K-STATE
Research and Extension

Insect and Mite Pests of Greenhouse Grown Tomatoes

Tomato, *Solanum lycopersicum*, is a vegetable grown outdoors under field conditions and in greenhouses (Figures 1a and 1b). Managing insect and mite pests in a greenhouse environment is challenging. Tomatoes are susceptible to insects and mites that feed on leaves, fruits, and/or flowers, causing damage that can lead to a reduction in yield. This publication provides information on the major insect and mite pests and strategies to manage their populations on greenhouse grown tomatoes.

Figures 1a and 1b. Tomato plants growing in greenhouse (Photos: Raymond Cloyd).

Major Insect and Mite Pests

The major insect and mite pests of tomatoes have piercing-sucking or chewing mouthparts. Insect and mite pests can cause damage when feeding on leaves, fruits, and/or flowers. They can also cause damage by transmitting viruses to tomato plants. The following descriptions of the major insect and mite pests of greenhouse grown tomatoes are based on their mouthparts.

Piercing-Sucking Mouthparts

Aphids

Several species of aphids feed on tomatoes, such as the green peach aphid (*Myzus persicae*), melon aphid (*Aphis gossypii*), and potato aphid (*Macrosiphum euphorbiae*).

Biology

Aphids are 1/16 to 1/8 of an inch (2.0 to 4.0 millimeters) long, green to black or yellow to pink, with cornicles (tubes) protruding from the back of the body (Figure 2). All aphids in greenhouses are females that produce live nymphs without mating. Each female can produce up to 100 live female nymphs that produce offspring, which results in another generation of aphid females. Mature aphid females may be winged or wingless. Horizontal airflow fans can disperse winged aphids within a greenhouse.

Figure 2. Aphids feeding on underside of leaf. Note the cornicles (tubes) protruding from the back of the body (Photo: Raymond Cloyd).

Damage

Aphids feed on the terminal growth (Figure 3) and the undersides and topsides of leaves (Figure 4), causing leaf distortion, plant stunting, and necrotic leaf spotting. During feeding, aphids produce honeydew, a clear, sticky liquid that serves as a growing substrate for black sooty mold. Black sooty mold interferes with photosynthesis and stains fruit (Figure 5), which reduces fruit quality. An extensive population of aphids results in white molted skins on leaves. In addition to direct feeding damage, aphids transmit viruses to tomatoes. For example, the green peach aphid transmits several viruses, including *Alfalfa mosaic* virus, *Potato virus Y*, and *Tobacco etch* virus.

Figure 3. Aphids feeding on the terminal growth of tomato plant (Photo: Raymond Cloyd).

Figure 4. Aphids feeding on the topside of a tomato leaf (Photo: Raymond Cloyd).

Figure 5. Black sooty mold on tomato fruit (Photo: Raymond Cloyd).

Stink bugs

Several species of stink bugs feed on tomatoes; however, the primary stink bug that feeds on tomatoes in greenhouses is the brown stink bug (*Euschistus servus*).

Biology

The life cycle of stink bugs consists of an egg, a nymph, and an adult. Adults are approximately 3 inches (7.6 centimeters) long, brown, and shield shaped. There are distinct colored markings and a triangle on the back of the body (Figure 6). Females lay clusters of 10 to 25 barrel shaped eggs on the underside of leaves. Nymphs emerge (eclose) from the eggs and transition through

Figure 6. Brown stink bug adult (Photo: Raymond Cloyd).

Figure 7. Brown stink bug adult feeding on tomato fruit (Photo: Raymond Cloyd).

five nymphal instars (stages between each molt). The older nymphs are round, green, have dark markings on the wing pads, and a triangle on the back of the body.

Damage

Stink bug nymphs and adults feed by inserting their mouthparts into tomato fruit (Figure 7) and injecting saliva containing enzymes that degrade plant tissues. They then withdraw plant fluids from the fruit. Feeding results in dark, pin sized markings or dimples surrounded by white or yellow discolored areas (Figure 8). Stink bugs overwinter as adults on the soil or growing medium, under leaves or leaf debris, and on weeds.

