Project Number 78-E5

ENCLOSURE 8

INVESTIGATIONS ON CONTROL OF THE NAVEL ORANGEWORM ON ALMONDS - 1978

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Summary of Results of Navel Orangeworm and Mite Studies, 1978

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These investigations were conducted in Kern County.

(a) The pyrethroids Ambush and Pydrin consistently out-performed other materials in control of navel orangeworm, but they lack registration at present.

(b) The use of Guthion 60 days before harvest continues to perform well against navel orangeworm as compared with all other registered treatments. It is often convenient to combine control of web-spinning mites with this timing, an added advantage. This timing does not provide suppression of peach twig borer.

(c) Results in 1978 with Imidan at hullsplit were superior to Sevin.

(d) Damage to pollinator varieties subject to heavy infestation by navel orangeworm (e.g. Merced) can be reduced, if they are treated (after Nonpareil harvest) during their hullsplit period (preferably by 50% hullsplit).

(e) The insecticide Larvin, a carbamate, though effective on navel orangeworm, required excessive dosages.

(f) In one set of observations, navel orangeworm infestation increased at the rate of 1/2% per day, for each day harvest was delayed.

(g) Applications by speed sprayer were more effective than by helicopter.

(h) In extensive observations in an experiment in 1978, peach twig borer did not appear to significantly influence navel orangeworm infestation. Peach twig borer did not appear to allow pre-hullsplit entry by navel orangeworm in this orchard. Oviposition trials indicate that almonds infested with peach twig borer were not more attractive to navel orangeworm than non-infested nuts.

(i) Navel orangeworm population development in spring was carefully followed with a view toward development of a temperature summation model.

(j) Spider mite infestations were shown to reduce both photosynthetic and transpiration rates using a dual isotope porometer. A portable "chlorophyll meter" appears to provide rapid means of evaluating mite damage to an almond leaf. Experiments were set up to test the effects of various mite damage levels on almond tree productivity.

(k) Aldicarb 15G (Temik) applied in the soil controlled tetranychid mites 58 days after application. Dosages of 1-3 lbs per acre appear to be the most appropriate for future tests.

(l) Trials comparing the effectiveness of UC55304, Zardex, PP-199, Morestan, and Omite against tetranychid mites were conducted. These acaricides were comparable in control 19 days after application. At 31 days all treatments had lost effectiveness.

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Investigations on the Control of the Navel Orangeworm on Almonds - 1978

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This report includes results of investigations comparing hullsplit treatments of various insecticides. Also reported are results from various schedules of Guthion, Imidan and Sevin in replicated large block trials with respect to navel orangeworm control and management of mites. Helicopter application of Guthion was included. Reports are also given on navel orangeworm seasonal development, with a view toward development of a heat summation model, the relationship between navel orangeworm and peach twig borer infestations, the relationship between varied degrees of mite infestation, photosynthesis and transpiration of almond leaves, and vegetative growth and yield, and the performance of acaricides under development.

INSECTICIDE STUDIES

<u>Comparison of insecticides at hullsplit</u>

The following materials were compared in 10 replicated single tree blocks and with full coverage sprays at hullsplit: the pyrethroids Ambush and Pydrin, the organophosphates Imidan and Lorsban, and the carbamates Sevin and Larvin.

Applications were made at 15% hullsplit. A sample taken immediately before treatment showed that a 2½% infestation had already established.

Results are shown in Table 1. Ambush and Pydrin and the high dosage of Larvin gave 65% control, and Lorsban, Imidan and the low

Table 1. Results of replicated experiment on control of navel orangeworm by full coverage sprays at 15% hullsplit, Nonpareils, McFarland, 1978.

Treatment	Formulation	Active ingredient per acre (lb)[1/]	% infested kernels at harvest[2/]
1. Pydrin	2.4EC	0.2	6.3 a
2. Ambush	2.0EC	0.2	7.1 ab
3. Larvin	75W	6.0	7.4 abc
4. Imidan	50W	4.0	9.8 bc
5. Larvin	75W	3.0	10.1 bc
6. Lorsban	50W	4.0	10.5 c
7. Sevin	80W	5.0	16.4 d
8. Untreated	-	-	20.6 e

[1/] Applied by handgun 7/14/78, 800 gal/acre, 15% hullsplit, in 10 replicated blocks of single tree plots.

[2/] Average of 10 samples, 300 nuts each, harvest 8/22/78, treatments not followed by same letter differ at 9/1.

dosage of Larvin gave 50% control. In previous years a 50% wettable powder of Sevin has been used in hullsplit experiments and has consistently provided about 50% control. This year the 80% wettable powder of Sevin was used and provided only 20% control. This differed from other treatments at odds of 99:1. A sample of the formulation used is being analyzed. The two formulations (50W and 80W) will be directly compared in a future trial. Samples of pyrethroid treated almonds were submitted for residue analysis.

Large block experiment

Previous experience has shown that "large" block trials must be conducted in uniform plantings and with replication, if possible. Otherwise, heterogeneity of infestation clouds results. We were fortunate to locate a uniform block with a significant mummy population through the cooperation of Superior Farms. Several comparisons were set up in duplicated blocks of 7 acres each as follows: Guthion in May and 60 days before harvest compared with Imidan in May and at hullcrack, and Sevin at hullcrack. As well, a separate comparison was made with Guthion applied in May by helicopter vs ground rig. Another aspect of this trial was to apply the May treatment on the peak of the large upswing in deposition of navel orangeworm eggs on egg traps.

Fourteen Nonpareil trees in each block were selected at random from the central 40 trees and sampled by shaking onto canvas, mixing, and drawing 250 nuts per tree.

In Table 2 we see that harvest came ahead of its original schedule and the sampling of the Guthion treatment aimed at a 60 day pre-harvest interval actually occurred 48 days after treatment. This treatment performed best, giving a 60% reduction in infestation. Results of the May

Table 2. Comparison of schedules for control of navel orangeworm, Nonpareil, McFarland, 1978.

		Rate[1/]	Schedule[2/]			
	Method of	a.i. per acre	May	July	July	% infested kernels
Applications	application	(lb)	2-3	6	14	at harvest[3/]
1. Guthion 50W "60-days" pre-harvest treatment	Ground	2.0		X		9.9
2. Imidan 50W hullsplit treatment	Ground	3.0			X	16.0
3. Guthion 50W spring treatment	Ground	2.0	X			18.6
4. Sevin 80W hullsplit treatment	Ground	5.0			X	19.1
5. Imidan 50W spring treatment	Ground	3.0	X			24.4
6. No treatment	-	-				25.8

1/ Two replications of 7 acres each. Applications by airblast sprayer in 350 gal/acre. Hullsplit 18% at 7/11/78.

2/ All treatment plots received Omite 6E on 6/12/78 and Plictran 50W on 7/22/78, both applied by helicopter. Mite control was satisfactory in all plots except the 2 treated with Sevin.

3/ Harvested 8/22-23/78. Average of 14 harvest samples; 250 nuts taken at random from each tree.

treatments, as compared with other years, favor the interpretation that sprays should not be applied until after egg deposition has peaked. Applying Guthion at the latter timing in 1976 gave 85% control, while the earlier timing of 1978 with Guthion provided only 30% reduction. Imidan has a shorter residual and was stressed by the early May timing and was not satisfactory when applied at that time. However, Imidan performed better at beginning of hullsplit, giving 40% reduction, at the same or better level of control as Guthion in early May or Sevin at hullsplit.

When Omite has been included with Sevin, good control of mites has resulted. In this experiment, mite control was separately handled by helicopter (see Table 2, footnote 2). Mite control was not satisfactory in the Sevin blocks but was quite adequate in all other treatments. This emphasizes the necessity of adding Omite (or Plictran) whenever Sevin is used, unless mites have been thoroughly suppressed by application with ground equipment.

<u>Effect of delayed harvest</u>

We examined the effect of a 7-day delay in harvest on increase in navel orangeworm damage. Forty trees were selected in the center of a block. Fourteen were harvested at the normal time and 14 trees were harvested seven days later. The trees selected for the earlier or later harvest were chosen at random. The results are shown in Table 3. The rate of change in this block was at ½% increase in navel orangeworm damage per day.

<u>Helicopter vs speed sprayer</u>

The results of this comparison are shown in Table 4. The speed sprayer gave better results.

Table 3. Comparison of infestation of kernels harvested on two dates in navel orangeworm control experiment plots, Nonpareil, McFarland, 1978.

Application	Rate[1/] a.i. per acre (lb)	Schedule July 6	July 14	% infested kernels[2/] on: Aug. 22-23	Aug. 29	Interval (days)	% increase infested kernels	% increase per day
1. Sevin 80W	5.0		X	14.5	17.8	7	3.3	0.5

[1/] Applications by airblast sprayer at 350 gal/acre. Hullsplit 18% on 7/11/78.

[2/] Average of 14 harvest samples; 250 nuts taken at random from each of 14 trees.

Table 4. Comparisons of schedules for control of navel orangeworm by ground and air applications, Nonpareil, McFarland, 1978.

Application	Method of application[1/]	Rate: a.i. per acre (lbs)	Rate: gal per acre	Schedule May 2-3	% infested kernels at harvest[2/]
1. Guthion 50W	Ground	2.0	350	X	10.9
2. Guthion 50W	Air	2.0	20	X	13.6
3. Guthion 50W	Air	2.0	40	X	16.9

[1/] Ground applications by airblast sprayer. Air applications by helicopter, May 2, 1978. Plots were 7-8 acres in size.

[2/] Harvested 8/22-23/78. Average of 14 harvest samples; 250 nuts taken at random from single tree.

Note: All treatment plots received Omite 30W on 6/12/78 and Plictran 50W on 7/22/78, both applied by helicopter. Control satisfactory.

Late Season Control for Navel Orangeworm

Infesting Late Harvested Merceds

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Two separate experiments were performed to determine the effectiveness of Sevin as a late season control for navel orangeworm infesting late-harvested Merceds. Merceds mature after the Nonpareil variety and some orchards are harvested much later than the Nonpareils. During this preharvest interval, increased navel orangeworm pressure and fewer nuts available for attack can cause infestation to rise to high levels.

