AgriLIFE EXTENSION
Texas A&M System

E-432

Whiteflies

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Although there are approximately 1,200 species of whiteflies worldwide, only a few species are of economic importance. Most whitefly species have a narrow range of host plants, but the ones that are considered pests may feed on and damage many vegetable and field crops, greenhouse and nursery crops and house plants.


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The name whitefly is derived from the generally white, wax-like substance that coats their bodies, particularly the wings. Some species are dark with colored wing patterns. All developmental stages secrete wax, and in nymphs (immatures), the appearance of accumulated wax filaments and plates is used in species identification.

The main whitefly species that feed on ornamental plants in Texas are the silverleaf whitefly (*Bemisia argentifolii* [Bellows & Perring]), the greenhouse whitefly (*Trialeurodes vaporariorum* [Westwood]) and the banded wing whitefly (*Trialeurodes abutiloneus* [Haldeman]). Other species include the citrus blackfly (*Aleurocanthus woglumi* Ashby), the citrus whitefly (*Dialeurodes citri* Ashmead) and the giant whitefly (*Aleurodicus dugesii* Cockerell). It is important to distinguish the different whiteflies because damage potential and susceptibility to control differs by species.

Description and Life Cycle

Whiteflies are small insects (1 to 3 millimeter). Adults have four broad wings of approximately the same size. The adult is the most mobile stage and is responsible for colonizing the host plant. Whiteflies can move and disperse over long distances by flying upward and being picked up and carried by air currents. Eggs are usually laid on the underside of young leaves and may be deposited randomly throughout the leaf, in circles, arcs or spirals, depending on the species.

The eggs hatch into mobile first instars called crawlers, which search and find a suitable feeding site. They then insert their mouthparts and remain in one place for the rest of their immature stages.

Second to fourth instars are called nymphs and resemble small scale insects. Nymphs are oval and may be pale yellow to black, depending on the species. The late fourth instar is also known as "pupa" because mobile adults emerge from the exoskeleton of sessile nymphs after development is complete. Silverleaf whitefly fourth instars are also known as "red-eye nymphs" because the relatively large eyes of the developing adult are already visible through the nymph integument (skin) during this stage.

The complete life cycle varies from about 2 1/2 to 5 weeks according to temperature conditions and species. Many overlapping generations can occur each year. Adults and nymphs feed by inserting their mouthparts into plant tissue and sucking phloem sap.

Silverleaf Whitefly


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The silverleaf whitefly is the most economically important whitefly species in Texas. Adults are 0.8-1.2 millimeter long with white wings (without markings) and pale yellow bodies. The wings are held in a roof-like position (about a 45-degree angle) over their bodies, whereas other whiteflies typically hold the wings nearly flat when at rest. As a result, the silverleaf whitefly appears more slender than other common whiteflies. Eggs are oblong, smooth and yellow to amber brown and are laid randomly on the underside

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of leaves. Nymphs are greenish-yellow, oval and flat. Late third and fourth instars develop distinctive eye spots and are often referred to as red-eyed nymphs. Silverleaf whitefly pupae are oval, flattened (with tapering sides) and lack the marginal fringe of wax filaments common to other whiteflies. Their hosts include more than 500 species representing 74 plant families.

Greenhouse Whitefly


Michael Parrella, U. California Davis

This is an occasional pest, especially in greenhouses. Adults are about the same size as the silverleaf whitefly (0.9-1.1 millimeter). The wings are held nearly parallel to the leaf and cover the abdomen when at rest. Eggs are occasionally laid in circular patterns on plants with smooth leaves. Eggs are oblong, smooth and are initially yellow but darken before hatching. Pupae are oval, slightly raised (with vertical sides) and have a fringe of wax filaments along the perimeter of their upper surface. Relatively large wax filaments project from their bodies; the number and length of these filaments varies with the host plant. Their hosts include more than 200 plant species.

Bandedwinged Whitefly


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This is an occasional pest of crops and ornamental plants, especially hibiscus. The adults are slightly larger than silverleaf and greenhouse whiteflies. They can be recognized by two irregularly shaped (in zig-zag pattern) gray bands on the front pair of wings. Except for these banded front wings, the adults are very similar in size and shape to adult greenhouse whiteflies.