Thrips

Several species of thrips feed on tomatoes in greenhouses, including tobacco thrips (*Frankliniella fusca*), onion thrips (*Thrips tabaci*), flower thrips (*Frankliniella tritici*), greenhouse thrips (*Heliothrips haemorrhoidalis*), and western flower thrips (*Frankliniella occidentalis*).

Biology

The thrips life cycle includes an egg, larva, pupa, and adult. Depending on the temperature, the life cycle takes two to three weeks to complete. Adult thrips are approximately 1/16 of an inch (1.5 millimeters) long, yellow brown to black, with red or black eyes, and hairs on the wings (Figure 9). Depending on species, females can lay up to 200 eggs during their lifespan. Larvae that emerge (eclose) from eggs are light yellow and feed on tomato leaves (Figure 10). Second instar larvae move to the base of tomato plants and enter the soil or growing medium to pupate. Adults emerge (eclose) from the pupae after approximately six days.

Damage

Thrips feed on plant leaves, causing leaf stippling and leaf necrosis (Figure 11). Adult thrips will also feed on tomato flowers and young fruit, causing scarring and distortion. In addition, thrips can transmit viruses to tomatoes, including *Tomato spotted wilt* virus.

Figure 8. Tomato fruit damaged by brown stink bug feeding (Photo: Raymond Cloyd).

Figure 10. Thrips larvae feeding on the underside of tomato leaf (Photo: Raymond Cloyd).

Figure 9. Western flower thrips adult (Photo: Raymond Cloyd).

Figure 11. Thrips damage on tomato leaves (Photo: Raymond Cloyd).

Twospotted spider mite

Twospotted spider mite (*Tetranychus urticae*) is the primary mite pest that feeds on tomatoes in greenhouses.

Biology

The twospotted spider mite life cycle involves an egg, larva, nymph, and adult. Depending on temperature, the life cycle takes one to two weeks to complete. Twospotted spider mite adults are 1/50 of an inch (0.5 millimeters) long, oval, red (Figure 12) to green yellow, with distinct black spots on both sides of the body (Figure 13). Adult females live about 30 days and can produce up to 100 eggs. Eggs are laid on leaf undersides along the mid veins. Six legged larvae emerge (eclose) from eggs and are yellow green. Larvae mature into eight legged nymphs and then become adults. Twospotted spider mites turn orange red in late summer through fall, and overwinter as fertilized females in leaf debris, weeds, or cracks and crevices in wooden benches.

Figure 12. Twospotted spider mites on underside of tomato leaf (Photo: Raymond Cloyd).

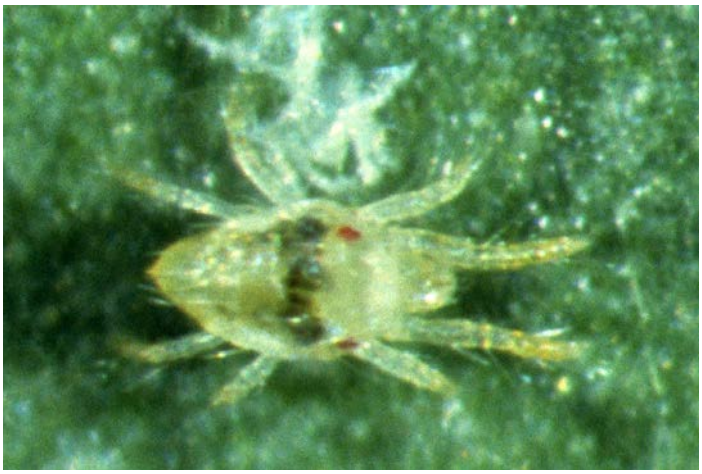

Figure 13. Closeup of twospotted spider mite. Note the black spots on both sides of the body (Photo: Raymond Cloyd).

Damage

Larvae, nymphs, and adults feed on the underside of tomato leaves causing bleaching, stippling (silvery gray to yellow spotting), and chlorotic spotting (Figures 14 and 15). Extensive twospotted spider mite populations can produce webbing on tomato leaves and stems (Figure 16), where all life stages (egg, larva, nymph, and adult) are present. The webbing allows twospotted spider mites to move among tomato plants, especially when tomato plants are spaced close together and leaves are touching.

