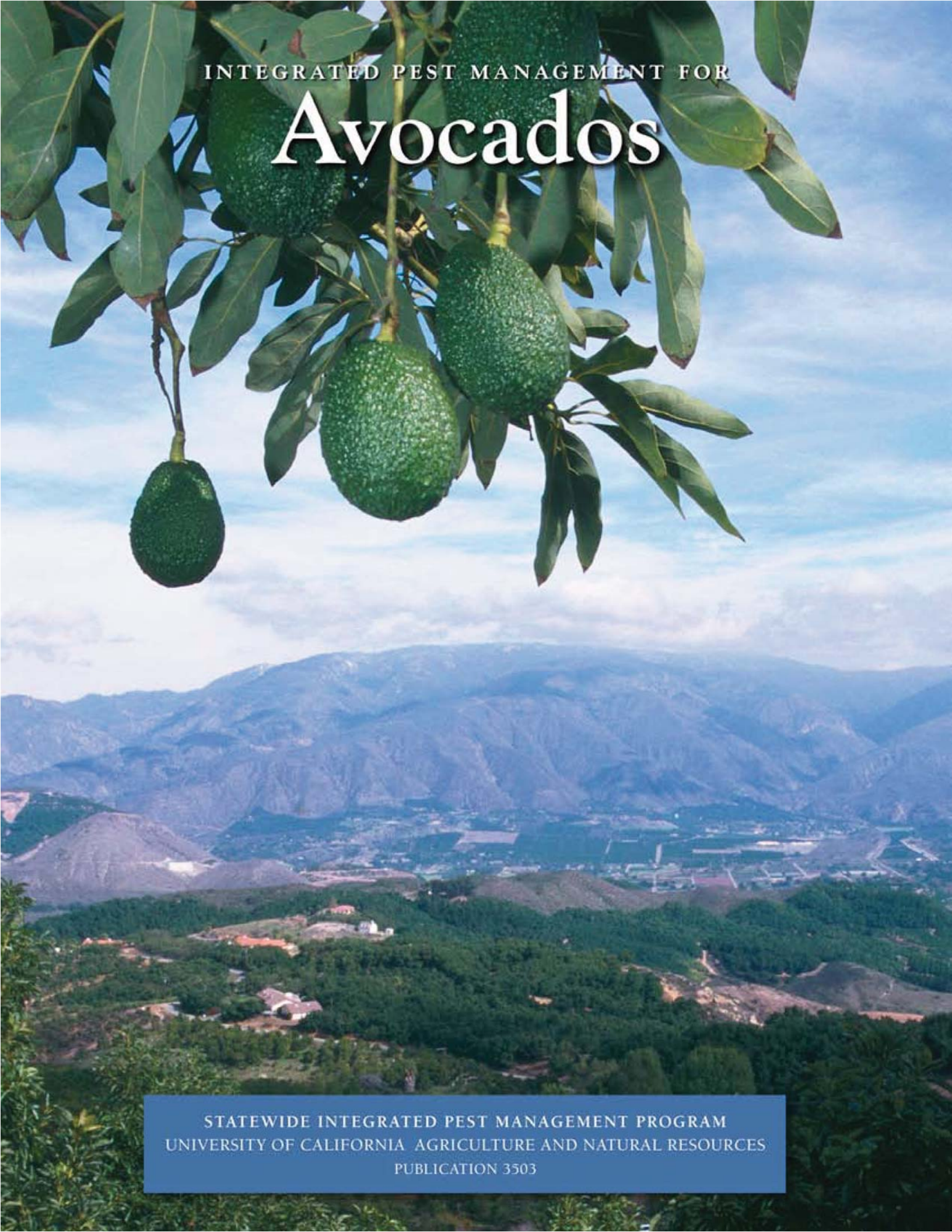

INTEGRATED PEST MANAGEMENT FOR

Avocados

STATEWIDE INTEGRATED PEST MANAGEMENT PROGRAM
UNIVERSITY OF CALIFORNIA AGRICULTURE AND NATURAL RESOURCES
PUBLICATION 3503

THRIPS

Thrips (spelled the same for singular or plural) are tiny, slender, insects. Thrips (order Thysanoptera) develop through five or six life stages (Figure 26) and have fringe-tipped wings as adults. Avocado thrips are pests in avocado, and (less frequently) greenhouse thrips can be pests as well. Citrus thrips *(Scirtothrips citri)* occasionally occur in avocado, especially in groves near citrus. Western flower thrips *(Frankliniella occidentalis)* commonly occur in avocado blossoms. Citrus and flower thrips do not damage avocado. Another thrips, *Neohydatothrips burungae*, has recently been discovered in avocados in southern California. It closely resembles avocado thrips but is of unknown importance. Several predatory thrips are important natural enemies of mites, plant-feeding thrips, and other pests.

Avocado Thrips

Scirtothrips perseae

Avocado thrips has become a key pest since its discovery in California in 1996. Although they have little affect on tree health, avocado thrips feed directly on immature fruit. The internal quality of the fruit is not affected, but obvious exterior feeding scars cause severe downgrading or culling of damaged fruit. Severe scarring when fruit are young can slow or stunt the fruit's growth.

Damage

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

As fruit grow, this early feeding becomes apparent as scabby or leathery brown scars 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 thrips injury.

Avocado thrips prefer to feed and lay eggs in succulent leaves. They move to young fruit when leaves harden. Almost all damage occurs when fruit are 0.2 to 0.6 inch (5–15 mm) long. Although Hass fruit are susceptible to thrips feeding until they reach about 2 inches (5 cm) in length, the feeding only causes scars on fruit when they are less than about ¾ inch (19 mm) long.

Description and Seasonal Development

Adult avocado thrips can be confused with adults of nonpest species, including citrus thrips and western flower thrips. Avocado thrips larvae resemble those of many other thrips species, including certain beneficial predaceous thrips. However, predatory thrips are seldom seen at high levels as can be common with avocado thrips. Make sure to distinguish correctly among the species, using Table 15 and the photographs in this chapter.