The first experiment involved a Sevin treatment on Merceds when 60-80% hullsplit and with a low initial navel orangeworm infestation. The second experiment involved a Sevin treatment when Merceds were 80-100% hullsplit with a relatively high infestation at time of treatment.

Materials and Methods

Experiment I.--The seven-year-old orchard used is located near Lerdo Hwy. and Industrial Farm Rd., Kern Co. Trees were planted on a 25x25 foot spacing and were irrigated with a movable sprinkler system. Merceds were alternately planted with Nonpareils in a 1:2 ratio with each row containing 54 trees. Four rows of Merceds were selected for the experiment.

In each of the 4 rows, 5 trees were randomly selected for results of a Sevin treatment and in the same rows, groups of 5 trees were selected as untreated controls. All other Merced trees not involved in the trial were also treated with Sevin.

One day prior to treatment, pre-treatment samples of 100 nuts per tree were taken. These nuts were randomly selected from all heights and from inside and outside the canopy. Samples were refrigerated until infestation could be tabulated. Sevin was applied on Aug. 30, 1978 at a rate of 5.0 lb a.i. (active ingredient) per acre in 500 gal of water, using an airblast sprayer. On Sept. 30, 31 days after treatment, all trees were shaken and nuts raked into piles. One hundred nuts were randomly selected from each tree and refrigerated until examined. Data were analyzed using an unpaired t-test.

Results and Discussion

Table 5 presents the average percent infestation of treated and untreated trees. Analysis of the data shows a significant difference, of 19:1 between the two samples. This difference represents an average increase of 6.8% in uninfested nutmeats for the treated trees and 38% increase of control of navel orangeworm. At $1 per pound for nutmeats, an orchard producing 1000 lb per acre of Merced trees would receive approximately $70 more per acre for nutmeats and $0.04 per lb or $40 per acre more for 6.8% fewer Merced rejects. These values must be measured against application cost. While these vary, it is apparent that Sevin used as a late season control for navel orangeworm on late harvested Merced can be profitable to the grower averaging yields as noted.

Experiment II.--In this experiment the goal was also late season control for navel orangeworm infesting late-harvested Merceds. However, this experiment differed from experiment I in that the Merceds were 80-100% hullsplit and had a relatively high infestation of navel orangeworm at time of treatment.

Table 5.—Control of NOW on Late Harvested Merceds.

	Lbs a.i. per acre	Gal. H_2O per acre	Average percent infestation[3/]: Pretreatment sample 8-29-78	Average percent infestation[3/]: 9-30-78 Harvest 31 days	Percent control
			Experiment I		
Sevin 80W[1/]	5.0	500	5.2	16.8	38[4/]
Untreated Check	-	-	4.9	23.6	-

	Lbs a.i. per acre	Gal. H_2O per acre	Average percent infestation[3/]: Pretreatment sample 8-16-78	Average percent infestation[3/]: 9-13-78 Harvest 29 days	Percent control
			Experiment II		
Sevin 80W[2/]	4.8	380	39.8	62.2	30
Untreated Check	-	-	38.9	70.9	-

[1/] Treatment date 8-30-78.

[2/] Treatment date 8-18-78.

[3/] Percent control equal to:

$$100 - \frac{\text{Average Percent Infestation Increase-Sevin}}{\text{Average Percent Infestation Increase-Untreated Control}}$$

[4/] Based on 2000, nut sample per treatment.

The nine-year-old orchard used is located at Famoso Porterville Hwy. and Hanniwalt, Kern Co. Trees were planted on a 25x25 foot spacing and irrigated with solid set sprinklers. Merceds were alternately planted with Nonpareils and Texas Missions in a 1:2:1 ratio, with every sixth row planted in Merceds. The experimental block consisted of 36 rows of Merceds, each row containing 38 trees. In each of the 36 rows two trees were selected for sampling as to results of treatment, except in rows 18 and 36 where 4 trees were selected from each, for a total of 40 sprayed trees. Untreated control trees consisted of 5 blocks of 4 trees each, totaling 20 trees, the location of which was selected at random. A pretreatment sample was taken from each of the 40 treated trees on Aug. 16, taking 50 nuts per tree. The 20 untreated trees were sampled at the same time, taking 100 nuts per tree. All nut samples were taken from all levels of the trees at random. Samples were refrigerated until examined. The treatment trees were sprayed 2 days following the pretreatment sample with an airblast sprayer at 4.8 lb a.i. of Sevin in 380 gal of water per acre. All other Merceds not involved in the trial were also sprayed with Sevin at this time.

Trees were shaken on Sept. 13, 31 days after treatment. Nuts were raked into piles and sampled at the same rate as in the pretreatment sample.

Results and Discussion

Table 5 presents the average percent infestation of treated and untreated trees at both sampling date. It is apparent that when nuts have an initial infestation of 40% and are approaching 100% hullsplit, little can be gained by treatment with Sevin. The 8.7% reduction in infestation amounts to 30% control of navel orangeworm, and at first glance this reduction might be considered favorable. However, when treated trees are already heavily infested and show a 22.4% increase of navel orangeworm through time, rising from 40% to 62%, economic control is nonexistent. In most situations when infestations exceed 50% the almond crop is no longer acceptable.

Based on this experiment it is apparent that once hullsplit has approached 100% and initial navel orangeworm infestation is high, little can be done to prevent extensive crop damage to late-harvested Merceds. However, the first experiment does indicate that if initial navel orangeworm infestation is relatively low and hullsplit is incomplete, late season treatments with Sevin can be beneficial. Adding information obtained this year to that of other trials of other years, treatment of Merceds (or other later varieties) should preferably be carried out as soon as possible after Nonpareil harvest, preferably when Merced hullsplit is 50% or less.

Benefits from insecticide treatment of Merceds, after Nonpareil harvest, can be considerable, provided that hullsplit of Merceds is still underway, and provided that infestation at time of treatment is relatively low.

Investigations of Navel Orangeworm and Peach Twig Borer Relationships

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The severe damage to almonds by the navel orangeworm and peach twig borer has led to research to determine what factors may be related to infestation rates. One such hypothesis is based upon the possible interaction between navel orangeworm infestations and peach twig borer infestations. The hypothesis suggests that either the pre-hullsplit entry of peach twig borer allows the navel orangeworm to infest the nuts earlier, or the peach twig borer infested nuts are more highly attractive to the navel orangeworm. Through the use of different insecticide applications, an attempt was made to establish different levels of peach twig borer infestations between three blocks within one orchard. If the hypothesis is valid, the following relationship should occur; a high peach twig borer population should result in a high navel orangeworm infestation, as well as the converse holding true. This relationship was tested for both the Nonpareil variety and the later maturing Merced variety.

Materials and Methods

Three blocks of 250 trees each were set up in an almond orchard approximately twelve miles northeast of Shafter, Kern County. The seven-year-old trees were drip-irrigated and planted on a 24'x24' pattern. The orchard consisted of the Nonpareil, Texas Mission, and Merced varieties. In addition, the soil was unusually sandy with evidence of salt toxicity on the pollinator varieties. The orchard was unique in that the heavy rains and winds of the previous winter, in conjunction with birds, had stripped the orchard bare of all mummy nuts. All three blocks received no dormant application due to the heavy rains of the previous winter. A single treatment was applied to two of the three large blocks on May 2. The check treatment received no treatment for navel orangeworm or peach twig borer. Diazinon 50W was applied to the second block at 4 lbs a.i. per acre, at the rate of 350 gallons per acre with a commercial ground rig. Guthion 50W was applied to the third block at 4 lbs a.i. per acre at the rate of 350 gallons per acre.

The orchard was monitored on the dates 5/26, 6/3, 6/17, 6/30, and 7/9 for navel orangeworm activity using Pherecon IV™ oviposition traps as described by Rice, 1976. The traps were hung in the tree approximately six feet high on the northeast corner.

On June 24, just prior to hullsplit, 35 Nonpareil trees were sampled at random throughout all three blocks, at 100 nuts per tree. The trees were partitioned into eight sectors, one division separating the tree at the midpoint into upper and lower regions, as well as along the north, south, east, and west axes. The nuts were taken into the lab to be examined.

On August 7, the Nonpareil variety was shaken by mechanical shakers. On August 8, 100 nuts per tree were sampled from 16 trees, taking 25 nuts from the ground per quadrant. The nuts were cracked open and examined for both navel orangeworm and peach twig borer larvae and pupae.

On August 20, the Merced variety was sampled at 10 trees per block at 100 nuts per tree. Again, all four sides and the upper and lower sectors of the tree were sampled equally. The nuts were kept refrigerated until counts could be made of both larvae and pupae.

Results

Within the 3500 green nuts sampled on June 24, no peach twig borer or navel orangeworm were found. Thus it appears that in this orchard the peach twig borer did not result in any early season damage which allowed pre-hullsplit entry by the navel orangeworm.

Infestation occurred after hullsplit as shown by samples taken at harvest. The association between navel orangeworm and peach twig borer was first examined within a single block to insure block homogeneity. The individual nut was considered the statistical sample unit with a mean percentage infestation being developed for every tree. The percent of nuts with peach twig borer that are infested by navel orangeworm was compared to the percent of non-peach twig borer infested nuts that are infested by navel orangeworm, as shown in Table 6. A nut was considered infested if either a larvae or pupa was found in either the hull or nut-meat. The Guthion block did not lend itself to this type of analysis due to its low peach twig borer population. Within the Nonpareil variety, the check block showed no significant differences between its navel orangeworm infestation of 6.7% in peach twig borer infested nuts and 11.9% in non-peach twig borer infested nuts using a completely random design, ANOVA. The Diazinon block did, however, show a significant difference between its percent navel orangeworm infestation of 0% in peach twig borer infested nuts and 4.8% in non-peach twig borer infested nuts. Within the Merced variety, the check block showed a significant difference between its navel orangeworm infestation in the peach twig borer infested nuts, 13.7%, and non-peach twig borer infested nuts, 29.4%. The Diazinon treated block exhibited no significant difference between the percent navel orangeworm infestation in either peach twig

Table 6. Mean % navel orangeworm infestation in peach twig borer and non-peach twig borer infested nuts at harvest.

