Further Progress on Biological Control of Persea Mite

Continuing Project; Year 5 of 3

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Benefit to the Industry

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 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 (≈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 subsequently occur. Non-chemical control options are the use of natural enemies, in particular commercially available phytoseiid mites for biological control of persea mite, and cultural control practices that reduce the pest's reproductive and colonization potential.

Objectives

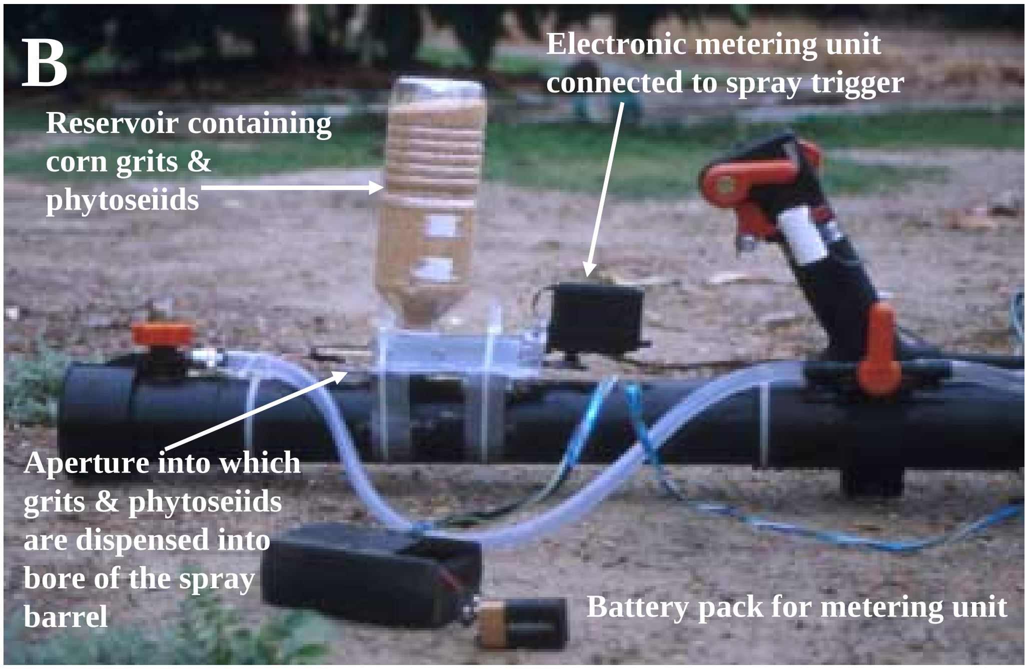
1. Evaluate a modified power sprayer for applying predator mites to trees for use in biological control programs of persea mite.
2. Investigate tree colonization mechanisms by persea mite after spring defoliation.
3. Characterize predatory behaviors of *Neoseiulus californicus* and *Galendromus helveolus*, two key phytoseiid predators of persea mite.

Summary

1) Power Sprayer Evaluations (work by Takano-Lee & Hoddle). A Stihl SR400 backpack mistblower (Fig. 1) was modified to mechanically dispense the phytoseiid predator, *Neoseiulus californicus* (McGregor) onto artificial and actual avocado trees. The ability of the mistblower to broadcast *N. californicus* vertically was initially evaluated on a group of four artificial trees (4 m height). Distribution of corn grits, the carrier material in which *N. californicus* is commercially packaged, was unevenly distributed. Analysis of sticky cards arranged at 0.5 m intervals on artificial trees indicated that 75% of grits adhered to cards at heights ranging from 1.5-3.5 m. In an avocado orchard, the efficacy of three treatments for dispensing *N. californicus* was assessed: (1) mistblower application of phytoseiids mixed with corn grits with water setting on 0.5 (provided a fine spray to adhere predators and grits to leaves); (2) mistblower application of phytoseiids mixed with corn grits with water setting on 1.0 (provided a coarse spray); and (3) 4-point hand-release of predators into 10 paper cups placed evenly around trees at shoulder height. Each release strategy used ≈ 19,000 predators and all treatments were compared to control trees that were not treated with *N. californicus* to determine naturally occurring densities of this predator on experimental trees. The mistblower successfully dispensed viable *N. californicus* mixed with corn grits onto avocado trees. Predators on trees treated with the mistblower were recovered in the field up to 16 days post-application. However, 5-fold higher levels of *N. californicus* were recovered from hand-release applications. These tests on artificial trees and avocado trees