Avocado thrips lay yellow to whitish, kidney-shaped eggs in the underside of leaves, in young fruit, and in fruit petioles. Avocado thrips then develop through two larval and two pupal stages (Figure 26). 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. Adults are 0.03 inch (0.7 mm) long. Adults are orange-yellow with distinct, thin, brown bands between segments on the abdomen and three small red dots (ocelli) on top of the head. Avocado thrips adults and second instars can be found anywhere on leaves, including on the upper surface, but they most often occur on the underside of tender, reddish foliage before or soon after leaves reach full expansion. Greenhouse thrips also occur on the upper surface of

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touching leaves, but greenhouse thrips adults are black and sluggish, unlike avocado thrips (Table 15).

Avocado thrips develop well under cool temperatures, conditions that resemble those of its native habitat in the highlands of Central American and Mexico. 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 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 six or more generations a year. Egg-to-adult development occurs in about 20 to 30 days when temperatures average 65° to 75°F (18° to 24°C). You can predict actual development time by monitoring temperatures in degree-days (Table 16).

The brown discolorations on the underside of this avocado leaf are caused by feeding by avocado thrips larvae. This leaf injury is harmless when moderate as shown here, but widespread leaf scarring may be a sign that thrips may be sufficiently abundant to become a problem when they move to feed on fruit.

JACK KELLY CLARK

Low avocado thrips populations produce only slight scarring, like this light brown streak on fruit near the stem.

Fruit are most susceptible to avocado thrips scarring when they are 0.2 to 0.6 inch (5–15 mm) long. Hass remain susceptible to feeding until they reach about 2 inches (5 cm) long, but feeding does not scar fruit larger than about ¾ inch (19 mm).

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Abundant thrips feeding on young fruit produces injury that becomes visible as severe scarring once the damaged tissue expands when the fruit grow. Thrips scarring often has a webbed pattern.