Figures 14 and 15. Twospotted spider mite feeding damage on tomato leaves (Photos: Raymond Cloyd).

Figure 16. Twospotted spider mite webbing on leaves and stems of tomato plant (Photo: Raymond Cloyd).

Whiteflies

The whitefly species that feed on greenhouse grown tomatoes are the greenhouse whitefly (*Trialeurodes vaporariorum*) and sweetpotato whitefly (*Bemisia tabaci*). Greenhouse and sweetpotato whiteflies can be identified using the pupa (fourth instar larva) and adult stages. The greenhouse whitefly adult body is white with white wings held horizontally over the body (Figure 17). A greenhouse whitefly pupa has sides perpendicular to the leaf surface, and waxy filaments around the periphery (Figure 18). An adult sweetpotato whitefly has a light yellow body with white wings retained, rooflike over the body at a 45 degree angle (Figure 19). A sweetpotato whitefly pupa appears flat on the leaf surface and does not have waxy filaments around the periphery (Figure 20).

Biology

The whitefly life cycle consists of an egg, larva, pupa, and adult. Depending on temperature, the life cycle can be completed in 25 to 30 days. Adults are 1/16 of an inch (1.5 millimeters) long with white to yellow bodies and four wings covered with white waxy powder (Figure 21). Whitefly females lay up to 200 eggs on the underside of tomato leaves during their 30 to 45 day lifespan. Greenhouse whitefly eggs are green to purple, and sweetpotato whitefly eggs are white to yellow brown with a black tip. Larvae emerge (eclose) from eggs and search for feeding sites on tomato leaves. Larvae are flat, oval, and transparent to yellow green (Figure 22). There are four larval instars, with the fourth instar referred to as a pupa or red eye stage. Larvae feed for two to three weeks before becoming pupae or fourth instar larvae. After approximately one week, adults emerge (eclose) from the pupae. All life stages (eggs, larvae, pupae, and adults) are located on the underside of tomato leaves (Figure 23).

Damage

Whitefly larvae and adults feed on the underside of tomato leaves, causing leaf yellowing, leaf distortion, plant wilting, and plant stunting. Like aphids, whiteflies produce honeydew, a clear, sticky liquid that serves as a growing substrate for black sooty mold. Black sooty mold interferes with photosynthesis and reduces the cosmetic appearance of tomato fruit. In addition, whiteflies can transmit viruses to tomatoes, including *Tomato yellow leaf curl* virus, *Tomato chlorosis* virus, and *Tomato severe rugose* virus.

Figures 19 and 20. Sweetpotato whitefly adult (left) and pupa (right) (Photos: Raymond Cloyd).

Figure 21. Whitefly adult (Photo: Raymond Cloyd).

Figures 17 and 18. Greenhouse whitefly adult (left) and pupa (right) (Photos: Lance Osborne, University of Florida).

Figures 22 and 23. Whitefly larvae on leaf underside (left) and whiteflies on underside of tomato leaf (right) (Photos: Raymond Cloyd).

Chewing Mouthparts

There are several caterpillars with chewing mouthparts that feed on tomatoes in greenhouses, including the cabbage looper (*Trichoplusia ni*), tobacco hornworm (*Manduca sexta*), tomato hornworm (*Manduca quinquemaculata*), and yellowstriped armyworm (*Spodoptera ornithogalli*).

Cabbage Looper

Biology

The cabbage looper life cycle includes an egg, larva (caterpillar), pupa, and adult. Adults are 1 inch (2.5 centimeters) long with gray brown mottled front wings. Each front wing has a silver spot near the center resembling a figure eight (Figure 24). Females can lay up to 300 eggs on the underside of tomato leaves. Larvae or caterpillars emerge (eclose) from the eggs and feed on tomato leaves. Older caterpillars are 1 inch (2.5 centimeters) long with white stripes extending the length of the body (Figure 25). They have three pairs of legs in the front of the body and three pairs of prolegs (fleshy appendages) at the back of the body, which leads to the caterpillars arching their back, creating a "looping" motion when moving. Caterpillars pupate in silken cocoons attached to tomato leaves.

