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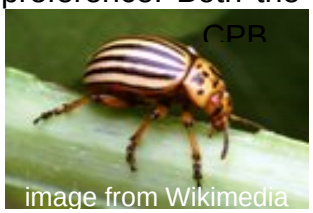
Insect Pests of Tomato

Tomato is the second most important vegetable crop grown in Maryland. Because of its value growers often apply pesticides too often in order to protect their investment. This often leads to development of insect resistance, environmental contamination, worker and food safety issues and poor management of pests. The key to any successful pest management program is to develop a regular scouting plan to gain information on insect pest populations that may be used to determine if insecticide applications are needed. Monitoring can consist of sampling groups of 10 plants which are randomly selected at 5-8 different locations in a field. Samples should be distributed throughout the field so that plants near the edges and middle of the field are examined. In recent years there has been a great increase in new control technologies available to growers, this makes management of insect pests in tomatoes an ongoing process. The new insecticides generally act against a narrower range of pest species than the older, broad-spectrum materials. Therefore, it is critical to properly identify the pest to be controlled and to determine its potential for damage. The only way to obtain this information is through routine scouting. The purpose of this guide is to serve as a reference for insect pest identification and for general management guidelines. Specific information on insecticides is available from EB-236 the pesticide recommendation guide for the mid-Atlantic region. Cultural controls, reduced risk pesticides as well as other pesticides are recommended for each pest.

Colorado potato beetle (CPB) (*Leptinotarsa decemlineata*) is a serious insect pest of potatoes but will also attack tomato, eggplant, and pepper in that order of preference. Both the adult striped beetle and the black-spotted, hump-backed red larvae are foliage feeders. Their feeding damage can greatly reduce yield and in some cases kill plants. The Colorado potato beetle has the ability to rapidly develop resistance to insecticides that are used repetitively for their control. This has been a serious problem on the east coast for many years. Colorado



potato beetles overwinter as adults in the soil. They become active in the spring as temperatures rise and begin to feed on weeds or early planted potatoes, even entering the soil to attack emerging foliage. Female beetles lay elongated oval orange-yellow eggs on the underside of foliage. Each female can lay 500 or more eggs over a 4-5 week period. Eggs hatch in four to nine days and the larvae begin to feed on potato foliage. They usually feed in groups and damage can be severe. The larval stage lasts two to three weeks. Full grown larvae burrow in the ground to pupate. In five to 10 days, the adult beetle emerges. This insect can go from egg to adult in as little as 21 days. The newly emerged adult female feeds for a few days before egg laying begins. There are two full generations each year.

Management Insecticides in the same chemical class usually have the same method of killing the insect. Resistance develops more rapidly when that insecticide is used repeatedly as the only control measure. Overuse of one insecticide may favor the development of resistance to other insecticides in the same chemical class. Consequently, to delay or prevent resistance it is important to avoid repeated use of one particular insecticide by rotating the insecticides used (see EB-236, CPB under white potatoes). Timing of sprays is critical for control. Overwintering beetles are attracted to fields over a period of several weeks; in the early season adults do not fly, but must walk to the nearest food source. That is why rotating at least ¼ mile away works so well. Potato plants can withstand considerable defoliation (30%) without yield loss. Generally, insecticides do not need to be applied unless there is more than one beetle or larva per plant. Pre-plant or at-planting insecticides work well in protecting plants: Cruiser seed treatment or imidacloprid, or Platinum, or Radiant at-planting. DO NOT use any of the at-planting or pre-treatment chemicals again during the season. Foliar chemicals include Actara, Agri-mek, Assail, Rimon, and SpinTor.