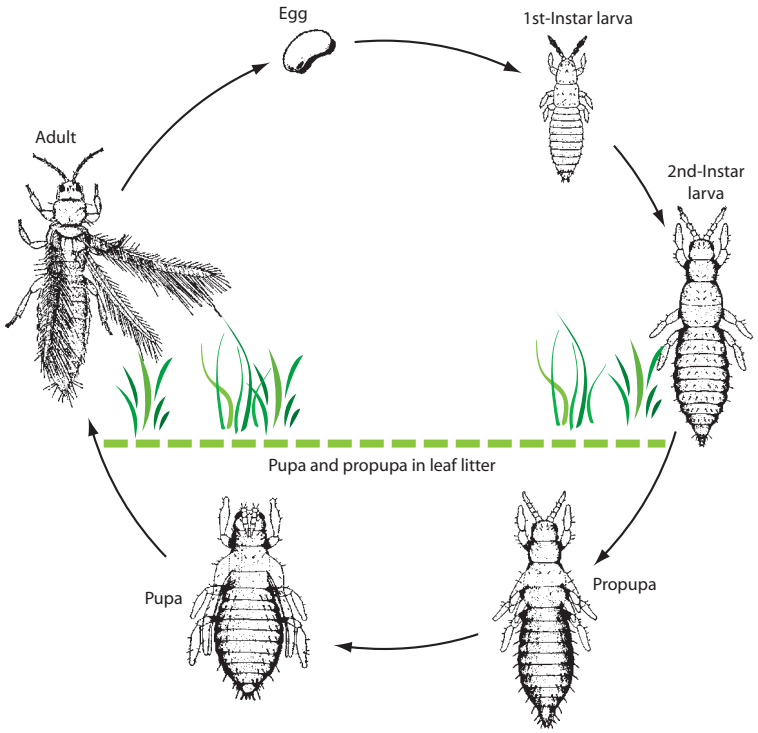

Figure 26. Thrips life cycle and stages. Thrips typically develop through five or six stages, depending on the species. Eggs are laid singly in the leaf tissue (plant-feeding pest species) or next to their prey (predatory species). The first two immature (larval) stages feed on plant tissue or prey. The one or two pupal stages do not feed. In species with two pupal stages, the active propupa (also called prepupa or pseudopupa) usually drops to the ground (leaf litter or soil) where the pupa (or late pseudopupa) develops into an adult. The adult flies back to the plant to feed and reproduce. *Adapted from:* Hoddle and Morse 2003; adult from Anonymous 1952; immatures from McKenzie 1935.

Table 15. Common Thrips and Their Distinguishing Characteristics in Avocado.

Name			Appearance	
Common	Scientific	Where most occur	Adults	Larvae
Pest thrips				
Avocado	*Scirtothrips perseae*[1]	on both sides of young leaves, on shoulders of young fruit	three red spots atop head, banded antenna, brown lines separating segments on upper side and underside of pale yellow abdomen, wing tips at rest extend beyond abdomen	pale yellow body
Greenhouse	*Heliothrips haemorrhoidalis*[1]	where fruit touch in clusters, upper leaf surface	black body with pale wings	white to yellowish body
Importance unknown				
—	*Neohydatothrips burungae*[1]	on avocado leaves	closely resembles *S. perseae*, but is often darker brownish and has bands only on upper side of abdomen	—
Innocuous thrips				
Citrus	*Scirtothrips citri*[1]	on avocado growing near citrus	body light orangish yellow to white, no bands on abdomen	light orangish, yellow, or white body
Western flower	*Frankliniella occidentalis*[1]	on or near flowers	thick, bristlelike hairs at the tip of the abdomen, which other species lack; body black, brownish, yellow, white, or orange; some individuals have brown abdominal bands; abdomen extends beyond wing tips at rest	yellow to orangish body
Beneficial predatory thrips				
Banded	*Aeolothrips* spp.[2]	among pest mites and thrips	black body, white wings have two distinguishing black bands	yellow body
Black hunter	*Leptothrips mali*[3]	among mites, scales, and pest thrips	dark brown or entirely black body, white wings, much more active than similar-looking greenhouse thrips	reddish brown body
Franklinothrips or vespiform	*Franklinothrips orizabensis*, *F. vespiformis*[2]	among lace bugs, mites, and pest thrips	mostly black body, with pale or white areas; distinctly narrow where abdomen meets thorax	yellow to orange body, swollen abdomen with red or dark orange band, body more stout or oval-shaped than avocado thrips
Sixspotted	*Scolothrips sexmaculatus*[1]	in colonies of mites	three dark blotches on each forewing, body pale to yellowish	yellow to whitish body

Families:
1. Thripidae
2. Aeolothripidae
3. Phlaeothripidae

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See *www.ucanr.org/ipm-avocado*

Table 16. Avocado Thrips' Average Development Time (in Days) and Adult (Female) Longevity at Five Constant Temperatures.

