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Agricultural Pests of the Dominican Republic

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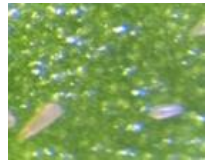
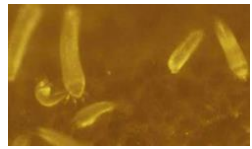
Citrus rust mite		citrus	russeting, smaller fruit, early fruit drop, stippling, defoliation, black spots on twigs, fruit water loss	87
Coconut mite		coconut	stippling, nut distortion/stun-ting, dark triangle patch on nut, oozing	88

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White flies		avocado, pepper, banana, plantain, coconut, citrus, beans, melon, potato, tobacco, tomato	leaf discoloration, leaf death, distortion, wilting, sooty mold	37
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Yellowstriped armyworm		pepper, rice, onion, beans, potato, tomato, tobacco	defoliation, skeletonizing, feeding on fruit	82

Note on Profiles:

The following profiles are of the most common pests of the main crops grown in the Dominican Republic- avocado, citrus, coconut, mango, banana, plantain, pineapple, tomato, potato, cabbage, tobacco, pepper, garlic, onion, rice, beans, papaya, and melon. Many of these insects attack other crops not listed in this guide.

The intent of this guide is to help identify pest characteristics and environmentally friendly ways to control them (integrated pest management).

Chemical controls should always be the last resort. Try to conserve biodiversity and continue to monitor before turning to chemicals. Always consult local extension office for pesticide usage, and always read and follow label.

Hemiptera (true bugs)

Aphids

Crops: various

Characteristics: tiny, soft bodied, and generally pear shaped with long legs and antennae. They can be green, black, yellow, red, brown, or covered in wax. Most have cornicles, tube-like structures on the end of the abdomen used to excrete honeydew. Some are winged and some are wingless. Nymphs resemble adults, except they are smaller in size.

Life cycle: they can lay eggs if they reproduce sexually in which they will overwinter as eggs. Some of these nymphs will become winged males and females and start a new colony on a new host. Others will remain wingless females on the current host. An asexual, wingless female will give birth to live wingless females and overwinter as adults. They have no pupal stage and go through four instars. They have multiple generations per year. Adults live for about one month.

Damage: feed on plant sap, causing plant stress, reducing aesthetic value by sooty mold formation, discoloration, weakened crops, reduced photosynthesis from sooty mold, white skin shells accumulate on plant, may transmit viruses and diseases, some species cause gall formation, decreased yield and marketability, stunting, leaf curling, and deformation. Some aphids attack shoots and roots. The plant will usually not be damaged by low to moderate numbers, however, they can easily become a high infestation.

Control: prevention is key. Monitor populations by inspecting plants for aphids. Especially look under leaves as they prefer it. Do not overuse nitrogen fertilizers, as nitrogen encourages aphid reproduction. Remove weeds (especially sowthistle and mustard), physically remove aphids with high

pressured water, prune infested parts, control ant populations as they tend aphids in exchange for honeydew, conserve natural enemies, start seedling inside or with protective covers, use silver-colored reflective mulch. Biocontrol includes ladybugs, lacewings, syrphid fly larvae, and parasitic wasps. Neem oil, insecticidal soap, horticultural oil, and pyrethrins are low risk pesticides to the environment and beneficial insects, which is recommended.

Adult (left) and nymph (right) green peach aphids (*Myzus persicae*)[64]

Adult brown citrus aphids (*Toxoptera aurantii*)[65]

Adult black citrus aphid (*Toxoptera citricida*)[66]

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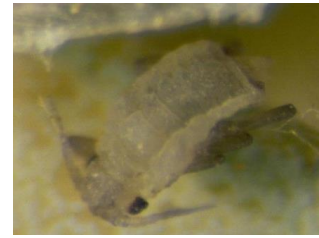
Adult cowpea aphids (*Aphis craccivora*)[69]

Adult alate rice root (*Rhopalosiphum rufiabdominale*)[70]



Adult corn leaf aphid (*Rhopalosiphum maidis*)[71]

Adult spirea aphid attended by an ant (*Aphis spiraecola*)[72]

Adult alate potato aphid (*Macrosiphum euphorbiae*)[73]

Adult mealy cabbage aphids (*Brevicoryne brassicae*)[74]

Adult cotton aphid (*Aphis gossypii*)[68]

Asian citrus psyllid (*Diaphorina citri*)

Crops: citrus

Characteristics: nymphs are wingless, yellowish-orange in color with red eyes and a flattened oval body. Adults are mottled greyish-brown with a light brown head, red eyes, and have a dusty appearance. The outer wing margins are dark brown, and the antennae have black tips and two black dots in the middle. Psyllids are sometimes confused with aphids, however psyllids are active jumpers, have longer antennae, and lack cornicles. Unlike other citrus insect pests, this psyllid feeds with its body raised at a 45-degree angle and its head down.

Life cycle: eggs are laid on the tips of growing shoots. Nymphs feed on the plant and go through five instars in 15-47 days. Adults can live 1-2 months and they have 9-10 generations per year.

Damage: both nymphs and adults are the damaging stages. Both adults and nymphs feed on plant juices and excrete honeydew, which creates sooty mold. Feeding also causes

leaf curling and twisting, yellowing, stunting, leaf and fruit drop, deformed fruit, death of new shoots, and transmission of the Huanglongbin (HLB) disease. The HLB disease causes uneven blotchy patterns of yellowing, undesirable fruits (bitter juice, hard, remains partially green, etc.), fruit drop, and eventually will kill the tree.

Control: inspect citrus trees, especially in new growth and continue to monitor. Inspect transplants and only use healthy and psyllid-free plants. Biocontrol includes parasitic wasps, ladybugs, hoverflies, lacewing larvae, minute pirate bugs, spiders, and birds. Control ants, as they protect psyllids in exchange for honeydew. Systemic insecticides and foliar sprays can be used, but make sure to vary the type of insecticide. Soil drenches should be applied when roots are actively growing and foliar sprays should not be applied during bloom, as they kill honeybees too. Neem oil, horticultural oil, and insecticidal soaps are more environmentally friendly options.

Asian citrus psyllid nymph[89]

Adult Asian citrus psyllid[109]

Asian citrus psyllid infestation and damage[110]

Chinch bugs (*Blissus leucopterus*)

Crops: rice

Characteristics: nymphs resemble adults and are tiny, red to black in color with a yellowish-white band. Adults are small and black with brown, yellow, or reddish legs, and white wings. They have two black triangles on the wing margins and one nearer the head. They also emit a bad odor when crushed.

Life cycle: eggs are laid singly or in clusters at the base or lower leaf sheaths of the plant and near the soil. Nymphs will go through five instars. They overwinter as adults in grasses. They reach maturity within a month and have two generations per year.

Damage: resembles frost damage**,** severe infestations can cause plant death. Light infestations usually do not damage crops.

Control: drown bugs in flood to kill and force them to move upward, which decreases feeding damage as to compared to feeding near the soil. Intercropping legumes in a grain field discourages infestations because chinch bugs cannot survive in shady and humid environments. Biocontrol includes a fungal disease during humid seasons. The climate alone can help control populations; rain can knock newly hatched nymphs off the plants, and humid weather is unfavorable to them. Rice seed treatments and foliar insecticides like pyrethroids are found to be effective.

Adult chinch bug [53]

Corn planthopper (*Peregrinus maidis)*

Crops: rice

Characteristics: nymphs resemble adults, only wingless, smaller in size, and may be a different color. At first the nymphs are white but become yellowish with brown markings as they grow older. Adults are bigger than others in its genus and are mainly brown with the top of the head and thorax being pale and underneath being dark. They have a large spur at the tip of their hind tibiae and can be long

winged or short winged with the wing tip being slightly patterned.

Life cycle: eggs are laid in a row on the upper surface of the midrib of the leaf and then covered with a waxy material. Eggs hatch in 5-12 days. Nymphs feed on leaves and go through 5-6 instars. They have no pupal stage and take 22-30 days to complete development. They overwinter as adults and generations per year depend on latitude and field conditions. For example, when plant quality decreases, the short-winged adults that have a shorter life cycle and higher egg production will switch to being long-winged to be able to disperse longer distances.

Damage: both nymphs and adults are the damaging stages and tend to aggregate. They are especially damaging in corn. They can transmit diseases like maize stripe virus, maize mosaic virus, and hopperburn, which cause discoloration, stunting, reduced grain production, and decrease plant health. They also feed on plant sap, resulting in honeydew production and the eventual sooty mold which decreases marketability and the plant's ability to photosynthesize.

Control: remove weeds, use resistant varieties, use light traps, inspect crops for bugs and hopperburn, flood seedbed for a day until the tips of seedling are exposed to drown planthoppers, can sweep with a net to remove some, although it will not remove eggs. Biocontrol includes spiders, Tytthus plant bugs, fly and wasp parasitoids, and water striders. Usually, biocontrol is enough to keep populations low, so it is important to conserve these natural enemies. Insecticides can be used, however, they can kill beneficial insects as well. This is not recommended if there are more beneficials than planthoppers.

Adult corn planthopper[87]

Leaffooted Bug (*Leptoglossus sp.*)

Crops: citrus, beans, melon, tomato

Characteristics: nymphs somewhat resemble adults, with only slight differences. Adults are usually brown or black with light markings, though some are orange or yellow. They look similar to stink bugs, except they have leaf like projections on their hind legs, hence their name. They also emit a bad odor when disturbed.

Life cycle: eggs are laid in masses on the underside of leaves. Nymphs hatch in one week and take 5-8 weeks to become adults. They overwinter as adults in aggregations in sheltered areas like tree bark and woodpiles. They have 2-3 generations per year.

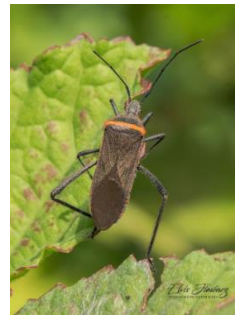
Damage: they suck plant juices and can transmit fungal yeast to the plants. Most damage is found on the fruit/nut; fruits can abort, black stains can be left on the fruit/nut, excrement left on fruit, fruit discoloration, all of which decrease marketability and/or yield.

