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Major Pests and Control Guidelines

Management of insect pests in Florida tomatoes is constantly changing in order to incorporate new technologies and to adapt to new pests. Pest management systems should be based upon scouting programs which provide information on pest populations and their damage potential, as well as information on beneficial insect populations, to aid growers in making management decisions. The Florida Tomato Scouting Guide with Insect Identification Keys (1996) should be consulted for scouting guidelines and action thresholds. Insecticidal control should be integrated with cultural and biological control to ensure long-term, stable management of pests. The reduced insecticide use that resulted from implementation of such programs in Florida permitted an increased role of naturally occurring natural enemies in managing pests, particularly leafminers. In the late 1980s, the introduction into Florida of two new major pests, the silverleaf whitefly and the western flower thrips, resulted in increased foliar applications of broad spectrum insecticides and temporarily reversed the trend toward reduced use of such insecticides. Outbreaks of other pests including leafminers and the tomato pinworm increased. Recent advances in our understanding of these new pests and their management, particularly in the areas of cultural control and selective chemical control, have allowed reduced reliance on broad-spectrum insecticides and a return to more integrated management practices. The major pests of tomato in Florida and guidelines for their management are described below.

Silverleaf whitefly (SLWF), Bemisia argentifolii. All stages are found generally on the undersides of leaves. The adult is small (5/64 inch) with a yellow body and white wings which are covered with powdery wax and held roof-like over the body. The egg is tiny and shaped like an upright football anchored to the leaf tissue by a tiny pedicle. Egg color is off white when newly deposited and changes to brownish when nearing hatching. There are four nymphal instars starting with the egg-sized, mobile crawler complete with legs, eyes and antennae. After settling it molts into a flat scale-like and immobile feeding stage (second instar) which is clear to whitish and has no external appendages. The nymph enlarges through two more instars by molting, eventually developing to a fourth instar or "pupa" recognized by its yellowish color, raised shape and prominent red eyes. Generation time is 15 to 30 days depending on temperature.
Adults and nymphs excrete honeydew which serves as a substrate for sooty mold. Heavy populations can debilitate plants directly through sap removal and indirectly through shading effects of sooty mold. Moderate populations can cause irregular ripening of fruit characterized by inhibited or incomplete ripening of longitudinal sections of fruit. Adults can vector a plant virus, tomato mottle geminivirus (TMoV). The threat of TMoV is proportional to the number of viruliferous whiteflies which is difficult to assess. Tomato is the major source of inoculum, so attention should be paid to the probable source of whiteflies invading a field, given that highest risk is from senescing, abandoned or 'volunteer' tomato.

SLWF populations are generally highest in south, southwest and west-central Florida during the spring although populations of viruliferous whiteflies in west-central Florida generally are greater in the fall. The whitefly is less often a problem in north Florida but may reach damaging numbers in summer. The SLWF is attacked by a variety of natural enemies including the parasitic wasps Encarsia spp. and Eretmocerus sp., and predators such as lady beetles, minute pirate bugs, and lacewings. Successful management has depended upon integration of cultural, biological and chemical control. Maintenance of at least one crop-free period of two months or more during which fields are kept free of crop residues to diminish virus inoculum and whitefly populations between seasons is recommended. Natural predation and parasitism of whiteflies in weed hosts is a major factor at this time. If successive plantings are required during the season, they should be separated the maximum distance possible by nonsusceptible crops. Soil application of a systemic insecticide at crop initiation has been a successful practice. To avoid the development of resistance in the SLWF to this insecticide, it is recommended that applications be made to the earliest “at risk” plantings using the lowest labelled rate. Fields should be scouted to determine the need for additional applications, using a different active ingredients, preferably an insect growth regulator or other selective material.

**Western Flower Thrips (WFT), Frankliniella occidentalis.** Adults are tiny (1/16 inch) slender, dark yellow insects with brown, hair-fringed wings. They are most often located in flowers, but also occur in terminal buds and, occasionally, on leaves. The egg is inserted in plant tissue, especially flower parts and very small fruit. Larvae, which are yellow and small without wings, inhabit primarily flowers but also inhabit terminal buds and leaves. A prepupal stage resembling the larva does not feed but falls to the ground and pupates in the soil. Generation type varies from 15 to 30 days depending on temperature.