	Temperature				
Life stage	**59°F (15°C)**	**68°F (20°C)**	**77°F (25°C)**	**81°F (27°C)**	**86°F (30°C)**
Egg	21	14	11	10	9
1st instar	4	3	2	1.5	1.8
2nd instar	7	4	3	2	2
Propupa	3	2	1.3	1.1	1.4
Pupa	7.5	4	2.5	2.4	2.5
Egg to adult	42.5	27	19.8	17	16.7
Adult longevity	40	14	8	7.5	3

One generation (egg to adult) requires 620.6 degree-days F (344.8 DD C), above a threshold of 44.4°F (6.9°C), with an upper threshold of 99.7°F (37.6°C). *Source:* Hoddle 2002.

Monitoring Guidelines

Examine newly flushed leaves during February and March to get an indication of whether enough avocado thrips are present to make a problem likely later, when young fruit appear. Monitor regularly every 7 to 10 days beginning as early as April, looking for both mites and thrips. Begin regular monitoring for thrips before young fruit are present and continue your monitoring through fruit set. Use a magnifying lens to inspect the underside of succulent leaves that are reddish brown to light green. Avoid leaves that are fully hardened and dark green, leaves that touch fruit or other leaves, and leaves that are very close to flowers and fruit. Thrips on hardened leaves and leaves that touch other leaves and fruit are often other species. To monitor young fruit, you can clip or pinch stems and examine the entire fruit surface. Depending on thrips densities, treatment decisions may be 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. Consult the most current *Avocado: UC IPM Pest Management Guidelines: Insects and Mites* (online at www.ipm.ucdavis.edu) for specific monitoring methods.

Monitor for avocado thrips by inspecting tender foliage on new shoots. Examine only succulent reddish brown to light green leaves. Do not sample fully hardened, dark green leaves, as avocado thrips rarely occur on old foliage.

Management Guidelines

Before making a treatment decision, consider factors that influence the likelihood of thrips damage. These include any history of thrips damage, the abundance of natural enemies, weather, fruit load, and age or size of fruit. If extensive leaf flush continues through fruit set, the need for treatment may be reduced because more of the thrips population will remain on the 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 decisions are also influenced by the grower's tolerance for scarring, the feasibility of treatment and availability of equipment, and the possibility that treatments will disrupt natural enemy populations or promote the development of pesticide resistance. Consult the most current *Avocado: UC IPM Pest Management Guidelines: Insects and Mites* (online at www.ipm.ucdavis.edu) for recommended thresholds.

Researchers are investigating the importation of new natural enemy species and the modification of cultural practices for control of avocado thrips. If you apply insecticides, 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.

When monitoring avocado thrips, inspect both foliage and small fruit, including under the calyx or fruit button.

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Biological Control. Natural enemies may suppress avocado thrips, but sometimes not enough to keep populations below damaging levels. Predatory thrips are the most important natural enemies, especially *Franklinothrips orizabensis*. At mild temperatures, about 77°F (25°C), *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 and 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 thrips (*Aeolothrips* spp.) also feed on avocado thrips, other pest thrips, and mites. Banded thrips, also called banded-wing thrips, supplement their diet with pollen and plant juice, and can complete their life cycle

JACK KELLY CLARK

Avocado thrips is a rapidly moving species that occurs on both sides of leaves. The mostly yellowish adult has light- and dark-banded antenna and three red eye spots on top its head. It has thin, brown bands between segments on its upper and lower abdomen. Avocado thrips lack stout tail bristles and their wing tips at rest extend beyond their abdomen.

