Book 2

Chapter 5

Insect and Mite Control

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AMORBIA (Western Avocado Leafroller)

Scientific name: *Amorbia cuneana*
(Reviewed 1/07, updated 6/10)

DESCRIPTION OF THE PEST

Western avocado leafroller (family Tortricidae), is primarily a pest of avocado. It occurs in most California groves and occasionally increases dramatically, causing severe fruit damage. This caterpillar also damages citrus, where it is called amorbia, its official common name. Amorbia is often called just "leafroller." However, amorbia, avocado looper, and orange tortrix all roll avocado leaves and web plant parts together with silk.

Amorbia (and orange tortrix) adults are bell-shaped when their wings are folded at rest. Their variably colored forewings are typically orangish to tan with dark markings. Adult amorbia are about 1 inch (2.5 cm) long, about twice the size of orange tortrix adults.

Each amorbia female lays about 150 to 200 eggs during her 2 to 3 week life. These light green, oval-shaped eggs occur mostly on the upper side of leaves close to the midrib. Amorbia (and orange tortrix) eggs are laid overlapping or shinglelike in a flat mass. Amorbia lays about 5 to 100 eggs per mass, with an average of 25 eggs per mass. Eggs darken and larvae emerge about 2 weeks after oviposition. Hatched egg masses resemble whitish patches on leaves.
Amorbia larvae develop through five instars. At maturity they are 0.75 to 1 inch long. Caterpillars are yellowish green when young, and mostly darker green when mature. Older larvae have one short dark horizontal line on their side on their thorax just behind the head and above the first pair of legs. Other avocado caterpillars lack these distinct black marks. Amorbia feed in nests of leaves and fruit tied together with silk. When disturbed, amorbia and orange tortrix larvae often wriggle violently and drop to the ground.

Amorbia pupate for 2 to 3 weeks in rolled leaves. The 0.5 to 0.75 inch long pupae initially are pale green, gradually turn tan, and become brown when mature.

Egg to adult development time is about 1.5 months at an average temperature of 75°F. Amorbia typically has three generations per year at warmer growing areas. From inland Ventura to San Diego Counties, most adults fly and females oviposit during January through April, May through

June, and during September through October. Two generations a year occur on average in coastal groves. In Santa Barbara County most moths emerge and lay eggs during March through June, and August through November.

DAMAGE

Young amorbia larvae chew the leaf surface, leaving a thin brown membrane or skeleton of leaf veins. Mature caterpillars consume the whole leaf, starting in the center or at the leaf edge. Young larvae often web terminal leaves together and feed within them. This damage becomes apparent when terminals grow and unfold. Mature avocado trees can tolerate considerable larval chewing without severe effects on tree growth or fruit yield.

Healthy trees tolerate some loss of chewed foliage and blossoms. Extensive defoliation can result in sunburned fruit and twigs. Economic damage occurs primarily when caterpillars damage fruit. When larvae web leaves to fruit or feed among touching fruit in a cluster, in these protected sites larvae feed on fruit skin. This scarring causes downgrading or culling of fruit.

MANAGEMENT

Conserve natural enemies, which usually keep caterpillars below damaging levels. Modify cultural practices to reduce pest reproduction and survival. Avoid applying broad-spectrum or persistent insecticides for any pests. Caterpillar outbreaks commonly occur after spraying malathion, which poisons parasites and predators. When pesticides are warranted, limit application to the most infested spots to provide refuges from which natural enemies can recolonize after treatment.

Biological Control

Birds, predaceous insects, and spiders commonly prey on caterpillars. Predators include assassin bugs, damsel bugs, lacewings, and pirate bugs. A naturally occurring nuclear polyhedrosis virus often kills many amorbia when caterpillar populations become high. The caterpillar pathogen Bacillus thuringiensis is commercially available as a selective insecticide.

Parasites, especially flies (family Tachinidae) are the most important natural enemies that usually keep amorbia populations below economically damaging levels. Tachinids attacking amorbia include Eumea (=Aplomya) caesar, Nilea (=Pseudoperichaeta) erecta, and at least 5 other species. Their black to dark grayish adults are about 0.25 to 0.33 inch (6–8 mm) long and resemble a common house fly, but have more prominent stout hairs. White tachinid eggs may be observed on or near a caterpillar's head. Brown to reddish, parchmentlike tachinid pupal cases are often found near the larger pupal cases of dead caterpillars.

At least 8 wasps species parasitize amorbia, including the external larval parasite Habrobracon (=Bracon) xanthonotus (Braconidae) and the internal pupal parasite Brachymeria ovata (Braconidae). Trichogramma spp., 0.04 inch (1 mm) long or smaller wasps, lay one to several eggs in each caterpillar egg. Black amorbia eggs are probably parasitized by Trichogramma.

Where naturally occurring parasitism is inadequate, amorbia has been controlled by releasing Trichogramma platneri during peak moth egg laying in late spring as determined by monitoring adults using commercially available pheromone-baited or black light traps. Commercial

suppliers typically provide Trichogramma as parasitized moth eggs glued to cardboard. The adult wasps should emerge soon after the shipment arrives. Protect cards from Argentine ants and other predatory insects. Keep a small portion from any purchase in a shady location in a clear container covered with tightly woven cloth. Observe wasp emergence to assess product quality.

Cultural Control
Prune to reduce foliage touching among adjacent trees and to minimize dead twig and plant debris accumulation in canopies. Thin or selectively harvest fruit in clusters. Pruning and thinning reduce protected sites and canopy bridges that facilitate insect movement between trees, thereby reducing the abundance of caterpillars, greenhouse thrips, and mealybugs. Remove abandoned citrus to reduce the likelihood that amorbia and orange tortrix will move from citrus to nearby avocado. Control weeds near avocado that host these caterpillars. Reduce dust in groves by driving slowly and oiling or watering dirt roads. Dusty conditions reduce the effectiveness of parasites and predators that attack caterpillars and other pests including mites and scales.

Organically Acceptable Methods
Biological and cultural controls are organically acceptable.

Monitoring and Treatment Decisions
Where problems may occur, monitor during at least spring and summer, especially after peaks in moth flights. Good places to monitor include where bright lights such as security lights are used outdoors because the nocturnal moths are attracted by lights to lay eggs nearby. Be sure to correctly distinguish the cause of any damage as other insects and certain abiotic disorders cause leaf holes resembling caterpillar chewing. Correctly identify the species of caterpillars. Alternate host plants, damage potential, monitoring methods, and natural enemies vary depending on the species of caterpillar. Look for caterpillar predators and larval diseases and parasitism. Natural enemy prevalence affects treatment decision-making. See MONITORING CATERPILLARS AND THEIR NATURAL ENEMIE for details on identification and monitoring methods including inspecting foliage for caterpillars and their damage (timed counts), trapping adults, shaking foliage to dislodge larvae (primarily for avocado looper), or a combination of these methods.

There are no established amorbia thresholds for pesticide application. Monitor parasites and other natural enemies several times to determine if their populations are increasing. If they are, the amorbia population will decrease. Spraying with malathion often leads to outbreaks of other pests and is not recommended. Bt sprays are the least disruptive to beneficials.

Treatment

Comon name (trade name)		Amount to use	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact. Not all registered pesticides are listed. Always read label of product being used.

A. TRICHOGRAMMA PLATNERI PARASITES# — 100,000 parasites/acre/season — —

COMMENTS: Make at least 2 releases a week apart during the period of peak egg laying (as determined by pheromone traps and visual inspection). Place parasite egg cards on at least 4 trees/acre for a total minimum release of 100,000 parasites/acre/season.

B. BACILLUS THURINGIENSIS spp. AIZAWAI#
(various products) — Label rates — 4 — 0

MODE OF ACTION GROUP NUMBER[1]: 11

COMMENTS: Effective when used to control early instars of the caterpillar.

C. BACILLUS THURINGIENSIS ssp. KURSTAKI#
(various products) — Label rates — 4 — 0

MODE OF ACTION GROUP NUMBER[1]: 11

COMMENTS: Effective when used to control early instars of the caterpillar.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

\# Acceptable for use on organically grown produce.

[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/.

— Not applicable.

PRECAUTIONS (see last page of this chapter)

ANTS

Scientific names:
Argentine ant: *Linepithema humile*
Native gray ant: *Formica aerata*
Southern fire ant: *Solenopsis xyloni*
(Reviewed 1/07, updated 6/10)

DESCRIPTION OF THE PEST

Most ants (family Formicidae) are wingless workers (sterile females). Workers search for food outside the nest, dig tunnels, and care for the tiny, pale, grublike ant larvae in the nest. Adult ants can also be winged males that die soon after mating or reproductive females (queens) that lay tiny elliptical eggs in underground nests. Queens and males are usually observed only during their brief mating season when they develop wings and swarm outside of the nest.
Ants have a narrow constriction between the thorax and abdomen. Their antennae are distinctly elbowed. Winged ants have hind wings that are much shorter than the forewings. It can be very helpful to identify the species present as ant biology and management often differ among species. An illustrated key is available.

The most prevalent species is the Argentine ant, which travels in characteristic trails with numerous individuals. Workers are about 0.13 inch (3 mm) long, uniformly deep brown to light black and do not sting and rarely bite. The Argentine ant has one petiole node (hump) between the thorax and the abdomen.

Native gray ants, also called field ants, are larger than the other ants. Native gray ants are up to 0.3 inch (7.5 mm) long and have one petiole node. Gray ants nest in topsoil or under rocks and debris. Individuals move in an irregular jerky manner and generally do not travel in trails or sting.

The southern fire ant, also called the California or native fire ant, is light reddish brown with a black abdomen. The entire body is covered with golden hairs. It has two nodes (humps) between the thorax and the abdomen. Workers size is variable range from 0.1 to 0.018 inch (2.5–4.5 mm) long. Southern fire ants nest beneath loose mounds or craters and do not aggregate in colonies as large as those of the Argentine ant. Southern fire ants may swarm over the ground and may sting when disturbed. They forage mostly in the morning and early evening and usually do not travel in conspicuous trails.

Be especially alert for the highly aggressive red imported fire ant *(Solenopsis invicta =S. wagneri)*. Red imported fire ants run up any objects they encounter and have a venomous sting, which can seriously injure people. Red imported fire ants can be recognized in part by their size, which varies greatly among workers. Large and small ants, 0.08 to 0.25 inches (2–6 mm) long occur together in the same clump or trail. Except for southern fire ants, which also range in size, workers outside the nest are about the same size for all other ants likely to be found in California groves. Report suspected red imported fire ant infestations to agricultural officials. Contacts include telephoning 1-888-4FIREANT toll free and the http://www.fireant.ca.gov Web site.

DAMAGE

Ants are important natural enemies of many insect pests and provide benefits such as improving soil. However, ants sometimes chew crop twigs and tender bark, damage irrigation tubing, or annoy workers. In avocado, ants are pests primarily because they disrupt biological control of other pests. Ants are primarily a problem in young avocado trees where mealybugs and other honeydew-producers are occasional pests. Ants protect these food sources from natural enemies, causing phloem-sucking insects to become more abundant. When honeydew-producers are present, ants also increase populations of armored scales and some other pests that do not excrete honeydew. Ants are general predators that attack most any other predator or parasite they encounter, regardless of what host that natural enemy is seeking.

MANAGEMENT

Periodically inspect for ants and bark damage under trunk wraps of young trees. Check for ants on trees of any age if honeydew-producing insects are a problem. If ants have swollen, almost translucent abdomens, this can indicate they are honeydew–collecting species.

Ants do not have effective natural enemies, except for competition with other ants. Cultivation controls ants, but creates dust and disturbing soil near trees damages roots. Insecticide mixed with bait is the preferred chemical control. Baits are slow acting, but effective over the long-term because they take advantage of ants' food-sharing behavior. Ants spread insecticide bait throughout the colony, including to nest-bound immatures and queens underground.

The best time to bait is late winter to early spring when ant numbers are relatively low. Bait effectiveness varies with ant species, availability of alternative food, active ingredient, type of bait, and the time of year. To determine which bait to use, offer a small quantity of each of several baits and observe which is preferred by the ants.

Solid baits are applied for fire ants. Argentine ant and other honeydew-feeding species are most effectively controlled by liquid baits, which must be applied in registered bait stations. Check for the registration and availability of new liquid baits and baits stations to control honeydew-feeding ants. Apply an effective bait in spots near nests or on trails. Spot treating takes advantage of ants' trailing behavior, which leads nest mates to locations where food is concentrated. Spot treatment minimizes toxicity to non-pest ant species, which compete with pest ants and help to limit their populations. Broadcasting baits or widespread spraying with insecticide is expensive, and may not reach many ants within nests underground.

Treatment

Common name (trade name)	Amount to use	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact. Not all registered pesticides are listed. Always read label of product being used.

A. STICKY POLYBUTENE MATERIALS#

(Tanglefoot)	Label rates	—	—

COMMENTS: For use on all varieties. Use polybutene-based products only. Do not apply sticky materials directly on the trunk; use a 6- to 18-inch wrap under the sticky material to protect the tree from sunburn. Exercise caution in applying multiple applications (more than 3 or 4); watch for symptoms of bark cracking. Apply the sticky band high enough to avoid sprinklers, dust, and direct sunlight. Reactivate periodically by rubbing with a stick to remove dust. Skirt- and canopy-prune trees so that ants have access only via the trunk. Check to ensure that low hanging branches, sticks, weeds, etc., are not allowing ants access to trees.

B. BORIC ACID#

(Gourmet)	Label rates	—	0

MODE OF ACTION GROUP NUMBER[1]: —

COMMENTS: Available only for organically grown fruit under a Special Local Need (SLN) registration. Liquid boric acid formulation with sweet bait for use only in approved bait stations that meet EPA ChemSAC criteria. For use against honeydew-feeding ant species, including Argentine ant and native gray ant.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

\# Acceptable for use on organically grown produce.

[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/.

— Not applicable.

PRECAUTIONS (see last page of this chapter)

AVOCADO BROWN MITE

Scientific name: *Oligonychus punicae*
(Reviewed 1/07, updated 1/07)

MITE PESTS OF AVOCADO – GENERAL INFORMATION

Spider mites (family Tetranychidae) and predatory mites (Phytoseiidae) are tiny 8-legged arthropods. Persea mite is a key pest of California-grown avocados. Avocado brown mite and sixspotted mite are sporadic pests. Several beneficial mites are important predators of pest mites and certain insects. Natural enemies and certain management strategies vary among pest mites. Identify the pest and natural enemy species in your grove and learn their biology so you can manage these pests appropriately as needed. For details about sampling techniques, see MONITORING PERSEA AND SIXSPOTTED MITES.

DESCRIPTION OF THE PEST

Avocado brown mite (family Tetranychidae) is dark brown, oval, and tiny (about 0.01 inch or 0.3 mm long). Its tiny amber-colored eggs have a short projecting stalk. At low populations most eggs are laid singly along the midrib. Eggs are increasingly found throughout the upper leaf surface as populations increase. In summer there may be two complete generations per month. Temperatures of 90° to 95°F or higher usually kill these mites and their eggs, as does the first cold weather in fall or early winter.

