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Whitefly Management Guide for Horticultural Crops

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Introduction

Whiteflies are insects in the insect order Hemiptera (true bugs) and family Aleyrodidae. They are economic pests of many field crops, vegetables, ornamentals, nursery crops, landscapes, bedding plants, and gardens. They received the name "whitefly" from a mealy, white wax-like powdery substance covering their wings and body. Adult whiteflies are weak flyers. They disperse over long distances by flying upward, and then being picked up and carried by air currents. Some species may have color patterns or bands on their wings. In Texas, the silverleaf/sweet potato whitefly (*Bemisia tabaci* Gennadius), the greenhouse whitefly (*Trialeurodes vaporariorum* Westwood), and the banded-wing whitefly (*Trialeurodes abutiloneus* Haldeman) are the principal whiteflies affecting ornamental and nursery crops (Figure 1). The MEAM1 and MED biotypes of the sweet potato whitefly are also present in Texas. Management of whiteflies often depends on the correct identification of species as different species vary in damage potential.

Identification of Whiteflies

Adult whiteflies are small insects (1 to 3 millimeters) with four broad wings of similar size, covered with white wax. The first instar nymphs are mobile, but too small to observe with the naked eye. The nymphal stages are transparent or light yellow, flattened to blend in with the plant surface, and can be overlooked. The last nymphal stage is also considered the pupal stage, though whiteflies have incomplete metamorphosis. Species can be identified by observing exoskeletal shell/body color, eye color, number of spiracles, and waxy filaments around the edge of the body of the fourth instars/pupa. Adults emerge from the nymphal/pupal shell through a T-shaped opening. The empty shells remain attached to the leaf surface.

Life Cycle

The whiteflies' life cycle includes the egg, nymphs, and adults (Figure 2). Adults and the first instars are mobile. Female whiteflies lay 150 to 300 eggs in their lifetime and deposit them singly on the underside of young leaves randomly. There are four nymphal instars. The first nymphal instars that hatch from eggs are known as "crawlers." This is the only mobile nymphal stage of whiteflies that search for favorable feeding sites on their host plant. Once the crawlers settle, inserting their piercing-sucking mouthparts, they remain in the same place for the rest of their nymphal stages, immobilized. The second to fourth nymphal stages

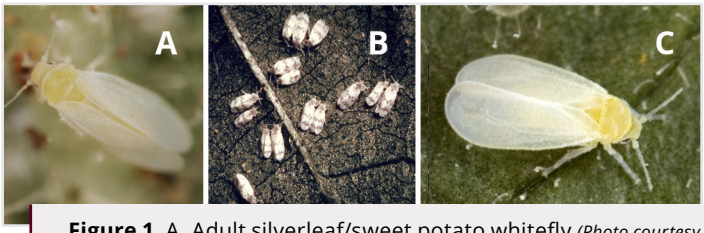

Figure 1. A. Adult silverleaf/sweet potato whitefly *(Photo courtesy of Dr. Patrick Porter)*. B. Banded-wing whiteflies *(Photo courtesy of Ronald Smith, Auburn University, Bugwood.org)*. C. Adult greenhouse whitefly *(Photo courtesy of David Cappaert, Bugwood.org)*.

Figure 2. Different life stages of whiteflies, which include eggs, nymphs, and adults *(Photo courtesy of Whitney Cranshaw, Colorado State University, Bugwood.org; edited by Rafia Khan)*.

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are oval, pale to yellow, and flattened with reduced antennae and legs, resembling scale insects. The fourth instar nymphs of the silverleaf/sweet potato whiteflies are known as "red-eye nymphs" because their large red eyes can be observed. Whiteflies can complete their life cycle (egg to adult) within 2 to 5 weeks depending on the temperature, species, and hosts. Silverleaf/sweet potato whiteflies and greenhouse whiteflies can breed year-round in warmer climates, having multiple generations and dispersing from one host to another. During winter months, whiteflies may migrate into greenhouses.

Plant Injury

Injury caused by whiteflies is both direct and indirect. Their feeding causes direct injury to the plant. Both adults and nymphs are phloem feeders: ingesting plant sap from stems and leaves using their piercing-sucking mouthparts. Infestation by a large population or prolonged feeding can result in yellowing and drying of foliage, leaf abscission, defoliation, and stem blanching. For example, whiteflies can cause whitening of poinsettias. Whiteflies excrete honeydew during feeding, which supports the growth of sooty mold and reduces the plant's photosynthetic rate. Plant vigor and attractiveness decrease due to feeding injuries caused by whiteflies. Whiteflies are also responsible for carrying and transmitting viral diseases. Silverleaf/sweet potato whiteflies can spread over 100 plant viruses. Cucurbit leaf curl virus, cucurbit stunting disorder virus, and squash leaf curl virus vectored by whiteflies have been reported in Texas.