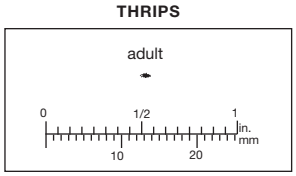
JACK KELLY CLARK

This western flower thrips (*Frankliniella occidentalis*) larva resembles avocado thrips larvae. Western flower thrips is not a pest in avocado. It mostly consumes pollen, so it is found primarily on flowers and leaves near blossoms.

MARK S. HODDLE

This recently introduced thrips (believed to be *Neohydatothrips burungae*) closely resembles avocado thrips. The arrangement of tiny hairs (setae) is used to reliably distinguish these species. But when compared with avocado thrips, *N. burungae* is often darker brown, with brown bands that occur only on top of its abdomen, not underneath.

In addition to being found anywhere on young fruit, these pale yellow to whitish avocado thrips larvae typically are found along major veins on the underside of succulent young leaves, as on this leaf with a reddish tinge.



JACK KELLY CLARK

The *Franklinothrips* larva has a swollen abdomen with a distinct red or dark orange band or dot. Its body is more stout or oval-shaped than avocado thrips's yellowish body.

JACK KELLY CLARK

Predatory thrips, especially *Franklinothrips orizabensis*, are the most important natural enemies of avocado thrips. *Franklinothrips orizabensis* and *F. vespiformis* (shown here) are virtually indistinguishable. Both are mostly black with pale to white areas, including at their thin waist.

JACK KELLY CLARK

Western flower thrips like this female can be confused with avocado thrips. Western flower thrips can be black, brownish, yellow, white, or orange. The abdomen of flower thrips has stout, bristlelike hairs at the tip, which can be seen with a hand lens, and the abdomen extends beyond the wing tips at rest.

FRANKLIN DLOTT

Banded (or banded-wing) thrips (*Aeolothrips fasciatus*) is a predator of other thrips and pests such as mites and whiteflies. Banded thrips are black with three broad white bands on each forewing.

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and persist even when their prey are scarce. Other general predators (especially green lacewings) and at least one parasitoid *(Ceranisus menes)* also attack avocado thrips.

Cultural Control. Avocado thrips damage may be affected by practices that alter the extent to which trees continue to produce tender foliage during fruit set and growth of young fruit. Consider modifying fertilization (amount, application method, formulation, and timing) and pruning (the extent and timing of branch removal) to induce plants to continue to produce tender foliage during about May and June, which may reduce the extent of thrips' natural migration from hardening leaves to young fruit.

Adding coarse organic mulch beneath trees and maintaining a mulch layer 6 inches (15 cm) thick may reduce the survival of avocado thrips that drop from trees to pupate. The effectiveness of mulching for thrips control is uncertain, though, and the labor costs involved in adding mulch may not be justified simply for thrips control. However, application of 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.

Neohydatothrips

Neohydatothrips burungae

A new species closely resembling avocado thrips was discovered in San Diego County in 2004. *Neohydatothrips burungae* has previously been reported throughout Central America. In Mexico it is relatively common on avocado and mango. The importance of *N. burungae* in California is unknown.

In comparison with avocado thrips, *N. burungae* has darker brown shading on the thorax, darker abdominal stripes (brownish rings around the top front of each abdominal segment), and brown bands that occur only on top of its abdomen, not underneath. However, this coloration pattern is variable and may not be a reliable way to distinguish these species. The reliable way to distinguish these thrips is according to differences in the position and size of setae (stout hairs) on the thorax and wings (see Figure 27). 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 of these rows of hairs on avocado thrips. Careful preparation of several specimens and a good microscope are necessary if you want to recognize these characters.