DAMAGE

Avocado brown mite is a sporadic pest, mostly in coastal growing areas. Bronzing of leaves, mite cast skins, and partial defoliation of some trees by avocado brown mite is most noticeable from about July to September. Severe infestations tend to occur in border row trees along dirt roads, where road dust is detrimental to mite predators. Ash deposited on leaves from wildfires reportedly also causes brown mite outbreaks.

Avocado brown mite feeds almost entirely on upper leaf surfaces. It causes no significant damage when population densities are low to moderate (about 10 to 20 adult females per leaf). If the spider mite destroyer lady beetle *(Stethorus picipes)* is present and reproducing well at this time, brown mite does not become a problem. Damage occurs if avocado brown mite averages about 50 to 70 adult females per leaf (about 100-200 motile stages, adults and nymphs combined). At these higher densities mites also colonize the lower leaf surface and sometimes fruit, and partial defoliation can occur. These higher populations cause leaf bronzing along the midrib, then along smaller veins, and finally the entire leaf turns brown.

MANAGEMENT

Natural enemies and temperature (hot or cold weather) usually maintain this mite at innocuous levels. Maintain good biological control by conserving natural enemies. Control dust and avoid applying broad-spectrum pesticides for any pests. When treating any pests, including avocado brown mite during late summer or fall, spot treat individual trees where possible.

Biological Control: Naturally occurring populations of the spider mite destroyer *(Stethorus picipes)* provide the majority of brown mite biocontrol. Predaceous mites (especially *Euseius*

hibisci and *Galendromus helveolus)* are also helpful, but predatory mites are primarily effective against sixspotted mite. Most other natural enemies listed as attacking persea mite also feed on avocado brown mite.

Cultural Control: Controlling dust, which improves predator activity, is critical for maintaining biological control. Oil or pave main orchard roads to reduce dust drift onto trees. When it is necessary to use dirt roads, drive slowly. Use a water truck or trailer to wet unpaved roads and prevent airborne dust, especially during summer months when heat convection currents carry dust well up into tree canopies.

Organically Acceptable Methods: Biological and cultural controls along with sulfur and some oil sprays are acceptable control methods in an organically certified crop.

Monitoring and Treatment Decisions: Look for bronzed leaves and brown mites during summer through fall monitoring for other pests such as caterpillars and persea mite, especially when monitoring in coastal groves. Consider monitoring specifically for brown mite in border rows along dirt roads during summer through fall where trees are dusty, were sprayed earlier in the season with a broad-spectrum insecticide, and after wildfires. Major outbreaks have occurred after spraying a broad-spectrum insecticide to control greenhouse thrips or omnivorous looper. To locate avocado brown mite and its webbing, use a hand lens (10X) to inspect along the midrib on the upper leaf surface. There is no suggested threshold for when treatment is warranted. Pesticide applications for avocado brown mite are rarely needed.

	Common name (trade name)	**Amount to use**	**R.E.I.+ (hours)**	**P.H.I.+ (days)**
When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.				
A.	NARROW RANGE OIL#	Label rates	4	0
	MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: Requires good coverage to be effective. Check with certifier to determine which products are organically acceptable.			
B.	WETTABLE SULFUR#	Label rates	1 day	0
	MODE OF ACTION: Unknown. An inorganic miticide. COMMENTS: Do not treat with sulfur when temperatures exceed 90°F to avoid leaf damage. Sulfur sprays are often not effective in coastal areas where temperatures do not promote fuming action.			

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

\# Certain products are acceptable for organically grown produce.

PRECAUTIONS (see last page of this chapter)

AVOCADO LACE BUG

Scientific name: *Pseudacysta perseae*
(Reviewed 1/07, updated 8/08)

DESCRIPTION OF THE PEST

Avocado lace bug (family Tingidae) occurs in parts of the Caribbean, Mexico, and southeastern United States. As of 2006, in California it occurs only in San Diego County. Also known as the camphor lace bug, it's only known hosts are various *Persea* species and the camphor tree *(Cinnamomum camphora)*, which is grown as a landscape ornamental and commercially for its aromatic extracts.

Lace bugs do not feed on fruit. Adults and nymphs feed in groups on the underside of leaves. This sucking pest causes chlorotic blotches on foliage, which become necrotic. Severely damaged leaves may drop prematurely. Defoliation can result in sunburned fruit and wood and stressed trees, reducing subsequent yield.

Adults are about 0.08 inch (2 mm) long oval shaped insects with a dark (black or brownish) head and thorax. Their abdomen, antennae, legs, and wing covers have both dark and light (orangish, yellowish, or white) areas. Nymphs are mostly dark and orangish, resembling the adults without wings. Eggs are laid on leaves within shiny black globs of excrement. Insects develop from egg to adult in about 1 month during warm weather and have several generations a year. All stages can be present throughout the year.

DAMAGE

Relatively little is known about this insect in California. Populations increase during summer, and high populations and severe foliage damage occur in California on some untreated avocado trees. Avocado lace bug is an intermittent pest in Florida on avocado.

MANAGEMENT

An important component of managing avocado lace bug is preventing its spread into uninfested areas. Do not move uncertified host material or dirty bins from infested areas. Clean bins and other potentially infested equipment and materials before bringing them into groves, as lace bugs may survive and spread on leaf debris. Conserve resident natural enemies that prey on lace bugs, including lacewing larvae and predatory thrips. The introduction of natural enemy species is being researched in an effort to provide classical biological control. At least two species of parasitic wasps kill avocado lace bug eggs in Florida, an unidentified species in the family Mymaridae and an *Oligosita* sp. (Trichogrammatidae).

Do not treat low populations of lace bugs. If populations are increasing and are anticipated to cause extensive foliage damage or premature leaf drop, where feasible make a foliar spray of short-persistence contact materials such as oil or pyrethrin. Avoid persistent, broad-spectrum insecticides, which can disrupt biological control of other pests in avocado. Certain systemic insecticides can be very effective and may be available for application through irrigation systems.

Organically Acceptable Methods Sprays of pyrethrin (PyGanic) and certain oils are acceptable for use in an organically certified crop.

Treatment

Common name (trade name)	Amount to use	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact. Not all registered pesticides are listed. Always read label of product being used.

A. NARROW RANGE OIL# — Label rates — 4 — 0
MODE OF ACTION: Contact including smothering and barrier effects.
COMMENTS: Requires good coverage to be effective. Check with certifier to determine which products are organically acceptable.

B. IMIDACLOPRID
(Admire Pro) — 14 fl oz/acre — 12 — 6
MODE OF ACTION GROUP NUMBER[1]: 4A
COMMENTS: Do not exceed 14 fl oz/acre per season. Apply by chemigation through low-pressure drip, trickle, microsprinkler or equivalent equipment. Application may only occur pre-bloom or during bloom period. Post bloom applications are not allowed. Bees shall not be used in avocado treated while avocado is in bloom. Remove bee hives from avocado orchards prior to application. Hives may be returned only after the avocado bloom period has ended.

C. PYRETHRIN#
(PyGanic) — Label rates — 12 — 0
MODE OF ACTION GROUP NUMBER[1]: 3
COMMENTS: Because there is little residual activity, repeat application may be needed in 2-3 weeks and control may be only partial.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

\# Acceptable for use on organically grown produce.

[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/.

PRECAUTIONS (see last page of this chapter)

AVOCADO THRIPS

Scientific name: *Scirtothrips perseae*
(Reviewed 1/07, updated 2/14, corrected 3/14)

DESCRIPTION OF THE PEST

Avocado thrips (order Thysanoptera) is a key pest that scars fruit. Adults lay eggs hidden inside the underside of leaves, in young fruit, and in fruit petioles. The thrips then develop through two larval and two pupal stages. The first instar is white to pale yellow. The second instar is larger, more robust, and bright yellow. Larvae are typically found along major veins on the underside of younger leaves and anywhere on the surface of young fruit. Although some pupation occurs on the tree in cracks and in crevices, about three-fourths of avocado thrips drop from trees to pupate in the upper layer of dry, undecomposed leaf litter. Pupae are rarely seen and they do not feed. Adults are 0.03 inch (0.7 mm) long and have fringed-tipped wings. Adults are orange-yellow with distinct thin brown bands between segments of their abdomen and three small red dots (ocelli) on top of the head.

Neohydatothrips burungae, a new species of unknown importance, closely resembles avocado thrips, and may reliably be distinguished only by an expert. *Neohydatothrips burungae* often is darker brownish and has bands only on upper side of its abdomen. Adult avocado thrips can closely resemble citrus thrips and to a lesser degree, western flower thrips, which occur on, but do not damage, avocado. Citrus thrips has no abdominal bands on its light orangish yellow to white body. Western flower thrips color is highly variable and some individuals have abdominal banding. Western flower thrips are most often found in flowers. Western flower thrips adults have thick, bristlelike hairs at the tip of the abdomen, which the other species lack. When at rest, avocado thrips' wing tips extend beyond its abdomen, while the abdomen of western flower thrips extends beyond the tips of its wings. Avocado thrips larvae resemble those of several other species, including certain beneficial predaceous thrips. Predatory thrips are seldom seen at high levels as can be common with avocado thrips larvae.

Avocado thrips develops well under cool temperatures. Populations typically begin increasing in late winter and spring, when avocado thrips feed on young leaves. Abundance peaks in late spring and early summer, when most fruit are young and after the growth flush when hardening of leaves induces thrips to move from foliage to feed on young fruit. Populations are suppressed by warm, dry conditions, but this weather usually occurs later in the season, when most fruit are larger and no longer susceptible to new damage.
Avocado thrips has 6 or more generations a year. Egg to adult development occurs in about 20 to 30 days when temperatures average 65° to 75°F. Actual development time can be predicted by monitoring temperature using degree-days.

DAMAGE

Although it has little effect on tree health, avocado thrips feed directly on immature fruit. Internal fruit quality is not affected, but obvious feeding scars cause severe downgrading or culling of damaged fruit. Severe scarring when fruit are young can slow or stunt fruit growth. As fruit grow, this early feeding becomes apparent as scabby or leathery brown scars that expand across the skin. Thrips scarring is sometimes called "alligator skin." Mechanical injury or

abrasion, such as from strong winds, also causes fruit scarring that can be confused with injury from thrips.

Avocado thrips prefer to feed and lay eggs in succulent leaves. Feeding on young leaves causes irregular bronzing or scarring on both sides of the leaf. Discoloration is typically concentrated along the midrib and lateral leaf veins, and then appears in scattered patches between veins as populations increase. Foliar feeding is usually unimportant, except when very high populations cause premature leaf drop.

Thrips move to young fruit when leaves harden after the growth flush has finished. Almost all damage occurs when fruit are 0.2 to 0.6 inches (5–15 mm) long. Although Hass fruit are susceptible to feeding until they reach about 2 inches, thrips feeding rarely causes scars on fruit larger than about 0.75 inches. This scarring on young fruit may not become obvious until fruit enlarge.

MANAGEMENT

Importation of new species of natural enemies and modifications of cultural practices are being investigated for controlling avocado thrips. If insecticides are applied, choose selective materials whenever possible to minimize adverse impacts on the natural enemies that usually provide good control of other avocado pests, including caterpillars, certain mites, scales, whiteflies, and other thrips.

Biological Control

Natural enemies may suppress avocado thrips, but sometimes do not reduce populations below damaging levels. Predatory thrips are the most important natural enemies, especially *Franklinothrips orizabensis.* At mild temperatures, about 77°F, *F. orizabensis* populations can increase readily if avocado thrips populations are increasing. This predator also eats other thrips, mites, and whiteflies, and feeds on avocado pollen and leaf juices. The adult *F. orizabensis* is mostly black with white or pale bands on its body, especially near its thin waist. Females lay eggs into plant tissue. Immatures develop through two larval and two pupal stages. First instars are yellowish with relatively long legs. Second instars have a distinctly swollen, bright orangish or red abdominal area. Pupation occurs in a silken cocoon. *Franklinothrips vespiformis,* black hunter thrips *(Leptothrips mali)*, and several banded-wing thrips *(Aeolothrips* spp.) also feed on avocado thrips, other pest thrips, and mites. Banded-wing thrips supplement their diet with pollen and plant juice, and can complete their life cycle and persist even when their prey are uncommon. Other general predators (especially green lacewings) and at least one parasitoid *(Ceranisus menes)* also attack avocado thrips.

Cultural Control

Avocado thrips damage is affected by practices that increase or decrease the abundance of succulent foliage during set and growth of young fruit. Modifying fertilization (amount, application method, formulation, and timing) and pruning (the extent and time of branch removal) alters the extent to which trees continue to produce tender foliage during about May and June. Research indicates that in comparison with pruning during February through April, pruning during January does not affect yield. January pruning may also induce additional

growth flush during fruit set, which may reduce thrips tendency to move from hardening leaves to young fruit.

Adding coarse organic mulch beneath trees and maintaining a mulch layer 6 inches thick may reduce survival of avocado thrips that drop from trees to pupate. The effectiveness of mulching to control thrips is uncertain and labor costs of adding mulch may not be justified solely for thrips control. However, applying coarse organic material such as composted yard waste beneath trees helps control *Phytophthora* root rot and weeds, and thrips reduction might be an additional benefit.

Organically Acceptable Methods
Biological and cultural controls along with sprays of the Entrust formulation of spinosad are acceptable for use in an organically certified crop.

Monitoring and Treatment Decisions
Adults and second instars can be found anywhere on fruit or leaves, including on the upper leaf surface. Avocado thrips most often occur on the underside of tender, reddish foliage before or soon after leaves reach full expansion. Examine newly flushed leaves during February and March to get an indication of whether thrips are abundant enough to be a likely problem later when young fruit occur.

Monitor regularly every 7 to 10 days beginning as early as April, looking for both mites and thrips. Begin regular thrips monitoring before young fruit are present and continue monitoring until most fruit exceed 0.75 inch in diameter. Look for thrips on 10 young leaves on at least 10 trees per grove. Use a magnifying lens to inspect the underside of these leaves and count the number seen. (Avoid leaves that are fully hardened and dark green, that touch fruit or other leaves, or are very close to flowers and fruit. Thrips on hardened leaves, touching leaves and fruit, and in flowers are often other species.) Calculate the average number of thrips per leaf: divide the total number of thrips counted by the number of leaves sampled (100). Young fruit can be monitored by clipping or pinching stems and examining the entire fruit surface for thrips, especially under the calyx. Be sure to correctly identify the thrips present, and record the results on a monitoring form (PDF).

Depending on thrips densities, treatment decisions are sometimes made based on thrips abundance on succulent leaves. A treatment decision generally should be made before most new fruit are set or before most thrips move from leaves to young fruit. Before making a treatment decision, consider factors that influence the likelihood of thrips damage. These include thrips damage history, natural enemy abundance, weather, fruit load, and age or size of fruit. If extensive leaf flush continues through fruit set, treatment need may be reduced because more of the thrips population will remain on tender foliage. Conversely, little or no succulent foliage during fruit set increases the extent to which thrips will feed on and damage young fruit. Treatment decision-making is also influenced by grower tolerance for scarring, treatment feasibility and equipment availability, and the possibility that treatments will disrupt natural enemies or promote the development of pesticide resistance. A general guideline is that an average of three to five thrips per leaf at fruit set warrants treatment.

