SWEETPOTATO WHITEFLY (SILVERLEAF WHITEFLY) (9/15)

Scientific name: *Bemisia tabaci* Biotype B, (formerly *B. Argentifolii)*

DESCRIPTION OF THE PEST

Sweetpotato whitefly is a major problem in California's southern desert and in the San Joaquin Valley.

Several species of whiteflies may infest cotton. Proper identification of sweetpotato whitefly is important because other whitefly species do not usually cause economic damage in cotton. Use a hand lens to examine both immatures and adults. Sweetpotato whitefly adults are tiny (0.06 inch or 1.5 mm long), yellowish insects with white wings. Their wings are held somewhat vertically tilted, or rooflike, over the body and generally do not meet over the back but have a small space separating them. Greenhouse whitefly (*Trialeurodes vaporariorum*) adults, the species that is most similar in appearance, hold their wings flatter over the back and there is no space separating the two wings where they join. Bandedwinged whiteflies (*Trialeurodes abutiloneus*) have brownish bands across their wings.

Whiteflies are found mostly on the undersides of leaves. They fly readily when plants are disturbed. The tiny, oval eggs hatch into a first nymphal stage that has legs and antennae and is mobile. The legs and antennae are lost after the first molt and subsequent stages remain fixed to the leaf surface. The last nymphal stage, often called the pupa or the red-eye nymph, is the stage that is easiest to identify. Sweetpotato whitefly pupae are oval and yellowish with red eye spots. The edge of the pupae tapers down to the leaf surface and has few to no long waxy filaments around the edge. In contrast, greenhouse whitefly and banded-winged whitefly pupae have many long waxy filaments around the edge and the edge is somewhat vertical where it contacts the leaf surface.

Sweetpotato whitefly is a multihost pest. Problems in cotton develop from sweetpotato whiteflies that overwinter in cole crops, ornamentals, and weeds. Numbers often increase in spring melons. Once these alternative host crops are harvested or destroyed, whiteflies migrate into adjacent cotton fields. As temperatures warm up, numbers rapidly increase, with the highest numbers occurring in mid- to late summer.

DAMAGE

Whiteflies are sucking insects and their feeding removes nutrients from the plant. Feeding by high populations may result in stunting, poor growth, defoliation, boll shed and reduced yields. As they feed, whiteflies produce large quantities of honeydew which, if deposited on fibers, will reduce cotton quality and may interfere with picking, ginning, and spinning. Honeydew also supports the growth of black sooty molds that stain lint, lowering its quality. The sweetpotato whitefly vectors the *Cotton leaf crumple virus* in southern California desert valleys.

MANAGEMENT

Whiteflies are difficult to manage once their populations have reached high levels. Repeated exposure to insecticide treatments is very likely to lead to development of resistant strains. In general, the best approach is an integrated pest management strategy that relies first on cultural and biological control methods and uses chemical controls only when needed.

Biological Control

Several wasps, including species in the genera *Encarsia* and *Eretmocerus*, parasitize whiteflies. Whitefly nymphs are also preyed upon by bigeyed bugs, lacewing larvae, and lady beetles. Sweetpotato whitefly is an introduced pest that has escaped its natural enemies. Some indigenous native parasites and predators, such as the sevenspotted lady beetle, *Coccinella septempunctata*, do attack it but do not keep it below damaging numbers.

Cultural Control

When possible, plant cotton at least one-half mile upwind from other key whitefly hosts such as melons, cole crops, and tomatoes. Maintain good sanitation in areas of winter and spring host crops and weeds by destroying and removing all crop residues as soon as possible. Control weeds in noncrop areas including head rows and fallow fields, and harvest alfalfa on as short a schedule as possible. Before destroying weeds, however, check them for whitefly predators and parasites because they can be an important source of these natural enemies. In addition, allow the maximum time between whitefly host crops and produce vegetables and melons in the shortest season possible.

Where whitefly infestations are severe, plan for early crop termination and defoliation. After harvesting, promptly destroy stalks to prevent regrowth and limit additional whitefly buildup. Use glyphosate with the defoliation treatment to reduce regrowth.