Variety	Mean % NOW in PTB infested nuts[4/]	Mean % NOW in non-PTB infested nuts[5/]
Nonpareil[1/]	6.7 a[3/]	11.9 a
Nonpareil[2/]	0 a	4.8 b
Merced[1/]	13.7 a	29.4 b
Merced[2/]	22.6 a	26.0 a

[1/]No treatment (check).

[2/]Sprayed with Diazinon 50W on 5/2/78.

[3/]Means in the same row followed by different letters are significantly different using completely random design ANOVA (P = .05).

[4/]Mean % navel orangeworm infestation in peach twig borer infested nuts, calculated as follows: $\frac{\text{\# nuts with PTB + NOW}}{(\text{\# nuts PTB + NOW}) + (\text{\# nuts w/PTB only})}$

[5/]Mean % navel orangeworm infestation in non-peach twig borer infested nuts, calculated as follows: $\frac{\text{\# nuts NOW only}}{(\text{\# nuts NOW only}) + (\text{uninfested nuts})}$

borer infested nuts or non-peach twig borer infested nuts, 22.6% and 26.0% respectively.

The above values suggest either the peach twig borer infestation does not significantly influence navel orangeworm infestation, as shown by the lack of statistically significant difference in means, or some antagonistic effect. Contrary to the hypothesis which would predict a higher percent infestation by navel orangeworm in the peach twig borer nuts, the converse of a lower percentage navel orangeworm infestation in peach twig borer infested nuts occurred in all four situations; this difference proving twice to be statistically significant.

The association was also looked at for differences between blocks. Again, the hypothesis would predict that the block with the highest peach twig borer infestation would have the highest navel orangeworm infestation. The mean percent navel orangeworm infestation in the nutmeats was compared between blocks, as well as the mean percent peach twig borer infestation in either the hull or the meat.

Because of the non-replicated nature of the blocks, differences between blocks cannot be completely ruled out, thus making the analysis more difficult. Due to the lack of mummy nuts from the previous season, the initial infestation of navel orangeworm within each block was non-existant, and therefore identical. Therefore, the navel orangeworm infestation must have resulted from the immigrating navel orangeworm population only. The navel orangeworm flight activity appears to be homogeneous between blocks with no significant differences detectable using completely randomized block design, ANOVA (Table 7). Because of the evidence for block homogeneity given above, a completely randomized block design ANOVA was used for interpreting the block infestation rates.

Table 7. Average number navel orangeworm per trap.

	Sampling Date				
Treatment	5/26[1/]	6/3[1/]	6/17[2/]	6/30[2/]	7/9[2/]
Check	6.3 a[3/]	6.9 a	3.2 a	1.8 a	2.3 a
Diazinon 50W	8.2 a	8.1 a	2.5 a	.53 a	2.1 a
Guthion 50W	11.5 a	4.9 a	2.3 a	2.1 a	3.1 a

[1/]Based on 10 traps per treatment.

[2/]Based on 15 traps per treatment.

[3/]Means in the same column followed by a different letter are significantly different using completely randomized design ANOVA (P = .05).

Within the Nonpareil sample of 8/7, as shown in Table 8 , the peach twig borer populations were statistically different from each other, with the check treatment having the highest infestation of 4.9%, followed by Diazinon with 2.9%, and Guthion with 0.1%. The navel orangeworm populations also showed significant differences between blocks at the 0.05% confidence level. The check block, having a navel orangeworm infestation of 8.4%, is significantly different from Diazinon and Guthion which are 3.4% and 3.9%, respectively, using Duncan's New Multiple Range Test. However, despite a significant difference between the Diazinon and Guthion blocks peach twig borer populations, no such differences were found between their navel orangeworm populations.

The Merced variety obtained the desired range of peach twig borer infestation levels between blocks. The check block had an infestation of 53% in the hull or meat, Diazinon with 26.4%, and Guthion with 0.2%. All three values are statistically different from each other as shown in Table 9.

Despite the dramatic differences in peach twig borer infestations, the navel orangeworm populations were not significantly different, with the check block having 9.9%, Diazinon block with 9.8%, and the Guthion block with 14.6%.

Oviposition Trial

The possibility of differential attractiveness between peach twig borer infested nuts and non-peach twig borer infested nuts to navel orangeworm was tested with the bioassay technique developed by Andrews and Barnes, 1977. The hypothesis of a relationship between peach twig borer and navel orangeworm infestation would suggest that peach twig borer infested nuts would be more highly attractive to the navel orangeworm

Table 8. Infestation levels of navel orangeworm and PTB in Nonpareil variety[4/], R-13 Superior Farms, 1978.

Application	Rate a.i. per acre (lbs)[1/]	% infested kernels[2/] navel orangeworm	% infested nuts[3/] peach twig borer
Check	-	8.4 a[5/]	4.9 a
Diazinon 50W	4.0	3.4 b	2.9 b
Guthion 50W	4.0	3.9 b	0.1 c

[1/] All treatments applied on 5/2.

[2/] % navel orangeworm in nutmeat only.

[3/] % PTB in nut (meat and hull).

[4/] Harvested 8/7.

[5/] Means followed by a different letter in the same column are statistically different using Duncan's New Multiple Range Test, ANOVA at the .05 level.

Table 9. Infestation levels of navel orangeworm and PTB in Merced variety[4/], R-13 Superior Farms, 1978.

Application	Rate a.i. per per acre (lbs)[1/]	% infested kernels navel orangeworm[2/]	% infested nuts peach twig borer[3/]
Check	-	9.9 a[5/]	53.3 c
Diazinon 50W	4	9.8 a	26.4 b
Guthion 50W	4	14.6 a	0.2 a

[1/]All treatments applied 5/2.

[2/]% navel orange in nutmeat only.

[3/]% PTB in nut (meat and hull) only.

[4/]Harvested 8/20.

[5/]Means followed by a different letter in the same column are statistically different using Duncan's New Multiple Range Test at the .05% level.

for oviposition than non-infested nuts.

Materials and Methods

A 6' high x 6' wide x 10' long fine-meshed, nylon cage was set up on a grassy strip near several cotton fields on the U.S.D.A. Research facility in Shafter, Kern County. Four Pherecon IV™ navel orangeworm oviposition traps were hung near each corner in a 2x2 Latin square design. Almonds were collected from a local orchard and allowed to emerge under a pyramidal cage. The moths were collected the following morning after emergence, thus producing approximately 100 1-day-old moths. These moths were then gently transferred to the field cage and allowed to oviposit on the test ovipositional traps for 1 or 2 nights.

On the nights of 9/4-9/5 and 9/15-9/16, two of the traps were filled with a bran bait (Rice, 1976) while the remaining two traps were left unbaited. On the nights of 9/9-9/10, 9/10-9/12, 9/12-9/14, and 9/16-9/18, two of the traps were filled with Merced almonds which were non-infested, the remaining two traps were filled with field-collected Merced almonds which were infested with peach twig borer larvae. All four traps were approximately equal in weight and volume. Results are shown in Table 10.

Results

The efficacy of the cage was retested using the bran as a known attractant. The traps baited with bran were approximately 2.4X as attractive as non-baited traps, this difference proving to be statistically significant using an unpaired t-test.

In contrast, the nuts infested with peach twig borer larvae did not show any differential attractiveness from the non-infested nuts, with

Table 10. Mean number of NOW eggs per trap with variously baited traps.

	# of eggs/trap													
	9/4-9/5		9/9-9/10		9/10-9/12		9/12-9/14		9/15-9/16		9/16-9/18			
Replicate	1	2	1	2	1	2	1	2	1	2	1	2	$\bar{X}$	$\bar{X}$
Non-infested nuts	-	-	3	1	14	9	82	112	-	-	124	191	67 a	
Nuts with peach twig borer	-	-	6	3	16	7	52	210	-	-	95	161	70 a	
Bran attractant[1/]	33	79	-	-	-	-	-	-	158	171	-	-		110.2 a
Non-Baited	49	10	-	-	-	-	-	-	67	60	-	-		46.5 b

[1/] Bait attractant prepared according to Rice, 1976.

[2/] Means followed by a different letter in the same column are significantly different using an unpaired t-test at .05 confidence level.

means of 67 and 70 eggs per trap respectively.

Conclusions

The relationship between peach twig borer and navel orangeworm is difficult to quantify as demonstrated by the varying results of the preceding experiments. There appears to be little influence on navel orangeworm populations by the peach twig borer. However, further studies should be initiated using replicated blocks with a portion receiving a dormant application to selectively destroy peach twig borer infestations and the remaining blocks receiving no dormant application.

Progress Report

Temperature Summation for Navel Orangeworm Development

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At the present time, the navel orangeworm is the major recurring pest in the southern San Joaquin Valley. This pest is difficult to manage successfully. A single insecticide application applied during spring emergence of the adults will reduce nutmeat infestation, however, the results of this control measure vary from year to year. This variation can probably be attributed to the difficulty in properly timing the spring spray; that is, applications are too early or late to best control newly hatched larvae. At the present time, the procedure for timing this spray uses ovipositional (egg) traps. However, egg trap data are difficult to interpret and somewhat impractical to use. Once the traps begin picking up eggs it is still not possible to predict when maximum egg laying will occur. After maximum egg laying occurs, it would be desirable to be able to predict when major egg hatch will occur.

Presently we are involved in developing a navel orangeworm temperature summation model. Once developed, this model will be used to predict peak adult emergence, subsequent oviposition and egg hatch. Temperature summation involves calculating the number of day degrees above the developmental threshold required by the navel orangeworm to develop in its various stages, from egg to adult. This method of insect population predicting is being developed for several insect pests, including the pink bollworm, codling moth, forest tent caterpillar and others.

Using a working model for the navel orangeworm will allow the grower or pest manager to predict the optimum time for scheduling an insecticide application. These predictions will be based on local weather data collected biweekly in mid-winter, and then daily as accumulated temperatures indicate the approach of adult spring emergence, oviposition and egg hatch.

