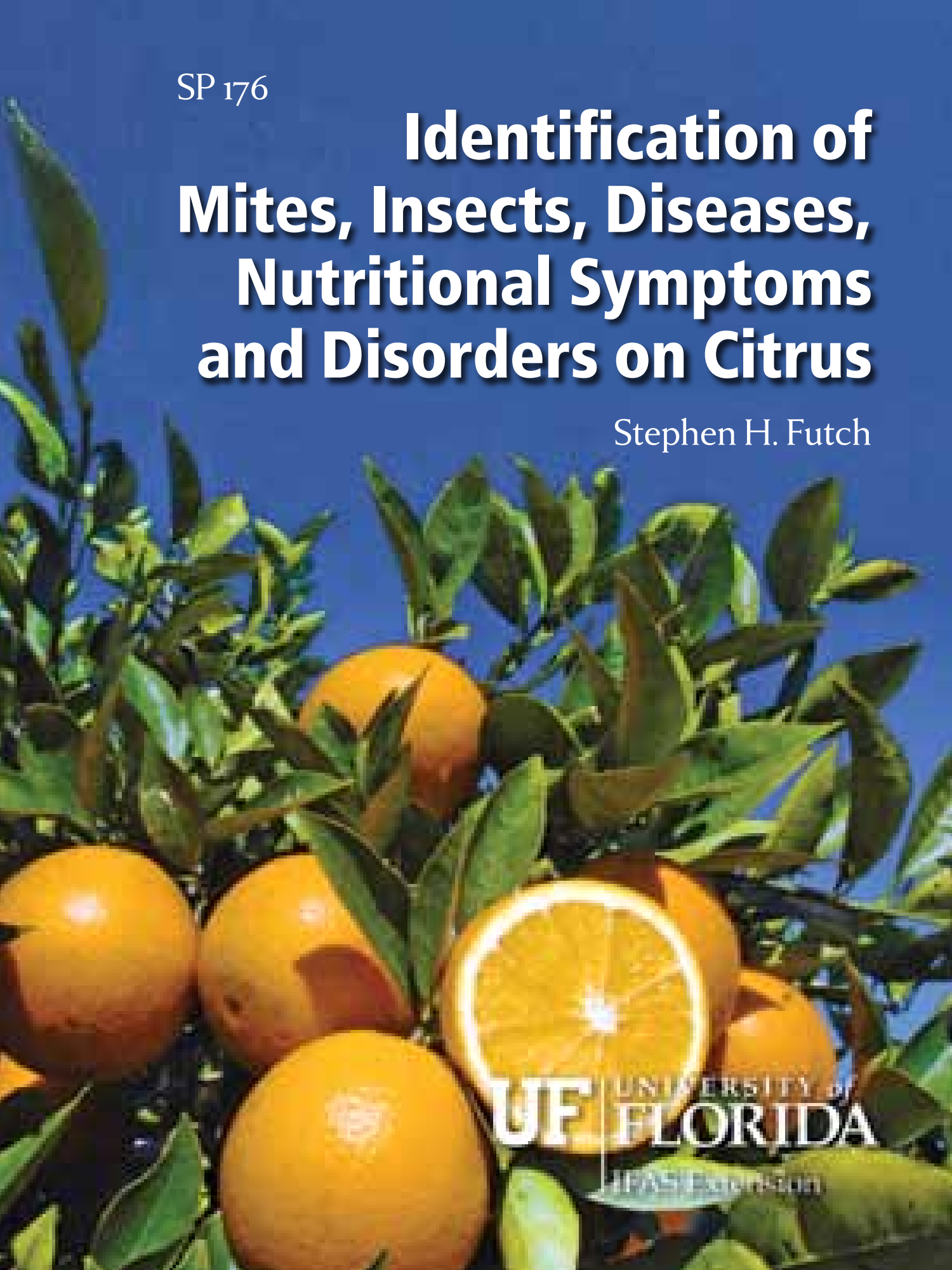
SP 176

Identification of Mites, Insects, Diseases, Nutritional Symptoms and Disorders on Citrus

Stephen H. Futch



Credits

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Drs. L.G. Albrigo, Ron Brlansky, Harold Browning, Carl Childers, Stephen Futch, Joe Knapp, Richard Lee, Clay McCoy, Megh Singh, Pete Timmer, David Tucker, Mongi Zekri, Ms. Terri Zito, Florida Department of Agriculture and Consumer Services, Florida Citrus Integrated Pest Management Handbook.

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This booklet is designed to assist in identifying the various mites, insects, diseases, nutritional symptoms and disorders that can occur in Florida citrus.

The following sources offer additional information on problems of Florida citrus:

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Citrus Rust Mite

Phyllocoptruta oleivora

The citrus rust mite (CRM) damages twigs, leaves, and fruit using piercing-sucking mouthparts. The adult body is elongated and wedge-shaped. Magnification is required to see CRM, as the adult is about 0.13 mm long. Color ranges from light yellow to straw. CRM can be found anytime during the year with peak populations occurring during June and July. CRM are suppressed biologically by the parasitic fungus *Hirsutella thompsonii* and various insect and mite predators.

Citrus Rust Mite-Damaged Fruit

Extensive CRM feeding on the fruit surface will result in surface blemishes that can lower the external grade of fresh fruit, reduce fruit size, and increase fruit drop. The CRM does not like full sun and will avoid it. The degree of damage to the fruit will depend on its population density and duration of feeding.

Citrus Rust Mite (CRM)

CRM-Damaged Fruit

Citrus Red Mite

Panonychus citri

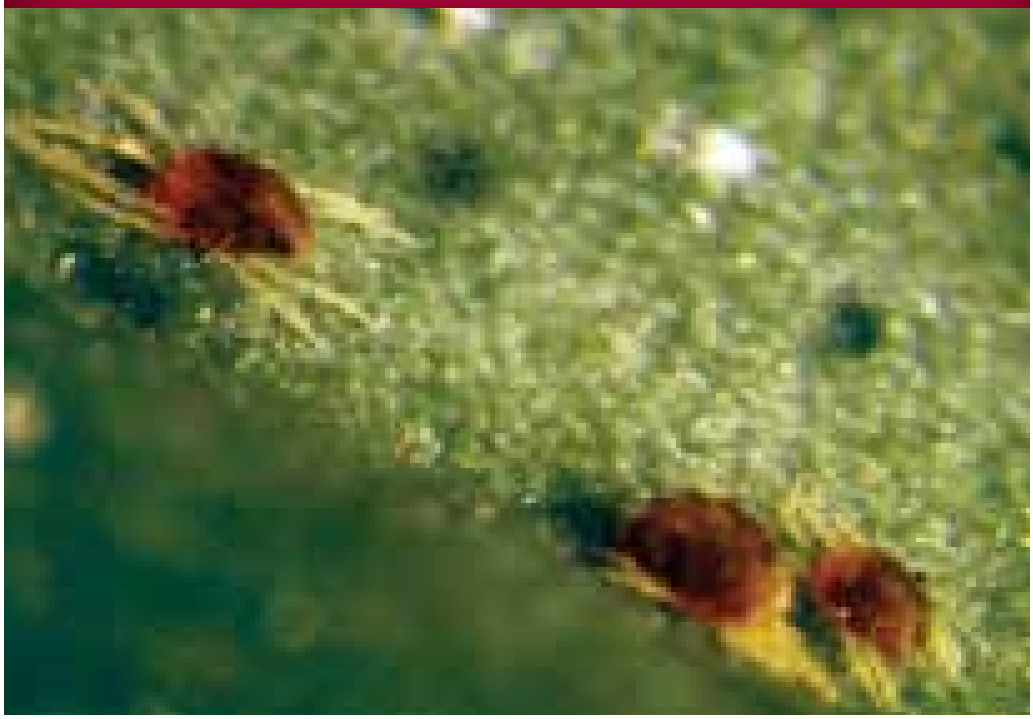
The mite is red in color. The female is oval and about 0.5 mm long. The adult male has a tapering abdomen and is smaller than the female. The round, red eggs are slightly flattened at the base with a vertical stalk projecting upward, often with webbing between the stalk and leaf surface.

Citrus Red Mite Leaf Damage

Citrus red mites feed on leaves, green twigs, and fruit using piercing-sucking mouthparts. Visible injury is characterized by light-colored, scratched (etched) areas that give the upper leaf surface a silvery appearance. Mite feeding and environmental stress can lead to mesophyll collapse and firing when extensive feeding occurs on the lower leaf surface. Fruit and twig damage are rarely seen.

