Using Neoseiulus californicus for Control of Persea Mite

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Benefits to the Industry

The persea mite, *Oligonychus perseae* Tuttle, Baker and Abbatiello (Acari: Tetranychidae) is the most serious foliar pest of exotic origin attacking avocados (*Persea americana* Miller [Lauraceae]) in California, USA. Colonial feeding by immature and adult *O. perseae* within silk nests on the undersides of leaves results in the production of characteristic brown necrotic spots. Once necrotic tissue caused by *O. perseae* feeding exceeds 8% of the leaf surface area, the probability of mature leaves defoliating increases substantially. *Oligonychus perseae* populations typically exhibit rapid growth during mid-summer and populations decline markedly over the period of late summer to mid-fall. Similar unimodal-type population trends are observed in avocado orchards in Michoacan, Mexico (the presumed country of origin for this pest) where pesticides are applied to control a suite of native avocado pests. *Oligonychus perseae* population declines in California probably occur because of summer heat-waves in inland desert areas or possible over-exploitation of resources which results in a shortage of nesting sites on leaves and subsequent lack of food.

There are no indigenous natural enemies in California avocado orchards that respond in a significant density dependent manner to increasing *O. perseae* numbers, and population growth is consequently unregulated by upper trophic level organisms. Foreign exploration efforts for biological control agents of *O. perseae* in Latin America to be used in a classical biological control program have been unsuccessful. However, seasonal inoculative releases of commercially available phytoseiids, in particular *Neoseiulus californicus* (McGregor) and *Galendromus helveolus* (Chant), onto avocado trees in full production orchards have proven extremely effective in controlling *O. perseae*. *Neoseiulus californicus* significantly reduced *O. perseae* population densities in comparison to control treatments (no predator release trees) and trees sprayed with insecticidal oil, the industry standard for controlling *O. perseae*. Although *G. helveolus* suppressed *O. perseae* densities as equally well as *N. californicus*, *G. helveolus* did not hold leaf damage below the 8% threshold needed to minimize the probability of leaf drop whereas *N. californicus* did. Furthermore, *N. californicus* is 33% cheaper to purchase than *G. helveolus* thus making it the natural enemy of choice for use against *O. perseae.*

Two questions relating to the use of *N. californicus* need to be resolved before this predator can be recommended for *O. perseae* control on avocados. Specifically, these issues are: (1) What is the minimum number of *N. californicus* that should be released per tree to provide suppression of *O. perseae*? (2) What are the minimum number of predator releases necessary to inoculate trees with adequate numbers of predators to provide acceptable suppression of *O. perseae*?

To determine the minimum release rate and release frequency, we investigated the efficacy of three release rates of *N. californicus* combined with three different release frequencies against *O. perseae* in a commercial avocado orchard in southern California. The level of control obtained by varying release rates and frequencies of *N. californicus* was compared to suppression of *O. perseae* attained with insecticidal oil applications and to population growth on trees where no control measures were implemented.

Investigating Release Frequency and Timing of *Neoseiulus californicus*

This study was conducted in a commercial avocado orchard in Irvine, Orange County, California, USA from Feb. 26, 1999 to Oct. 26, 1999 inclusive. The trial was run in a 2.6 ha plot planted with 660 'Hass' avocado trees 5-7 years of age. All trees in this plot were subjected to commercial cultural practices (i.e., fertilization and irrigation).

The experimental *N. californicus* treatments we deployed in this orchard against persea mite were:

1. 500 Cal x 1 - one release of 500 *N. californicus* when 50% of all (n = 660) sampled leaves were infested with one or more motile *O. perseae*.
2. 500 Cal x 2 - two sequential releases of 500 *N. californicus* when 50% (release 1) and 75% (release 2) of all sampled leaves (n = 660) had one or more motile *O. perseae*.
3. 500 Cal x 3 - three sequential releases of 500 *N. californicus* when 50% (release 1), 75% (release 2), and 95% (release 3) of all sampled leaves (n = 660) had one or more motile *O. perseae*.
4. 1000 Cal x 1 - Same as treatment 1, except 1000 *N. californicus* were released at the first treatment threshold.
5. 1000 Cal x 2 - Same as treatment 2, except 1000 *N. californicus* were released at each treatment threshold.
6. 1000 Cal x 3 - Same as treatment 3, except 1000 *N. californicus* were released at each treatment threshold.
7. 2000 Cal x 1 - Same as treatment 4, except 2000 *N. californicus* were released at the first treatment threshold.
8. 2000 Cal x 2 - Same as treatment 5, except 2000 *N. californicus* were released at each treatment threshold.
9. 2000 Cal x 3 - Same as treatment 6, except 2000 *N. californicus* were released at each treatment threshold.
10. Oil - Trees received two sequential applications of narrow range (NR) 415 Supreme spray oil (Leffingwell, Kirkiland Washington, USA) at 5% in water (1.92 l/tree) applied by hand with a mechanical Stihl power sprayer to simulate application by helicopter. Sprays were applied when 50% (Aug. 24, 1999) and 75% (Oct. 1, 1999) of all sampled leaves were infested with one or more motile *O. perseae*.
11. Control - No treatments were applied to suppress *O. perseae* population growth.

