Project No. 84-G2 - Navel Orangeworm, Mite & Insect Research
Egg Trap Improvement and Oviposition Disruption

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Objectives: (1) To modify the existing navel orangeworm egg trap to better reflect field ovipositional patterns. (2) To develop effective, economical control of American plum borer. (3) To determine the potential of almond oil as an ovipositional disruptant of navel orangeworm.

Interpretive Summary:

Egg Trap Improvement. Standard navel orangeworm (NOW) egg traps were compared to improved egg traps in six orchards in Kern, Fresno, San Joaquin and Butte counties. The improved traps were painted black, baited with 30 g (above window) of ground almond press cake plus 10% crude almond oil and had extended ovipositional ridges above the windows. Egg deposition on improved traps increased from 1.3 to 2.7 times that on standard traps, and the white NOW eggs were more visible on the black traps, thus reducing counting time. Based on these results, we recommend painting the existing NOW trap black and changing the bait formulation from 15 g almond press cake to 30 g almond press cake plus 10% crude almond oil. We do not recommend extending the ridges because of difficulties in constructing and reading the traps. The ground almond press cake and crude almond oil will be commercially available next season from Trece Inc., 635 S. Sanborn Rd., Suite 17, Salinas, CA 93901.

American Plum Borer Complex Control. The American plum borer complex consists of a number of species, i.e., American plum borer, plum limb borer, carpenterworm and peach twig borer. This complex can be controlled with Sevin or diazinon, at labelled rates, plus 4:1 to 6:1 water to white interior latex paint, applied from the ground to the secondary branches. The insecticides do not have to be applied in a preventive manner but can be applied after insect activity has been observed. Several months of control can be expected from a single application.

Ovipositional Disruption. Four orchards (10 to 40 ac) in Fresno and Madera counties were divided into two equal parts. One half of each orchard was treated with 5 gals crude almond oil per acre in 100 gal water per acre by air blast orchard sprayer in late April. The other half of each was untreated. Oviposition of NOW, as measured by egg traps, was reduced by 82% by the oil treatment and there was a corresponding decrease of about 83% in the number of NOW-infested mummies. The crude almond oil caused some phytotoxicity and some leaf drop occurrred. This study demonstrated that crude almond oil can disrupt the host-finding ability of NOW. This novel control procedure may ultimately provide inexpensive NOW control while at the same time being less destructive than conventional insecticides to beneficial insects and mites.

INVESTIGATIONS ON NAVEL ORANGEWORM EGG TRAP IMPROVEMENT, CONTROL OF AMERICAN PLUM BORER COMPLEX, AND NAVEL ORANGEWORM OVIPOSITIONAL DISRUPTION

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I. Improvements in the Efficiency of the Navel Orangeworm Egg Trap

The navel orangeworm (NOW) is considered the key pest in almond production. The strategy developed to control navel orangeworm is based on early harvest, winter mummy nut removal, and chemical control at first generation and/or hull-split. Timing of the insecticidal application for the first generation is based on the accumulation of day-degrees beginning at the time eggs are deposited on navel orangeworm egg traps. However, the present egg trap does not indicate in all cases the beginning of egg deposition due to many influencing factors. An improvement in the efficiency of the egg trap would better indicate the true initiation of egg deposition in the spring and thus aid in improved timing of the spring treatment. An improvement in the efficiency of the egg trap might also aid in the hull-split treatment by allowing the treatment to be applied at egg-laying and not at a fixed period of time, i.e., at 10% hull-split.

Research conducted during 1982 and 1983 demonstrated that the efficiency of the egg trap can be increased substantially by changing trap color, bait formulation and trap texture. Research was conducted throughout the state in 1984 to compare the performance of improved and standard NOW egg traps. This research is reported here.

A. Methods and Materials

The study was conducted in six orchards: two in Kern Co., two in Fresno Co., one in San Joaquin Co., and one in Butte Co. Standard NOW egg traps baited with 15 g of ground almond press cake were compared to standard egg traps which were painted black, baited with 30 g of ground almond press cake plus 10% crude almond oil by weight, and had extended ovipositional ridges above the trap windows. Ten traps of each type, were alternated down tree rows, skipping at least two trees between traps and one tree row between lines of traps. The 20 traps were placed in the orchards in late March or early April and monitored twice a week until pollinator harvest. The bait was changed once a week. At harvest, 1000 nuts from both the main and pollinator varieties were inspected for NOW infestation. The hull-spit dates and insecticide usage were noted.

1. Kern County

   a. Orchard 1

The orchard was a 16-year-old Nonpareil, Merced and Mission. The traps were placed in the Nonpareil rows on March 23 and monitored until Sept. 21. Hull-split began on July 4 in the Nonpareils and on about Aug. 5 in the Merceds. The Nonpareils were shaken on Aug. 15 and the Merceds on Aug. 31. The orchard was treated on July 2 with 4 lb/ac Guthion and 2 pt/acre Omite.