The eggs are oblong and smooth and may be laid irregularly or in neat circles on the leaves, depending on the host plant species. Eggs are pale yellow and turn pink before hatching. Pupae are oval, slightly raised (with vertical sides) and have a fringe of wax filaments along the upper perimeter. Pupae have a dark area in the upper surface of the integument, which distinguishes them from the pupae of greenhouse whiteflies. Important ornamental hosts include poinsettia, geranium, hibiscus and petunia.

Other Whitefly Species


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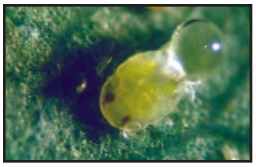
The citrus blackfly is a sporadic pest of ornamental plants and a potentially serious pest of citrus, especially in South Texas. Both nymphs and adults are easily distinguished from other whitefly species by their dark color. Adult citrus blackflies are 1.3-1.6 millimeter long with slate-blue wings and red abdomens. Females lay eggs in a characteristic spiral pattern. Nymphs and pupae are dark black, with a fringe of white wax filaments along the upper perimeter.

Citrus whiteflies are an occasional pest of citrus in southern Texas but may also attack ornamental plants and trees such as Boston ivy, chinaberry, laurel cherry, crepe myrtle, English ivy, gardenia, green ash, jasmine, osage orange, prickly ash, trumpet vine, water oak, persimmon and wild olive. Adults are very similar to adult greenhouse whiteflies but have broader wings and feed mainly on shrubs and trees, especially citrus. Nymphs and pupae are similar to those of the silverleaf whitefly but are much rounder in shape.

Giant whitefly adults are about three times larger than other common whiteflies. Wings overlap when at rest and are mottled with grey markings. Common hosts include bamboo, begonia, bird of paradise, citrus, geranium, hibiscus, ivy, jasmine, morning glory, lantana, passion flower, philodendron and pittosporium. Nymphs and pupae secrete long cylindrical strands of wax extending up to two inches (50 millimeters) from the leaf surface. Accumulation of these wax strands resembles fluffy-white hair. Females deposit eggs and wax in spiral patterns that appear as white concentric circles on the undersides of host plant leaves.

Damage

Whiteflies can damage plants directly or indirectly. Direct damage is caused through their feeding, which removes plant sap and stunts plant growth, especially in young plants. Silverleaf whitefly feeding has been associated with several plant disorders, including silverleaf of squash, stem blanching and whitening of poinsettia and cruciferous vegetables, and irregular ripening of tomatoes. Indirect whitefly damage is caused by the large amounts of sticky honeydew secreted during feeding. Honeydew may cover plants and support the growth of sooty mold, which reduces the plant's ability to use light for photosynthesis. In addition to direct and indirect damage, whiteflies may carry and transmit viral diseases that can severely damage susceptible plants.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Integrated Pest Management

Integrated pest management (IPM) is a strategy to avoid or prevent pest damage with minimum adverse impact to human health, environment and non-target organisms. Successful IPM of whiteflies involves:

- Implementing cultural control practices to limit whitefly colonization.
- Frequent monitoring of populations.
- Accurate species identification and pest diagnosis to select proper control action.
- Using pertinent information to decide when treatment is necessary.
- Using effective pest management tools, including tolerant species or varieties (when available), natural enemies and insecticides.

Cultural Control

Cultural control practices are aimed at avoiding or preventing whitefly infestations, eliminating sources of whiteflies and keeping whiteflies out of growing areas. To implement cultural control you should:

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- Thoroughly inspect new plants before purchase and reject or treat any infested material.
- Make sure the plants are free of whiteflies before putting them with established plants.
- Keep target areas free of weeds that can serve as whitefly hosts.
- When feasible, avoid growing susceptible plants of different ages together in one place or immediately replanting after harvest when pests from a previous crop may still be present.
- Avoid excess irrigation and fertilization, which may increase the susceptibility of plants to whiteflies.
- Avoid planting when whiteflies are expected to migrate from other hosts. Whiteflies migrate from alternate hosts because numbers have become too high or the crop is being harvested (e.g., after cotton defoliation).
- When practical, isolate groups of plants using row covers, screens or plastic sheets.
- Remove and destroy heavily infested plants from the landscape so they will not contaminate other plants.
- Break the whitefly reproductive cycle by having periods of time with no host plants in the greenhouse or garden.