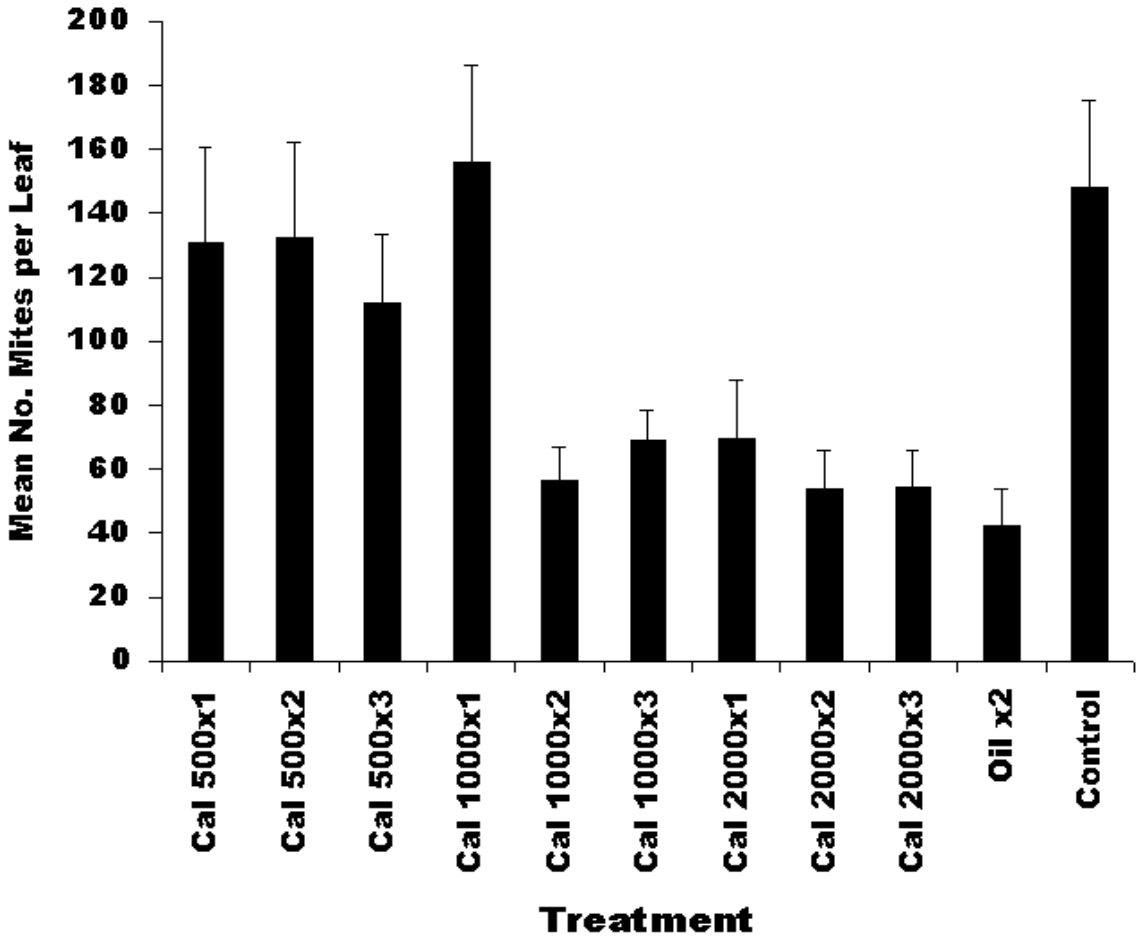
Predators were released onto trees by attaching paper cups to branches and pouring predators and corn grits into cups.

Every sampling period, 10 mature leaves were removed from each experimental tree. Leaves were picked randomly at shoulder height around each tree, placed in labeled bags, and returned to the laboratory. Leaves were examined under a dissecting microscope and the number of motile *O. perseae* was recorded per leaf. For each treatment on each sampling date, we calculated the percentage of leaves infested with *O. perseae*, and the average number of *O. perseae* per leaf. Average maximum densities of *O. perseae* were compared among treatments with a nested ANOVA and means were separated with Tukey's Studentized Range Test at the 0.05 level of significance.

