Biology, Management, and Resistance Monitoring of Avocado Thrips and Persea Mite

Year 1 of 3

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September 2006

Benefit to the Industry

Our research is aimed at assisting with effective management of avocado thrips and persea mite. We will study how to use available pesticides most effectively, will search for new control materials, hopefully with different modes of action from available materials to reduce the potential for pesticide resistance development, and will evaluate alternative methods of pesticide application and timing of treatments.

Resistance monitoring with persea mite and avocado thrips is important to be able to distinguish between a control failure and damage caused by heavy population pressure, less than optimal application, timing of treatment, etc. Should resistance appear (as has been the case with avocado thrips resistance to sabadilla [Veratran D]), it will be important to determine how quickly resistance reverts, to what extent treatments after reversion are effective, and what resistance management protocols might maintain the useful life of various pesticides. In our opinion, it is unlikely that selective materials like abamectin [AgriMek], spinosad [Success], and sabadilla will be easily replaced if these materials are lost due to resistance.

At present, we have limited control options available to control avocado thrips and persea mite. Research is underway to determine if imidacloprid applied in irrigation water (Admire) is effective as an avocado thrips management tool. At present, growers have only (1) Oil or (2) AgriMek (with a small amount of oil to assist AgriMek leaf penetration) for persea mite management. Screening trials have identified several new and effective materials for both avocado thrips and persea mite but it will be several years, if not longer, before these materials are registered for use in California. Grower restraint in not over-using AgriMek will be critical over the next few years until these new classes of chemistry become available. Some growers have used AgriMek in the spring for avocado thrips control and then the same material in the summer or fall for persea mite management. Because abamectin residues are extremely persistent in leaves and fruit (resulting in mortality for as long as 2-3 months), this could lead to resistance in either avocado thrips or persea mite or both. Growers really should not use this material for control of both pest species within the same year.

Objectives

Objective 1. Conduct laboratory and field screening trials with new materials potentially useful against avocado thrips. Prioritize materials to be considered for registration on avocado and coordinate with work being done on citrus thrips as funded by the Citrus Research Board. Conduct screening trials of new materials potentially effective against persea mite. A number of new miticides have become available in recent years, persea mite appears to be a recurrent problem, and a new material with chemistry different from AgriMek is needed.

Objective 2. Monitor avocado thrips populations for resistance to Veratran D, AgriMek, and Success and obtain baseline resistance levels at several field sites before and after Veratran D and AgriMek are used extensively. Continue to monitor for persea mite resistance to AgriMek and any new materials registered for use against this species.

Summary

Objective 1. Pesticide Screening Research.

1.A. Citrus Thrips Screening Assists in Avocado Thrips Research.

Our research on citrus thrips as funded by the California Citrus Board feeds into avocado thrips research, at no cost to the avocado industry (and likewise, avocado research benefits citrus growers and our citrus thrips project). Both of these insects are in the genus *Scirtothrips* and although they are different species, we have found that they generally respond in a similar manner to many pesticides. There are differences, however. On citrus, Success + Oil is the most popular material for citrus thrips control whereas on avocado, AgriMek + Oil appears to outperform Success + Oil.

