Thrips management in greenhouse/hoop house/nursery

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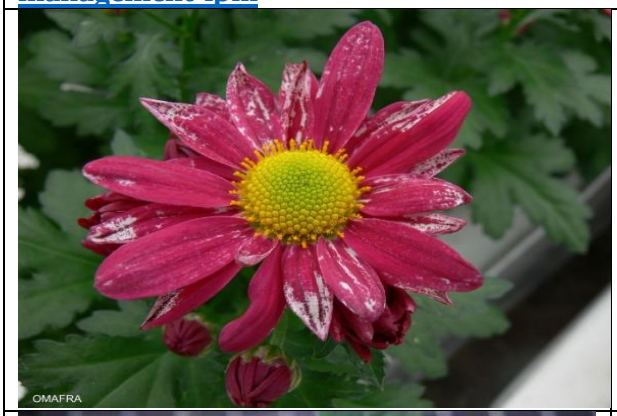
https://ncipmhort.cfans.umn.edu/ipm-identifying-pests/greenhouse-integrated-pest-management-ipm



Top, Gerbera daisy with thrips damage
http://greenhouseipm.org/pest/thrips/
Bottom, Poinsettia damage from thrips
https://ag.umass.edu/greenhouse-floriculture/photos/thrips-western-flower-thrips-injury-on-poinsettia

Top, Thrips damage on eggplant
https://www.infonet-biovision.org/PlantHealth/Crops/Eggplant
Bottom, Tomato spotted wilt (TSWV) damage on tomato
https://aces.nmsu.edu/ces/plantclinic/tomato-spotted-wilt-viru.html

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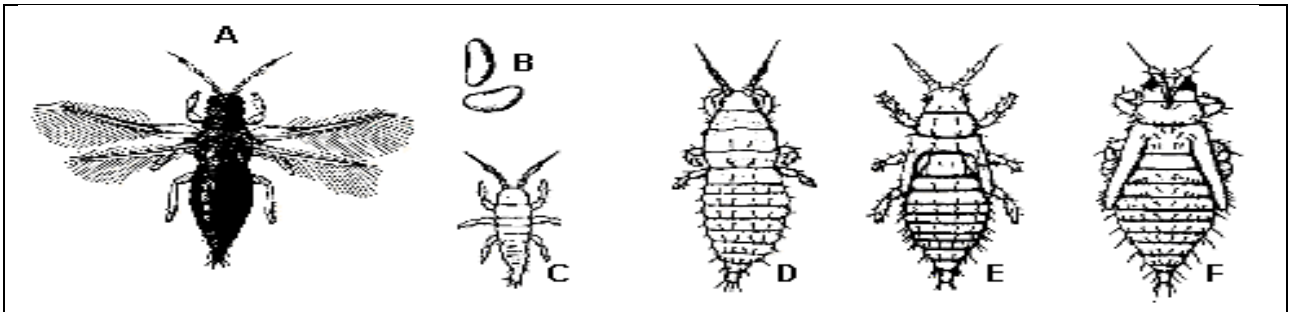
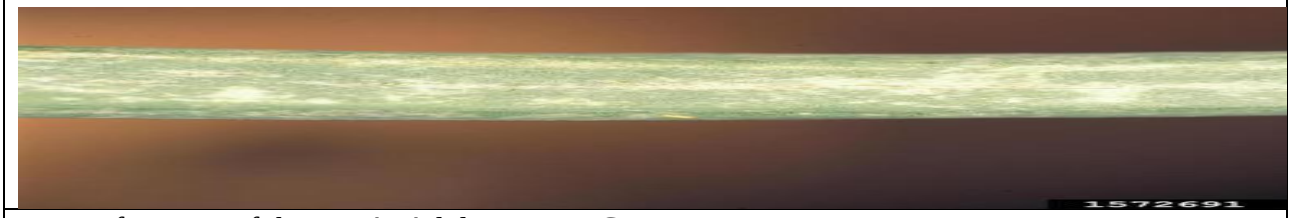