Control: usually they are not an issue, but occasionally there will be an outbreak. Low numbers can be handpicked

and killed, remove overwintering sites (juniper, cypress, citrus, and eucalyptus trees, barns, and buildings), remove weeds, add row covers (may interfere with pollination), prune trees, shake or beat trees under a white sheet and kill fallen bugs, conserve natural enemies and biodiversity. Biocontrol includes the wasp, *Gryon pennsylvanicum*, which attacks eggs, Tachinid flies parasitize nymphs and adults, birds, spiders, and assassin bugs. Insecticides can be used but usually not needed. If needed, broad spectrum pyrethroids can be used, however they kill beneficial insects as well. Insecticidal soap, neem oil, or pyrethrin may control nymphs.

Adult leaffooted bug (*Leptoglossus Cinctus*)[54]

Adult citron bug (*Leptoglossus gonagra*)[55]



Adult leaffooted bug (*Phthiacnemia picta*) [56]

Leafhoppers

Crops: rice, beans, papaya, melon, potato

Characteristics: nymphs resemble adults but may be of different color. Adults are small with long wedge-shaped bodies and one or more rows of spines on their hind legs. They can be brown, green, yellow, gray, or mixed colors. They walk sideways quickly and jump when disturbed.

Life cycle: eggs are laid in veins, shoots, or stems and nymphs hatch in about 10 days. Nymphs feed on the tender parts of the plant and go through five instars before becoming adults. They have no pupal stage and overwinter as adults or eggs. It takes them 12-30 days to become adults. Most have one generation per year, but some can have up to six.

Damage: both nymphs and adults cause damage. They feed on plant sap, causing stippling, curling, discoloration ("hopperburn"), early leaf fall, and leaf death. Like aphids, they excrete honeydew, which eventually will grow sooty mold, which decreases aesthetic value and the plant's ability to photosynthesize. Leafhoppers shed their skin with every molt, leaving cast skins on foliage. Some can transmit diseases that can cause yellowing, dwarfing, distorted foliage, abnormal shoot production, reduced yield, and eventually death.

Control: they are usually a nuisance pest that do not need control, however, it is good to remove weeds, conserve biodiversity, and inspect plants regularly to prevent an infestation. Biocontrol includes assassin bugs, brown lacewings, damsel bugs, green lacewings, ladybugs, minute pirate bugs, parasitic wasps, and spiders. Horticultural oil, insecticidal soap, and neem oil can be sprayed early in the growing season. Make sure to get the underside of leaves, as they are found there.

Adult common green leafhopper (*Hortensia similis*)[79]

Adult corn leafhopper (*Dalbulus maidis*)[80]

Adult potato leafhopper (*Empoasca fabae*)[81]

Adult *Empoasca kraemeri*[82]

Hopper burn damage[83]

Hopper burn damage on rice[84]

Stippling[85]

Leafcurl[86]

Mealybugs

Crops: avocado, citrus, coconut, mango, banana, plantain, pineapple

Characteristics: adult females are pink, small, oval, wingless insects covered in white/grey wax, making them look powdery. Some may have a waxy tail. Males have wings and look like gnats.

Life cycle: most species will lay up to 600 yellow eggs in her lifetime. The exception is the long-tailed mealybug, which produces live young. They go through 3-4 nymphal stages before becoming an adult. It takes the immatures six weeks to two months to become adults. Adult females will die after laying eggs.

Damage: can be found on any plant part including roots, however, they mainly feed on stem tips, leaves, and stem axils. They cause stunting, leaf yellowing, leaf distortion, defoliation, wilting, and black sooty mold. Males do not cause plant damage. The citrus mealybug injects toxin from

its saliva, which can cause other problems besides mentioned above.

Control: prevention is key: inspect plants regularly, including incoming plants. If there is an infestation, repeated use of systemic insecticides can be used, however if heavily infested, destroying the plant is the best option especially in a greenhouse. Biocontrol includes lady bugs, lacewings, and Syrphid flies. The mealybug destroyer (*Cryptolaemus montrouzieri*) can be purchased commercially to control the citrus mealybug. If using insecticides, contact sprays would only work during the crawler stage.

Citrus mealybug (Planococcus citri)[1]

Longtailed mealybug *(Pseudococcus longispinus)*[2]

Adult and immature coconut mealybugs *(Nipaecoccus nipae)*[3]

Obscure mealybug *(Pseudococcus viburni)*[4]

Rice stinkbug (*Oebalus pugnax*)

Crops: rice

Characteristics: nymphs resemble adults but have no wings and at first are bright red with black markings. Adults are yellowish-brown in color with two spines on their shield behind the head. They are a bit elongated and flat.

Life cycle: eggs are laid in clusters of double rows on grass leaves and seed heads and hatch in about five days. Nymphs feed and go through five instars in 15-28 days. They can have up to five generations per year.

Damage: both nymphs and adults damage plants. They feed on the seed endosperm, which causes shriveled kernels or empty seed shells. Rice kernels may get yellow to black spots (called "pecky rice") due to pathogens entering from feeding. Feeding in all causes a decrease in yield and quality grade due to broken kernels.

Control: changing planting date, if possible, can avoid damage, and remove weeds**.** Biocontrol includes the Scelionid parasitic wasp, sand wasps, assassin bugs, spiders, jumping spiders, and birds.

Adult rice stinkbug[78]

Scales

Crops: various crops

Characteristics: there is a lot of variation of scales (continue below for a reference of different species), however, there are two categories: soft scale and armored scale. Soft scales are generally circular, dome shaped, and are soft, powdery, or cottony looking. Armored scales have a hard covering, are flat, and vary in shape. Regardless of the category, they all share common characteristics. Nymphs, called crawlers, are the only mobile stage, besides the adult males which are gnat-like. Adult females have a waxy covering and no visible legs or antennae.

Life cycle: generally, eggs are laid with the female under her waxy cover. After hatching, the crawlers move around the plant to find a place to settle. Once they settle, they begin feeding and creating their protective wax covering. They tend to overwinter as adults. They have several generations per year.

Damage: all scales feed on plant sap, which causes yellowing, wilting, stunting, weakened plant health, reduction in visual aesthetics, and eventual death if very high infestations. Since scales suck plant fluids, their saliva may carry toxins that affect the plant as well. Soft scales produce "honeydew", excess sugar excreted from feeding, which may attract other unwanted insects like wasps and fire ants, but eventually will cause the growth of sooty mold. This sooty mold can decrease the plant's ability to photosynthesize, and it decreases the plant's aesthetic value and marketability. Armored scales do not produce honeydew.

Control: prevention is key with scales because of their ability to colonize the entire plant in a short amount of time. Monitor the crawler stage with a magnifying lens or by putting double sided sticky tape on branches. Prune plants and properly dispose of infested plants and plant parts. It is

important to conserve beneficial insects. Controlling ants may help, as they protect and tend scales in exchange for honeydew. If at low numbers, scales can be physically picked off and soaked in soapy water or rubbing alcohol. Wiping leaves with a mild detergent mixed with water can remove scales and sooty mold but try to avoid getting the solution onto the soil. Biocontrol includes ladybugs, parasitic wasps, and fungal pathogens. In the case of heavy infestation, disposing of the plant entirely may be the best solution. Chemical products can effectively control scales when sprayed during the crawler stage (it is harder to treat once adults). Identify the type of scale first before choosing the chemical control. Horticultural oils, insecticidal soap, dormant oils, and soil drenches are effective. Dead scales do not fall off, so it is important to check first if they are alive. If they are soft and leave a smear when crushed, it is alive. If it's dry, it is dead.

Adult female black thread scale *(Ischnaspis longirostris)*[3]

Adult and crawler Florida wax scales (*Ceroplastes floridensis*)[3]

Adult female coconut scales (*Aspidiotus destructor)*[58]


Adult male coconut scale *(Aspidiotus destructor)*[57]


Adult female mining scale (*Howardia biclavis)*[1]


Adult female *Chrysomphalus dictyospermis*[60]

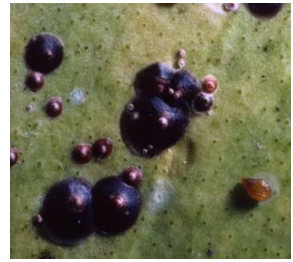

Adult female *Kilifia acuminats*[62]


Adult female *Chrysomphalus dictyospermi* [61]

Adult female black scale (*Parasaissetia nigra*)[59]

Adult female hemispherical scale (*Saissetia coffeae*)[1]

Adult female citrus snow scale (*Unaspis citri*)[3]

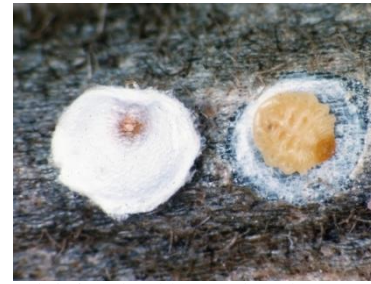


Adult female Florida red scale (*Chrysomphalus aonidum*)[1]

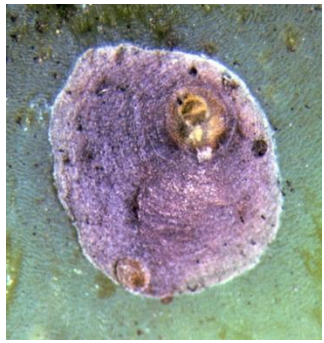
Adult female purple scale (*Lepidosaphes beckii*)[61]

Adult female black scale (*Saissetia oleae*)[3]

Adult female chaff scale (*Parlatoria pergandii*)[60]



Adult female white peach scale (*Pseudaulacaspis pentagona*)[1]



Adult female trilobe scale (*Pseudaonidia trilobitiformis*)[61]

Adult female green shield scale (*Pulvinaria psidii*)[61]

Adult female stellate scale (*Vinsonia stellifera*)[63]

Adult female pineapple scale (*Diaspis bromeliae*)[1]

Southern green stinkbug (*Nezara viridula*)

Crops: avocado, pepper, rice, citrus, beans, potato, cabbage, tobacco, tomato

Characteristics: nymphs are black with orange, red, and yellow markings on their backs. As they get older, they still have the markings, but start turning green. Adults are light green with a shield shaped body and an inverted green triangle with 3-4 white dots on their back. They emit a foul smell when disturbed.