Pest Monitoring and Diagnosis

Whiteflies, like many other pests, reproduce very rapidly. A single female may lay 150-300 eggs during her lifetime. When temperatures are high at the peak of summer, whiteflies may complete development in 16-18 days. In the absence of natural enemies and other natural control factors such as heavy rain, a few individuals can produce thousands in a very short time. Therefore, it is important to monitor plants frequently. Do not wait until damage is obvious because whitefly control is very difficult to achieve at that point. Inspect the undersides of old and new leaves weekly for all whitefly stages. The more plants you inspect, the more likely you will be to detect problems sooner, when management is easier. Record the number of whiteflies per plant or the percentage of plants infested. This information is critical in deciding whether or not treatment is necessary.

Although yellow sticky traps sold at garden stores may be used to detect when and where whitefly adults are occurring, they are not useful in estimating population density on plants. They should be placed just above the plant canopy and must be checked and replaced every week.

Once you have detected whiteflies on plants, accurate species identification is essential in deciding whether or not further action is required and what treatment to use. Learn the different species of whiteflies that commonly attack the plants you are trying to protect and the natural enemies of whiteflies that may be common in your area. Use a magnifying lens (10X) to facilitate observation.

Silverleaf whiteflies and, occasionally, greenhouse whiteflies may cause serious damage to plants. Managing these species may be very difficult if populations are not detected early. Bandedwinged whiteflies will feed on several weeds and ornamental plants but will reproduce on only a few of them. Management may be necessary only on plants that harbor eggs and nymphs. Giant whitefly adults tend to remain on the plant where they developed. This tendency leads giant whitefly populations to be initially clustered on a few plants, which helps a grower to manage them. Removing and destroying relatively few infested leaves may significantly reduce populations. Citrus blackfly and citrus whitefly are two species that are controlled well by native and introduced natural enemies and generally do not require treatment. Consult your county Extension agent for additional help identifying a species.

Management Considerations

A certain number of whiteflies may be tolerated when they do not cause significant damage. This tolerance level varies according to the host plant and individual preferences. A few adults feeding on plants will usually not cause significant damage and do not warrant treatment. However, if monitoring reveals an increasing number of eggs and nymphs on young leaves and the weather conditions are favorable, intervention may be required to prevent future damage.

Intervention may be physical/mechanical control, biological control or chemical control. Physical/mechanical control includes removing heavily infested leaves or plants and using a high-pressure water spray on the underside of leaves. Removing infested leaves from plants may be enough to control small populations on less preferred hosts. Removing a few infested plants early may prevent future problems. High-pressure water sprays will wash away honeydew and sooty mold accumulations and reduce populations of adults and nymphs. High-pressure water sprays are recommended at least once a week for three consecutive weeks and can be repeated as necessary.

Biological Control

Biological control is the manipulation of natural enemies to prevent or suppress damage from pests. Several species of predators and parasitoids are natural enemies of whiteflies. Predators of whiteflies include ladybeetles (*Delphastus* and *Nephaspis*), green lacewings (*Chrysopa* and *Chrysoperla*), minute pirate bugs (*Orius*), big eyed bugs (*Geocoris*) and damsel bugs (*Nabis*). Parasitoids (insect parasites) of whiteflies include minute wasps (*Encarsia* and *Eretmocerus*) about 1 millimeter long and either yellow, dark brown or bicolor (brown head and yellow body), depending on the species. Females of these tiny, parasitic wasps lay their eggs inside whitefly nymphs. When the wasp eggs hatch, the larvae feed internally on the whitefly nymphs, eventually killing them.

In addition to predators and parasitoids, whiteflies are naturally attacked by insect pathogens. Spores from the fungal pathogen *Beauveria bassiana*, which causes white-muscardine disease in insects, have been formulated into insecticidal products (see Table 1).