Hosts

Silverleaf whiteflies and greenhouse whiteflies have a wide host range, including wild and cultivated plants. Ornamental plants susceptible to whiteflies include fuchsias, gardenias, lantanas, redbuds, crape myrtles, roses, hibiscuses, ivies, gerbera daisies, verbenas, chrysanthemums, salvias, begonias, primulas, and mandevillas. Greenhouse and garden fruits and vegetables such as tomatoes, peppers, cucumbers, beans, squashes, eggplants, watermelons, and sweet peppers are some of the most susceptible.

Integrated Pest Management (IPM)

A variety of pest management techniques and strategies are used in IPM to reduce pest populations or minimize their economic impact while maintaining plant quality. Management strategies for whiteflies include cultural, mechanical, biological, and chemical.

Scouting/Monitoring

Whiteflies can establish a population within a short time depending on the temperature. The undersides of old and new leaves of susceptible plants need to be checked frequently for white filaments, exuviae (shed exoskeletal shells), or any life stage of whiteflies. Chlorotic leaves or stems, honeydew, or sooty mold can also be regarded as signs of whitefly infestation. Finding adults or immature stages often requires a magnifying lens (10X). Visual inspection and planned recordkeeping of whiteflies per leaf or plant, or the percentage of plants infested can direct the future management plan. Yellow sticky traps may be less useful as only adults in a high-density population are detected. However, yellow sticky cards need to be placed above the plant canopy at the beginning of the planting to monitor adult introduction to the crop. Additionally, the cards need to be replaced weekly. Species identification is also important to develop an action plan.

Cultural Control

Before purchasing them, the plants need to be checked to avoid introducing any new pests that can lead to future infestations. Sanitation measures such as keeping the greenhouse free of weeds; and removing crop residues, debris, etc.; can reduce the available alternative hosts of whiteflies. The vegetation outside of the greenhouse also requires attention for sanitation or removal. The use of excess irrigation and fertilization, and excessive pruning can facilitate the development and establishment of a whitefly population. Removal of heavily infested plants from the landscape can protect other plants in the area. Keeping the greenhouse fallow for a few weeks can reduce the whitefly population significantly.

Mechanical Control

Removal of heavily infested leaves or plants, and the use of high-pressure water spray can physically remove whiteflies. The discarded materials (leaves, plants, pots, residues, whiteflies, etc.) should be placed inside a sealed plastic bag and removed from the property. Using a high-pressure water spray is also useful to remove honeydew or sooty mold from the leaves.

Biological Control

Biological control agents are effective tools to manage whiteflies (Table 1). Several predators, parasitoids, and pathogens can be released preventively to regulate whitefly populations. The listed biological control agents are commercially available. Companies that produce beneficial insects have side effects/compatibility databases to guide the use of insecticides if biological control agents are present.

Table 1. Biological control agents that can be used as part of an IPM program for whiteflies.	
Biological Control Agent	**Control Type**
Delphastus spp. (Ladybeetles)	Predator
Delphastus catalinae (Ladybeetle)	Predator
Nephaspis oculatus (Ladybeetle)	Predator
Chrysopa spp. (Lacewing larvae)	Predator
Orius spp. (Minute pirate bugs)	Predator
Geocoris spp. (Big-eyed bugs)	Predator
Nabis spp. (Damsel bugs)	Predator
Dicyphus hesperus (Mirid bug)	Predator
Amblydromalus limonicus (Predatory mite)	Predator
Amblyseius montdorensis (Predatory mite)	Predator
Amblyseius swirskii (Predatory mite)	Predator
Encarsia formosa (Parasitic wasp)	Parasitoid
Eretmocerus eremicus (Parasitic wasp)	Parasitoid
Eretmocerus mundus (Parasitic wasp)	Parasitoid
Lecanicillium lecanii (Entomopathogenic fungus)	Fungus
Beauveria bassiana (Entomopathogenic fungus)	Fungus

Chemical Control

A large variety of chemical are available to help control whitefly populations as part of an integrated pest management program. Both conventional insecticides (Table 2) and more natural chemical products (Table 3) can be used to help control whiteflies. Some insecticides will consist of a mixture of active ingredients. These insecticides are not listed in Tables 2 and 3, but they should contain at least one of the active ingredients listed within the tables. Texas A&M AgriLife does not endorse any companies or products listed. All trade names included in this factsheet are for educational purposes only.

Pesticide Application and Safety

The use of broad-spectrum insecticides should be limited because they can interfere with several natural enemies that help to manage whitefly populations. All label instructions must be followed for the judicious use of chemicals. It is also a violation of federal law to use pesticides in a manner that is inconsistent with the label. Consult with local Extension/product agents about the insecticide labels for targeted life stages, product rates, application information, application sites, and restrictions. Rotate products with different modes of action (MOA) to limit pesticide resistance. It is also recommended to avoid two sequential applications of any group of insecticides with the same MOA.

