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Avocado Thrips Subproject 2: Pesticide Evaluations and Phenology in the Field

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Benefits to the Industry

This is the second year of field monitoring of the new avocado pest, and the field dynamics of avocado thrips in response to temperature, humidity, leaf flush and fruit set are somewhat better understood now. Also, natural enemy impact, and interaction of other factors, such as persea mite damage and management practices on thrips populations are better known. This increased knowledge on the basic biology of the thrips and its natural enemies in the field, the effectiveness of different pesticides on thrips population growth and natural enemy survivorship is greatly helping with management strategies for this pest.

Objectives

The objectives of the field studies conducted in Ventura County have been:

1. Conduct field pesticide efficacy studies with sabadilla and other registered and unregistered materials for control of avocado thrips.
2. Monitor the phenology of avocado thrips at 3 sites in Ventura County. Specially, the movement and densities of thrips on foliage, bloom, fruit and soil over the course of 1 year.
3. At each study site, the presence and densities of natural enemies and the impact on avocado thrips.
4. Evaluate the interaction between persea mite infestations and avocado thrips damage.
5. In cooperation with Hoddle, monitor the impact of field releases of commercially available natural enemies identified from laboratory studies or collected from foreign exploration efforts.
6. Evaluate various practices (such as fertilization, irrigation and pruning) which might reduce avocado thrips levels and severity of damage.

Summary

Pesticide screening. A pesticide screening trial conducted in June, July and August at two locations provided excellent information on pesticide efficacy. At one site, the softer, more environmentally benign products, sabadilla + sugar, Agri-Mek + NR 415 oil and NR oil alone, all gave excellent knockdown (Table 1). These materials were also softer on beneficials (Table 2). The more broad-spectrum and environmentally harsh products, such as Baythroid and malathion gave better knockdown, but also resulted in elevated persea mite populations, several weeks post-treatment. This was also true of the NR 415 oil, as well after 8 weeks (Table 3).

At the second test site, although the results were more varied (as were tree vigor and thrips populations), they were similar to the first site.

On the basis of the ground spray results, an aerial spray by helicopter using either NR 415 Oil, Agri-Mek (10 oz/ac) + NR 415 Oil, or Agri-Mek (20 oz/ac) + NR Oil. These were applied in two 25 gal/ac passes. The results indicated no knockdown whatsoever, and spray cards in the field at the time of application indicated very little coverage (Table 4).

Based on these initial results, the application was reapplied using in NR 415 Oil, Agri-Mek (20 oz./ac) + NR 415 Oil and Baythroid, but at 100 gals/ac. This time all three treatments gave good knockdown of the thrips. Sufficient wind turbulence provided under-leaf coverage as verified by spray cards (Table 4). After 20 DAT, however, persea mite populations began rising in the NR 415 Oil and Baythroid treatments (Table 5), resulting in significant defoliation. Oil has been used successfully to control persea thrips by air, and why it is causing a persea flair up in conjunction with avocado thrips is unclear.

Even though, Agri-Mek + NR 415 Oil has given the best results , it is imperative that adequate coverage is obtained to be effective. Gallonage trials (i.e. coverage) are planned for this year, hi the meantime, to reinforce a Section 18, fruit residue studies were successfully performed.

Our pesticide treatment scenarios study was conducted in the Las Posas Valley. Our attempt was to learn which of the following treatment strategies was best:

1. Sabadilla only starting pre-bloom.
2. Sabadilla only starting post-bloom.
3. Starting post-bloom with sabadilla followed by NR 415 Oil for the second application.

The study was severely compromised by several factors. First, the post-bloom treatments were actually made at early bloom at the grower and his PCA's discretion. Second, and most important, significant lack of efficacy resulted from several of the treatments, suggesting a serious problem with spray coverage. Third, we experienced significant fruit drop after the oil treatment. This was unexpected considering our previous experience with late season oil sprays for persea mite several years ago. We saw no phytotoxicity at that time from very high rates of oil (8-18%).

Although we were unsuccessful in accomplishing the original goal of this trial, we have gained valuable information. First, we need to avoid the application of NR 415 Oil over young fruit and reserve it's use for pre-bloom of late season. Second, we now are convinced there is a serious problem with aerial spray coverage industry-wide. This is a major explanation for the erratic results reported by PCA's using sabadilla these past two seasons. The coverage problem is confirmed by the previous aerial sprays using Agri-Mek and Baythroid.

