Results of 2001 Avocado Thrips Field Pesticide Efficacy Trials

Pascal Oevering[1], Joseph G. Morse[2], Mark S. Hoddle[2], Ben A. Faber[1], Phil A. Phillips[1],

Anthony A. Urena[2], and Darren R. Anderson[2]

[1]Ventura County Cooperative Extension, 669 County Square Drive, Suite 100, Ventura, CA 93003

[2]Department of Entomology, University of California, Riverside, CA 92507

Summary:

- Fallbrook Prebloom Study: Helicopter treatments of avocado trees in Fallbrook during early anthesis (24 March 2001, approximately 50 days before fruit set) with both 10 or 20 oz Agri-Mek + 2% Narrow-Range 415 spray oil were effective in maintaining avocado thrips at low levels until 72 days post-treatment and increased the percent of fruit in packinghouse Grade 1 from 70.5% (untreated control) to 84.9 (10 oz) or 84.5% (20 oz).
- Santa Paula Fruit Set Study: When treatments were applied 4 weeks in advance of fruit set, 20 oz Agri-Mek by helicopter outperformed either one or two applications (the second 21 days after the first) of 10 oz Success. Timing of Success applications appears critical – treatments with this material should be applied no more than 1-2 weeks before fruit set.
- The Stihl SR-400 backpack sprayer provided good spray coverage of 15' tall avocado trees but provided poor coverage of trees 25-35' in height.
- Agri-Mek and Success have similar chemistries. To prevent avocado thrips developing resistance to these materials, growers should limit applications of either material to one treatment per year.

Several meetings of an informal avocado thrips workgroup composed of pest control advisors, growers, UC researchers, and California Avocado Commission representatives developed two main objectives for avocado thrips field pesticide efficacy trials in 2001. These were (1) to determine if early, prebloom applications of Agri-Mek were sufficiently persistent to maintain avocado thrips at low levels through the period of fruit set and retention and (2) to compare the efficacy of Success and Agri-Mek applied close to the period of fruit set. We describe below the results of a 2001 prebloom trial conducted in Fallbrook, San Diego Co., and a fruit set trial conducted in Santa Paula, Ventura Co.

Methods, Fallbrook Prebloom Trial. To test treatment performance under challenging conditions, a 15 acre 21-year old Hass avocado grove planted on a mix of Mentone, Topa Topa, and Zutano seedling rootstocks was chosen for the trial based on high avocado thrips levels in previous years, hilly terrain, and the presence of large trees (most trees were 25 to 35 feet in height; some were as tall as 45 feet). Tree spacing was 23 x 23 feet resulting in 82 trees per acre. Based on terrain, the site was separated into 12 plots that might be individually treated with a helicopter. Four trees in the center of each plot were chosen as initial "data trees." On 15-16 March 2001, we sampled avocado thrips levels on data trees in each of the 12 plots using a 20 foot pruning pole to collect fully expanded but tender leaves from a 15-25 foot height in the tree. Five leaves were sampled per data tree and all immature and adult avocado thrips were counted on the undersurface of each leaf.

Based on the 15-16 March thrips levels, 4 plots were assigned to each of 3 treatment regimes (1) 10 oz Agri-Mek 0.15 EC + 2% Narrow-Range 415 spray oil (Unipar Oil, Leffingwell, Kirkland, WA) in 100 gallons per acre applied by helicopter; (2) 20 oz Agri-Mek + 2% oil in 100 gallons per acre applied by helicopter; and (3) Control / Backpack spray. Each of the 4 plots assigned to regime 3 were divided in half and 4 additional data trees were sampled as above on 22 March. One-half of these plots served as (3a) an untreated control and one-half were sprayed with (3b) 20 oz Agri-Mek + 2% oil in 82 gallons per acre using a backpack sprayer (an experimental use permit was obtained to use this material off-label; the label restricts grounds applications to a minimum of 100 gpa). Based on the beginning of bloom (late cauliflower stage with as much as 20% anthesis on some trees) and a concern that later treatments would be in jeopardy due to the presence of honey bees (in San Diego Co., Agri-Mek treatments are strictly proscribed in avocados during bloom when honey bees are present), helicopter treatments were applied the morning of 24 March 2001 using a Bell 206 B3 Jet Ranger helicopter with a 36 foot wide boom (swath width of 40 feet) with CP nozzles/90° deflectors. Flying speed was 15-20 mph. Backpack sprays were applied 26-27 March using a model SR-400 Pacific Stihl low-volume backpack mist-sprayer (L&M Fertilizer, Temecula, CA) set at nozzle setting #4 (this resulted in good spray coverage to a height of approximately 20 feet - see pp. 16-17 in Hoddle et al. 2001 for the results of an evaluation of this sprayer).

To provide better accuracy in monitoring treatment efficacy, an additional 4 data trees were chosen next to the initial 4 data trees in each plot (thus 8 data trees total x 4 replicates x 4 treatments = 128 data trees in total) for post-treatment sampling. This still left a buffer of 3-4 trees between data trees and the edge of the adjacent plot. Post-treatment leaf sampling was done as before with a 20 foot picking pole except only immature avocado thrips were counted on the undersurface of 5 leaves on each of the 8 data trees. This sampling started 11-12 April 2001 and continued every two weeks until 18 June when avocado thrips levels declined on leaves due to movement to developing fruit. We decided against monitoring thrips levels on fruit due to a shortage of fruit on many data trees. Due to thrips damage occurring on fruit in some plots (especially the untreated control), the pest control advisor monitoring this grove wrote a second spray application recommendation on 3 July 2001. At this time, fruit were typically 3/4” in length. Unfortunately, a number of groves in the region had high avocado thrips levels at this time, there was a long spray queue, and by the time a helicopter was available (more than 2 weeks later), the treatment was cancelled due to the majority of fruit being no longer susceptible to thrips feeding damage.