Citrus Red Mite

Citrus Red Mite Leaf Damage



Texas Citrus Mite

Eutetranychus banksi

Mature mites are about 0.4 mm long. Males are more slender than females and are tan to brownish green with dark green to black spots on the upper side of body. Females are broadly oval and somewhat flattened. The adult mite has eight easily visible legs. The egg is flat and disc-shaped with a pronounced rim. Color varies from yellow to green prior to hatching.

Colony of Texas Citrus Mites

This mite prefers the upper leaf surface, with eggs being deposited along the midrib and lateral veins. Infestations can occur year-round, with highest numbers in spring and/or fall. Injury is nearly identical to damage caused by the citrus red mite.

Texas Citrus Mite

Colony of Texas Citrus Mites

Six-Spotted Mite

Eotetranychus sexmaculatus

The adult is pale yellow and 0.35 mm long. It has 1 to 3 pairs of dark spots on the upper surface of the body, and is slightly smaller than either the citrus red mite or the Texas citrus mite. It is found mostly along the midrib of the lower leaf surface. Eggs are round and light yellow in color, with a short stalk or mast on the upper surface.

Six-Spotted Mite Damage to Leaves

Colonies feed along the petiole and midvein of the lower leaf surface mainly during March and April. A distinct depression usually forms on the lower leaf surface where colonies of this mite occur. Raised yellow areas develop on the upper leaf surface immediately opposite the sites of lower leaf feeding. Heavy mite infestation causes the leaves to curl, become twisted, and eventually turn bright yellow.

Six-Spotted Mite

Six-Spotted Mite Damage to Leaves

Purple Scale

Lepidosaphes beckii

The armor of the adult female is 2 to 3 mm long, purple to dark brown, elongated, and usually curved. The armor of the male is much shorter and more slender. The eggs are found under the covering of the scale. After hatching, the crawlers are pearl-white and less than 0.25 mm long. Infestations may occur at any time, but are usually highest during May. Purple scale prefer a dense canopy area of the tree and are found on leaves, twigs, and fruit. Chemical sprays for the control of purple scale are generally not required, as in most cases it is biologically controlled by a parasitic wasp, *Aphytis lepidosaphes*.

Fern Scale

Pinnaspis aspidistrae

Scale bodies are white, elongated, and about 1.5 to 2.25 mm long. They are found on leaves and small twigs and not on large limbs and trunks.

Purple Scale

Fern Scale

Citrus Snow Scale (Male and Female)

Unaspis citri

The adult female is 1.5 to 2.25 mm long. The female armor is shaped like an oyster shell, with a central longitudinal ridge. It is brownish purple to black, with a gray border. The immature male armor is white, with parallel sides and three longitudinal sections, one central with two marginal ridges. The adult male is winged and light yellow. The crawlers are oblong and light orange to reddish in color.

Citrus Snow Scale on Tree Trunk

Citrus snow scales primarily attack the trunk and large limbs of the tree but can be found on leaves, twigs, and fruit under high population levels. All stages of development are present through most of the year.

Citrus Snow Scale (Male and Female)

Citrus Snow Scale on Tree Trunk

Florida Red Scale

Chrysomphalus aonidum

Florida red scale's circular armor is made up of three concentric rings. The color is dark reddish brown with a conspicuous light brown center. The adult female is about 2.0 to 2.2 mm in diameter. The adult male is small, gnatlike, and free-flying. Red scale attacks leaves, green twigs, and fruit.

It is usually under biological control by the small wasp, *Aphytis holoxanthus*.

Caribbean Black Scale

Saissetia neglecta

The female is 3 to 5 mm long and brown to black. It has a very tough shell that is nearly circular or hemispherical in shape. Ridges along the outer scale body form an "H." Adult males are free-flying. Crawlers are about 0.34 mm long and are light brown. Scales are found on young stems. They secrete large amounts of honeydew, and the adjoining foliage becomes heavily coated with sooty mold.

Florida Red Scale

Caribbean Black Scale

Soft Brown Scale

Coccus hesperidum

The scale body is flat and oval, light brown with brown stippling, and 2.5 to 4 mm long. This scale gives birth to pale yellow crawlers. They secrete large amounts of honeydew and the adjoining foliage becomes heavily coated with sooty mold.

This scale is heavily parasitized and is rarely a major problem.

Florida Wax Scale

Ceroplastes floridensis

The adult female is covered with a thick layer of soft wax. The scale is highly convex, somewhat angular, and oval. The color is white, sometimes with a pinkish cast, becoming dirty white with age. Young scales have a similar wax covering. Large amounts of honeydew are secreted by the scales.

Soft Brown Scale

Florida Wax Scale

Cottony Cushion Scale

Icerya purchasi

The scale is broadly oval and bright reddish brown. The body is covered by waxy secretions and has a white fluted egg sac of cottony appearance attached to the posterior. Total length, including egg sac, is 10 to 15 mm.

Populations are highest in drier months, generally during spring and/or fall. Natural mortality of the young scales and predatory and parasitic control are usually adequate for control.

Chaff Scale

Parlatoria pergandii

The scale covering is irregularly rounded to oblong. The color is brownish to grayish. The body of the female, the eggs, and the crawlers are purple. Chaff scale is found on bark and leaves and can infest fruit. When fruit is infested, the areas around the scale will remain green as the fruit matures.

Cottony Cushion Scale

Chaff Scale

Ortezia Scale*

Orthezia praelonga

The mature female is slightly flattened, oval-shaped, 2 mm long and 1.25 mm wide and gray. Eggs are 0.4 x 0.2 mm, white and change to green prior to hatching. Adult males have a single pair of wings and are free flying. The cycle from egg to adult is approximately 47 days and adults can live up to 5 months.

Both males and females are found in the more shaded part of the tree, usually on the tree trunk. The scales result in the production of copious amounts of sooty mold and subsequent tree decline if not controlled. The initial infestation is usually isolated on a single plant. The scale can be spread from tree to tree by worker movement or by wind.

Ortezia is known to have numerous other host plants, including various weed species, thus inspection of nearby vegetation is essential when controlling this pest.

*Not present in Florida as of 2011.

Ortezia Scale

Aphid Injury to Foliage

Injury to citrus foliage can result from aphids feeding on young, tender leaves. Feeding by the aphids causes the leaves to be reduced in size, curled, and twisted. This distortion is permanent.

Secretion of honeydew by aphids results in adjoining foliage becoming covered with sooty mold.

Spirea or Green Citrus Aphid

Aphis citricola

The spirea aphid is green and about 1.8 mm long. Winged forms have a pale pink to dark brown thorax with a green abdomen.

Aphids injure young, tender growth, causing leaves to curl. Inspect for these insects at frequent intervals when new growth starts, especially during spring months.

Aphid Injury to Foliage

Spirea or Green Citrus Aphid

Melon Aphid

Aphis gossypii

The smallest of the aphids that infest citrus, averaging about 1.5 mm long. It is dark gray or dull black while on citrus, but its color will vary with hosts.

Leaves damaged by melon aphid become cupped, curved, and distorted, but are not tightly curled.

Brown Citrus Aphid

Toxoptera citricida

This aphid is 1.8 to 2.5 mm long and dark brown to black in color. It prefers to feed on tender new citrus growth, causing the young leaves and stems to curl and die prematurely. Large populations will be found on green stems and along the leaf midrib.

This aphid can effectively transmit citrus tristeza virus (CTV).

Melon Aphid

Brown Citrus Aphid

Citrus Mealybug

Planococcus citri

The soft oval body of a mealybug is 3 mm long and is ringed by lateral waxy filaments and longer tail-like filaments at the posterior end. Eggs are laid in a white cottony mass behind the female. Newly hatched nymphs are light yellow and free of wax.

Citrus Mealybug between Fruit

Mealybugs produce large amounts of honeydew, resulting in sooty mold. Mealybugs like protected areas in the tree, such as under the calyx of the fruit, between fruit that touch, or under leaves which rest against the fruit. Heavy infestations can reduce tree vitality, cause leaf defoliation when the mealybugs feed on leaves and twigs, distort fruit, and cause fruit drop.

Citrus Mealybug

Citrus Mealybug between Fruit

Citrus Whitefly

Dialeurodes citri

Whitefly adults, both male and female, are small, 1.2 mm long winged insects that resemble tiny moths. Whitefly eggs are laid on the underside of the leaf and are nearly smooth and pale yellow. Upon hatching, the nymphs are oval, thin and translucent.