Greenhouse Thrips

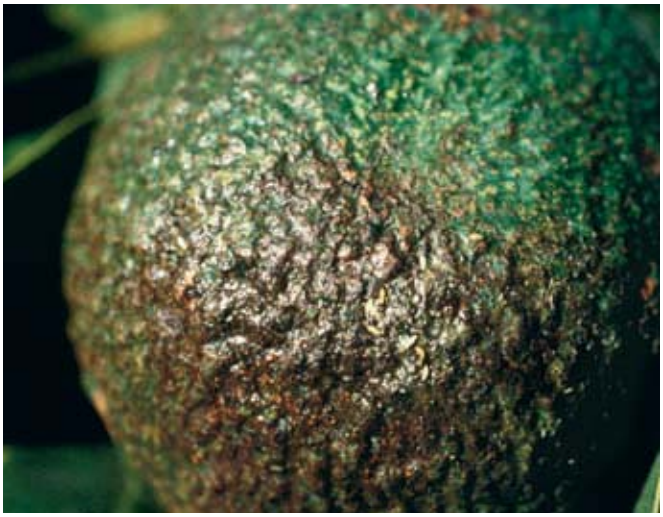
Heliothrips haemorrhoidalis

Greenhouse thrips occurs primarily on broadleaved evergreen plants including citrus and many ornamentals. It occasionally is a serious pest in coastal avocado groves. Damage to leaves from greenhouse thrips, although unsightly, is of no significance to tree health. Feeding on fruit skin causes scarring and the downgrading and culling of fruit at the packinghouse.

Damage

Thrips injury on foliage begins to show in June as small, white-gray patches on upper leaf surfaces where these 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 becomes thick, hard, and cracked. Black specks of thrips excrement may be noticeable.

Greenhouse thrips prefer to feed where leaves or fruit touch each other. This early feeding damage causes pale to whitish discoloration with specks of black excrement.



PHIL A. PHILLIPS

Several greenhouse thrips larvae infest the bottom of this fruit. Later in the season, greenhouse thrips damage to leaves and fruit darkens to this brownish discoloration.

Excerpted from *Integrated Pest Management for Avocados*, ANR Publication 3503
See *www.ucanr.org/ipm-avocado*

Most damage occurs when fruit are 2 to 7 months old. Economic damage occurs when thrips cause scars or blemishes larger than ¾ inch (19 mm) in diameter on fruit. Damage usually is most severe on fruit in clusters or where fruit touch leaves, as the thrips are protected where fruit touch. Mexican seedling avocados and Hass avocados are extremely susceptible. Least-susceptible varieties include Anaheim, Dickinson, Fuerte, and Nabal, which are not widely planted in California. On green fruit avocado varieties like Bacon and Zutano, greenhouse thrips are not considered a pest, as they feed primarily on foliage.

Description and Seasonal Development

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 after about 4 to 5 weeks during summer, longer during the winter. Before hatching, 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 the abdomen. They periodically drop this excrement, leaving dark specks on fruit and foliage that can help you locate infestations during monitoring.