Damage

Caterpillars feed primarily on tomato leaves, creating irregular shaped holes. They may sometimes feed on the fruit.

Tobacco hornworm and tomato hornworm

Biology

The tobacco hornworm and tomato hornworm life cycles consist of an egg, larva (caterpillar), pupa, and adult. Adults are referred to as hawk or sphinx moths with a wingspan of 4.5 to 5.0 inches (11.5 to 12.5 centimeters). Adult females lay eggs on the underside of tomato leaves. Larvae or caterpillars emerge (eclose) from the eggs and start feeding on leaves. Tobacco hornworm caterpillars are green with seven white stripes on each side of the body (Figure 26). Tomato hornworm caterpillars are green with eight stripes on each side of the body (Figure 27). Both have a horn that protrudes from the back of the body. The tobacco hornworm horn is red, whereas the tomato hornworm horn is black. When fully grown, tobacco and tomato hornworm caterpillars are 3 to 4 inches (7.5 to 10 centimeters) long. The caterpillars eventually fall off tomato plants onto the soil or growing medium surface, tunnel into the soil or growing medium, and pupate. Tobacco and tomato hornworm overwinter as pupae in the soil or growing medium.

Damage

Tobacco hornworm and tomato hornworm caterpillars feed on the leaves and fruit of tomato plants for three to four weeks. They feed on the upper part of tomato plants, removing plant tissue and creating holes in green fruit. Older caterpillars consume more plant tissue than younger caterpillars.

Figure 24. Adult cabbage looper (Photo: UC Regents).

Figure 25. Cabbage looper caterpillar feeding on tomato leaf (Photo: Raymond Cloyd).

Figures 26 and 27. Tobacco hornworm caterpillar (top) and tomato hornworm caterpillar (bottom) feeding on tomato leaf (Photos: Raymond Cloyd).

Yellowstriped armyworm

Biology

The yellowstriped armyworm life cycle includes an egg, larva (caterpillar), pupa, and adult. Depending on temperature, the life cycle takes between 30 and 90 days to complete. Adults have front wings patterned gray brown with light and dark markings, and a tan to brown diagonal band near the center (Figure 28). Females lay clusters of 200 to 500 eggs on the underside of tomato leaves. Each female can lay more than 2,000 eggs during her lifespan. Larvae or caterpillars emerge (eclose) from eggs and transition through six larval instars.

Figure 28. Adult yellowstriped armyworm (Photo: Entomology and Nematology Department University of Florida).

Figures 29 and 30. Yellowstriped armyworm caterpillar (Photos: Raymond Cloyd).

Older caterpillars are 1.5 to 2 inches (40 to 50 millimeters) long and brown gray to black with two distinct yellow stripes extending along each side of the body (Figure 29). Two black triangle shaped spots are on top of each body segment (Figure 30). The head is brown with black markings and has an inverted 'V'. Yellowstriped armyworm overwinters as a pupa in the soil or growing medium. Adults emerge (eclose) from pupae in April through May.

Damage

Young caterpillars feed on tomato leaves (Figure 31), and older caterpillars feed on leaves and tunnel into fruit (Figure 32). Caterpillars feed for approximately three weeks.

Figure 31. Yellowstriped armyworm caterpillar feeding on tomato leaf (Photo: Raymond Cloyd).

Figure 32. Yellowstriped armyworm caterpillar tunnelling into tomato fruit (Photo: Raymond Cloyd).

Management of Insect and Mite Pests

Managing insect and mite pests of greenhouse grown tomatoes involves various strategies to prevent or maintain insect and mite pest populations below plant damaging levels, including scouting, cultural, sanitation, physical/mechanical, pesticides, and biological control.