Peak populations occur in June through July and September through October. They produce large amounts of honeydew, on which sooty mold fungi develop. The sooty mold fungi may retard photosynthesis, thereby reducing the tree's ability to produce carbohydrates. Whiteflies are suppressed biologically by the parasitic fungus *Aschersonia aleyrodes*.

Citrus Whitefly (Adult)

Citrus Whitefly (Pupae)

Citrus Blackfly

Aleurocanthus woglumi

Blackfly adults are small, four-winged, black insects that are 1.2 mm long. The eggs are laid in spiral patterns on the underside of leaves. The eggs are oval and creamy white, gradually changing to brown. The nymphs and pupae are oval, black, and covered with spines.

Citrus blackflies produce large amounts of honeydew, on which sooty mold fungi develop. Heavy infestations can cause rapid deterioration of trees and reduced future crops.

Biological control by the parasites *Encarsia opulenta* and *Amitus hesperidum* is effective against this pest.

Citrus Blackfly (Immature)

Citrus Blackfly (Adults and Eggs)

Citrus Leafminer

Phyllocnistis citrella

Adults are minute moths (4 mm wingspread) with white and silvery iridescent scales on the forewings and several black and tan markings, plus a black spot on each wingtip.

Eggs are laid individually on the underside or upper surface of leaves or green twigs.

Upon entering the leaf, the larva begins to feed, producing a serpentine larval mine. Larvae are minute (up to 3 mm long), translucent greenish yellow, and located inside the leaf mine. Leaf mines can be present on both the upper and lower leaf surfaces. Adults emerge about dawn and are active in the morning, late afternoon, and at night. Females lay eggs in the evening and at night.

Damage includes the mining of the leaf and fruit, resulting in leaf drop and stem dieback.

Citrus Leafminer (Fruit)

Citrus Leafminer (Foliage)

Asian Citrus Psyllid (Adult)

Diaphorina citri

The adult Asian citrus psyllid is 3 to 4 mm long with a brown mottled body and wings. A brown band extends around the periphery of the outer half of the wing. The adult female lays its eggs on tips of growing shoots or between unfurling leaves. During her several-month life span, she may lay up to 800 eggs, which will develop in 15 to 47 days, depending upon the season.

Citrus psyllid is a major vector of citrus greening or Huanglongbing disease worldwide.

Asian Citrus Psyllid (Nymph)

Diaphorina citri

The nymphs are 0.25 mm long in the first instar and 1.5 to 1.7 mm in the last or fifth instar. They are yellowish orange, with large wing pads. The eggs are approximately 0.3 mm long, elongated, and almond-shaped.

When larvae feed on the foliage, they withdraw large quantities of sap, causing leaf distortion.

Asian Citrus Psyllid (Adult)

Asian Citrus Psyllid (Nymph)

Mediterranean Fruit Fly

Ceratitis capitata

The Mediterranean fruit fly (medfly) has a yellowish body with white, brown and black accents, two white bands on the abdomen, and black spots visible on the thorax. It averages 3.5 to 5 mm long.

The female medfly lays 2 to 30 eggs inside mature fruit. The eggs hatch, and the larvae begin feeding on fruit tissue, causing fruit drop.

Medfly has a wide host range. Eradication of localized infestations with a combination of bait sprays and sterile male releases has been very successful.

Caribbean Fruit Fly

Anastrepha suspensa

The Caribbean fruit fly has a wide host range in Florida and the Caribbean region. The adult is approximately 12 to 15 mm in length and yellowish brown, with brown bands crossing the abdomen. The transparent wings have dark patterns. The mature female deposits her yellow eggs in the albedo; upon hatching, the larvae move through the fruit.

Mediterranean Fruit Fly

Caribbean Fruit Fly

Oriental Fruit Fly

Dacus dorsalis

The oriental fruit fly is approximately 6 to 8 mm long and is yellow except for dark markings on the thorax. A "T" is formed at the juncture of the median strip and a transverse band on the abdomen.

The oriental fruit fly has a wide host range. The adult lays its eggs in the fruit, where they require about 3 weeks to develop and later pupate in the soil.

Mexican Fruit Fly

Anastrepha ludens

The Mexican fruit fly is about 9 to 11 mm long and generally yellowish brown in color. Longitudinal marking of a somewhat lighter color is found on the thorax. The wings are transparent except for mottled areas and are striped with yellowish brown bands.

The Mexican fruit fly is native to Mexico, and its host range is more restricted than that of the Mediterranean fruit fly. All but acid citrus are attacked, with grapefruit being a favored host.

Oriental Fruit Fly

Mexican Fruit Fly

Greasy Spot on Leaf

Mycosphaerella citri

Infection by greasy spot results in cellular swelling, producing a blister formation on the lower leaf surface. A yellow mottle appears at the corresponding point on the upper leaf surface. The swollen tissue starts to collapse and turn brown, and eventually the brown or black symptoms become clearly visible. Heavy infection causes leaf drop to occur in the winter months.

Greasy Spot Rind Blotch

Mycosphaerella citri

Pinpoint black specks occur between the oil glands with infection on grapefruit. When specks coalesce they give rise to a symptom called greasy spot rind blotch or pink pitting. The living cells adjacent to the specks often retain a green color for much longer than normal or when the fruit is degreened by ethylene treatment.

Greasy Spot on Leaf

Greasy Spot Rind Blotch

Scab

Elsinoë fawcettii

Small, pale orange, somewhat circular, elevated spots are the first evidence of the disease. As the leaves develop, the infection forms well-defined, wartlike structures or excrescences on one side of the leaf, often with a conical depression on the opposite side. The crests of the wartlike growths usually become covered with a corky pale tissue. The infected spots may run together, covering large areas of the fruit or leaves. Badly infected leaves become very crinkled, distorted, and stunted.

Fruit that is severely attacked when very small often becomes misshapen.

Scab can be particularly severe on Temples and lemons, and often is troublesome on Murcotts, Minneola tangelos and grapefruit.

Scab Infection on Leaves

Scab Infection on Fruit

Sweet Orange Scab

Elsinoë australis

Sweet orange scab is caused by *Elsinoë australis* which is similar to common citrus scab, *Elsinoë fawcettii*. Sweet orange scab infests young fruit of all sweet oranges and some tangerine varieties, but does not attack leaves. The wartlike lesions are tan to gray and are flatter than citrus scab. Young fruit is susceptible for up to 8 weeks after petal fall. While the spores can be transported in air only a limited distance, the main spread is by rain splash in and between trees.

Sweet orange scab can be controlled by properly timed fungicide applications during the susceptible period from bloom to 8 weeks of age.

Sweet Orange Scab

Melanose on Grapefruit

Diaporthe citri

Lesions are small, raised, superficial dots, pustules, and irregularly shaped spots. They feel like sandpaper when touched. Pustules are larger on grapefruit than on round-orange varieties.

Tear Stain Melanose

Diaporthe citri

The pustules often form a tear-streaking pattern caused by water flowing down the surface and carrying spores. Fruit is not immune to infection until about 12 weeks after petal fall.

Spores of *Diaporthe citri* arise from fruiting structures that develop on twigs that have recently died. The spores are moved to fruit and foliage via rain.

Phomopsis stem-end rot of mature fruit after harvest is also caused by *Diaporthe citri*.

Melanose on Grapefruit

Tear Stain Melanose

Melanose on Leaves

Diaporthe citri

Melanose first appears on the young leaves as minute, dark, circular depressions with yellowish margins. Later they become raised, rough, and brown, and the yellow margins disappear. Leaves infected when very young may become distorted. Young green twigs can be infected.

In most cases, it is not economical to try to control melanose on foliage.

Star Melanose

Star melanose is a term used to describe copper damage to fruit and leaves. Developing lesions become corky and darker than melanose lesions and the shape of the lesion often resembles a star. It is probably unrelated to melanose.

Melanose on Leaves

Star Melanose

Alternaria Brown Spot on Fruit

Alternaria alternata

This fungus attacks fruit, leaves, and young shoots of susceptible varieties. Dancy tangerines and Minneola tangelos are the most severely affected varieties. Varieties like Murcott and Orlando tangelo are less affected.

On fruit, the first symptoms appear as small, slightly depressed, black spots that can cause the young fruit to fall from the tree. Fruit is usually immune to infection after reaching 3 to 4 months of age.