Tomato Fruitworm (*Helicoverpa zea*) is one of the most damaging insect pests of tomato in Maryland. The tomato fruitworm feeds on tomato, corn and cotton and is also called the corn earworm and the cotton bollworm. It also attacks soybeans, peppers, tobacco, beans, okra and eggplant. The larvae are variable in color, ranging from pale yellow, to red, to green, to brown with pale stripes running lengthwise. Young larvae have several rows of black bumps along their backs and two bristle-like hairs in each bump. Older larvae are densely covered with microscopic spines that make the larvae feel rough. Fruitworms overwinter as pupae in the top 2-6 inches of soil. Adults emerge from mid-May to early June and have 2-3 generations per year in Maryland. The moths lay eggs at night on leaves near green fruit. Eggs are white when first laid and develop a reddish brown band 24 hr before hatching. After the egg hatches, the larvae feed for a short period of time on the foliage before attacking the fruit. They prefer to feed on green fruit and usually do not enter ripe fruit. Damage consists of small holes


Fruitworm

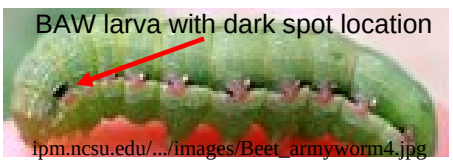
in the stem of the fruit when larvae are small but the larvae are cannibalistic, so there is rarely more than one larva per fruit. Larvae usually complete development in a single fruit, but when fruits are small they may feed on several. The tomato fruitworm has a wide host range and the attractiveness of tomatoes for egg laying vary with the time of year. Early fruitworm generations attack corn,


Small fruitworm larva


Large larva and damage

particularly when it is silking, but later season tomato plantings are often damaged more severely because fruitworm populations generally increase as the season progresses. The most severe fruitworm damage in tomatoes frequently occurs after dry-down or harvest of adjacent corn as tomatoes become the preferred site for egg laying. **Management** Fruitworm can be a major pest in Maryland tomato fields and calendar-based insecticide sprays are not recommended. Though it can seem like it is a preventative strategy; the calendar-based spray program is not cost-effective, destroys natural enemies, and poses a hazard to the environment. A more effective strategy for managing fruitworms is to monitor fields regularly for signs of insects or damage and to apply an insecticide only when necessary. Field trials in Maryland have demonstrated that use of the insect monitoring program will reduce pesticide applications and any damage by the pest. The critical period for tomato fruitworm is when fruit is present; fruitworms are usually not a concern before flowering unless high numbers are present. Insecticide sprays are only necessary when tomato fruit are present and tomato fruitworm moths are being caught in pheromone traps. If moth catches are low (1-4 moths per week), sprays are not necessary. The presence of silking corn in the area will usually divert moths from tomato to corn. When trap catches reach >10 male moths per week and corn silks have dried down, an insecticide should be applied. For fruit sampling; pick 100 fruit at least 1 inch in diameter at random throughout the field. Check to see if any fruit have worm-feeding damage. Slice open damaged fruit to determine if damage is due to fruitworm (feeding deep inside fruit, feces often present) or armyworm (feeding usually confined to the surface). It is important to know which worm species is present to select the most effective insecticide needed. Fruitworm eggs are not affected by most insecticides. Reduced risk chemicals for fruitworm control include: Avaunt, Confirm, SpinTor, and Proclaim. Other chemicals include: Pyrethroids, Renounce, and Coragen.

Beet Armyworm (*Spodoptera exigua,* BAW) is an occasional pest usually later in the season (late August or September) in tomato and pepper. Like the fruitworm, BAW moths are active at night and eggs are deposited in masses covered by white, feathery scales from the female. Beet armyworm larvae



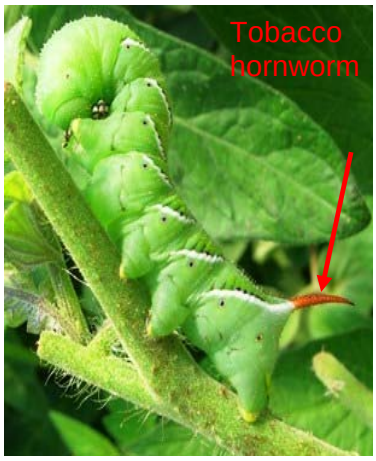
are smooth, without hairs, and vary in color from dull green to black. Older larvae have a broad, light-colored stripe along the side of the body and usually have two large dark spots just above the middle pair of true legs (red arrow). **Management** Beet armyworm egg masses are deposited randomly throughout a tomato plant, often on the underside of leaves. It is common to see many small armyworm larvae feeding on the underside of tomato leaves before they disperse throughout the plant. Beet armyworm is primarily a foliage feeder, but they will also attack fruit, usually creating single or closely grouped round or irregularly shaped holes. Feeding damage is usually superficial, and larvae only occasionally develop inside the fruit. Unfortunately, decay organisms enter the feeding-damaged areas and can rot the fruit. Therefore, it is prudent to check young plants regularly for beet armyworm egg masses or small larvae. The presence of beet armyworm larvae can also be detected by shaking foliage over a shake cloth. Reduced risk chemicals for BAW control include: Avaunt, Confirm, SpinTor, and Proclaim. Other chemicals include: Lannate, but pyrethroids are not recommended for control of this pest.

