Biological, botanical, and microbial control of spider mites on strawberries

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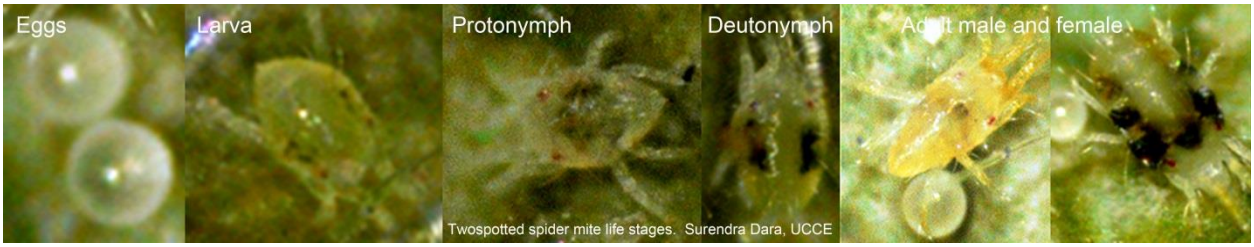
Multiple species of spider mites infest strawberries in California. Twospotted spider mite (*Tetranychus urticae*) is a predominant and commonly occurring species in all strawberry growing regions on the Central Coast. Strawberry spider mite (*Tetranychus turkestani*) can also be found along with twospotted spider mite populations especially in the Santa Maria area during warmer parts of the production season. Another species of spider mite, Lewis mite (*Eotetranychus lewisii*) appears to occur in the Oxnard area in fields near caneberries. Lewis mites have been known to occur in the Santa Maria area at very low numbers. Carmine spider mite (*Tetranychus cinnabarinus*) may also be present at low numbers in some areas.



Biological Control

Natural enemies play an important role in managing pest populations. Multiple species of predatory mites are commercially available. Several California strawberry growers complement chemical control of mites with the use of predatory mites.

Predatory mites belong to four categories – Type I, Type II, Type III, and Type IV.

Type I: These predatory mites are specialists feeding exclusively on spider mites (family Tetranychidae) that produce considerable webbing. They require feeding on spider mites for their survival and reproduction. Type I predators are aggressive and voraciously feed on pest mites. Because of their dependence on spider mites, Type I specialists rapidly decline and cannibalize when pest mite populations decline.

Type II: These are also specialist predators, but they feed on spider mites and other species of mites. They also feed on pollen and in some cases on thrips and other species of predatory mites. Having more food choices for survival and reproduction, Type II specialists continue to be present in the absence of spider mites and are less likely to cannibalize.

Type III: These are generalist predators that feed on multiple species of mites that include spider mites, eriophyid mites, and tarsonemid mites and insects such as thrips and whiteflies. They also feed on

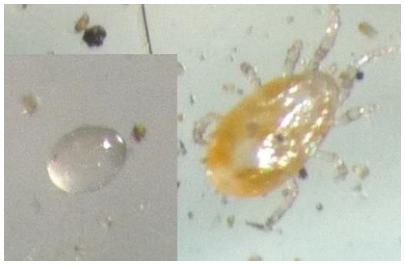
pollen, honeydew, and plant juices. Type III generalists are also known to cannibalize and feed on other species of predatory mites in the absence of pest mites or other food sources.

Type IV: These mites primarily feed on pollen and can also feed on pest mites.

There are five species of predatory phytoseiid mites (Acari: Phytoseiidae) that are commercially available for spider mite control.

Egg and adult of *Phytoseiulus persimilis*

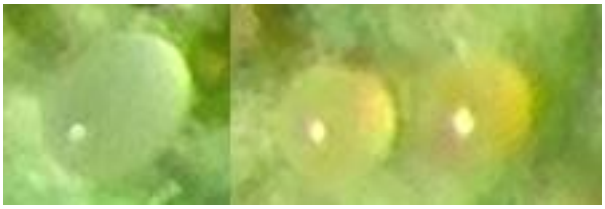
Phytoseiulus persimilis is a Type I specialist that exclusively feeds on spider mites. It is bright orange, teardrop-shaped and moves rapidly. It prefers cooler temperatures and is sensitive to hot and dry conditions. So, it is more effective during earlier parts of the production season before temperatures increase.



Egg and adult of *Neoseiulus* sp.

Neoseiulus fallacis is a Type II specialist that primarily feeds on spider mites. It is translucent to peach or orange and appears to have a flatter body compared to spider mites or *P. persimilis*. It is also sensitive to hot and dry conditions.