Biological control can be achieved by importing and releasing natural enemies from areas where pests originate, by purchasing and releasing commercially available natural enemies or by conserving naturally occurring ones. Importing natural enemies—also known as classical biological control—involves coordinated efforts of university, state and federal scientists and regulators. Classical biological control programs have been conducted against several whitefly species including silverleaf whitefly, citrus whitefly, citrus blackfly and giant whitefly.

The purchase and release of natural enemies is also known as augmentation biological control. Augmentation biological control has been effective in controlling whiteflies in greenhouse ornamental production. A list of commercial suppliers of natural enemies in North America can be obtained by visiting *www.cdpr.ca.gov/docs/ipminov/bensupp.htm*.

Delphastus pusillus is the most whitefly-specific predator available. It feeds primarily on whitefly eggs but may also consume nymphs. It is particularly useful in reducing whitefly populations in greenhouses, although it may also be used outside. Recommended release rates are seven to ten per m^2 (10 $ft.^2$).

Eretmocerus eremicus is the most effective parasitoid available for biological control of silverleaf whitefly, while *Encarsia formosa* is effective for treating the greenhouse whitefly. Parasitoids are effective at suppressing low whitefly population densities and may prevent a pest outbreak but do not control an existing one. Recommended release rates in the greenhouse vary with whitefly population density from three wasps per 2 m^2 (2 per 15 $ft.^2$) every 1-2 weeks, starting at first sign of whitefly presence, to three or more weekly introductions of three to nine wasps per m^2 (10 $ft.^2$) when whitefly populations are initially established, to weekly releases of one to three wasps per plant for highly susceptible crops like poinsettia.

The easiest biological control method in a landscape is to conserve naturally occurring predators and parasitoids. Conservation biological control involves the careful selection and use of pesticides only when necessary to prevent pest damage. Judicious use of insecticides not only will preserve natural enemies but will also reduce health and environmental risks.

Chemical Control

Several classes of insecticides are labeled for use against whiteflies on ornamental plants. Table 1 lists some whitefly control products available to commercial ornamental producers, and Table 2 shows products available to homeowners. Insecticidal soaps and horticultural oils are contact insecticides that cause suffocation and desiccation of nymphs and adults. Soaps and oils are among the best alternatives for whitefly control by home owners because they are effective, preserve natural enemies and are relatively safe. It is important to thoroughly cover the underside of leaves and repeat applications. Insect growth regulators, when applied during the immature stages, prevent adult whitefly development. These products generally do not kill adult whiteflies present at the time of a treatment.

To reduce the impact of insecticides on natural enemies, avoid the frequent use of broad-spectrum insecticides (those labeled against many pests) because these also kill predators and parasitoids. Avoid frequent, long-term use of insecticides with the same mode of action because this may lead to the growth of populations of insects that are resistant to the chemicals. Insects that are resistant to one insecticide may also be resistant to other insecticides (cross-resistance).

Under certain temperature, humidity, water and shade conditions, pesticides may also cause injury to certain plants (phytotoxicity). Generally, apply pesticides during early morning or late afternoon to avoid the hottest part of the day. Water plants 1-2 days before applying pesticide. Always check the product label for the list of plants that may be injured by the pesticide.

For information on whitefly pest management on vegetable gardens and citrus, see Extension publication B-1300. For more information on Texas insects and entomology, see *http://insects.tamu.edu*.

Table 1. Insecticidal products to control whiteflies on commercial ornamental production (always read and follow directions printed on label; some products may have restrictions)