Top, Life stages of thrips: A. Adult, B. Egg, C-D. Larvae, E. Prepupa, F. Pupa
NC State Extension, https://content.ces.ncsu.edu/insect-and-related-pests-of-flowers-and-foliage-plants/thrips-found-on-flowers-and-foliage
Bottom, Thrips damage
Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org

There is never one thrips

Thrips are the worst pests in greenhouses as they have short generation time and are resistance to many insecticides, which permits thrips to reach high population size very fast. Thrips are in the order Thysanoptera, which means fringe wings. Thrips are tiny, slender insects with two pairs of feather-like, long, narrow wings, which have few or no veins and bear fringes of long, fine hairs along their margins. The wings are held parallel along the back when at rest. Immature forms of thrips are wingless. Colors vary from white to straw yellow to brown.

Many species of thrips are commonly found in greenhouses: greenhouse thrips, *Heliothrips haemorrhoidalis*, Eastern flower thrips, *Frankliniella tritici*, Western flower thrips, *Frankliniella occidentalis*, and chilli thrips, *Scirtothrips dorsalis*.

Thrips feed by puncturing the outer layer of leaf and sucking out the cell contents, causing stippling and silvering of the leaf surface as well as damage to flower and fruit. Thrips can be noticed because of the black spots of feces that they leave behind on leaves. Western flower thrips vector virus that prevent the plant from flowering and growing.

Life cycle

Eggs are laid on leaves. Thrips hatch from an egg and develop into larval that feed and then turn into non-feeding prepupa and pupa, before becoming an adult. In Western flower thrips, the pale prepupae and pupae drop to the soil or leaf litter. Greenhouse thrips pupate on the lower leaf surfaces. Thrips may have 8 generations a year in a greenhouse, with the life cycle from egg to adult taking 2 weeks. The adults can survive from 30 to 45 days. Female thrips lay 150 to 300 eggs. Nymphs are whitish to slightly yellowish in color and produce a globule of fecal fluid at the tip of their abdomen. These globules of fluid increase result in black specks on foliage.

Monitoring
If you want to monitor only for adult thrips, use the blue sticky cards. To monitor for a wider range of flying greenhouse pests such as winged aphids, whiteflies, and fungus gnats, use yellow sticky cards. The number of thrips per card should be recorded weekly and graphed to detect trends. This information will help you decide whether a population is increasing or decreasing and assist you in correctly timing your pesticide applications.

Trap counts and tolerance levels
Adult thrips can also be monitored by hanging bright yellow sticky traps in or near host plants. Anywhere above 10 thrips/card a week are a threshold for which cultural, chemical, and biocontrol must be applied.

Trap counts and keeping records are meaningful in two ways. Keeping records over time will provide information on what direction the population is changing and at what rate. This information is useful in determining the efficacy of a treatment or control measure. Tolerance levels or damage thresholds determine the damage that is likely to occur at a particular population level. Tolerance levels will vary depending upon the crop, its stage of growth, local market standards and whether or not either INSV or TSWV are present at the site. Record thrips counts on cards and correlate this information to the damage you see on your crops. Begonias and poinsettias are have damage thresholds of around 10 thrips on a card. However, if INSV or TSWV is present, the tolerance levels for thrips is zero and a strict thrips control program should be implemented.

Biological control
Biological control can only work when thrips populations are low, less than 10 per yellow sticky card. Higher numbers must be treated with both insecticide and biocontrol tactics.

The predatory phytoseid mites, *Amblyseius cucumeris, A. swirskii, Macrocheles robustulu, and Hypoaspis miles* are used for immature thrips control. Like thrips, they prefer small niches where contact between predator and prey is likely even without specific searching. The mites establish themselves on leaves, usually on the undersides, and are most effective in attacking thrips.

These predators feed on pollen when thrips populations are low and must be introduced before a thrips population has built up to damaging levels. *Amblyseius swirskii* and some strains of *A. cucumeris* do not undergo diapause and can be released during the short days of winter. Temperature is critical with *A. swirskii* since it is not active below 59°F. Release one –five predaceous mites per square foot of growing area, but release rates vary depending on the species predatory mite that is used. The mite *Hypoaspis miles* can be released in the soil for pupae and fungus gnat management.