Alternaria Brown Spot on Foliage

Alternaria alternata

On susceptible varieties, only the young leaves and shoots can be infected. When these are infected, the fungus produces brown, necrotic, blighted areas of various sizes, which are usually surrounded by yellow halos on the plant tissue.

Alternaria Brown Spot on Fruit

Alternaria Brown Spot on Foliage

Black Spot

Guignardia citricarpa

Black spot is found on all commercial citrus species except Tahiti lime in many subtropical regions with high summer rainfall. The causal agent is *Guignardia citricarpa* which reproduces on fallen, infected leaves.

Infected fruit is not suitable for fresh market but can be processed. Black spot can cause fruit drop and reduce yields. Symptoms on fruit or leaves appear as small, round, sunken necrotic spots with gray centers and may be surrounded by green tissue or a dark brown ring and yellow halo.

Fruit remain susceptible for 4-5 months after fruit set. Disease pressure is greater on older trees than on young ones.

Fungicide applications must be carefully timed to coincide with infection periods. Frequent sprays (up to 5) during the susceptible period may be required in heavily infested blocks.

Black Spot

Postbloom Fruit Drop (PFD) (Flower)

Colletotrichum acutatum

The disease appears as peach- to brown-colored necrotic spots on the petals of flowers and causes fruit drop and the formation of persistent buttons (calyx).

Damage is most severe on navel and Valencia oranges, but can be found on all varieties of citrus, including lemons and limes.

PFD is highly moisture dependent. Free water and high humidity are needed for infection, but windblown rain and/or rain splash are needed for dispersal of the spores from infected tissues to nearby healthy blooms.

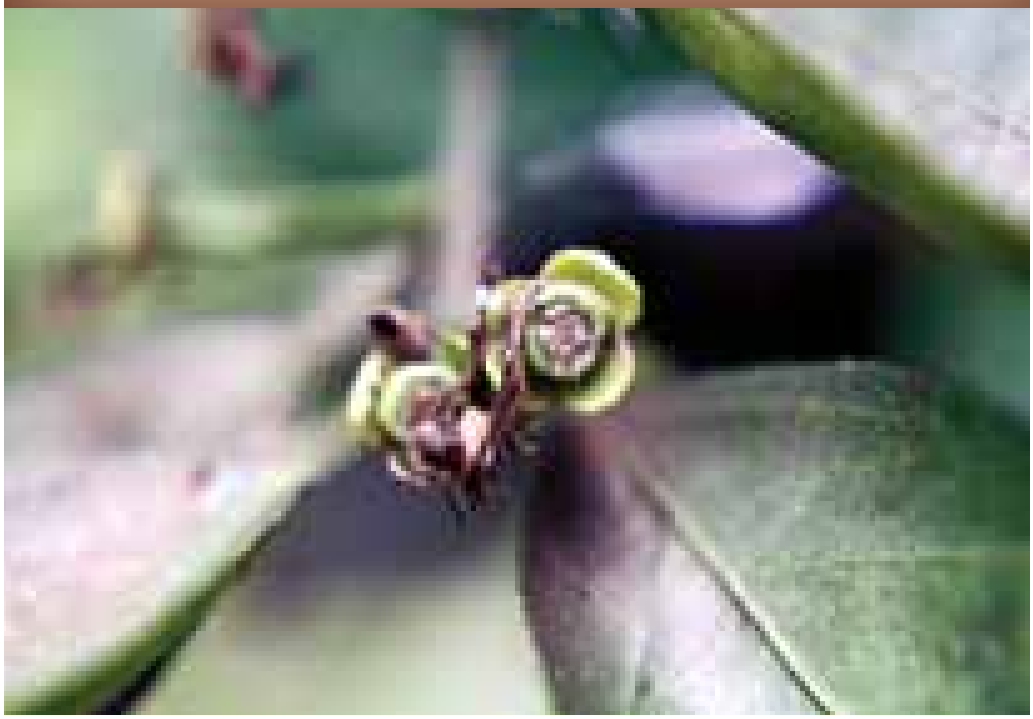
PFD Persistent Buttons

Colletotrichum acutatum

PFD appears to overwinter on the surface of leaves, twigs, and buttons.

Postbloom Fruit Drop (PFD) (Flower)

PFD Persistent Buttons



Asiatic Citrus Canker

Xanthomonas citri subsp. *citri*

Infection by citrus canker can begin as a pinpoint spot on upper or lower leaf surfaces, twigs, and fruit. As the infection ages, it increases in size, forming a raised, somewhat circular lesion on both sides of the leaf, which may be surrounded by a water-soaked area. The infected area may be surrounded by a yellow ring or halo (especially leaves). Additionally, as infected leaf tissue ages, it may fall out of the leaf, leaving a hole or holes in the leaf tissue. Repeated infection cycles reduce density of fruit and leaves, reducing tree productivity over time.

Leaves damaged by citrus leafminer are easily infected by citrus canker, as the wounded tissue allows easy penetration by the bacteria.

Asiatic Citrus Canker (Fruit)

Asiatic Citrus Canker (Leaves)

Blight

The cause of citrus blight is unknown. Tree symptoms include a general tree decline. Leaves are reduced in size, off-color, and in a permanent wilt, and may express zinc deficiency. Leaf flushes may be delayed, and flowering is sporadic. As the disease progresses, leaf density decreases and twig dieback increases due to the tree's inability to conduct water via the xylem. Suckers and sprouts often grow from main branches as the decline progresses. Trees rarely die of blight, but become unproductive. While most rootstocks are susceptible to blight, trees on rough lemon and Carrizo citrange are highly susceptible. Blight is a major problem in the humid tropical and subtropical areas of the world.

Blight

Citrus Variegated Chlorosis (CVC)*

Xylella fastidiosa

CVC is a major decline disease affecting most citrus species with sweet oranges being highly susceptible. While not lethal, severely affected trees become unproductive.

Symptoms include interveinal chlorosis with brown spots on the lower leaf surface and corresponding chlorotic areas on the upper surface. Lesions enlarge, wither and dry with time. Early leaf symptoms may be confused with zinc deficiency. Symptoms may appear on a single branch or the entire tree canopy. Fruit from affected branches are smaller, reducing their value for processing.

The causal agent is *Xylella fastidiosa*, a xylem-limited bacterium. CVC bacterium is graft-transmissible and vectored by various sharpshooter species. Control measures include insecticide applications for the vector, removal of infected young trees, and pruning to remove infected branches on mature trees.

*Not present in Florida as of 2011.

Citrus Variegated Chlorosis (CVC)

Greening or Huanglongbing (HLB)

Citrus greening is associated with the bacterium, *Candidatus* Liberibacter spp. and infects all citrus species. Infected trees have low yields and decline with time.

Visual symptoms include chlorotic foliage with leaf drop. Fruit are small, poorly colored, often lopsided with aborted seeds and may fall prematurely.

Infected leaves exhibit a variegated type of chlorosis referred to as 'blotchy mottle.' The blotchy appearance is not symmetrical on two sides of the mid vein and will appear on both sides of the leaf.

Visual symptoms in the foliage first appear on a few leaves on a single branch and progress with time to encompass the entire canopy. The leaves may be smaller than normal and upright in growth. The chlorosis can resemble mineral deficiencies like zinc, iron, and manganese.

The Asian and the American liberibacters are spread by the Asian citrus psyllid and the African form is transmitted by another species of psyllid.

Greening (Aborted Seeds)

Greening in Leaves

Manganese Deficiency

Foliage deficiency appears as dark green bands along the midrib and main veins surrounded by light green interveinal areas. As the severity increases, the light green interveinal areas develop a bronze appearance.

A temporary mild deficiency pattern on new shoots is not detrimental to the growth or the fruiting of the citrus tree.

Magnesium Deficiency

The first symptom of magnesium deficiency will occur on mature foliage as a yellowish green blotch near the base of the leaf and between the midrib and the outer edge. The yellow area enlarges until the only green parts remaining are at the tip and base of the leaf as an inverted V-shaped area on the midrib. With acute deficiency, the leaves may become entirely yellow and eventually drop. Note the varying degrees of deficiency, with healthy leaf shown at the far left.

Manganese Deficiency

Magnesium Deficiency

Zinc Deficiency

In the early stages, zinc deficiency appears as small blotches of yellow occurring between green-colored veins in the leaf. With severe deficiency, leaves may become entirely yellow except for the green veinal areas.