Type/Source	Insecticide (Commercial Name)	Site Use[1]	REI[2] (hours)	Notes
Biological	Beauveria bassiana (BotaniGard®; Naturalis®)	L, GH, N	4	Repeated applications are necessary. Do not mix with most fungicides. Fungicide applications may affect efficacy
Oil	Horticultural oil (SunSpray Ultra-Fine Spray Oil®)	L, GH, N	4	Do not use with sulfur fungicides
Oil	Clarified hydrophobic extract of neem oil (Triact®)	L, GH, N	4	Check label for list of plants that may be treated. Some products also act as fungicides
Soap	Potash soap (Safer-Insecticidal Soap®, M-Pede®)	L, GH, N	4 - 12	Contact with insect and repeated applications are necessary
Botanical	Pyrethrin + PBO (Pyrenone Crop Spray®)	L, GH, N	12	PBO is piperonyl butoxide, a synergist
Botanical	Pyrethrin + rotenone (Pyrellin®)	GH, N	12	
Fermentation Product	Abamectin (Avid®)	GH, N	12	Commercial use only
Chloronicotinyl	Imidacloprid (Marathon®, Merit®)	L, GH, N	12	Use only once every 16 weeks
Pyridazinone	Pyridaben (Sanmite®)	GH, N	12	Contact with insect required
Pyridine-azomethine	Pymetrozine (Endeavor™)	L, GH, N	12	
Insect Growth Regulator	Azadirachtin (Azatin XL®, Safer BioNeem®)	L, GH, N	4	Contact with insect and repeated applications are necessary
Insect Growth Regulator	Diflubenzuron (Adept®)	GH	12	Contact with insect and weekly applications are necessary
Insect Growth Regulator	Kinoprene (Enstar®)	GH	4	Apply before bloom
Insect Growth Regulator	Fenoxycarb (Precision®)	L, GH, N	12	Max 30 applications per year in greenhouses
Insect Growth Regulator	Pyriproxyfen (Distance®, Pyrigro®)	L, GH, N	12	Apply no more than two times per cropping cycle or no more than two times per 6 months
Pyrethroid	Bifenthrin (Talstar®, Orthro® products)	L, GH, N	12	
Pyrethroid	Cyfluthrin (Decathlon®, Tempo®)	L, GH, N	12	
Pyrethroid	Fenpropathrin (Tame®)	L, GH, N	24	Restricted use product
Pyrethroid	Fluvalinate (Mavrik®)	L, GH, N	12	
Pyrethroid	Permethrin (Astro®)	L, GH, N	12	
Organophosphate	Acephate (Orthene® Turf, Tree & Ornamental Spray)	L, GH, N	12	Can affect growth of new roses
	Diazinon (KnoxOut®)	L, N	12	
	Malathion (various products)	L, GH, N	12	

[1]GH, N, L represent approved site use; L = landscape, GH = greenhouse, and N= nursery.

[2]REI = restricted entry interval (consult product label).

Table 2. Homeowner packaged whitefly control products (always read and follow directions printed on label)

Type/Source	Insecticide (Commercial Name)	Notes
Oil	Horticultural oil (SunSpray Ultra-Fine Spray Oil®, Volck® Oil Spray, Dexol® Dormant and Summer Oil Spray)	Do not use with sulfur fungicides
Oil	Clarified hydrophobic extract of neem oil (Greenlight™ Neem Concentrate)	Check label for list of plants that may be treated. Some products also act as fungicides
Soap	Potash soap (Safer® Insecticidal Soap Insect Killer, Concern® Insect Killing Soap, Ortho® Insecticidal Soap®)	Contact with insect and repeated applications are necessary
Botanical	Pyrethrum (X-Clude Pyrethrum®)	
Botanical	Pyrethrin + PBO (Spectricide® Houseplant & Garden Spray, Ortho® Rose & Flower Insect Killer, Schultz™ Instant House Plant Insect Spray)	PBO is piperonyl butoxide, a synergist
Botanical + Soap	Pyrethrum + potash soap (Safer® Houseplant Insect Killer®)	
Chloronicotinyls	Imidacloprid (Bayer® Advanced Garden™ Rose & Flower Insect Killer)	
Insect Growth Regulator	Azadirachtin (Safer® BioNeem)	Contact with insect and repeated applications are necessary
Pyrethroid	Bifenthrin (Orthro® products)	
Pyrethroid	Cyfluthrin (Decathlon®, Powerforce Muti-Insect Killer®)	
Pyrethroid	Permethrin (Spectricide® Lawn &Garden Insect Control)	
Pyrethroid	Resmethrin (Dragon® Whitefly & Mealybug Spray)	
Organophosphate	Acephate (Orthene®; Isotox® Insect Killer) Diazinon (Ortho® Diazinon Plus Insect Spray, Dexol® Diazinon 25% Spray, Spectricide® Diazinon Multi-purpose Insect Spray Concentrate) Disulfoton (DiSyston®) Malathion (various products)	Can affect growth of new roses

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