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Biological Control of Persea Mite, *Oligonychusperseae* Tuttle, Baker & Abatiello (Acari: Tetranychidae) and Investigation of Host Plant Resistance

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Benefit to the Industry

Biological control of persea mite with phytoseiids has the potential to provide a sustainable, non-chemically based management strategy for this pest. Effective control of persea mite is necessary to minimize premature defoliation which results from mite feeding. High persea mite populations (1) adversely affect photosynthetic activity which reduces crop production. (2) Mite induced defoliation promotes flush for avocado thrips to feed and reproduce on. (3) A reduction in persea mite nests will reduce refuges for avocado thrips to pupate in. Quantification of host plant resistance and determination of underlying mechanisms of resistance will assist plant breeding efforts to develop varieties resistant or tolerant to persea mite feeding.

Objectives

The objectives of our biological control research have been to identify the most efficacious predatory mites of those commercially available and to determine if inundative releases of phytoseiids can reduce persea mite densities to levels attainable with pesticides. Our second avenue of investigation has been to quantify avocado cultivar resistance to persea mite and to determine mechanisms underlying variation in host susceptibility.

Summary

The Problem: Persea mite, *Oligonychus perseae,* 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 a major pest in the state of Michoacán 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 (100-500 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. One non-chemical control option is the use of natural enemies, in particular commercially available phytoseiid mites for biological control of persea mite.

Biological Control Experiments: Work completed in 1997 indicated that the phytoseiids with the greatest potential for controlling persea mite were *Neoseiulus californicus* (McGregor) and *Galendromus helveolus* (Chant). In 1998, we investigated the efficacy of these two predators when released at three different times at one release rate. We compared the level of control achieved with phytoseiids to that attained with oil applications. The trial was conducted at Camarillo in Ventura County on trees that were 5-6 years of age.

Treatments: We had five treatments in this experiment. *Treatment one (cal):* Three releases of 2000 N. californicus per tree. *Treatment 2 (hel):* Three releases of 2000 G. helveolus per tree. *Treatment 3 (c+h):* Three releases of 1000 *N. californicus* and 1000 *G. helveolus* combined for at total of 2000 predators per release. *Treatment 4 (oil):* Hand applications of 415 NR oil at 5% at a rate of 0.4 gallons per tree to simulate helicopter applications. *Treatment 5 (ctl):* Control treatment, persea mites developed on trees in the absence of any treatments to reduce numbers. Each treatment was replicated on 6 individual trees for a total of 30 experimental trees. Each week 10 leaves were picked from each tree (for a total of 300 leaves weekly) and returned to the laboratory and the number of persea mites on each leaf was recorded by treatment. The trial ran for 32 weeks (March 18-October 24, 1998).

Release Strategies and Timings, and Oil Applications: Phytoseiids were received from the insectary in vermiculite in plastic vials. Prior to release we quantified numbers received and identified the species as those ordered. Phytoseiids in vermiculite were poured by hand into 8 paper cups that were attached with binder clips to branches and evenly distributed at shoulder height around the tree. Phytoseiids were observed to disperse from cups onto foliage. Three phytoseiid releases were made when 50%, 75%, and 100% of sampled leaves in the orchard had 1^+ motile persea mites. Two oil applications were made when 50% and 75% of sampled leaves were infested with 1^+ motile persea mites.

Results: Three releases of *N. californicus, G. helveolus,* and a combination of both predators significantly reduced persea mite numbers when compared to control trees (no treatments) and oil treated trees. Oil treated trees exhibited substantial persea mite resurgence after treatment and this was probably due to the elimination *of Euseius hibisci,* a common generalist predator in avocado orchards (Fig. 1). *Euseius hibisci* did not decrease in numbers on biological control or control trees (Fig. 2).

Fig. 1. Persea mite trends on experimental trees.