Coordinate treatment decision-making with any persea mite management. Certain materials applied to control avocado thrips (usually earlier in the season) can reduce the need for persea mite treatment (which usually is applied later in the season). Only one application per season may be permitted or recommended for certain materials (e.g., abamectin) to reduce the development of pesticide resistance. Rotate among chemical classes when making multiple applications to reduce the development of pesticide resistance.

Treatment

Common name (trade name)	**Amount to use**	**R.E.I.+ (hours)**	**P.H.I.+ (days)**

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact. Not all registered pesticides are listed. Always read label of product being used.

A. ABAMECTIN*
(Agri-Mek 0.15 EC and others) Label rates 12 14
MODE-OF-ACTION GROUP NUMBER[1]: 6
. . . *plus* . . .
NARROW RANGE OIL
(415) 1% See label See label
MODE OF ACTION: Improves translaminar movement and persistence of insecticide.
COMMENTS: Use with 1-2% narrow range (415) oil in a minimum of 50 gal water/acre for aerial applications and 100 gal water/acre for ground applications. On large trees aerial applications may require larger volumes of water to achieve desired efficacy. Control may last 4 or more weeks. Only use in an alkaline or slightly acidic solution. Do not tank mix with nutrients. To avoid promoting pesticide resistance, do not make more than one application of any abamectin product every 2 years.

B. SPINETORAM
(Delegate) WG 4–7 oz 4 1
MODE-OF-ACTION GROUP NUMBER[1]: 5
. . . *plus* . . .
NARROW RANGE OIL
(415) 1% See label See label
MODE OF ACTION: Improves translaminar movement and persistence of insecticide.
COMMENTS: To delay resistance, do not apply spinetoram more than once per year. Trials against avocado thrips have shown that spinetoram provides more persistent control than spinosad. Choose a lower rate for light infestations and/or small trees and a higher rate for heavy infestations and/or large trees. Toxic against some natural enemies (e.g., *Franklinothrips orizabensis* predatory thrips) when sprayed and for 8-24 hours after. The short residual persistence of this pesticide, however, allows most populations of natural enemies to survive quite well. Apply in a minimum of 50 gal water/acre. On larger trees, aerial applications may require larger volumes of water to achieve desired efficacy. Control may last 3 or more weeks. Only use in an alkaline or slightly acidic solution. Do not tank mix with nutrients.

C. SPIROTETRAMAT
(Movento) 8–10 fl oz 24 1
MODE-OF-ACTION GROUP NUMBER[1]: 23
COMMENTS: Spirotetramat is in the same chemistry class as the miticide spirodiclofen (Envidor). We are still learning how to best time the application of spirotetramat but the presence of young leaves or bloom appear to greatly assist in plant uptake and conversion in the plant to the active form (spirotetramat enol), which is highly systemic. Plant uptake is also improved by the addition of oil (e.g., 1% narrow range oil NR-415) or a surfactant.

D. FENPROPATHRIN*
(Danitol) 2.4 EC 16–21.33 fl oz 24 1
MODE-OF-ACTION GROUP NUMBER[1]: 3

COMMENTS: Fenpropathrin is a contact miticide (not translaminar or systemic). There is no evidence that the addition of oil improves efficacy. Very effective against both avocado thrips and persea mite. Limit use to once every 3 years to reduce the rate that pyrethroid resistance evolves. Because of past worker exposure concerns, do not add more than 1% oil to fenpropathrin applications and within 7 days of application, any workers that re-enter the orchard should wear coveralls, chemical resistant gloves, socks plus shoes, face protection, and protective eyewear.

E. SABADILLA

(Veratran-D)#	10–15 lb PLUS up to 10 lb sugar-based spray adjuvant in 50-200 gal water	24	Do not apply at harvest

MODE OF ACTION: Stomach poison
COMMENTS: Must be ingested to be effective. Thrips feed more actively and are killed to a greater degree in warm weather. Acidify water in the spray tank to a pH of 4.5 before adding sabadilla; use a registered citric acid adjuvant or other approved acidifying agents. Re-treat when thrips populations reappear, usually every 2-3 weeks or so. Resistance to sabadilla has been detected in some avocado thrips populations.

F. SPINOSAD

(Entrust SC)#	4–10 fl oz	4	1
(Success)	5–10 fl oz	4	1

MODE-OF-ACTION GROUP NUMBER[1]: 5
. . . *PLUS* . . .

NARROW RANGE OIL			
(415)	1%	See label	See label

MODE OF ACTION: Improves translaminar movement and persistence of insecticide.
COMMENTS: To delay resistance, do not apply spinosad more than twice per year; apply only once per year if spinetoram is used. Trials against avocado thrips have shown that spinetoram provides more persistent control than spinosad. Choose a lower rate for light infestations and/or small trees and a higher rate for heavy infestations and/or large trees. Toxic against some natural enemies (e.g., *Franklinothrips orizabensis* predatory thrips) when sprayed and for 8-24 hours after. The short residual persistence of this pesticide, however, allows most populations of natural enemies to survive quite well. When applying to organically grown produce, be sure that the oil used is also organically acceptable. Apply in a minimum of 50 gal water/acre. On larger trees, aerial applications may require larger volumes of water to achieve desired efficacy. Control may last 3 or more weeks. Only use in an alkaline or slightly acidic solution. Do not tank mix with nutrients.

‡ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

Acceptable for use on organically grown produce.

[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/.

PRECAUTIONS (see last page of this chapter)

GREENHOUSE THRIPS

Scientific name: *Heliothrips haemorrhoidalis*
(Reviewed 1/07, updated 6/10)

DESCRIPTION OF THE PEST

Greenhouse thrips (order Thysanoptera) occurs primarily on broadleaved evergreen plants including avocado, citrus, and many ornamentals. Adult greenhouse thrips are black with white legs and white wings. Adults seldom fly, and all stages of this tiny insect are sluggish. Males are not found in California, where each parthenogenic female can lay up to 60 eggs during her life. Eggs are inserted singly into fruit or the upper or lower leaf surface. Eggs hatch in about 4 to 5 weeks during summer, longer during the winter. Unhatched eggs gradually increase in size, causing a swelling (egg blister) in the leaf cuticle that can be seen with a hand lens.

Greenhouse thrips larvae and pupae are pale yellow to whitish with red eyes. Larvae carry a greenish red to black globule of liquid feces on the tip of their abdomen. They periodically drop this excrement, leaving dark specks on fruit and foliage that help to locate infestations during monitoring. Most greenhouse thrips occur in fruit clusters and where leaves and fruit touch.

Greenhouse thrips has about five to six generations a year. All life stages are usually present throughout the year. In some colder areas, overwintering is primarily as eggs, with newly hatched larvae appearing about mid-February. Greenhouse thrips populations are lowest during winter and spring, but can become abundant enough to damage fruit during early summer or fall. On Hass, where most greenhouse thrips reside on fruit, much of the population is removed annually at harvest.

DAMAGE

Greenhouse thrips occasionally is a serious pest in coastal avocado groves. Feeding on fruit skin causes scarring and the downgrading and culling of fruit at the packing house. Damage to leaves, although unsightly, is of no significance to tree health. Thrips injury on foliage begins to show in June as small, white-gray patches on upper leaf surfaces where thrips are found in the greatest numbers. The pale discoloration of foliage and fruit caused by early infestations turns brownish later in the season. The epidermis of injured leaves and fruit become thick, hard, and cracked. Black specks of thrips excrement may be noticeable.

Most economic damage occurs when fruit are 2 to 7 months old. Economic damage occurs when thrips cause scars or blemishes larger than 0.75 inches in diameter on fruit. Damage usually is most severe on fruit in clusters or where fruit touch leaves, as thrips are protected where fruit touch. Mexican seedling avocados and Hass are extremely susceptible. Least susceptible varieties include Anaheim, Dickinson, Fuerte, and Nabal, which are not widely planted. On green fruit avocado varieties like Bacon and Zutano, greenhouse thrips are not a pest as they feed primarily on foliage.

MANAGEMENT

Biological control, cultural practices, grove microclimate, and weather influence whether greenhouse thrips will be a problem on susceptible (Hass and Mexican seedling) avocado.

Conserve natural enemies of thrips and other pests. Consider modifying harvest and pruning practices to control greenhouse thrips. If pesticide application is warranted, spot treat infested areas and avoid spraying the entire grove. Use selective materials for thrips and other pests whenever possible. Application of broad-spectrum pesticides often leads to outbreaks of pests such as caterpillars and mites.

Biological Control: An important egg parasite, *Megaphragma mymaripenne* (family Trichogrammatidae), often kills about 25 to 50% of greenhouse thrips eggs in coastal avocado. Parasitized eggs develop a relatively large round hole, usually in the middle of the egg blister, where the adult parasite emerges. When a greenhouse thrips emerges, part of the egg shell is often visible at the side of the egg blister.

Thripobius semiluteus (family Eulophidae) attacks second-instar larvae. The normally yellow to whitish thrips larvae turn black and swell around the head when a larva of this parasitic wasp matures inside. *Thripobius* egg to adult development time is about 3 weeks when temperatures average 70°F. Thrips populations decline when about 60% of larvae are parasitized. Natural control due to *Thripobius semiluteus* is inconsistent. Release of several thousand *Thripobius* per acre per week has controlled greenhouse thrips in coastal avocado, but *Thripobius* may not currently be commercially available.

Predaceous thrips including black hunter thrips and vespiform thrips *(Franklinothrips* spp., family Aeolothripidae), prey on greenhouse thrips. However, many predators apparently avoid greenhouse thrips because of their fecal excrement. Beneficial thrips and thrips-feeding general predators are discussed in AVOCADO THRIPS.

Cultural Control: The earlier the harvest, the less thrips damage on harvested fruit. Early harvest (about June or July) of all mature fruit on infested trees also reduces damage to next season's crop. Especially on Hass, where a large proportion of the greenhouse thrips feed and breed on fruit, early harvest minimizes the crop-to-crop overlap period, reducing the number of thrips that can move from old to new fruit.

When fruit prices are low, making early harvest less economical, selectively size-pick the larger fruit in clusters and where fruit and leaves touch. Size-picking reduces greenhouse thrips populations by removing some thrips. Thinning clustered fruit and pruning dense canopies eliminates harborage, which reduces the density of greenhouse thrips, as well as caterpillars and mealybugs.

Organically Acceptable Methods: Biological and cultural controls and sprays of pyrethrin (PyGanic) are acceptable for use on an organically certified crop.

Monitoring and Treatment Decisions: Map or record the locations of infestations and check these areas each year. Greenhouse thrips problems tend to reoccur at the same sites within groves, typically where the microclimate is moderate. From late March through July, monitor for greenhouse thrips about every 10 to 14 days, at least in coastal groves. Concentrate in less exposed and interior grove areas where temperature and humidity are moderate and where your records document greenhouse thrips were most abundant during previous seasons. If greenhouse

thrips are present, also monitor trees where mature fruit was held the longest before harvest.

Monitor on the inside and the north side of trees, away from direct sun exposure. Examine where older fruit touch in clusters and the upper surface of older leaves. Look for colonies of greenhouse thrips, bleached tissue, and black excrement specks. Be sure to correctly distinguish the species of any thrips you find.

Record on a monitoring form the number of greenhouse thrips (adults and larvae combined) per fruit on 10 fruit from each of at least 10 trees per grove. Calculate the average number of thrips per fruit: divide the total number of greenhouse thrips by the total number of fruit sampled (100).

One study indicates greehouse thrips damage can be predicted based on "thrips-weeks" (the number of thrips present x number of weeks they feed). When a colony of thrips are feeding in a group on a fruit, about 25 thrips-weeks (e.g., one thrips feeding for 25 weeks, or five thrips feeding for 5 weeks) may produce a 0.75 inch (19 mm) diameter, economically important scar. There are no more specific guidelines for when treatment is warranted.

Treatment

	Common name (trade name)	**Amount to use**	**R.E.I.+ (hours)**	**P.H.I.+ (days)**

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact. Not all registered pesticides are listed. Always read label of product being used.

A. PYRETHRIN/PIPERONYL BUTOXIDE
(Pyrenone Crop Spray) — Label rates — 12 — 0
MODE OF ACTION GROUP NUMBER[1]: 3/unknown
COMMENTS: Because there is little residual activity, repeat application may be needed in 2-3 weeks and control may be only partial.

B. PYRETHRIN#
(PyGanic Crop Protection, etc.) — Label rates — 12 — 0
MODE OF ACTION GROUP NUMBER[1]: 3
COMMENTS: Because there is little residual activity, repeat application may be needed in 2-3 weeks and control may be only partial.

C. SABADILLA
(Veratran-D) — 10–15 lb — 24 — when dry
MODE OF ACTION: unknown
COMMENTS: Acidify water in the spray tank to a pH of 4.5 before adding sabadilla; use a registered citric acid adjuvant or other approved acidifying agents. Less effective than pyrethrin. Wet, cool weather conditions limit the use of this material because thrips feeding is reduced under these conditions.

D. MALATHION 8 — 1.5 pt/100 gal — 12 — 7
MODE OF ACTION GROUP NUMBER[1]: 1B
COMMENTS: Treat only infested trees to avoid destroying natural enemies of mites, loopers, scales, and other potential secondary pests.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

Acceptable for use on organically grown produce.

[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/.

PRECAUTIONS (see last page of this chapter)

NEOHYDATOTHRIPS

Scientific name: *Neohydatothrips burungae*
(Reviewed 1/07, updated 1/07)

DESCRIPTION OF THE PEST

Neohydatothrips burungae was discovered in San Diego County in 2004. It has previously been reported throughout Central America. In Mexico it is relatively common on avocado and mango. Little is known about its biology.

Neohydatothrips burungae closely resembles avocado thrips. In comparison with avocado thrips, *N. burungae* often has darker brown shading on the thorax, darker abdominal stripes (brownish rings around the top front of each abdominal segment), and brown bands occur only on top of its abdomen, not underneath. However, coloration is variable and may not reliably distinguish these species. These thrips can be separated by differences in the position and size of setae (stout hairs) on their thorax and wings. For example, *Neohydatothrips burungae* has a continuous or complete row of short stout hairs on both midveins within its forewings. Avocado thrips has relatively few hairs along these midveins on its front wings; there are sizable gaps in both these rows of hairs on avocado thrips. Careful preparation of several specimens and a good microscope are needed to recognize these characters.

DAMAGE

The importance of *N. burungae* in California is unknown.

MANAGEMENT

No specific monitoring or management methods are recommended for *N. burungae.* Whether any management is warranted is unknown.

OMNIVOROUS LOOPER

Scientific name: *Sabulodes aegrotata*
(Reviewed 1/07, updated 6/10)

DESCRIPTION OF THE PEST

The omnivorous looper (family Geometridae), also called looper or avocado looper, feeds on several dozen plant species. Omnivorous looper occurs in most avocado groves, generally in low numbers, unless natural enemies are disrupted by application of broad-spectrum insecticides.

