California Avocado Society 1997 Yearbook 81: 81-90

AVOCADO THRIPS: A SERIOUS NEW PEST OF AVOCADOS IN CALIFORNIA

Mark S. Hoddle and Joseph G. Morse
Department of Entomology, University of California, Riverside, California 92521

Avocado thrips is a new pest of major economic significance in California avocado orchards. This insect was first discovered in June 1996 damaging fruit and foliage in Saticoy and Oxnard, Ventura County, California. By July 1997, infestations of avocado thrips were north of the initial discovery area in San Luis Obispo County and south in San Diego County. Heavily infested orchards in Ventura County experienced 50-80% crop damage in 1997, and much of the fruit was either unmarketable or downgraded in packing houses. Avocado thrips has only been reported from California as a major pest. This suggests that in the country of origin, this pest may be rare and under good natural control either through the action of natural enemies, regional weather patterns, host plant resistance, or the combined impact of all three potential control factors.

Avocado thrips was previously an undescribed species new to science, and its country of origin was unknown following its discovery in California. Taxonomic work by Dr. S. Nakahara with the USDA-ARS Systematics Laboratory in Beltsville, Maryland, has produced a name (the official scientific name is *Scirtothrips perseae* (Thysanoptera: Thripidae), and the recommended common name is avocado thrips) and morphological description of this pest[7]. Morphological comparisons have determined that avocado thrips is more closely related to *Scirtothrips* species in Latin America than *Scirtothrips* species *(e.g.,* citrus thrips, *Scirtothrips citri)* in North America. Consequently, foreign exploration efforts for this thrips and its natural enemies will be concentrated in Latin America.

Foreign Exploration for Avocado Thrips and Thrips Natural Enemies

Determining the geographic distribution of avocado thrips is essential if natural enemies climatically pre— adapted to California are to be located and successfully established for biological control of this pest. Because *S. perseae* exhibits monophagy *(i.e.,* feeds on only one host plant) or highly restricted oligophagy *(i.e.,* only feeds on two-three host plants) in California, we suspect that the natural range of this pest is closely correlated with the centers of origin of the host plant. Three distinguishable ecological races or subspecies of avocado *(Persea americana* Miller) are recognized[1-8,10], these being (1) Mexican *(P. americana* var. *drymifolia),* (2) Guatemalan *(P. americana* var. *guatemalensis)* and (3) West Indian (P. *americana* var. *americana)* types[1]. All three areas will be searched for avocado thrips and natural enemy surveys will be conducted.

Foreign exploration for avocado thrips was first conducted October 8-13, 1997, in Coatepec-Harrinas and Atlixco in Mexico. With considerable assistance from Mexican colleagues, backyard and roadside plants and trees in abandoned orchards were sampled for avocado thrips. Collected thrips were sorted at UCR, and 130 specimens were slide mounted in Hoyers and sent to Dr. Nakahara for identification. Avocado thrips were found on avocados at Coatepec-Harrinas and Atlixco in Mexico **(Figure 1).** Of the 130 specimens sent to Dr. Nakahara for identification, 118 were positively identified as *Scirtothrips perseae.*

Hoddle (UCR) and Dr. Phil Phillips (UCCE, Ventura County) will continue exploration efforts for avocado thrips and natural enemies in Mexico and Guatemala in 1998-99. Exploration for avocado thrips in Oaxaca, southern Mexico, will be conducted in April 1998. This area is of particular interest because in 1971 a *Scirtothrips* sp. was intercepted at the Port of San Diego on foliage of smuggled plants that had originated from Oaxaca. The species of thrips has not been identified but it is very similar to *S. perseae* and thought to be the same species. At present, we do not know if avocado thrips is native to Mexico or if finds in Mexico represent a northwards range expansion of this insect from more southern areas *(e.g.,* Guatemala). Avocado thrips has not been found in Costa Rican avocado orchards, but the closely related *S. astrictus* has. Avocados growing in the West Indies will also be searched for avocado thrips and natural enemies.

Figure 1. *Present known locations of avocado thrips in Coatepec-Harrinas and Atlixco in Mexico.*

Working Toward a Better Understanding of the Developmental and Reproductive Biology of Avocado Thrips

Virtually nothing is known about the developmental and reproductive biology of avocado thrips. Basic knowledge of avocado thrips biology is necessary if effective management with natural enemies and pesticides is to be achieved in California. The biology of avocado thrips is being studied at UCR. The objectives of this research are to determine the reproductive and developmental biology of avocado thrips under three temperature regimens (20°C [67°F], 25°C [76°F], and 30°C [86°F]). Laboratory work will (a) determine development times for each stage of the thrips life cycle, (6) determine the daily and lifetime fecundity of mated and unmated female thrips, and (c) determine the longevity of adult male and female thrips. This information will be used to predict thrips phenology in the field and may assist with timing pesticide applications and natural enemy releases.