Eggs inserted individually in fruit cause dimples, sometimes surrounded by a white area, especially on the blossom end of the fruit. Heavy dimpling results in cullout and downgrading. The WFT is a vector of tomato spotted wilt virus (TSWV) and is a key pest in north Florida during the spring but is rarely a pest in the fall. Although the WFT has not been a pest of field tomatoes in south Florida, TSWV has occurred sporadically but at low incidence. Since WFT pupae occur in the soil, new plantings of tomatoes should not be planted following, near or adjacent to old, infested plantings.

**Tobacco thrips, Frankliniella fusca.** Adults are dark brown or black and thereby easily distinguished from the WFT. It is an occasional inhabitant of flowers, terminal buds, and leaves. The tobacco thrips also vectors TSWV. Although tomato is not a preferred host, viruliferous adults may migrate into fields from tobacco or peanut, especially in the fall, and transmit TSWV to tomato by probing with their mouth parts. Therefore, tomato should not be planted adjacent to or near these TSWV susceptible crops.

**Other thrips.** Eastern flower thrips (F. tritici), the Florida flower thrips (F. bispinosa) and the melon thrips (Thrips palmi) are some common thrips that resemble WFT and may be numerous in blooms. Eastern flower thrips is most abundant in north Florida but is not a pest of tomato. Florida flower thrips is common throughout the state and may cause bud abscission if present in very high numbers (>5 per flower), but is not a known vector of TSWV. Melon thrips is not known to transmit TSWV and is not a pest of tomato; however, it is a serious pest of many other vegetables such as pepper, eggplant and cucumber.
Vegetable Leafminer (VLM), *Liriomyza sativae, L. trifolii*. The adult is a small fly, approximately 1/8 inch long, with a black head, yellow between the eyes, a black thorax and a tube-like “ovipositor” at the end of the abdomen used to puncture the upper leaf surface for egg laying. The white, oval egg is inserted in the leaf tissue, but many punctures (called stipples) are used by the adult for feeding and do not contain eggs. The larva, a yellow maggot with black, sickle-shaped mouth hooks, feeds between the upper and lower leaf surface for approximately seven days, leaving a serpentine mine containing a string of black frass (fecal matter). The mature larva exits from the mine and falls to the ground (or plastic mulch) where it molts to a pupa within a golden brown, barrel-shaped and ribbed, puparium from which the adult emerges in seven to 14 days. Generation time is 15 to 28 days depending upon temperature.

Leafminers reduce photosynthetic area and may provide entry points for foliar pathogens. Heavily damaged leaves become necrotic, predisposing fruit to sunscald. VLM may be an important pest in south and central Florida but is only an occasional pest in north Florida.

A number of parasitic wasps attack VLM in Florida (see below). Some are larval parasites that attack larvae and complete their development in the leaf miners. Others are larval-pupal parasites that attack larvae but do not complete their development until after VLM pupation occurs. Females of larval parasites sting the VLM larvae and inject a paralyzing venom which causes the hosts to cease feeding. The parasite eggs are deposited either adjacent to or inside of the VLM larvae, depending upon parasite species. Female parasites may also paralyze VLM larvae without depositing an egg. Parasite larvae are solitary and after several days of development may be seen inside or adjacent to their leafminer host by holding the leaflet against a strong light and observing with a hand lens. Larvae pupate within the leafmines and are also readily visible. Females of larval-pupal parasites lay eggs within VLM larvae without paralysing them. The eggs hatch but parasite larval development is arrested until after the VLM larvae pupate. The larvae complete their development within the VLM pupae and pupate within the VLM puparia. As a result, parasitism due to larval-pupal parasites is difficult to assess without collecting VLM puparia and holding them in the laboratory for leafminer and parasite emergence.