Adults are mostly tan to orangish on top, with a narrow black band across the middle of the wings. They are white on the underside and have a wingspan of about 1.75 to 2 inches. Females live 2 to 3 weeks, laying eggs in clusters of 3 to 80 on the underside of leaves. Each barrel-shaped egg has a ring of tiny projections around one end. Eggs initially are pale green, then turn shiny reddish to brown. Eggs hatch about 8 or 9 days after oviposition, leaving transparent shells.

Young larvae are pale yellow and about 0.06 inch long. Mature larvae are 2 to 2.5 inches long and mostly yellow to pale green or pink, with a gold-colored head. Older larvae have variable dark brown, black, green, or orangish lines along their sides. In addition to three pairs of true legs behind the head, avocado looper has two pairs of appendages (prolegs) near its rear on abdominal segments 6 and 10. Larvae travel in a characteristic looping manner, where they extend their body forward, then draw their rear forward to meet their forelegs. This arches their body up into a loop. When disturbed, omnivorous loopers often drop and hang from leaves on a silken thread.

Larvae feed about 6 weeks, then pupate within rolled or webbed leaves. Pupae are 1 to 1.25 inches long and white when first formed. The case darkens as a moth with brownish wings develops and can be seen through the pupal case. Pupation lasts 1 to 4 weeks.

Populations increase with increasing temperatures in spring. Omnivorous looper typically has four (and perhaps five) generations per year at warmer growing areas. From inland Ventura to San Diego Counties, most adults fly and oviposit during January through March, May through June, August through September, and October through November. Three generations a year are typical in coastal Santa Barbara County, where moths typically emerge and lay eggs during March through April, June through July, and August through September. Depending on temperature, egg to adult development takes 2 to 5 months.

DAMAGE

Leaf damage is especially evident on terminal shoots. Very young larvae feed only on the leaf surface, leaving a characteristic brown membrane. Older larvae chew all the way through the leaf, often leaving only the midrib and large veins. Full-grown larvae can consume an entire leaf in 1 day. Healthy avocado trees tolerate considerable leaf damage without severe effects on growth or yield. Extensive feeding can result in sunburn and may reduce yield the following year.

Economic damage occurs primarily when caterpillars damage fruit. Both young and old larvae can chew fruit. If young fruit is fed on, it sometimes becomes misshapen. Chewing typically scars the fruit surface, which may cause fruit to be culled or downgraded.

MANAGEMENT
Conserve natural enemies, which usually keep caterpillars below damaging levels. Modify cultural practices to reduce pest reproduction and survival. Avoid applying broad-spectrum or persistent insecticides for any pests. Caterpillar outbreaks commonly occur after spraying malathion, which poison parasites and predators. When pesticides are warranted, limit application to the most infested spots to provide refuges from which natural enemies can recolonize after treatment.

Biological Control: Spiders are important looper predators, especially in orchards that have not been sprayed with pesticide or recently subject to a freeze. Assassin bugs, birds, damsel bugs, lacewings, and pirate bugs and predatory insects also prey on caterpillars.

Granulosis virus frequently infects and kills larvae when they become abundant. A virus epidemic can cause the looper population to rapidly decline within 1 to 2 weeks. Virus-killed caterpillars are immobile and range in appearance from white and swollen to brownish and shriveled. Diseased larvae cease feeding, become lethargic, and eventually liquefy and then dry up.

Wasps, especially *Trichogramma* egg parasites and three larval parasites (family Braconidae), are the most important natural enemies. *Apanteles caberatae* and *Meteorus tersus* are solitary internal parasites of larvae. The *Apanteles caberatae* larva pupates in a 0.1 inch, whitish silken cocoon near its dead host. The *Meteorus tersus* larva pupates in a brown or yellowish parchmentlike cocoon, which often hangs suspended beneath leaves or twigs on a 1 to 2 inch long thread. One to several pale *Habrobracon* (=*Bracon) xanthonotus* larvae feed externally on each looper, then each pupates in a 0.12 inch long white silken cocoon near the shriveled dead caterpillar.

At least 5 fly species (family Tachinidae) attack omnivorous looper, including *Eumea caesar, Hyphantrophaga* (=*Eusisyropa) virilis,* and *Nilea erecta.* Their black to dark grayish adults are about 0.25 to 0.33 inch long and resemble a common house fly, but have more prominent stout hairs. White tachinid eggs may be observed on or near a caterpillars' head. Brown to reddish, parchmentlike tachinid pupal cases are often found near the larger pupal cases of dead caterpillars.

Trichogramma platneri naturally parasitizes looper eggs, which turn black when parasitized. Where natural biological control is inadequate, omnivorous looper has been controlled by releasing *T. platneri* in late spring or early summer during peak moth egg laying, as determined by monitoring using commercially available pheromone-baited or black light traps. Until all *T. platneri* have emerged, protect cards from Argentine ants and other predatory insects. Keep a small portion from any purchase in a shady location in a clear container covered with tightly woven cloth. Observe wasp emergence to assess product quality.

Organically Acceptable Methods: Biological controls and sprays of *Bacillus thuringiensis* are acceptable for use on an organically certified crop.

Monitoring and Treatment Decisions: Where caterpillar problems may occur, monitor during at least spring and summer, especially after peaks in moth flights. Good places to monitor include

where bright lights such as security lights are used outdoors because the nocturnal moths are attracted by lights to lay eggs nearby. Be sure to correctly distinguish the cause of any damage as other insects and certain abiotic disorders cause leaf holes resembling caterpillar chewing. Correctly identify the species of caterpillars. Alternate host plants, damage potential, monitoring methods, and natural enemies vary depending on the species of caterpillar. Look for caterpillar predators and larval diseases and parasitism. Natural enemy prevalence affects treatment decision making.

MONITORING CATERPILLARS AND THEIR NATURAL ENEMIES methods include shaking foliage to dislodge larvae, inspecting foliage for caterpillars and their damage (timed counts), trapping adults, or a combination of these methods.

When inspecting foliage, if 15 healthy omnivorous looper larvae are found per hour of search, treatment may be warranted. Modify this guideline based on orchard history and the extent of biological control. If caterpillar damage has previously been a problem or broad-spectrum pesticides have been applied it is more likely that treatment will be needed. If natural enemies are increasing, this may indicate treatment can be delayed or avoided. If looper populations are near the guideline, monitor parasites and other natural enemies several times. With higher levels of larvae, watch for evidence of viral disease. When a nuclear polyhedrosis virus is present, looper populations will often crash within 2 weeks. Diseased larvae cease feeding, become lethargic, and eventually liquefy and then dry up in their nests. Spraying with malathion often leads to outbreaks of other pests and is not recommended. Bt sprays are the least disruptive to beneficials.

Treatment

	Common name (trade name)	**Amount to use**	**R.E.I.+ (hours)**	**P.H.I.+ (days)**
	When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact. Not all registered pesticides are listed. Always read label of product being used.			
A.	TRICHOGRAMMA PLATNERI PARASITES#	100,000 parasites/acre/season	—	—
	COMMENTS: Make at least 2 releases a week apart during the period of peak egg laying (as determined by pheromone traps and visual inspection). Place parasite egg cards on at least 4 trees/acre for a total minimum release of 100,000 parasites/acre/season.			
B.	BACILLUS THURINGIENSIS spp. AIZAWAI#			
	(various products)	Label rates	4	0
	MODE OF ACTION GROUP NUMBER[1]: 11			
	COMMENTS: Effective when used to control early instars of the caterpillar.			
C.	BACILLUS THURINGIENSIS ssp. KURSTAKI#			
	(various products)	Label rates	4	0
	MODE OF ACTION GROUP NUMBER[1]: 11			
	COMMENTS: Effective when used to control early instars of the caterpillar.			

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

Acceptable for use on organically grown produce.

[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/.

— Not applicable.

PRECAUTIONS (see last page of this chapter)

PERSEA MITE

Scientific name: *Oligonychus perseae*
(Reviewed 1/07, updated 2/14)

MITE PESTS OF AVOCADO—GENERAL INFORMATION

Spider mites (family Tetranychidae) and predatory mites (Phytoseiidae) are tiny 8-legged arthropods. Persea mite is a key pest of California-grown avocados. Avocado brown mite and sixspotted mite are sporadic pests. Several beneficial mites are important predators of pest mites and certain insects. Natural enemies and certain management strategies vary among pest mites. Identify the pest and natural enemy species in your grove and learn their biology so you can manage these pests appropriately as needed. For details about sampling techniques, see MONITORING PERSEA AND SIXSPOTTED MITES.

DESCRIPTION OF THE PEST

Persea mite (family Tetranychidae) is a key pest that occurs in most avocado-growing areas of California except the Central Valley. It is most damaging to Hass, Gwen, and a few other varieties. Esther, Pinkerton, and Reed are of intermediate susceptibility. The Bacon, Fuerte, Lamb Hass, and Zutano varieties are much less affected. Many ornamentals and weeds also host persea mite. When persea mites were first introduced into California in the early 1990s, individual mites from heavy populations on avocado trees were seen drifting onto leaves of adjacent stone fruit trees, although they did not feed. Since that time, however, populations have been reduced and persea mites have not been observed on stone fruit trees or fruit, and *Prunus* species are not known to be a host of this mite.

Persea mite develops from an egg through a six-legged larval stage and two eight-legged nymphal stages before becoming an eight-legged adult. Adult females have an oval-shaped body that is slightly flattened and elongated. Females and immatures are yellowish or greenish with two or more small dark blotches on their abdomen. Old females that have ceased oviposition turn darker green and become somewhat smaller and inactive. Males are smaller than reproductive females. Males are somewhat pear-shaped, slightly flattened, and yellowish with or without small dark spots. Persea mites feed and reproduce mostly beneath webbed patches or silk-covered "nests."

Each female lays about 2 to 4 dozen eggs during her life. Eggs are round, pale yellow, and develop red eye spots as they mature. Egg to adult female development time is about 2 to 3 weeks when temperatures average 77° to 63°F. Generation time can be accurately estimated by monitoring degree-days.

Cool winter temperatures slow persea mite population growth. Mite densities are lowest about March and gradually increase through spring feeding on new leaf flush. Populations generally peak in July and August. Persea mite populations are suppressed, and populations may decline rapidly, when the daily high temperature is 100°F or more on several consecutive days and humidity is low.

DAMAGE
High persea mite populations cause premature leaf drop and defoliation. Defoliation leads to sunburned bark and fruit, aborted or dropped fruit, and severely stressed trees, which later reduces yields.

Persea mite feeding on the underside of leaves causes discrete circular chlorotic to brown spots on the lower leaf surface. These spots become visible on the upper leaf surface. Persea mite colonies are small and can become very numerous. Each colony can produce dense webbing, which resembles a silvery spot on the underside of the leaf. High persea mite populations can often be recognized by numerous brown-spotted, green leaves hanging from trees and on the ground beneath infested trees. Heavily infested canopies can appear lighter colored overall when viewed from a distance.

Persea mite damage early in the season can be confused with sixspotted mite damage. Sixspotted mite webbing is less dense and usually does not occur in small circular patches. Sixspotted mite feeding causes brown to purplish irregularly shaped blotches, in comparison with the roundish, mostly scattered spots created by persea mite. Damage from sixspotted mites is generally confined to areas immediately adjacent to veins, while persea mite often feeds throughout the lower leaf surface. Persea mite also sometimes feeds on the upper leaf surface, but mite feeding on the upper leaf surface is usually caused by avocado brown mite. Avocado brown mite feeding causes the upper leaf surface to appear bronzed or scorched and damage does not occur in discrete circular spots.

MANAGEMENT
Minimize tree stress to reduce the effect of persea mite feeding on trees. Appropriate irrigation frequency and amounts, good management of avocado root rot and other key pathogens, and harvesting fruit early will reduce the adverse impact of mite feeding. If treating, whenever possible choose pesticides that have low residual toxicity or are non-toxic to natural enemies.

In the early stages of a significant infestation, highly refined or narrow-range petroleum oils or certain other materials can be applied. Treat only where necessary and leave unsprayed areas to conserve beneficials and provide refuges from which natural enemies and pesticide-susceptible pests can recolonize treated trees. Maximize the interval between treatments and alternate applications among pesticides with a different mode of action to reduce the rate at which pesticide resistance develops.

Biological Control
Numerous predators feed on persea mite. Predaceous mites include *Amblyseius* (=*Neoseiulus) californicus, Euseius hibisci, Galendromus annectens,* and *G. helveolus.* Black hunter thrips *(Leptothrips mali)*, sixspotted thrips *(Scolothrips sexmaculatus)*, brown lacewings *(Hemerobius* spp.) and green lacewings *(Chrysopa* and *Chrysoperla* spp.), dustywings (family Coniopterygidae), a predatory midge *(Feltiella* sp., Cecidomyiidae), a rove beetle *(Oligota oviformis,* Staphylinidae), and the spider mite destroyer lady beetle *(Stethorus picipes)* are other common predators. Most predators are not highly effective because of persea mites' protective webbed nests. However, conserve natural enemies because they can reduce persea mite

populations, and predators often provide good biological control of avocado brown mite and sixspotted mite.

Commercially available predators include predatory mites *(Amblyseius californicus, Galendromus annectens,* and *G. helveolus,* family Phytoseiidae) and green lacewing larvae *(Chrysoperla* spp.). Often relatively few predaceous mites are present through the winter because populations of their persea mite prey have been suppressed by hot summer weather. Introducing *Galendromus helveolus* helps to control persea mite if sufficient numbers of predators are introduced and releases are well-timed. If predator releases are planned, monitor persea mites regularly in late February through summer and release predaceous mites when about 50% of leaves have one or more active-stage pest mites. To check the viability of purchased predaceous mites, gently pour some mites and any shipping substrate into a clear jar and look for an abundance of fast-moving mites, which indicates predators arrived in good condition.

Cultural Control
Eliminate or reduce persea mite alternate host plants growing near avocado, including mite-susceptible ornamentals, non-commercial fruit trees, and weeds. Provide trees with appropriate irrigation and other good cultural care to maintain the flush of new growth and compensate for mite-induced leaf drop. However, be careful not to overfertilize. Excess fertilization, especially with quick-release formulations, may increase persea mite populations and damage during late spring and summer due to increased foliar nitrogen. Spraying the underside of leaves with a forceful stream of water can reduce mite populations on a few small trees where this is feasible. Whitewash trunks and major limbs to protect bark and wood from sunburn after premature leaf drop.

Organically Acceptable Methods
Biological and cultural controls and sprays of certain oils are acceptable for use on an organically certified crop.

Monitoring and Treatment Decisions
Inspect leaves for mites, mite damage, and natural enemies about every 7 to 10 days from mid-March through at least August, and perhaps through October. Coordinate monitoring and treatment decision-making for persea mite and avocado thrips, which are usually the key invertebrate pests feeding on leaves. Mite monitoring frequency, and the need for treatment and choice of material, can be affected by thrips management decisions. Certain materials applied (usually earlier in the season) to control avocado thrips can also control or suppress mite populations (which are usually treated later in the season if needed). Some materials can adversely impact natural enemies, so applying a less selective material early for thrips may increase the need to later treat mites. Only one application per season may be permitted or recommended for certain materials (e.g., abamectin) to reduce the development of pesticide resistance. Rotate among chemical classes when making multiple applications to reduce the development of pesticide resistance.