Seasonal development and behavior. Biological monitoring of avocado thrips and its predators in untreated grower-cooperator orchards has continued all season long at three sites, Carpinteria, Somis, and Moorpark. At all sites, avocado thrips has a slower start this season compared to last season. PCA's and growers at other commercial avocado orchards had great difficulty in predicting the best timing for pesticide applications due to the erratic weather, the protracted bloom period, and the resultant unpredictable thrips populations. The avocado thrips populations varied greatly at all three sites, as well as the predator complex and fruit scarring.

The peak avocado thrips activity coincides with foliar flushes during the year (Graph 1). This activity corresponds to a high of 1.3 thrips per leaf in Moorpark, 12.8 in Somis and 13.8 in Carpinteria for the month of March. The second peak occurred in mid-June to late June for Moorpark - 3.I/leaf, Somis - 16.5, and Carpinteria - 12.2. This level of thrips activity has resulted in 7%, 69% and 48% scarring in this year's fruit for the respective sites. For these respective sites, the packouts for last year were 5% #2, 17% #2 and 10% #2.

1999 crop damage looks to be twice as high as last year, possibly due to wet/cool spring extending the growth flush period and providing nearly unlimited soft tissue for thrips feeding. This flush hardened off just as this year's crop was setting, creating tremendous pressure on young fruit as the thrips began feeding on the new, softer tissue. Moorpark was the most stable plot over the year with the lightest thrips pressure. Thrips populations tapered off quickly in Moorpark and Somis in mid- to late August when fruit size and foliage hardened off. At Carpinteria, the thrips remained active until mid-September. The fruit and foliage were later in hardening off at this site.

Leaf duff sampling for predators and thrips pupae has fielded some interesting information. We have found that thrips pupation in the leaf duff occurs primarily (85%-100%) in the upper one third (2") of the duff layer which is generally quite dry. This was true even during the hottest part of the summer. Most potential predator populations (75%-100%) occurred in the same layer. This behavior may have strong implications regarding our ability (inability) to manage thrips at the soil/leaf duff arena with an inoculative or inundative biological control strategy (e.g. entomophathogenic fungi or nematodes). Timing of such applications may be necessary immediately following an irrigation or rain.

Natural enemies. A lacewing release trial was intimated in July in Santa Paula. Release rates of 100 and 1000 *C. carnea* larvae per tree every two weeks for a total of five releases were compared to NR 415 Oil treatment and an untreated check. After 4 weeks, the 1000 larvae per tree treatment was significantly different from the check, with slightly lower thrips populations. After this time, thrips populations began declining rapidly in all plots and differences between treatments were negligible. More significantly was that at the highest rate of lacewing release, persea mite populations were reduced.

At $1.50 per 1000 for lacewing larvae, the small reduction resulting from multiple releases at a cost of $150 per acre per release plus labor is certainly not cost effective. We did experience some quality control problems from the insectary with several of the early releases which may have compromised the results somewhat.

Most important things learned this season were:

1. Thrips viability and population dynamics are negatively impacted by several days' exposure to temperatures exceeding 95°F couples with low relative humidity (Hoddle's research at UCR, verified by our local field biology plots). This also tends to coincide with lack of tender tissue as food source.
2. Aerial applications are generally unsuccessful when helicopters apply thrips materials in 25-35 gpa, even on small trees.
3. Agri-Mek is the best candidate product to rotate with sabadilla for avocado thrips management.
4. A likely future treatment strategy for thrips might be a pre-bloom (and thus pre-fruiting) treatment with NR 415 Oil, followed by a sabadilla treatment at fruit set, followed by a later treatment of Agri-Mek (if needed) which would also help with persea mite. Under high thrips pressure, the Agri-Mek might be used at fruit set followed by sabadilla if needed for further fruit protection. Late season mites could be picked up by either NR 415 Oil or Agri-Mek.

Table 1
1998 Avocado Thrips Ground Spray Trial:

Mean Number of Larval Thrips per Leaf

Rate	**6/1 d-4**	**6/8 d+3**	**6/15 d+10**	**6/19 d+14**	**6/26 d+21**	**7/3 d+28**	**7/10 d+35**	**7/17 d+42**	**7/24 d+49**	**7/31 d+56**
0.1 lb ai/a	11.23a	0.57a	3.42a	3.45a	0.35a	0.67a	2.85a	8.32a	13.73a	10.88a
10 fl. oz. 1%	12.27a	13.57b	12.42cd	24.18bc	3.90b	3.65b	9.42a	13.92b	16.07a	7.92a
15 lb 10 lb	11.27a	2.32b	12.77de	33.75cd	8.87cd	17.98c	26.22a	15.73bc	--	9.87a
5 gal/a	11.53a	16.50b	18.05e	41.62d	28.53e	27.02c	30.53a	--	--	6.67a
1.5 pts./a	11.97a	4.25b	10.93b	18.85b	6.77bc	6.20b	20.45a	--	--	7.47a
	10.88a	24.27b	17.38de	37.72cd	15.55de	18.68c	22.90a	24.07c	19.63a	6.57a