Life cycle: eggs are laid in clusters of 30-130 on the undersurface of leaves and hatch in 5 days to 3 weeks, depending on the season, and tend to aggregate. Nymphs start feeding in the second instar and go through five instars, with each molt taking seven days. They overwinter as adults and adults live for several months. They take 65-70 days to reach maturity and can have up to four generations per year.

Damage: feed on plant sap on any plant part but tend to prefer growing shoots and developing fruits. Growing shoots can wither and may die. The fruit will have brown or black spots from feeding puncture wounds, which decreases marketability. Fruit may also drop, wither, or deform. They may also transmit tomato bacterial spot.

Control: control weeds, plant trap borders (legumes). Trap crops should be sprayed or plowed before nymphs become adults, which will prevent their migration to main crops. Introduced biological control is very effective that chemical control may not be needed. The parasitic flies, *Trichopoda pennipes* and *Trichopoda pilipes,* and the parasitic wasp, *Trissolcus basalis*, are the most effective. However, ants and spiders also predate on the stinkbug. Chemical sprays can be applied at blossom and fruit formation, but usually are not required.

First instar green stink bug nymph [38]


Third instar green stink bug nymph [39]


Fifth instar green stink bug nymph [40]


Adult green stink bug[40]

Tomato bug (*Nesidiocoris tenuis*)

Crops: tobacco, tomato

Characteristics: adults are small, green, slender, and elongate bugs with light brown antennae and a black band behind the eyes. Females are larger in size than males and are more rounded. Nymphs resemble adults, except they are smaller, without the scutellum (the triangle shape on their backs), and have no black markings like adults. Early nymphs kind of look like aphids: green, soft bodied, and no wings. All nymphal stages have dark brown eyes.

Life cycle: eggs are deposited on host plant and hatch seven days later. Nymphs feed on the plant (they eat other insects)

and go through five molts. They do not pupate and become adults in 14 days. They have a shorter life cycle if they feed on white fly or moth eggs and larvae than if they feed on thrips or mites.

Damage: the tomato bug is actually considered a beneficial insect in biocontrol. They will sometimes feed on plant juices if there is not enough food, which is why they can become an agricultural pest. If populations are too high, they can cause fruit and flower drop, spots on fruits, and deformed flowers and fruits.

Control: usually not needed if there is plenty of prey available for them.

Adult tomato bug[104]

White flies

Crops: avocado, pepper, banana, plantain, coconut, citrus, beans, melon, potato, tobacco, tomato

Characteristics: generally, nymphs look like scales (oval and flat) and identification is usually based on the nymph. Some nymphs may have fluffy waxy filaments (wooly whitefly). Adults resemble tiny white moths with a yellowish abdomen and are covered in a white powder. The underside of leaves usually look cottony.

Life cycle: eggs are laid on the underside of leaves in a circular shape. They will hatch 5-7 days later. The nymphs will go through four instars and in the first instar (called crawlers) they are mobile and find a spot to settle. The later instars are immobile. They take about 40 days to complete cycle, depending on temperature and species. Have many generations per year.

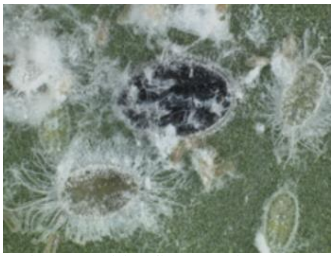
Damage: both matures and immatures are the damaging stages. They feed on the plant sap causing leaf yellowing/silvering, leaf death, distortion, wilting, and sooty mold caused by honeydew production, which decreases marketability.

Control: monitor populations by using sticky traps. Physically remove infested plant parts by pruning and hedging, vacuuming, or spraying with a strong force of water. Natural enemies already present tend to attack the nymphs such as lacewings, thrips, Coccinellid beetles, and damsel bugs. The parasitic wasp, *Eretmocerus* sp., the Yuma spider mite, and the *Tydeus* spp (mite) are particularly effective at controlling the woolly white fly. Try to conserve natural enemies. Decrease ant populations. Chemical insecticides such as spray oils, insect growth regulators, neonicotinoids, organophosphates, and pyrethroid sprays are also effective, however white flies can develop resistance quickly due to their fast growth.

Woolly white fly nymphs (*Aleurothrixus floccosus*)[22]

Coconut white fly nymphs (*Aleurotrachelus atratus)*[23]

Spiraling white fly nymphs and adults (*aleurodicus dispersus)*[24]



Solanum white fly nymphs (*Aleurotrachelus trachoides)*[25]

Greenhouse white fly adults (*Trialeurodes vaporariorum)*[26]

Diptera (flies)

Leafminers (*Liriomyza* spp.)

Crops: garlic, onion, beans, melon, cabbage, tomato, pepper, potato

Characteristics: larvae are yellowish and legless. Adults are very small yellow flies with red eyes and yellow legs. They have dark wings and a mostly black thorax and abdomen from the top view.

Life cycle: eggs are laid in the epidermis of mature leaves. Eggs hatch 2-4 days later. Larvae feed within the leaves, creating irregular mines, and go through four instars before pupating in the soil (most common), underside of leaves, or within the tunnel, depending on species, for about ten days. They take 15 days to a month for complete development and have many generations per year.

Damage: leaf stippling, leaf mines (blotchy, blister, or serpentine mines), both of which decrease the plant's ability to photosynthesize. Premature leaf drop is also common, which can cause fruit sun scalding, plant growth reduction, and entry of fungal and bacterial diseases. Tomatoes are found to be more resilient than other crops.

Control: monitor adults by using sticky traps or by placing a yellow bowl with soapy water next to infested crop. Counting larvae and pupae is possible, but very time consuming. Remove weeds, deep plow crop residues to bury emerging adults, conserve biodiversity, destroy infested plants, avoid overusing nitrogen fertilizers, remove other plants like chrysanthemum and marigolds that are known to host leafminers, rotate crops, maintain good plant health and irrigation. Using plastic mulches and staking plants has been shown to increase leafminer activity on crops. The best biocontrol is the Braconid, Eulophid, and Pteromalid parasitic wasps, which do the best job of controlling

populations. Spiders, predatory wasps, ants, and nematodes also predate on leafminers. Insecticides can be used, although most of the time are not needed if natural enemy populations are high. Insecticides can also reduce the population of already present biocontrol organisms, however if treatment is necessary, Bt (Bacillus thuringiensis) is the most recommend and growth regulators also work well. Insecticidal soap, horticultural and plant oils (rosemary, neem, peppermint) are organic methods. Because insecticide resistant is high in the leafminers, it is important to rotate the type of insecticide.

American serpentine leafminer larva (*Liriomyza trifolii*)[3]

Adult American serpentine leafminer (*Liriomyza trifolii*)[3]

Adult pea leafminer (*Liriomyza huidobrensis*)[59]

Adult vegetable leafminer (*Liriomyza sativae*)[75]

Adult cabbage leafminer (*liriomyza brassicae*)[99]

Serpentine mines[13]

Blotch mines[100]

Coleoptera (beetles)

Banana root borer (*Cosmopolites sordidus*)

Crops: banana, plantain

Characteristics: larvae are white with a reddish-brown head and are legless. Adults are a shiny dark brown to charcoal color with little dents. Their legs have hook-like extensions, and they have long beaks.

Life cycle: eggs are laid singly between stems, leaf sheaths, and around the corm. Eggs hatch in about a week. Larvae bore into the corm and feed for 15-20 days then pupate for six to eight days. Adults can live for over two years.

Damage: most damage is done by the larvae boring into the corm, which weakens the plant and can cause the plant to fall over easily. They may vector diseases.

Control: use freshly cut trunks (pseudostems) and corms as traps or use pheromone traps, as they are attracted to them. Perform rotations, cut pseudostems as high as possible, cut and destroy residues and infested trees, have good drainage to prevent diseases. The most important biocontrol agent is the Histerid beetle. Chemical products can be used as well.

Adult banana root weevil[75]

Banana root weevil damage[76]

Banded Cucumber Beetle (*Diabrotica balteata*)

Crops: pepper, potato, cabbage, tomato, tobacco, melon

Characteristics: eggs are yellow and oval. Larvae are white to cream in color. Adults have a red head and a yellowish

body with green horizontal bands, however, sometimes the lines are absent.

Life cycle: two to 15 egg clusters of around 100 eggs are laid in soil cracks and hatch within 5-9 days. Larvae go through three instars, which takes 11-17 days to become a pupa. They will pupate in the soil for 4-6 days. Adults live on average for 26 days.

Damage: both larvae and adults cause damage. Larvae feed only on roots, which may kill seedlings and may increase the chances of Fusarium wilt. Adults will eat all plant parts (blossoms, leaves, crown, roots, etc.), causing defoliation and damage on fruit surfaces, reducing marketability (especially in young melons). They can also carry virus diseases in beans and the squash mosaic virus.

Control: control weeds, avoid planting cucurbits next to corn, rotate crops, plant trap crops, implement insect nets. Natural enemies include the Tachinid fly and nematodes. Granular and foliar insecticides may be used.

Banded cucumber beetle larvae[15]

Banded cucumber beetle adult[16]

Cigarette beetle (*Lasioderma serricorne*)

Crops: tobacco

Characteristics: larvae look like small hairy white grubs. They look very similar to the drugstore beetle, only they have longer hair and the head has a dark marking. Adults are small, reddish-brown beetles with a rounded and oval body shape covered in fine hairs. Their head faces down, making it not visible from the top. When disturbed they tuck their head and legs and do not move.

Life cycle: eggs are laid in stored products (tobacco, dog food, dry fruits, flour, books, medicines, etc.) and hatch 6-10 days later. Larvae feed for 5-10 weeks and go through six instars before pupating. They have yeast in their digestive system that allows them to consume a variety of foods, which includes low quality food like cardboard. They create a cocoon made from food and debris and pupate for 1-4 weeks. They take 40-90 days to complete their lifecycle and have five to six generations per year.

Damage: besides directly feeding on stored foods and items, they contaminate with their presence, frass (feces), and pupal cases. They can also indirectly damage goods by feeding on the packaging.