*Amblyseius swirks*i mites arrive from insectaries in sachets that are placed on plants. You often find these sachets inside hanging baskets in the summer. The sachets need to be deployed when thrips populations are 10 or lower for each yellow card.

Predatory true bugs in the genus *Orius* (minute pirate bugs) are commercially available for thrips control. Pirate bugs are voracious, reproduce well in greenhouses, and attack all stages of thrips.

Pirate bugs are released onto ornamental pepper plants that are in flower which serve as a banker plant attracting the thrips and harboring the predators. Recent research reported that the cultivar "Purple Flash" was more effective as a banker plant than the ornamental pepper variety "Black Pearl" which has been used over the past few years for this purpose. About 60-80 pirate bugs can be released per flowering pepper plant. Also, use lacewing larvae, *Chrysoperla* to control thrips.

Several pathogens can control thrips. Test a small sample of nematodes before using to make sure that the nematodes are alive. Parasitic nematodes, *Steinernema feltiae, Steinernema carpocapsae* and *Heterorhabditis bacteriophora* can be sprayed on the soil surface or the foliage. *Steinernema feltiae* is primarily used against fungus gnat larvae and thrips pupae in the soil. Once they find their prey, the nematodes will enter through an opening like the mouth or anus of the insect. Inside, the nematodes release a bacteria that kills the insect. The nematodes reproduce inside the insect, and then emerge through the decaying body.

The entomopathogenic fungus, *Beauveria bassiana*, can be applied as a fine mist spray over soil and foliage to control thrips in greenhouses. The entomopathogenic fungus, *Metarhizium anisopliae*, is available.

Insecticides

When applying insecticides for thrips control, use a droplet size that is less than 100 microns in diameter to attain contact that is more effective. Also, apply insecticides every two to three weeks before peak thrips activity to ensure control of adults before they begin to lay eggs. When thrips populations are high, insecticide application should be every 7 days. Rotate among classes of insecticides to delay the development of resistance. Research suggests using an insecticide for two to three weeks, then switching to an insecticide in another class. There is no single insecticide that will provide total thrips control. See the insecticide table.

Neonicotinoid insecticides, such as Flagship, Safari and Tristar, have shown effectiveness against thrips in the past. Mesurol was one of the more effective products for thrips control, but results have been more inconsistent in recent years.

Avid (abamectin) can be tank mixed with an insect growth regulator (IGR), such as Azatin O or AzaGuard, and applied as a foliar spray two times, seven days apart. IGRs, insect growth regulators for immatures and are generally used in combination with adulticides and after a good knockdown has been achieved with other products. IGR labeled for trips control are Pedestal (novaluron), Enstar, and Fulcrom, Distance (pyriproxifen).

Pyridaly (Overture), Kontos (spirotetramat), and Aria (flocidamid) are slow acting and are for suppression, not knock down.

Thrips control in the soil for WFT pupae are a combination of IGR, nematodes, and microbial products. Nematodes *Steinernema feltiae* control the pupal stages of thrips in the soil, such as western flower thrips, but not greenhouse thrips that pupate on leaves. Applications to the soil every two to three weeks of Distance (pyriproxyfen) +Talsatr (bifenthrin), BotaniGard (*Beauveria bassiana*), Preferal (Isaria), Met52 (*Metarhyzium*), and Grandevo (*Chromobacterium*).

