Accidental introduction of new insect pests is a major factor changing pest management in Florida agriculture, pepper not excluded. The pepper weevil (*Anthonomus eugenii*) has been an important pest since the mid-1930s and is considered the key pest in the south and south-central production areas. Melon thrips (*Thrips palmi*) is a more recent introduction, which has been extending its range north and west since first detected in southern Dade county in December 1992. This pest can become a limiting factor in pepper production in southern Florida. Broad mite (*Polyphagotarsonemus latus*) was not mentioned in the 1988 pepper production guide, but can also cause notable losses in yield and quality. Management strategies have also changed in recent years, including a shift to more general use of selective insecticides such as *Bacillus thuringiensis* to control armyworms (*Spodoptera* spp.). The importance of cultural controls such as crop rotation to reduce pest pressure, and regular scouting to provide current information on pest incidence as a basis for management decisions are emphasized. Not only do these practices make economic sense in and of themselves, they reduce the use of broad-spectrum insecticides, thereby favoring the pest-reducing activities of beneficial insects. Below are short descriptions of the major pests of pepper in Florida, as well as some beneficial insects, and also some management guidelines.

### Major Pests, Beneficial Insects, and Management Guidelines

**Pepper weevil (PW), *Anthonomus eugenii***

The adult is a small (1/6 inch) black or grey beetle with a long snout (proboscis) and elbowed antennae. Adults use the mandibles at the end of the proboscis to feed on leaf or flower buds. Females also use the mandibles to bore a small hole in developing fruit or flower buds. The hole is plugged with fecal matter (frass) after an egg is deposited. A tiny legless grub hatches from the egg and eats its way toward the seed core of the fruit where it feeds on seeds and pulp, passing through larval growth stages or instars. Damaged fruit become contaminated by insect parts, frass and rotted tissue, and will eventually fall from the plant. Pupation takes place inside the fruit within a small cell created by larval feeding. The emerging adult may feed within the fruit for awhile before escaping through a circular hole chewed in the wall of the fruit.

Black nightshade can serve as a secondary host to maintain small numbers of pepper weevil during...
fallow periods. Since development times decrease as temperature increases and since adults will migrate readily from old fields to new plantings, populations generally build up during the season so that populations are greatest in later spring plantings. Since adults tend to move to lower, more protected and less visible plant parts as temperatures increase, scouting efforts should concentrate on a search for adults in leaf whorls, flowers and fruit during morning hours. Commercially available pheromone traps may also aid in early detection. Fruit and flower buds should be examined for damage and fallen fruit and buds examined for presence of larvae. If possible, all damaged and fallen fruit should be removed and destroyed. Adjacent or nearby sequential plantings should be avoided. Crops should be deep-plowed immediately following harvest and after treating with insecticide to reduce adult movement into nearby fields and to reduce survival over the summer. Nightshade in and around fields should be controlled to reduce population survival between crops. Chemical control is difficult because all stages but the adult are protected within the fruit, so that only the adult weevil is vulnerable to insecticides. Frequent sprays may be necessary starting in the initial stages of infestation in order to avoid unacceptable levels of damage.

**Armyworms, Spodoptera spp.** Adults are white, grey and brown, with wingspans between 1 - 1½ inches, and are active at night. Eggs are laid in masses of 50 to 200 on the undersides of leaves and are usually covered with hairy scales. Hatching larvae, or caterpillars, feed gregariously on the underside of foliage, initially scraping away all leaf tissue except the transparent epidermis giving a "windowpane" effect. Caterpillars 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 2 to 3 inches and feed primarily on foliage and fruiting structures. Mature larvae drop to the ground and pupate in the soil.

**Beet armyworm (BAW), Spodoptera exigua.** The adult is relatively small for an armyworm with a wingspan of 1 inch. The front wing is streaked with cream, grey, light brown and black and the hind wing is white with some dark on margins. Eggs are laid in large masses of 100 to 200 or more and hatch in about three to four days. Larvae are dark caterpillars, 2 inches long at maturity, with a yellowish brown head and a yellowish line along each side interrupted by a large dark spot on first abdominal segment. Larvae have two rows of dark triangles on dorsal surfaces. The larval stage lasts 14 to 21 days and the pupal stage seven to ten days (generation time 29 to 35 days). Young larvae feed on the lower leaf surface of leaflets leaving "windowpanes" and older larvae consume foliage and eat large holes in fruit. The BAW is common in south and central Florida but is only an occasional pest in north Florida. Although the BAW is generally more susceptible to broad spectrum insecticides than the BAW, rapid migration and large egg masses can make adequate control difficult.

**Yellowstriped armyworm (YAW), S. ornithogalli.** The adult, eggs, generation time, and damage are similar to SAW. Larvae are similar to SAW, except that the head is dark and the lateral marks on each segment behind the true legs are bisected by a thin white line. The YAW is a common pest only in north Florida. Many insecticides are efficacious against YAW, including selective insecticides such as *Bacillus thuringiensis.*
**Melon thrips, Thrips palmi.** Adults are tiny (1.5 millimeter) slender, dark yellow insects with brown-lined wings. They may first appear in flowers but may also occur on foliage, especially on the undersides of young leaves. Many similar species inhabit flowers, so identification requires a microscope. The egg is inserted in plant tissue, especially flower parts and very small fruit. Larvae, which are yellow and small without wings, inhabit flowers, fruit (especially under the calyx) and foliage, congregating where veins converge. Such congregations clearly denote melon thrips. A prepupal stage resembling the larva does not feed but falls to the ground and pupates in the soil or in leaf litter. Generation type varies from 15 to 30 days, depending on temperature.