Our grower cooperator was most accommodating in allowing us to individually strip harvest each of the 128 data trees early in the season, 22-25 January 2002, so that results could be made available rapidly. All fruit on each tree were picked and field graded in 10% increments (0, 1-10, 11-20%, etc.) for the percent fruit surface area scarred by avocado thrips. Fruit from the 8 data trees in each plot were kept in separate bins and on 26 January, each of the 16 lots of fruit (4 replicates of each of 4 treatments) were run through the West Pak packinghouse in Temecula. At the packinghouse, the goal was to compare our field grading to what a grower might typically obtain from his handler. The number and weight of fruit in each standard avocado size class was obtained separately for Grade 1, 2, and 3 fruit from each of the 16 plots ("peewee" size fruit and rots/splits are excluded from data presented; Grade 3 or fruit severely scarred by avocado thrips are marketed by this packinghouse as a special "PapaCado" brand fruit).

Methods, Santa Paula Fruit Set Trial. To compare Agri-Mek and Success treatments by backpack and helicopter during fruit set, a 7-year old Hass avocado grove planted on Duke 7 rootstock was selected in Santa Paula. Trees were about 15 ft tall and were planted 21 ft apart within a row and 18 ft between rows on level terrain (115 trees per acre). The site was separated into 18 plots, 3 by 12 trees in size, and 6 trees in the center row of each plot were chosen as "data trees." On 15 May 2001, we sampled avocado thrips levels on data trees in each of the 18 plots on fully expanded but tender leaves from 4-6 ft height in the tree. Ten leaves were sampled per data tree and all immature and adult avocado thrips were counted on the undersurface of each leaf.

Based on the 15 May thrips levels, 3 plots were assigned to each of 6 treatment regimes (1) 10 oz per acre Success 2 SC (Dow AgroSciences LLC, Indianapolis, IN) by helicopter, (2) 10 oz Success by backpack, (3) 10 oz Success by helicopter with an identical second treatment 21 days later (7 June 2001), (4) 20 oz Agri-Mek by helicopter; (5) 20 oz Agri-Mek by backpack, and (6) no treatment (control).

All materials were applied in 50 gpa with either an SR-400 Pacific Stihl backpack sprayer or a Bell 206B3 Jet Ranger helicopter. Applications included 1% NR415 oil. Just prior to application, one water sensitive paper (Syngenta) was attached to the underside of a leaf in each quadrant at a height of 4-7 ft of data tree 1 and 6 in each plot. Papers were removed after 1-2 hrs and percent spray coverage was calculated by assessing coverage within each square of an 860 square grid placed on top of each card. During the second application (7 June 2001), too many papers were blown off trees to justify spray coverage analyses.

Post-treatment leaf sampling was done as before, counting adult and immature avocado thrips and any natural enemies present on the undersurface of 10 leaves on each of the 6 data trees. This sampling began 21 May 2001 and continued every week until 27 July. On 5 February 2002, 20 fruit on each of 96 data trees were measured for size, height in the tree, and were field graded in 10% increments (0, 1-10, 11-20%, etc.) for the percent fruit surface area scarred by avocado thrips.

Results, Fallbrook Prebloom Trial. Figure 1 shows the trend in avocado thrips levels before and after treatments were applied 24 March ("Air") and 26-27 March 2001 (Backpack = "BP"). Prior to treatments, thrips levels averaged 5.3 (control) to 9.2 (air 10 oz) thrips per leaf (for the precount only, both immature and adult thrips on leaves were counted, almost all were immature thrips). During the trial, thrips levels in the untreated control plots remained at moderate levels, ranging from 3.4 (+18d = 11 April) to 6.9 (+44d = 7 May) immature thrips per leaf. All three chemical treatments were effective in reducing thrips levels until 72 days post-treatment. The last leaf count, taken 86 days post-treatment (June 18), showed some elevation in thrips levels to a high of 2.1 thrips larvae per leaf in the backpack plots (levels were starting to come up, however, in all of the treated plots). After this last count, thrips levels on leaves dropped precipitously, as most of the thrips had moved to the fruit.

Fig. 1. Fallbrook Prebloom Study: Impact of Treatments on Thrips Levels on Leaves