Control: wrap infested items in plastic and throw away, freeze items in a plastic bag for 4-7 days to kill every stage, or heat items in an oven for an hour at 190°F or 16-24 hours at 120°F. Freezing and heating can also be used as a prevention method to kill any undetected beetle. Maintain good sanitation and store foods in airtight containers. Biocontrol includes Tenebrionid, Clerid, and ground beetles, predatory mites, and parasitoid wasps. Chemical treatments are usually not needed, however, residual insecticides can be applied in cracks and crevices. Sticky traps, fumigation, and insect growth regulators work well. These are mainly used for large scale or commercial farms.

Cigarette beetle larva (left) and drugstore beetle larva (right)[103]


Adult cigarette beetles [75]

Citrus root weevil (*Diaprepes abbreviates*)

Crops: avocado, citrus, beans, mango, potato, papaya

Characteristics: larvae are creamy white grubs with dark heads and no legs. Adults are black with yellow, orange, or red colors on their back, which gives the appearance of black lines. They also have a long head and can fly.

Life cycle: oblong eggs are laid in clusters in folded leaves. They hatch about eight days later and fall to the ground to feed on roots for a couple of months and then pupate in the soil. Adults live 3-4 months and emerge year-round.

Damage: both adults and larvae cause damage. Adults cause notching at the leaf margins, especially of young leaves. Larvae feed on roots, causing root girdling, death of plant, and root rot infection.

Control: confirm damage is from weevils, as grasshoppers and caterpillars also notch at the margin. Do this by looking for adults, as larvae are in the soil and hard to find. Do not search immediately after heavy rain because the rain causes

them to fall off the plant. They spread quickly through contaminated soil and debris, so maintaining proper sanitation practices help decrease the spread. Horticultural oils and growth regulators are effective against eggs. Soil applications can be used to control larvae, and short residual foliar sprays can be used to control adults. Using fungicides for the roots will help fight any infection caused by the weevil.

Mature (left) and young (right) citrus root weevil larvae[49]

Adult citrus root weevil [50]

Flea beetle

Crops: beans, potato, cabbage, tobacco, tomato

Characteristics: larvae are small, worm-like, and cream-colored. Adults are black, metallic, bronze, brown, or bluish/greenish in color and some have stripes. When disturbed they will jump, hence the name.

Life cycle: eggs are typically laid in soil, roots, or leaves, and sometimes on flowers and ornamental plants. They pupate in the soil and overwinter as adults in the soil or leaf litter. They have 1-2 generations per year.

Damage: soil larvae feed on plant roots, but usually do not impact plants, with the exception of the tuber flea beetle

(*Epitrix tuberis*), which scars potatoes. Leaf dwelling larvae will feed on leaves. Adults often produce shot holes on leaves and feed on stems as well. Like with the larvae, injuries caused by the beetle do not impact the plant much. However, seedlings are at a higher risk of damage.

Control: monitor using sticky traps in the spring. Physically remove beetles with a vacuum or sweep net (they are good jumpers) and dispose correctly. Control weeds, remove old plant debris, use transplants, sow many seeds to improve chance of survival, add thick mulches, plant crops as late as possible, use covers on rows or screens around seedlings and remove during bloom to allow for pollination. Plant trap crops before the main crop is planted. They will go towards the tallest and earliest crops, like radishes, and once present, spray or destroy. Biological control mainly controls the larval population, however the Braconid wasp, *Microctonus vittatae*, is known to kill the adult beetles. Diatomaceous earth and kaolin clay help repel adults. Spinosad and pyrethrins are some effective chemical controls.

Adult potato flea beetle (*Epitrix* cucumeris)[42]

Adult potato flea beetle (*Epitrix fasciata*)[42]

Potato damage caused by larvae[43]

Shot hole leaf damage[44]

Pepper weevil (*Anthonomus eugenii*)

Crops: pepper

Characteristics: larvae are creamy white grubs with yellow-brown heads, no legs, and few hairs. Adults are small black beetles with cream speckles over the body. They are very arched with long breaks and antennae.

Life cycle: eggs are laid beneath the bud or pod surface and covered with a brown fluid that hardens. They hatch in 3-5 days. Larvae feed within the buds or fruit and go through three instars. They pre-pupate for about five days then pupate for about five more days. Adults emerge 3-4 days later. They reach maturity in 20-30 days and have up to eight generations per year.

Damage: both adults and larvae cause damage. Adults cause black dots on fruits from feeding which decrease marketability. Larvae cause inner fruit molding, browning, and premature color change, all of which decrease marketability. Both larvae and adults cause bud and fruit drop, and fruit deformation.

Control: monitor by using yellow sticky traps or by inspecting bugs and fruit. Remove and destroy fallen fruit and surrounding wild pepper plants, perform crop rotation. There is not much biocontrol, but parasitic wasps are known to attack larvae, though it is minimal in controlling populations. Foliar sprays like pyrethrin can be used at bud formation.

Pepper weevil larva[51]

Adult pepper weevil[52]

Rice water weevil (*Lissorhoptrus oryzophilus*)

Crops: rice

Characteristics: larvae are slender, white, legless, C shaped larvae with projections resembling spines. Adults are greyish-brown with a long beak and a dark brown V shaped marking on their backs.

Life cycle: eggs are laid into leaf sheaths under water and hatch 4-9 days later. Larvae mine in the leaf for about a day then move to the soil to feed on roots and continue their development. After 27 days they are ready to pupate in mud cocoons attached to rice roots. They overwinter as adults in

grasses and debris. They take about 35 days to reach maturity and have 2-3 generations per year.

Damage: larvae and adults cause damage. Larvae cause most damage by feeding on roots, which leads to decreased yields, stunting, and increased weeds. Adults feed on the upper leaf layer, resulting in long skeletonized scars. Adult feeding may kill seedlings and they tend to feed at night.

Control: inspect plants for elongated scars on leaves or put traps after flooding. Control weeds around field and aquatic weeds, drill seeding when field is dry, winter flooding, plant early, increase field size. Pyrethroids and insect growth regulators could be applied, however the timing is important, so read labels before applying.

Adult rice water weevil[114]

White grubs/May or June beetles (*Phyllophaga spp.)*

Crops: avocado, pepper, rice, citrus, beans, banana, plantain, potato, pineapple

Characteristics: larvae are large C shaped grubs with a brown head and six legs. The abdominal end is opaque, often filled with soil, and with spines that help determine the species. Adults range in color from yellow to dark reddish-brown to black, and some are brightly colored. They are oblong and glossy.

Life cycle: eggs are deposited in the soil in clusters of 15-20 eggs and hatch about three weeks later. Larvae feed on roots and overwinter. This repeats until it is ready to pupate and they go through three instars. They pupate in the soil and emerge a few weeks later and stay in the ground. They will overwinter again as adults. Development can take up to four years for some species.

Damage: both adults and larvae are damaging. Adults defoliate and larvae feed on roots, disrupting the plant's ability to take up nutrients and water. Damage is very similar to drought stress: wilting, yellowing, and stunting. They may kill young plants. Indirect damage can happen from animals digging for beetles and grubs.

Control: remove grass and weeds, plant clover or alfalfa, and avoid planting corn or potatoes (in fields that were grasses) during the years of high infestation. Plow in late spring or early fall to kill the different stages and expose them to animals to eat. Avoid no-till, maintain good plant health. Biocontrol includes skunks, raccoons, turkeys, sandhill cranes, parasitic wasps and flies, and the *Cordyceops* fungus which attacks the grubs. Be sure to properly identify the grubs to know which chemical to use.

May beetle (right) and grub(left)[77]

Lepidoptera (moths/butterflies)

Bean leafroller (*Urbanus proteus*)

Crops: beans

Characteristics: young larvae are yellowish with a very large blackish-brown head. As they become older, they gain black speckles and one black and two yellow longitudinal lines along their backs. Adults are fairly large brown skippers with tails on their hind wings and five to seven light colored square or rectangular markings on their forewings. Their bodies and wings have iridescent green scales.

Life cycle: eggs are laid singly or in clusters on the lower leaf surface and hatch 3-4 days later. During the day they are found hiding in rolled leaves then come out at night to feed. Larvae go through five instars in 15-20 days before pupating on the plant in rolled leaves for 7-20 days. They reach maturity in about one month.

Damage: the larval stage is the damaging stage as they defoliate.

Control: can handpick and destroy larvae, although this would require unrolling leaves or doing so at night, which is not ideal. Biocontrol includes Tachinid flies, wasps, stinkbugs, and the nuclear polyhedrosis virus. Bt is not recommended and if needed, foliar sprays should be applied in late season beans.

Mature bean leafroller larvae[105]

Adult bean leafroller skipper (longtail skipper)[106]

Bean pod borer (*Maruca vitrata*)

Crops: beans

Characteristics: larvae are cream or pale greenish-yellow with a dark brown head and two rows of black oval spots along their back. Adults are slender bodied brown moths with silver blotches near the middle of the wings and their hind wings are silver with brown tips.

Life cycle: eggs are laid singly or in small clusters on flower buds and terminal shoots of young plants. Eggs hatch about three days later and larvae feed on foliage and flowers (early instars) and bean pods (older instars) for about 13 days before pupating under plant litter. They pupate for 6-7 days before emerging as adults. Adults are nocturnal and hide on the underside of leaves during the day. Adults live for 6-10 days.

Damage: the larval stage is the damaging stage. They feed on foliage, flowers, and bean pods, reducing yields. The bean pods themselves are unusable as they have entry holes, built up frass, and eaten seeds. In fact, they can cause an 80% yield loss. Entry holes allow pathogens and water into the pod, which stains undamaged seeds. They rarely damage peanuts and soybeans.

Control: inspect plants for symptoms. Make sure to unfold leaves and open flowers and pods to find feeding caterpillars. Check the underside of leaves as well for adults. Hand pick and kill larvae, plant early, use resistant or tolerant varieties, use early maturing varieties, remove other leguminous plants from around the field as they host the caterpillars, intercrop or rotate with maize, sorghum, or cowpeas, maintain plant health, conserve biodiversity. Prune silk-infested leaves and older leaves to allow more sunlight and aeration. Insecticides could be used, although they are difficult to apply since larvae are usually found inside flowers

or pods, however, Bt and neem oil are recommended and should be applied before larvae enter bean pods.