Fruit scaring emanates from the stem end following crevices between locule lobes. Foliar damage may also be severe. Adults are quite mobile and can move into new plantings quickly from old fields. Therefore, old fields should be destroyed as soon as possible after the last harvest and new fields should not be planted adjacent to or near old fields. In addition to infestations of pepper, melon thrips can easily increase on successive plantings of eggplant, cucumber, potato, beans, and watermelon which are also susceptible to damage from this pest. Tomato is a nonsusceptible alternative that can be used to separate such crops in time and space. Most conventional insecticides seem to stimulate melon thrips populations, possibly by eliminating predators that otherwise control them. Therefore, broad-spectrum insecticides should be avoided as much as possible in preference to selective materials when available.

**Western Flower Thrips (WFT), Frankliniella occidentalis.** The WFT has been an occasional pest of pepper in the east coast and northern production areas. They are similar to melon thrips in appearance but less likely to inhabit foliage. The egg is inserted in plant tissue, especially flower parts and very small fruit. At high densities, WFT causes flower abortion and poor fruit set. The WFT is also a vector of tomato spotted wilt virus which has a broad host range including pepper.

**Aphids, (Aphididae).** Aphids are soft-bodied, sucking insects that can rapidly colonize plants due to short generation time and efficient dispersal ability. Adults are delicate, pear- or spindle-shaped insects with a posterior pair of tubes (cornicles), which project upward and backward from the dorsal surface of the abdomen and which are used for excreting a defensive fluid. Winged and nonwinged forms are all female and give birth to living young (nymphs). Nymphs are smaller but otherwise similar in appearance to wingless adults which they become in 7 to 10 days.

The green peach aphid, *Myzus persicae*, is the most common aphid species in Florida peppers. Adults vary from .04 to .08 inch in length and are light green to yellow to pink and pear-shaped. The tubercles (bumps between antennae) point inward and are a distinguishing characteristic. Winged forms have a black patch on the back of the abdomen.

Heavy aphid infestations may result in plant debilitation, sooty mold growth on honeydew and leaf distortion. Aphids also spread plant viruses such as tobacco etch and pepper mottle. Acquisition and transmission of these viruses is rapid but the virus does not persist in the aphid for more than several minutes. Most transmission results from winged aphids probing, rejecting, flying to another plant and probing again, rather than by feeding by colonizing aphids. Conventional insecticides are of little help in controlling these nonpersistent aphid-borne viruses, and may even increase the rate of spread by increasing aphid movement. Sources of infection are nearby infested fields of tomato, tobacco or other host plants. Related weeds such as nightshade may also supply inoculum. Frequent (one per week) sprays of an approved mineral oil, if initiated early enough in the infection cycle, may provide protection by interfering with probing behavior.

**Broad mite, Polyphagotarsonemus latus.** Adults are tiny, white, eight-legged mites and are usually most numerous on the underside of young, emergent foliage. Males can sometimes be seen carrying females "piggyback". Nymphs are similar though somewhat smaller than adults. Eggs are about ¼ the size of adults, round with white, opalescent spots and glued to the plant surface. Generation time may be as short as eight days, depending on temperature.
Broad mite feeding distorts plant tissue, causing leaves to become thickened and narrow, giving them a "strappy" appearance. Heavy feeding causes flower abortion and dark, smooth russetting of fruit. Infestations are often spotty, but may become more generalized, especially in late fall. Chemical control is not difficult but should be timely. Heavy infestation may require two applications five days apart to allow time for eggs to hatch. Specific acaricides are usually recommended over broad-spectrum acaricide/insecticides to better conserve beneficial insects.

**Vegetable Leafminer (VLM), Liriomyza sativae, L. trifolii.** Leafminers are generally not serious pests of pepper in Florida, although damaging populations have been seen in south Florida. The adult is a small fly, approximately 3/32 inch long, with a black head, yellow between the eyes and black thorax. Females have 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 black string of frass (fecal matter). The mature larva exits from the mine and falls to the ground (or plastic mulch) where it pupates within a golden brown, barrel-shaped and ribbed, puparium from which the adult emerges in 7 to 14 days.

Serentine mines in leaves reduce photosynthetic area and may provide entry points for foliar pathogens. Heavily damaged leaves become necrotic, predisposing fruit to sunscald. A number of parasitic wasps attack VLM in Florida and may be responsible for the low levels of infestation generally seen. Wasp larvae develop on or in the leafminer larva or pupa, and pupation occurs in or near host remains. The wasp stings the host and injects a paralyzing venom causing the host to cease feeding. Larvae are solitary and, after several days of development -- by use of a hand lens against strong light -- may be seen inside or adjacent to their leafminer host.

**Beneficial insects.** Parasitic wasps (Hymenoptera: Braconidae and Chalcidoidea) generally kill their host in order to complete development to the adult. Adults may act as predators too by feeding on hemolymph (blood) from wounds made with the ovipositor (egg laying "stinger") of unused hosts. The wasps are small to minute with elongate bodies usually light brown to black or metallic, and 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 inside or feeding on their insect hosts which may include any pest species. *Lysiphlebus* is a small wasp with an ant-like head, relatively long antennae with many segments and a forewing with one complete cell. They attack aphids, laying their eggs inside the host and converting it to a bloated brownish "mummy" from which the adult emerges through a round hole in the abdomen.

Predators consume numerous prey through their lifetime. Minute pirate bugs (*Orius* spp.) are small (5/64 inch) and black with white wing bases and wing tips. They feed on insect eggs, 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 ½ 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 hardened forewings are colored tan, black or red and spotted or marked with contrasting colors of red, black, yellow or white. Eggs are elongate, yellow 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 no antennae, four pairs of legs and a body divided into two sections joined by a slender stalk. All are predaceous on a wide variety of insects.