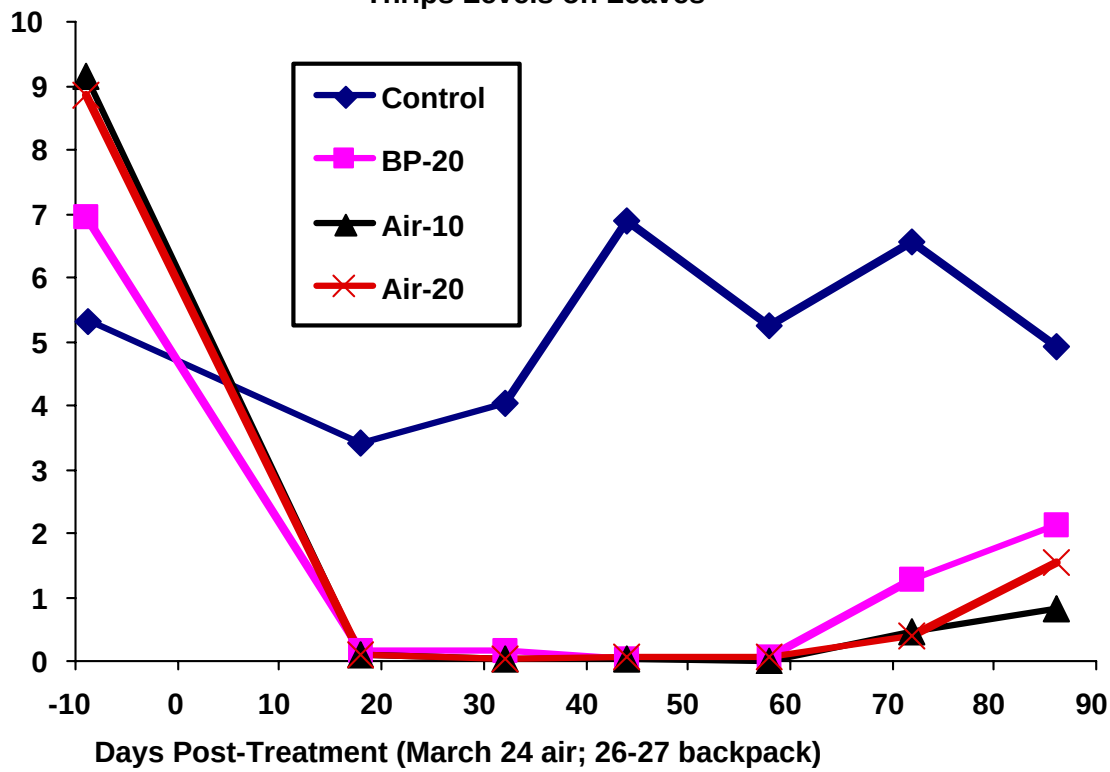


Figure 2 shows the result of field grading all fruit from each of the 8 data trees in each plot (8 trees x 4 replicate plots = 32 trees in total per treatment) for the percent surface area scarred by avocado thrips. Our best guess was that fruit with 0-10, 11-30, and >30% of their surface scarred might be graded as Grade 1, 2, and 3, respectively so scarring "classes" 1, 2, and 3 were defined in this manner. Using this classification, 87, 86, 70, and 68% of the fruit in the Air 20 oz, Air 10 oz, Backpack 20 oz, and Control, respectively were placed in Class 1.

Fig. 2. Fallbrook Prebloom Study: In-Field Scar Counts Averaged Across Trees in each Treatment