An accurate temperature summation model requires specific biological information; the more precise this information the closer the model will predict emergence and other functions of the moth. In analyzing the behavior of the navel orangeworm we have determined the need for several specific areas of information.

1. To determine the developmental threshold for the egg, larval and pupal stages.

2. Knowledge of the rate of development and the age structure of the overwintering population prior to spring emergence.

3. Establishment of flight, mating, and egg laying parameters including temperature, photoperiod, and humidity effects on these activities of the moth.

Preliminary data suggest that the navel orangeworm developmental threshold for lab reared egg and larval stages lies between 55-60 degrees Fahrenheit, with the pupal developmental threshold occurring at a slightly higher temperature. Future laboratory and field experiments will yield more precision. Field and laboratory data also indicate that under optimum conditions, development from egg to adult can take place in as little as 26-29 days.

This rate of development is greatly retarded in spring, as demonstrated by preliminary observations this spring. Orchard mummies artificially inoculated with navel orangeworm eggs at the peak moth oviposition period produced the first adult moth 63 days later at 15% hullcrack. These development-temperature-time relationships will be further explored in the coming season, once developmental thresholds have been established.

Thorough field sampling this past winter showed that the navel orangeworm develops throughout the winter at an extremely reduced rate. Oviposition the previous fall (1977) had ceased by mid-November causing the population to become somewhat discrete i.e., tightly grouped in structure. This discreteness becomes more and more pronounced with approximately 80% of the population residing in the 6th instar and pupal stage by early spring. This information was determined by classifying larvae found in mummies into their respective instars and by using egg traps. Figure 2 indicates the frequency of occurrence of the different developmental stages of the navel orangeworm at varying time intervals. If these data are compared to egg trap data (Figure 1) it can be seen that little adult emergence has occurred as of 4-20-78 (indicated by lack of eggs), and that the majority of the population is grouped into the 6th instar and pupal stages. Field sampling also indicated that on 4-20-78 prior to maximum oviposition, the navel orangeworm population density, i.e., number of navel orangeworm/mummy nut was .6. However, on 5-19-78 after maximum oviposition, the density of navel orangeworm had nearly doubled (Figure 2). This illustrates the importance of reducing this emerging spring brood prior to population buildup. This information also suggests that a single accurately timed spray would greatly reduce this emerging population.

Temperature, photoperiod, and humidity are probably the major environmental factors governing navel orangeworm flight, mating and

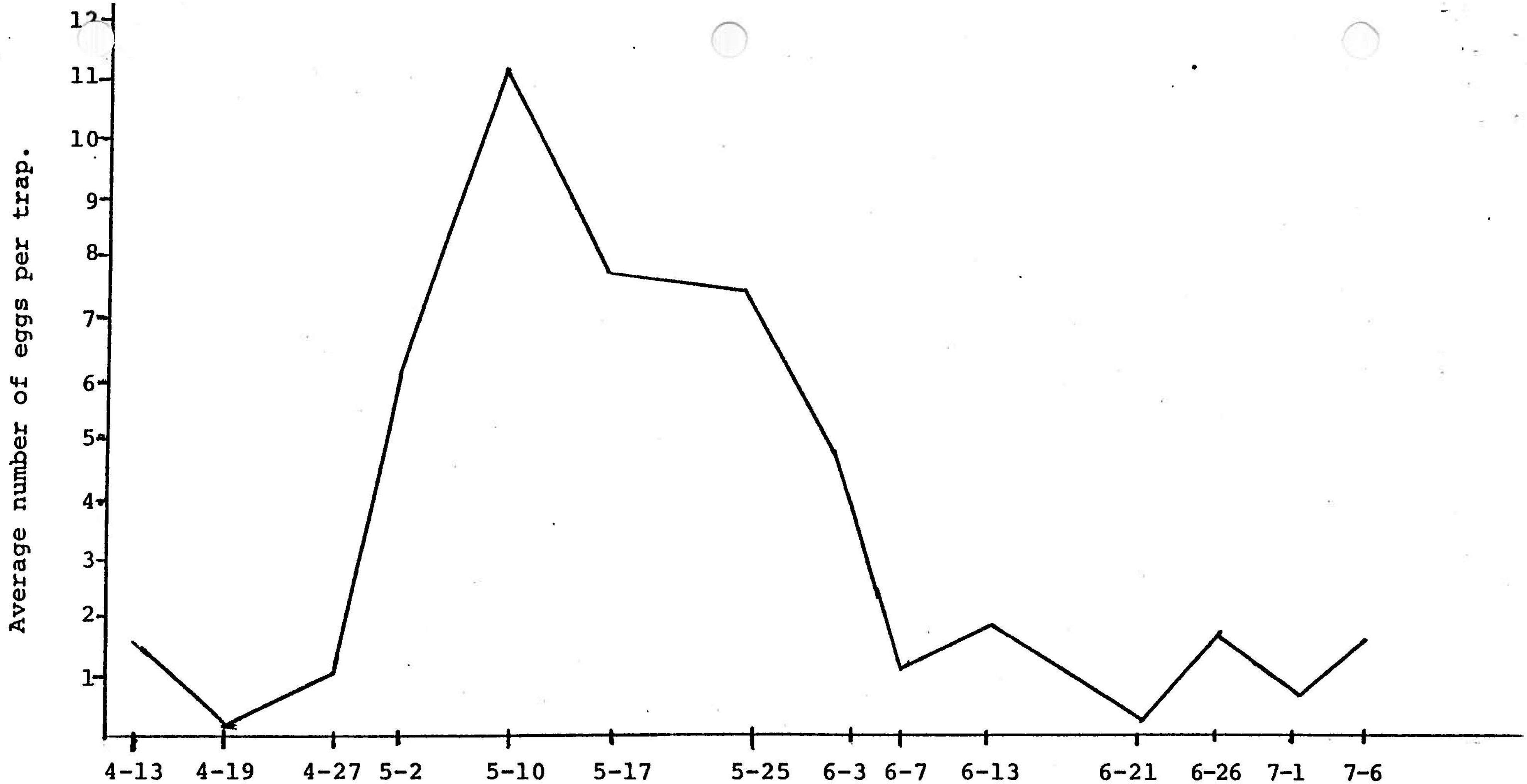

Fig. 1.--Average number of navel orangeworm eggs per trap per day[1/]. Code 72, Roberts Farms, 1978.

[1/]Based on ten egg traps.

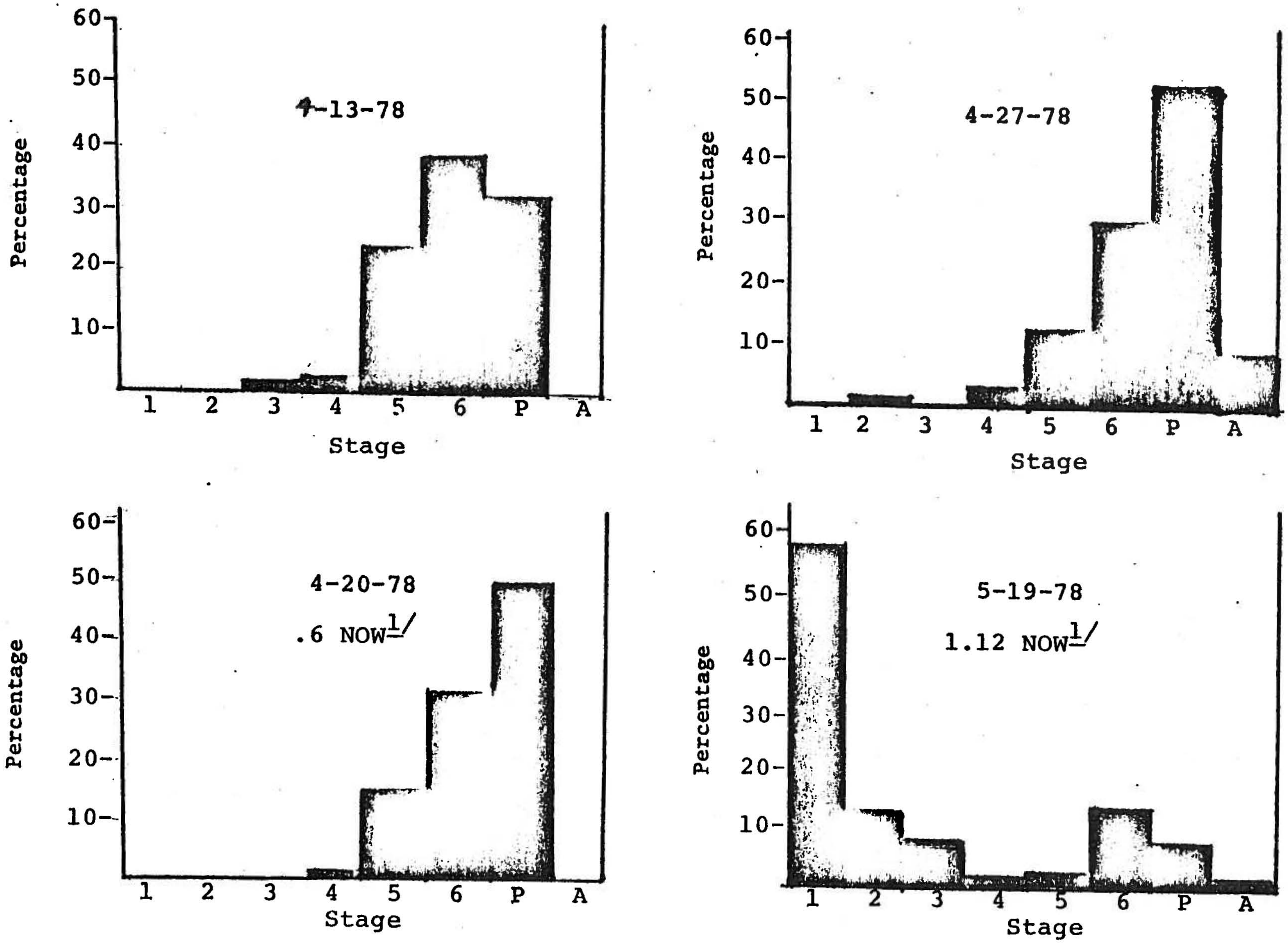

Fig. 2.--Age structure for navel orangeworm in mummy nuts (1-6 = instar, P = Pupa, A = Adult). Code 72, Roberts Farm, 1978.