Neoseiulus californicus is a Type II specialist that primarily feeds on spider mites, but also has Type III generalist characters. It appears similar to *N. fallacis*. It can withstand warmer conditions better than *P. persimilis* and *N. fallacis*. It can withstand cold temperatures for short periods and tolerates relative humidity range from 40-80%.



Larger and oval egg of *Neoseiulus* sp. on the left compared to smaller and round eggs of twospotted spider mite on the right. Size and shape of eggs and characteristics of adults can help distinguish beneficial and pest mites and make management decisions.

Egg and adult of *Galendromus occidetalis* along with spider mite egg in the middle. Photo by Jack Kelly Clark.

Galendromus occidentalis also known as western predatory mite is a Type II specialist that primarily feeds on spider mites. It prefers warm temperatures and tolerates dry conditions as low as below 30% relative humidity. It is sensitive to cooler temperatures.

Amblyseius andersoni is a Type III generalist predator. It can tolerate high temperatures when relative humidity is high.

Among these predatory mites, *P. persimilis*, *N. fallacis*, and *N. californicus* are the most commonly used species in strawberries. Using the right species depending on the environmental conditions is important for the success of biological control. Timing insecticide and acaricide applications in a manner that is

least disruptive to the predatory mites is essential. When chemical pesticides are necessary, softer materials should be selected.

In addition to the predatory mites, several species of natural enemies feed on spider mites. They include big-eyed bug (*Geocoris* spp.), black lady beetle (*Stethorus* sp.), black rove beetle (*Oligota oviformis*), brown lacewing (*Hemerobius* spp.), damsel bug (*Nabis* spp.), green lacewing (*Chrysopa*spp.), minute pirate bug (*Orius tristicolor*), predatory midge (*Feltiella acarivora*), and the predatory sixspotted thrips (*Scolothrips sexmaculatus*).

Top row: Big-eyed bug, black lady beetle, black rove beetle, brown (upper), and green lacewing (lower)
Bottom row: Damsel bug, predatory midge larva, minute pirate bug, and sixspotted thrips. Photos by Jack Kelly Clark, UC IPM

Botanical and Microbial Control

Botanical materials are plant-based products such as azadirachtin, cotton seed oil, and rosemary oil that have activity against spider mites. Entomopathogenic fungi like, *Beauveria bassiana* are available in organic and conventional formulations for use against spider mites and can be used in combination with chemical miticides. Additionally, other microbial products based on bacteria like *Burkholderia* spp. and *Chromobacterium subtsugae* are also commercially available. To avoid the risk of resistance development, which can result from repeated use of miticides especially from the same mode action group, rotating chemical pesticides that have different modes of actions and using botanical and microbial alternatives can be an effective strategy.

In 2013, a small plot study was conducted in conventional Santa Maria strawberries using chemical, botanical, and microbial miticides. Treatments include: (i) Untreated control, (ii) Acramite 50 WS (bifenazate) 1 lb, (iii) Agri-Mek SC (abamectin) 4.29 fl oz, (iv) BotaniGard ES (*B. bassiana*) 1qrt + Acramite 0.75 lb, (v) Eco-Mite 1% (rosemary and cotton seed oils), (vi) Fujimite 5 EC (fenpyroximate) 2 pt, (vii) Fujimite XLO 2 pt, (viii) Grandevo *(C. subtsugae)* 2 lb, (ix) Venerate (*Burkholderia* spp.) 2 gal, and (x) Nealta (cyflumetofen) 13.7 fl oz. Treatments were applied using a backpack sprayer on May 16 and 25 and mite counts were made 3 and 7

days after each application (pre-treatment data were not available). There were fewer eggs and mobile stages of mites compared to untreated control, but the means were not significantly different ($P \geq 0.05$) when data from four observation dates were combined. All treatments were similar in their efficacy against spider mites and comparable to Acramite 50 WS, which was used as the chemical standard. Eco-Mite, rosemary and cotton seed oil combination and Venerate provided control that was as good as chemical treatments – Fujimite 5EC and Nealta. BotaniGard ES and Acramite 50 WS combination at their lowest label rates also provided control similar to Acramite 50 WS at the highest label rate. Control by the new formulation of Agri-Mek SC was also similar to the grower standard. This study demonstrates the efficacy of new and existing miticides and emphasizes the potential of non-chemical alternatives.

Using predatory mites and a variety of chemical, botanical, and microbial pesticides at an appropriate time will be a good IPM strategy.