Under severe deficiency, leaves will also be smaller and have narrow pointed tips. This deficiency has been referred to as "little leaf" and "mottle leaf." Trees with citrus blight may also show leaf symptoms of zinc deficiency.

Iron Deficiency

In mild cases, leaf veins are darker green than interveinal areas, with symptoms appearing first on new foliage. In severe cases, interveinal areas become yellow, with entire leaf areas eventually becoming ivory in color. Trees may become partially defoliated, with eventual twig and canopy dieback.

Zinc Deficiency

Iron Deficiency

Molybdenum Deficiency

Molybdenum deficiency used to be referred to as yellow spot. Today, molybdenum deficiency is seldom found in Florida. When found, it appears as large, yellow, interveinal chlorotic spots with deposits of gum on the lower leaf surface of the old summer flush leaves. As deficiency increases, the spots will increase in number and coalesce, forming larger chlorotic spots.

Boron Deficiency

Boron deficiency is usually associated with small lumpy areas in the peel and brown areas in the albedo, central core, and/or flesh of the fruit. Trees deficient in boron lack vigor and may have excessive fruit drop.

Boron deficiency is easily corrected with applications of boron to either the soil or foliage.

Molybdenum Deficiency

Boron Deficiency

Nitrogen Deficiency

Nitrogen deficiency can usually be distinguished from the other deficiencies by the general appearance of yellowing foliage over the entire tree in the absence of any distinctive leaf patterns. In mild deficiency, the foliage will be light green. As the deficiency intensifies, the green turns yellow.

Yellow Vein or Winter Chlorosis

With yellow vein chlorosis, the midribs, lateral veins, and a band of leaf tissue bordering them become yellow, while the rest of the leaf remains a normal green color.

This chlorosis is frequently attributed to the girdling of individual branches or the tree trunk. It may also occur with the onset of cooler weather in the fall and winter, as a result of a lack of nitrogen uptake from the soil by the plant.

Nitrogen Deficiency

Yellow Vein or Winter Chlorosis

Biuret Toxicity

Biuret is an impurity in urea fertilizer. Leaf symptoms appear as irregular, yellowish green, interveinal chlorotic areas, appearing first at leaf tips and spreading over the entire outer areas of the leaf surface. As the severity increases, only the midribs and parts of the major veins remain green.

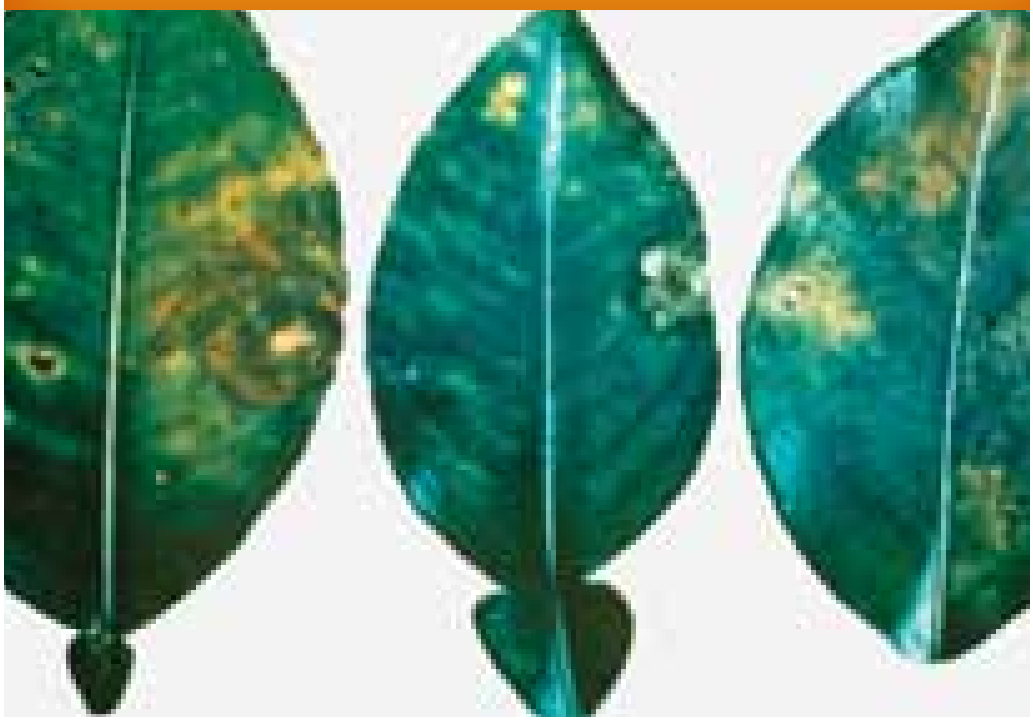
Fertilizer/Salt Burn

Leaves develop irregular brown necrotic areas, usually near the tips or margins, as a result of salt burn. This may be attributed to salts coming from the irrigation water, saltwater intrusion, salts blown by the wind, or actual contact of the foliage with fertilizers.

Excessive salt damage can result in leaf injury, defoliation, and, eventually, dieback of twigs.

Biuret Toxicity

Fertilizer/Salt Burn



Copper Deficiency (Twig)

Mild copper deficiency is usually associated with large, dark green leaves on long, soft, angular shoots. The shoot ends will begin to sag, producing branches that appear curved or "S"-shaped. These twigs will usually develop blisterlike pockets of clear gum near nodes between the wood and bark. As the twig matures, reddish brown eruptions occur in the outer portion of the bark. Severely affected twigs commonly die back from the tip, with new growth appearing from multiple buds.

Copper Deficiency (Fruit)

Fruit symptoms include dark, reddish brown, gum-soaked areas of irregular shape on the surface.

Copper Deficiency (Twig)

Copper Deficiency (Fruit)

Foot Rot Lesion on Trunk

Phytophthora nicotianae, P. palmivora

Lesions on a tree trunk usually occur on the bark at or just above the bud union on susceptible scions or rootstocks.

The lesions will first appear as a drop of gum on the surface of the plant's bark. Upon further investigation, a brown, discolored, necrotic, slippery area will be found under the bark. In some cases, the margin of the infected area will break away from the healthy area and may curl back. Lesions may expand and eventually girdle the entire circumference of the tree trunk.

Chlorotic Foliage Due to Foot Rot

When the trunk is partially girdled by foot rot, the foliage may become dull and chlorotic, with the mid- and main lateral veins of each leaf becoming yellow while the rest of the leaf remains nearly normal. This is similar to yellow vein chlorosis, which is caused by impairment of nutrient flow through the girdled trunk and eventually leads to nitrogen deficiency.

Foot Rot Lesion on Trunk

Chlorotic Foliage Due to Foot Rot

Brown Rot on Citrus Fruit

Phytophthora spp.

A leathery, olive-brown discoloration or rind rot may develop when Phytophthora inoculum in the soil is splashed by rain onto low-hanging fruit. Brown rot is most often seen in Florida during September and October, when color break of fruit occurs. Environmental conditions that favor the development of brown rot of citrus fruit are wetness for more than 2 hours for several days in succession and temperatures of 75-85˚F.

Brown Rot on Citrus Fruit

Eastern Lubber Grasshopper

Romalea microptera

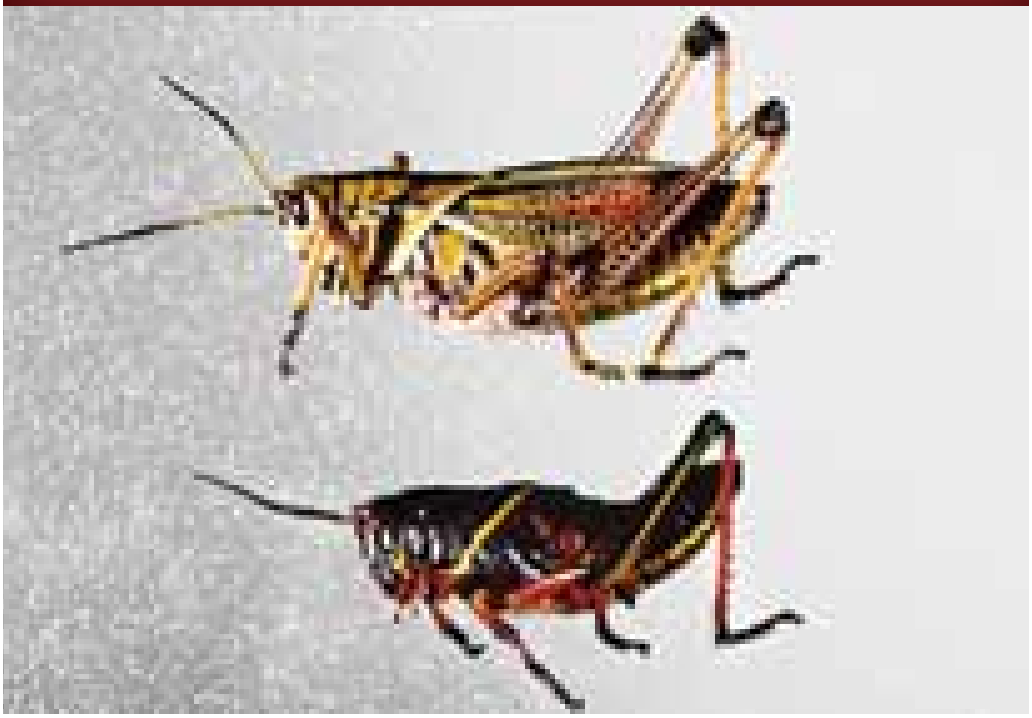
The eastern lubber grasshopper can be a pest, causing defoliation of young citrus trees. The adult is a brilliant yellow with red and black markings. It is incapable of flight and 50 to 60 mm long. The nymphs are almost solid black, with yellow and occasionally red markings.

