are more likely to be successful if combined with proper cultural controls such as providing proper irrigation and fertility for the species grown, and sanitation practices. Prevent pest infestations on incoming plant material by establishing a quarantine area. Thorough weed control (weeds are a source of spider mites) both inside and outside the greenhouse is vital. Overhead watering may help wash spider mites off leaves.

Biological Controls

Predatory mites, predatory midges and predatory beetles can all be used in a biological control program. Different species of predatory mites (*Phytoseiulus persimilis*), *Neoseiulus (Amblyseius) californicus*, *Amblyseius andersoni*, *Galendromus occidentalis*, *Mesoseiulus longipes*, and *Neoseiulus (Amblyseius) fallacis* are each adapted to different environmental conditions (temperature and relative humidity levels). A predatory midge (*Feltiella acarisuga*) and a predatory ladybeetle (*Stethorus punctillum*) are also commercially available.

Some of the biological control agents used against thrips (*Neoseiulus (Amblyseius) cucumeris*, *Orius* sp. and *Amblyseius swirskii*) may also feed on spider mites but cannot be relied upon for control. The generalist aphid predator, *Chrysoperla* spp. may also feed upon spider mites. Some growers may also release the generalist predatory soil dwelling mite, *Stratiolaelaps scimitus* near perimeter walls, for use against the diapausing spider mites that are hiding in cracks and crevices.

***Phytoseiulus persimilis*, a predatory mite**

Adult *Phytoseiulus persimilis* feeds on all stages of two-spotted spider mites. This specialist predator can only survive by feeding upon two-spotted spider mites. The adult *P. persimilis* is bright red in color, pear-shaped, long-legged, slightly larger, and more active than spider mites. Adult females lay eggs that are about 3x the size of two-spotted spider mite eggs and are more football shaped than the round two spotted spider mite eggs.

The development time for *P. persimilis* is shorter than for spider mites; about 5 days at 86°F, 9 days at 68°F, and 25 days at 59°F. At temperatures above 86°F, *P. persimilis* cannot keep up with the reproduction of two spotted spider mites. At low relative humidity (less than 60%), eggs shrivel and do not hatch. Optimum conditions are relative humidity above 75% and temperatures over 68° F. It does not go into a diapause stage. *P. persimilis* is attracted to the chemical odors produced by plants infected with spider mites as it searches for its prey by touch and scent. Both adults and nymphs actively search plants

for two-spotted spider mites. *P. persimilis* can spread through a greenhouse as long as plant leaves are in contact with each other. Since the 1960's, *Persmilis* has been used in greenhouse vegetables but the glandular hairs on greenhouse tomato leaves reduce its dispersal.



Figure 3: *Phytoseiulus persimilis*. Photo by L. Pundt



Figure 4: Predatory mite eggs (within circle) are larger and football shaped compared to round, oval spider mite eggs. Photo by D. Ellis



Figure 5: Dead, shriveled spider mites that have been fed upon by predatory mites. Photo by D. Ellis

Tips for *P. persimilis* use

- Release early when mite populations are low and two spotted spider mites are first noticed.
- This voracious, specialist predatory mite needs to have spider mite prey or it will disperse or starve.
- *P. persimilis* is available either in a granular carrier or on bean leaves with all life stages and a food source.
- When using carrier product, check first by sprinkling some of the product onto a white sheet of paper and look for the active predatory mites.
- Gently roll the tube to mix the predatory mites in the carrier before application.
- Sprinkle material on leaves.
- Concentrate releases near hot spots of mite activity.

- Relative humidity should be greater than 75% and temperature above 68°F for some hours of the day. Lightly misting plants or walkways may increase humidity levels.
- Spider mite colonies should be reduced in 2 to 3 weeks.
- Contact your supplier for information on release rates. Supplier recommended release rates vary depending upon susceptibility of crops or cultivars to spider mites, length of crop time and infestation levels.
- To evaluate effectiveness, look for dead, shriveled spider mites that have been fed upon by persmilis. Adults and nymphs actively search for prey and suck them dry.

***Neoseiulus (Amblyseius) californicus*, a predatory mite**

Neoseiulus (Amblyseius) californicus is slower acting than *P. persimilis* but has a broader host range than *P. persimilis* and survives longer in the absence of prey by feeding upon other plant feeding mites (such as broad and cyclamen mites) and thrips. *N. californicus* may also feed upon mold, nectar and pollen. This slow acting predatory mite is useful for keeping low spider mite populations under control and can be released preventively. In situations where high temperature or relative humidity variations can occur, *N. californicus* may be a better choice than *P. persimilis*. You can also release *N. californicus* in combination with *P. persimilis*.

Tips for *N. californicus* use

- Release as soon as possible after receiving.
- It is available in a granular carrier or in breeding sachets.
- Gently roll the tub to mix the predatory mites in the carrier before application.
- *N. californicus* is active at temperatures between 46°F to 95°F, 40-80% RH.
- Consult with your supplier for information on release rates.