What Release Strategy Worked Best?

Comparisons of mean peak *O. perseae* densities per leaf across the 11 different treatments were significantly different (F= 8.46; df= 10, 55; p= 0.0001) (Fig. 1). Substantial reduction of *O. perseae* densities with *N. californicus* was obtained once a minimum release of 2000 phytoseiids per tree had been made. Levels of control with *N. californicus* at release rates of 2000 predators per tree or higher were similar to suppression obtained with insecticidal oil (Fig. 1).

Fig. 1. Comparison of mean (± SE) maximum *Oligonychus perseae* densities per leaf across treatments. Means followed by the same letters are not significantly different from each other at the 0.05 level.



Total releases of 1500 or fewer *N. californicus* per tree did not reduce *O. perseae* densities significantly in comparison to control trees. A single release of 2000 *N. californicus* or two releases of 1000 *N. californicus* provided similar levels of control, suggesting release frequency was unimportant for attaining control of this pest but total numbers of predators released per tree was important. Releases exceeding 2000 predators per tree did not provide an appreciable increase in control regardless of release rate and timing when compared to trees receiving a cumulative total of 2000 *N. californicus*.

Using *Neoseiulus californicus* in Commercial Orchards

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 86 persea mites are counted on just one leaf in a 10 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 10 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 25 leaves out of 50 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 over the last three years 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, releasing predators for the first time at 75% and 95% leaf infestation, persea mite populations will be too high for the predators to afford control. Biological control can be achieved when predator releases begin at the 50% leaf infestation level and a second release is made at the 75% level of infestation.

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*. Field trials have shown that G. annectens is not an effective natural enemy of persea mite on avocados and its use is not recommended.

A minimum cumulative release of 2000 *N. californicus* per tree is 6-10 times more expensive per acre when compared to aerial applications of NR 415 oil for control of *O. perseae*. Releasing predators in paper cups as we do for experimental purposes is not an efficient way to evenly distribute natural enemies onto trees as predators need to disperse from these localized release points to provide canopy-wide pest suppression. Improved *O. perseae* control with lower release rates of *N. californicus* may be attained if predators could be uniformly and artificially dispersed through the canopy.

Some PCAs have reported good control of persea mite by making releases of *N. californicus* at a rate of 5000 per acre. To make releases, the upper surface of a persea mite infested leaf is

spritzed with water. A small amount of corn grits with predators is then sprinkled onto the dampened leaf. The water traps the grits with predators. As the water dries the predators free themselves and commence searching for prey. Every tree in an infested block is treated in this manner. No research has been conducted to verify the effectiveness of this predator release rate or the efficacy of the leaf spritzing technique for persea mite control.