1/ Average number of navel orangeworm per mummy nut.

oviposition. At present, unreplicated data suggests that the navel orangeworm has a flight temperature threshold requirement near 60° Fahrenheit. The flight temperature threshold may be related to that for mating and oviposition. These environmental parameters governing the navel orangeworm will be further elucidated this coming season.

The Effects of Different Infestation Levels of Spider Mites on Almond Tree Productivity

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The effects of spider mites on almond tree productivity in relation to infested and non-infested trees were reported by Andrews and Barnes in 1977. An attempt to discriminate more critical mite levels was initiated in July 1978 in addition to further attempts to understand the mite-host plant interactions. Through the use of the term mite day, 1 mite feeding for 1 day, a more definitive value can be assigned to the mite load to which a tree has been subjected.

Experiment A

Materials and Methods

Sixteen randomized blocks of four trees each were utilized on a 4-year-old flood irrigated orchard. All blocks consisted of the Nonpareil variety planted on a 24'x24' design. Four levels of mites were used. Treatment 1: mite free, treatment 2: low, treatment 3: moderate, treatment 4: high. The mites were sampled by taking 32 leaves/tree from all four sides of the tree as well as upper and lower regions equally. The excised leaves were placed in dampened bags and kept refrigerated until all mobile mite stages could be counted under a 10X stereoscope.

The trees of treatment 1 were kept mite free, as well as the two adjacent pollinator rows, using a standard commercial acaricide, Plictran 50W at 2 oz a.i./100 gallons. The acaricide was applied by a high pressure handgun using ca. 5 gal/tree on 7/25. This treatment was repeated on the following dates, 8/5 and 8/28, as a precautionary measure.

The initial mite sample for the plot was taken on 7/20 by randomly sampling 23 trees at 15 leaves per tree. The treatment 1 trees were sampled for mites on 7/24, just prior to their being sprayed. The remaining three treatments were sampled for mites on 7/26. All four treatments were sampled on 8/3 and 8/10. The trees of the second level were allowed to develop damage until sporadic stippling was noticed, at which time on 8/5 the second treatment was sprayed with Pictran 50W at 2 oz a.i./100 gal. The trees of the 3rd treatment had been moderately stippled as well as 7 trees of the 4th treatment were heavily stippled and starting to defoliate. On 8/11, both the 3rd treatment and the 7 of the 4th were also sprayed with Plictran 50W. On 8/16 the remaining 9 trees of the 4th treatment were sampled for mites and sprayed out with Plictran 50W on 8/17. On 8/18 the 1st, 2nd, and 3rd treatments were sampled for mites, with all 4 treatments being sampled on 9/7 and 10/12.

The effects of mites on almond trees were evaluated in terms of productivity (yield) and vegetative growth. Eleven of the sixteen blocks' trees were knocked with a rubber mallet. The nuts and debris were collected from a canvas spread underneath the tree. Because of the young trees' low fruit set, the entire crop/tree was weighted to the nearest 1/4 oz. The nuts were allowed to dry and then reweighed. A subsample of 200 nuts was randomly selected and cracked by hand. Both the nutmeats and resulting residue consisting of hulls, shells, and debris were individually weighed. The trees total productivity was then determined using the following formula:

$$\frac{\text{total lbs whole nuts}}{\text{tree}} \times \frac{\text{lbs dried sample}}{\text{lbs original subsample}} \times \frac{\text{lbs/200 nutmeats}}{\text{lbs 200 nutmeats + lbs residue}} = \frac{\text{lbs nutmeats}}{\text{tree}}$$

The vegetative growth components include terminal growth and girth. The girths of the trees were taken on 8/5 and 8/19 by using a cloth tape measure at a height of 15 cm above ground. The terminal growth component was unattainable due to a high infestation by peach twig borer infestation impairing terminal growth.

Results

The effects of mites on girth did not show any significant difference with Treatments 1, 2, 3, and 4, having girth means of 34.0", 32.9", and 33.3", respectively.

Likewise, the yield was unaffected by 1978's mite infestation with Treatments 1, 2, 3, and 4 having means of 0.49, 0.58, 0.61, and 0.53 lbs respectively.

Both of the above parameters are in agreement with previous studies by Andrews and Barnes 1977 which showed that a mite infestation did not affect the current year's productivity, but rather the following year's. Thus, this orchard having been stressed this year should show a decrease in productivity next year. Because of the varying mite loads between treatments, a relationship between mite load and productivity will be studied next year in relation to terminal growth, girth, defoliation, bud production, and yield.

The total number of mite days or "mite load" is currently being determined for each tree. The effects on these trees will be incorporated into the research on photosynthetic rates and transpiration described in the next section. The yield and vegetative growth components will be examined to determine and quantify the effects of loss in physiological capabilities resulting from mite damage. In addition, studies on the differential effects of early and late season infestations will also be undertaken next year.

The Effects of Spider Mites on Almond Tree Photosynthetic and Transpiration Rates

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The effects of mites on almond productivity was first shown to be of economic importance by Andrews and Barnes, 1977. In order to both understand and quantify these effects, research was undertaken to evaluate the mite's effects on photosynthetic and transpiration rates through the use of a dual isotope porometer. An attempt was also made to define the injury level of mite damage to a tree through the use of a term, mite-day. One mite-day being defined as one mite feeding for one day.

Materials and Methods

A random block design was set up in a four-year-old, flood irrigated orchard, 1 mi. south of Shafter, Kern County. The design consisted of 5 blocks of two trees each. One tree within each block was sprayed early in the season with Plictran 50W to prevent mite damage. The remaining tree was left unsprayed so as to allow normal mite build up. The control trees were sprayed at 2 oz a.i./100 gal at approximately 5 gal per tree. The trees were sprayed on the following dates to insure complete seasonal control; 7/17, 8/5 and 8/16. One of the mite infested trees was sprayed out early on 8/9 due to its very high mite population.

Counts were made of the mite population about every 7 days. The trees were equally sampled from the upper and lower segments of the tree, as well as along the eight compass points. A total of 48 leaves were sampled in this fashion from every tree. The leaves were dampened and kept refrigerated until counts of all mobile mite stages could be made under a 10X stereoscope.

The dual isotope porometer is a field portable instrument which is capable of measuring the photosynthetic and transpiration rates of a leaf. The effects of spider mites on a leaf's photosynthesis and transpiration rates may be measured with the porometer, which in turn will later be correlated with productivity. The photosynthetic and transpiration rates of a leaf are calculated as a function of the uptake of radioactive materals from the porometer. The samples are then taken back into the lab for analysis using a scintillation counter.

The ten trees were stratified into 24 sectors to insure even sampling by the porometer over the entire tree. The tree was divided into 3 equal height levels, each level in turn being partitioned along the eight compass points. The porometer was used to sample one leaf at random within each sector, as well as six additional samples being randomly sampled over the entire tree, thus giving a total of 30 samples per tree. This method results in overall mean photosynthetic and transpiration rates for each tree. The trees were sampled in this fashion on July 21, Aug. 2-3, Aug. 16-17, and Aug. 30. These means were then analyzed for their relationship to the tree's mite load (accumulated mite-days).

Another device which was used was the chlorophyll reflectance meter which gives an indirect measure of a leaf's chlorophyll content. The chlorophyll meter's application was directed towards two goals, the first is an attempt to understand how the mite is influencing the tree's productivity, e.g., by reducing chlorophyll content of leaves.

The second aspect of the chlorophyll meter is its application as a pest management tool. The chlorophyll meter represents a relatively inexpensive technique for assessing the damage by mites to a leaf. The meter is clamped onto a leaf and gives an instantaneous measure of the leaf's chlorophyll content. The pest management advisor may be able to determine the extent of mite damage to an orchard with much less effort than conventional methods.

On the dates Aug. 5 and Aug. 19, all ten trees had leaves sampled in an identical fashion to the mite sampling scheme. These leaves were wiped off and the mite damage was assessed using the chlorophyll meter. This technique resulted in an overall measure of the mite damage for the entire tree. These means were then analyzed for their relationship to actual mite counts which were being taken throughout the season.