Scouting

To detect insect and mite pest populations early, scout tomato plants weekly. Scouting also helps determine insect and mite pest population trends during the growing season. Yellow sticky cards placed 4 to 6 inches (10.1 to 15.2 centimeters) above tomato plants will capture the adult life stage of thrips and whiteflies. Conduct visual inspections of tomato plants once per week by examining the topside and underside of tomato leaves to detect the presence of aphids, caterpillars, stink bugs, thrips, twospotted spider mites, and whiteflies. Use a 16 power hand lens (Figure 33) to check the leaf underside for eggs and larvae or nymphs of thrips, twospotted spider mites, and whiteflies. Shake leaves over an 8.5 x 11 inch (21.5 x 27.9 centimeters) white sheet of paper attached to a clipboard (Figure 34). Look for insect and mite pests, such as aphids, thrips, and twospotted spider mites, moving around on the white sheet of paper. Inspect tomato transplants received from an outside supplier for insect and mite pests before introducing the plants into the greenhouse.

Figure 33. 16 power hand lens (Photo: Raymond Cloyd).

Figure 34. Scouting for insect and mite pests on a tomato crop (Photo: Raymond Cloyd).

Cultural

Proper watering and fertility can reduce the susceptibility of tomato plants to insect and mite pests. However, do not overfertilize tomato plants with nitrogen based fertilizers because tomato plants that contain a high nitrogen content promote the development and reproduction of insect and mite pests, such as aphids, twospotted spider mite, and whiteflies.

Sanitation

Remove weeds from within the greenhouse and around the greenhouse perimeter because weeds may harbor or serve as an alternative host for insect and mite pests. In addition, weeds serve as a reservoir for the viruses that aphids, thrips, and whiteflies transmit. Place a 1 inch (2.5 centimeters) layer of gravel 10 to 20 feet (3 to 6 meters) around the greenhouse perimeter to prevent weeds from establishing (Figure 35). Remove tomato plant debris from within the greenhouse after the growing season to eliminate overwintering sites for certain insect and mite pests.

Figure 35. Gravel placed on the outside of a greenhouse to prevent weed establishment (Photo: Raymond Cloyd).

Figure 36. Yellow sticky tape used in a tomato greenhouse to capture adult insect pests.

Physical/mechanical

Remove caterpillars, such as cabbage looper, tobacco and tomato hornworm, and yellowstriped armyworm, by hand during the growing season to reduce damage to tomato plants. Place caterpillars into a container of soapy water to kill them. Twospotted spider mite and whiteflies are typically located on the lower leaves of tomato plants. Therefore, remove the lower leaves of tomato plants infested with twospotted spider mites and whiteflies.

Installing yellow sticky tape among tomato plants throughout the greenhouse (Figure 36) will capture the adult life stage of insect pests, such as moths, thrips, and whiteflies. The strategy can reduce the number of larvae, nymphs, and adults in subsequent generations, thus decreasing damage to tomato plants. Replace the yellow sticky tape twice during the growing season because the glue stickiness declines over time.

Insect exclusion screening can be placed over greenhouse openings (Figure 37) to prevent the adult life stage of moths, thrips, and whiteflies from entering greenhouses from the outside. Restricting the entry of insect pests into the greenhouse can reduce the number of pesticide applications and help protect tomato plants from thrips and whiteflies that transmit viruses to tomatoes. The mesh size of insect exclusion screening depends on the insect pest. For example, insect exclusion screening for thrips is 192 microns or 76 mesh. Insect exclusion screening installed over greenhouse openings can prevent the adult stages of certain insect pests, including thrips and whiteflies, from entering greenhouses from outside sources, such as field grown crops. However, if not properly installed, insect exclusion screening can lead to an increase in temperature and relative humidity inside the greenhouse by restricting airflow.

Figure 37. Insect exclusion screening placed over greenhouse opening (Photo: Raymond Cloyd).

Pesticides

Pesticides, in this case, insecticides and miticides labeled for use in greenhouse tomato production systems, can be used to manage insect and/or mite pest populations below plant damaging levels. Read the pesticide label directions and wear the appropriate personal protective equipment. Thorough coverage of all plant parts, including leaves, fruits, and flowers, is important to manage insect and mite pest populations below plant damaging levels. To increase the effectiveness of pesticide spray applications, space tomato plants within the greenhouse to allow for thorough coverage of all plant parts. Aphids, thrips, twospotted spider mite, and whiteflies reside on the leaf underside of tomato plants. Consequently, pesticide applications must target the underside of leaves. Larvae and nymphs are generally more susceptible to pesticide applications than adults. Because the eggs and pupae of insect and mite pests are not susceptible to most pesticides, repeat applications may be necessary.