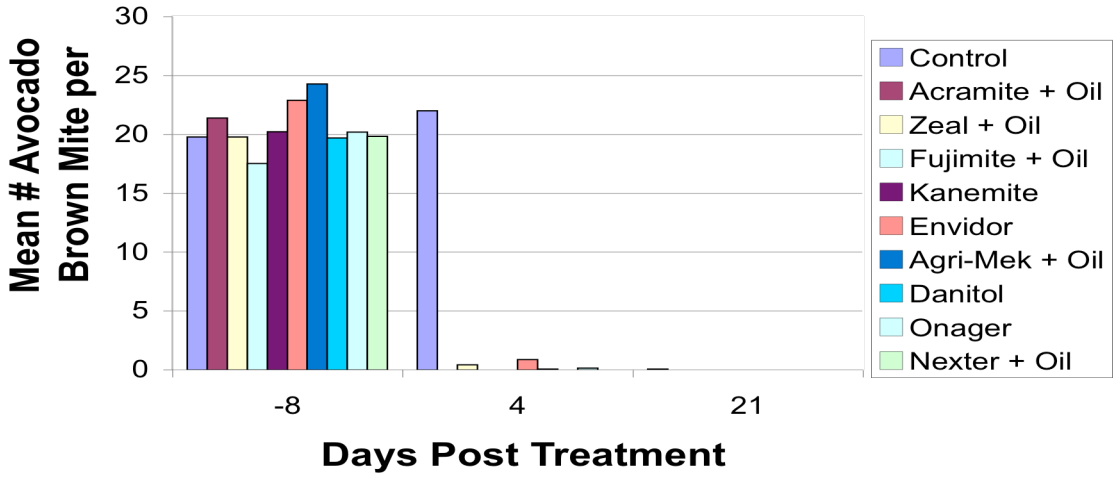
Citrus thrips screening research has identified two new effective thrips products and screening against avocado thrips has confirmed that one of them is active against this insect (the citrus thrips screen with the second product was finished in August and we have not yet had a chance to test it against avocado thrips). In addition, screening work done on avocado thrips has identified a third new product, which also appears to have efficacy against citrus thrips. These three new products are (1) a new spinosyn in the same class of chemistry as Success, which appears to be much more active against avocado thrips than Success is (it will not be a new class of chemistry for avocado; registration expected late 2007 or early 2008), (2) a quite persistent feeding inhibitor from Nichino which is quite active against avocado thrips (registration possibly by 2009, it is reported as a new, but undisclosed, class of chemistry), and (3) spirotetramat from Bayer (this is the material not yet tested against avocado thrips, it is in IRAC class 23, the same class as Envidor, the tetronic acid derivatives; registration is targeted for approximately 2009).

We are encouraged by three new products being identified with thrips activity. Over the past ten years, very few new products have come forward and having three show up within the last two years is quite encouraging.

1.B. Persea Mite Pesticide Screening Trial. As mentioned above, we believe it is imperative that an alternative to abamectin [AgriMek] be found for persea mite control so that growers restrict abamectin use to at most a single treatment per year (less than every year would be even better if feasible) and use it only for avocado thrips control, using a different chemical with alternative chemistry for persea mite control, if treatment is needed. Towards this end, with the assistance of Steve Peirce and Guy Witney, we found an avocado grove near Fallbrook, CA with moderate persea mite densities and conducted a screening trial with 8 treatments applied on 3 November 2004. Although persea mite densities were moderately high prior to treatment (9.2 – 9.3 per leaf), they crashed within 3 weeks after treatment, even on untreated control trees.

As a result, we repeated the persea mite study in 2005, adding an additional experimental miticide. We appreciate the cooperation of pest control advisor Joe Barcinas (Entomological Services, Inc.) and Jesse Ruiz (Irvine Ranch Co.). Treatments were applied to 3.5-year old Hass avocado trees near Irvine on 29 September 2005 using a Stihl 400 backpack mistblower sprayer to simulate helicopter treatment and using a dilution rate of 100 gallons of water per acre. In addition to high persea mite levels prior to treatment (Fig. 2), this grove had moderate avocado brown mite levels and all treatments reduced brown mite levels as monitored on day 4 post-treatment (Fig. 1). However, brown mite populations crashed due to heavy rain by day 21 post-treatment and thus, we were unable to determine what the long-term impact of these materials might have been on avocado brown mite.