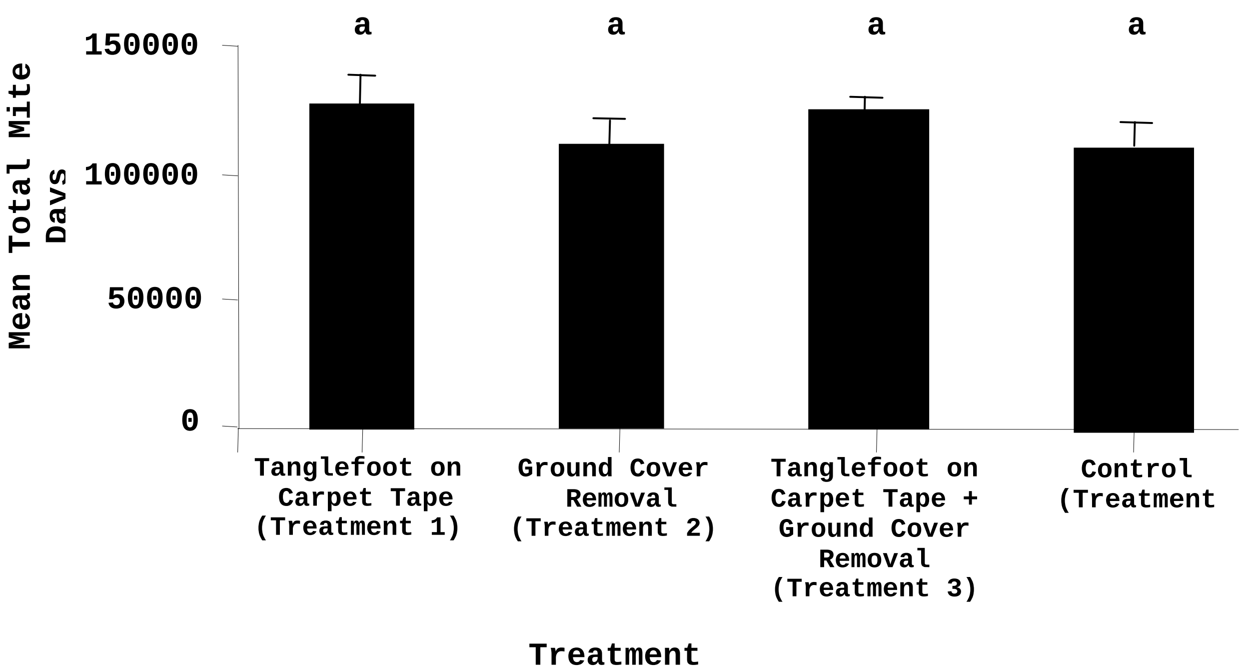
demonstrated the potential of the mistblower for field applications of viable phytoseiids for control of spider mites on trees. Further work is needed to increase the application rates of predators to trees to reduce application times, and field trials are needed to evaluate the efficacy of sprayer applied predators for control of persea mite in comparison to traditional hand-releases of *N. californicus* in paper cups.

Figure 1. Stihl SR400 mistblower modified for applying phytoseiids to avocado trees (A) and the prototype electronic metering unit attached to the mistblower (B).



2) Cultural Control of Persea Mite (Work by Takano-Lee, Virzi, & Hoddle). Populations of *Oligonychus perseae* Tuttle, Baker and Abbatiello (Acari: Tetranychidae) were monitored for 37 weeks in an avocado (*Persea americana* Miller) orchard in Fallbrook California, USA. Three cultural control methods were tested to determine their potential for reducing vertical recolonization of avocado tree trunks by *O. perseae* that fall to the orchard floor on leaves during periods of natural or mite-induced defoliation. Control methods examined were: (1) Tanglefoot® barriers on tree trunks. (2) Removal of ground cover and leaf litter under tree canopies, and (3) Tanglefoot® barriers combined with ground cover removal. All treatments were compared to control trees that were not subjected to any of the preceding cultural practices. No significant differences in *O. perseae* populations or *O. perseae*-induced leaf damage were found among trees receiving different treatments (Fig. 2). Four species (*Galendromus* spp., *Amblyseius* spp., *Euseius hibisci*, and *Neoseiulus californicus*) of naturally occurring phytoseiid populations were also monitored during this study. Natural enemy numbers were not adversely affected by cultural control attempts targeting *O. perseae*. Aerial applications of abamectin with NR 415 oil for *Scirtothrips perseae* Nakahara (Thysanoptera: Thripidae) had an adverse effect on *Galendromus* spp., which are important predators of *O. perseae* in avocado orchards.