Parasitism may provide high levels of mortality, especially late in the season. Therefore, insecticides with low or no toxicity to leafminer parasites should be selected for controlling leafminers and other pests. Insecticides applied for leafminer control should target small larvae for best results.

Tomato Pinworm (TPW), *Keiferia lycopersicella*. The adult is a small gray moth (wing span about 1/2 inch) which is most active at dusk. The female emits an odor, or pheromone, which attracts males from long distances downwind for mating. Eggs are pale yellow to orange and are usually deposited singly or in groups of two to three on lower surfaces of foliage. Larvae are purplish-gray, 3/8 inch long at maturity, and found inside blotch mines, leaf folds or fruit, usually around the stem attachment. The pupa is formed in a silken cocoon covered with sand particles near the soil surface or on the plastic mulch surface. Total generation time varies from 28 to 67 days depending on temperature.

Heavy feeding on foliage may cause defoliation, but damage to fruit is usually the worst consequence of TPW infestations. Damaged fruits are contaminated with insect parts, silk and frass, and may rot from introduction of pathogens. The TPW is an important pest in the spring in south and central Florida and summer or late fall in North Florida, especially after populations have built up over the preceding season. Initiating a crop with clean transplants is an important first step in TPW management. Known host plants are limited to tomato, eggplant and potato, so new plantings should be separated as much as possible from previous plantings of these crops. Field sanitation and timely destruction of abandoned fields are important to reduce populations in summer. Mating disruption by application of commercially available pheromone preparations is preferred over insecticidal control in order to conserve parasites and predators of TPW.

*Armyworms, Spodoptera spp.* Armyworm adults are moths marked variously with white, grey and brown and have wingspans between one and 1 ½...
inches. They are active at night depositing eggs on the undersides of leaves in hair-covered masses of 50-200. Hatching larvae are gregarious, feeding together on the underside of foliage, initially scraping away all leaf tissue except the transparent epidermis thus giving a "windowpane" effect. Armyworm larvae are caterpillars that are variously marked in brown, grey, green and black, with five sets of prolegs and head sutures forming an inverted "Y" (as opposed to an inverted "V"). Larvae grow to a maximum size of two to three inches and feed primarily on foliage but will attack fruit structures when they are encountered. Mature larva drop to the ground and pupate in the soil, often in the soil holding the plastic mulch in place.

Southern armyworm (SAW), *S. eridania*. The adult is relatively large (1 ½ inch wingspan) with the front wing streaked with cream, grey, light brown and black and the hindwing white with some dark on the margins. Eggs are laid on the undersides of leaves in large masses of 100 to 200, covered with a felt-lime mat of body hair, which hatch in about three to four days. Larvae are dark caterpillars, two yellowish lateral lines interrupted by a large dark spot on the first abdominal segment. Large larvae have two rows of dark triangles on the dorsal surface. The generation time is 29 to 35 days. SAW is the most common armyworm pest of tomato in south and central Florida but is only an occasional pest in north Florida.

Beet armyworm (BAW), *Spodoptera exigua*. The adult is smaller than SAW, (wingspan one inch) with the front wing light brownish grey with indistinct lines and the hindwing white. Egg masses are also smaller than SAW, numbering usually 50 to 75 eggs but are otherwise similar. Larvae are generally green, mottled with white spots, one to 1¼ inch long at maturity and often with a small black spot above the second pair of true legs. Generation time 25 to 35 days. Tomato is not a preferred host for BAW but the insect may occasionally reach damaging levels anywhere in the state. The BAW is more difficult to control than the SAW.

Yellowstriped armyworm (YAW), *Spodoptera ornithogalli*. The adults and eggs are similar to the SAW. YAW larvae have dark heads and dark lateral marks bisected by a thin, white line on each segment behind the true legs. The YAW is a serious pest in north Florida during the fall but is rarely present in south and central Florida.