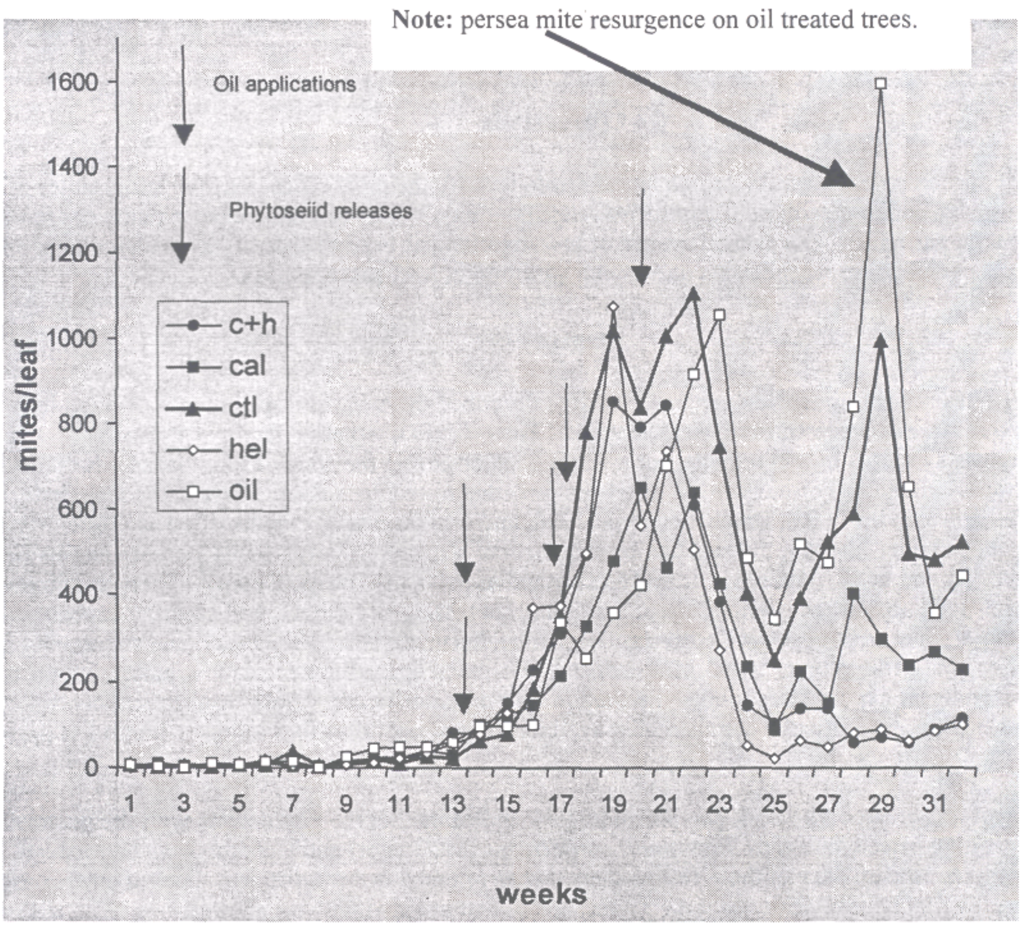
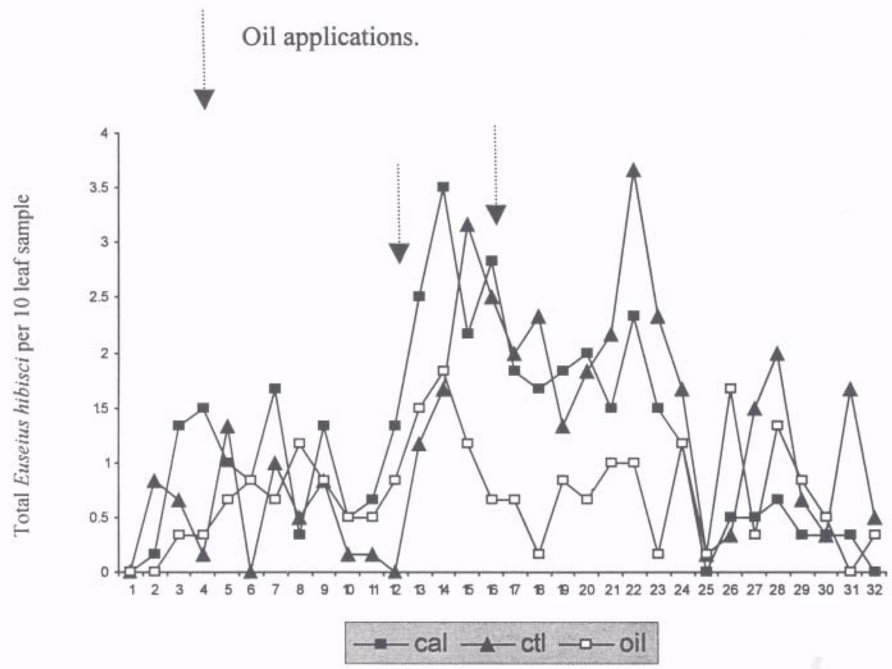
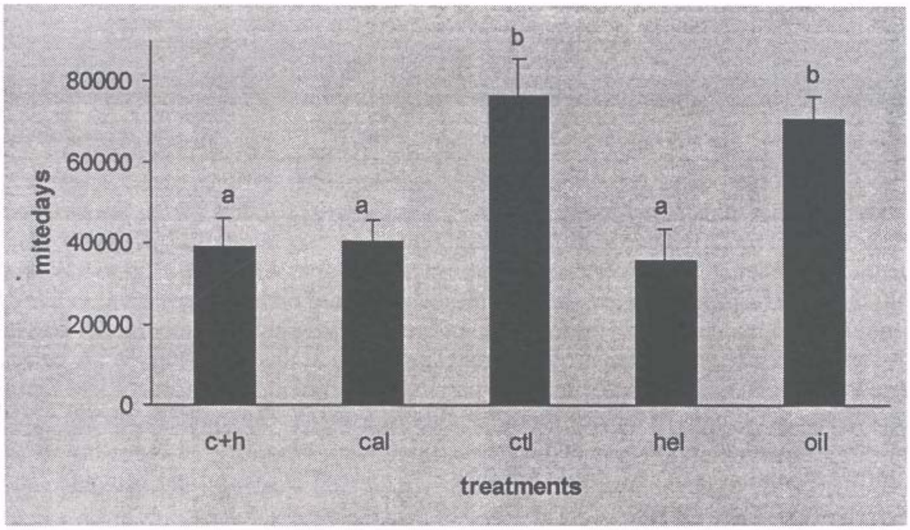