Acala varieties, which require less time to mature than Pima varieties, may have fewer whitefly infestations. In general, all Pima varieties are more attractive to sweetpotato whitefly than upland cotton varieties. of the upland varieties, hairy-leaf cottons are more susceptible than smooth-leaf varieties.

Organically Acceptable Methods
Cultural and biological controls and sprays of insecticidal soap, some oils, and azadirachtin are acceptable for use on organically grown cotton.

Resistance
Some pyrethroid and organophosphate insecticides have lost their effectiveness for controlling whiteflies. Repeated applications of a product may build high resistance levels in whiteflies. To delay and manage resistance, do not treat successive generations of whiteflies with same product or with insecticides that have the same mode of action number; rotate insecticides with a different mode of action number during the season.

Unsprayed alternative host crops, from which sweetpotato whiteflies migrate into sprayed cotton fields, may be an important source of susceptible whitefly genes and therefore may act as resistance management agents.

Monitoring and Treatment Decisions
Routinely check field margins for whiteflies; these areas are usually infested first. Be especially alert for rapid population buildup when nearby host crops are in decline. During these critical periods, check cotton fields twice weekly. Whitefly adults and nymphs need to be monitored on undersides of leaves from early squaring to harvest. Check for whitefly adults on undersides of leaves—if 3 or more are found, rate the leaf as infested. For whitefly nymphs, place a quarter-sized ring between the central and left-side main veins and check for presence or absence of large nymphs. Score the leaf as infested if any large nymphs are present (3rd and 4th instars) within the quarter-sized ring.

To improve efficiency of your monitoring program, combine sampling of spider mites with other pests. From early squaring to boll development, combine sampling for spider mites, aphids, and whitefly as described in MONITORING SPIDER MITES, APHIDS, AND WHITEFLY. From open boll to harvest follow guidelines described under MONITORING FOR APHIDS AND WHITEFLY. Monitoring forms are available on the online version of this guideline.

The treatment threshold is 40% of leaves infested with large nymphs or 40% of leaves infested with whitefly adults—but remember, a leaf is not called "infested" unless at least 3 whitefly adults are present. If using insect growth regulators (IGRs), nymphs must also be present to justify treatment. If high numbers of adults are at field edges, but no nymphs, an edge treatment with a non-IGR may be required.

Early-season treatments for sweetpotato whitefly nymphs should be limited to IGRs (buprofezin [Courier], pyriproxyfen [Knack], or spiromesifin [Oberon]), or nonpyrethroid insecticides. Pyrethroids should not be used until later in the season when the bolls are open, because they increase populations of spider mites and aphids by causing them to reproduce faster; they are more toxic to natural enemies of aphids, spider mites, and sweetpotato whiteflies than the other materials; and they are most effective against adult whiteflies, whereas nonpyrethroids are most effective against nymphs.

The IGRs (buprofezin and pyriproxyfen) may be applied only once per season; an application of either one may provide up to 6 weeks of whitefly control. Spiromesifen may be applied twice during the season. Sample carefully to be sure that an application is needed before applying IGRs, and use only full-field treatments. Use of insect growth regulators for whitefly control can reduce outbreaks of mites and aphids because of their selectivity.

In fields where whitefly populations are migrating in from overwintering sites or from other cotton fields and adults and eggs are present but nymphs are rare, a nonpyrethroid (acetamiprid [Assail], chlorpyrifos [Lorsban], oxamyl [Vydate]) treatment can be used. In fields with young plants, an IGR may also be required after immigration from overwintering sites has subsided. Edge treatments of nonpyrethroids may also be useful under these conditions. Treat when leaf-turn samples average 10 or more adult whiteflies per leaf. If higher populations are present at the field margins than in the field centers, treat only field margins; this will help reduce cost as well as preserve beneficials. Treatment usually can be delayed until mid-July in the San Joaquin Valley. Holding off treatment until mid-July also reduces selection for pesticide resistance, which can develop rapidly in this pest.

Later in the season when bolls are open and lint is exposed, if there is a massive influx of sweetpotato whitefly from other cotton fields, use a pyrethroid such as bifenthrin (Brigade) or fenpropathrin (Danitol) in combination with DEF or an organophosphate to provide quick knockdown of adults.