American Grasshopper

Schistocerca americana

The American grasshopper is light brown with black markings and is approximately 25 to 45 mm long. Nymphal stages feed on the leaves and stems of citrus trees, causing extensive defoliation. The adult grasshopper is able to fly for up to 30 to 50 feet in each flight.

Eastern Lubber Grasshopper



American Grasshopper

Katydid and Leaf Damage

Microcentrum rhombifolium

The broadwinged katydid is bright green and approximately 50 to 64 mm long. Several generations occur each year, with the largest populations occurring in June through September. Katydids feed on foliage and can cause extensive defoliation to young trees. They may also feed on the peel of fruit, causing large, smooth, sunken areas on developing fruit.

Katydid Eggs

Katydid eggs are easy to identify, as they are laid in a row along the leaf margin.

Katydid and Leaf Damage

Katydid Eggs

Cricket Damage to Peel

Hapithus agitator, Orocharis luteolira

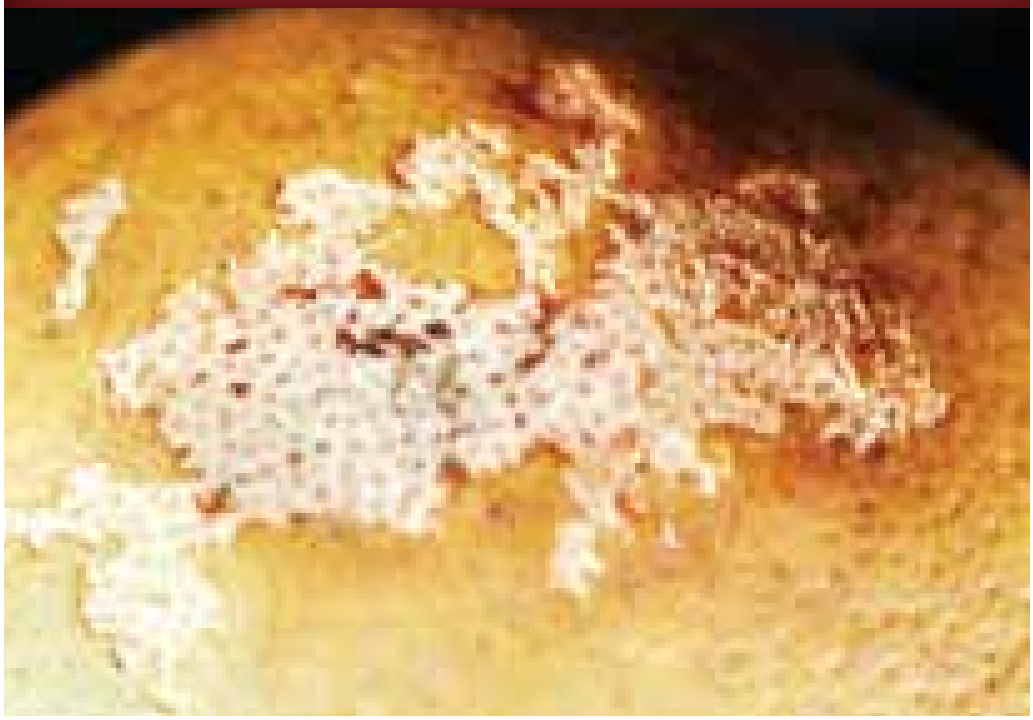
The restless bush cricket and the false jumping bush cricket can cause fruit damage by feeding on the peel before the fruit reaches 12 mm in diameter. The extent of the peel blemish will depend on the extent of the feeding. In some cases, extensive feeding can cause fruit drop. Both crickets are dark brown to black and about 20 mm long.

Leaffooted Bug

Leptoglossus phyllopus

The adult leaffooted bug is dark brown in color and approximately 20 mm long. The leaffooted bug feeds on fruit with piercing-sucking mouthparts that puncture the fruit rind. Insect feeding will result in premature color break and fruit drop.

Cricket Damage to Peel



Leaffooted Bug

Southern Green Stink Bug

Nezara viridula

The southern green stink bug is bright green and broadly oval. The adult female is approximately 12 mm long, with the male being slightly smaller. Stink bug numbers are usually highest in October through December and March through April. Damage to the fruit is a result of the insect feeding with a piercing-sucking mouth. This results in peel damage and may cause fruit drop.

Plant Bug Damage to Fruit

Plant bug feeding on fruit may cause damage to the peel. The fruit will prematurely break color at the feeding sites, and in some cases the fruit can drop. A thin slice through the peel (as pictured) will reveal dark areas in the albedo, indicating plant bug feeding sites.

Southern Green Stink Bug

Plant Bug Damage to Fruit

Orangedog Larvae

Papilio cresphontes

The larva of the swallowtail butterfly will feed on the foliage of young citrus trees and can cause extensive damage and defoliation. The larval stage is a brown and white caterpillar that may resemble bird droppings and is approximately 35 to 65 mm in length. Several orangedog larvae can completely defoliate a small one-year-old citrus tree in several days.

Swallowtail Butterfly

The adult swallowtail butterfly has velvet black wings with yellow markings and is approximately 100 to 154 mm from wing-tip to wing-tip.

Orangedog Larvae

Swallowtail Butterfly

Diuron Toxicity

The first symptoms of root uptake injury may appear as a slight yellowing or clearing of the major leaf veins. As the toxicity increases, additional areas along the veins will yellow.

Direct contact with diuron on the leaf surface will cause leaves to turn entirely yellow and necrotic and fall from the tree.

Bromacil Toxicity

The first symptoms of root uptake injury may appear as a yellowing or mild chlorosis of the midrib and veins. The finer veins in the leaf also become chlorotic. More severe damage caused by contact to the leaves will be expressed as a partial or total yellowing or bronzing of the leaf blade. Defoliation will eventually result in severe cases.

Diuron Toxicity

Bromacil Toxicity

Gramoxone (Paraquat) Injury

Direct spray contact with the foliage or fruit will cause varying degrees of chlorosis and necrotic spotting with no distinctive pattern. Any green tissue, such as leaves, stems, and twigs, may exhibit the necrotic damage.

Gramoxone will not be taken up by roots, as this material has no soil activity.

Gramoxone (Paraquat) Injury (Foliage)

Gramoxone (Paraquat) Injury (Fruit)

Glyphosate Injury (Foliage)

Glyphosate injury results from the material being absorbed and translocated by the green tissue. This material has no soil activity. Leaf damage in the form of spots and/or defoliation may result up to several weeks after application. New growth that occurs after damage to affected twigs or other places on the canopy may appear as small, narrow, strap-shaped leaves. Multiple bud growth may also appear.

Glyphosate Injury (Fruit)

Fruit that comes in contact with glyphosate sprays may exhibit burn-like rind damage, and fall from the tree if damage is severe.

Glyphosate Injury (Foliage)

Glyphosate Injury (Fruit)

2,4-D Injury

Symptoms on new shoot growth are curling or rolling of the leaves, producing a boat-shaped distortion. Twigs will also be distorted. The injury is a result of direct spray application or drift from adjacent sprayed areas. Injury to the tree trunk can result from excessive application to the soil. It appears as girdling or bark scaling, at or just below the soil line.