Yellowstriped Armyworm *(Spodoptera ornithogalli)* has become more of a problem in the northeastern United States over the last 10 years. In the past this species of armyworm has only been able to overwinter in warmer areas of the U.S. moving up into the mid-Atlantic in late summer. The mild winters we have been experiencing has allowed the yellow striped armyworm to overwinter farther north than before and invade tomato fields in the early summer. Larvae usually have a yellow or cream colored strip running along the length of their body which can be pale gray to black. On the first abdominal segment there is a large dark spot on both sides of its body. Eggs are laid in groups of 20-30 near fruit. Small larvae feed on leaves for a short time and then attack fruit. Feeding damage to fruit consists of 1/8 – 1/4 inch wide holes, over the entire fruit and fruit cluster. One or two larvae can destroy two to three clusters of tomato fruit.


Yellow striped AW and damage

Management Leaves must be inspected in June so that this pest can be found when small and before it feeds on fruit. Identification of the pest is essential to understand when controls should be started. Growers should watch for this pest in their tomatoes each year, because its population will fluctuate greatly from year to year and field to field. The presence of the yellow striped armyworm one year does not necessarily mean it will return next year to that or neighboring fields. If damaging populations are found and larvae are small *Bt* (XenTari) can be used effectively. If larvae are larger then reduced risk pesticides such as Confirm, Avaunt, SpinTor can be used as well as other pesticides such as bifenthrin, Warrior, and Lannate,

HORNWORMS feed primarily on solanaceous plants (those in the tomato family). They include tobacco, tomato, eggplant, pepper and some weedy plants. Tobacco and tomato plants are preferred. There are two species of hornworm commonly encountered in the field; the tobacco hornworm (*Manduca sexta*) and the tomato hornworm (*Manduca quinquemaculata*). These two species look and behave very similarly. Hornworm eggs are smooth, spherical and about 1/16 inch in diameter. Light green at first, they turn white before hatching, which takes place 3-6 days after being laid. Larger larvae usually have green bodies with seven diagonal white stripes along their side and a red "horn-tail" (tobacco horn worm (red arrow)-most common in Maryland), or eight V-shaped markings with a black "horntail" (tomato hornworm (red arrow). Hornworms can grow 3-1/2 to 4-1/2 inches in length. After feeding for three weeks, hornworm larvae burrow into the soil to pupate. Moths emerge in 2-3 weeks. Each moth deposits one to five eggs per plant. Heavy egg deposition is common in August and early September and during this period of time foliage feeding by small larvae should be carefully looked for. At least two generations occur each season in Maryland. Hornworms strip leaves from plants. If a heavy infestation develops caterpillars also feed on developing fruit. Rather than bore into the fruit, they feed on the surface leaving large, open scars, but fruit damage is less common than loss of leaves.



Management Hornworm damage usually begins to occur in midsummer and continues throughout the remainder of the growing season. Hornworms are often controlled by parasitic wasps (Brachonid wasps). These parasitoids lay eggs into the hornworms where their larvae feed inside, and then pupate on the backs of the hornworms. These pupal cases are seen as white projections on the back of the hornworm. If parasitized hornworms are found on the crop, feeding will have ceased, so leave the larva for the next generation of beneficial wasps to emerge. These natural enemy populations can be greatly reduced by frequent pesticide applications. The best management tactic is to wait until small larvae are found and fruit begins to mature before applying insecticides. Reduced risk and other pesticides used for fruitworm control can also be used for hornworm control.

