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## Using *Phytoseiulus persimilis* to Control Twospotted Spider Mite in Greenhouses

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*Phytoseiulus persimilis* is a tropical predatory mite introduced to Germany from Chile on orchids in 1958. Since then it has spread throughout the world and been developed and successfully used for controlling twospotted spider mites (TSSM) on both outdoor and greenhouse crops. Under the right temperature and humidity conditions it is an efficient mite-eating machine: TSSM are quickly controlled and adult *P. persimilis* disperse in search of more prey. They feed almost exclusively on spider mites and will die out if they fail to locate any. Available through several suppliers of biocontrol organisms, *P. persimilis* usually arrive in vials or bottles of 1,000 as a mixture of adults and nymphs (young stages) with a carrier (such as corn cob grit or vermiculite) to aid in dispersing the mites around the crop. Sometimes these predators are sold on bean leaves, which are placed directly on the crop. Success with *P. persimilis* depends on several factors that enterprising greenhouse growers should be aware of prior to a voyage of biocontrol discovery.

In greenhouses, *P. persimilis* is often used to control twospotted spider mites on cucumber, tomato, peppers, strawberry, dieffenbachia, English ivy and interiorscape ornamentals, to name a few. TSSM injure plants by sucking contents from plant cells, often leaving foliage with a pale flecking or russetting. They usually prefer the underside of leaves near veins or curled leaf margins where their webbing may also be visible. Leaves may turn yellow and eventually fall or fruit may not ripen well; in severe infestations the webbing covers leaves and flowers and plants may be killed. TSSM have a history of resistance or tolerance to pesticides, putting biocontrol in an even more favorable light.

TSSM adults are named for the two dark green spots on either side of the body which are most obvious under a 10x hand lens. The body is usually oval and a pale yellowish or translucent white; under cooler conditions and shorter daylength the mites are orangey red, hence they are sometimes called 'red spider.' *P. persimilis* adults are slightly larger, shiny, orange-colored and more pear-shaped than TSSM. As adults, both



species have eight legs but their nymphal stages have but six. TSSM eggs are almost clear and almost spherical, while those of *P. persimilis* are ovoid, turn from clear or whitish to reddish as they develop, and are at least twice as large. These features are more visible under a handlens, but sharp eyes can usually detect the mites and their differences unaided. Behaviours differ as well: *P. persimilis* appears more 'spidery' and moves more quickly than its prey. Usually *P. persimilis* is detected around areas with TSSM. After mating a *P. persimilis* female can lay up to 60 eggs during its lifetime of several weeks, consuming around 5 to 20 TSSM eggs and mites each day. Tables 1 and 2 show some developmental information for both *P. persimilis* and TSSM.

Before deciding to try *P. persimilis*, first determine whether the greenhouse and area meet the necessary environmental criteria: temperatures should generally range from 70-80°F. Higher temperatures (>82°F/28°C) adversely affect *P. persimilis* reproductive rates and shift the balance in favor TSSM. Temperatures over 86°F/30°C should be avoided and *P. persimilis* stops eating altogether at 95°F/35°C. Humidity is ideal around 70-90% - eggs are particularly sensitive to levels below 60%. Bright sun should be avoided if possible. Furthermore, the predators need a way to disperse from plant to plant via overlapping leaf 'bridges.' Plants grown closely spaced under shade or subdued light with a dense canopy that maintains a high humidity are ideal for *P. persimilis*.

Secondly, there should be a clear plan for addressing other expected pest or disease problems. *P. persimilis* is extremely sensitive to many pesticides, even when used nearby in the same greenhouse, and therefore will work best in an environment where most insecticides, miticides and fungicides are rarely, if ever, used. *P. persimilis* may still be affected by traces of some pesticides several months after a treatment. Foliar-applied wetting agents are also likely to be disruptive. Some materials that harm the beneficials can still be used if they are known to have limited residual activity. Table 3 lists materials with minimal or short-term effects on *P. persimilis*. A contingency plan for managing TSSM and other insect, mite or disease problems, if necessary, should consider using these materials. Not all pesticides have been tested adequately for their effect on *P. persimilis*. Cooperative Extension personnel may be a source of additional information; dealers often provide advice with their products.

Check on the economics and logistics of using *P. persimilis* before placing an order. Shipping costs can be significant, since the live predators are usually sent by



next-day or second-day delivery. Release rates involve some guesswork, but some have recommended approximately 20/yd<sup>3</sup> (20/m<sup>3</sup>) or 2 per damaged leaf (2 per plant for small plants). Another source suggests applying two per damaged leaf on ornamentals and up to 6 on every other undamaged plant. Hairy or sticky foliage, which slows down the predators, may require higher rates. Can suppliers provide guaranteed delivery during especially cold or hot weather? Will someone be available to receive the package and place it out of extreme cold or heat? How long between ordering and arrival? What time of day should the package arrive? Suppliers may offer a discount for standing orders over several weeks or months.

Fourth, monitoring is critical. TSSM population levels should be low when releases are begun; if more than 1 TSSM per leaf is found it may be wise to first reduce populations to 10% infested leaves or fewer using insecticidal soap. Releases can be made as soon as foliage is dry and TSSM populations are sufficiently low. Plan to inspect plants regularly every two weeks to determine the progress of control. Turn over several leaves on randomly selected plants, looking for both TSSM and *P. persimilis*; TSSM infestations tend to be quite spotty. Adjust release rates and locations as needed, distributing more predators where infestations are growing and fewer where no TSSM are found. Since situations vary greatly, try to randomly sample plants from locations throughout the greenhouse where mite infestations are likely to be. Older plants in warm locations are sometimes more infested than, say, young seed-grown bedding plants. Look for TSSM infestations particularly on lower to mid-canopy leaves and especially in bright, dry sunny areas. Areas with new or problem infestations can be tagged and targeted for heavier releases and closer watching.