True bugs (Hemiptera). True bugs are sucking insects with only three lifestages (egg, nymph and adult). Adults are characterized by the leathery basal portion of the forewing. Nymphs resemble adults in shape but are often colored differently and do not have fully developed wings. Stinkbugs (Pentatomidae) are green or brown shield-shaped bugs ½ to two-thirds inch long. Eggs are barrel-shaped and found on undersides of leaves in masses of 10 to 50. Nymphs are similar in shape to adults, but more brightly colored and patterned. Leaffooted bugs (Coreidae) are dark-colored true bugs with parallel sides. Three species attack tomato in Florida, two of which have flattened hind tibia (lower leg). Eggs are metallic and ovate but somewhat flattened laterally and laid in clusters. Nymphs are oblong in shape and colored red, especially on the abdomen. Both stinkbugs and leaffooted bugs emit a strong odor when disturbed.

Nymphs and adults of both stinkbugs and leaffooted bugs suck juices from green fruit leaving a puncture which later may become surrounded by a discolored zone due to invasion of secondary pathogens. Stinkbug feeding punctures are often surrounded with a lightened, sometimes depressed blotch beneath the fruit surface. Leaffooted punctures may cause fruit to become distorted as they enlarge. True bugs are occasional pests throughout Florida.

Beneficial insects. Parasitic wasps generally kill their host in order to complete development to the adult stage. Adults may act as predators too by feeding on hemolymph (blood) from wounds made with the ovipositor (egg laying "stinger") of unused hosts (host feeding). The wasps are small to minute with two pairs of usually transparent wings. Eggs are elongate, and often laid through a needle-like ovipositor into or near the insect host. Larvae are tiny and maggot-like, developing within or adjacent to their insect hosts which may include any pest species. Braconids are small wasps with antlike heads, relatively long antennae with many segments and forewings with at least one complete vein. The
small black wasp *Opius* lays its eggs inside leafminer larvae. The larva develops in leafminer larva but does not complete its development until after pupation of the leafminer host. Chalcids are small to tiny wasps with elbowed antennae of 12 or fewer segments and only one incomplete vein in the forewings. *Diglyphus* spp., *Neochrysocharis* spp., *Oenonogastra* spp. and *Halticoptera* spp. are small black or metallic chalcid wasps that lay their eggs in or on leafminer larvae. *Encarsia* spp. *Eretmoceros* spp. (Aphelinidae) are tiny, yellowish parasites of whiteflies with elbowed antennae and clear wings with only one small vein off the anterior margin. As many hosts may be killed by adult host feeding as by larval feeding. The microscopic egg is laid into (*Encarsia*) or below (*Eretmoceros*) whitefly nymph. The wasp larva is a microscopic, legless grub feeding inside a whitefly nymph. The pupa can be seen inside the whitefly pupal case with the red eyes and body outline usually visible. An orange to brown deposit ("meconium"), defecated by the pupating larva, can be seen adjacent to the abdomen of *Encarsia* pupa. Predators consume numerous prey throughout their lifetime. The minute pirate bug, *Orius* spp. (Hemiptera), are small (5/64 inch), black with white wing bases and wing tips. They feed on insect eggs, whiteflies, thrips and mites. Adult green lacewings are about 3/4 inch long with delicate lace-like wings and shining golden eyes. Eggs are laid singly on silken stalks which project 1/2 inch above the surfaces of leaves or stems to which they are attached. Larvae are elongate, spindle-shaped ("alligator-like") with long sickle-like mandibles and feed on aphids, insect eggs and small caterpillars. Ladybird beetles are 1/16 to 1/4 inch long and semi-hemispherical. The hard forewings are colored tan, black or red, and spotted or marked with contrasting colors of red, black, yellow or white. Yellow eggs are elongate and laid on end in clusters. Larvae are elongate, tapering posteriorly, generally dark with bright markings and covered with spines. Pupae are found on foliage, wrapped in the last larval exuvia (skin). Adults and larvae feed on insect eggs, aphids, mites and small caterpillars. Spiders are noninsect arthropods with four pairs of legs and no antennae. The body is divided into two sections joined by a slender stalk. All are predaceous on a wide variety of insects.