Fig. 2. *Euseius hibisci* trends on phytoseiid treated trees, control trees (no treatment) and oil treated trees. Note the decline in *E. hibisci* numbers following oil applications, this may have influenced persea mite resurgence observed in Fig. 1.



The season long persea mite feeding burden was quantified by computing average total mite-days per leaf for each treatment as the sum of all weekly average densities of persea mite per leaf multiplied by 7 days. Statistically significant differences in mite-days were detected with ANOVA across treatments (Fig. 3). All biological control treatments had less mite-days than oil or control trees which were indistinguishable. This suggests that spraying oil twice as we did was similar to do nothing for persea mite control and more expensive.

Fig. 3. Mite feeding days by treatment. Bars with the same letters are not statistically significant at the 0.05% level.

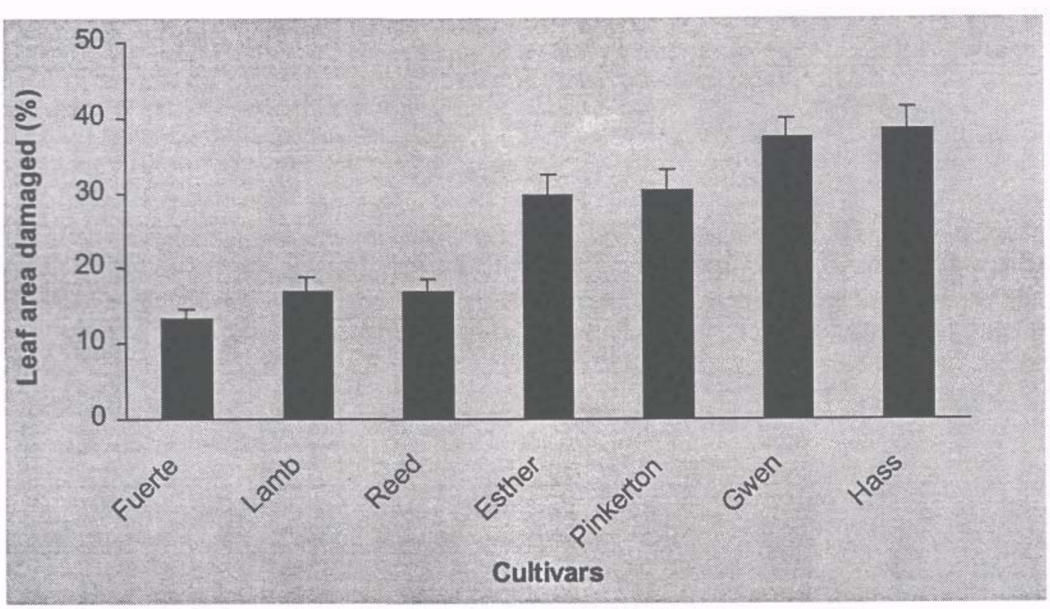


Conclusions and Future Research: The predator recommended for persea mite control is *N. californicus* as this natural enemy is 33% cheaper than *G. helveolus* and works just as effectively. However, at the current experimental release rate control of persea mite is uneconomical. Further work is being conducted to determine the minimum number of *N. californicus* to release to control persea mite and what the timings of those releases should be. Determination of minimum release rates by hand will provide the baseline for mechanical releases of *N. californicus* onto trees with tractor mounted sprayers that blow predators into the canopy. Mechanical application is particularly attractive for three reasons. (1) It reduces the labor involved with releases making them more affordable. (2) Mechanical releases standardize release rates and coverage which varies with human labor, especially as workers fatigue. (3) It will provide greater coverage of the canopy than can be attained by hand. When mechanically applied, predators are dispersed over the entire canopy instead of being concentrated around a few release points from which they disperse. This result in releases of fewer predators to attain control.