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

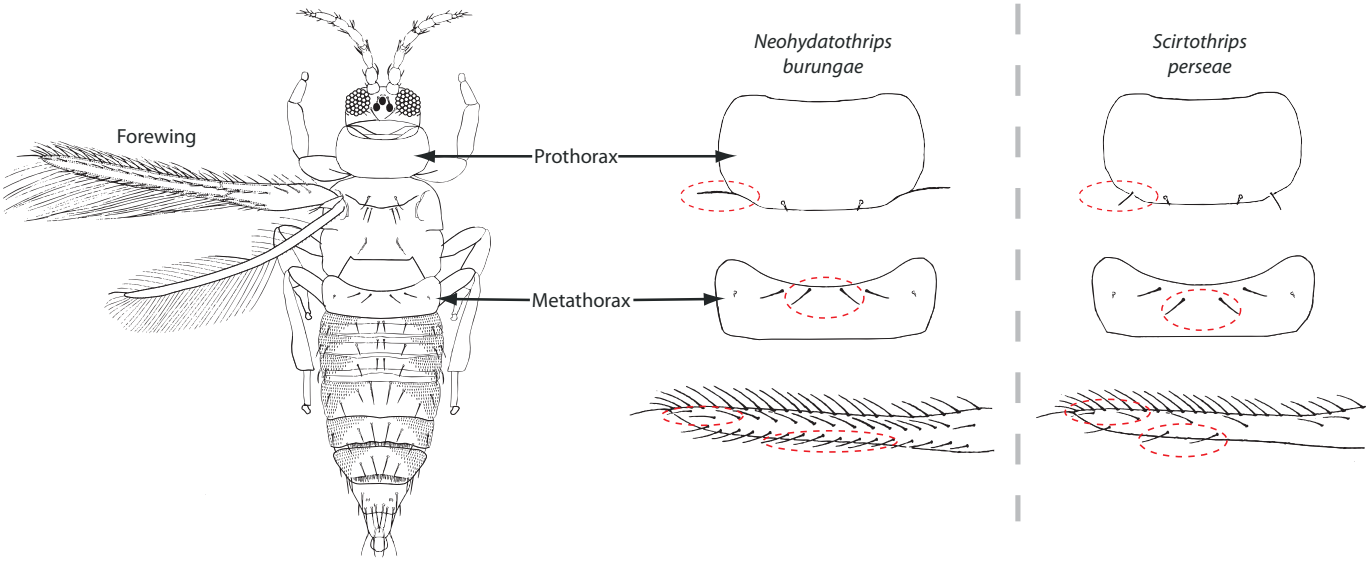


Figure 27. Avocado thrips *(Scirtothrips perseae)* and *Neohydatothrips* sp. (probably *N. burungae*) can be distinguished by the positions and size of the stout hairs (setae) on the thorax and the forewing veins as circled in red. *N. ?burungae* (?="probably") has a long hair projecting from the rear outer edge on each side of its prothorax (top left circle), while in *S. perseae* the corresponding hairs are small. Both species have four hairs on the center front of their metathorax (the last thoracic segment), where the metathorax and middle thoracic segment (mesothorax) meet. In *N. ?burungae* all four hairs are situated along the front edge (middle left circle), whereas in *S. perseae* the middle pair of these hairs is set back from the front edge. *N. ?burungae* also has continuous or complete rows of hairs on both veins on each forewing. In the front row, the second from the last hair is out of line and set back from the edge. In contrast, *S. perseae* has relatively few hairs on the outer part of each forewing and there are sizable gaps in the rows of hairs on both wing veins.

Western flower thrips *(Frankliniella occidentalis)* has two complete rows of forewing midvein hairs, except the second to last hair on *F. occidentalis* is not out of line (not dislocated as in bottom left circle). Western flower thrips also has two long hairs projecting from the rear outer edge on each side of its prothorax, not the single long hair on each side as on *N. ?burungae*.

Citrus thrips *(Scirtothrips citri)* forewing veins closely resemble those of *Scirtothrips perseae*: there are relatively few hairs and sizable gaps between hairs. Citrus thrips has one long hair projecting from the rear outer edge on each side of its prothorax like on *N. ?burungae*.

All these species have numerous hairs on both the front and rear edges of their wings. The hairs along the rear edge are particularly long and slender (shown only on the whole insect diagram). Careful preparation of several specimens and a good microscope are needed to recognize these characters. *Illustrations adapted from:* Bailey 1941, Gill 1997, Kono and Papp 1977, Watson 2005.

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See *www.ucanr.org/ipm-avocado*

Monitoring Guidelines

Map or record the locations of infestations and check these areas each year. Greenhouse thrips problems tend to reoccur at the same sites within a grove, typically where the microclimate is more 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 wherever your records indicate that greenhouse thrips were most abundant during previous seasons. If greenhouse thrips are present, it is also important to 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 fruit where they touch in clusters and the upper surface of older leaves. Look for colonies of greenhouse thrips, bleached tissue, and black excrement specks. Make sure to correctly identify the species of any thrips you find (see Table 15).

One study indicates that greenhouse thrips damage can be predicted based on "thrips-weeks" (the number of thrips present × the number of weeks they feed). When thrips feed in one spot on a fruit, approximately 25 thrips-weeks (e.g., one thrips feeding for 25 weeks, or five thrips feeding for 5 weeks) may produce a ¾-inch (19 mm) diameter, economically important scar.