Table 2. List of conventional insecticides used as part of a whitefly management program.		
Insecticide Class	**Active Ingredients (Trade Name)**	**Notes**
Pyrethroids (3A)	Bifenthrin (Attain® TR/Talstar®) Cyfluthrin (Decathlon™) Fenpropathrin (Tame®) tau-Fluvalinate (Mavrik®)	• Broad-spectrum • Short to long residual • Applied as a foliar spray only • Very active
Neonicotinoids (4A)	Imidacloprid (Marathon®/Benefit®/Mantra®) Dinotefuran (Safari®) Thiamethoxam (Flagship®)	• Nerve toxicant • Fast active • As a foliar spray, absorbed into the leaf tissue where they can be fed upon by insects • Works as a systemic when applied as soil drenches • Very low mammalian toxicity
Butenolides (4D)	Flupyradifurone (Altus™)	• Foliar spray only • Very active • Long residual
Spinosyns (5) and Sulfoximines (4C)	Spinetoram + Sulfloxaflor (XXpire®)	• Nerve toxicant • Activity on sucking pest comes primarily from sulfoxaflor • Safe to most beneficial insects • Very low mammalian toxicity

Table 2. List of conventional insecticides used as part of a whitefly management program.		
Juvenile Hormone Analogues (7A)	Kinoprene (Enstar®)	• Can cause phytotoxicity in blooms • Suggested use at the pre-bloom stage
Fenoxycarb (7B)	Fenoxycarb (Preclude®)	• Insect growth regulators
Pyriproxyfen (7C)	Pyriproxyfen (Distance®/Fulcrum®)	• Insect growth regulators
Pyropenes (9D)	Afidopyropen (Ventigra®)	• Slow-acting • Long residual • Safe to beneficial insects
Benzoylureas (15)	Diflubenzuron (Adept®)	• Slow-acting • Immature stages only • Not highly effective
Buprofezin (16)	Buprofezin (Talus®)	• Insect growth regulator
METI Acaricides and Insecticides (21A)	Pyridaben (Sanmite®) Tolfenpyrad (Hachi-hachi®) Fenazaquin (Magus®)	• Provides knockdown and residual control • Applied as pest populations build prior to reaching economic thresholds
Tetronic and Tetramic Acid Derivatives (23)	Spirotetramat (Kontos®) Spiromesifen (Savate®)	• Slow-acting • Long residual
Diamides (28)	Cyantraniliprole (Mainspring®) Cyclaniliprole (Sarisa™)	• Insects can feed on absorbed leaf tissue when applied as a foliar spray • Works as a systemic when applied as a soil treatment • Fairly safe to beneficial insects • Very low mammalian toxicity
Flonicamid (29)	Flonicamid (Aria®)	• Stops insect feeding within 30 minutes • Provides excellent residual control • Can be applied as a foliar spray, broadcast spray, or soil drench
Pyrethroids (3A), and Neonicotinoids (4A)	Cyfluthrin + Imidacloprid (Discus®)	• Broad-spectrum insecticide • Provides excellent insect control on field and container ornamental pests
Bifenazate (20D) + Avermectins (6)	Bifenazate + Abamectin (Sirocco™)	• Use in a thorough resistance management program • Apply the product on plants that are hosts of labeled pests with multiple generations per crop per year, and use resistance management practices
Diamides (28) + Flonicamid (29)	Cyclaniliprole + Flonicamid (Pradia™)	• Foliar activity • Must be applied in scheduled protective programs and used in rotation • with products with a different mode of action

Table 3. List of biological and organic insecticides, and soaps and oils used as part of a whitefly management program.		
Type	**Active Ingredients (Trade Name)**	**Notes**
Compound of Unknown Mode of Action (Unknown/UN)	Azadirachtin (AZATIN®/Molt-X®/ Azatrol®)	• Insect growth regulators treat only immatures/nymphs • Spray on a small area to check phytotoxicity • Safe to beneficial insects • Very low mammalian toxicity
Fungal Agents	*Beauveria bassiana* Strain GHA (BotaniGard®) *Beauveria bassiana* Strain PPRI 5339 (Velifer®) *Isaria fumosorosea* Apopka Strain 97 (Ancora®) *Isaria fumosorosea* Strain FE 9901 (NOFLY™) *Metarhizium brunneum* Strain F52 (Met52®)	• Slow-acting • Sensitive to environmental conditions
Pyrethrins (3A)	Pyrethrins (Pyreth-It®)	• Nerve toxicant • Provides fast activity but will offer only hours to a day of control • Subject to rapid reinfestation • Broad-spectrum and will kill beneficial insects
Soaps	Potasium Salts of Fatty Acids (Safer®)	• Acts by contact on the cuticle (outer surface of the exoskeleton)
Nonspecific Mechanical and Physical Disruptors (UNM)	Mineral oil (Ultra-Pure® Oil/ SuffOil-X®/Mite-E-Oil®/TriTek™)	• Suffocates and disrupts insect cuticles • Must contact the pest directly • Some oils may burn plant leaves in hot and sunny weather • Many oils are organic • Botanical oils are primarily repellents
Botanical Essence (including synthetics, extracts, and unrefined oils with unknown or uncertain mode of action/UNE)	Neem Oil (Triact®) Potassium Salts of Fatty Acids (M-Pede®) Botanical Essences (Bare Ground Just Scentsational Garlic Scentry Concentrate) Pyrethrins + Oils (Pycana®)	• Used as a foliar spray • Contact insecticide • This product can be applied up to harvest