Bean pod borer larva[113]

Adult bean pod borer moth[112]

Beet armyworm (*Spodoptera exigua*)

Crops: pepper, garlic, onion, beans, tomato, potato

Characteristics: Larvae are green to yellow during their first and second instars and later develop pale stripes during the third instar. They become darker with a dark lateral stripe in the fourth instar, and on the fifth instar they change to green with pink or yellow with a white lateral stripe. They also have dark spots and lack hairs and spines. The adults are mottles grey and brown colored moths with white hind wings with a marginal dark line.

Life cycle: clusters of 50-150 green-white eggs are laid by the moth usually near blossoms, tip of branches, and leaves. The egg masses are covered with a cottony substance and eggs hatch in 2-3 days. The larvae go through five instars before becoming adults, and then pupate in the soil for 6-7 days in the summer. Once emerged, they mate and lay eggs within 2-3 days. Adults die within 10 days after mating. It takes about 24 days to complete its lifecycle.

Damage: larvae are the concern, as they feed on foliage and fruit. They cause defoliation, skeletonizing, holes in fruits, and can stunt or kill seedlings.

Control: hand-pick and destroy larvae, remove weeds along garden/field borders. Biocontrol includes bigeyed bugs, spiders, minute pirate bugs, damsel bugs, assassin bugs, lacewings, parasitic wasps, Tachinid flies, and fungal/viral diseases. Insecticides may be used; Bt and Spinosad are organic treatments. Planting border strips on alfalfa helps retain natural enemies and prevent the larvae from going to the actual crops.

Beet armyworm newly hatched larvae[5]

Young beet armyworm larvae[6]

Mature beet armyworm larvae[7]

Adult beet armyworm moth[8]

Cabbage looper (*Trichoplusia ni*)

Crops: beans, melon, potato, cabbage, tobacco, tomato

Characteristics: larvae are greenish with a white stripe on each side and are somewhat hairy. Sometimes they have faint white stripes on their back. Their head and legs are light green or light brown. As they walk, they create a loop shape. Adults are a mottle grey-brown moth with a white U shape and dot/circle on each wing. The hind wings are dark brown with a tan edge.

Life cycle: eggs are laid singly or in small clusters on leaves and will hatch in 2-10 days. Larvae feed for about 20 days, go through five instars, and then pupate on the underside of foliage, soil, or plant debris for 4-13 days. Adults emerge and live for 10-12 days. They reach maturity in 18-25 days. Depending on location, they can have 1-7 generations per year.

Damage: the larval stage is the damaging stage. They defoliate; younger larvae feed on lower leaves and older larvae will create large holes and sometimes feed at the leaf margin. They will also leave frass at the feeding sites, contaminating the product. Killing young plants and causing fruit sun scald are other damages.

Control: monitor/inspect plants, plant cabbage looper resistant varieties, physically remove larvae and properly dispose. The parasitic wasps, *Trichogramma* spp. are effective biological control. Insecticides are available (like Bt) but would require multiple applications. It is important to not repeat the same application.

Cabbage looper larvae[34]


Adult cabbage looper moth[35]

Citrus leafminer (*Phyllocnistis citrella*)

Crops: citrus

Characteristics: larvae are found in leaves creating mines and leaving trails of frass. The larva itself is small and yellow. The adult is a very small moth with white and silvery iridescent forewings and a black spot on each tip of the wings. They also have black markings on the forewings and long fringe scales (looks hairy) on the body and wings.

Life cycle: eggs are laid singly on the underside of leaves at night and hatch 2-10 days later. Larvae feed within the leaf and go through four instars in 20 days. They pupate in the mine in a pupal cell near the leaf margin for 6-22 days. They have multiple generations per year and total development time is 13-52 days. Adults live for a few days.

Damage: the larval stage is the damaging stage. They create serpentine mines in young leaves, which decreases aesthetic value. They rarely mine on fruits. High infestations can cause decreased fruit yield, growth retardation in young trees, leaf curling, and entry points for the citrus canker bacteria.

Control: adults are hard to see, so monitor based on leaf mines. Hang pheromone traps about shoulder height of trees

and identify caught adults to determine control method. Avoid pruning more than once a year (they do not lay eggs on hardened leaves), avoid applying nitrogen fertilizers when populations are high, do not prune off mined leaves (unmined parts still photosynthesize), remove shoots growing from the trunk base (water sprouts), and conserve natural enemies. Biocontrol includes parasitoid wasps. Since larvae are found within the leaves, they are hard to reach for insecticides. Usually, the previously mentioned control methods are enough to control populations, however in case of a high infestation, apply during egg laying or drench in soil before new growth. Avoid broad spectrum insecticides as they kill beneficials and therefore may cause a buildup of other pests.


Citrus leafminer larva[89]


Adult citrus leafminer moth[3]


Serpentine mines[89]

Corn earworm (*Helicoverpa zea*)

Crops: pepper, beans, tobacco, tomato

Characteristics: larvae look very similar to tobacco budworm. They can be brown, green, pinkish, yellow, or blackish, with an orangish net-like head. Above the spiracles they have a dark lateral stripe on both sides and a pale stripe below the spiracles. They also have microspines along their body. Adults are usually a tanish moth with a dark spot near the center of the wings.

Life cycle: eggs are laid singly on leaf hairs or corn silk and hatch 3-4 days later. Larvae feed on the plant and older larvae tend to turn cannibalistic on other larvae. They go through six larval instars in about 22 days. They pupate in the soil for 10-25 days, depending on temperature. Adults live for 15 days but can live up to 30 days and are nocturnal.

Damage: the larval stage is the damaging stage. They feed on foliage, blossoms, buds, and fruits, which increase the chances of pathogens. In corn they feed on silk and kernels.

Control: monitor moths with blacklight or pheromone traps. Hand pick and kill any larvae, plant trap crops, remove weeds, till to destroy overwintering sites, plant resistant varieties, plant earlier in the season to avoid egg laying. Biocontrol includes wasp parasitoids on eggs, ladybugs, soft winged flower beetles, green lacewings, minute pirate bugs, bigeyed bugs, nematodes, fungi, and birds. Bt and mineral oil are recommended, however other foliar sprays can be applied too. If spraying on corn, make sure to spray the silk since they tend to hide and feed within the silk.

Corn earworm larva[102]

Adult corn earworm moth[6]

Corn earworm exit hole[53]

Corn earworm damage[53]

Diamondback moth (*Plutella xylostella*)

Crops: cabbage

Characteristics: larvae are very small and green with a few short hairs that have small white patches surrounding the hairs. Their last prolegs form a V shape. When disturbed they wiggle violently. Adults are small, slender, greyish brown moths with a cream-colored band along their backs.

Life cycle: eggs are laid singly or in small clusters on leaves and sometimes other plant parts, which take about six days to hatch. Larvae go through four instars in 25-30 days. They pupate in a silk cocoon on leaves for about 8.5 days. Adults live 12-16 days and overwinter.

Damage: the larval stage is the damaging stage. They defoliate, leaving the leaf veins, and disrupt head formation and seedlings, which decrease yield and marketability. It is usually a minor pest, however, infestations may happen to where control is needed.

Control: monitor by counting larvae or damage level, or by using pheromone traps. Rain tends to kill larvae and adults, so irrigating with overhead sprinklers versus drip or furrow irrigation is better. Intercropping and inspecting transplants also help prevent infestations. Natural enemies include Braconid, Ichneumonid, and Eulophid parasitoids, fungi, and viruses. As for insecticides, Bt is the most recommended.

Diamondback moth larvae[3]

Adult diamondback moth[3]

Fall armyworm (*Spodoptera frugiperda*)

Crops: potato, tomato, rice, beans, cabbage, melon, pepper, garlic, onion

Characteristics: recently hatched larvae are greenish with a black head and as they grow older, they become reddish-brown with mottled-white markings and lateral white lines along their back. They have elevated spots, spines, and a light-colored inverted Y on the head. The adults are mottled brown-grey moths with whitish hind wings with a dark border.

Life cycle: dome shaped egg masses of 100-200 eggs are laid on foliage with a substance that gives it a fluffy appearance. Eggs hatch within 2-3 days. The larvae go through six instars in about 14 days in warm temperatures and 30 days in cooler temperatures. They will then pupate in the soil and sometimes on the soil surface surrounded by a cocoon made of debris. They pupate for 8-20 days, depending on temperature. Adults live 10 days on average.

Damage: larvae cause damage by defoliating. They burrow into the soil and feed on young plants, causing poor plant growth.

Control: planting early and/or planting early maturing varieties avoids the armyworms that develop later in the season. Avoid planting on different dates in the same area because it gives the armyworm a year-round food supply. Have good soil and plant health (healthy plants can recover from damage easier than unhealthy ones). Biocontrol includes wasp parasitoids, fly parasitoids, spined soldier bug, insidious flower bugs, striped earwigs, Carabidae beetles, birds, rodents, skunks, pathogens, fungi, viruses, and nematodes. To promote biocontrol, incorporate plant diversity on the property. This also includes plants that attract the armyworm so that it attacks it instead of the crop. Granular, liquid, and spray insecticides may also be used.

Young fall armyworm larva[12]

Mature fall armyworm larva[13]

Adult fall armyworm moth[14]

Granulate cutworm (*Feltia subterranea*)

Crops: garlic, citrus, potato, cabbage, tobacco, melon, onion, beans, tomato

Characteristics: eggs are of hemispherical shape and are white. As the eggs age, they become darker. Larvae are grey to reddish brown, have a yellow-brown head, a faint gray lateral band, and darker lines on their back. The adults are brown-grey moths with kidney shaped and round spots on their wings that are connected by a dark band. Their hind wings are white.

Life cycle: eggs are laid in clusters or singly on foliage and hatch in 3-5 days. At the beginning, larvae are found feeding on foliage during the day and night, however, as they become older, they hide in debris or soil during the day and feed at night. They will go through 5-7 instars before pupating. The larval stage lasts 22-32 days, depending on the number of instars. They will then pupate in the soil for 10-20 days. Adult moths then emerge and mate. They live on average 14 days.

Damage: the larval stage is the damaging stage. They eat seedlings, defoliate/skeletonize older plants, and feed and burrow into fruits. Can cause "rindworm" in cucurbits.

