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Biology and Management of the Persea Mite

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Persea mite, *Oligonychus perseae* Tuttle, Baker, and Abatiello (Acari: Tetranychidae) was first described in 1975 from specimens collected from avocado foliage that were intercepted from Mexico at an El Paso, Texas quarantine facility. Persea mite is native to Mexico and damages avocados in arid regions, but it is not considered a major pest in the state of Michoacan where Hass avocado production is greatest. Persea mite has also been recorded from Costa Rica. Persea mite was first discovered attacking avocados in San Diego County in 1990, and was originally misidentified as *Oligonychus peruvianus.* By the summer of 1993, the pest had spread north to Ventura County. Santa Barbara had its first record in spring 1994, and in 1996 persea mite had established in San Luis Obispo County. There are no records of this pest in the San Joaquin Valley. Contaminated fruit bins, harvesting equipment, and clothing probably assisted in the dispersal of persea mite throughout California. High mite densities (»500 per leaf) and subsequent feeding can cause partial or total defoliation of trees. Mite-induced defoliation opens the tree canopy, increasing the risk of sunburn to young fruit and exposed tree trunks. Premature fruit drop can occur because of stress induced by mite feeding.

Persea Mite Identification and Biology

Identification. Persea mites feed in colonies beneath protective webbing in nests that are formed along midribs and veins on the undersides of leaves, and feeding damage produces characteristic circular necrotic spots. The closely related avocado brown mite, *Oligonychuspunicae,* feeds on upper leaf surfaces and, feeding damage by avocado brown mite results in bronzing of upper leaf surfaces. Six-spotted mite, *Eotetranychus sexmaculatus,* is very similar in appearance to persea mite and it also feeds on undersides of leaves. Six-spotted mites prefer to feed adjacent to the midrib and large lateral veins. Feeding damage is different from that caused by persea mite in that six-spotted mites do not produce circular feeding colonies covered with dense webbing and necrotic spotting is purplish and irregular in appearance. All three pest mites damage leaves by removing chlorophyll during feeding (see Hoddle's web-site for photographs of pests and damage they cause. The address can be found in the "Background Reading" section.)

Persea Mite Biology. Persea mite has five developmental stages (egg, larva, protonymph, deutonymph, and adult). All lifestages are predominantly found in nests where feeding, mating, reproduction, and development occurs. Sex ratio is generally two females to one male. A generalized life cycle for persea mite is shown in Diagram A, and Table 1 summarizes important aspects of persea mite biology.

Table 1.

Biology of persea mite on Hass avocado at three different temperatures

Biological Attribute	20°C (67°F)	25°C (77°F)	30°C (86°F)
Average adult life span	40 days	27 days	15 days
No. eggs laid per female	37 eggs	46 eggs	21 eggs
Egg to adult development time	17 days	14 days	9 days
No. days for eggs to hatch	7 days	6 days	4 days