Tomato Pinworm *(Keiferia lycopersicella* (TPW) is usually not an important pest in Maryland, but at times in certain fields it can be a major problem. Large pinworm larvae are dark gray and covered with purple spots. Early stage larvae feed on leaves and create blotch-type mines. This damage appears similar to leaf-miner damage. In some cases, larvae may tie the leaf together with silk and feed in the protected area inside. Later stage larvae that bore into the fruit, usually at the calyx or stem end, cause the most serious damage. Pinworm larvae make dry burrows in the core and do not penetrate very far into the fruit. When infested fruit is picked, caterpillars may be difficult to detect, unless they have been feeding long enough to create small piles of brown granular frass at the edge of the calyx. Because the pinworm has many generations per season, it becomes a more serious pest as the season advances. The greatest damage occurs when tomatoes are grown from early in the season through the fall.

TPW leaf-mining damage

Tomato pinworm larva

Management. While pinworms can be controlled with mating disruption techniques, this is not usually necessary in Maryland as the infestations will be sporadic and usually not economical. To reduce future populations of pinworm, crop residues should be destroyed after harvest by burning or plowing-under. If pinworm is a serious pest in the area, avoid growing more than one crop per year. Check transplants carefully for pinworm infestation before setting them in the field. Late evening insecticide applications are usually more effective because they will also control adult moths. Pyrethroids and the reduced risk pesticides SpinTor, and Proclaim are effective chemical controls.

Cabbage loopers *(Trichoplusia ni)* are commonly found in tomato fields, but they rarely cause serious damage. It is a foliage feeder, and rarely attacks the fruit. When large populations are present they can lower yields by reducing plant vigor and increasing sun scald of fruit through foliage loss. Loopers are green with white stripes running lengthwise down the body. Loopers have only three pairs of prolegs. The young larvae are often found on the underside of leaves where they feed leaving most veins intact. Usually, insecticides applied to control tomato fruitworm keep cabbage looper under control.

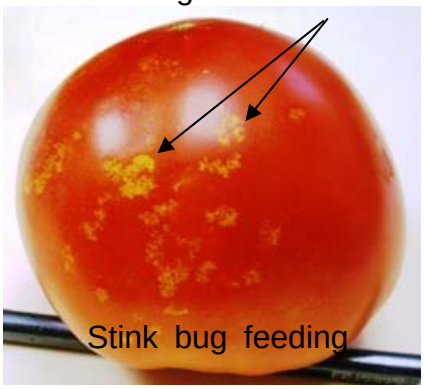
Cabbage looper

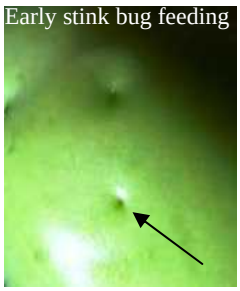
Stink bugs Several species of stink bugs are serious pests of tomatoes and various other vegetable crops. In the last 5 years stink bugs have shifted from being an occasional minor pest to a frequent major pest in tomatoes. The two most common stink bug pests in Maryland are the brown (*Euschistus servus*) and green stink bugs (*Acrosternum hilare*). All adult stink bugs are shield-