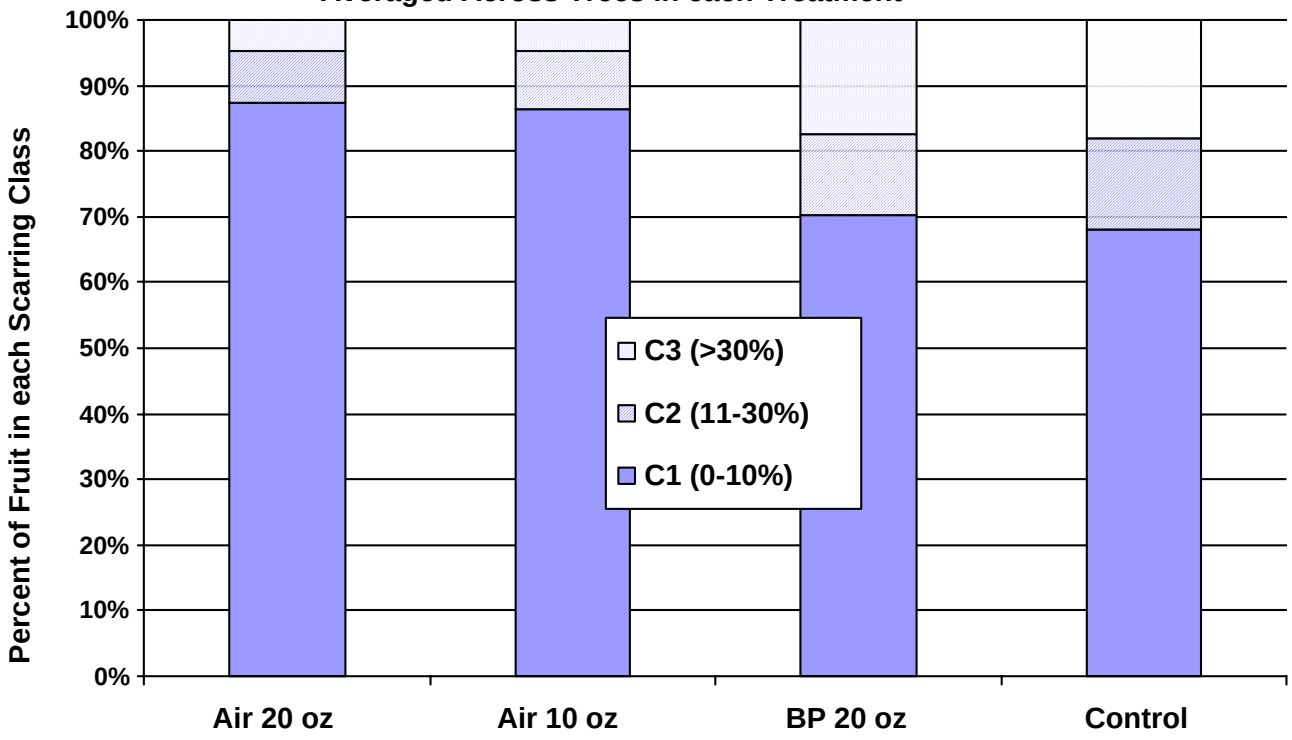
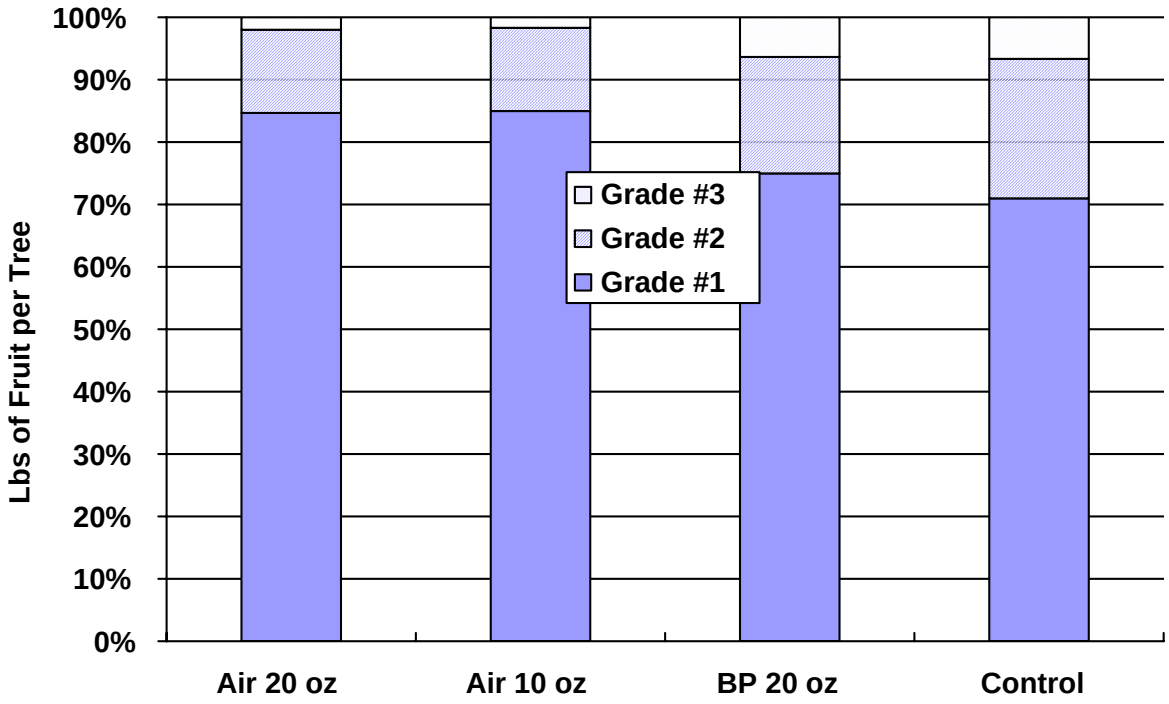


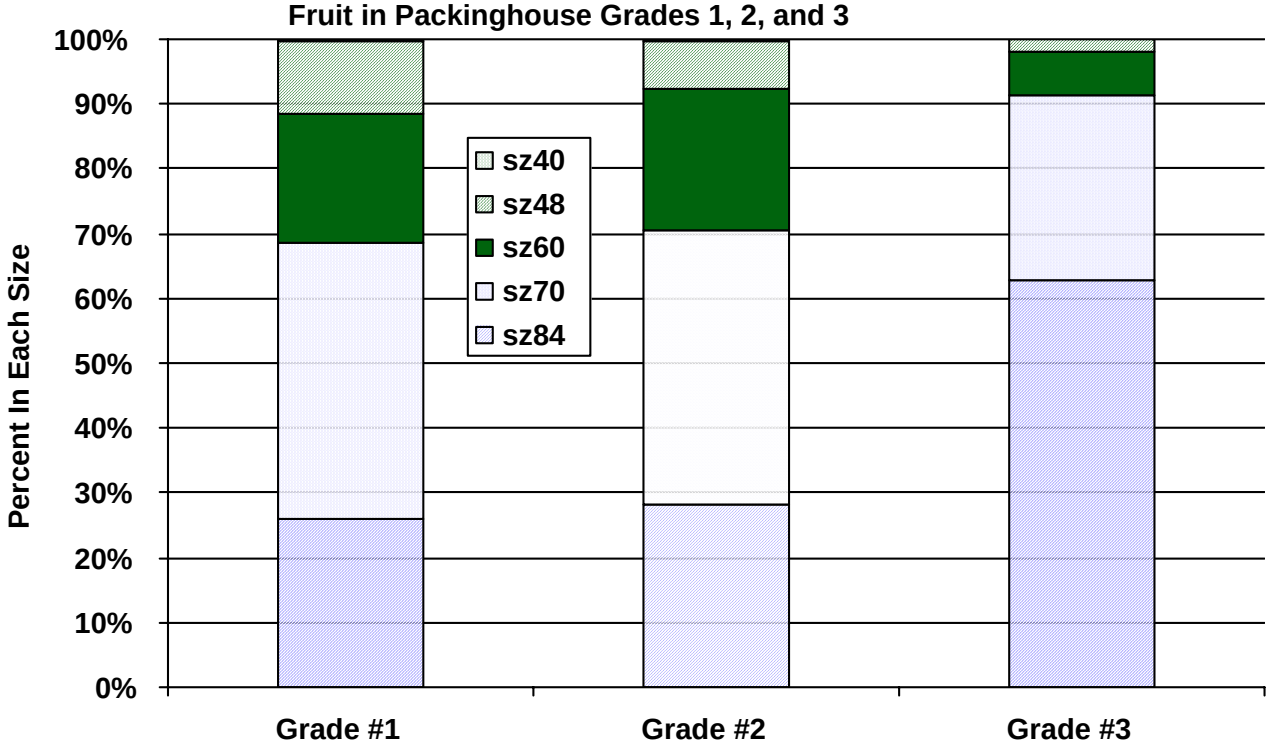
Figure 3 shows the result of normal packinghouse grading of fruit from each of the experimental plots. Consistent with the on-tree fruit scarring data from Figure 2, there was little difference in the percent of fruit going to each grade comparing plots treated with 20 oz (84.5, 13.4, and 2.1% Grades 1, 2, and 3) versus 10 oz (84.9, 13.5, and 1.6%) of Agri-Mek by air. Both air treatments resulted in less fruit scarring than was seen in either the backpack or control plots. There was a somewhat larger but not extreme difference when comparing the grading of fruit in the plots treated with the backpack sprayer (74.8 ,18.7, and 6.6% Grades 1, 2, and 3) versus those that were not treated in the control (70.5, 22.3, and 7.2%).