Monitoring Persea Mite Populations

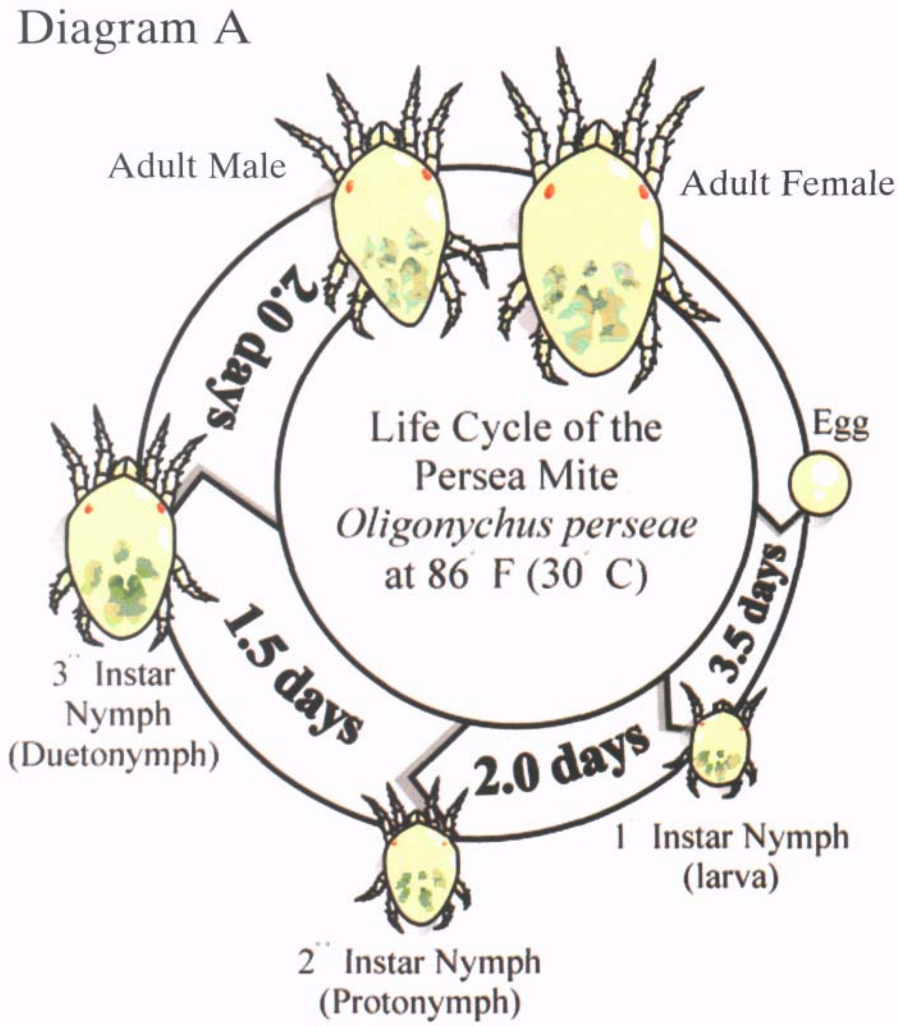
When deciding to initiate control measures (chemical or biological) against persea mite, it is important to have an estimate of the number of mites infesting leaves and the percentage of leaves infested on trees so treatments can be applied to maximize impact. The number of mites per leaf can be quickly estimated in the field by counting the number of mites on part of a picked leaf. To estimate persea mite numbers, move through a section of the orchard and randomly pick ten leaves of mixed age. Using a 10x-14x hand lens count the number of motile mites that are within the viewing area of the lens along the upper side of the half second vein of each leaf.

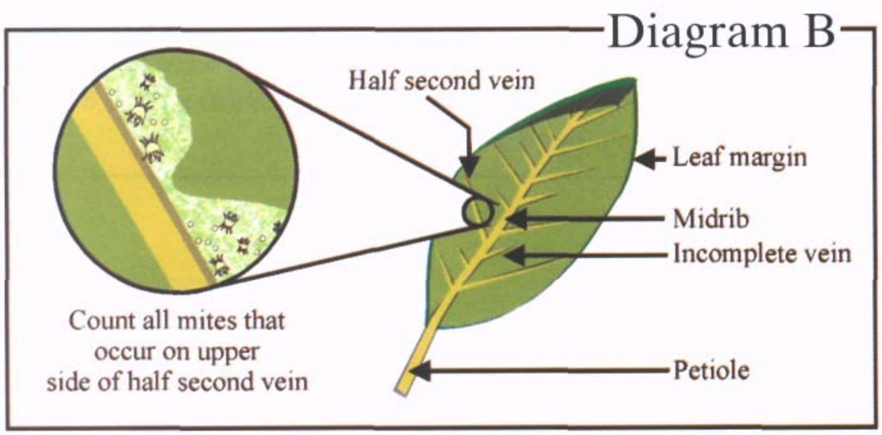
The half second vein is located on the left side of the upturned leaf and it is the second complete vein that extends from the midrib to the leaf margin (Diagram B). Tally the total number of persea mites on all ten leaves, divide by ten to get the average across all sampled leaves. Multiply the average by twelve (this is the correlation factor used to estimate the total number of persea mites per leaf) and the resulting number is an estimate of the number of mites per leaf (see Machlitt 1998 for more details on this technique). An example estimating the number of persea mites is given below:

No. persea mites per leaf = total no. of mites counted is divided by 10 average no. mites per leaf) x 12 (correlation factor)
Consider the example where a total of 72 persea mites were counted across all 10 randomly sampled leaves
Estimated number of mites = (72 * 10) x 12 = 7.2 x 12 = 86.4 persea mites per leaf

Predator mites feeding on persea mite inside nests can be estimated from half second vein counts in a similar fashion. The correlation factor for predators on randomly selected leaves is six.

No. predator mites per leaf = total no. predators counted is divided by 10 (average no. predators per leaf) x 6 (correlation factor)
Consider the example where a total of eight *Galendromus* spp. were counted inside nests when persea mite counts were being done
Estimated number of predators per leaf = (8-^10) x 6 = 0.8 x 6 = 4.8 *Galendromus* spp. per leaf





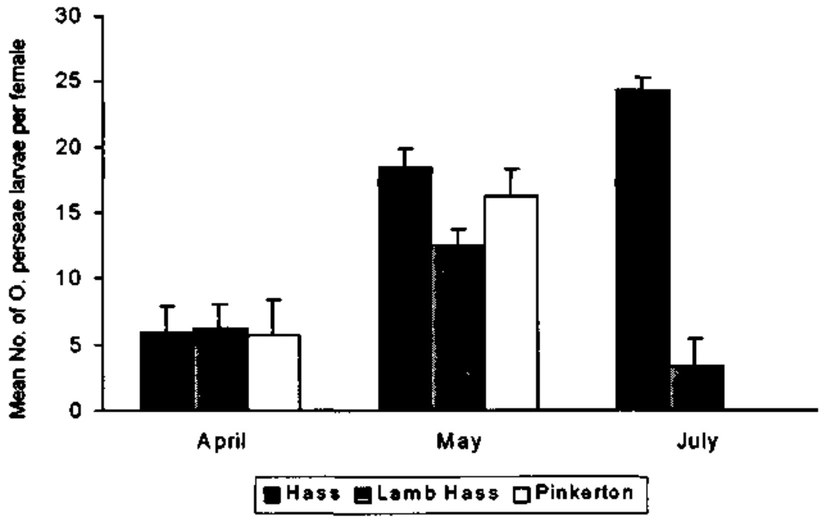
Pest control advisors (PCAs) can be hired or orchard workers can be trained to monitor numbers of persea mites and predators using this sampling method.

Cultivar Susceptibility

Avocado cultivars vary in their susceptibility to persea mite feeding damage. By calculating the average percentage of leaf area damaged by mite feeding, cultivars can be ranked from least susceptible to most susceptible. When cultivars are ordered in this manner the following ranking is attained: Fuerte (average leaf area damaged by feeding persea mites is 13.3%) <Lamb Hass (16.9%) = Reed (16.9%) <Esther (29.7%) <Pinkerton (30.2%) <Gwen (37.4%) <Hass (38.4%). The mechanism by which Fuerte and Lamb Hass reduce feeding damage is unknown but it could be related leaf chemistry which may reduce mite survivorship or reproduction rates, or both.