Rotate pesticides with different modes of action to mitigate insect and/or mite pest populations from developing resistance. Use a pesticide with the same mode of action within a generation, which is generally one to two weeks, before switching to another pesticide with a different mode of action.

Bumble bees, including *Bombus impatiens,* are used in greenhouse tomato production systems (Figures 38 and 39) to pollinate tomato flowers. Do not apply pesticides when tomato plants are flowering and bumble bees are present in greenhouses.

Biological control

Two types of beneficial insects and mites are used for biological control of insect and mite pests: parasitoids and predators. Parasitoids attack insect pests, including aphids, caterpillars, and whiteflies. For instance, a female inserts an egg into an aphid using an egg laying device called an ovipositor (Figure 40). A larva emerges (ecloses) from the egg and feeds on the internal

Figure 38. Bumble bee hive box (Photo: Raymond Cloyd).

Figure 40. Parasitoid attacking aphid (Photo: Atiaf Agricultur Trading).

Figure 39. Bumble bees inside hive box (Photo: Raymond Cloyd).

Figure 41. Mummified or parasitized aphids on leaf underside (Photo: Raymond Cloyd).

contents of the aphid. Feeding by the larva results in the formation of a parasitized or mummified aphid that is gray or brown and located on the underside of a leaf (Figure 41). Properly identify aphids and whiteflies to species because parasitoids will only attack certain aphid and whitefly species. Predators feed on a wide range of insect and mite pests. In general, the larvae or nymphs and adults are predaceous, however, this is not always the case. Table 1 lists the beneficial insects and mites that can be purchased from distributors/suppliers and released into greenhouse tomato production systems.

Release beneficial insects and mites early in tomato production to manage insect and mite pest populations below plant damaging levels. Before releasing beneficial (predatory) mites onto tomato plants, lightly mist the leaves with water (Figure 42) to ensure that the beneficial mites do not fall off the plants. Distribute beneficial mites onto the leaves of tomato plants (Figure 43) and check (Figure 44) to confirm that the beneficial mites are alive and moving around on the leaves.

Natural populations of beneficial insects that enter greenhouses during the growing season may attack certain insect pests, such as aphids and hornworm caterpillars. For example, hornworm caterpillars may have white cocoons attached to their body (Figure 45). Adult parasitoids will emerge from these white cocoons and lay eggs into hornworm caterpillars present on tomato plants.

Figure 42. Lightly misting plant leaves before releasing beneficial mites (Photo: Raymond Cloyd).

Figure 44. Checking plant leaves to ensure beneficial mites are alive and moving around on plant leaves (Photo: Raymond Cloyd).

Figure 43. Distributing beneficial mites onto plant leaves (Photo: Raymond Cloyd).

Figure 45. Tomato hornworm with white cocoons on the body (Photo: Raymond Cloyd).

Table 1. Insect and mite pests, beneficial insects or mites, and beneficial types that can be purchased from distributors/suppliers and released into greenhouse tomato production systems.

Insect/Mite Pest	Beneficial Insect/Mite	Beneficial Type
Aphids	*Aphidius colemani*	Parasitoid
	Aphidius ervi	Parasitoid
	Aphelinus abdominalis	Parasitoid
	Aphidius matricariae	Parasitoid
	Aphidoletes aphidimyza	Predator
	Chrysoperla carnea	Predator
Thrips	*Neoseiulus (Amblyseius) cucumeris*	Predator
	Amblyseius swirskii	Predator
	Orius insidiosus	Predator
	Dalotia (Atheta) coriaria	Predator
Twospotted Spider Mite	*Phytoseiulus persimilis*	Predator
	Neoseiulus californicus	Predator
	Neoseiulus fallacis	Predator
	Feltiella acarisuga	Predator
Whiteflies	*Encarsia formosa*	Parasitoid
	Eretmocerus eremicus	Parasitoid
	Amblyseius swirskii	Predator

Raymond A. Cloyd, *Horticultural Entomology and Plant Protection Specialist*

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