Consider the effect of weather on treatment decision-making. Heavy winter rains and high winds can substantially reduce subsequent mite populations and damage. Persea mite populations are

suppressed or may crash when the daily high temperature is 100°F or more on several consecutive days and humidity is low.

There are no research-based thresholds for when persea mite treatment is warranted. Develop treatment guidelines satisfactory for your situation by keeping good records and adapting your monitoring and management methods as appropriate. Regularly monitor and record mite densities and compare these numbers from year-to-year with records of your control actions and their effectiveness. See MONITORING PERSEA AND SIXSPOTTED MITES for additional information.

Treatment

	Common name (trade name)	**Amount to use**	**R.E.I.+ (hours)**	**P.H.I.+ (days)**

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact. Not all registered pesticides are listed. Always read label of product being used.

A.	*GALENDROMUS* MITES#	2,000/tree	—	—
	. . . or . . .			
	NEOSEIULUS CALIFORNICUS#	2,000/tree	—	—

COMMENTS: Make a single release of 2,000 mites/tree, or two releases each of 1,000 mites/tree, when regular monitoring of leaves for mite presence-absence shows that about 50% of leaves have one or more active-stage pest mites, typically in spring or early summer. The most effective release strategy is to dispense predator mites and carrier (e.g., corn grits) in small paper cups attached to branches. Attach 4 cups per tree evenly distributed around the canopy on avocado branches that are shaded from the sun. Add about 250 to 500 predators per cup depending on the release rate. The predators will disperse from the cups.

B.	ABAMECTIN*			
	(Agri-Mek 0.15 EC and others)	Label rates	12	14

MODE-OF-ACTION GROUP NUMBER[1]: 6

COMMENTS: Use with 1-2% narrow range (415) oil in a minimum of 50 gal water/acre for aerial applications and 100 gal water/acre for ground applications. On large trees aerial applications may require larger volumes of water to achieve desired efficacy. Control may last 3 or more weeks. Only use in an alkaline or slightly acidic solution. Do not tank mix with nutrients. To avoid promoting pesticide resistance, do not make more than one application of any abamectin product every 2 years.

C.	SPIRODICLOFEN			
	(Envidor 2 SC)	18–20 fl oz	12	2

MODE-OF-ACTION GROUP NUMBER[1]: 23

COMMENTS: Only one application allowed per crop season. Spirodiclofen is a contact miticide (not translaminar or systemic). There is no evidence that the addition of oil improves efficacy. Spirodiclofen is in the same chemistry class as spirotetramat (Movento). Minimum application volumes are 50 gal/acre by either ground or air.

D.	ETOXAZOLE			
	(Zeal 72%)	2–3 oz	12	1

MODE-OF-ACTION GROUP NUMBER[1]: 10B

COMMENTS: Maximum of one application per year. Etoxazole shows some translaminar activity and addition of a surfactant or oil (more research is needed) may improve efficacy. Do not use stickers; they appear to limit translaminar activity. Apply in a minimum of 20 gal/acre by air or 50 gal/acre by ground. Etoxazole works primarily as an ovicide and larvicide (kills mite eggs and larvae).

E.	FENPYROXIMATE			
	(Miteus)	2 pt	12	1

MODE-OF-ACTION GROUP NUMBER[1]: 21
COMMENTS: Apply in a minimum of 95 gal/acre by ground or 50 gal/acre by air. Fenpyroximate is a contact miticide (not systemic). There is no evidence that the addition of oil improves efficacy.

F. FENPROPATHRIN*
(Danitol 2.4 EC) 16–21.33 fl oz 24 1
MODE-OF-ACTION GROUP NUMBER[1]: 3
COMMENTS: Fenpropathrin is a contact miticide (not translaminar or systemic). There is no evidence that the addition of oil improves efficacy. Very effective against both avocado thrips and persea mite. Limit use to once every 3 years to reduce the rate that pyrethroid resistance evolves. Because of past worker exposure concerns, do not add more than 1% oil to fenpropathrin applications and within 7 days of application, any workers that re-enter the orchard should wear coveralls, chemical resistant gloves, socks plus shoes, face protection, and protective eyewear.

G. NARROW RANGE OIL# Label rates See label See label
MODE OF ACTION: Contact including smothering and barrier effects.
COMMENTS: Requires good coverage to be effective. Check with certifier to determine which products are organically acceptable.

‡ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.
# Acceptable for use on organically grown produce.
* Permit required from county agricultural commissioner for purchase or use.
[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/.
— Not applicable.

A. GALENDROMUS MITES# 2,000/tree — —
. . . *or* . . .
NEOSEIULUS CALIFORNICUS# 2,000/tree — —
COMMENTS: Make a single release of 2,000 mites/tree, or two releases each of 1,000 mites/tree, when regular monitoring of leaves for mite presence-absence shows that about 50% of leaves have one or more active-stage pest mites, typically in spring or early summer. The most effective release strategy is to dispense predator mites and carrier (e.g., corn grits) in small paper cups attached to branches. Attach 4 cups per tree evenly distributed around the canopy on avocado branches that are shaded from the sun. Add about 250 to 500 predators per cup depending on the release rate. The predators will disperse from the cups.

B. ABAMECTIN*
(Agri-Mek 0.15 EC and others) Label rates 12 14
MODE OF ACTION GROUP NUMBER[1]: 6
COMMENTS: Use with 1-2% narrow range (415) oil in a minimum of 50 gal water/acre for aerial applications and 100 gal water/acre for ground applications. On large trees aerial applications may require larger volumes of water to achieve desired efficacy. Control may last 3 or more weeks. Only use in an alkaline or slightly acidic solution. Do not tank mix with nutrients. To avoid promoting pesticide resistance, do not make more than one application of any abamectin product per year in each grove.

C. SPIRODICLOFEN
(Envidor 2 SC) 18–20 fl oz 12 2
MODE OF ACTION GROUP NUMBER[1]: 23

COMMENTS: Only one application is allowable per crop season.

D.	FENPROPATHRIN* (Danitol 2.4 EC) MODE OF ACTION GROUP NUMBER[1]: 3	16–21.33 fl oz	24	1
E.	NARROW RANGE OIL# MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: Requires good coverage to be effective. Check with certifier to determine which products are organically acceptable.	Label rates	see label	see label

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

\# Acceptable for use on organically grown produce.

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

[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/.

— Not applicable.

PRECAUTIONS (see last page of this chapter)

SIXSPOTTED MITE

Scientific name: *Eotetranychus sexmaculatus*
(Reviewed 1/07, updated 8/08)

MITE PESTS OF AVOCADO—GENERAL INFORMATION

Spider mites (family Tetranychidae) and predatory mites (Phytoseiidae) are tiny 8-legged arthropods. Persea mite is a key pest of California-grown avocados. Avocado brown mite and sixspotted mite are sporadic pests. Several beneficial mites are important predators of pest mites and certain insects. Natural enemies and certain management strategies vary among pest mites. Identify the pest and natural enemy species in your grove and learn their biology so you can manage these pests appropriately as needed. For details about sampling techniques, see MONITORING PERSEA AND SIXSPOTTED MITES.

DESCRIPTION OF THE PEST

The oval adults are about 0.01 inch (0.3 mm) long. Their body is lemon yellow, often with about six dark blotches on the abdomen, although some individuals have no distinct spots. Females lay tiny, globular, pale greenish yellow to translucent or pearly white eggs, which have a slender projecting stalk. About 25 to 40 eggs are laid over 10 to 20 days. Eggs hatch in 5 days to 3 weeks, depending on temperature. In summer, mites reach maturity in 8 to 12 days. Populations are heaviest in spring and early summer.

DAMAGE

Sixspotted mite is an occasional pest, mostly near the coast in foggy areas of San Luis Obispo and Santa Barbara counties. It generally is under good control in the interior growing areas (Riverside and San Diego counties) because of predators and warm weather. Sixspotted mite can become a problem anywhere if trees are drought-stressed or pesticides used to control other pests disrupt mite biological control.

Sixspotted mite feeds only on the lower avocado leaf surface. It causes irregular brown to purplish discoloring, mostly along the midrib and larger veins. Sixspotted mite produces webbing, but not the dense roundish silk patches formed by persea mite.

MANAGEMENT

Enhance biological control by conserving natural enemies. Minimize dust. Avoid applying non-selective pesticides that are toxic to predaceous insects and beneficial mites that control plant-feeding mites and other pest insects. Limit any needed applications to spots where pests are most abundant.

Biological Control: Sixspotted mite is controlled primarily by predatory mites (family Phytoseiidae). These phytoseiids include *Amblyseius*(=*Typhlodromalus) limonicus* and *Galendromus helveolus. Euseius hibisci,* a shiny pear-shaped predator, is important in part because it can maintain and increase its populations on avocado pollen when pest mites are scarce. *Typhlodromus rickeri* also preys on sixspotted mite around Santa Barbara County. The spider mite destroyer lady beetle *(Stethorus picipes)* and sixspotted thrips *(Scolothrips sexmaculatus)* are other important natural enemies.

Cultural Control: Encourage predators by oiling or paving main orchard roads to control road dust. Drive slowly when it is necessary to use dirt roads. Consider using a water truck or trailer to wet dirt roads, especially before travel during summer months when heat convection currents carry dust well up into the tree canopies. Individual backyard trees can be hosed down in early to mid-summer to remove dust and enhance biological controls.

Organically Acceptable Methods: Biological and cultural controls and sulfur and certain oil sprays are acceptable for use on an organically certified crop.

Monitoring and Treatment Decisions : Look for sixspotted mite when monitoring persea mite (see MONITORING PERSEA AND SIXSPOTTED MITES). Be sure to distinguish the mite species present. When specifically monitoring for sixspotted mite, select trees in dusty and more humid locations of groves. Use a hand lens to examine along the midrib and lateral veins on the underside of interior canopy leaves. Look for brown to purplish discoloring, mite webbing, and mites.

Sixspotted spider mite can severely stress trees at relatively low densities by causing premature leaf drop. However, populations rarely exceed an average of 2 to 3 mites per leaf. At this low abundance sixspotted mite is not damaging, does not warrant treatment, and is easily overlooked.

Treatment

	Common name (trade name)	**Amount to use**	**R.E.I.+ (hours)**	**P.H.I.+ (days)**
	When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.			
A.	NARROW RANGE OIL#	Label rates	4	0
	MODE OF ACTION: Contact including smothering and barrier effects.			
	COMMENTS: Requires good coverage to be effective. Check with certifier to determine which products are organically acceptable.			
B.	WETTABLE SULFUR#	Label rates	1 day	0
	MODE OF ACTION: Unknown. An inorganic miticide.			
	COMMENTS: Do not treat with sulfur when temperatures exceed 90°F to avoid leaf damage. Sulfur sprays are often not effective in coastal areas where temperatures do not promote fuming action.			

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

\# Certain products are acceptable for organically grown produce.

PRECAUTIONS (see last page of this chapter)

BROWN GARDEN SNAIL

Scientific name: *Cantareus aspersus (=Helix aspersa)*
(Reviewed 1/07, updated 8/08)

DESCRIPTION OF THE PEST

The brown garden snail (Phylum Mollusca, family Helicidae) has a soft, slime-covered brown body. Its body and a pair of antennalike sensory appendages can be withdrawn into its shell. The hard spiraling shell grows up to about 1.25 inches in diameter. The shell is brown, tan, and yellow patterned in bands, flecks, and swirls.

Snails are hermaphroditic; they contain both male and female organs. After mating, snails drop eggs in a scattered group in a sheltered spot on topsoil. Mature snails lay eggs up to six times during a year, depending on climate and moisture.

Snails are most active during the night and early morning when surfaces are damp. In southern California, particularly along the coast, young snails are active throughout the year. Mature snails hibernate in topsoil during cold weather.

DAMAGE

Extensive chewing of blossoms, leaves, and shoots stunts the growth of young trees and trees that have been topworked. The brown garden snail can especially be a problem following wet winters and springs. Brown garden snail feeding is not a problem in mature groves. Thick, dry leaf mulch suppresses snail numbers and large trees tolerate any modest chewing.

MANAGEMENT

Inspect young and topworked trees regularly for chewing damage, especially during and after wet conditions. Be sure to distinguish the cause of damage. Caterpillars, earwigs, Fuller rose beetle, grasshoppers, and June beetles also chew tree foliage. Inspect surfaces for slimy or dry silvery trails characteristic of snails and slugs. Look for snails hidden under trunk wraps or other shelters near trunks.

Modify cultural practices, encourage biological control, and exclude snails from canopies to provide good control. Control weeds in young groves and groves where tree canopies are sparse as low vegetation favors snails. Retain dropped leaves and apply coarse organic mulch around trunks to retard snail populations and to suppress root rot and weeds. Frequent microsprinkling encourages snail problems. Increase the interval between irrigations to the extent compatible with good tree growth. Trim branches that touch soil to restrict snail access to canopies and expose the soil surface to drying.

Birds and other small vertebrates, parasitic flies, and several types of predatory beetles commonly prey on snails. The predatory decollate snail *(Rumina decollata,* family Subulinidae) is widely distributed in southern California. Decollate snail is commercially available and legal for introduction only in southern California counties. Decollate introductions are not recommended in avocado. Establishment of significant decollate populations usually requires several years after introduction, and brown garden snail primarily is a pest when avocado trees are young.

Snails and slugs are repelled by copper. Commercially available bands of copper foil wrapped around trunks exclude snails. Certain snail baits are available for spot applications. Molluscicides also kill predatory decollate snails. Pesticides are rarely warranted for mollusk control in avocado.

Treatment

	Common name (trade name)	Amount to use	R.E.I.+ (hours)	P.H.I.+ (days)
	When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact. Not all registered pesticides are listed. Always read label of product being used.			
A.	METALDEHYDE G COMMENTS: Use the higher rate for heavy infestations.	20–40 lb/acre	12	0
B.	COPPER BANDS# COMMENTS: Place copper foil band around the tree trunk at a height of 1-2 feet above the ground. Overlap the copper foil on the tree trunk about 8 inches so it will slip and allow for trunk growth.	Label rates	—	—
C.	BORDEAUX MIXTURE# (10:10:100) MODE OF ACTION: An inorganic insecticide. COMMENTS: A slurry containing tribasic copper sulfate can be sprayed on trunks to act as a barrier. Not all copper compounds are approved for use in organic production; be sure to check individual products. Be sure to follow label directions for products used. For information on making a Bordeaux mixture, see UC IPM Pest Note: Bordeaux Mixture, ANR Publication 7451.	Label rates	see label	see label
D.	IRON PHOSPHATE (Sluggo) COMMENTS: Apply using standard fertilizer spreader. If ground is dry, wet it before applying bait. Reapply as bait is consumed or at least every 2 weeks. Check with your organic certifier to determine if this product is acceptable for use on organically certified produce.	Label rates	0	0

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

\# Acceptable for use on organically grown produce.

[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/.

— Not applicable.