To investigate the effect of host plants on persea mite reproduction and survivorship, mites were reared on three different avocado cultivars which exhibited different levels of susceptibility to persea mite feeding. Hass was used as the highly susceptible variety, Pinkerton as moderately susceptible, and Lamb Hass as the resistant cultivar. A life table study in the laboratory using leaves collected from South Coast Field Station in April, June, and July showed no difference in mortality and rate of development of *O. perseae* of either the first or second generation reared on either Hass, Pinkerton or Lamb Hass cultivars. Although *O. perseae* exhibited no difference across cultivars with respect to reproductive rates when reared on leaves collected in late spring (April) and early summer (June), reproduction was significantly higher on Hass avocados in mid summer (July) and more offspring were produced on Hass leaves at this time (Fig. 1). A corresponding increase in percentage leaf area damaged by mite feeding was also observed at South Coast Field Station on Hass in July. We suspect that seasonal changes in the nutritional quality of leaves is the major factor determining susceptibility of avocado cultivars to *O. perseae* and changes in Hass leaf chemistry in mid-summer promotes *O. perseae* population growth. Similar mechanisms do not appear to operate in Lamb Hass hence *O. perseae* numbers do not reach similar densities on this cultivar.

Fig. 1. We speculate that in July (i.e., mid-summer) the nutritional quality of the Hass cultivar changes and persea mite reproduction is enhanced at this time. This correlates with the observed timings of outbreaks in the field. Similar changes in chemistry may not occur on Lamb Hass hence persea mite is unable to reach damaging densities.



It is also possible that differences in leaf morphology between cultivars can affect persea mite densities in the field. For example, leaf hairs may favor natural enemy activity by providing refuges (called domatia), or leaves on different cultivars may exhibit some form of repellency that causes mites to abandon resistant cultivars to search for more suitable host plants at certain times of the year. Increasing cultivar diversity in orchards should be considered as a strategy to reduce damage and associated yield reductions from persea mite.

Alternative Host Plants

In addition to avocados, persea mite can develop on a wide range of fruit, ornamental, and weed plants. This pest has been recorded feeding on leaves of Thompson and Flame seedless grapes *(Vitus* spp.), apricots, peaches, plums and nectarines (all *Prunus* spp.), persimmons *(Disopyrus* spp.), milkweed *(Asclepiasfuscicularis),* sow thistle *(Sonchus* sp.), lamb's quarters *(Chenopodium alburn),* sumac *(Rhus* sp.), carob *(Ceratonia siliqua),* camphor *(Camphora officinalis),* roses *(Rosa* spp.), acacia *(Acacia* spp.), annatto *(Bixa orellana),* willow *(Salix* spp.), and bamboo *(Bambusa* spp.). Good sanitation practices (i.e., elimination of favored weed species) and removal of alternate host plants (i.e., ornamental plants and non-commercial fruit trees in orchards) that act as persea mite reservoirs are useful cultural control practices that should be employed in an integrated persea mite management program.

Using Predatory Mites to Control Persea Mite on Avocados

Based on the results of field trials, the phytoseiids with the most potential for controlling persea mite are *Galendromus helveolus* and *Neoseiulus californicus.* Work is currently in progress refining release rates and timings of these predators. More research is required before recommendations for use of these predators can be made. However, some practical guidelines for using phytoseiids in avocado orchards in southern California are:

(1) Monitoring persea mite populations. If predator mite releases are being considered, it is best to make releases based on the percentage of leaves infested with persea mite rather than the average number of mites per leaf. Consider the following example where eighty-six persea mites are counted on just one leaf in a ten leaf sample; thus the average number of mites per leaf is 8.6; however 90% of those leaves have no persea mites. If predators are released under these conditions, they will only find food on one leaf in every ten searched. Consequently, it will be difficult for predators to find food and released natural enemies may not be able to establish in orchards as a result. A better strategy is to release predators when twenty-five leaves out of fifty randomly inspected leaves has one or more persea mite (i.e., 50% of leaves are infested with low numbers of persea mites). Here, every second leaf predators search will have food, and this increases the likelihood of released predators establishing in the orchard and reproducing in response to increasing persea mite population growth. Our work has shown that at 25% leaf infestation, there are too few persea mites available for predators to establish. Predators will establish at the 50%, 75%, and 95% leaf infestation levels. However, at 75% and 95% leaf infestation, persea mite populations are too high for the predators to afford control, but control can be achieved when releases begin at the 50% leaf infestation level.