		
Greenhouse thrips (*Heliothrips haemorrhoidalis*)	Western flower thrips (*Frankliniella occidentalis*)	Eastern flower thrips (*Frankliniella tritici)*
UCLA statewide IPM program http://ipm.ucanr.edu/PMG/H/I-TS-HHAE-CO.004.html	UCLA statewide IPM program https://cisr.ucr.edu/western_flower_thrip.html	Univ Wisconsin, La Crosse http://bioweb.uwlax.edu/bio210/s2012/peterson_ama3/classification.htm

Western flower thrips

In Western flower thrips, the pale prepupae and pupae drop to the soil or leaf litter. Western flower thrips (WFT) are probably the most serious pest of floriculture crops in the world and is native to the Southern US. WFT damage plants directly by feeding and laying eggs on the plant, and indirectly by acting as vectors for tospoviruses such as tomato spotted wilt virus (TSWV) and impatiens necrotic spot virus (INSV). Seven species of thrips are vectors for TSWV, but the only confirmed vector for INSV is WFT. WFT acquire tospoviruses by feeding on infected host plants during the two larval instars and remain infected for life. Adult WFT, however, are not infected by feeding on tospovirus-infected plants because tospoviruses pass right through the gut. As a result, tospoviruses do not enter the salivary fluid and, thus, cannot infect plants.

Several host plants are susceptible to both and INSV, but it is important to note that not all plants susceptible to TSWV or INSV are hosts for WFT. Although WFT may probe non-host plants, they do not continue to feed and do not lay eggs. If thrips do not lay eggs (even though that plant is susceptible to tospovirus), that particular plant is not considered as a reservoir for either tospovirus. A complete host list for WFT has not been established, but finding any WFT larvae during plant inspections serves as warning that control measures are needed.

The Agdia QTA-Tospo test kit, manufactured by Agdia Incorporated, Elkhart, Indiana uses a linked immuno-sorbent assay (ELISA) to detect the presence of specific viral proteins in the sample tissue. Separate kits are available from Agdia to detect TSWV and INSV. Another option for detecting tospoviruses is to send a plant sample to a plant disease diagnostic clinic. Samples may be sent to the University of Minnesota Plant Disease Clinic, 495 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108.

Blue cultivars of petunia plants (Petunia x hybrida) are excellent early indicators for the presence of WFT feeding and the transmission of tospoviruses because petunias are not systemically infected with either TSWV or INSV. In response to a tospovirus infection, petunias show a hypersensitive response.

To set up a monitoring program using petunias, remove flowers from the indicator plants before placing them in greenhouses because petunia flower petals do not express local lesions and attract WFT away from the leave. Flag the indicator plants with blue pie pans or metal sheets to increase the effectiveness of the indicator plants since WFT are more sensitive to blue than to other colors. Look for WFT feeding scars, which are whitish and have an irregular outline. Brown or black-edged lesions will develop on the edges of thrips feeding scars within 3 days if a tospovirus has been transmitted.

Greenhouse thrips
In Greenhouse thrips, the pale prepupae and pupae stay on the leaves. This species is native to South America, but was first described as a species in 1833 from specimens found in a greenhouse in Europe. It now is found worldwide in humid climates, either in tropical regions or in greenhouses. In the U.S. it can be found living outdoors along the southern states from Florida to California and in greenhouses throughout the country.

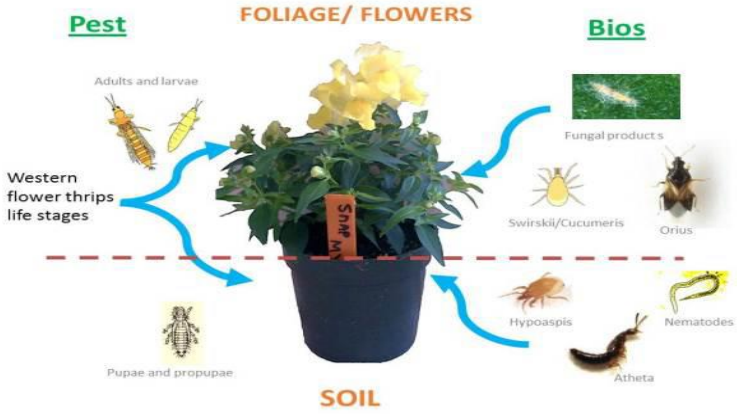
		
Adult chilli thrips, *Scirtothrips dorsalis* Andrew Derksen, USDA-APHIS, Bugwood.org	Chilli thrips damage causing curling of leaves. Florida Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Bugwood.org.	Chilli thrips damage causing reddening of the leaves. Matthew Chappell, University of Georgia, Bugwood.org

Invasive chilli thrips
Chilli thrips (*Scirtothrips dorsalis*) attack new foliage growth, and deform and discolor foliage. Chilli thrips are much smaller than western flower thrips and difficult to distinguish from other thrips species without the aid of a compound microscope. Adults are pale with dark wings and less than 2 mm in length and immatures are also pale in color and resemble the immatures of many other thrips species.