Control: manually pickoff and dispose larvae. Add physical barriers such as nets or row coverings to prevent moths from laying eggs. Other cutworms can be controlled by weed management, however, it is not too effective for granular cutworms. Biocontrol includes Braconid and Ichneumonid wasps, Tachinid flies, and pathogens. Liquid, granule, or bait insecticides can be used, with bran-based baits being the most effective.

Granulate cutworm larva[17]

Adult granulate cutworm moth[18]

Melonworm (*Diaphania hyalinata*)

Crops: beans, melon

Characteristics: larvae are yellowish green, and as they mature they will gain two white stripes along their body, however they tend to fade before pupating. Adults are moths with hair at the tip of the abdomen. Their wings are iridescent white in the middle and edged with black.

Life cycle: eggs are laid in small clusters at night in buds, stems, and on the underside of leaves and hatch in 3-4 days. Larvae feed on the plant and go through five instars. They pupate in silken cocoons on the underside of leaves for about 10 days. They take about one month to complete their life cycle and have up to three generations per year.

Damage: the larval stage is the damaging stage. They defoliate, may burrow into fruit, create scars on melon skins, all which decrease marketability and yield.

Control: it is best to monitor by checking for larvae. Plant trapping crops (squash is preferred by the melonworm), add row covers, early planting, and intercrop corn, beans, and squash. Biocontrol includes the nematode *Steinernema carpocapsae*, although not too effective alone. Neem oil and Bt can be used on foliage to treat larvae. Chemical pesticides can also be used, however, they may kill pollinators.

Mature melonworm larva[3]

Adult melonworm moth[6]

Palm leaf skeletonizer (*Homaledra sabalella*)

Crops: coconut

Characteristics: larvae have colorless bodies with a dark brown band on the thorax and a dark brown head. Adults are small silvery beige moths with a black spot on the thorax and two black spots on each wing.

Life cycle: eggs are laid in masses on palm leaves and are covered with a brown papery material. Larvae hatch and feed in groups in silken tubes that are covered in frass and store 35-100 caterpillars. Caterpillars will pupate within the webbing. Adults live 3-10 days, and they have five generations per year.

Damage: the larval stage is the damaging stage. They skeletonize leaves, leave brown blotches on leaves, leaves may dry and die, all of which decrease aesthetic value and the plant's ability to photosynthesize. Healthy trees, however, rarely die from feeding.

Control: maintain good plant health, cut and burn infested leaves, wash/wipe infested leaves, spray leaves with high pressured water, and inspect transplants. Biocontrol includes ground beetles and parasitic wasps and flies. Insecticides are not effective since the caterpillars are protected by the webbing. Spraying the tree with insecticides after pruning may be effective.

Adult palm leaf skeletonizer moth[13]

Adult palm leaf skeletonizer moth[116]

Palm leaf skeletonizer frass tubes[96]

Potato tuber moth (*Phthorimaea operculella*)

Crops: pepper, potato, tobacco, tomato

Characteristics: larvae are creamy or greenish in color with a brown head. As they grow they become a pink or greenish color. Each segment has bristles. Adults are moths and have silvery grey-brown fringed wings with dark spots (males) or an "X" (female) and grey hind wings.

Life cycle: 60-200 eggs are laid on foliage or soil cracks and hatch in 2-6 days. Larvae feed on the plant for about two weeks, then pupate in the soil for 6-29 days, depending on temperature. They take about one month to complete life cycle. Adults live up to 10 days. May have multiple generations per year.

Damage: the larval stage is the damaging stage. They eat any plant part including potato tubers. Cause foliage blistering, death, and mining. The most important damage is tuber damage from larvae that either make their way through the plant to the tuber or from dropped leaves they were on. They are most problematic in potatoes, which is the focus of this section. They bore into tubers, creating tunnels filled with frass, which decreases yield and product quality. These tunnels will cause a passageway for diseases, too.

Damage is also common in stored potatoes. In tomatoes and peppers, they will damage foliage and unripe fruits.

Control: monitor to prevent infestations by using pheromone traps. Eliminate weeds, plant potatoes deeper in soil (harder for larvae to reach), eliminate infested seeds, eliminate debris piles (removes overwintering site), harvest on time, do not leave potatoes aboveground overnight (exposes potatoes to moths). Improve storage management by keeping temperatures below 52°F and maintaining proper sanitation. Irrigating to prevent cracks from getting larger is very effective at preventing larvae reaching potatoes. Biological control includes two species of Braconid wasps (*Copidosoma koehleri* and *Bracon gelechiae*). Chemical control can be used for adults and larvae; Bt is an organic and effective treatment.

Potato tuber moth larva[31]

Potato tuber moth female (right) and male (left) adults[32]

Potato tuber moth damage on potato[33]

Southern armyworm (*Spodoptera eridania*)

Crops: tomato

Characteristics: larvae are green or dark green with a light brown or reddish-brown head. They have patterns as well, but they are variable. Older larvae gain a narrow white line dorsally and more laterally. They also have a yellowish-orange stripe on each side and a dark spot on each abdominal segment. Adults have brown-grey mottled front wings with black markings. Some may have a bean-shaped marking, some may not, and some may have a black band instead. The hind wings are whitish with a light brown outlined margin.

Life cycle: eggs are laid in clusters on leaves and are covered with moth scales. They hatch in 4-6 days. Larvae go through six instars and primarily feed on the lower leaf surfaces at night. 14-20 days later they will pupate in the soil for about 11-13 days. They take 30-40 days to complete their life cycle.

Damage: larvae defoliate, skeletonize, bore into fruit and stem tissues, and feed on tubers.

Control: monitor using pheromone traps and inspecting plants. Hand pick and drown larvae in soapy water.

Biological control includes wasp parasitoids, stinkbugs, and fungus. Foliar insecticides work better if applied when larvae are small. Bran bait may be used for larger larvae.

Southern armyworm larvae feeding on a tomato[3]

Adult southern armyworm moth[3]

Soybean looper (*Chrysodeixis includens*)

Crops: beans, tomato

Characteristics: larvae are green with light longitudinal stripes on both sides and along the back. When they walk, they loop (like cabbage loopers). They may have black or green thoracic legs, whereas the cabbage looper has green. Adults are mottled brown and grey moths with a golden glitter look. They have two silver spots in the middle of their forewings. Their hind wings are a lighter brown color. They are easily confused with the cabbage looper.

Life cycle: eggs are laid on the underside of leaves and hatch three days later. Larvae feed on the leaves for 2-3 weeks and go through six larval instars before pupating. They pupate in silken cocoons on the underside of leaves for 7-9 days. They take about 27 days to reach maturity and may

have one generation per year, but possibly more in hotter regions.

Damage: the larval stage is the damaging stage. They defoliate and sometimes will feed on fruits, leaving them with scars. They tend to start defoliating from the lower inside canopy to outward and up.

Control: handpick larvae and kill. Biocontrol includes hemipterans, parasitic wasps, nematodes, and fungal pathogens. Although they are normally not considered a pest of economic importance, outbreaks can occur. If this is the case, Bt is recommended.


Soybean looper larva[111]


Adult soybean looper moth[105]

Striped grass looper (*Mocis latipes*)

Crops: rice

Characteristics: larvae are yellow-brown in color with three longitudinal stripes along their back. The middle stripe is orangish, and the outer ones are a darker brown color. They also have a brighter yellow stripe on their sides. They have striped heads, and two distinct spots on their back

when their back rises. Like the cabbage looper, the striped grass looper makes a loop as it walks. The adult is a mottled light brown moth. There are two brown spots in the center of the front wings, as well as little black dots at the wing margin.

Life cycle: eggs are laid singly or in clusters on grasses (rice) at night and hatch in 3-5 days. Larvae feed mainly at night for 20-40 days and go through about six instars. They will pupate within folded leaves for 6-12 days. Adults live for 10-20 days. They complete their life cycle in 40-60 days and have several generations per year.

Damage: larvae defoliate and leave leaf notches on margins.

Control: light traps, sugar-based baits, and pheromone traps are effective for moths since larvae hide during the day. Destroy weeds, especially grasses, and keep crops healthy. Biocontrol includes ground beetles, bigeyed bugs, parasitic flies, and nematodes. Foliar insecticides and Bt can be used.

Striped grass looper larva[45]

Adult striped grass looper moth[46]

Sugarcane borer (*Diatraea saccharalis*)

Crops: rice

Characteristics: larvae are whitish in color and have two forms: winter, without spots and a hair on each segment, and summer, with large brown spots with a hair on each body segment. Adults are yellow-brown moths with wings that have brown lines to the wing margin. Males have a dark hind wing, and females a white hind wing.

Life cycle: eggs are laid in clusters of 2-50 eggs on the surface of leaves and hatch in 4-6 days. Larvae bore into the plant stalk, go through five instars in about 25 days and overwinter in this stage as well. They pupate in the plant for about 10 days. Adults live 3-8 days. They can have up to five generations per year.

Damage: the larval stage is the damaging stage. Larvae bore into plants (common in sugarcane and corn), which causes weakening or death of plants, breakage, stunted growth, reduced seed production, holes on leaf blades, and increased risk of fungal growth.

Control: destroy leftover debris to eliminate overwintering sites, and plant resistant varieties. Biocontrol includes Trachinids, Braconids, and *Trichogramma* spp. Parasitoids. Foliar insecticides can be applied when larvae are young and before they burrow into stalk.

Sugarcane borer larva[47]


Adult sugarcane borer moth[48]

Tobacco budworm (*Heliothis virescens*)

Crops: pepper, beans, tobacco, tomato

Characteristics: larvae are yellowish green with a yellow-brown head at first then later become light green, pinkish, or maroon colored with a brown head and light longitudinal bands along their back. They also have black microspines along their backs. They look very similar to the corn earworm. Adults are brownish tan moths with a light tinge of green. There are three dark transverse bands with lighter and narrower bands on the front wings. Hind wings are whitish with a dark band at the margin.

Life cycle: eggs are laid on blossoms, fruit, and terminal growth. Larvae feed on the plant and go through 5-7 instars

then pupate in the soil for about 13 days. Adults overwinter and live for about 20 days. They have 4-5 generations per year.