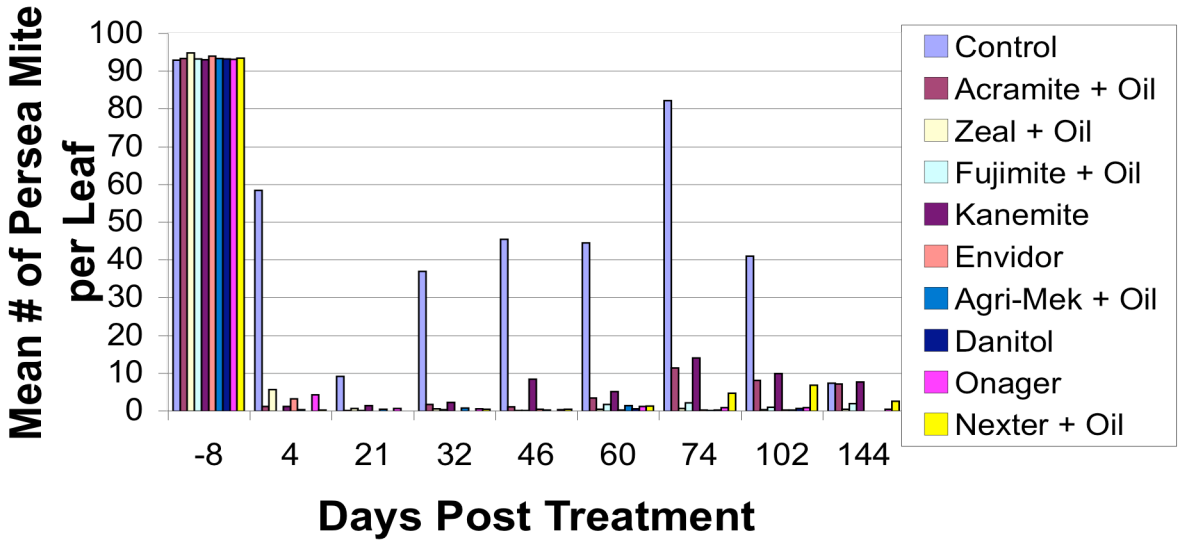
Figure 1. Avocado Brown Mite Levels in the 2005 Irvine Persea Mite Trial.



Fortunately, persea mite levels started to recover in the water spray control plots by day 32 post-treatment and both this and later counts showed good separation between different candidate miticides (Figs. 2, 3). Based on numerical counts (not statistical separation) taken 144 days post-treatment (Fig. 4), we ranked miticide efficacy as 1. Envidor, 2. Zeal + Oil, 2. Onager (tie), 4. AgriMek + Oil, 4. Danitol (tie), 6. FujiMite + Oil, 7. Nexter + Oil, 8. Acramite + Oil, and 9. Kanemite. Treatments 1-6 were considered quite effective at day 144 post-treatment, which is a substantial period of time for treatments to remain effective. Envidor and Onager are in the same

class of chemistry and based on discussions with the involved chemical companies and IR-4 (the federally funded program that assists in registering new chemicals on speciality crops such as avocado), we decided to prioritize Zeal + Oil for initial registration on California avocados (this was influenced by IR-4 already having a Zeal work request on mangos which is in the subtropical fruits classification [according to IR-4's taxonomy], the crop grouping that includes avocados). Based on aggressive action and funding provided by both the California Avocado Commission (thanks to Guy Witney and Steve Peirce) and the manufacturer (Valent), IR-4 was able to initiate IR-4 research on Zeal in 2006. Thus, Zeal might be available by 2009 (or earlier if industry pressure can be brought to bear). After a number of discussions, we prioritized Envidor as the second material to move towards registration on avocados and Guy Witney attended the early September IR-4 meeting in Indianapolis which resulted in this project receiving a closely contested A rating, which should mean work should start in 2007. The third product we will push for registration on avocado for persea mite control is FujiMite + Oil (saving Danitol for use against avocado thrips; registration of this product is expected ca. 2009).

Figure 2. Persea Mite Levels in the 2005 Irvine Persea Mite Trial.