Table 2
1998 Avocado Thrips Ground Spray Trial:

Mean Number of Predators per Leaf

Treatment	Rate	6/1 d-4	6/8 d+3	6/15 d+10	6/19 d+14	6/26 d+21	7/3 d+28	7/10 d+35	7/17 d+42	7/24 d+49	7/31 d+56
Baythroid 2 EC	0.1 lb ai/a	0.17a	0.00b	0.00a	0.00c	0.00a	0.00a	0.00a	0.03a	0.03b	0.00a
Agri-Mek 0.15 EC + NR 415 Oil	10 fl. oz. 1%	0.13a	0.40a	0.12a	0.12bc	0.10a	0.15a	0.10a	0.07a	0.33a	0.03a
Vertran-D + Sugar	15 lb 10 lb	0.20a	0.38a	0.13a	0.33a	0.08a	0.12a	0.08a	0.08a	--	0.05a
NR 415 Oil	5 gal/a	0.33a	0.62a	0.40a	0.25cb	0.07a	0.03a	0.08a	--	--	0.07a
Malathion	1.5 pts./a	0.20a	0.40a	0.17a	0.03c	0.00a	0.02a	0.08a	--	--	0.02a
Untreated Control		0.13a	0.50a	0.51a	0.52a	0.08a	0.20a	0.08a	0.03a	0.27a	0.05a

Five year-old "Hass" avocado trees. Statistical separation is by Duncan's MRT after log(n+1) transformation, p=0.05.

Table 3
1998 Avocado Thrips Ground Spray Trial:

Mean Number of Persea Mites per Leaf

Treatment	**Rate**	**6/1 d-4**	**6/8 d+3**	**6/15 d+10**	**6/19 d+14**	**6/26 d+21**	**7/3 d+28**	**7/10 d+35**	**7/17 d+42**	**7/24 d+49**	**7/31 d+56**
Baythroid 2 EC	0.1 lb ai/a	0.00a	0.00a	0.08a	0.12a	0.05a	0.30a	1.37a	1.58a	3.77a	6.22a
Agri-Mek 0.15 EC + NR 415 Oil	10 fl. oz. 1%	0.08a	0.00a	0.02a	0.02a	0.03a	0.00a	0.58a	0.12a	1.32a	2.80a
Vertran-D + Sugar	15 lb 10 lb	0.08a	0.02a	0.05a	0.03a	0.22a	0.28a	1.37a	2.85a	--	9.13a
NR 415 Oil	5 gal/a	0.08a	0.27a	0.08a	0.12a	0.03a	0.25a	1.17a	--	--	1.10a
Malathion	1.5 pts./a	0.00a	0.83b	0.03a	0.07a	0.05a	0.13a	1.53a	--	--	4.38a
Untreated Control		0.08a	0.15a	0.13a	0.12a	0.08a	0.20a	0.97a	1.95a	4.98a	10.00a

Five year-old "Hass" avocado trees. Statistical separation is by Duncan's MRT after log(n+1) transformation, $p=0.05$.

TABLE 4
1998 Aerial Spray Trial
Avocado Thrips Larvae per Leaf

North Block

	1st Aerial (6/5)				2nd Aerial (6/20)									
Treatment	**Rate**	**6/4 d-1**	**6/8 d+3**	**6/12 d+7**	**Retreat**	**6/22 d+2**	**6/26 d+6**	**7/3 d+13**	**7/10 d+20**	**7/17 d+27**	**7/24 d+34**	**7/31 d+41**	**8/7 d+48**	**8/12 d+53**
Untreated Control		10.9a	20.8a	44.8a	Same	26.7a	17.6a	26.9a	4.8ab	7.9a	10.1a	6.9bc	7.8bc	6.3a
NR 415 Oil	2 gpa	15.7a	20.8a	52.4a	Same	10.2b	17.9a	28.6a	9.2a	14.2a	NA	8.3ab	7.0bc	2.1b
Agri-Mek 0.15 EC + NR 415 Oil	10 fl. oz. 1 gpa	10.7a	17.8a	33.7a	20 fl. oz. 1 gpa	2.1c	4.6b	8.8b	1.9b	0.7c	9.5a	4.8bc	4.8c	1.6b
Agri-Mek 0.15 EC + NR 415 Oil	20 fl. Oz. 1 gpa	12.2a	32.6a	38.6a	Baythroid 2.0 EC 0.1 lb ai/a	0.9d	1.5c	5.9c	1.0c	2.8b	5.8b	12.3a	12.6a	2.8b