Figure 2. Average total mite days for each treatment calculated over 37 weeks of observation. Means with same letters were not significantly different at the 0.05 level (ANOVA).



3) Predatory behavior of commercially available phytoseiids (work by Takano-Lee & Hoddle). Predatory behaviors of *Neoseiulus californicus* (McGregor) and *Galendromus helveolus* (Chant) attacking *Oligonychus perseae* Tuttle, Baker and Abbatiello on avocado leaves were videotaped and analyzed. Behaviors were recorded for "fresh" predators that were used ≤ 48 hr post receipt from a commercial insectary and "cold stored" predators that were maintained at 12^{o} C for ≈ 14 days. Fresh and cold stored *G. helveolus* were observed to attack *O. perseae* only after invading webbed nests. Conversely, fresh and cold stored *N. californicus* employed three different modes of predatory attack: (1) intercepting and attacking migrant *O. perseae* outside of web nests; (2) attacking prey through nest webbing; or (3) invading and attacking *O. perseae* inside nests. The frequency of attack modes is presented in Table 1. Predatory efficacy of both *N. californicus* and *G. helveolus* was reduced following cold storage, as both species either required more time on average to complete measured behaviors, or engaged in certain predatory behaviors less frequently in comparison to predators that were not stored at low temperatures.

Various aspects of *G. helveolus* behavior suggested that this predator is specially adapted to a web nest invasion lifestyle. *Galendromus helveolus* spent significantly greater amounts of time resting than *N. californicus*, and resting activity occurred primarily within nests upon cessation of feeding. This distinctive resting period may have occurred because *G. helveolus* engaged in low activity periods post prey consumption. We observed that *G. helveolus* became greatly distended after feeding and had difficulty exiting *O. perseae* nests (grooming was the predominant activity in between these resting periods). In addition, we observed that 16% of cases in which *G. helveolus* invaded a nest, *O. perseae* motiles fled the nest. High residency times by *G. helveolus* may increase opportunities to ambush motiles after they return to nests. Nest residency by *G. helveolus* may reduce risk of intraguild predation by naturally occurring predators on avocados such as *N. californicus* or *Euseius hibisci* Chant (Acari: Phytoseiidae) or *Stethorus* spp. (Coleoptera: Coccinellidae). Intraguild predation of phytoseiids within the avocado system by other phytoseiids or predaceous insects has not been studied. The possible occurrence of intraguild predation in avocado cropping systems needs investigation because augmentative releases of commercially-available predators will encounter naturally-occurring low density predator populations and these interactions could adversely affect biological control programs. *Galendromus helveolus* also displayed a significant preference for consuming eggs rather than *O. perseae* motiles, suggesting that utilization of a nest invasion strategy may be beneficial for predators attacking sedentary and defenseless prey that are unable to abandon intact nests. The slower mobility of *G. helveolus* (in comparison to *N. californicus*) may also explain its preference for eggs, as well as its inability to patrol for and successfully capture migrant tetranychids outside of nests.

In contrast to *G. helveolus*, *N. californicus* spent more of its time outside of nests searching. Consequently, our laboratory data support existing literature that the high activity levels of some *Neoseiulus* species probably enhances their utility as generalist biological control agents because of enhanced prey encounter rates. The high mobility of *N. californicus* on avocado leaves may result in higher encounter rates of occupied *O. perseae* nests and individual motile mites outside of nests. The ability of *N. californicus* to execute three different modes of predator attack reflects a flexibility of lifestyle that allows exploitation of tetranychid prey either within or outside of webbed nests.

Table 1. Modes of phytoseiid predator attack.

Storage Treatment	Species	Attack Mode	Percentage Engaging in Activity	n =
Fresh	*Galendromus helveolus*	NI	100.00%	12
	Neoseiulus californicus	NI	17.00%	2
	Neoseiulus californicus	NI + PG	8.33%	1
	Neoseiulus californicus	NP	8.33%	1
	Neoseiulus californicus	NP + PG	8.33%	1
	Neoseiulus californicus	PG	58.00%	7
Cold storage	*Galendromus helveolus*	NI	100.00%	12
	Neoseiulus californicus	NI	25.00%	3
	Neoseiulus californicus	NI + NP	17.00%	2
	Neoseiulus californicus	NP	8.00%	1
	Neoseiulus californicus	NP + PG	8.00%	1
	Neoseiulus californicus	PG	42.00%	5

NI = Nest invasion (i.e., predator enters nest), NP = nest penetration (i.e., predator attacks prey through nest webbing), PG = patrolling (i.e., predator attacks prey outside of nest)