Because IR-4 requests more than a single efficacy trial to support their work and an eventual registration request, we conducted a third persea mite trial, this time in the "north" (to complement the Irvine trial in the "south"). We appreciate the cooperation of pest control advisor Tom Roberts (Integrated Consulting Entomology) and the Newhall Land and Farming Company. Treatments were applied 25 July 2006 using a 100-gallon PBM Co. trailer sprayer (Model 100 ATT = All Terrain Trailer, L & M Fertilizer, Temecula) to apply 10 treatments to 5-year old Hass avocado trees in Fillmore, CA, using a dilution concentration of 100 gallons of water per acre. We started out with healthy persea mite levels (Fig. 5) but high temperatures have resulted in persea mite levels crashing, even on the water-treated control trees. Hopefully, persea mite levels will recover this fall as the weather cools, allowing us to evaluate treatment efficacy.

Figure 3. Persea Mite Levels on Day 102 in the 2005 Irvine Persea Mite Trial.

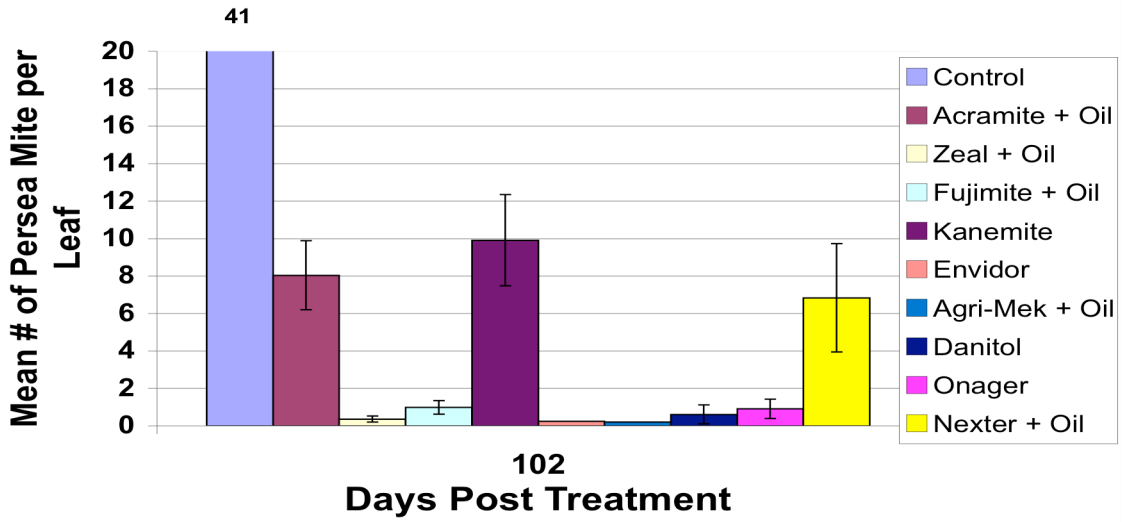


Figure 4. Persea Mite Levels on Day 144 in the 2005 Irvine Persea Mite Trial.