***Amblyseius andersonii*, a predatory mite**

This predatory mite feeds upon spider mites, broad mites, cyclamen mites and eriophyid mites. It may also survive on thrips and fungal spores in the absence of mites. *A. andersonii* can be released when there are low numbers of spider mites. If hot spots develop, *P. persimilis* can be used with *A. andersonii*. *A. andersonii* is active at a wide range of temperatures (42 - 104 °F) and can tolerate cooler temperatures than other mites can. It can be applied to both greenhouse and outdoor crops and is available in a granular carrier or in breeding sachets or strips of sachets.

***Neoseiulus (Amblyseius) fallacis*, a predatory mite**

This predatory mite feeds upon spider mites and cyclamen mites. The shiny pear shaped adults (1/50 inch long) are tan to light orange in color with long legs. *N. fallacis* can survive in the absence of prey on other small arthropods and pollen. *N. fallacis* tolerates a wide range of temperatures (48-85° F) but does best where there is a dense plant canopy and relative humidity over 50%. *N. fallacis* is available on bean leaves or in a granular carrier. You can also release *N. fallacis* in combination with *P. persimilis*.

***Galendromus occidentalis*, a predatory mite**

This predatory mite feeds upon two- spotted spider mites. *G. occidentalis* does best at temperatures between 50° F to 115° F and 30 to 60% relative humidity. If mite populations are low, *G. occidentalis* can feed upon pollen. *G. occidentalis* is available in a granular carrier.

***Mesoseiulus longipes*, a predatory mite**

This predatory mite feeds upon spider mites and does best at temperatures between 80-90 °F but can tolerate lower humidity levels (40% RH at 70° F).

***Feltiella acarisuga*, a predatory midge**

A small (1/16 of an inch long) predatory gall midge (*Feltiella acarisuga*) feeds on two-spotted spider mites. (Another species of gall midge is commercially available for use against aphids.) Adults live for 2 or 3 days, are more active at night and rest during the day on the underside of leaves. Females lay orange to red eggs among the spider mite colonies, eggs hatch in 3 to 5 days. The larvae stage is the only predacious stage.

Adults emerge from the pupae. This predatory midge develops from egg to adult in 10 days at 80° F and 34 days at 59°F with relative humidity between 60 to 95%. Extended periods of relative humidity below 60% may reduce their survival and reproduction, optimum relative humidity is 80%.

Feltiella is shipped in the pupal stage and adults emerge soon after arrival. They are best released late at night or early in the morning. *Feltiella* can be used with *P. persimilis* (depending upon the crop and pest levels). Adults are excellent flyers so they may be able to reach hanging baskets and other hard to reach ornamental crops. *Feltiella* is also able to forage on the hairy leaves of greenhouse tomatoes whereas the tomato's glandular hairs reduce the survival and reproduction of *P. persimilis*.



Figure 6: Predatory midge larvae. Photo by L. Pundt

After about a week of feeding, larvae pupate on the underside of leaves forming tiny, white velutinous pupal cocoons.



Figure 7. *Feltiella acarisuga* pupae, Photo by L. Pundt

Tips for *Feltiella acarisuga* use

- Commercially available as pupae on paper pieces in pots or boxes. Pierce paper disc on the cover, so the adult midges can emerge.
- Open the box containing the predatory midges, place close to spider mite infestations. Let box stand for one week until adults have emerged.
- When scouting, look for the nearly white pupal cases near the midrib on the leaf undersides and for the bright orange larvae.

***Stethorus punctillum*, a predatory ladybird beetle**

This small, (1/10 of an inch long) black predatory beetle feeds on all life stages of spider mites. Adults can fly, allowing them to locate spider mite colonies that are not accessible to predatory mites. Their yellow oval eggs are laid singly in or near mite colonies. Larvae are slow moving with conspicuous legs. Larvae and adults feed on all stages of spider mites. Optimum conditions are moderate to high temperatures (61-90° F). They can also feed on small arthropod eggs, aphids, nectar, and pollen. *Stethorus* prefer smooth leaved plants and cannot readily travel the hairy leaves of greenhouse tomatoes. These predatory ladybird beetles are best used in combination with predatory mites.

For information on compatibility of pesticides with natural enemies, consult the following databases or consult with your biological control supplier.

Pesticide Compatibility Databases

Refer to online databases or apps such as those maintained by:

- Koppert's online interactive database: <https://www.koppertus.com/side-effects-database/>
- Biobest: <https://www.biobestgroup.com/en/side-effect-manual>
- Bioline Agrosciences <https://www.biolineagrosciences.com/> (download Bioline app)
- BASF (formerly Becker Underwood): <https://betterplants.basf.us/> (click on Solutions, Biological Controls, Nemasys Chemical Compatibility Guide”).
- Bioworks: <https://www.bioworksinc.com/>
- Regular monitoring, in conjunction with cultural controls help insure the successful use of predatory mites, midges and beetles against spider mites.

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Greenhouse Scout™ Cornell University (iTunes)

Summarizes information on biocontrol of common greenhouse insect pests and an interactive interface for collecting, organizing, and presentation of scouting data, and product application for insect management.

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