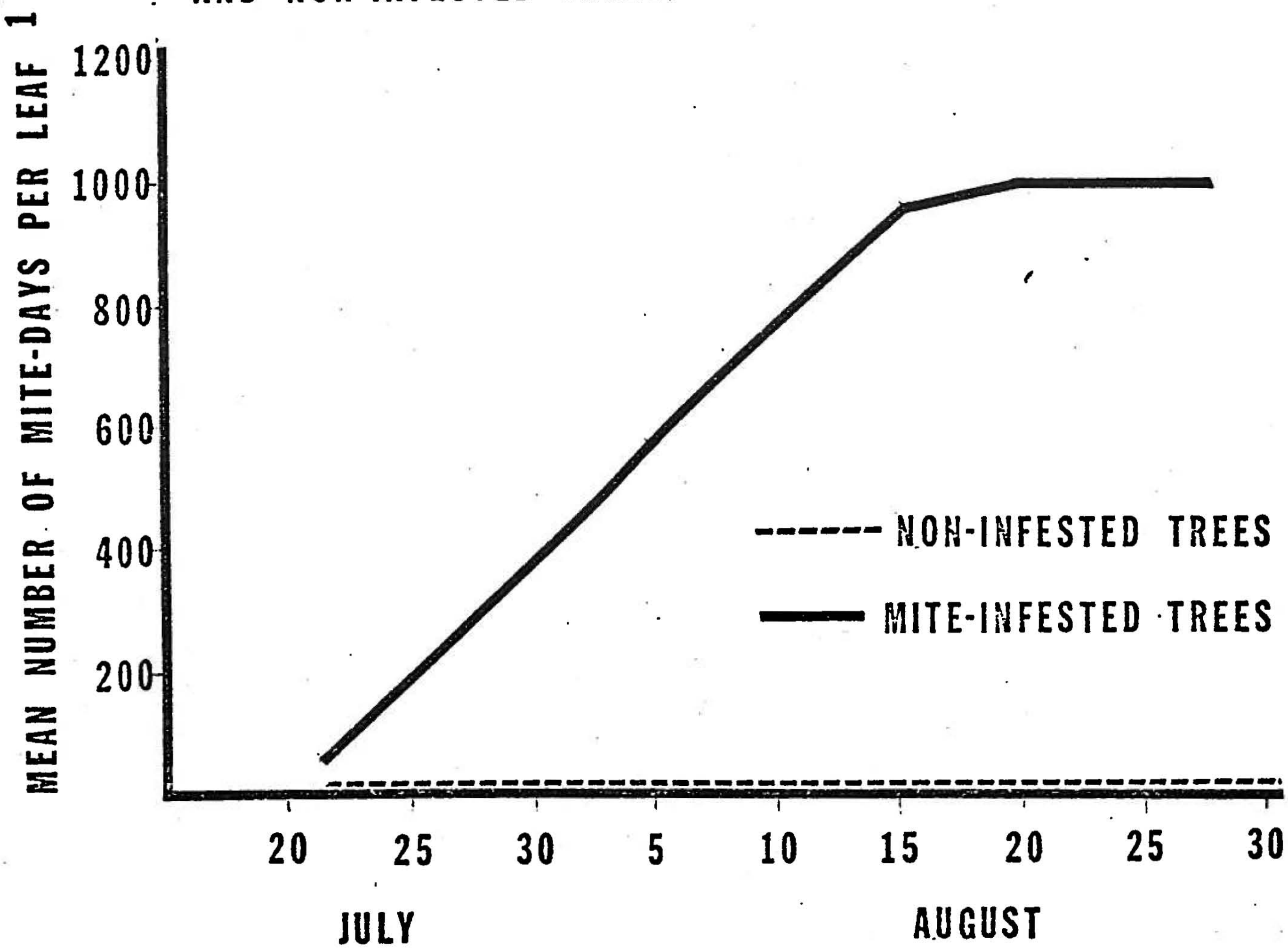
The vegetative growth of the tree will also be looked at in relation to the loss in photosynthetic capabilities of the tree as well as its mite load. The terminal growth was shown to be highly sensitive to mite damage in past observations, but 1978's growth could not be measured due to peach twig borer damage to the terminals.

Results

The mite infestation was shown to significantly reduce both the photosynthetic and transpiration rates of the tree. The mean number of mite-days accumulated for each treatment throughout the season is reported in Figure 3.

The transpiration rates were shown to be reduced by the mite infestation. The initial transpiration rates were not significantly different between the two treatments, but each subsequent sampling date showed a statistically significant difference in transpiration between the mite

FIG. 3 MEAN NUMBER OF MITE-DAYS PER LEAF IN MITE-INFESTED AND NON-INFESTED TREES.



1 BASED ON 5 TREES AT 48 LEAVES PER TREE.

infested and non-infested trees as shown in Fig. 4. However, both groups showed a decrease in transpiration with time. This decrease may possibly be explained by the fact that the orchard received no water from July 28 to October 3. As the trees became more water stressed, the transpiration rates would be expected to decline.

The photosynthetic rates behaved in a similar manner with initially no difference between the two treatments. As the season progressed and the mite load increased, the photosynthetic rate of the mite infested trees became significantly lower at every sample date, as shown in Fig. 5. Again, the general downward trend of both the non-infested and mite infested tree's photosynthetic rates may be explained by the increasing water stress throughout the season.

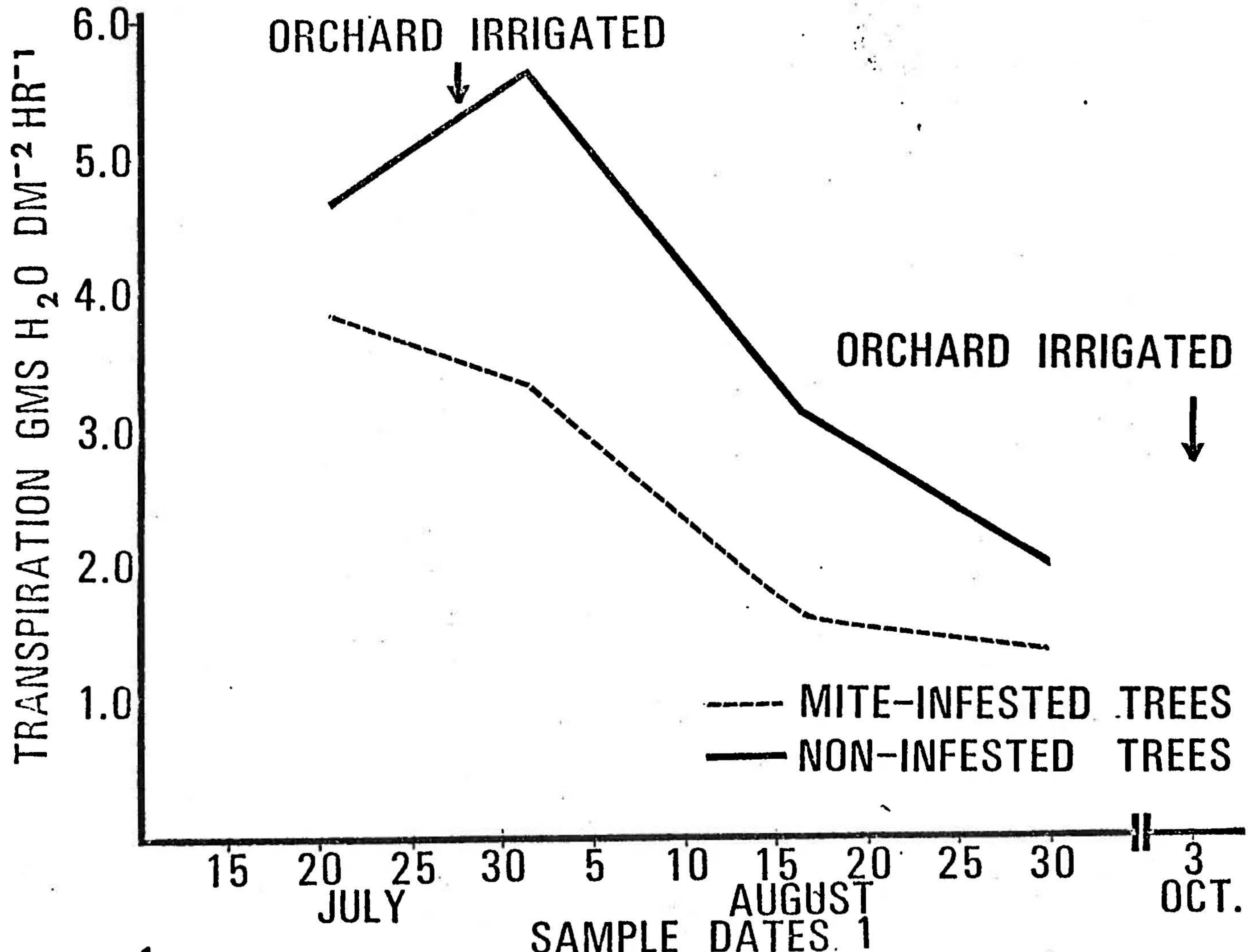
Next year's measurements of yield and vegetative growth will be analyzed in respect to the lowered transpiration and photosynthetic rates.

The chlorophyll meter's relationship to mean number of mite days per leaf in shown in Fig. 6 with the regression having a correlation coefficient of .92. Thus, the chlorophyll meter appears to give a good index of mite damage to a leaf. The possibilities of its application as a pest management tool will be evaluated in future studies.

Conclusion

Mites have been shown to dramatically reduce the photosynthetic and transpiration rates in almond trees. Continued research in this area will attempt to determine what levels of reduced photosynthetic rates will result in economically significant losses in yield and vegetative growth. The final goal of this research is to provide some information upon which to base an economic threshold for mites.

FIG. 4 . SEASONAL TRANSPIRATION RATES OF MITE-INFESTED AND NON-INFESTED TREES.