Fig. 3. Fallbrook Prebloom Study: Fruit Weight in Packinghouse Grades 1, 2, and 3 versus Treatment



In grading fruit for thrips scarring in the field, we noticed that very few severely scarred fruit were large. We also noticed that there was a fair amount of off-bloom fruit, much of it heavily scarred. Figure 4 shows the percent of fruit in packinghouse Grades 1, 2, and 3 that were of sizes 84 to 40 (size 96 fruit were excluded from this analysis because most of these fruit were placed in Grade 2 regardless of thrips scarring levels; size 36, 32, 28, and 24 fruit were also excluded as there were very few fruit of these sizes, regardless of treatment). Because of the large number of off-bloom fruit, we hesitate to suggest that fruit that are heavily scarred by avocado thrips do not size. However, these preliminary data suggest that very few Grade 3 fruit were large.

Fig. 4. Fallbrook Prebloom Study: Size Distribution of Fruit in Packinghouse Grades 1, 2, and 3



Results, Santa Paula Fruit Set Trial. Figure 5 shows the spray coverage for each of the 23 April (helicopter = Air; Backpack = BP) applications. Spray coverage by backpack (81-90%) was higher than that observed with the helicopter applications (33-41%).

Fig. 5. Santa Paula Fruit Set Trial: Spray Coverage

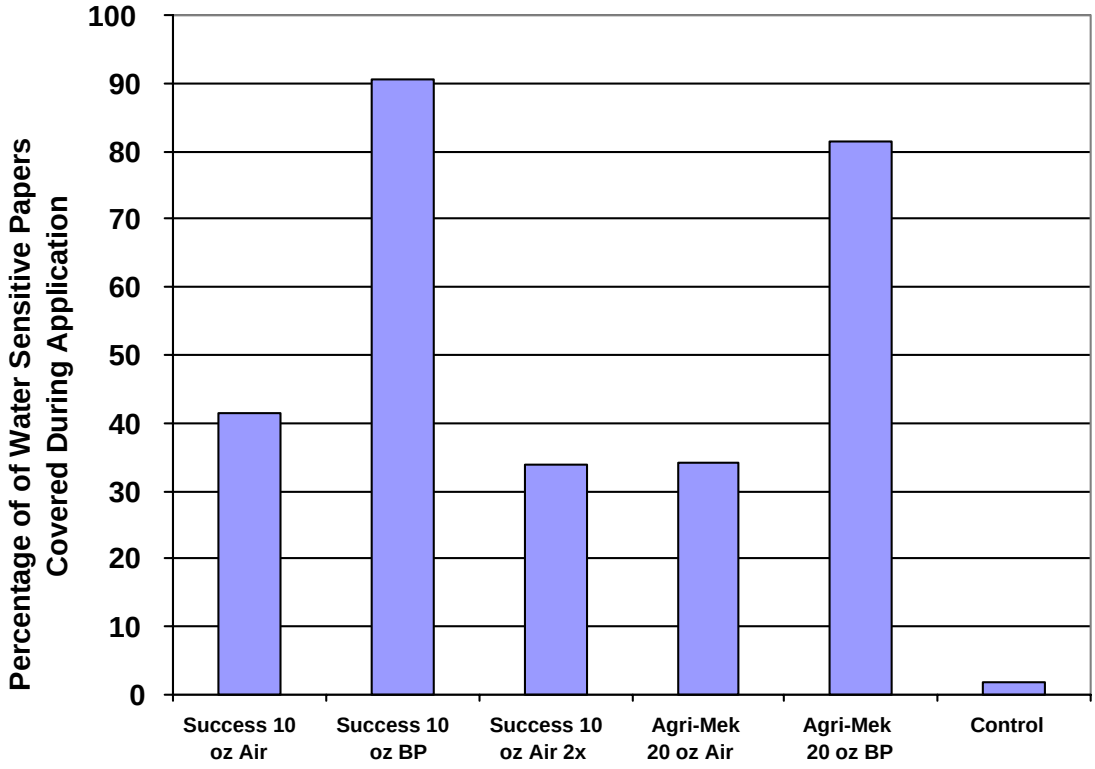
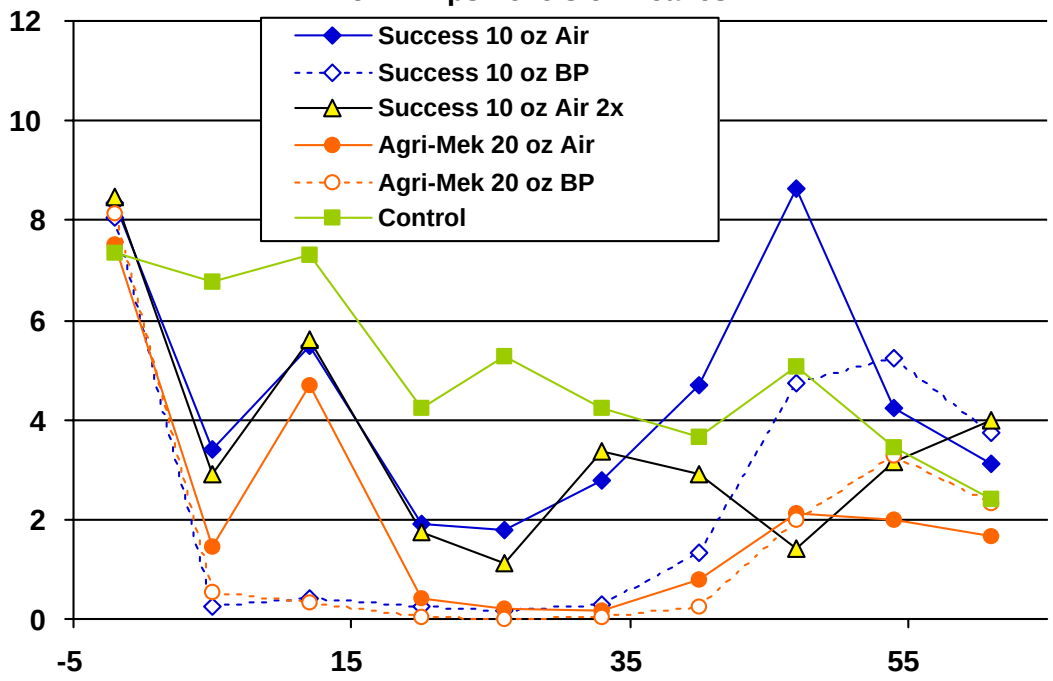


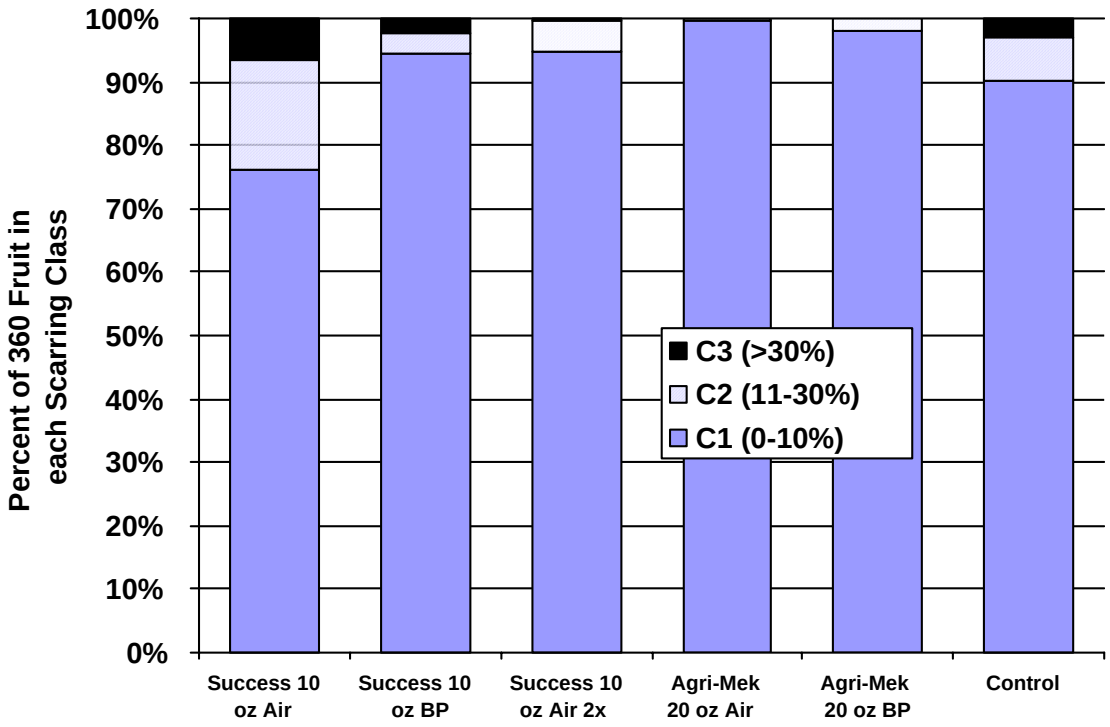
Figure 6 shows the trends in immature avocado thrips levels before and after treatments were applied. The backpack applications suppressed thrips numbers more quickly than aerial applications. The effect of Agri-Mek lasted longer than Success. Thrips populations resurged in plots with a single aerial application of Success with thrips level increasing beyond levels recorded in control plots. The second aerial application of Success prevented this resurgence.