(2) ***Assessing predator quality.*** Predatory mites are shipped in bottles of vermiculite or corn grits which should be packaged in styrofoam boxes with ice packs to reduce heat stress during transit. Before releases are made, a sub-sample of the shipment should be examined to ensure a good quality product has been received. To check quality, gently shake the bottle of grits to evenly distribute predators and pour some grits with predators into a small clear jar. If a lot of small, fast running mites are seen, you can assume the shipment has arrived in good condition. If few predators are seen, call the supplier and negotiate a deal for more predators or change the supplier.

(3) ***Release methodology.*** Even coverage of trees is very important when releasing phytoseiids and this can be very difficult to achieve. In field experiments, grits are poured into eight small paper cups which are evenly distributed around trees and attached to branches with binder clips. Predators disperse from cups onto foliage. Some PCAs use leaf blowers to spray phytoseiids onto trees that are damp with dew. The dew temporarily traps predators which, upon freeing themselves, begin searching for prey. The effectiveness of the leaf blower technique has not been determined experimentally. Mechanical distribution technology using tractor mounted dispensers which spray predatory mites into the canopy are currently being developed and tested. This predator release technique may show promise for use in avocado orchards, particularly where ground is moderately flat. Releasing predators at a few release points (e.g., one to three trees are treated and dispersal by predators from these trees throughout the orchard is anticipated) is an ineffective approach to using these biological control agents and wide ranging releases throughout orchards are recommended.

Spraying for Persea Mite and Conserving Natural Enemies

In some instances persea mite infestations will be severe enough to warrant chemicallybased control to reduce damage to leaves and the possibility of defoliation. Field trials evaluating the efficacy of miticides in Ventura County indicate that water, Agri-Mek (this product currently has Section 18 restricted use permit for avocado thrips control), and NR 435 oil were the most effective compounds tested for control of persea mite. These treatments reduced persea mite numbers by 75%. However, a corresponding decrease in natural enemy numbers may occur and resurgence of persea mite on oil treated trees has been documented. Water applied to trees with a hand gun at 150-200 psi, physically disrupted persea mite nests and exposure because of nest damage may increase this pest's vulnerability to natural enemies or adverse environmental conditions (e.g., increased risk of desiccation). Pesticide evaluation studies in avocado orchards for persea mite control are continuing.

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), it is necessary to use pesticides that have minimal impact on natural enemies and to provide refuges for biological control agents. Compatible pesticides have short residual activity or are non-toxic to natural enemies. Biological control agents can be protected in refuges. Untreated trees provide refuges for natural enemies, allowing them to re-colonize sprayed areas. Natural enemies can be purchased from insectaries to re-inoculate orchards after pesticide treatments have been made or to augment the orchard's indigenous natural enemy fauna (see Hunter 1997 for suppliers of beneficial insects).

Frequent use of a limited number of pesticides with similar modes of action (e.g., nerve poisons) can result in the development of resistance. Pesticide resistance is the developed ability of a pest population to withstand pesticides that were formerly effective. The rate at which resistance develops in a population is related to the intensity of pesticide use. To prolong pesticide efficacy for persea mite, it is advisable to limit the frequency of applications by spraying only when necessary, to alternate between miticides with different modes of action, and to leave areas of the orchard untreated (this will conserve natural enemies and allow survival of susceptible persea mites that can breed with mites with resistance genes thereby reducing the rate at which resistance develops). Decisions to spray should be based on population monitoring results of both persea mites and natural enemies and consultation with a PC A may be warranted before applying pesticides for persea mite control.

Background Reading

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UC IPM Spider Mites Web Page, (you can load the following keywords into a search engine: UC IPM Spider Mites Pest Notes). http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn006.html