Simazine Injury

Initial simazine injury symptoms may first appear as yellowing of leaf margins, progressing to an interveinal yellowing with veins remaining green. Under severe injury, defoliation may result.

2,4-D Injury

Simazine Injury

Norflurazon Toxicity

Toxicity due to root uptake causes a white chlorosis of the midrib, which will later extend through the remainder of the veins in the leaf.

This toxicity symptom is similar to other toxicities except for the white vein color, vs. a pale yellow color with other herbicides.

Norflurazon Contact Injury

Injury caused by direct contact to the leaves will appear as white spots. In some cases, leaves may become distorted.

Norflurazon Toxicity

Norflurazon Contact Injury

Citrus Tristeza Virus (Stem Pitting Strains)

Stem pitting occurs on scions. It reduces fruit size on limes and grapefruit and affects sweet orange production in some areas of the world.

Citrus Tristeza Virus (Trunk)

CTV is transmitted by several aphid species and by infected budwood.

At the present time, when trees on sour orange become infected with CTV, they may become stunted and grow very slowly. In some cases, they will die very quickly. Currently, the enzyme-linked immunosorbent assay (ELISA) test done in laboratories can detect CTV in plant tissue. In the field, growers can remove a piece of bark across the bud union and look for the presence of pinholing or honeycombing areas on the inner face of the bark or brown discoloration at the bud union. However, these symptoms are not always present on infected trees.

Citrus Tristeza Virus (Stem Pitting Strains)

Citrus Tristeza Virus (Trunk)

Psorosis Bark Scaling

Psorosis is caused by a virus. The most common is psorosis A, which usually develops as bark scaling on the upper branches of the tree and may produce brown gum pockets in the area of infection. Leaf-flecking symptoms may appear on young foliage during early spring. Tree vigor, reduced yield, and increased susceptibility to freezes have been noted. Virus-free budwood should be selected when budding citrus trees to avoid psorosis.

Exocortis Bark Scaling

Exocortis is a viroid and causes dwarfing of trees grafted on susceptible rootstocks, such as Carrizo citrange, Rangpur, Palestine sweet lime, and trifoliate orange. Scaling of the susceptible bark below the bud union will occur in most cases. Exocortis is budwood-transmissible and mechanically transmissible on tools.

Psorosis Bark Scaling

Exocortis Bark Scaling

Cachexia (Xyloporosis)

Cachexia is caused by a viroid. Symptoms of xyloporosis are stem pitting and gum impregnation of the bark in sensitive cultivars such as *Citrus macrophylla*, Rangpur and Palestine sweet lime.

This pitting and gum impregnation usually occurs near the bud union, but can be found in other parts of the tree.

Xyloporosis can be transmitted by infected budwood and contaminated cutting tools.

Cachexia (Xyloporosis)

Leprosis

Leprosis is caused by a locally systemic virus that produces lesions on citrus leaves, twigs, and fruit of oranges and to a lesser extent, mandarins. The lesions are chlorotic and somewhat circular. Lesions on the stem may coalesce causing bark scaling with subsequent leaf and fruit drop along with stem dieback in severe cases.

Leprosis is transmitted by several species of *Brevipalpus* mites. Control of *Brevipalpus* is the main suppression practice along with good production practices. Well-maintained groves tend to have fewer problems than poorly maintained groves.

Leprosis was found in Florida in the late 1800s and was widespread by 1925. For some unknown reason, leprosis began to disappear in the 1930s and could only be found in a few isolated, poorly maintained locations in the 1960s.

Leprosis

Adult Citrus Root Weevils

Left to right:

Little Leaf Notcher
Artipus floridanus

Fuller Rose Beetle
Asynonychus godmani

Northern Citrus Root Weevil
Pachnaeus opalus

Southern Blue-Green Root Weevil
Pachnaeus litus

Diaprepes Root Weevil
Diaprepes abbreviatus

Root Weevil Larvae

The larvae hatch from the egg and drop from leaves to the ground, entering the soil to begin feeding on the roots. They remain in the soil through the pupal stage and emerge as adults. Larvae vary in color slightly, but all have visible mouthparts. Species are identified by frontal sutures. Larvae may have up to eleven instars.

Adult Citrus Root Weevils

Root Weevil Larvae

Leaf Notching Due to Adult Root Weevil Feeding

Adult root weevils feed on young, tender leaves at night, in the early morning, or in the late afternoon. The most visible plant damage is a marginal notching of the leaf. Adult feeding always begins at the leaf margin. The amount of leaf consumption differs between species. Once the citrus leaves have matured, feeding on leaves is reduced as the insect moves to alternate host plants.

Root Damage Resulting from Root Weevil Larval Feeding

Larvae fall to the soil surface and immediately move into the soil. They begin by feeding on the fibrous feeder roots, moving to the major lateral or pioneer roots of the plant as they grow. Larvae cause damage by channeling on the outer portion of the root, or by girdling a root, thereby causing root death. Larvae channeling on the root allows easy entry sites for *Phytophthora*. Feeding times and preferred feeding sites depend on species and soil conditions.

Leaf Notching Due to Adult Root Weevil Feeding

Root Damage Resulting from Root Weevil Larval Feeding

Little Leaf Notcher

Artipus floridanus

This species is the smallest of the common weevils, measuring only about 5 to 6 mm in length. Adult insects are grayish white, flightless, and all female. Adults can be found throughout the year, with peak emergence occurring during April-May, August-September, and November-December. This weevil is found mainly along Florida's east coast and can be found on a wide range of hosts (150 species).

Fuller Rose Beetle

Asynonchus godmani

The flightless adults are brownish to gray in color, about 8 mm long, and all female. Adult Fuller rose beetles can emerge anytime throughout the year, but peak emergence is from May through July. This weevil can be found in both coastal and central Florida from Gainesville to south of Homestead.

Little Leaf Notcher

Fuller Rose Beetle

Blue-Green Citrus Root Weevil

Pachnaeus spp.

Both species are fairly large (8 to 14 mm long) and can fly. Both males and females can be found in Florida. The southern blue-green citrus root weevil is bright blue-green to aqua; the northern citrus root weevil is pale gray-green, but occasionally bright aqua specimens are found. The difference between the two species is the presence or absence of a pronotal notch on the leading edge of the wing covers.

Adults may emerge from the soil during any month, but peak emergence is generally from mid-May to mid-July. Adults can be found on as many as 70 species of plants throughout Florida.

Southern Blue-Green Citrus Root Weevil

Northern Citrus Root Weevil

Diaprepes Root Weevil

Diaprepes abbreviatus

This is the largest of the weevils found on citrus, with a length of 9 to 20 mm. The adults have a black background, with colored scales ranging from white to orange on the wing covers. Adults can be found throughout the year, with two peak emergence periods occurring in April through June and in September. This weevil can fly, and both male and female weevils can be found.

Diaprepes root weevil has been observed on more than 75 species of plants in Puerto Rico and Florida. It is the most damaging of all the five root weevil species. Root feeding by older larvae may wound structural roots, opening the way for bark infection by *Phytophthora* spp. and severe root girdling.

Diaprepes Root Weevil

Wind Scar

Wind scar can result when young, tender fruit rubs against leaves or stems. The damaged areas darken, with subsequent wound periderm formation that expands as the fruit grows. Tissue damaged early completely sloughs off, leaving a smooth, silvery to brownish blemish. Later damage leads to a rough surface.

Thorn/Bird Puncture

The injured area of the fruit will have single to multiple puncture sites that will vary in size and depth depending on the injury. In severe cases, the fruit will fall from the tree before reaching maturity.

Wind Scar

Thorn/Bird Puncture

Chimera

A chimera is a genetic mutation that can occur on a twig, branch, or fruit, and will have characteristics different from the rest of the tree. The mutation can have a different color, texture, or shape. In the case of fruit, only a section or several sections may be affected. Generally, such mutations produce fruit of inferior quality and should be avoided, unless the mutation has some superior quality or feature.

Chimera (Fruit)

Chimera (Foliage and Fruit)

Brown Gum Spots on Leaves

This injury usually appears on the lower surface of leaves that have been exposed to direct sunlight or frost injury. The brown gum spots are irregular in shape and have a hard, smooth, raised surface.

Hail Injury

Fruit that is injured by hail will be pitted, and the depressions will become cracked and corky. If the injury occurs when the fruit is young, the injured area will be smooth. In cases where the injury is severe, decay organisms may invade the fruit, causing it to fall from the tree before maturity.