On arrival, the package should be placed in a cool place out of direct sun. The predators should be distributed as soon as possible, although early morning is probably best. They can be held overnight but *P. persimilis* should not be exposed to excessive cold or heat. Inspect the vials or bottles carefully on arrival to verify whether mites have arrived in good condition. They should be active (at room temperature) and visible on close inspection with or without a handlens.

If no directions for releases are provided, lightly mist plants first and rotate vials gently to disperse the mites. Vials and mites should be brought to room temperature before release. The *P. persimilis* +carrier is then sprinkled directly onto leaves especially where infestations are found. Bean leaves with *P. persimilis* should be placed directly on



foliage out of direct sun. Use bean leaves for curative releases when TSSM is already present in the greenhouse, since there may be a few TSSM on the bean leaves along with the predators. Misting helps mites and carrier to stay on foliage, raises humidity and does not appear to adversely affect the *P. persimilis*. Drenching foliage during and after releases, however, is not desirable. *P. persimilis* can be applied to trunks of interiorscape trees, where they will disperse to the upper canopy. Some practice is needed in distributing the mites evenly around a crop, but care should be taken to place material directly onto foliage. The *P. persimilis* mites are easily observed as they begin to disperse in search of their prey. They usually migrate to lower leaf surfaces and can be observed devouring TSSM adults, nymphs and eggs. Under dry conditions (below 60-70% humidity) occasionally misting plants or soaking walkways in the greenhouse may be beneficial. Keep records of when and where releases were made.

Since *P. persimilis* feed primarily on mites and will "eat themselves out of a job" releases should be made regularly, e.g once or twice a month, Expect to see control after four to six weeks. A two-week release schedule should be planned until experience suggests otherwise. TSSM can be reintroduced into greenhouses on infested plants and/or on air currents through vents. Check plants at least twice a month for both TSSM and *P. persimilis* populations, adjusting release rates and locations accordingly. As temperatures increase, TSSM levels may also develop more quickly and require correspondingly higher release rates. Orders may need to be planned well in advance to anticipate these needs - verify protocols with suppliers. When temperatures are generally over 80°F/27°C in the summer, other mites may be more suitable than *P. persimilis*. *Amblyseius californicus* and *Phytoseiulus longipes* will tolerate warmer and drier conditions. *A. californicus* will survive better than *P. persimilis* when TSSM populations are low. *Amblyseius fallacis* is another predatory mite that feeds on TSSM, thrips and pollen and is reportedly resistant to permethrin (Pounce/Astro) and endosulfan (Thiodan).

Table 1. Development time (days) of *P. persimilis* at different temperatures.<sup>8</sup>

Temperature	Egg-Adult	Pre-Oviposition Period	Total Egg - Egg
59F/15C	19.6	5.6	25.2
68F/20C	7.2	1.9	9.1
86F/30C	3.9	1.1	5.0

Table 2. Development of twospotted spider mite (TSSM) and *P. persimilis* (Pp) on strawberry at 68F/20C and beans at 77F/25C and 81F/27C.<sup>2,5,6</sup>

	TSSM/68F	Pp/68F	TSSM/81F	Pp/77F
Longevity (days)	18	30	19	36
Eggs per female	37.9	53.3	144	60.4
Eggs per female per day	2.4	2.4	8	2.7
Sex ratio females:males	2.9:1	4.1:1	-	-

Table 3. Some materials compatible with *Phytoseiulus persimilis*

**Little or no disruptive effects**

*Insecticides*

Bt (Bactospeine, Dipel 2X)  
 cyromazine (Citation)  
 diazinon (Knox-Out)  
 diflubenzuron (Dimilin)  
 dinocap (Karathane)  
 fenoxycarb (Precision. PT 2100 Preclude)  
 kinoprene (Enstar)  
 methoprene  
 nicotine (fumigant)  
 oxamyl (Oxamyl 10G, soil application)

*Growth Regulators*

B-Nine  
 Cycocel

*Fungicides*

captan  
 chlorothalonil (Daconil 2787, Exotherm Termil)  
 copper compounds  
 etridiazole (Truban, Terrazole; drench)  
 fenarimol (Rubigan)  
 fosetyl-Al (Aliette)  
 iprodione (Chipco 26019)  
 mancozeb (Dithane T/O, Protect T/O)  
 oxycarboxin (Plantvax)  
 propamocarb (Banol)  
 sulfur  
 thiram  
 triadimefon (Strike)  
 triforine (Triforine EC)  
 vinclozolin (Ornalin)

**Materials disruptive but with short residual period (1-2 weeks)**

*Insecticides*

abamectin (Avid)  
 chlorpyrifos (Dursban, PT 1325 DuraGuard)  
 dicofol (Kelthane)  
 dienochlor (Pentac)  
 dichlorvos (Vapona, DDVP)  
 endosulfan (Thiodan)  
 malathion  
 naled (Dibrom)  
 potassium salts of fatty acids (M-Pede, insecticidal soap)  
 pyrethrins (Pyrellin, PT 1100 Pyrethrum, PT 1600A X-clude)  
 resmethrin (EC 26, PT 2100 Resmethrin)  
 sulfotepp (Plantfume 103, Dithio)

*Fungicide*

thiophanate-methyl (Domain, Cleary's 3336)



## References

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