Brown stink bug

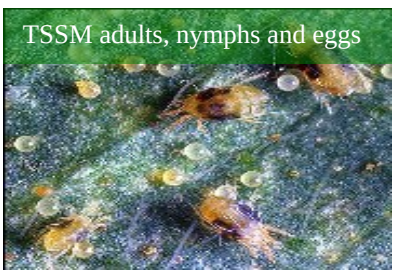
shaped. Green stink bugs are about 1/2 to 3/4 inch in length. They are bright green with a narrow orange-yellow line bordering the major body regions. Brown stink bugs are dull brown and 1/2 to 5/8 inch long. Stink bugs overwinter as adults in ditch banks, fence rows and in wooded areas. They become active in spring when temperatures rise above 70° F. Each female lays up to several hundred eggs in clusters with 20-30 eggs each. Stink bugs usually reach high population levels in July through early October. Nymphs and adults pierce plants with their needlelike mouthparts and suck sap from pods, buds, blossoms and seeds. The degree of damage depends on the developmental stage of the plant when the stink bug pierces it. Immature fruits and pods punctured by bugs become deformed as they develop. Seeds can be damaged and shriveled with germination often being reduced. In tomato their feeding causes a malady known as cloudy spot. This occurs when the stink bug removes the contents of cells below the outer-skin of the tomato which causes the empty cells to fill with air and appear as white areas. As the tomato ripens these areas can turn yellow (black arrows). These white or yellow areas are soft and spongy and if spots are large or numerous make the tomatoes unmarketable. **Management** One of the challenges with managing stink bugs is that they feed on over 52 plants, including native and ornamental trees, shrubs, vines, weeds and many cultivated crops. The preferred hosts are nearly all wild plants. Stink bugs build up numbers on these alternative hosts and can move quickly to cultivated hosts as their preferred food sources become mature. Stink bugs usually move into fields from borders and this is the first place to look for their damage. It is difficult to see stink bugs on the plant and a better strategy is to look for any stink bug feeding on tomato fruit. Early feeding looks like a small dimpled area on green fruit. If a few of these are found an insecticide should be applied especially if fruit trees are in the area of the tomato fields. Stink bugs are difficult to control with the chemicals available with brown stink bugs being more difficult to control than green. There are no reduced risk chemicals that are effective for stink bug control with the possible exception of Venom. Other pesticides that can be used are: pyrethroids, Danitol and Thionex.


Green stink bug


Stink bug feeding


Early stink bug feeding

Twospotted spider mites (*Tetranychus urticae* (TSSM*)* are very small, 1/80 - 1/60 inch long, with 2 spots on their back pests that are a problem usually in late July and August during hot dry weather. Mites overwinter in leaf debris in and around fields. In spring, the reddish mites feed on weed hosts, such as chickweed, clovers, and some grasses. Females


TSSM adults, nymphs and eggs

find their way into fields by climbing to the top of their feeding site and releasing a long string of silk from their abdomen that catches a breeze and they become airborne. Because they have such a wide host range, wherever they land they can usually start to feed. Females can lay 50-100 spherical eggs. Unfertilized eggs turn into males, and fertilized ones turn into females. The life cycle of the mites can be as short as 5-7 days in the summer. Mite infestations usually start on the field edge and move towards the center over time. Hot, dry weather conditions favor rapid development of eggs, increases feeding of nymphs and adults, and decreases the abundance of pathogenic fungi. Dusty conditions also favor mite activity. Both nymph and adult mites feed by piercing the cell walls of the leaf and sucking out the juices. Twospotted spider mites damage appears as a yellow discoloration or a mottled sand blasted appearance on tomato leaves, which can take on a bronze, then brown color. **Management** During hot, dry conditions continue for several weeks, and then fields should be checked closely, especially along borders and near grassy areas. The underside of several lower leaves should be checked for mite activity. A 10X hand lens can be used to identify mites. Also, leaves can be shaken over a piece of paper, and the dislodged mites can be seen crawling about. If mites are found along the border of a field, the whole field should be checked for the presence of mites. An exact threshold for mites has not been developed. If there are only a few mites along the field borders with little mite activity in the interior of the field, then a treatment is not necessary, or just the border around the field may be treated. If there are mites found in scattered areas throughout the field and there is webbing found on the undersides of leaves, then a treatment will be necessary. Natural enemies help control and reduce mite populations under most circumstances and therefore, insecticide applications should be kept to a minimum. Natural enemies, however, can be overwhelmed by mite reproduction during hot, dry weather. There are several reduced risk chemicals available for mite control in tomato: Acramite and Agrimek. These other pesticides will also control two spotted spider mites: Oberon, Danitol, and if populations are not large bifenthrin.