Rotate classes of insecticides to manage resistance. This includes all insecticides used in the field, including those used for other insect pests during the current season. Whitefly control with insecticides is maximized by thorough spray coverage. Ground application may give more complete coverage than air.

Common name (Example trade name)	Amount per acre**	REI‡ (hours)	PHI‡ (days)

The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table. When choosing a pesticide, also consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Not all registered pesticides are listed. Always read the label of the product being used.

EARLY TO MID-SEASON (Light population mid-season)

Insect growth regulators

A. BUPROFEZIN
(Courier SC) — Label rates — 12 — 21
SELECTIVITY: High
PERSISTENCE: PEST: Long NE:[2] Long
MODE-OF-ACTION GROUP NUMBER1[1]: 16
COMMENTS: Chitin synthesis inhibitor; effective against nymphs. Apply no more than twice per season. Apply no sooner than 21 days after pyriproxyfen.

B. PYRIPROXYFEN
(Knack) — 8–10 fl oz — 12 — 28
SELECTIVITY: High
PERSISTENCE: PEST: Long NE:[2] Short
MODE-OF-ACTION GROUP NUMBER1[1]: 7C
COMMENTS: Juvenile hormone mimic; sterilizes adults and eggs; prevents adult emergence. Use only once per season. Apply no sooner than 14 days after buprofezin.

EARLY TO MID-SEASON (Light population mid-season)

A. SPIROMESIFEN
(Oberon 2SC) — See comments — 12 — 30
SELECTIVITY: High
PERSISTENCE: PEST: Unknown NE:[2] Unknown
MODE-OF-ACTION GROUP NUMBER1[1]: 23
COMMENTS: Early in the season, use 6 fl oz/acre; from mid- to late season 8-16 fl oz/acre. Do not apply more than 3 applications per crop season or at intervals less than 7 days or exceed 32 fl oz/acre/season.

MID- TO LATE-SEASON

A. ACETAMIPRID
(Assail 70WP) — 1.7–2.3 oz — 12 — 28
SELECTIVITY: High
PERSISTENCE: PEST: Moderate–Long NE:[2] Short
MODE-OF-ACTION GROUP NUMBER1[1]: 4A
COMMENTS: A neonicotinoid. Treat when adult whiteflies first appear, do not wait until nymphs are present. Do not exceed 0.4 lb a.i./acre per crop or make more than 4 applications per season. Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

B. SPIROMESIFEN
(Oberon 2SC) — See comments — 12 — 30
SELECTIVITY: High
PERSISTENCE: PEST: Unknown NE:[2] Unknown
MODE-OF-ACTION GROUP NUMBER1[1]: 23
COMMENTS: Early in the season, use 6 fl oz/acre; from mid- to late season 8-16 fl oz/acre. Do not apply more than 3 applications per crop season or at intervals less than 7 days or exceed 32 fl oz/acre per season.

C. FLUPYRADIFURONE
(Sivanto 200SL) 10.5–14 fl oz 12 14
SELECTIVITY: High
PERSISTENCE: PEST: Moderate NE:[2] Short
MODE-OF-ACTION GROUP NUMBER1[1]: 4D

D. DINOTEFURAN
(Venom) 1–3 oz 12 14
SELECTIVITY: Moderate to High
PERSISTENCE: PEST: Moderate NE:[2] Short
MODE-OF-ACTION GROUP NUMBER1[1]: 4A
COMMENTS: A neonicotinoid. Kills lady beetles. Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

E. CLOTHIANIDIN
(Belay) 3–6 fl oz 12 21
SELECTIVITY: Low
PERSISTENCE: PEST: Moderate NE:[2] Long
MODE-OF-ACTION GROUP NUMBER1[1]: 4A
COMMENTS: Toxic to bees 0–5 days after treatment. May induce outbreaks of spider mites. Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

LATE-SEASON USE

Bifenthrin may be used alone for control of light-to-moderate populations. For moderate-to-heavy populations use the pyrethroid bifenthrin (Brigade) in combination with fenpropathrin (Danitol) in combination with oxamyl (Vydate) or an organophosphate. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.
Whitefly susceptibility to insecticides may change during the season depending upon use patterns.