Damage: the larval stage is the damaging stage. They mainly bore into flowers and blossoms, but can also attack tender foliage, leaf petioles, and stalks. Feeding also allows an access point for pathogens. These result in lower yields and marketability.

Control: destroy weeds, mow, hand pick caterpillars and drown in soapy water. Biocontrol includes the *Polistes* spp. wasps, parasitoid wasps, bigeyed bugs, damsel bugs, minute pirate bugs, spiders, and fungi. Insecticides can be used, however, they can kill beneficial insects as well. Bt is recommended.

Tobacco budworm larvae[101]

Adult tobacco budworm moth[101]

Tobacco hornworm (*Manduca sexta)*

Crops: pepper, potato, tobacco, tomato

Characteristics: eggs are green and somewhat iridescent. Recently hatched larvae are yellow-green in color and have a long horn on their rear end. Older larvae are bright green with white diagonal lines, with dots next to the lines, and a red horn on their rear end. These are easily confused with the tomato hornworm, which has a black horn and V shaped lines. Adults are moths with mottled brown, black, and white front wings and striped hindwings. The abdomen has six pairs of yellow-orange spots. Again, not to be confused with the tomato hornworm, which has five pairs of spots.

Life cycle: eggs hare laid on leaves and hatch in 1-3 days. Larvae go through 4-5 instars before pupating. The larval stage lasts 3-4 weeks. Before pupating, they will go through a "prepupal" stage, where the larva wanders to find a suitable pupating location and starts forming its pupating shell. Once the location is found, it enters the pupal stage, and the shell hardens. The adult moth's lifespan is 2-3 weeks. They have one or two generations per year.

Damage: the larval stage is the damaging stage. They defoliate, eat/scar unripe fruit, which may lead to pathogens entering and reduction in fruit production. They also feed on blossoms and stems when there is no more foliage left. Adults are considered beneficial pollinators and feed on nectar.

Control: hand pick and destroy larvae in soapy water, set light traps for adults, till soil to destroy pupae, rotate crops with crops not attacked by hornworms, and conserve natural enemy populations. Biocontrol includes birds, small mammals, ladybugs, green lacewings, paper wasps, and Braconid wasps. Braconid wasps will parasitize the larvae, so if a larva has white cotton-like balls on its back, it was parasitized and therefore can be left alone. Pesticides are

usually not needed in a garden, however in a larger setting it may be used. Bt and Spinosad are some examples of pesticides.


Tobacco hornworm larva[19]


Adult tobacco hornworm moth[20]


Parasitized tobacco hornworm larva[21]

Tomato pinworm (*Keiferia lycopersicella*)

Crops: potato, tomato

Characteristics: larvae start out yellow-gray with a brown head and as they grow they become a mottled brownish to purplish black. Adults are small mottled greyish brown moths with fringed wings.

Life cycle: eggs are laid singly or in small groups and after hatching, they tunnel into the leaf to feed, leaving blotch mines (see “leafminers” on page 39). Mature larvae will enter stems or fruits or live and feed in folded leaves. They will have a total of four instars before pupating in the soil. Adults are nocturnal. They have 4-8 generations per year.

Damage: the larval stage is the damaging stage. They feed on leaves, stems, and fruit. On leaves they will fold and “tie” the leaves, on fruit they will leave tiny holes (entry/exit holes), many times with frass, which creates and access point for pathogens. They are usually hard to see in the fruit.

Control: field sanitation is key, as many infestations start from larvae in infested fruit, seedlings, containers, or infested crop residues left on the field. Due to this, it is a good idea to destroy leftover plants after harvest and inspect transplants. Handpick mined leaves and destroy, plow fields to destroy overwintering sites, crop rotation may help. Biocontrol includes parasites. Insecticides can be used in the first and second instars. Mature larvae live within leaf folds or fruit, making them hard to control with insecticides. Pheromone traps are also effective.

Tomato pinworm larva[28]

Adult tomato pinworm moth[107]

Tomato pinworm damage[108]

True armyworm (*Mythimna unipuncta)*

Crops: beans, potato

Characteristics: larvae are brown, grey, or greenish with longitudinal stripes along the body and a wide dark stripe on their sides. Sometimes the larva has a lighter stripe under the dark stripe. Its head is yellow-brown and has a net-like appearance. Adults are reddish-brown moths with grey hind wings that are white at the edges. There are one or two light spots in the center of the front wing as well as white lines with black dots towards the wing margin.

Life cycle: eggs are laid in clusters of 2-5 rows on leaf sheaths or blades. They will hatch 3-6 days later but can take up to 24 days depending on temperature. Larvae generally go through six instars and feed for 20-30 days. Instars 3-6 are nocturnal and are found in soil or soil debris during the day. They overwinter as larvae and pupate in the soil or soil debris for 7-40 days, depending on the season. They take 30-50 days to complete development. Adults are nocturnal and lay eggs 4-5 days after emergence and live 9-19 days.

Damage: the larval stage is the damaging stage. They heavily skeletonize, leave holes in leaves, and, as older instars, defoliate entire leaves.

Control: monitor adults with pheromone traps, capture adults with blacklight traps, or can capture caterpillars by hand. Eliminate weeds, till fields to destroy larval habitat, avoid planting grain crops near fields, mow cover crops, improve irrigation and fertilization (improves plant health), and conserve biodiversity. Biocontrol includes wasp and fly parasitoids, ground beetles, ants, hemipterans, spiders, birds, fungi, bacteria, and nematodes. Chemical pesticides can be used; foliar sprays can be used but are most effective when most of the larvae are one inch long. Bran baits sprayed with insecticides can also be used to treat larvae.

True armyworm larva[37]

Adult true armyworm moth[36]

Yellowstriped armyworm (*Spodoptera ornithogalli*)

Crops: pepper, rice, onion, beans, potato, tomato, tobacco

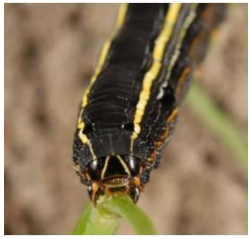
Characteristics: larvae come in different colors, but usually have a wide brown band on their dorsal side with a faint white line in the middle. They also have black markings resembling triangles with a white or yellow band right beneath them. They have an orange or pink band on their sides. There is also an inverted "V" on their head. Adults are brow-grey moths, with patterns on the front wings and white hindwings with a brown margin.

Life cycle: green to pink-brown eggs are laid in large clusters on the underside of leaves. The eggs hatch 3-5 days later. Larvae will go through 6-7 instars and tend to spin silk strand. They will remain a larva for 14-20 days until ready to pupate. They pupate in the soil for 9-22 days and then emerge into an adult.

Damage: larvae cause damage: defoliation, skeletonizing, and feeding on fruits.

Control: harvesting early, removing border plants, cutting fields, adding physical barriers, and handpicking and destroying larvae will help decrease populations. Biocontrol includes bigeyed bugs, spiders, minute pirate bugs, damsel bugs, lacewings, Tachinid flies, viral diseases, and the parasitic wasp *Hyposoter exiguae*. Bt sprays are an organic treatment, which should be used when larvae are young.

Yellow-striped armyworm larva[9]



Yellow-striped armyworm larva face with inverted "V"[11]

Adult yellow-striped armyworm moth[10]

Thysanoptera (thrips)

Thrips

Crops: avocado, pepper, garlic, onions, citrus, coconut, beans, papaya, melon, banana, plantain, tobacco, tomato

Characteristics: tiny, slender, log-shaped, usually black or brown, and are winged.

Life cycle: eggs are laid in plant tissue and hatch in about 6 days. They have two larval stages, which take about 6 days,

then they enter a prepupal and pupal stage, which take about 4 days. They pupate on the plant or drop in the soil. They take about 16 days to reach maturity. Adults can reproduce parthenogenetically and produce only males. Females that have been mated produce male and female offspring. They live for about 35 days and can have up to eight generations per year.

Damage: leaf stippling**,** fruit scarring, distortion, vector impatiens necrotic spot virus and tomato spotted wilt virus, stunting, premature drop, discoloration/silvering. Not all thrips are bad, some feed on mites, thrips, and other insects.

Control: monitor populations with sticky traps or by shaking foliage on white paper or cloth. Prune and destroy infested parts, use row covers, reflective mulch or mesh, control weeds, grow plants adapted for that site, keep plants healthy, avoid too much nitrogen fertilizer, remove old foliage, use resistant cultivars. Biological control includes green lacewings, predatory thrips, minute pirate bugs, mites, and parasitic wasps. Chemical control can be used, however, they do not prevent virus transfers. Insecticides include insecticidal soaps, contact sprays (that do not leave persistent residues), horticultural oils, and pyrethrins. Systemic insecticides and neonicotinoids can be used as well, but they can be toxic to beneficial insects as well.

Adult melon thrips (*Thrips palmi*)[27]

Adult onion thrips (*Thrips tabaci*)[28]

Adult greenhouse thrips (*Heliothrips haemorrhoidalis*)[29]

Adult redbanded thrips (*Selenothrips rubrocinctus*)[30]

Acari (mites)

Broad mite (*Polyphagotarsonemus latus*)

Crops: pepper, beans, papaya, mango

Characteristics: need magnification to see. Adults have swollen yellowish to green colored bodies. Females have a light stripe that forks near the end of their body and their two hind legs are whip-like. Males lack the stripe and have enlarged hind legs. Nymphs look like adults, only smaller in size.

Life cycle: eggs are laid in fruit depressions (look like white tuffs) and on the underside of leaves. Eggs hatch 2-3 days later as larvae and another 2-3 days later become nymphs. Adult females die after egg laying (8-13 days) and males live 5-9 days. They have multiple generations per year.

Damage: terminal bud and leaf deformation, leaves turn downward and turn a copper or purplish color, leaf curl, lateral buds break off more than usual, aborted blooms, stunting, fruit cracks and scarring, early fruit drop, and reduced yields and marketability. Fruit damage is more seen on the shaded part of the fruit.

Control: inspect for stunted growth, deformed terminal buds, mite aggregations especially on shaded side of fruit. Mite symptoms are similar to boron deficiencies, physiological disorders, or herbicide injury so it is important to confirm the presence of mites to choose the right control method. Control Argentine ants if present, as they contribute to infestations. Maintain good plant health. These mites are usually found with citrus rust mites, too. Biocontrol includes predatory mites. Chemical controls include miticides, and insecticidal soaps or oils (more environmentally friendly than miticides).