Damaged leaves will be torn and will have a somewhat shredded appearance.

Brown Gum Spots on Leaves

Hail Injury

Lightning Injury

Trees that have been struck by lightning may have a few twigs in the upper portion of the tree that are dead. If a direct strike occurs, the tree may be killed. In some cases the bark may be split; in many cases the bark at the soil line will be killed and will slough off with age, resulting in the tree being girdled. One of the characteristics of lightning injury is that the bud eyes of twigs or nodes will remain green while the surrounding tissue darkens and dies.

Lichens

Lichens may occur on the trunk, branches, and twigs of the tree. They are found on old neglected trees. The growth on the tree does not invade the tissue and is considered harmless.

Lichens vary in color and form, with gray-green being the most common.

Lightning Injury

Lichens

Spray Burn

Spray burns to the fruit peel and/or foliage can result from various factors related to chemical application, including application rate, combinations of several compounds, water quality, and environmental factors. While those chemicals listed in the annual Florida Citrus Pest Management Guide have been found to be safe and effective when used individually, not all possible chemical combinations have been studied.

Caution should be used when mixing several chemicals together in one spray, as this can increase the potential for spray burn.

The extent of damage will vary from one site to another and among varieties.

Spray Burn (Foliage)

Spray Burn (Fruit)

Sunburst Leaf Injury

Sunburst tangerine trees may exhibit severe brownish leaf and stem blistering from excessive rust mite feeding. The blistering is an apparent latent response to earlier mite feeding. Blistering will be greatest on the petiole and along the midrib vein. Mite feeding on leaves late in the fall may cause chlorotic areas to form and may result in premature leaf drop.

Rio Grande Gummosis

Initial symptoms of Rio Grande gummosis include narrow cracks in the bark that produce a pale yellow, water-soluble gum. The gum may accumulate on the bark or be washed away by rainfall, staining the area below the cracks in the bark. As the disease progresses, gum pockets may develop beneath the bark.

Sunburst Leaf Injury

Rio Grande Gummosis

Stylar-end Russetting

Stylar-end russetting is usually found on the stylar end of the fruit, and consists of a network of fine corky lines. The actual cause is unknown, but is assumed to be associated with mite injury.

In cases of extensive stylar-end russetting, the fresh fruit grade can be lowered.

Creasing

Creasing is a narrow, sunken furrow on the rind surface which, when peeled to the albedo, will be cracked or pulled apart in appearance. Creasing is most prevalent on thin-skinned fruit varieties like tangerines, and to a lesser extent on round oranges.

Low potassium levels are often noted in trees producing creased fruit.

Stylar-end Russetting

Creasing

Aschersonia Fungi

Aschersonia fungi infect whitefly nymphs, producing a red or yellow raised growth in and over the nymph. As the fungi ages, the colors will fade.

These are friendly fungi, and sprays to reduce the populations should not be considered.

Sooty Mold

Sooty mold is a thin, dense, black fungus that grows on the honeydew secreted by insects like aphids, unarmored soft scales, whiteflies, and mealybugs. Sooty mold can be found on leaves, stem, and fruit.

While sooty mold does not directly damage the tree, it reduces the amount of sunlight reaching the leaf surface, reducing the plant's ability to produce carbohydrates. Sooty mold on fruit can be difficult to remove in the packinghouse, thus reducing fruit external quality.

Aschersonia Fungi

Sooty Mold

Measles

The leaves of affected trees are covered with numerous pale yellow spots. Chlorotic spots appear on the upper leaf surface, whereas on the lower surface they are slightly raised, dirty white to brown in color. Spot numbers range from a few to many on a given leaf. Individual spots may be up to 1.6 mm in diameter. Symptoms may appear over a large portion of the canopy or confined to a given limb. The disorder generally appears on the same limb or limbs over time. The cause of the disorder is unknown, but is assumed to be a genetic variant. The disorder is more frequently observed on sweet orange cultivars.

Measles

SCIENTIFIC NAMES

Aleurocanthus woglumi – Citrus Blackfly
Alternaria spp. – Alternaria Brown Spot
Amitus hesperidum – Parasite on Citrus Blackfly
Anastrepha ludens – Mexican Fruit Fly
Anastrepha suspensa – Caribbean Fruit Fly
Aphis citricola – Spirea/Green Citrus Aphid
Aphis gossypii – Melon Aphid
Aphytis holoxanthus – No common name
Artipus floridanus – Little Leaf Notcher
Aschersonia aleyrodes – Whitefly Fungus
Asynonychus godmani – Fuller Rose Beetle
Candidatus Liberibacter – Greening/
Huanglongbing (HLB)
Ceratitis capitata – Mediterranean Fruit Fly
Ceroplastes floridensis – Florida Wax Scale
Chrysomphalus aonidum – Florida Red Scale
Coccus hesperidum – Soft Brown Scale
Colletotrichum acutatum – Postbloom Fruit Drop
Dacus dorsalis – Oriental Fruit Fly
Dialeurodes citri – Citrus Whitefly
Diaphorina citri – Asian Citrus Psyllid
Diaporthe citri – Melanose
Diaprepes abbreviatus – Diaprepes Root Weevil
Elsinoë australis – Sweet Orange Scab
Elsinoë fawcettii– Scab
Encarsia opulenta – Parasite on Citrus Blackfly
Eotetranychus sexmaculatus – Six-Spotted Mite
Eutetranychus banksi – Texas Citrus Mite
Guignardia citricarpa – Black Spot

Hapithus agitator – Crickets
Icerya purchasi – Cottony Cushion Scale
Lepidosaphes beckii – Purple Scale
Leptoglossus phyllopus – Leaffooted Bug
Microcentrum rhombifolium – Katydid
Mycosphaerella citri – Greasy Spot
Nezara viridula – Southern Green Stink Bug
Orocharis luteolira – Crickets
Orthezia praelonga – Ortezia Scale
Pachnaeus litus – Southern Blue-Green Root Weevil
Pachnaeus opalus – Northern Citrus Root Weevil
Panonychus citri – Citrus Red Mite
Papilio cresphontes – Orangedog
Parlatoria pergandii – Chaff Scale
Phyllocnistis citrella – Citrus Leafminer
Phyllocoptruta oleivora – Citrus Rust Mite
Phytophthora spp. – Brown Rot
Phytophthora nicotianae – Foot Rot
Phytophthora palmivora – Foot Rot
Pinnaspis aspidistrae – Fern Scale
Planococcus citri – Citrus Mealybug
Romalea microptera – Eastern Lubber Grasshopper
Saissetia neglecta – Caribbean Black Scale
Schistocerca americana – American Grasshopper
Toxoptera citricida – Brown Citrus Aphid
Unaspis citri – Citrus Snow Scale
Xanthomonas axonopodis pv. *citri* – Citrus Canker
Xylella fastidiosa – Citrus Variegated Chlorosis (CVC)

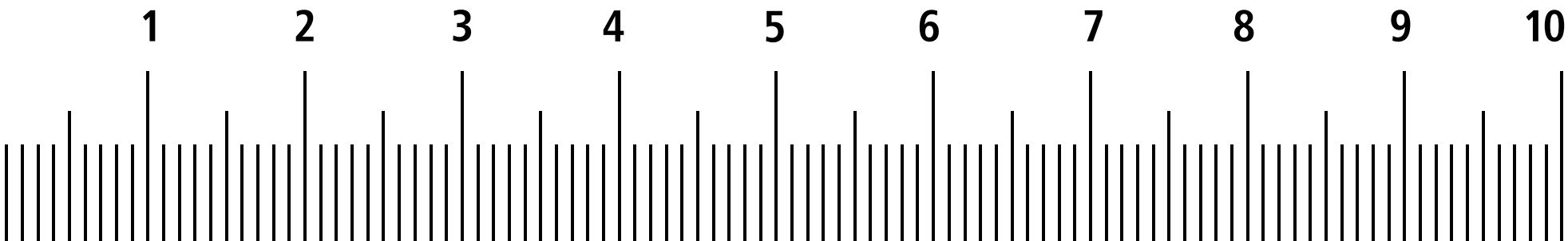
INDEX

Measurement Conversion

1/8" = 3.2 mm
1/4" = 6.4 mm
1/2" = 1.3 cm
1" = 2.54 cm or 25.4 mm
2" = 5.0 cm
1 cm = 10 mm

Measurements in this publication are given in the metric system. The above conversion chart is included for convenience.

Centimeters (cm)



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