Management Guidelines

Biological control, cultural practices, grove microclimate, and weather influence whether greenhouse thrips will be a problem on susceptible (Hass and Mexican seedling) avocados. Conserve the natural enemies of thrips and of other pests. Consider modifying your 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. Consult the current *Avocado: UC IPM Pest Management Guidelines: Insects and Mites* (online at www.ipm.ucdavis.edu) for specific pesticide recommendations.

Biological Control. *Megaphragma mymaripenne* (family Trichogrammatidae) is an important parasite of thrips, often killing about 25 to 50% of greenhouse thrips eggs in coastal avocado trees. Parasitized eggs develop a relatively large, round hole, usually in the middle of the egg blister, showing where the *Megaphragma mymaripenne* adult emerged. In contrast, 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. Egg-to-adult development time for *Thripobius* is about 3 weeks when temperatures average 70°F (21°C). Thrips populations decline once about 60% of larvae are parasitized. Natural control from *Thripobius semiluteus* is inconsistent. Release of several thousand *Thripobius* per acre per week has controlled greenhouse thrips in coastal avocado trees, but *Thripobius* may not be commercially available when you need it.

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

Monitor for greenhouse thrips by inspecting fruit where they touch other fruit or leaves. Also examine the upper surface of older leaves.

JACK KELLY CLARK

Greenhouse thrips are relatively sluggish. They feed in groups of black adults and pale larvae. Larvae often carry, and periodically drop, a dark drop of liquidy excrement.

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See *www.ucanr.org/ipm-avocado*

JACK KELLY CLARK

This adult *Thripobius semiluteus* is a black and yellowish parasitic wasp that attacks greenhouse thrips larvae.

JACK KELLY CLARK

Black hunter thrips *(Leptothrips mali)* adults and larvae are dark brown or reddish or entirely black. The adult of this predator has white wings, resembling an adult greenhouse thrips. However, black hunter thrips is much more active than the slow-moving greenhouse 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 the next season's crop. Especially on Hass, where a large proportion of the greenhouse thrips feed and breed on fruit, an early harvest date will minimize the crop-to-crop overlap period, reducing the number of thrips that can move from old to new fruit.

An alternative to early harvesting is to 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 fruit clusters and pruning dense canopies eliminates harborage, and that reduces the density of greenhouse thrips as well as caterpillars and mealybugs.

JACK KELLY CLARK

Greenhouse thrips larvae are yellow to whitish. When parasitized, greenhouse thrips larvae turn black and swell around the head as a *Thripobius* wasp larva matures inside. At left are black, immobile *Thripobius* pupae. The adult greenhouse thrips (bottom) is also black, but it has white wings and moves.

CATERPILLARS

Caterpillars are the larvae of moths and butterflies (order Lepidoptera). Omnivorous looper, western avocado leafroller (amorbia), and (least frequently) orange tortrix are sporadic pests in avocado. Healthy trees can tolerate some loss of chewed foliage and blossoms but extensive defoliation can result in sunburn to fruit and twigs. Economic damage occurs primarily when caterpillars chew and scar fruit. Conservation of natural enemies is the primary strategy, as caterpillars are usually kept naturally under effective biological control.

Identify and Monitor Caterpillars. Where problems may occur, monitor caterpillars and identify the species in your grove. Alternate host plants, damage potential, monitoring methods, and natural enemies vary depending on the caterpillar species. Larvae can be difficult to identify, particularly when they are young, partly because individuals of the same species often vary in color. Closely examine several individuals, perhaps with a hand lens or microscope. Use the photographs and larval key (Figure 28) to identify the prevalent species. Look for caterpillar predators and for larval diseases and parasitism. The abundance of caterpillar natural enemies in the grove will influence your decision on whether to treat and what methods to use.

Monitor at least during spring and summer by looking for caterpillars and damage, trapping adults, or using a combination of methods, depending on which caterpillar species are prevalent and which management methods you plan to use. Consult the latest *Avocado: UC IPM Pest Management Guidelines: Insects and Mites* (online at www.ipm.ucdavis.edu) for specific monitoring recommendations and suggested action thresholds.

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See *www.ucanr.org/ipm-avocado*