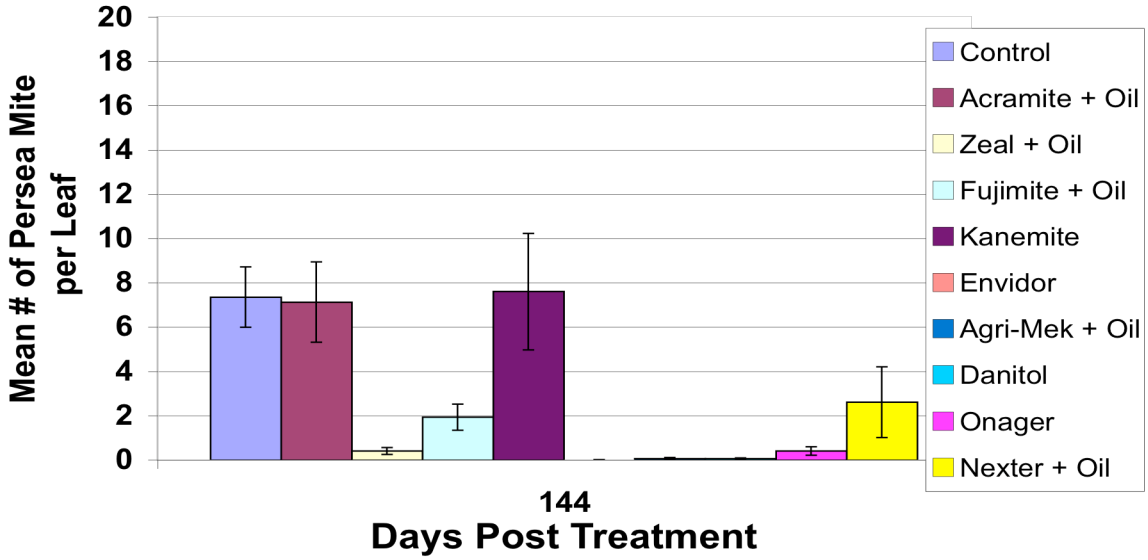
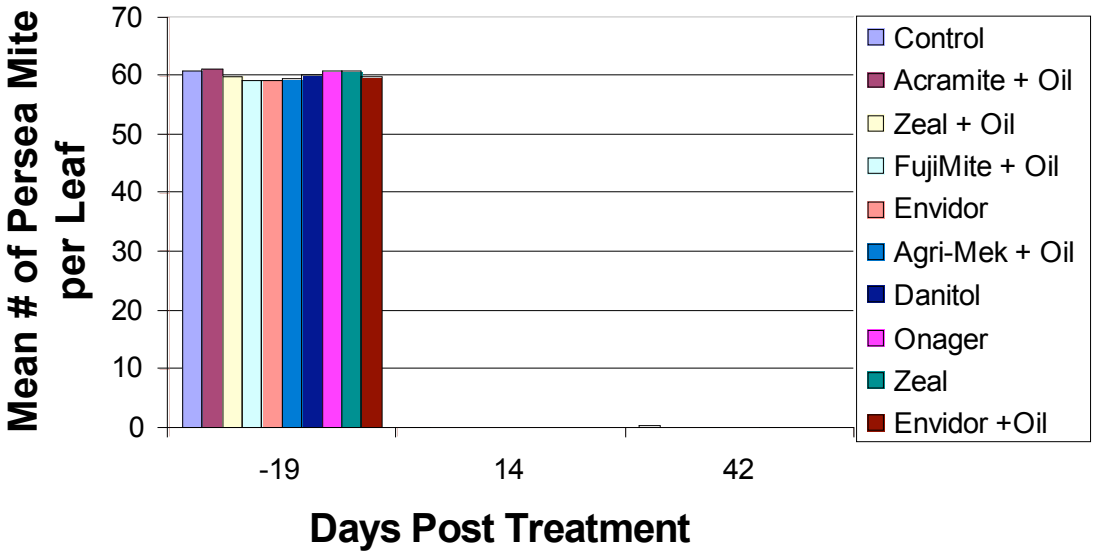


Figure 5. Persea Mite Levels in the 2006 Fillmore Persea Mite Trial.



1.C. Assistance Provided to Support Studies with Admire Pro in 2006.

Potted nursery plant screening trials of four systemic pesticides in collaboration with Drs. Frank Byrne and Nick Toscano in 2004 showed that imidacloprid (the active ingredient in Admire 2F and Admire Pro) had efficacy against avocado thrips (see p. 47 of Morse et al. 2004). In 2005, we ran our first field study comparing imidacloprid uptake after application in irrigation water to small (6-8 year-old) versus large (30-40 feet tall) commercial avocado trees in Fallbrook (see Morse et al. 2005a). Leaf bioassays were conducted on various dates post-treatment using either avocado lace bug or avocado thrips. In addition, levels of imidacloprid and its breakdown products were monitored in leaves. Results were encouraging in relation to avocado lace bug control but not in relation to avocado thrips control – imidacloprid uptake at this site was not high enough to provide high levels of thrips mortality, especially on the large trees.