A. BIFENTHRIN*
(Brigade 2 EC) 2.6–6.4 fl oz 12 14
SELECTIVITY: Low
PERSISTENCE: PEST: Long NE:[2] Long
MODE-OF-ACTION GROUP NUMBER1[1]: 3A
COMMENTS: A pyrethroid. Apply in a minimum of 5 gal water/acre with ground equipment or 1 gal/acre by air. When applying by air, 1 qt of emulsified oil may be substituted for 1 qt water in the finished spray. May also be applied in refined vegetable oil. Do not apply more than 0.3 lb a.i./acre per season or make more than 3 applications per season. Do not graze livestock in treated areas or cut treated crops for feed. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

B. FENPROPATHRIN*
(Danitol 2.4EC) 8–16 fl oz 24 21
SELECTIVITY: Low
PERSISTENCE: PEST: Long NE:[2] Moderate
MODE-OF-ACTION GROUP NUMBER1[1]: 3A
COMMENTS: Acephate is an organophosphate and fenpropathrin is a pyrethroid. Do not feed gin trash or treated forage to livestock or allow animals to graze on treated fields. Do not exceed 2.66 pt/acre per season. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.
. . . PLUS . . .
OXAMYL*
(Vydate C-LV) 17–34 fl oz 48 14
SELECTIVITY: Low
PERSISTENCE: PEST: Long NE:[2] Short
PERSISTENCE: (Pest) Moderate, (Natural Enemies) Moderate
MODE-OF-ACTION GROUP NUMBER1[1]: 1A
COMMENTS: A carbamate. Apply in sufficient refined vegetable oil (minimum 3 pt/acre) or in sufficient water to obtain thorough coverage. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.
. . . or . . .
CHLORPYRIFOS*
(Lorsban Advanced) 1–2 pt 24 14
SELECTIVITY: Moderate
PERSISTENCE: PEST: Moderate NE:[2] Short
MODE-OF-ACTION GROUP NUMBER1[1]: 1B
COMMENTS: An organophosphate. Avoid drift and tailwater runoff into surface waters. Certain formulations emit high amounts of volatile organic compounds (VOCs); use low-VOC formulations. **Regulations affect use for the San**

Joaquin Valley from May 1 to October 31, 2015 and 2016. Review the Department of Pesticide Regulation's updated fact sheet. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

. . . or . . .

ACEPHATE
(Orthene 97) 0.5 – 1 lb 24 21
SELECTIVITY: Low
PERSISTENCE: PEST: Long NE:[2] Short
PERSISTENCE: (Pest) Long, (Natural Enemies) Moderate
MODE-OF-ACTION GROUP NUMBER1[1]: 1B
COMMENTS: An organophosphate. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

ORGANICALLY ACCEPTABLE ALTERNATIVES

A. INSECTICIDAL SOAP#
(M-Pede) 2.5 oz/gal 12 0
SELECTIVITY: Low
PERSISTENCE: PEST: Short NE:[2] Short
MODE OF ACTION: A contact insecticide with smothering and barrier effects.
COMMENTS: Spray to wet all infested plant surfaces and repeat treatments at weekly to biweekly intervals. Rotate sprays to avoid more than three consecutive sprays of this material.

B. NARROW RANGE OIL#
(TriTek) 1–2 gal/ 100 gal water 4 0
SELECTIVITY: Low
PERSISTENCE: PEST: Short NE:[2] Short
MODE OF ACTION: Contact including smothering and barrier effects.
COMMENTS: Works by suffocating eggs, nymphs, and adults. Requires total spray coverage.

C. AZADIRACHTIN#
(Neemix 4.5) 0.25–1 pt 4 0
SELECTIVITY: Moderate
PERSISTENCE: PEST: Short NE:[2] Short
MODE-OF-ACTION GROUP NUMBER1[1]: un
COMMENTS: Kills nymphal stages only; use low rate when pest pressure is low or in conjunction with a material that kills adult whiteflies. In an organically certified crop, the use of this material is restricted.

** Mix with sufficient water to provide complete coverage.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

Acceptable for use on organically produced cotton.

1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode-of-action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

2 NE = natural enemies