PRECAUTIONS (see last page of this chapter)

BRANCH AND TWIG BORER

Scientific name: *Melalgus (=Polycaon) confertus*
(Reviewed 1/07, updated 1/07)

DESCRIPTION OF THE PEST

The adult branch and twig borer (family Cerambycidae) is a slender brown beetle about 0.5 to 0.75 inches long. Its body is cylindrical, and the head and prothorax are narrower than the body. Females lay eggs in the dead wood of many different species of native and cultivated trees and shrubs. Larvae bore into heartwood and feed there for a year or more. Pupation occurs within the tree and adults emerge in early summer. There is one generation per year.

DAMAGE

When present, borers cause a recognizable hole in branches. This entrance to a larval feeding tunnel often exudes sugary sap that turns white and flaky. Infested branches with tunnels can be easily broken by wind. Branch and twig borer is not common in avocado and seldom causes economic injury.

MANAGEMENT

Borers prefer injured, dying wood and stressed, slow-growing trees. Protect trees from sunburn and injuries, such as by whitewashing exposed bark. Provide appropriate irrigation to keep trees healthy. Remove badly diseased or borer-infested trees and branches from the orchard. Promptly destroy brush piles. Branch and twig borers can emerge from cut limbs of many species and attack nearby trees. Spraying insecticides does not kill borer larvae. Pesticides are not recommended for this insect.

EUROPEAN EARWIG

Scientific name: *Forficula auricularia*
(Reviewed 1/07, updated 1/07)

DESCRIPTION OF THE PEST

The introduced European earwig (family Forficulidae) is the most common of several earwig species that can occur in avocado. Adults are about 0.75 inch long, reddish brown, and have a pair of prominent tail appendages that resemble forceps. Most species have wings under short, hard wing covers, but earwigs seldom fly. Immature earwigs resemble small, wingless adults.

Earwigs feed mostly at night and hide during the day. Common hiding places include bark crevices, mulch, topsoil, protected (touching) plant parts, and under trunk wraps. Females lay masses of 30 or more eggs in soil. Nymphs are whitish and remain in soil until their first molt, after which they darken and begin searching for food. Earwigs generally have one or two generations a year. They can be active year round.

DAMAGE: Earwigs feed on dead and living insects and insect eggs, other organisms, and on succulent plant parts. Earwigs occasionally damage buds and leaves on young or newly grafted trees. They can be especially problematic on trees with trunk wrappers or cardboard guards. The cause of damage can be difficult to distinguish from that of other chewing pests that hide during day and feed at night, including brown garden snail, Fuller rose beetle, and June beetles.

MANAGEMENT

If you suspect that earwigs are causing damage, lift and shake or sharply tap any trunk wrappers and look for earwigs dropping to the ground, where they quickly scurry for cover. Alternatively, place a folded newspaper or burlap bag near the base of several trees with chewed foliage. Check these traps or earwig hiding places the next morning. Cans with sardine or tuna fish oil are highly attractive to earwigs, which will climb into containers and drown. It may be necessary to cover liquid traps with heavy screening to exclude feeding by domestic and wild animals drawn to the fish odor. Remove trunk wrappers where pests hide when wraps are no longer needed, thereby reducing earwig populations. Earwigs rarely are abundant enough to warrant chemical treatment, except on young trees bordering uncultivated areas. Check with your farm advisor or County Agricultural Commissioner about registration status of baits for treating earwigs.

FALSE CHINCH BUG

Scientific name: *Nysius raphanus*
(Reviewed 1/07, updated 8/08)

DESCRIPTION OF THE PEST

The false chinch bug (family Lygaeidae) adult is mostly light to dark gray, elongate, and about 0.12 inch (3 mm) long. Females lay eggs on host plants or in cracks in soil. The mostly pale gray nymphs have inconspicuous reddish to brown abdominal markings. There are from four to seven generations per year. All stages can be present throughout the year.

During winter and early spring, false chinch bug primarily feeds on foliage, stems, and seeds of wild grasses and cruciferous weeds. When vegetation dries or is cut, bugs move to feed on virtually any nearby green plants, including irrigated fruit and nut trees, grains, and vegetable crops.

DAMAGE

False chinch bug occasionally causes severe injury on young trees by sucking sap from shoots and young stems. Infested shoots wither and die suddenly after attack, which typically occurs in May and June. Economic damage occurs in groves away from the coast only on young trees in border rows adjacent to uncultivated areas or grasslands. Otherwise healthy mature trees tolerate bug feeding.

MANAGEMENT

Monitor during late winter and early spring if young avocado trees are growing inland near unmanaged areas most susceptible to false chinch bug migrations. Before winter weeds dry or are cut, look for bugs on fences and weedy areas adjacent to young trees. If false chinch bugs are abundant, consider treating weedy borders to kill bugs before they migrate.

Treatment

Common name (trade name)	Amount to use	R.E.I.+ (hours)	P.H.I.+ (days)
When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.			
A. MALATHION 8 MODE OF ACTION GROUP NUMBER[1]: 1B COMMENTS: Apply as a foliar spray. Use of this material will disrupt biological control of other pests such as scales, thrips, mites, and whiteflies.	4–9 pt/acre	12	7

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

[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/.

FULLER ROSE BEETLE

Scientific name: *Pantomorus cervinus*
(Reviewed 1/07, updated 8/08)

DESCRIPTION OF THE PEST

Adult Fuller rose beetles are brown to grayish snout beetles (weevils, family Curculionidae), about 0.36 inch (9 mm) long. Adults are all females, which lay eggs in clusters of several dozen in crevices on the tree or under loose bark. Larvae drop to the ground and feed on weed or tree roots, but larval feeding does not damage trees. Overwintering is as grubs that pupate beginning about May to July. Adults emerge during about June through September. They feed for 2 weeks before laying their first eggs. Feeding and egg-laying can continue into winter. There is one generation each year.

DAMAGE

Fuller rose beetle is an occasional problem in young avocado plantings and replantings. It can also damage top-worked, recently grafted, or severely pruned trees that have relatively little foliage. Fuller rose beetle usually is abundant only on avocado growing near citrus or other preferred hosts.

Fuller rose beetle adults chew leaf margins, causing a ragged, notched, or serrated appearance. Most chewed leaves are on lower branches because adults cannot fly and must climb trunks and branches to reach foliage. Leaf chewing on older, well-foliated trees is not economically important.

MANAGEMENT

During late winter or early spring, apply a sticky barrier to trunks to exclude weevils if they may be a problem. Encircle a smooth section of trunk with a flexible wrap or tape and apply the sticky material on top to prevent direct contact with, and injury to, bark. A parasitic wasp *(Fidiobia citri,* family Platygastridae) parasitizes up to 50% of Fuller rose beetle eggs in citrus. Parasitized eggs darken and may persist long after unparasitized eggs have hatched. This parasite's importance in avocado is unknown.

Starting in June, inspect susceptible young or top-worked trees for leaf notching made by newly emerged adults. Be aware that caterpillars, earwigs, June beetles, grasshoppers, and snails also chew avocado leaves. Larvae and pupae of the exotic Diaprepes root weevil *(Diaprepes abbreviatus)* resemble Fuller rose beetle and adults of both species chew leaves. Be certain to identify the cause of problems before taking action. If suspected Diaprepes root weevils are found, notify agricultural officials as prompt management action may be warranted.

Treatment

Common name (trade name)	Amount to use	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

A. STICKY POLYBUTENE MATERIALS#
(Tanglefoot) — Label rates — —
COMMENTS: For use on all varieties. Use polybutene-based products only. Do not apply sticky materials directly on the trunk; use a 6- to 18-inch wrap under the sticky material to protect the tree from sunburn. Exercise caution in applying multiple applications (more than 3 or 4); watch for symptoms of bark cracking. Apply the sticky band high enough to avoid sprinklers, dust, and direct sunlight. Reactivate periodically by rubbing with a stick to remove dust. Check to ensure that low hanging branches, sticks, weeds, etc., are not allowing ants access to trees.

B. MALATHION 8 — 4–9 pt/acre — 12 — 7
MODE OF ACTION GROUP NUMBER[1]: 1B
COMMENTS: Apply as a foliar spray. Use of this material will disrupt biological control of other pests such as scales, thrips, mites, and whiteflies and is not very effective against Fuller rose beetle.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

\# Acceptable for use on organically grown produce.

[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/.

— Not applicable.

PRECAUTIONS (see last page of this chapter)

GRASSHOPPERS

Scientific name:
Devastating grasshopper: *Melanoplus devastator*
Valley grasshopper: *Oedaleonotus enigma*
(Reviewed 1/07, updated 8/08)

DESCRIPTION OF THE PEST

Grasshoppers (order Orthoptera) are robust, elongate insects with winged adults that are good flyers. Commonly they are brown, gray, green, or yellowish insects with greatly enlarged hind-leg femurs adapted for jumping. Grasshoppers have relatively short antennae, which distinguishes them from crickets, katydids, and other Orthoptera, which have long antennae.

Most species of grasshopper overwinter as eggs and have only one generation a year. Adults live and feed for 2 to 3 months, during which females typically deposit elongate pods of about 20 to 100 eggs in the topsoil of undisturbed areas. Eggs hatch when soil warms in spring. The nymphs feed on most any species of nearby green plant, molting five or six times before becoming adults.

Nymphs and adults readily move. Each individual typically feeds on several different plants. As vegetation is consumed or dries when the rainy season ends, grasshoppers migrate to succulent plants. Adults, sometimes in a large swarm, can fly several miles a day. Nymphs readily jump, walk, or are carried by wind.

Grasshopper populations vary from year to year. Grasshoppers become more numerous after warm, moist springs produce abundant vegetation in uncultivated areas, favoring grasshopper survival. Conversely, parasites and bacterial, fungal, and protozoan diseases can cause grasshopper populations to crash. Many grasshoppers are eaten by arboreal predators such as birds and robber flies (family Asilidae) and soil-dwelling egg predators such as blister beetles (Meloidae).

DAMAGE

Grasshoppers become economic pests when young tree foliage is extensively chewed by large numbers of insects migrating from unmanaged vegetation. Mature trees are not harmed by grasshopper feeding.

MANAGEMENT

Do not take control action based solely on damage. Caterpillars, earwigs, Fuller rose beetle, June beetles, and snails also chew leaves. Some management methods vary depending on the cause. Where abundant, grasshoppers can be observed during the day feeding openly and flying or jumping among plants.

Grasshoppers can be difficult to manage once large numbers move onto young trees. If you believe grasshoppers may become a problem, monitor for them in uncultivated areas near young trees. Before adjacent vegetation dries or is cut, consider applying insecticide combined with bait or spraying border areas to kill grasshoppers before they migrate and start to damage crops.

Treatment

Common name (trade name)	Amount to use	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact. Not all registered pesticides are listed. Always read label of product being used.

A. MALATHION 8 — 4–9 pt/acre — 12 — 7
MODE OF ACTION GROUP NUMBER[1]: 1B
COMMENTS: Only treat infested trees to avoid destroying natural enemies of mites, loopers, scales, and other potential secondary pests.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

[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/.

PRECAUTIONS (see last page of this chapter)

JUNE BEETLES

Scientific name: *Coenonycha testacea, Serica fimbriata,* and *Serica alternata.*
(Reviewed 1/07, updated 8/08)

DESCRIPTION OF THE PEST

June beetles (sometimes called Junebugs) and May beetles include various species in the family Scarabaeidae. Adult beetles fly into avocado from untilled fields and brushland during late spring or early summer. Adults chew tree foliage at night and when present night-after-night can completely defoliate a large number of young trees in a single grove. During the day, adults hide under litter or burrow into the upper 2 inches of soil, reappearing the following night to resume feeding.

Serica spp. are the most common and widely distributed scarabs in avocado. The adult *Serica fimbriata* is 0.6 inch long and velvety brown with faintly striated wing covers. *Serica alternata* and *Coenonycha testacea* adults are 0.4 inch long and uniformly shiny brown. Adult scarabs are robust beetles, although *C. testacea* is almost rectangular and is distinctly more narrow than the *Serica* spp. Scarab larvae are C-shaped, cream colored, soil-dwelling grubs. June beetles have one generation per year.

DAMAGE

During spring they sometimes injure young, newly planted trees, typically near uncultivated land away from the coast. Chewing on mature trees with a well-developed canopy is generally of no economic importance.

MANAGEMENT

Determine whether chewing is actually caused by June beetles and not other nocturnal pests, including earwigs, Fuller rose beetles, and snails. Caterpillars and grasshoppers also cause similar damage. June beetles can be detected, and perhaps controlled somewhat in small plantings, by deploying blacklight traps at night during late winter and spring. It may be best to deploy any blacklight traps somewhat away from the young or topworked trees. Placing traps in mature trees near new plantings and along grove edges bordering unmanaged vegetation reduces the risk that traps placed among susceptible hosts might attract adult beetles to those plants.

Treatment

Common name (trade name)	Amount to use	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

A. MALATHION 8 — 4–9 pt/acre — 7 — 12
MODE OF ACTION GROUP NUMBER[1]: 1B
COMMENTS: Apply as a foliar spray at night when beetles are feeding in trees. Use of this material will disrupt biological control of other pests such as scales, thrips, mites, and whiteflies.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

[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/.

PRECAUTIONS (see last page of this chapter)

ARMORED SCALES

Scientific name:
Latania scale: *Hemiberlesia lataniae*
California red scale: *Aonidiella aurantii*
Dictyospermum scale: *Chrysomphalus dictyospermi*
Greedy scale: *Hemiberlesia rapax*
(Reviewed 1/07, updated 1/07)

DESCRIPTION OF THE PEST

Armored scales are rarely a problem on avocados in California.

Armored scales (family Diaspididae) have a flattened, slightly convex cover that at maturity is about 0.06 inch (3 mm) in diameter. This platelike cover usually can be removed to reveal the actual scale body underneath. Armored scale covers typically have a different colored, slight protuberance (exuviae or "nipple") and concentric rings, which form as each nymphal stage enlarges its cover. Females develop roundish covers. For species with males, their covers are elongate in late instars.

Latania and greedy scale can reliably be distinguished only by an expert. Their covers are gray, tan, or white. Dictyospermum scale has a yellowish brown cover that is somewhat darker than the similar-looking, orange to reddish California red scale cover. California red scale and latania scale occur throughout the plant, with relatively even distribution among fruit, leaves, and wood. Dictyospermum scale infests mostly fruit and leaves. Greedy scale is usually limited to twigs and branches.

Latania scale and greedy scale females lay eggs beneath their cover, from which crawlers hatch. California red scale and dictyospermum scale give live birth to young crawlers. Greedy scale and latania scale reproduce without males, at least in California. Both California red scale and dictyospermum scale produce males, which as immatures develop under elongate covers.

DAMAGE

Scales in avocado are usually under good biological control. Latania scale occasionally damages avocado. High latania scale populations on bark can kill twigs, especially on young trees. Unlike many plant-sucking insects, armored scales do not secrete any noticeable liquid. Economic damage is from scale covers on the fruit skin, which appear as tiny dimples or light-colored spots. Feeding may also cause small discolored spots in the skin. Internal fruit quality is not impaired, but infested or spotted fruit may be culled. California red scale is a rare problem, and only on avocado near citrus. Dictyospermum scale and greedy scale occur in avocado only at innocuous densities.