Fig. 6. Santa Paula Fruit Set Trial: Impact of Treatments on Thrips Levels on Leaves



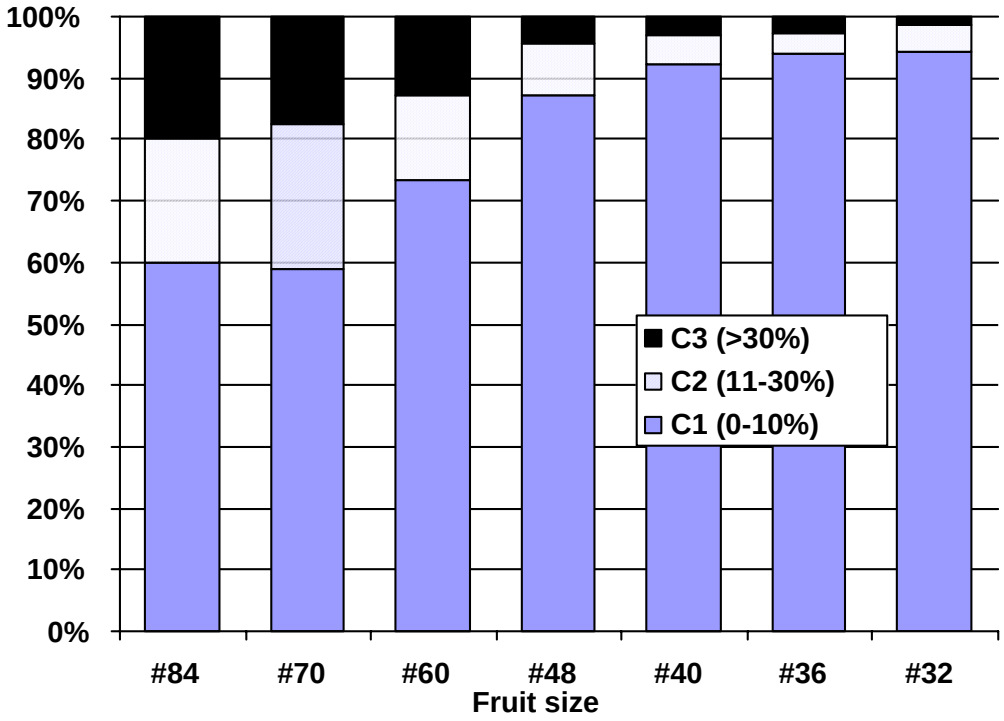
The number of adult avocado thrips pre-treatment ranged from 0.7-1.3 per leaf; this number decreased within one week for all applications and remained below 0.5 per leaf for 50 days with Agri-Mek and 20 days with Success (data not shown). Numbers of natural enemies pre-treatment ranged from 0.8-1.4 per leaf and this number decreased below 0.5 per leaf within one week with backpack applications. Most of the natural enemies observed in all plots were *Euseius tularensis*, a predatory mite which can have some impact on avocado thrips and other mites found on avocado. For Agri-Mek and Success applications by air, natural enemy numbers dropped below 0.5 per leaf after 2 weeks. For all applications (including the control) natural enemy numbers did not reach pre-treatment level again during the observation period (data not shown). Figure 7 shows the result of field grading 20 fruit from each of the 6 data trees in each plot (20 fruit x 6 trees x 3 replicate plots = 360 fruit in total per treatment) for the percent surface area scarred by avocado thrips. Similar to the Fallbrook prebloom trial, our guess was that fruit with 0-10, 11-30, and >30% of their surface scarred might be graded as Grade 1, 2, and 3, respectively so scarring "classes" 1, 2, and 3 were defined in this manner. Using this classification, 76, 94, 95, 99, 98, and 90% of the fruit in the Success Air 10 oz, Success BP 10oz, Success Air 10 oz 2x, Agri-Mek 20 oz Air, Agri-Mek 20 oz BP and control, respectively, were placed in Class 1. There was no statistical difference in scarring levels when comparing the same materials applied by air or backpack, with the exception of the single Success application by air, which resulted in higher scarring levels than with all other treatments including the control. Agri-Mek applications resulted in less scarring than was seen in the control plots, while the remaining Success treatments did not differ from the control.

Fig. 7. Santa Paula Fruit Set Trial: Percentage Fruit Scarring Versus Treatment



As seen in the Fallbrook prebloom trial, we noticed that very few severely scarred fruit were large. Figure 8 shows the percent of fruit in the fruit set trial in Class 1, 2, and 3 that were of sizes 84 to 32, and shows a strong negative correlation between fruit size and scarring. Very few class 3 fruit (>30% of surface area scarred) were large.