Based on the 2005 data, Dr. Byrne compared imidacloprid passage through soil columns containing different types of soils. The Fallbrook soil where we ran the 2005 study was determined to be a very challenging soil. Dr. Byrne tested a number of soils in the Temecula area and based on these results, we set up three spring 2006 Admire field trials, one each in (1) a very challenging, (2) a conducive (to imidacloprid uptake by the tree), and (3) intermediate type of soil. At this point in time, our plans for 2006 Admire field studies were reasonable in scope (i.e. field studies at each of 3 trial locations; no plans for soil or flower, nectar, or pollen sampling).

During the spring of 2005, avocado thrips caused substantial levels of fruit scarring in a large number of avocado groves both in the south and the north. Many growers have asked us why this was the case. We hypothesize that the heavy winter rains during late 2004 and early 2005 lead to

more than normal early 2005 tree flush and higher avocado thrips levels later in the spring. In a number of cases, interior groves (e.g., Temecula) which had seldom received heavy fruit scarring saw exactly that, probably because weather conditions favored avocado thrips build-up more than had been the case in the past (i.e. cooler than normal weather during April - June allowed thrips to continue to build to high levels). As a result, growers and pest control advisors were nervous about avocado thrips management going into 2006 and when it became apparent that there would likely be a shortage of helicopters in the south, substantial pressure was applied to submit a 24c supplemental label request allowing use of Admire Pro. The only way in which Bayer CropScience would support the 24c label was if substantial additional data were taken at the three Temecula sites.

Collection of additional data was extremely laborious and meant that plans for other avocado research subprojects had to be delayed (we had planned substantial AgriMek resistance monitoring and also an additional potted nursery trial evaluating new experimental products).

Objective 2. Pesticide Resistance Monitoring.

We had intended to do substantial AgriMek resistance monitoring with avocado thrips during 2006. Instead, however, research effort was focused on persea mite efficacy trials and assisting with the Admire Pro field studies described above. In addition, avocado thrips levels were relatively low during late summer 2006 when we again had time for bioassays, making thrips resistance work difficult.

Relevant Recent Publications (2003 to present)

Byrne, F. J., N. C. Toscano, A. A. Urena, and J. G. Morse. 2005. Quantification of Imidacloprid Toxicity to Avocado Thrips *Scirtothrips perseae* Nakahara (Thysanoptera: Thripidae), Using a Combined Bioassay and ELISA Approach. Pest Manage. Sci. 61: 754-758.

Hoddle, M. S. and J. G. Morse. 2003. Avocado Thrips Biology and Control. AvoResearch Special Edition, Spring 2003. 8 pp.

Hoddle, M. S., G. S. Bender, J. G. Morse, D. Kellum, R. Dowell, G. W. Witney. 2005. Avocado Lace Bug. AvoResearch. Spring 2005. Calif. Avoc. Commission, Irvine, CA. 2 pp.

Hoddle, M. S., K. M. Jetter, and J. G. Morse. 2003. The Economic Impact of *Scirtothrips perseae* Nakahara (Thysanoptera: Thripidae) on California Avocado Production. Crop Protection 22(3): 485-493.

Hoddle, M. S., K. M. Jetter, and J. G. Morse. 2003. Introduction and Establishment of Exotic Insect and Mite Pests of Avocados in California, Changes in Sanitary and Phytosanitary Policies, and Their Economic and Social Impact. Chapter 12, pp. 185-202. *In*: Exotic Pests and Diseases: Biology and Economics for Biosecurity. (D. A. Sumner, ed.). Iowa State Press, Ames, IA.