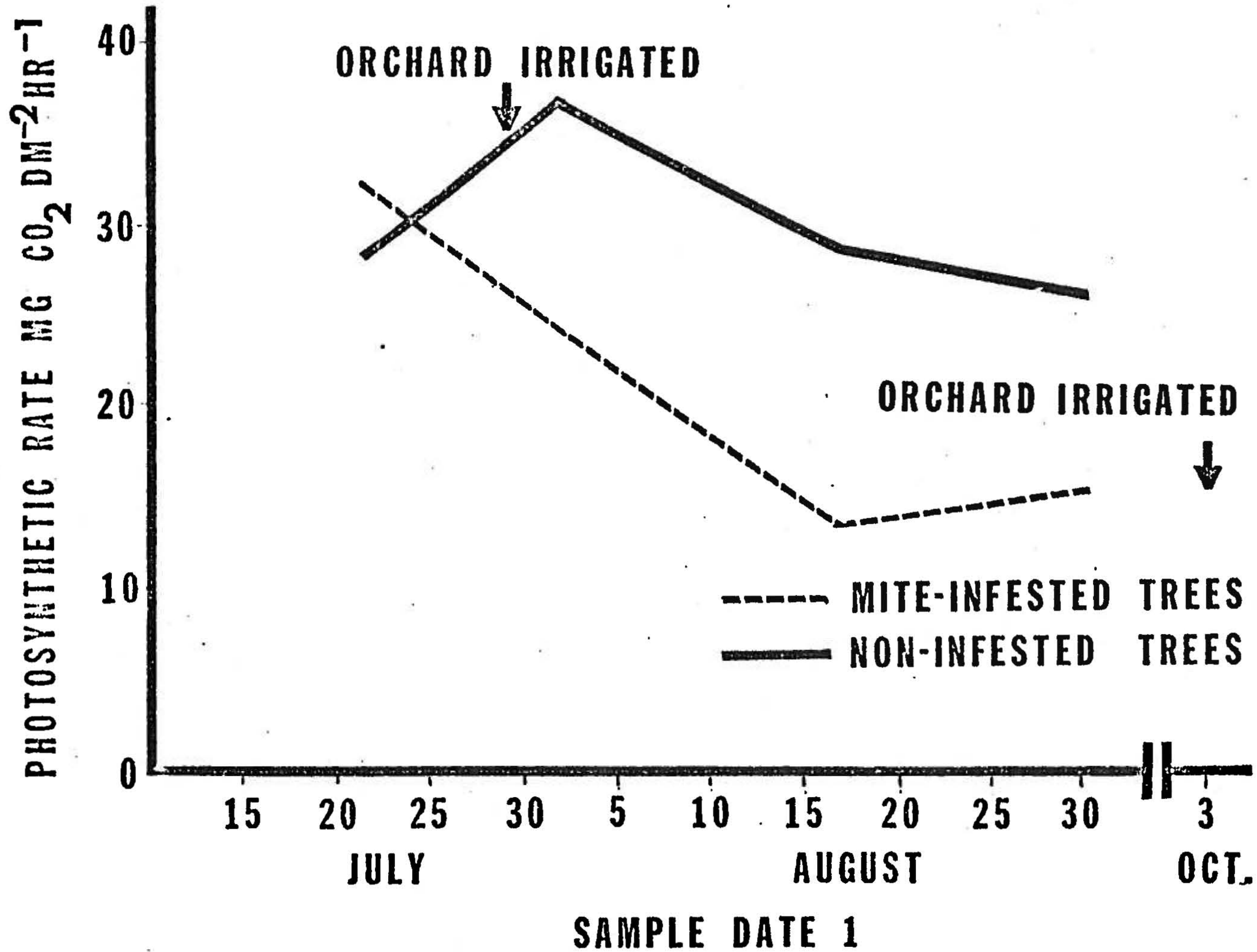


1 SAMPLED WITH DUAL ISOTOPE POROMETER

2 BASED ON 5 TREES.

3 BASED ON 4 TREES.

FIG. 5 SEASONAL PHOTOSYNTHETIC RATES OF MITE-INFESTED AND NON-INFESTED TREES.

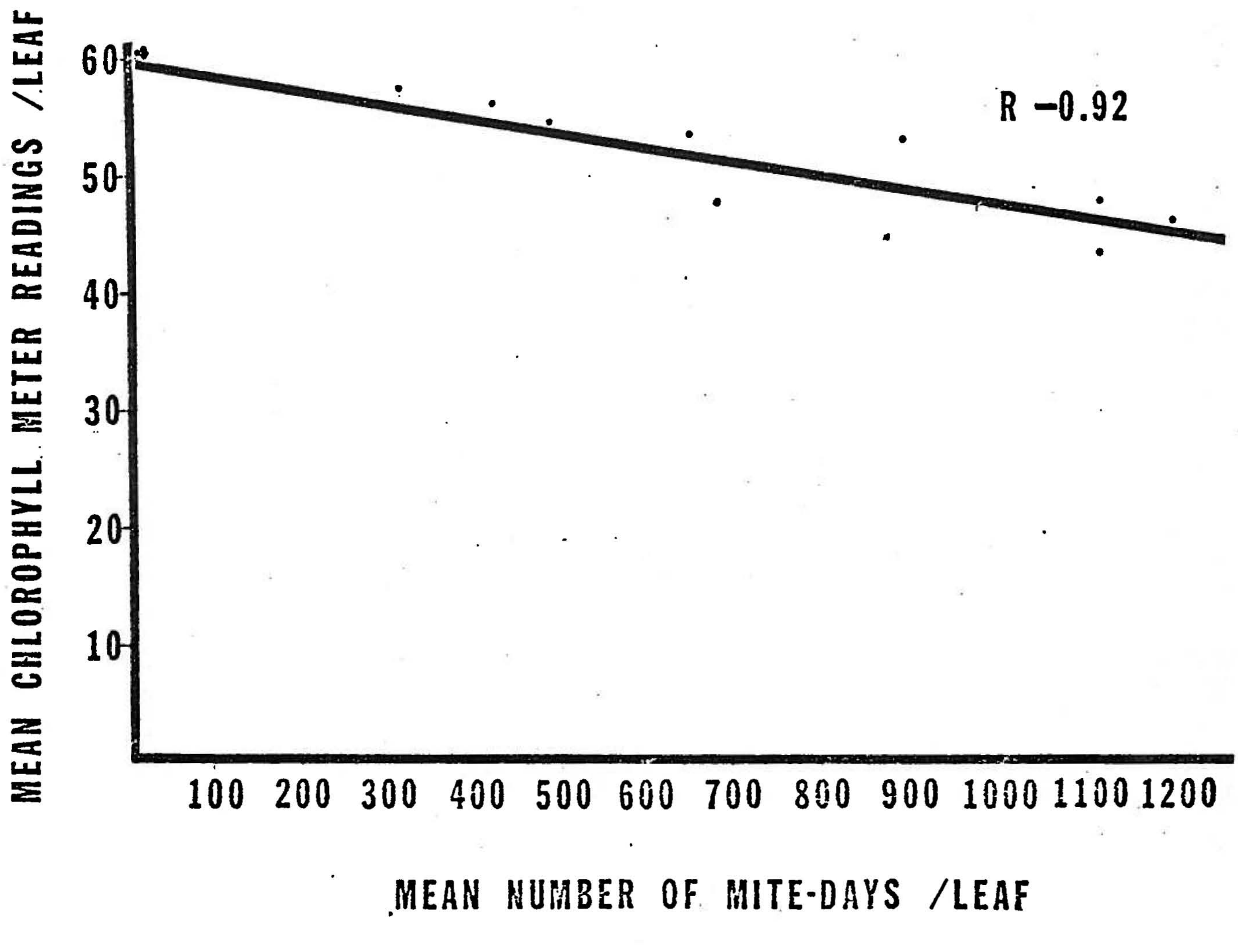


1 SAMPLED WITH ISOTOPE POROMETER

2 BASED ON 5 TREES

3 BASED ON 4 TREES

FIG. 6 RELATIONSHIP BETWEEN CHLOROPHYLL METER READINGS AND MITE-DAYS.



Trial of a Granular Systemic Insecticide Aldicarb 15 G (Temik) Applied to the Soil for Control of Mites on Almonds

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The purpose of this experiment was to test various rates of Temik (Aldicarb) 15% granular formulation as an acaricide for controlling tetranychid mites on almonds. Of special interest in this experiment was aldicarb's long-term efficacy for mite control as demonstrated in a trial in 1977 on drip irrigated trees. Data concerning aldicarb's effects on mite predators and phytotoxicity were also tabulated.

Methods and Materials

The experiment was conducted near Lerdo Hwy and Industrial Farm Rd., Kern Co., in a portion of a Minnehoma Farms almond orchard. The seven-year-old trees were placed in a 25x25 foot planting, with alternating double rows of the Nonpareil variety to a single row of the Merced variety. The orchard was irrigated with a movable sprinkler system watering every other row.

The experimental design used was a randomized block, consisting of 4 blocks of trees, with 5 trees per block. Three of these blocks were the Nonpareil variety and one block the Merced variety. Various rates of granular aldicarb (Table 11) were applied using 2 soil shanks set 1 foot apart with a soil depth of 3-4 inches. The shanks were pulled by tractor, depositing the aldicarb 6 feet from the base of the tree, only on irrigated rows. Each treatment began at 12 feet before each tree

Table 11.--Aldicarb 15 G efficacy trial. Average number of hatched mites per leaf[1] for each of 4 treatments at the nine sampling dates.

Lbs. a.i. aldicarb/A	6-5 Pretreatment	6-12 6 days	6-20 14 days	6-28 22 days	7-12 36 days	7-25 49 days	8-3 58 days	8-11 66 days	8-25 80 days
	Sample Date								
Check	.01 a[2]	.06 a	0 a	0 a	0.4 a	6 a	44.8 a	15.3 a	1.1 a
.6125	0 a	.01 a	0 a	0 a	0.3 a	5 a	28.6 ab	4.1 b	.7 a
1.25	.01 a	0 a	0 a	0 a	0.07 a	.4 b	5.3 c	2.6 b	.5 a
2.50	.01 a	0 a	0 a	0 a	0.1 a	2.5 a	9.7 bc	3.5 b	.09 a
5.00	0 a	0 a	0 a	0 a	0 a	.09 b	.4 c	.2 b	.03 a

[1] Samples 6-5 through 7-12 based on four replicates of 16 leaves each. Samples 7-25 through 8-25 based on four replicates of 32 leaves each.

[2] Means in the same column followed by the same letter are not significantly different at the 5% confidence level as determined by Duncan's New Multiple Range Test.

and stopped 12 feet past, with a buffer of one tree between each treatment level. Using this design, treatments were kept 25 feet apart.

Mites were slide mounted on 7-25-78 from leaf samples for species identification. Based on these mounts, the population was determined to be a mixture of 72% Pacific mite and 28% citrus red mite. Leaves (16-32) were sampled from each tree in all blocks at 6, 14, 22, 36, 49, 58, 66 and 80 days after aldicarb application. The trees were circled taking leaves randomly from 1-2 meters in height and from inside and outside the canopy. These samples were placed in labeled paper bags and immediately refrigerated.

Results

Table 11 presents the mean number of tetranychid mites per leaf for each of the 9 sampling dates. Satisfactory control was evident in 3 of the 4 application rates at 58 days after treatment, however, significant mite populations did not occur on any of the trees in any block until the 36th day after treatment. Without specific information on the rapidity of aldicarb uptake, speculation on efficacy for these 36 days of near zero mite densities cannot be made. However, it may be assumed that if mite control were occurring on the 58th day after treatment, mite control probably occurred several weeks prior to this date. It is noted that there was a slightly higher average mite population on trees treated at 1.25 lbs a.i. per acre as compared with 2.50 lbs a.i. per acre. This inconsistency can be attributed to 1 tree in the 2.50 lbs a.i. per acre treatment containing abnormally high mite densities on several sampling dates. It is possible that the shank applicator clogged or malfunctioned at this tree. On the 66th day after treatment all dosages were significantly lower than the check blocks, but all blocks were declining in mite densities. This decline cannot be attributed to mite predators because of their insignificant numbers (Table 12).