Before commencing laboratory studies, we needed to determine if female avocado thrips laid eggs in the undersides or topsides of young avocado leaves. To ascertain this, we recorded the number of thrips larvae emerging from undersides and topsides of young leaves collected from an infested orchard, and found that 19.5 times more thrips emerge from bottoms than tops *(i.e.,* 78 larvae were recorded from bottoms *us.* 4 from tops of leaves). Based on these results, we presented avocado leaf bottoms to female thrips for feeding and oviposition in the laboratory.

To commence our laboratory work, we needed very young first instar thrips larvae. We collected newly emerged thrips larvae by containing adult thrips collected from the field in round glass cells (2.8 cm diameter; 1.5 cm height) in groups of 5-7 on young avocado leaves into which females oviposited. Adult thrips were then removed from glass cells and translocated to new leaves daily until death. Leaves in which females oviposited were kept on saturated foam rubber pads in stainless steel trays in temperature cabinets at 25°C and 30°C. Leaves were checked daily for egg hatch and numbers of emerging thrips were recorded. Newly emerged first instar thrips were then isolated individually on young avocado leaves in plexiglass Hunger cells and developmental stages determined daily until adulthood. Isolated adult male and female thrips were transferred to fresh avocado leaves and monitored daily for longevity. Daily fecundity of mated and unmated female thrips reared from eggs at 25°C was determined by moving females to fresh leaves every 24 hrs and previously exposed leaves were held at 25°C, and monitored daily for emergence of first instar larvae.

The developmental biology of avocado thrips has been determined at 25°C and 30°C and is presented in Table 1. Work on reproductive and developmental biology at 20°C is still in progress.

Table 1. *Developmental times in days for eggs, larvae, pupal stages, and adult longevity of avocado thrips (Scirtothrips perseae) at 25°C and 30°C, and fecundity of female thrips at 25°C. All means are presented with standard errors.*

Stage	Mean time in days spent in stage (±SE)	
	25°C	30°C
Eggs	11.89 ± 0.10	8.86 ± 0.09
First instar larvae	1.76 ± 0.12	1.63 ± 0.06
Second instar larvae	4.09 ± 0.19	2.19 ± 0.11
Propupae	1.17 ± 0.07	1.24 ± 0.07
Pupae	2.50 ± 0.10	2.41 ± 0.11
Adult females (longevity)	9.85 ± 0.90	3.86 ± 0.51
Adult males (longevity)	11.20 ± 1.20	1.67 ± 0.33
No. of offspring: mated females	18.00 ± 1.56	
No. of offspring: unmated females	20.28 ± 2.92	

In a side by side study, emergence rates of avocado thrips larvae were substantially reduced at 30°C. At 30°C, 61% fewer thrips larvae emerged from leaves compared to 25°C *(i.e.,* 153 larvae emerged at 30°C and 390 emerged at 25°C). To determine the developmental times of larvae and pupae at 30°C, we had to hatch larvae at 25°C to get enough larvae to work with. Furthermore, at 30°C adult female and male longevity is reduced by 61% and 85%, respectively **(Table 1).** Consequently, we were unable to determine how many eggs females lay at 30°C because fewer eggs hatch and adults do not live for long at this temperature. These results may explain why avocado thrips numbers fall to very low levels over the summer in the inland valley areas. This pest seems to be intolerant of moderately high temperatures, and we suspect that at 90°F (32°C), fewer eggs hatch successfully and reduced adult longevity results in population declines.

Based on the information we have gained from our laboratory work and studies on other *Scirtothrips* spp., we are gaining a better understanding of the life cycle of this pest. Our knowledge on the avocado thrips life cycle can be summarized as follows: female thrips lay eggs singly in an incision made into soft plant tissue with the ovipositor, and the underside of young leaves is preferred. Following egg hatch, developing thrips pass through two actively feeding immature stages called larvae. Avocado thrips has more than one pupal stage, as do most other species of thrips. The first *Scirtothrips* pupal stage is the propupa, and the second is the pupa. Thrips do not feed as propupae or pupae and are sedentary, although they can still walk and run if provoked. Second instar larvae look for protected spaces to pupate *(e.g.*, cracks in bark) and many drop into the soil and leaf litter below host plants to pupate. We know very little about avocado thrips pupation biology, and substantial work is required to improve our understanding of this part of the lifecycle in orchards. For example, we need to determine the number of larvae that pupate on trees, numbers that fall or jump from trees to pupate in the soil, and levels of survivorship and agents responsible for pupal mortality. Following pupation, adult thrips move back onto host plant foliage and young fruit to commence feeding and reproduction. A generalized *Scirtothrips* life cycle is shown in **Figure 2.**