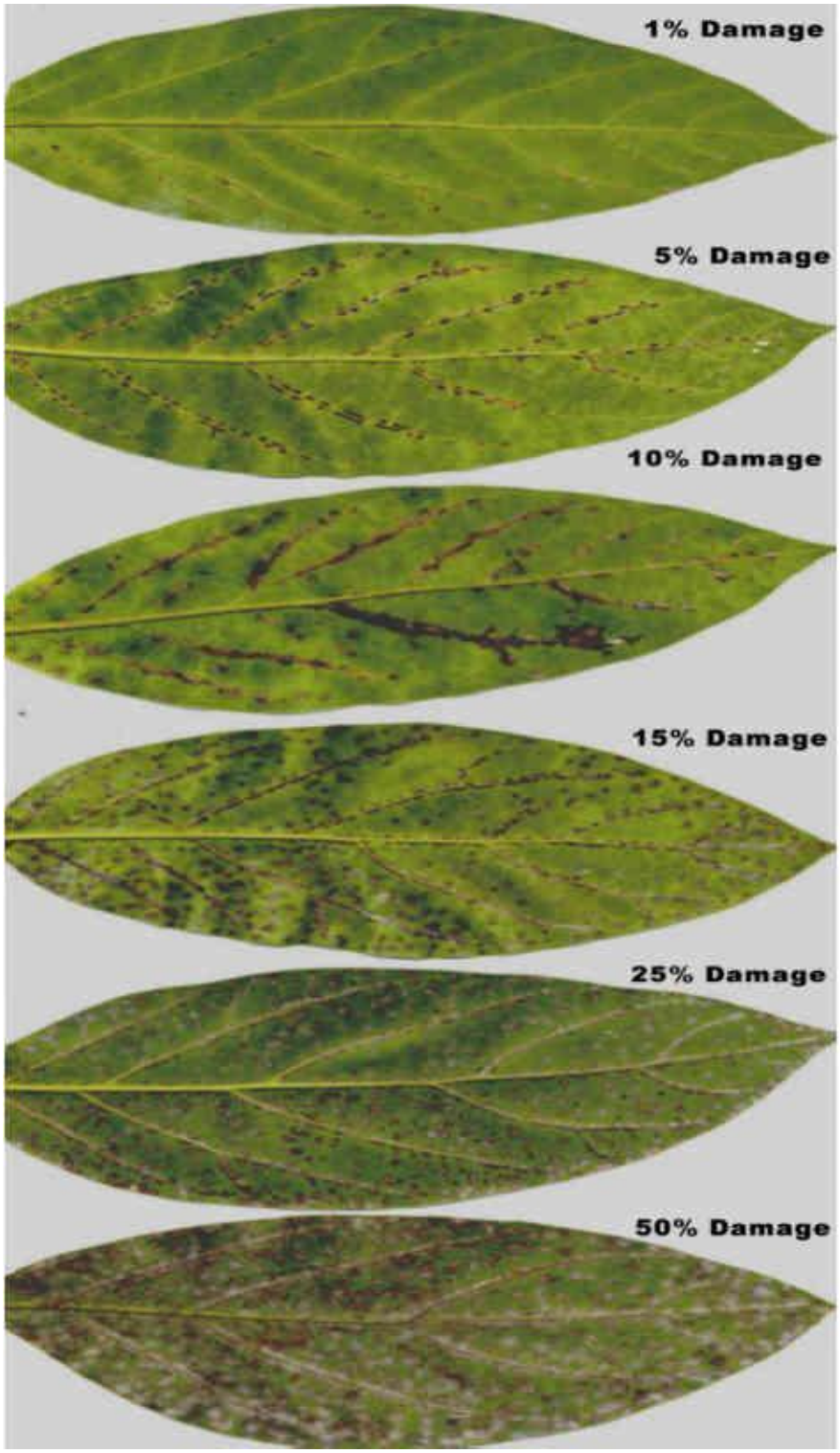
Mechanical applicators that spray metered aliquots of predators and carrier (e.g., corn grits) onto trees have the potential to improve predator distribution in the canopy thereby enhancing control. Mechanical dispensing systems mounted on tractors have been shown to be more effective for evenly distributing Phytoseiulus persimilis Athias-Henriot for control of *Tetranychus urticae* Koch (two-spotted spider mite) in strawberries than similar releases made by hand. Mechanical releases are superior to hand-releases because natural enemies are distributed at a consistent rate in the crop, time to release and subsequent labor costs are reduced, and in some instances, natural enemy viability can be enhanced. We are currently evaluating the efficacy of mechanical application of *N. californicus* for *O. perseae* control on avocados.

Monitoring Persea Mite Numbers and Visually Assessing Feeding Damage

Predator releases should begin when 50% of sampled leaves have one or more motile persea mites (not eggs) per leaf. If releases are made too early (i.e., at 25% leaf infestation) there is not enough food for predators to establish. If releases are made too late (i.e., at 95% leaf infestation) persea mite numbers are too high for predators to control and significant leaf damage will result. A second release of predators can be made when 75% of sampled leaves have more than one motile persea mite. To estimate the number of leaves infested with persea mite choose 50 leaves at random from several trees and calculate the percentage infestation by multiplying the total number of leaves with one or more motile persea mites by two (e.g., 15 infested leaves out of 50 is 30% leaf infestation). *Neoseiulus californicus* does not appear to over winter in large numbers in California avocado orchards and predator releases need to be made each year. Furthermore, field studies suggest that *N. californicus* will not disperse from central release points in orchards and this predator needs to be released onto each tree in the orchard if it is to be effective.

Photographs of avocado leaves damaged by persea mite feeding can be used to assist with decisions regarding control measures. Measurements of persea mite feeding damage to leaves that have fallen from avocado trees to the ground indicates that average feeding damage to the leaf surface of fallen leaves is 15-22%. However, 86-90% of fallen leaves have damage equal to or greater than 7.5-10%. From these data it appears that the probability of leaf drop increases greatly once 7.5-10% of the leaf surface is damaged by persea mite feeding and control measures may need to be implemented before this 7.5-10% level of damage is observed. There are no experimental data to verify the effectiveness of using these damage estimates as treatment thresholds. Damage to leaves can be estimated visually by using the color photographs below. Some PCAs recommend spray treatments when sampling indicates there are 70-100 persea mites per leaf.

Persea Mite Feeding Damage to Avocado Leaves



*As persea mite feeding damage increases the number of individual necrotic spots on leaves declines as nests begin to merge. Consequently, mite numbers decline also as there is less food for them to survive on.

Background Reading

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Additional information on persea mite and its natural enemies is available on the world-wide web at: www.biocontrol.ucr.edu