Hoddle, M. S., J. G. Morse, and R. Stouthamer. 2005. Biology and Management of Avocado Lace Bug (ALB) in California. Pp. 1-13, *In*: *Proceedings*, California Avocado Commission Research Symposium, October 29, 2005, California Avocado Commission, Santa Ana, CA. 133 pp.

Humeres, E. C. and J. G. Morse. 2005. Baseline Susceptibility of Persea Mite (Acari: Tetranychidae) to Abamectin and Milbemectin in Avocado Groves in Southern California. Experim. & Appl. Acarol. 36: 51-59.

Humeres, E. C. and J. G. Morse. 2006. Resistance of Avocado Thrips (Thysanoptera: Thripidae) to Sabadilla, a Botanically Derived Bait. Pest Manage. Sci. (In Press).

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Morse, J. G. 2004. Avocado Thrips Resistance: A Real Concern for the Future. Update, Mission Avocados, Oxnard, CA. December 2004, p. 3.

Morse, J. G. and M. S. Hoddle. 2006. Invasion Biology of Thrips. Ann. Rev. Entomol. 51: 67-89.

Morse, J. G., F. Byrne, and N. C. Toscano. 2005a. Evaluation of Systemic Chemicals for Avocado Thrips and Avocado Lace Bug Management. Pp. 24-33, *In*: *Proceedings*, California Avocado Commission Research Symposium, October 29, 2005, California Avocado Commission, Santa Ana, CA. 133 pp.

Morse, J. G., E. C. Humeres, A. A. Urena, P. J. Watkins, A. P. Flores, and D. R. Anderson. 2003. Biology and Chemical Control of Avocado Thrips; Pesticide Resistance Monitoring with Avocado Thrips and Persea Mite. *In*: Proceedings, California Avocado Commission Research Symposium, November 1, 2003, California Avocado Commission, Santa Ana, CA. pp. 55-67.

Morse, J. G., F. J. Byrne, E. C. Humeres, N. C. Toscano, A. A. Urena, L. J. Robinson, P. J. Watkins, A. P. Flores, and D. R. Anderson. 2004. Biology and Chemical Control of Avocado Thrips; Pesticide Resistance Monitoring with Avocado Thrips and Persea Mite. Pp. 43-53, *In*: *Proceedings*, California Avocado Commission Research Symposium, October 30, 2004, California Avocado Commission, Santa Ana, CA. 125 pp.

Morse, J. G., A. A. Urena, E. C. Humeres, L. J. Robinson, A. P. Flores, and P. J. Watkins. 2005b. Biology, Management, and Resistance Monitoring of Avocado Thrips and Persea Mite. Pp. 14-23, *In*: *Proceedings*, California Avocado Commission Research Symposium, October 29, 2005, California Avocado Commission, Santa Ana, CA. 133 pp.

Morse, J. G. and G. W. Witney. 2005. Avocado Thrips – Resistance to Pesticides. AvoResearch, Spring 2005, Calif. Avoc. Commission, Irvine, CA. 2 pp.

Tollerup, K. E. and J. G. Morse. 2006. The Effect of Horticultural Spray Oil and Surfactants on the Residual Efficacy of Spinosad against Avocado Thrips, *Scirtothrips perseae* (Thysanoptera: Thripidae). J. Agric. & Urban Entomol. (In Press).

Triapitsyn, S. V. and J. G. Morse. 2005. A Review of the Species of *Ceranisus* Walker (Hymenoptera: Eulophidae) in the New World. Trans. Amer. Entomol. Soc. 131: 69-86.

Witney, G. 2004. The Long Road to Section 18 Registration. AvoResearch 3(1): 3-4.

Other Relevant Publications

Morse, J. G., R. L. Metcalf, M. L. Arpaia, and R. E. Rice. 1995. Risks of Exotic Pest Introductions from Importation of Fresh Mexican Hass Avocados into the United States. UC Center for Exotic Pest Research and College of Natural & Agric. Sciences, Univ. of Calif., Riverside, CA. 163 pp.