MANAGEMENT

Biological control is the primary scale control method. Conserve natural enemies by controlling ants, minimizing dust, and avoiding application of broad-spectrum, persistent insecticides. If certain areas of a grove have high armored scale populations, determine whether encrusted fruit can be selectively harvested and sent to a packing house that uses brushes or pressure-washing

equipment that can remove scale covers from fruit. In the infrequent event that direct control may be justified, oil spray has little long-term adverse impact on natural enemies. Time any scale treatments to occur soon after most scale crawlers have emerged.

Biological Control: Predatory insects and parasitic wasps control most scales. Armored scale parasites include species of tiny *Aphytis* and *Aspidiotiphagus* (family Aphelinidae), and *Comperiella* and *Signiphora* (family Encyrtidae). Most scale predators feed on both armored and soft scales and often on other pests. Predators include brown and green lacewings, pirate bugs, predaceous mites such as *Cheletomimus berlesei* and *Hemisarcoptes malus,* and sixspotted thrips.

Predaceous Coccinellidae include the spotless lady beetle *(Cycloneda sanguinea)*, steelblue lady beetle *(Halmus chalybeus)*, and twicestabbed lady beetle *(Chilocorus orbus =C. stigma)*. As adults, these lady beetles are about 0.16 to 0.2 inch (4–5 mm) long. Spotless lady beetle has a black and white head and thorax and orangish wing covers without markings. Steelblue lady beetle is metallic bluish. Twicestabbed lady beetle is shiny black with two large orangish spots on its wing covers. Its larvae are black to brownish with a yellowish transverse band and are covered with branched spines.

Organically Acceptable Methods: Biological control and some oil sprays are acceptable for use on an organically certified crop.

Monitoring and Treatment Decisions: In the rare situation where treatment is warranted, spray oil after the end of maximum crawler emergence. To time an application, monitor scale crawlers by trapping them with transparent tape that is sticky on both sides. Wrap tape traps tightly to encircle each of several twigs near female scales. Replace traps weekly when crawlers are expected. Preserve traps sandwiched between clear plastic and light blue paper, and label papers with the trap date and location. Visually compare crawler abundance in traps among monitoring dates. Treat when it is obvious that more crawlers per trap were caught during previous weeks and catches have definitely declined. If persistent populations of California red scale are present, consider releasing a small number (perhaps 10,000) of *Aphytis melinus* near the scale infested trees after purchasing them from an insectary.

Treatment

Common name (trade name)	Amount to use	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact. Not all registered pesticides are listed. Always read label of product being used.

A. NARROW RANGE OIL# — Label rates — 4 — 0
MODE OF ACTION: Contact including smothering and barrier effects.
COMMENTS: Requires good coverage to be effective. Oil does kill some beneficial wasps and suppresses beneficial mite populations, however the residue does not persist and parasitic wasps can emerge from parasitized scale or be commercially released soon after treatment. Check with certifier to determine which products are organically acceptable.

B. APHYTIS MELINUS# — About 10,000 per infested site — — — —
COMMENTS: For release against California red scale only. Make a single release, or several smaller release at about 2 week intervals, totaling approximately 10,000 parasites per infested site. Time release so that the parasites can attack unmated female scales. Visually monitor scales and release parasites when a significant proportion of the scale population is at or approaching the virgin female stage. Alternatively, monitor using pheromone-baited sticky traps and release parasites at or just before a male flight, which is approximately 800 degree-days after the peak of the previous generation male scales.

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

\# Certain products are acceptable for organically grown produce.

— Not applicable.

PRECAUTIONS (see last page of this chapter)

ORANGE TORTRIX

Scientific name: *Argyrotaenia citrana*
(Reviewed 1/07, updated 6/10)

DESCRIPTION OF THE PEST

Orange tortrix (family Tortricidae) is an uncommon problem on avocados grown in coastal areas. It rarely is injurious at inland growing areas. Orange tortrix feeds on various weeds and crops including citrus, grape, and strawberry.

Orange tortrix and amorbia adults resemble each other. They are orangish to tan moths with dark shading across their folded wings. At rest, their folded wings flare out at the tip so their overall shape resembles a bell. Orange tortrix adults are about 0.4 inch long, about one half the size of amorbia adults.

Orange tortrix and amorbia females lay eggs overlapping in a mass. Orange tortrix oviposits on the surface of young leaves, green twigs, or green fruit. Each egg is pale green, flat, oval, and has a finely reticulated surface. Females lay several clusters that range from a few eggs to over 150 eggs per mass. Eggs hatch in about 9 days.

Larvae usually feed singly on shoot tips or on succulent leaves in nests they web together with silk. Larvae develop through 5 to 7 instars over about 40 days. They are about 0.08 inch (2 mm) long at hatching and about 0.5 inch long when mature. Larvae have a brownish or straw-colored head and prothoracic plate (the top of first segment behind the head). The variable body color is dark gray, greenish, straw-colored, or tan. Orange tortrix and amorbia larvae typically wriggle vigorously backwards or sideways when disturbed. Orange tortrix may drop to the ground or remain suspended from the leaf on a silken thread.

Larvae form a dense silken cocoon where they pupate within webbed foliage. Adults emerge in about 1 to 3 weeks, depending on temperature. Orange tortrix has two to four generations per year, with all stages present throughout the year.

DAMAGE

Most larval chewing occurs within silken webs on outer-canopy shoots. During bloom, tiny larvae sometimes feed among flowers. Larvae also feed on green bark, girdling some twigs. White exudate may cover wounds on larger twigs. Least common is fruit feeding, but this is the economic damage. Fruit injury closely resembles damage from other avocado caterpillars, except that orange tortrix tends to chew deeper holes. Feeding near the stem end of fruit and on the stem may cause fruit to drop.

MANAGEMENT

Conserve natural enemies, which usually keep caterpillars below damaging levels. Modify cultural practices to reduce pest reproduction and survival. Avoid applying broad-spectrum or persistent insecticides for any pests. Caterpillar outbreaks commonly occur after spraying carbamate or organophosphate insecticides, which poison parasites and predators. When pesticides are warranted, limit application to the most infested spots to provide refuges from which natural enemies can recolonize after treatment.

Biological Control: More than one dozen parasite species and various predators attack orange tortrix, including assassin bugs, birds, damsel bugs, lacewings, and pirate bugs. These usually provide excellent biological control. Parasites include *Trichogramma platneri* and several tachinid flies as described in the section AMORBIA. Common internal larval parasitic wasps are *Apanteles aristoteliae* (family Braconidae) and *Exochus* spp. (Ichneumonidae).

Organically Acceptable Methods: Biological controls and sprays of *Bacillus thuringiensis* are acceptable for use on an organically certified crop.

Monitoring and Treatment Decisions: Where caterpillar problems may occur, monitor during at least spring and summer. Good places to monitor include where bright lights such as security lights are used outdoors because the nocturnal moths are attracted by lights to lay eggs nearby. Be sure to correctly distinguish the cause of any damage as other insects and certain abiotic disorders cause leaf holes resembling caterpillar chewing. Correctly identify the species of caterpillars. Alternate host plants, damage potential, monitoring methods, and natural enemies vary depending on the species of caterpillar. Look for caterpillar predators and larval diseases and parasitism. Natural enemy prevalence affects treatment decision making. See MONITORING CATERPILLARS AND THEIR NATURAL ENEMIES for details on identification and monitoring methods including inspecting foliage for caterpillars and their damage (timed counts), trapping adults, shaking foliage to dislodge larvae (primarily for avocado looper), or a combination of these methods.

There are no established thresholds, and treatment for orange tortrix is rarely warranted. If sprays are needed, use *Bacillus thuringiensis* when larvae are small. Spraying with malathion often leads to outbreaks of other pests and is not recommended.

Treatment

Common name (trade name)	Amount to use	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact. Not all registered pesticides are listed. Always read label of product being used.

A.	BACILLUS THURINGIENSIS spp. AIZAWAI# (various products) MODE OF ACTION GROUP NUMBER[1]: 11 COMMENTS: Effective when used to control early instars of the caterpillar.	Label rates	4	0
B.	BACILLUS THURINGIENSIS ssp. KURSTAKI# (various products) MODE OF ACTION GROUP NUMBER[1]: 11 COMMENTS: Effective when used to control early instars of the caterpillar.	Label rates	4	0

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\# Acceptable for use on organically grown produce.

[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/.

PRECAUTIONS (see last page of this chapter)

GLASSY-WINGED SHARPSHOOTER

Scientific name: *Homalodisca vitripennis (=H. coagulata)*
(Reviewed 1/07, updated 4/07)

DESCRIPTION OF THE PEST

Glassy-winged sharpshooter (family Cicadellidae) sucks leaf and stem xylem tissue, and vectors *Xylella fastidiosa* bacteria lethal to certain crops. While feeding, adults and nymphs excrete large amounts of liquid, which gives fruit and foliage a whitewashed appearance. Glassy-winged sharpshooter adults feed on over 300 plant species and can reproduce (lay eggs) in about 100 species.

Sharpshooters are active insects that walk rapidly sideways or readily jump when disturbed. The glassy-winged sharpshooter is a larger than most other leafhoppers. Adults are about 1/2 inch (13 mm) long and dark brownish with white and yellowish patches and spots. Pale head spots help to distinguish glassy-winged sharpshooter from the native smoke-tree sharpshooter *(Homalodisca lacerta)*, which has light-colored wavy lines on the head.

Females lay eggs in a cluster of about one dozen eggs within the lower surface of leaves. Eggs initially resemble a greenish blister on the leaf, which females cover with a white chalky secretion. Eggs turn brown as they mature and leave a permanent brown to gray scar in leaf tissue after nymphs emerge.

Immature glassy-winged sharpshooters develop through several stages (instars) and resemble small adults, except the immatures are wingless, uniformly olive gray, and have prominent bulging red eyes. Smoke-tree sharpshooter nymphs appear very similar but have blue eyes.

The glassy-winged sharpshooter has two generations per year in California. Although all life stages can be found year-round, reproduction and immature stages occur mostly from late winter through fall. Overwintering adults oviposit in late winter and early spring. Nymphs mature into first generation adults during about April through early June. Most second generation adults appear during later summer through fall, and can survive overwinter until the following season.

DAMAGE

Glassy-winged sharpshooter is not currently damaging in avocado. Quarantines may require treatment of nursery stock before young avocado trees can be shipped.

Glassy-winged sharpshooter is a serious pest of certain other crops because it vectors lethal *Xylella fastidiosa* diseases such as almond leaf scorch, oleander leaf scorch, and Pierce's disease of grapes. No leafhopper-vectored avocado diseases have been observed in the United States. However, strains of *Xylella* in other parts of the world, such as one reportedly damaging avocado in Costa Rica, could be damaging if introduced into California.

MANAGEMENT

Avocado nurseries may be required to treat stock and meet other requirements when producing

and shipping young avocado trees. Contact the county department of agriculture for current quarantine compliance rules.

In established avocado groves, glassy-winged sharpshooter generally requires no management. However, monitoring may be warranted if avocado are grown near untreated citrus or other favored hosts. Yellow sticky traps are useful for monitoring adults of glassy-winged sharpshooter and their primary parasites *(Gonatocerus* spp.) Mid-summer through fall are the best times to deploy and inspect traps. Glassy-winged sharpshooters become most abundant during their second generation, when they move into avocado from nearby citrus.

If abundant in avocado, consider removing or replacing nearby alternate hosts such as favored ornamentals and abandoned citrus. Because glassy-winged sharpshooters reproduce in great numbers on citrus, consult with nearby citrus growers regarding any plans to promote biological control (e.g., conserve egg parasites) or treat sharpshooters in citrus.

Biological Control: Several *Gonatocerus* spp. wasps parasitize glassy-winged sharpshooter eggs. Parasitized eggs are easily recognized by a tiny, round hole at one end of the glassy-winged sharpshooter egg through which the adult parasite emerged. *Gonatocerus ashmeadi* is commonly found wherever glassy-winged sharpshooter occurs in California. In southern and coastal areas of California, *Gonatocerus morrilli,* can be very effective in the late summer, when the second generation of eggs are deposited. *Gonatocerus fasciatus, G. novifasciatus,* and *G. triguttatus* also occur at low levels in California.

Organically Acceptable Methods: Biological controls are organically acceptable.

LONGTAILED MEALYBUG

Scientific name: *Pseudococcus longispinus*
(Reviewed 1/07, updated 1/07)

DESCRIPTION OF THE PEST

Nymphs and adult female mealybugs (order Pseudococcidae) are soft, oval, white powder- or wax-covered insects. Adult males are tiny, two winged insects with two long tail filaments, but are rarely seen. In many mealybug species the female lays tiny yellow eggs in an ovisac, a mass of eggs intermixed with white wax. Longtailed mealybug produces no external egg sacs; it gives live birth to nymphs. Longtailed has two to four overlapping generations a year. All stages can occur throughout the year.

Longtailed mealybug is the only species common in California avocado. Other species to look out for because they infest avocado elsewhere include citrus mealybug *(Planococcus citri)*, pink hibiscus mealybug *(Maconellicoccus hirsutus)*, and vine mealybug *(Planococcus ficus)*, none of which are reported pests of avocado in California.

The citrus, longtailed, and vine mealybugs have distinct, well-developed wax filaments around their body margin. Female longtailed mealybugs have tail filaments almost as long as the body length. Citrus and vine mealybug filaments are relatively short. Pink hibiscus mealybug lacks distinct waxy filaments.

Have unfamiliar mealybug species identified by an expert. For example, the introduced vine mealybug has not been found in California groves, but it infests avocado elsewhere. Pink hibiscus mealybug in California has been limited to Imperial county. Introduced parasites, especially *Anagyrus kamali* (Encyrtidae), are providing good biological control. If pink hibiscus mealybug is discovered elsewhere in California, notify agricultural officials as prompt management action may be warranted.

DAMAGE

Mealybugs suck phloem sap. When abundant, they can reduce tree vigor, foul plants with sticky honeydew, and promote growth of blackish sooty mold that fouls fruit. Mealybug populations are usually very low. They occasionally are pests of young trees. New scion grafts on old (top-worked) trees have sometimes been damaged by longtailed mealybugs abundant during late winter to early spring.

MANAGEMENT

Conserve natural enemies that control most mealybug populations. Selectively controlling ants causes longtailed mealybug populations to decline and can prevent outbreaks. Reduce dust, which interferes with natural enemies. Whenever possible, apply only selective or short-residual pesticides when treating other pests. Pesticide application is not recommended for mealybugs in avocado.

Biological Control: Mealybug predators include green lacewing *(Chrysoperla* spp.) larvae, pirate bugs, predaceous fly larvae, and lady beetles, such as the mealybug destroyer *(Cryptolaemus montrouzieri)*. Parasitic wasps are especially important in controlling outbreaks because the

wasps specialize on mealybugs and reproduce rapidly. *Acerophagus notativentris, Arhopoideus peregrinus,* and *Anarhopus sydneyensis* (family Encyrtidae) parasitize longtailed mealybug.

Organically Acceptable Methods: Biological control is organically acceptable.