A leaf phytotoxicity similar to salt burn was observed and tabulated on the 58th day after treatment (Table 13). From this data it is evident that aldicarb at 5.0 lbs a.i. per acre causes considerable tip burn, especially to the Merced variety and is possibly unacceptable at this rate. The lower rates, especially 1.25 lbs a.i. per acre, caused little or no tip burn and gave excellent mite control.

Residue samples were taken at harvest for analysis; this data is unavailable at the present time.

In future tests, aldicarb rates of 1-3 lbs a.i. per acre should be examined. These ranges seem to provide adequate mite control and cause little or no leaf phytotoxicity. Other parameters that should be investigated in the future are Temik's results on the various almond varieties, and the dosage levels required in relation to tree age. These parameters should be correlated with the various types of irrigation systems used.

Table 12.--Total number[1] of mite predators for each of five treatments.

	Pretreatment			6 Days			14 Days			22 Days			36 Days			49 Days			58 Days			66 Days			80 Days		
Lbs a.i.	6-5			6-12			6-20			6-28			7-12			7-25			8-3			8-11			8-25		
Aldicarb 15 G/A	GL[2]	SST[3]	Ph[4]	GL	SST	Ph	GL	SST	Ph	GL	SST	Ph	GL	SST	Ph	GL	SST	Ph	GL	SST	Ph	GL	SST	Ph	GL	SST	Ph
Check	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	2	2	0	15	24	0	1	2
.6125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	7	7	0	5	0
1.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
2.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	9	0	2	0
5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

1/ Samples 6-5 through 7-12 based on four replicates of 16 leaves each. Samples 7-25 through 8-25 based on four replicates of 32 leaves each.

2/ Green Lacewing.

3/ Sixspotted Thrips.

4/ Phytoseiidae, predacious mites.

Table 13--Mean phytotoxicity rating for five treatment levels of aldicarb 15 G 58 days after treatment.

Lbs. a.i. aldicarb/A	5	2.5	1.25	.6125	0
Mean Rating[1/]	2.56[2/]	2.08	1.45	1.22	1.13

[1/] Based on four replicates of 32 leaves each.

[2/] Rating system used: 1 = no damage

2 = leaf tip burnt 1-2.5 mm.

3 = leaf tip burnt 2.5-5.0 mm.

4 = leaf tip burnt 5.0 mm +.

Field Acaricide Trials

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An experiment was performed in July 1978, to compare the effectiveness of four acaricide treatments. The northeast corner of a 60-acre flood-irrigated orchard, approximately 1 mile south of Shafter, Kern County, was selected as the test site. The compounds Zardex (.8 EC), UC55304 (4 EC) at two rates, and Omite (30W) were compared for their toxic effects on an infestation which included several species of spider mites. On July 24, twenty male Tetranychus mites were mounted for species identification. The mite infestation was essentially a composite of 45% twospotted mite and 55% pacific mite, with citrus red mite being found in low numbers. In addition, the treatment's effects on the natural enemy complex, the sixspotted thrips, green lacewing, and a predatory phytoseiid mite were also investigated.

Materials and Methods

A completely randomized block design was implemented with a total of six blocks, four of the Nonpareil variety and two of the Mission variety. The trees were four years old and on a 24x24 foot planting which minimized drift.

On July 24, the compounds were applied with a high pressure hand gun which delivered a fine dense spray at 400-450 lbs per sq. inch. A check treatment of water was applied in a similar fashion to allow for any losses due to hydraulic pressure. An average of 5 gallons per tree, 380 gallons per acre, was applied resulting in coverage to run-off.

Table 14. Mean number of mobile stages of *Tetranychus* per leaf[1/] for various acaricide treatments at 5 sampling dates. Shafter, CA., July 1978.

		Sample					
	Oz. a.i.	Pretreatment	4 days	9 days	14 days	19 days	31 days
Compound	per 100 gal.	7/24	7/28	8/2	8/7	8/12	8/24
Water check	-	50.6 a[2/]	35.6 a	23.4 a	37.9 a	54.7 a	13.2 a
Omite 30W	10.5	51.5 a	.8 b	.3 b	1.2 b	2.0 b	11.2 a
UC55304 4EC	4.0	52.1 a	.03 b	.05 b	.2 b	.9 b	9.2 a
UC55304 4EC	8.0	50.0 a	.03 b	0.0 b	.2 b	.7 b	7.9 a
Zardex .8EC	24.0	59.0 a	1.7 b	1.0 b	2.3 b	6.3 b	7.3 a

[1/] Based on six replicates of 20 leaves for sampling dates 7/24 and 7/28.

[2/] Means in the same column followed by the same letter are not significantly different at the 5% level using Duncan's New Multiple Range Test.

Table 15. Mean number of phytoseiid mites per leaf[1] for the various acaricide treatments at 5 sampling dates. Shafter, CA., July 1978.

		Sample					
	Oz. a.i.	Pretreatment	4 days	9 days	14 days	19 days	31 days
Compound	per 100 gal.	7/24	7/28	8/2	8/7	8/12	8/24
Water check	-	0.0 a[2]	.02 a	.04 a	.03 a	.3 a	.2 a
Omite 30W	10.5	.05 a	.0 a	0.0 a	0.0 a	.01 b	.08 b
UC55304 4EC	4	0.0 a	0.0 a	0.0 a	0.0 a	0.0 b	.03 b
UC55304 4EC	8	.05 a	0.0 a	0.0 a	0.0 a	0.0 b	0.0 b
Zardex .8EC	24	.07 a	0.0 a	.08 a	.14 a	.18 a	.47 a

[1] Based on six replicates of 20 leaves for sampling dates 7/24 and 7/28.
Based on six replicates of 40 leaves for sampling dates 8/2, 8/7, 8/12, and 8/24.

[2] Means in the same column followed by the same letter are not significantly different using Duncan's New Multiple Range Test.

Effects of Three Acaricides on the Pacific Mite, Twospotted Mite, Citrus Red Mite, and Their Predators

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An experiment was conducted in a portion of an almond orchard located one mile south of Shafter, Kern Co. The goal of this experiment was to determine the relative effectiveness of PP 199, Morestan, and Omite as a control measure for tetranychid mites. The efficacy in controlling these mites and their effects on mite predators were tabulated.

Materials and Methods

The plot consisted of 3-year-old trees planted in a 24x24 design and was flood irrigated. No insecticides had been applied in the orchard prior to this trial. The experimental layout used was a randomized block design. This consisted of six blocks with five randomized treatments in each block. Of the six blocks, four blocks contained the Nonpareil variety and two the Merced variety. Mites from pretreatment leaf samples were slide mounted for species identification. Based on 31 mounted males, the population was determined to be a mixture of three species; 58% pacific mite, 39% twospotted mite, and 3% citrus red mite. In one case all three species were found on the same leaf.

The acaricide treatments (Table 16) were applied using a handgun with a pressure of 400 pounds, providing full coverage. The check trees were sprayed in the same manner as the acaricide-treated trees but with water. Leaves (16-32) were sampled from each tree in all blocks, 1, 7, 19, and 31 days after treatment. The trees were circled taking leaves

Table 16.--Acaricide efficacy trial. Average number of hatched mites per leaf[1/].

		Sample date				
Treatment	Oz. AI/ 100 gal	Pretreatment 7/23	24 hours 7/26	7 days 7/31	19 days 8/12	31 days 8/24
Check	-	49 a[2/]	29.0 a	52.0 a	83 a	64 a
Omite 30W	10.5	60 a	1.05 b	0.36 b	4 b	40 bc
Morestan 25W	4.0	39 a	0.01 b	0.24 b	3 b	25 c
PP 199 12.5 DG	1.6	47 a	0.07 b	0.15 b	7 b	56 ab
PP 199 12.5 DG	3.2	43 a	0.01 b	0.04 b	3 b	36 bc

[1/]Samples 7/23 through 7/31 based on six samples of 16 leaves each. Sample 8/12 through 8/24 based on six samples of 32 leaves each.

[2/]Means in the same column followed by the same letter are not significantly different at the 5% confidence level as determined by Duncan's New Multiple Range Test.

randomly from 1-2 meters in height and from inside and outside the canopy. These samples were placed in labeled bags and immediately refrigerated. The leaf samples were counted within 48 hours after sampling.

The number of predators, i.e. sixspotted thrips, green lacewings and phytoseiids were also tabulated.

Results

In Table 16 the average number of mites per treatment level for each of the five sampling periods is shown. A relatively comparable and satisfactory control of mites in all four treatments is evident up to 19 days after treatment. At 31 days the lowest dosage of PP 199-treated trees had surpassed in mite densities its pretreatment sample, indicating a total breakdown in effectiveness. At this time, all other treatments were at unacceptably high levels, indicating their loss of effectiveness.

At each sampling date all mite predators were tabulated (Table 17). Their densities appear insignificant at all sampling points.

Residue samples were taken at harvest for the various treatments; data is unavailable at the present time.

Table 17.--Total number of mite predators per leaf[1/] found in each of five treatments.

		Sample date														
		Pretreatment														
	Oz. AI/	7/23			7/26			7/31			8/12			8/31		
Treatment	100 gal.	GL[2/]	SST[3/]	Ph[4/]	GL	SST	Ph	GL	SST	Ph	GL	SST	Ph	GL	SST	Ph
Check		0	.01	.01	0	0	.01	0	.04	0	.005	.005	.04	.02	.10	.06
PP 199 12.5 DG	1.6	.01	.03	0	0	0	0	0	0	0	.01	0	.005	.01	.01	.01
Omite 30WP	10.5	.01	0	.06	0	0	.01	0	0	0	0	0	.05	.01	.01	.04
PP 199 12.5 DG	3.2	0	0	.01	.01	0	0	0	0	0	0	0	0	.01	.02	.04
Morestan 25WP	4.0	.02	0	.01	0	0	0	0	0	0	0	0	0	.02	.04	.01

1/ Sample 7/23 through 7/31 based on six samples of 16 leaves each. Sample 8/12 through 8/31 based on six samples of 32 leaves each.

2/ Green lacewing.

3/ Sixspotted thrips.

4/ Phytoseiids.