Host Plant Resistance Studies

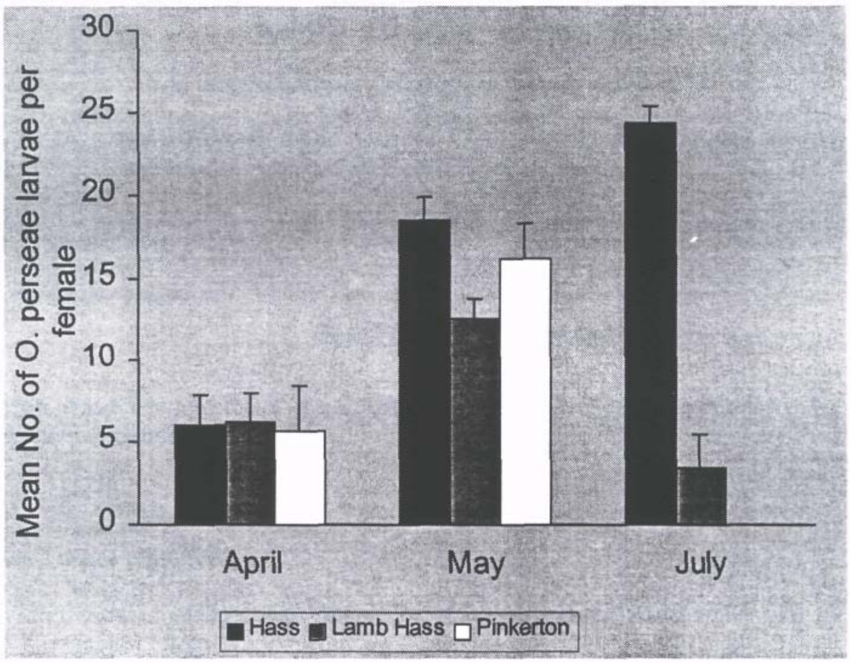
Avocado cultivars vary in their susceptibility to persea mite feeding. In 1998, we quantified feeding damage to seven different avocado varieties grown in mixed plots at South Coast Field Station in Irvine. Damage was measured with automated image analysis soft ware and three categories of susceptibility were observed; highly susceptible (e.g., Hass), moderately susceptible (e.g., Pinkerton), and resistant (e.g., Lamb Hass) to persea mite feeding (Fig. 4).

Fig. 4. Mean percentage feeding damage by persea mite on leaves of various avocado cultivars collected from South Coast Field Station and analyzed with automated image analysis software.



Resistance Mechanisms: 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 in reproductive rates when reared on leaves collected in late spring (April) and early summer (June), net reproduction and intrinsic rate of increase were significantly higher on Hass avocados in mid summer (July) and more offspring were produced on Hass leaves at this tune (Fig. 5). A corresponding increase in percentage leaf area damaged by mite feeding was also observed at South Coast Field Station on Hass in July. We suggest 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. 5. We speculate that in July (i.e., mid-summer) nutritional quality of 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.



Conclusion: Increasing cultivar diversity in orchards should be considered as a strategy to reduce damage and associated yield reductions from persea mite. Lamb Hass appears to be a suitable cultivar for use in orchards that suffer severe persea mite damage.

Background Reading

Aponte, O. & J. A McMurtry. 1997. Damage on "Hass" avocado leaves, webbing and nesting behavior of *Uligonychus perseae* (Acan: Tetranychidae). *Experimental and Applied Acarology* 21**:** 265-272.

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