Spraying for Avocado Thrips, Conserving Natural Enemies, and Reducing Resistance Development to Sabadilla

To reduce the likelihood of resurgence (recovery of pest populations, sometimes to levels higher than before treatments began) and secondary pest outbreaks (release of non-pest insects from biological control due to natural enemy mortality from pesticides,or pesticide stimulation) it is necessary to use insecticides that are compatible with natural enemies and to provide refuges for biological control agents. Compatible insecticides have short residual activity or are non-toxic to natural enemies. The botanical insecticide sabadilla is compatible with natural enemies because it has short residual activity and is not toxic to most natural enemies.

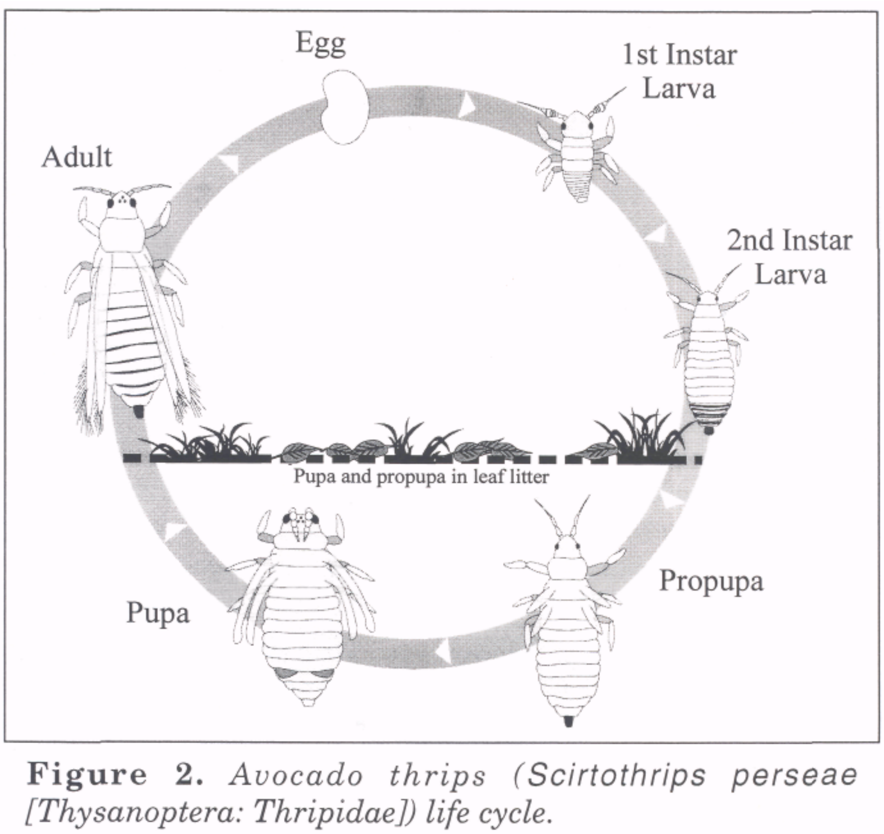

Figure 2. *Avocado thrips (Scirtothrips perseae [Thysanoptera: Thripidae]) life cycle.*

Sabadilla is a botanical pesticide which is made from the ground seeds of a lily-like

Caribbean plant, *Schoenocaulon officinale.* The name sabadilla is derived from the Spanish "cevadilla" meaning "little barley," which the dried seeds of the plant resemble. Seeds are harvested, ground using a mill, the alkaloids extracted, and the final 50 Ib bag of formulated sabadilla contains 80% (40 Ibs) sugar (the bait) and 0.2% sabadilla alkaloids (the active ingredient). Sabadilla is a mixture of seven different alkaloids known collectively as veratrine; two of these alkaloids, cevadine and veratridine, are predominant in sabadilla formulations[2,3].