South Block

	1st Aerial (6/5)				2nd Aerial (6/20)									
Treatment	**Rate**	**6/4 d-1**	**6/8 d+3**	**6/12 d+7**	**Retreat**	**6/22 d+2**	**6/26 d+6**	**7/3 d+13**	**7/10 d+20**	**7/17 d+27**	**7/24 d+34**	**7/31 d+41**	**8/7 d+48**	**8/12 d+53**
Untreated Control		10.9a	20.8a	44.8a	Same	26.7a	17.6a	26.9a	4.8a	7.9a	10.1b	6.9a	7.8a	6.3a
NR 415 Oil	2 gpa	11.1a	16.6a	29.9b	Same	10.9b	13.6a	21.7a	3.8a	5.6ab	NA	6.1a	5.2a	1.6bc
Agri-Mek 0.15 EC + NR 415 Oil	10 fl. oz. 1 gpa	12.4a	16.1a	33.8cb	20 fl. oz. 1 gpa	3.2c	4.8b	6.5b	0.5b	1.1c	3.8c	2.3c	2.5a	1.0c
Agri-Mek 0.15 EC + NR 415 Oil	20 fl. Oz. 1 gpa	9.9a	21.2a	41.4ab	Baythroid 2.0 EC 0.1 lb ai/a	2.1c	1.4c	5.7b	0.6b	3.1b	22.4a	4.4b	6.0a	1.7b

TABLE 5
1998 Aerial Spray Trial
Persea Mites per Leaf

North Block

		1st Aerial (6/5)		2nd Aerial (6/20)										
Treatment	**Rate**	**6/4 d-1**	**6/8 d+3**	**6/12 d+7**	**Retreat**	**6/22 d+2**	**6/26 d+6**	**7/3 d+13**	**7/10 d+20**	**7/17 d+27**	**7/24 d+34**	**7/31 d+41**	**8/7 d+48**	**8/12 d+53**
Untreated Control		0.00a	0.00a	0.00a	Same	0.00a	0.03a	0.00a	0.03a	0.05a	1.30a	0.77a	1.08a	1.98a
NR 415 Oil	2 gpa	0.00a	0.13a	0.80b	Same	0.33a	0.32a	0.10a	3.38bc	9.52bc	9.52b	7.95bc	7.35bc	11.32c
Agri-Mek 0.15 EC + NR 415 Oil	10 fl. oz. 1 gpa	0.00a	0.01a	1.13b	20 fl. oz. 1 gpa	0.18a	0.35a	0.73a	2.57b	2.57b	7.82b	6.50b	3.53b	3.72b
Agri-Mek 0.15 EC + NR 415 Oil	20 fl. Oz. 1 gpa	0.00a	1.07b	4.03b	Baythroid 2.0 EC 0.1 lb ai/a	1.22b	1.37a	2.92b	9.05c	25.08c	27.30c	22.25c	26.27c	24.88d

South Block

		1st Aerial (6/5)		2nd Aerial (6/20)										
Treatment	**Rate**	**6/4 d-1**	**6/8 d+3**	**6/12 d+7**	**Retreat**	**6/22 d+2**	**6/26 d+6**	**7/3 d+13**	**7/10 d+20**	**7/17 d+27**	**7/24 d+34**	**7/31 d+41**	**8/7 d+48**	**8/12 d+53**
Untreated Control		0.00a	0.00a	0.00a	Same	0.00a	0.03a	0.00a	0.03a	0.05a	1.30a	0.77a	1.08a	1.98a
NR 415 Oil	2 gpa	0.00a	0.00a	0.80b	Same	1.10b	0.13a	0.18a	4.65c	13.48c	13.48bc	22.0c	15.05c	14.63b
Agri-Mek 0.15 EC + NR 415 Oil	10 fl. oz. 1 gpa	0.00a	0.00a	1.13b	20 fl. oz. 1 gpa	0.30ab	0.13a	0.08a	0.37b	1.70b	5.12b	3.78b	3.90b	3.53a
Agri-Mek 0.15 EC + NR 415 Oil	20 fl. Oz. 1 gpa	0.00a	0.00a	4.03b	Baythroid 2.0 EC 0.1 lb ai/a	2.05b	1.37b	0.72a	2.92c	7.80c	24.43c	23.70c	17.22d	13.28b

6 tree subsamples per treatment, 10 leaves counted per tree

Graph 1: Populations of Avocado Thrips and Predatory Thrips