TSSM damage on leaf
Whitney Cranshaw

Flea beetles. All solanaceous plants are susceptible to flea beetle attack, but eggplant and to a lesser extent potato are especially vulnerable. There are many different species of flea beetles that will attack solanaceous and cruciferous crops. The more common species that attack solanaceous plants are the eggplant (*Epitrix fuscula)*, tobacco (*Epitrix hirtipennis)* and potato (*Epitrix subcrinata*) flea beetles. The eggplant flea beetle adult is an oval, black; 1/10 inch long beetle that has thickened, ”jumping” hind legs. Its antennae are about 2/3 the length of its body. This species resembles the potato flea beetle but has black

legs and slightly hairy wing covers. The potato flea beetle is also about 1/10 inch long and brownish black. The tobacco flea beetle is about the same size, but is yellowish brown with a dark band across its wings. All eggs of these species are < 1/250 inch long and pointed at one end. Though white at first, eggs gradually become yellowish-gray. A typical flea beetle larva is white with a brown head and three pairs of brown legs near its head. Larvae become 1/16 inch long when fully grown. In general, flea beetles overwinter as adults in soil or crop debris and emerge from hibernation in mid- to late March. Weedy hosts such as horsenettle and pokeweed are infested until crop hosts become available. Eggs laid in soil near the bases of plants hatch in about one week. Larvae emerge from the eggs and feed on roots or tubers for 2 to 3 weeks. After developing through three instars, larvae pupate in the soil. The pupal stage lasts 7 to 10 days. Beetles emerge from the soil, and feed on leaves for 2 months or more. Flea beetles complete 1-3 generations each year in Maryland. Adult flea beetles feed on both leaf surfaces but usually on the underside where they chew small, circular holes through to the upper cuticle, which frequently remains in place for a time before falling out. The circular holes give the plant a “shotgun” appearance; large numbers of these shotgun holes may destroy entire leaves. Flea beetles can be serious pests early in the season when plants are small, < six inches tall. As plants grow larger they can withstand substantial flea beetle damage without yield loss. Flea beetle larvae feed on roots where they seldom cause any yield loss to eggplant; however this feeding may cause damage to tuber crops such as beet and potato. **Management** Cultural practices such as destruction of crop residue, weed control and late planting help minimize flea beetle problems. The removal of crop residue reduces the number of favorable overwintering sites for flea beetles. Covering plant beds with a cheese-cloth-like material is beneficial. Control of weeds such as horsenettle and pokeweed around garden sites eliminates important early beetle food sources. Delayed planting favors the development of host plants over the establishment of flea beetles in tomato fields. If defoliation becomes severe on small or medium sized plants one application with a pyrethroid will usually take care of the problem.

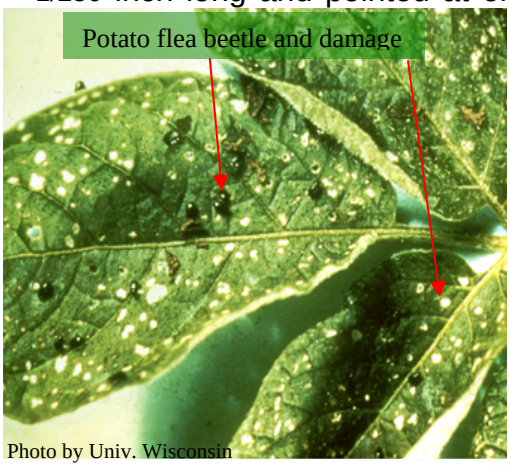

Potato flea beetle and damage

Photo by Univ. Wisconsin

Thrips (most being flower thrips *Frankliniella* spp) may infest tomatoes, including western (WFT) *(Frankliniella occidentalis)* and eastern *(Frankliniella tritici)* flower thrips, and tobacco thrips *(Frankliniella fusca).* Thrips are tiny (1/16 inch), slender insects that vary in color from yellow or orange (most common color) to dark brown or black. Thrips overwinter in plant debris or on weeds such as winter annuals found in