Chilli thrip is native to Southeast Asia is an important pest of crops in tropical and subtropical regions. In 2005 a population of this pest was first detected in the United States on landscape

roses in Florida. In November 2007, chilli thrips were identified on landscape roses in Houston. Chilli thrips have also been detected on a number of ornamental and vegetable plants in retail stores in Northeast and South Texas. Attacks and causes significant damage to over 100 vegetable, ornamental, and fruit crops, particularly peppers, eggplant, and tomatoes.

The life cycle of chilli thrips is similar to that of other common thrips species, such as the western flower thrips. Chilli thrips feeding causes leaf, bud, and fruit bronzing. Damaged leaves may curl upward and appear distorted. Infested plants become stunted or dwarfed and leaves may detach from the stem at the petioles in some plant species.



Graphic from: 2015 Thrips Control: Unleash the Arsenal *Rick Yates*
http://www.ballpublishing.com/GrowerTalks/ViewArticle.aspx?articleid=21442

Table 1. Pesticides labeled for thrips in greenhouses.

Mode of Action Number	Common Name	Trade Name
1B	acephate	1300 Orthene TR, Orthene TT&O, Orthene TT&O 97
1B	chlorpyrifos	DuraGuard ME
1B and 3	chlorpyrifos and cyfluthrin	Duraplex TR
3	bifenthrin	Talstar Select, Attain TR
3	cyfluthrin	Decathlon 20 WP
3 and 27A	pyrethrins and PBO (piperonyl butoxide)	Pyrethrum TR, Pyronyl Crop Spray
1A	methiocarb	Mesurol 75-W
4A	imidacloprid	Marathon II, 1% Granular, 60 WP and many others
6 and 20D	Floramite (bifenazate) and abemectin	Siroco
7A	kinoprene	Enstar AQ

		IGR for immatures, use in combination with knock down insecticide.
7D	pyriproxifen	Distance IGR for immatures, use in combination with knock down insecticide.
15	novaluron	Pedestal IGR for immatures, use in combination with knock down insecticide.
18B	azadirachtin (neem)	Aza-Direct, Azatin XL, Neemix 4.5 IGR for immatures, use in combination with knock down insecticide.

5	spinosad	Conserve SC
6	abamectin	Avid 0.15EC, Abamectin E pro, Flora-Mek 0.15 EC and others
13	chlorfenapyr	Pylon
23	spirotetramat	Kontos
28	cyantraniliprole	Mainspring
29	flonicamid	Aria
unknown	pyridalyl	Overture
beneficial fungus	*Beauveria bassiana*	Botanigard ES, 22WP
beneficial fungus	*Isaria fumosorosea*	Preferal
beneficial fungus	*Chromobacterium subtsuggae*	Grandevo
beneficial nematode	*Steinernema*	
desiccator membrane disruptors	horticultural oil	Ultra-Pure Oil

Mention of a pesticide does not constitute an endorsement of any product and any omission from this list is unintentional. The pesticide label is the ultimate authority for pesticide use.

IRAC numbers

The Insecticide Resistance Action Committee (www.irac-online.org) has assigned IRAC numbers for each chemical class, and these numbers are on labels to make it easier to rotate classes of insecticides and prevent resistance

New England Greenhouse Floriculture Guide, A Management Guide for Insects, Diseases, Weeds and Growth Regulators. https://ag.umass.edu/greenhouse-floriculture/publications-resources/new-england-greenhouse-floriculture-guide