Adult broad mite[97]

Broad mite damage[98]

Broad mite damage[98]

Citrus rust mite (*Phyllocoptruta oleivora*)

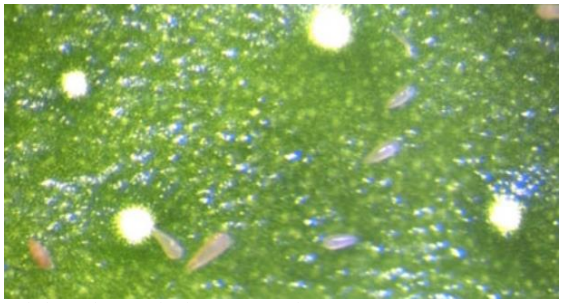
Crops: citrus

Characteristics: magnification is needed to see them. Adults are wedge-shaped, yellowish in color, and have four short legs near their head.

Life cycle: these mites do indirect fertilization, where the male will deposit a spermatophore (a protein capsule filled with sperm) and the female takes it up. She can start laying eggs 1-2 days later. Eggs are laid singly or in clusters on fruit or the underside of leaves. Nymphs will go through two instars with each lasting 1-3 days. They reach maturity in 10-14 days, depending on temperature. Adult females live for about 20 days, and they can have up to 30 generations per year.

Damage: they infest branches, twigs, leaves, and fruit, fruit skin scarring and cracking (russeting), reduced fruit size, fruit bronzing, increased fruit water loss, early fruit drop, leaf stippling, twigs may get black spots, defoliation. All of these result in decreased marketability, quality, and yield.

Control: biocontrol includes predatory mites and the fungus *Hirsutella thompsonii*. Miticides are the primary control method for these mites. Wettable sulfur and oils can be used but must be carefully applied as they can kill beneficial insects and mites. Sometimes fungicides are applied on crops. If this is used it will kill the beneficial fungus.



Adult and nymph citrus rust mites[95]

Russeting[94]

Coconut mite (*Aceria guerreronis*)

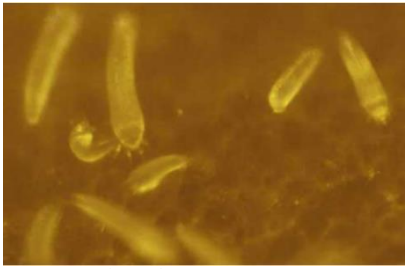
Crops: coconut

Characteristics: need magnification to see mites. Colonies look like silvery patches and individuals are translucent white in color and elongate with four legs, not eight like other mites. Nymphs resemble adults.

Life cycle: eggs are laid on plant surfaces and nymphs go through two stages before becoming adults. They reach maturity within ten days.

Damage: stippling, nut distortion and stunting, young coconuts will show pale yellow triangular patches that later become brown. This can continue to become dark brown lesions and oozing of the nut. They can reduce coconut meat and water. These result in decreased yields.

Control: first identify and confirm mite species by looking at damage and mites under a microscope. Prune infested parts and properly dispose, intercrop, and maintain good irrigation and plant health. Biocontrol includes predatory mites and the fungus *Hirsutella thomsonii*. Miticides could be used, although not recommended because they leave residues on the fruit, which usually are harvested throughout the year.



Coconut mite colony[95]

Coconut mite damage[96]

Spider mites (*Tetranychus* sp.)

Crops: pepper, garlic, citrus, coconut, beans, papaya, melon, banana, plantain, potato, cabbage, tomato

Characteristics: can be seen with the naked eye. They are not insects, but rather arachnids. They look like tiny moving dots, however at magnification one can see adults are

wingless, have no antennae, are oval shaped, have eight legs, and two red eyespots. Females will usually have dark patches on each side with bristles. They can be yellowish or red. Nymphs are also eight-legged and resemble adults, just are a smaller size. They are easy to recognize by their ability to spin webs, hence their name.

Life cycle: eggs are laid in a fine web on leaves, which hatch in about three days. Nymphs go through two instars and complete development in 5-20 days, depending on temperature. Adults live 2-4 weeks and overwinter in leaf litter or bark. They have multiple generations per year.

Damage: stippling, discoloration, leaf fall, webbing covering plant parts, fruit sunburn from leaf drop, decreased yields, and if infestations are too high, they can lead to plant death.

Control: monitor and inspect the underside of leaves. If stippled leaves are present, check for spider mites. To confirm presence, shake leaves onto a white sheet of paper and they will fall onto it. Mites favor hot and dusty conditions, so irrigate the surrounding areas and especially water stressed plants to keep moisture (best method). Spray plants with strong water force to knock down spider mites, especially on the underside of leaves. Biocontrol is another best method to control spider mites. It includes predatory mites, sixspotted thrips, western flower thrips, spider mite destroyer ladybugs, minute pirate bugs, bigeyed bugs, and lacewing larvae. Using insecticides usually cause more mite problems since they also kill the natural enemies. If needed, however, insecticidal soap, insecticidal oil (like neem oil, canola, or cottonseed soils), garlic extract, clove oil, mint oil, rosemary oil, and cinnamon oil, can be applied. Sulfur sprays are also shown to be effective, however they may burn some plants and not others. Prevent spraying during hot weather and/or when plant is water stressed.

Adult twospotted spider mite (*Tetranychus urticae*)[90]

Adult red spider mite (*Tetranychus urticae*)[91]

Spider mite infestation[44]

Spider mite infestation (webbing)[92]

Texas citrus mite (*Eutetranychus banksi*)

Crops: citrus, papaya

Characteristics: can be seen without magnification. Adults are tan to brownish green with dark brown and greenish spots and lines on their sides. Males are smaller than females, elongated, and have very long legs. Females, on the other hand, are round, flattened, and have an H-shape marking on their backs. Nymphs resemble adults, only they are smaller in size.

Life cycle: eggs are laid along the midrib and near the margins of the leaves in the upper surface of the plant. At cooler temperatures, adults can live for several months, but at hotter temperatures, only for several weeks. It takes them about a month to reach maturity in cooler weather, and about ten days in hotter weather.

Damage: they tend to feed on the upper surface of leaves, causing stippling and discoloration. They eventually make their way down the tree. At high populations they may feed on fruit which causes scarring and early fruit drop. Leaves can fall off while the leafstalk stays on, which is what separates them from other mites. Leaf drop can cause reduced photosynthesis, early fruit drop, and fruit sunburn. As a result, a decrease in yield and quality.

Control: provide good irrigation and dust control. Biocontrol includes predatory mites, lacewings, predatory thrips, and fungi. Miticides are effective, although it may not be necessary.

Adult male (left) and female (right) Texas citrus mites[3]

Tomato russet mite (*Aculops lycopersici*)

Crops: pepper, tomato

Characteristics: magnification is needed to see them. Adults are yellowish or pink and conical shaped. Nymphs resemble adults but are smaller.

Life cycle: eggs are laid on leaves and stems and hatch 2 days later. Nymphs go through two stages in about two days. If the temperature is ideal, they can become an adult within a week. Adult females live for about 22 days and males for 19 days. Females can reproduce sexually, producing both males and females, or asexually, producing only females.

Damage: leaf silvering/bronzing, stem loses hair and may crack, wilting, leaf or plant death, fruit and leaf fall, leaf curling, sunburned fruits due to leaf loss, and fruit surface discoloration. Damage tends to start near the ground and work its way up. These are similar to thrip and broad mite damage, so confirm mites before choosing control method.

Control: inspect transplants, avoid planting in hot and dry weather, maintain good plant health, avoid transplanting near infested crops or weeds, destroy infested plant debris, sanitize equipment. Biocontrol includes predatory mites. Besides maintaining plant health and sanitation, sulfur spray or dust is usually recommended and should be applied when mites are present. Remember to cover the underside of leaves and lower part of stem.

Adult tomato russet mite[93]

Definitions

- **Biological control (biocontrol):** the use of other organisms (called natural enemies) to control pests. These organisms can be animals, pathogens, parasites, and other insects.
- **Bt (*Bacillus thuringiensis*):** a naturally occurring bacteria found in soils that are used as an organically accepted pesticide.
- **Crawler stage:** the immature stages of scales, which are mobile.
- **Crop rotation:** planting different crops every season on the same land. This helps improve and maintain soil fertility.
- **Frass:** insect feces.
- **Honeydew:** excess sugary substance excreted by hemipterans from feeding on plant sap.
- **Instar:** insect developmental stage between molts.
- **Intercrop:** growing a crop among different other crops. Example: beans, squash, and corn tend to be grown together to maximize yields.
- **Nymph:** an immature insect that resembles the adult, like cockroaches and many hemipterans.
- **Overwintering sites:** locations where insects spend the winter.
- **Parthenogenetically:** asexual reproduction (females can reproduce without a male).
- **Pheromone traps:** an insect trap that lures insects by using pheromones.
- **Spiracles:** pores/openings on an insect used for respiration.
- **Spinosad:** an organically accepted pesticide derived from a naturally occurring soil bacteria.
- **Systemic insecticides:** insecticides that are absorbed and transported throughout the plant.

Reference Photos

Stippling[44]

Leaf curling (left) healthy leaves (right)[59]

Sticky trap[115]

Sooty mold[116]

Root girdling[117]

Shot holes[44]

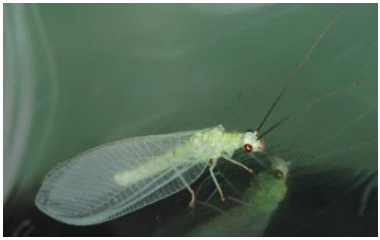
Shot holes[85]

Pheromone trap[118]

Stem axil[119]

Fruit sunburn (sunscald)[83]

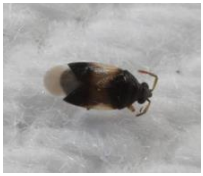
Reflective mulch[120]



Adult lacewing[121]

Bigeyed bug[44]

Ichneumonid wasp parasitizing a lily leaf beetle larva[122]



Minute pirate bug[123]

Damsel bug[44]

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