Flower thrips

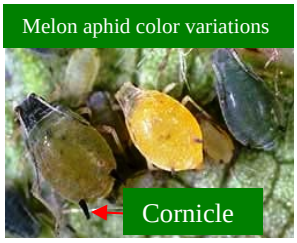
or around fields. In the spring they fly to plants producing flowers where they feed on pollen and nectar. They prefer to feed in flowers but also occur in flower and leaf buds and, occasionally, on leaves. They are more likely to be found on leaves of vegetables early in the season when these leaves have pine pollen on them. Pine pollen, as well as other tree pollens is quite commonly found on plants in the field. Thrips then feed on this pollen. These early season thrips populations rarely result in any problems later in the season unless several weekly applications of pyrethroids are made early in the season. There are two larval stages and a pupal stage. Immature thrips are sometimes transparent and take on the appearance of whatever plant part they are on, which can make them almost impossible to see even with a 10x hand lens. Thrips have only the left mandible and use this mouthpart to punch a hole or scrape the leaf surface of the plant disrupting cells and feeding on the cell contents. This feeding method damages tomatoes in several ways. Feeding in blossoms may cause blossom drop, or fruit may not develop properly and become deformed. Feeding on foliage may cause a bronzing or silvering of foliage. Eggs inserted (oviposited) in fruit causes dimpling, and the damaged area may appear firm and white if western flower thrips is the species that oviposited (red arrow). Some thrips species (western flower thrips, onion thrips and tobacco thrips, but not the common eastern flower thrips) are also vectors of tomato spotted wilt virus (TSWV), a potentially devastating disease of tomato. Infected plants have dark lesions on the foliage and fruit show characteristic halo markings. If plants are infected early in the season they remain small and never produce a crop. If infected later in the season fruit often becomes unmarketable. Only immature thrips can acquire the virus when they feed on an infected plant, adults cannot, but only adults can vector the virus to another plant. TSWV has not been much of a problem in Maryland, but can be intermittently found in tomato fields in August and September in the southern parts of the state. Although research in the SE United States has demonstrated that even low numbers of thrips can infest fields with TSWV, in Maryland it is rare that any field would have economic infestations of thrips or TSWV unless many pesticide applications previously had been made. **Management** To determine thrips presence; sample 20-40 flowers while scouting. Thrips will be visible inside the flower using a 10x hand lens, or the flower may be shaken over a piece of paper to dislodge the thrips for observation. The recommended thrips treatment threshold is five thrips per flower. Reduced risk chemicals that will control thrips include: Assail, SpinTor, and Venom with other chemicals such as pyrethroids, Renounce and Proaxis also working. DO NOT over apply chemicals for thrips


Oviposition damage by WFT


TSWV symptoms on tomato


TSWV symptoms on tomato

control as this will increase the likelihood of resistance developing. Over application of pyrethroid insecticides favors the increase of western flower thrips which are very good vectors of TSWV and also cause more damage to tomato flowers.



Aphids There are many different species of aphids that could be found in a tomato field. Aphids are small, soft-bodied insects that vary in color from pale yellow to red to green to black, depending on the species (with one species capable of having several colors), the host plant, and time of season. Direct-feeding damage by aphids is rarely severe enough to kill plants. They pierce plant tissue with needlelike mouthparts, which may result in blossom shed or curling or stunting of new growth. They also produce a sticky material called honeydew that supports growth of a black sooty mold fungus, if the honey dew gets on the fruit it is difficult to remove making the fruit unmarketable. Three species of aphids can be found on tomato in Maryland, the melon, potato and green peach aphids. Melon aphids (*Aphis gossypii*) are pear-shaped and vary from yellow to dark green, but have dark colored cornicles (slender tailpipe-like appendages, red arrow). Potato aphids *(Macrosiphum euphorbiae)* are soft-bodied, elongated tear-shaped insects that may be solid pink, green-pink mottle or light green with a dark stripe and are about 1/8 inch long and have a pair of long, slender cornicles. Adult females give birth to live young, called nymphs. Although slightly smaller than adults, nymphs are similar in color and shape. The green peach aphid *(Myzus persicae)* is pear shaped and pale yellow to green with the cornicles being green and much shorter than the potato aphid.