At present, we have only sabadilla to use in control of avocado thrips. Trials are underway evaluating other control options, and we hope to have one or more additional materials available as soon as possible (unfortunately, in today's highly regulated environment, it is unclear how quickly this can be accomplished). Narrow-range oil showed promise against avocado thrips in a small plot efficacy trial conducted in Ventura County. Oil is assumed to act by physically clogging the spiracles (breathing holes) of thrips, and good coverage is more critical than with a baits such as sabadilla. Further evaluations under more demanding conditions of speed-sprayer or aircraft applications to full-sized trees are planned.

In 1997, some growers used as many as six treatments of sabadilla to control avocado thrips (this was the extreme at a few sites). Based on extensive experience with citrus thrips and other insects, we believe there is a strong likelihood that avocado thrips will develop resistance to chemicals which are used repeatedly for control *(e.g.,* with only 1—2 treatments per year, citrus thrips showed resistance to dimethoate in 1980[6]. Insecticide resistance is the developed ability of an insect population to withstand insecticides that were formerly effective. The rate at which resistance develops in a population is related to intensity of insecticide use. Ideally, we would like to have three or four different chemicals (with different modes of action) to use for avocado thrips control that we could rotate in order to delay the rate at which resistance develops[5].

Given this scenario, what strategy should we adopt for management of avocado thrips? As much as possible, it would be wise to withhold treatments for avocado thrips until young fruit that are vulnerable to scarring are present on the tree. If the trees are healthy, and unless extreme thrips levels are present, we don't believe that leaf damage from feeding during winter or early spring should be of concern.

Presence of avocado thrips during this time may actually be beneficial because they will provide a food source for natural enemies *(e.g.,* predaceous thrips such as black hunter or *Franklinothrips vespiformis*[4]*)* to build up on. What levels of thrips on leaves should be a concern, and would it be wise to put on a single treatment before susceptible fruit are present for the purpose of reducing thrips levels? We don't yet have a definitive answer to this question; but as much as possible, it is suggested that treatments not be applied prior to when fruit damage is observed. This strategy will both maximize natural enemy effectiveness and slow the rate at which sabadilla resistance develops.

Extensive sampling of avocado thrips levels should be done in association with sampling of natural enemy levels (predaceous thrips rather than predatory mites) and fruit phenology. Sabadilla treatments should most efficiently be targeted at first instar and early second instar thrips. Sabadilla is less effective against large larvae and adults. Sabadilla is not very persistent (residues decline to quite low levels after one week), and it is important that treatments be timed and applied carefully. With such a strategy, we hope that sabadilla treatments can be restricted to two, or at most three, treatments per year, thus preserving this material as an effective option for avocado thrips control.

Recommendations for insecticidal control of avocado thrips will improve as knowledge on biology and phenology of avocado thrips and its natural enemies increases, when key natural enemies are screened for susceptibility to registered insecticides, and as results of insecticide field trials are analyzed.

References Cited

1. **Bergh, B. and N. Ellstrand.** (1986). Taxonomy of the avocado. California Avocado Society Yearbook 70: 135-145.
2. **Hare, J. D.** (1996). Purification and quantitative analysis of veratridine and cevadine by HPLC. Journal of Agriculture & Food Chemistry 44: 149-152.
3. **Hare, J. D., and J. G. Morse.** (1997). Toxicity, persistence, and potency of sabadilla alkaloid formulations to citrus thrips (Thysanoptera: Thripidae). Journal of Economic Entomology 90: 326-332.
4. **Hoddle, M.** S. (1997). The avocado thrips and thrips natural enemies. A four page factsheet available from the California Avocado Commission.
5. **Immaraju, J. A., J. G. Morse, and R. F. Hobza.** (1989). Field evaluation of insecticide rotation and mixtures as strategies for citrus thrips (Thysanoptera: Thripidae) resistance management in California. Journal of Economic Entomology 83: 306-314.
6. **Morse, J. G., and O. L. Brawner.** (1986). Toxicity of pesticides to Scirtothrips citri (Thysanoptera: Thripidae) and implications to resistance management. Journal of Economic E tomology 79: 565-570.
7. **Nakahara,** S. (1997). Scirtothrips perseae (Thysanoptera: Thripidae), a new species infesting avocado in southern California. Insecta Mundi 11: 189-192.
8. **Popenoe, F. O.** (1915). Varieties of the avocado. California Avocado Society Yearbook 1: 44-69.
9. **Popenoe, F. O.** (1952). Central American fruit culture. Ceiba 1: 269-311.
10. **Storey, W. B., B. Bergh, and G. A. Zentmyer.** (1986). The origin, indigenous range, and dissemination of the avocado. California Avocado Society Yearbook 70: 127-133.