SOFT SCALES

Scientific names:
Black scale: *Saissetia oleae*
Brown soft scale: *Coccus hesperidum*
European fruit lecanium: *Parthenolecanium corni*
Hemispherical scale: *Saissetia coffeae*
(Reviewed 1/07, updated 1/07)

DESCRIPTION OF THE PEST

Black scale is the most common soft scale (family Coccidae) in California avocado. Other species occasionally present include brown soft scale, European fruit lecanium, and hemispherical scale. Pyriform scale occurs on avocado in landscapes, but is absent or rare in commercial groves.

Soft scales at maturity are 0.08 to 0.2 inch (2–5 mm) in diameter. The soft scale's surface is the actual body wall of the insect and, unlike armored scales, cannot be removed. Adults are black, brown, or orangish with a hemispherical, humped, or round shape. The exception is pyriform scale, which is flattened and somewhat deltoid (pointed at one end and rounded at the other). White wax projects from beneath the margin of female pyriform scales.

Mobile first instars (crawlers) emerge from eggs laid under the female's body. First instars settle to feed within a day or two of emergence. These nymphs are oval and yellow, pale orange, or reddish. Soft scales retain barely visible legs and are able to move slowly, as they molt through three instars. On evergreen hosts such as avocado, after the crawler stage scales usually spend the rest of their life in one spot.

DAMAGE

Soft scales rarely are pests in avocado. They suck phloem sap from foliage and twigs. Rarely do they feed on fruit. Where soft scales are abundant, the large quantities of sticky honeydew they excrete promotes growth of blackish sooty mold, which can foul fruit.

MANAGEMENT

Soft scales usually are controlled by predators and parasites. Conserve natural enemies by reducing dust and selectively controlling ants. Whenever possible, apply only selective or short-residual pesticides to control other pests. Treating scales is rarely warranted.

Parasitic wasps are especially important in controlling scales. Parasites include *Coccophagus* spp. (family Aphelinidae) and *Metaphycus* and *Microterys* spp. (Encyrtidae). Scale-feeding lady beetles include *Chilocorus*, *Hyperaspis,* and *Rhyzobius* species and along the south coast, the steelblue lady beetle *(Halmus chalybeus)*. Lady beetles can easily be overlooked because many are tiny, colored and shaped like scales, or (as small larvae) feed hidden beneath scales' body. Lacewings, predaceous bugs, and predatory mites are among the other invertebrates that at least occasionally feed on scales.

WHITEFLIES

Scientific names:
Giant whitefly: *Aleurodicus dugesii*
Greenhouse whitefly: *Trialeurodes vaporariorum*
Mulberry whitefly: *Tetraleurodes mori*
Nesting whitefly: *Paraleyrodes minei*
Redbanded whitefly: *Tetraleurodes perseae*
(Reviewed 1/07, updated 1/07)

DESCRIPTION OF THE PEST

Whiteflies (order Aleyrodidae) are named for the appearance of the small (0.12 inch, 3 mm or less) pale powdery adults. Females lay tiny oblong eggs on foliage. The first-instar nymphs that hatch from eggs are initially mobile and called crawlers. Crawlers soon settle to feed and lose their legs. The subsequent three nymphal stages are inactive. Nymphs are generally flattened and oval and may resemble certain soft scales. Whiteflies are identified to species primarily by the color, shape, and waxiness of the fourth-instar nymph or pupa. In approximate order of their abundance, the species in California avocado are redbanded whitefly, nesting whitefly, greenhouse whitefly, mulberry whitefly, and giant whitefly.

All whiteflies have similar life cycles. All life stages can be present at any time, with several generations each year. For example, one redbanded whitefly generation from egg to adult takes about 6 weeks when temperatures average 77°F.

DAMAGE

Whiteflies suck phloem sap. They excrete honeydew, which collects dust and supports growth of blackish sooty mold fungi that can foul fruit. Honeydew attracts ants, which interfere with the biological control of whiteflies and other pests. Giant whitefly, greenhouse whitefly, and mulberry whitefly each have hosts in over a dozen plant families. Nesting whitefly prefers citrus, but also infests avocado and some ornamental broadleaf evergreens. Redbanded whitefly in California has been found only on avocado. Whiteflies have many natural enemies and usually are under good biological control.

MANAGEMENT

Conserve natural enemies, which provide partial to complete biological control of most whitefly species unless disturbed by ants, dust, or insecticides. Control dust by oiling or paving main orchard roads. Use a water truck or trailer to wet unpaved roads, especially during summer months when dust moving up into the tree canopies can especially disrupt natural enemies. Where ants are abundant on trees, consider applying barriers or insecticide baits to control them. Apply selective materials for other pests, such as *Bacillus thuringiensis* (Bt) for caterpillars, to conserve natural enemies.

No pesticide applications are recommended for whiteflies in avocado. Chemical treatment of whiteflies often is not effective; temporary suppression may be achieved only to be followed by a resurgence of the pest, especially after applying certain broad-spectrum insecticides. Have any

unfamiliar whiteflies identified by an expert. New species periodically are introduced into California.

Biological Control: Parasitic wasps are the most important natural enemies. These include many *Cales*, *Encarsia*, and *Eretmocerus* spp. (family Aphelinidae). Parasitized immature whiteflies often change color and have round parasite exit holes. Predators of whitefly nymphs include bigeyed bugs (*Geocoris* spp.), green lacewings (*Chrysoperla* spp.), lady beetles (*Delphastus* spp.), and pirate bugs (*Orius* spp.). Spiders feed on adult whiteflies.

Cultural Control: Avoid moving uncertified or infested plant material from one orchard to another to minimize pest spread. Make sure bins are clean when transporting bins from giant whitefly infested areas to clean groves. Do not bring plant materials into California from other states or out of the country because they may be infested. Control dust.

Organically Acceptable Methods: Biological and cultural controls are organically acceptable.

PRECAUTIONS FOR USING PESTICIDES

Pesticides are poisonous and must be used with caution. **READ THE LABEL BEFORE OPENING A PESTICIDE CONTAINER**. Follow all label precautions and directions, including requirements for protective equipment. Apply pesticides only on the crops or in the situations listed on the label. Apply pesticides at the rates specified on the label or at lower rates if suggested in this publication. In California, all agricultural uses of pesticides must be reported. Contact your county agricultural commissioner for further details. Laws, regulations, and information concerning pesticides change frequently. This publication reflects legal restrictions current on the date next to each pest's name.

Legal Responsibility. The user is legally responsible for any damage due to misuse of pesticides. Responsibility extends to effects caused by drift, runoff, or residues.

Transportation. Do not ship or carry pesticides together with food or feed in a way that allows contamination of the edible items. Never transport pesticides in a closed passenger vehicle or in a closed cab.

Storage. Keep pesticides in original containers until used. Store them in a locked cabinet, building, or fenced area where they are not accessible to children, unauthorized persons, pets, or livestock. DO NOT store pesticides with foods, feed, fertilizers, or other materials that may become contaminated by the pesticides.

Container Disposal. Dispose of empty containers carefully. Never reuse them. Make sure empty containers are not accessible to children or animals. Never dispose of containers where they may contaminate water supplies or natural waterways. Consult your county agricultural commissioner for correct procedures for handling and disposal of large quantities of empty containers.

Protection of Nonpest Animals and Plants. Many pesticides are toxic to useful or desirable animals, including honey bees, natural enemies, fish, domestic animals, and birds. Crops and other plants may also be damaged by misapplied pesticides. Take precautions to protect nonpest species from direct exposure to pesticides and from contamination due to drift, runoff, or residues. Certain rodenticides may pose a special hazard to animals that eat poisoned rodents.

Posting Treated Fields. For some materials, restricted entry intervals are established to protect field workers. Keep workers out of the field for the required time after application and, when required by regulations, post the treated areas with signs indicating the safe re-entry date. Check with your county agricultural commissioner for latest restricted entry interval.

Preharvest Intervals. Some materials or rates cannot be used in certain crops within a specified time before harvest. Follow pesticide label instructions and allow the required time between application and harvest.

Permit Requirements. Many pesticides require a permit from the county agricultural commissioner before possession or use. When such materials are recommended, they are marked with an asterisk (*) in the treatment tables or chemical sections of this publication.

Processed Crops. Some processors will not accept a crop treated with certain chemicals. If your crop is going to a processor, be sure to check with the processor before applying a pesticide.

Crop Injury. Certain chemicals may cause injury to crops (phytotoxicity) under certain conditions. Always consult the label for limitations. Before applying any pesticide, take into account the stage of plant development, the soil type and condition, the temperature, moisture, and wind. Injury may also result from the use of incompatible materials.

Personal Safety. Follow label directions carefully. Avoid splashing, spilling, leaks, spray drift, and contamination of clothing. NEVER eat, smoke, drink, or chew while using pesticides. Provide for emergency medical care IN ADVANCE as required by regulation.

Insects and Mites I

Pests of Primary Concern

Fig.1 Western avocado leafroller larva

Fig.2 Adult Argentine ant tending brown soft scale

Fig.3 Brown leaves caused by avocado brown mites

Fig.4 Avocado lace bug, *Pseudacysta perseae,* colony on the underside of a leaf and damage on the upper side of adjacent infested leaves

Fig.5 Avocado fruit scarred by avocado thrips, *Scirtothrips perseae*

Fig.6 Fruit scar caused by greenhouse thrips

Fig.7 Adult *Neohydatothrips burungae* closely resembles avocado thrips. Like avocado thrips, it has three red head spots but is often darker than avocado thrips and the brown bands occur only on the top of the abdomen and not underneath

Fig.8 Omnivorous looper larva

Fig.9 Persea mite colony

Fig.10 Sixspotted mite damage

Insects and Mites II

Young Tree Pests

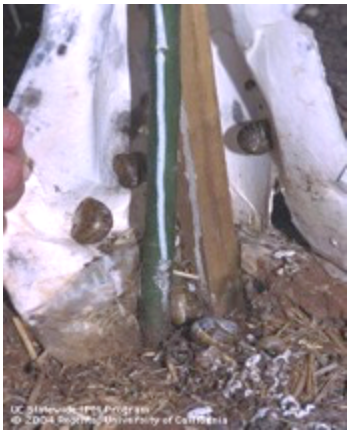

Fig.1 Removing cardboard wrap from around a young avocado trunk to reveal brown garden snails, *Helix aspersa,* hiding underneath

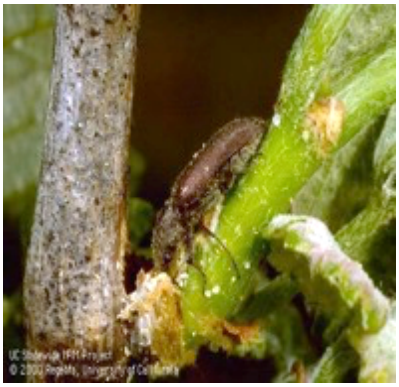

Fig.2 Adult branch and twig borer, *Melalgus (=Polycaon) confertus,* on grape shoot

Fig.3 European earwig

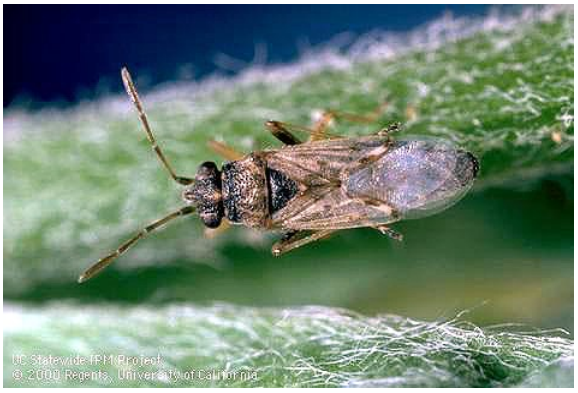

Fig.4 Adult false chinch bug, *Nysius raphanus.*

Fig.5 Adult Fuller rose beetle (weevil)

Fig.6 Adult devastating grasshopper

Fig.7 Adult masked chafer, *Cyclocephala pasadenae,* digging in soil

Insects and Mites III

Uncommon or Rarely Managed Pests

Fig.1 Greedy scale colony

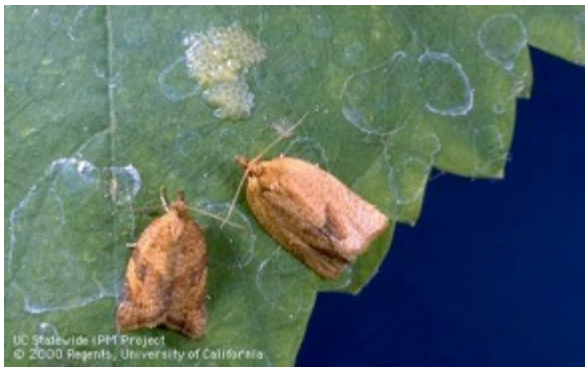

Fig.2 Adults and an egg mass of the orange tortrix, *Argyrotaenia franciscana*

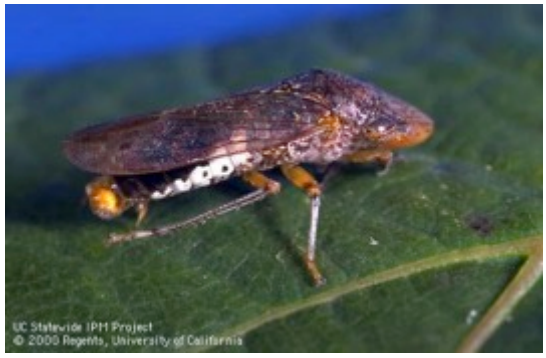

Fig.3 Glassy-winged sharpshooter leafhopper adult on wine grape leaf

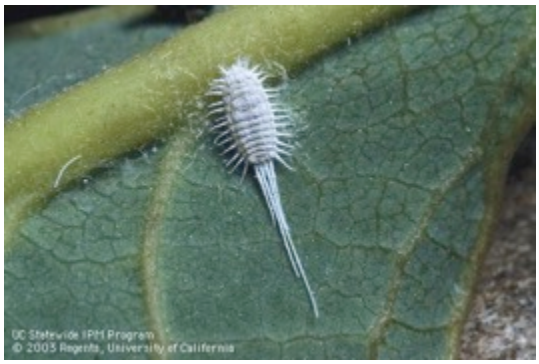

Fig.4 Female longtailed mealybug, *Pseudococcus longispinus*

Fig.5 Adult black scale and a black scale nymph in the 'rubber' stage

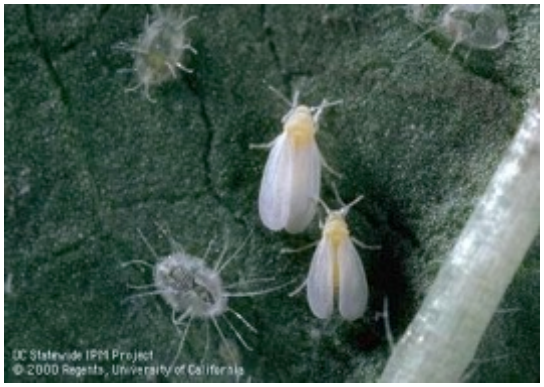

Fig.6 Two adult greenhouse whiteflies, *Trialeurodes vaporariorum,* with nymphs