Management Aphids usually are not an important pest in tomatoes unless too many pesticide applications have been made. Pyrethroid and carbaryl insecticide if used too often can cause an outbreak of these pests in tomato or pepper. These pesticides are broad-spectrum and kill many beneficial insects. These beneficial insects or natural enemies, such as predators (lady beetles and their larvae, syrphid fly and lace wing larvae), and parasitic wasps keep aphid populations under control most of the time unless their populations are disrupted. If aphid populations do increase to damaging levels there are several reduced-risk pesticides available that will give excellent control: Actara, Assail, Fulfill, imidacloprid, Platinum and Movento.

Whiteflies (Silver leaf whitefly *Bemisia argentifolii, Greenhouse whitefly and common whitefly*). Although the silver leaf whitefly and other whitefly species are found in Maryland, they are not a major problem. The silverleaf whitefly is small, about $^{1}/_{32}$ inch long and whitish yellow. The head is broad at the antennae and narrow toward the mouthparts. The wings are held roof-like at about a 45-degree angle, whereas other whiteflies usually hold the wings nearly flat over the body. As a result, the silverleaf whitefly appears more slender than other common whiteflies. The eggs are whitish to light beige. They are inserted on end in the undersides of new leaves. The nymphal stage appears glassy to opaque yellow. Its body is flattened and scale-like. The pupa or fourth nymphal instar will be somewhat darker beige-yellow and opaque. This pest feeds on many different kinds of plants. The most common hosts in Maryland include poinsettia, tomato, squash, cucumbers, and melons. Silverleaf whiteflies damage plants directly and indirectly. Direct damage results from their feeding activity, which involves them sucking plant sap. Both the adults and nymphs contribute to direct damage. Chlorotic (yellow) spots sometimes appear at the feeding sites on leaves. Heavy infestations cause leaf wilting. In addition, as they feed they excrete honeydew (a sugary substance), which the sooty mold fungi feed on. The resulting dark splotches on the leaves may reduce photosynthesis and other physiological functions of the plant. Indirect damage results from their activity as disease vectors. The silverleaf whitefly carries and spreads several important viral diseases of tomatoes, lettuce and melons in the southeastern United States, but does not vector these viruses to any great extent to Maryland vegetable crops.

Photo by

Management Whiteflies should not become a problem in most fields, but occasionally their populations can increase to such levels that they begin to directly damage the plant. If sooty mold is found on many plants or fruit an insecticide application is needed. This should only occur rarely and in the latter part of a season. Chemicals recommended for aphid control will work for whitefly control.

Potato Leafhopper (*Empoasca fabae)* adults are about 1/10 inch long, wedge-shaped and greenish-yellow. The potato leafhopper has wings that are transparent green and are folded back when at rest. They also have a variable number of white spots on top of their head and along their thorax. Eggs are white and elongated and are laid inside the veins on the underside of leaves hatching in 7-10 days. A female leafhopper lives about a month, producing one to six eggs per day. Nymphs are light green and cannot fly. They mature in about two weeks, after which mating occurs 48 hours later. Three or four generations are produced each year. Leafhoppers overwinter in the Gulf States and move up on fronts from the south over the spring and summer. Leafhoppers feed on more than 100 cultivated and wild plants, including bean, potato, alfalfa, soybean, and peanut. Both nymphs and adults feed on the undersides of the leaves. Adult leaf hoppers are primarily responsible for the feeding injury to potato plants. Injury starts with a yellowing along leaflet margins with a slight rolling. This injury is soon followed by a gradual browning starting at the leaflet's tip and margin ("hopper burn"- red arrows), and expanding until the entire leaflet is dead. Defoliation can occur that results in a reduction in yield. These symptoms are sometimes confused with drought stress and are much more common on potato than tomato.


Potato leafhopper adult and nymph


"Hopper burn" on potato

Management Monitor fields for populations and correctly identify the leafhopper. There are many leafhoppers that do not damage potato. Sample 30-40 leaves in 3-5 areas of a field for leaf hopper nymphs. A threshold for treatment is one nymph per 10 leaves. Controlling leafhoppers after hopper burn is observed in the field is too late, yield has already been lost. Reduced risk pesticides to use include: at planting, Admire and Platinum. Reduced risk foliar treatments include Actara and Provado. Other chemicals include: pyrethroids, Vydate, Thimet and Thiodan.