Fig. 8. Santa Paula Fruit Set Trial: Distribution of Fruit Scarring Versus Fruit Size



Conclusions, Fallbrook Prebloom Trial. The Fallbrook trial was designed to provide a strong challenge to the early, prebloom (early anthesis) Agri-Mek spray concept. Despite thrips levels on leaves not exploding to high levels as we have seen in several other studies, we believe we accomplished this objective. Helicopter treatments were applied 24 March 2001, approximately 50 days before fruit set (fruit set occurred approximately May 14, 51 days after the 24 May helicopter treatment). With this long period between treatment and the presence of fruit susceptible to thrips damage, the Agri-Mek treatments remained remarkably effective. Our conclusion is that Agri-Mek treatments, if applied properly, can suppress avocado thrips population growth for 60-80 days. We suggest that growers work with a knowledgeable pest control advisor and read and follow the label (e.g., regarding the presence of honey bees). If label restrictions allow, the ideal timing for Agri-Mek treatments would be closer to fruit set than was used in our trial (i.e. during peak or late bloom). With this later timing, it is unlikely that a second spray would be required in most situations. Very few pesticides effective against avocado thrips are likely to become available in the near future. With Agri-Mek and Success being of similar chemistries, it is wise to limit treatments of either material to a single application per year. Growers using multiple applications of these materials are more likely to develop resistance in their groves, resulting in relatively few future options for effective thrips control.

Based on the Fallbrook prebloom study, it appears that the backpack sprayer is not effective in treating large avocado trees (i.e. trees of 25-35 foot height). This is consistent with a previous study run in Ventura County, which evaluated the backpack sprayer on trees of various sizes and concluded that good spray coverage could be achieved on trees up to 15-20 feet in height (Hoddle et al. 2001). With trees taller than this, our data suggest that thrips survive in the upper portions of the tree and lead to considerable fruit scarring (close to the level seen in the untreated control plots). We believe that ground spraying for avocado thrips control can be extremely effective but that better spray coverage (for trees taller than 15') than that achieved with the backpack sprayer is needed. Such coverage could be achieved with a hand spray gun attached to a pump providing 300 psi or more pressure.

Leaf infestation and fruit scarring data from the Fallbrook prebloom trial showed little difference between plots treated with 10 versus 20 oz of Agri-Mek by air. Previous trials comparing these rates showed slightly better control with 20 oz than with 10 oz. Based on label restrictions, no less than 10 oz per acre should be used. Our opinion is that low levels populations might be treated with 10 oz per acre but that it is probably wise to use 15-20 oz per acre in situations where avocado thrips levels are high (i.e. > 5 immature thrips per fruit).

Conclusions, Santa Paula Fruit Set Trial. Based on the fruit set trial results, the backpack sprayer is effective in treating avocado trees of 15 ft in height. The trial also showed that applications with the backpack sprayer covered a larger area on the underside of leaves and had a more rapid impact on thrips populations than did helicopter applications. These performance differences in backpack and aerial sprays did not result in a difference in fruit scarring, which is probably because fruit set occurred 4 weeks after application; by that time, aerial sprays had also suppressed thrips populations. The grove did not need a second application later during the season and this suggests that applications several weeks before fruit set are sufficient to reduce thrips numbers for the season.

The results with Success in this trial showed that the timing of application is more critical with this material than with Agri-Mek. Agri-Mek suppressed thrips levels for 40 days, long enough to last through fruit set and development to "golf ball" size fruit. Success suppressed thrips for a shorter period. When the thrips population resurged, natural enemies were absent (as a result of treatments), they could not assist with thrips suppression, and thrips numbers increased exponentially for 3 weeks. In our opinion, this suggests that Success timing is critical and when applied too early, may result in more fruit damage than not treating at all. A double Success application, timed three weeks apart, was not effective in suppressing thrips numbers as well as a single Agri-Mek application. We believe that two Success applications timed closer together may perhaps give better results, but for resistant management purposes, we do not recommend more than one treatment of Agri-Mek or Success (combined) per year. Therefore, we suggest using Success no earlier than 1-2 weeks before fruit set and using Agri-Mek for earlier applications when thrips levels in the orchard warrant treatment.

Acknowledgements

A number of persons and organizations provided essential assistance in performing the trials described in this report. Special thanks is due all of the following: Steve Peirce and Guy Witney of the California Avocado Commission helped arrange numerous aspects of the trials; Matt Hand and Mark Nyberg of Southern California Entomology and Tom Roberts of Integrated Consulting Entomology helped in grove selection and in making treatment timing decisions; helicopter treatments were applied by Pacific Rotors, Fallbrook and Aspen Helicopters, Ventura; Syngenta Crop Protection, Inc. and Dow AgroSciencies LLC provided pesticides used in the trials; L&M Fertilizer in Temecula was accommodating in renting field equipment; Steve Duey, Mike Fahr, and Gus Gunderson provided field sites where the trials were performed; A&G Grove Service provided field labor which allowed us to individually harvest data trees in Fallbrook; Bryan Carey, Paul Flores, Steve Martin, Christine Payne, Lindsay Robinson, John Rodgers, Gilly Sherman, and Pamela Watkins provided technical assistance in field counts and during the fruit harvest; and West Pak Avocado, Inc. in Temecula was most helpful in individually grading fruit from separate research plots in the Fallbrook spray trial. This research was supported in part by grants from the California Avocado Commission.

References Cited

Hoddle, M. S., J. G. Morse, P. Phillips, B. Faber, and P. Oevering. 2001. Recent progress on avocado thrips biology and management. pp. 5-18. In: Proceedings, California Avocado Commission Research Symposium, October 20, 2001, California Avocado Commission, Santa Ana, CA.