The NOW infestation was 12.4% in the Nonpareils and 14.5% in the Merceds. It should be noted that a large number of mummy nuts were in the orchard, particularly Missions which were not harvested the previous year. On March 23, 1984, the Nonpareils had 1.7 mummies/tree and the Merceds had 4.3.

b. Orchard 2

The orchard was a 15-year-old Nonpareil, Merced and Mission. The traps were placed in Nonpareil rows on March 21 and monitored until Sept. 24. Hull-split began on July 1 in the Nonpareils and on Aug. 5 in the Merceds. The Nonpareils were shaken on Aug. 20 and the Merceds on Sept. 2-3. No insecticides were applied during the season. The NOW infestation was 6.4% in the Nonpareils and 22.0% in the Merceds. This orchard also had a large number of mummy nuts.

2. Fresno County

a. Orchard 1

The orchard was a 10-year-old Merced and Thompson. The traps were placed in both Merced and Thompson rows on April 2 and monitored until Sept. 27. Hull-split began on Aug. 6 in the Merceds and was not recorded for the Thompsons. The Merceds were shaken on Sept. 4-7 and the Thompsons on Sept. 21-25. No insecticides were applied during the season. The NOW infestation was 0.7% in the Merceds and 0.5% in the Thompsons.

b. Orchard 2

The orchard was a 10-year-old Nonpareil and Carmel. The traps were placed in the Nonpareil rows on April 5 and monitored until Sept. 27. Hull-split began on July 6 in the Nonpareils and was not recorded for the Carmels. The Nonpareils were shaken on Aug. 15 and the Carmels on Sept. 6. No insecticides were applied during the season. The NOW infestation was 0.2% in the Nonpareils and 0.3% in the Carmels.

3. Butte County

The orchard was a 20-year-old Nonpareil, Thompson and Neplus. The traps were placed in the Nonpareil rows on March 26 and monitored until Sept. 21. Hull-split began on July 16 in the Nonpareils and on Aug. 6 in the Thompsons. The Nonpareils were shaken on Aug. 25-27 and the Thompsons on Sept. 20. The orchard was treated on May 10 with 4 lb/ac Guthion and 1.25 lb/ac Vendex, on July 17 with 4 lb/ac Guthion and 2.25 pt/ac Omite and on Aug. 17 (Nonpareil and Thompson) with 8 oz/ac Pounce and 1.2 lb/ac Plictran. The NOW infestation was 0.9% in the Nonpareils and 0.8% in the Thompsons.

4. San Joaquin County

The orchard was a 20-year-old Nonpareil and Neplus. The traps were placed in both the Nonpareil and Neplus rows on March 28 and monitored until Aug. 30. Hull-split began about July 9 on the Nonpareils and July 26 on the Neplus. The Nonpareils were shaken on Aug. 30 and the Neplus on Sept. 6. The orchard was treated on July 12-15 with 3.5 lb/ac Guthion and 1.5 lb/ac Plictran. The NOW infestation was 1.1% in the Nonpareils and 0.4% in the Neplus. It should be noted that only 803 nuts were inspected in the Nonpareil and 246 in the Neplus.

B. Discussion

In the Kern County orchards, the improved traps had 1.3 and 1.4 times more eggs deposited on them than were deposited on the standard traps (Table 1, Figs 1 & 2). This increase in egg deposition was far less than that in the other orchards. It was observed that these orchards had a large number of mummy nuts which was not the case in the other orchards. Since the improved trap more closely resembles the mummy nut than does the standard trap, it is believed that under high mummy nut levels, the improved traps became less competitive.

In the Fresno orchards, the improved traps had 2.7 and 2.2 times more eggs than did the standard traps (Table 1, Figs. 3 & 4). In orchard No. 1, the ovipositional patterns on the two types of traps were vastly different, with a much higher peak egg deposition on the improved traps. Also, in both orchards, the peak egg-laying was more discernible with the improved traps.

In the Butte County orchard, the improved traps had 1.7 times more eggs than did the standard traps (Table 1, Fig. 5). Both types of traps showed the same ovipositional pattern; however, in all cases more eggs were deposited on the improved traps.

In the San Joaquin County orchard, the improved traps had 2.0 times more eggs than did the standard traps (Table 1, Fig. 6). Again, the peak oviposition was more discernible with the improved traps.

C. Conclusion

The effectiveness of the standard Zoecon NOW egg trap was improved by changing trap color, bait formulation and trap texture. Most changes can be made quite easily and inexpensively. The trap color can be changed by simply spraying the traps with black enamel which can be purchased from any hardware store. The black color will make the white NOW eggs more visible and thus reduce counting time. The bait formulation (almond press cake plus 10% crude almond oil) can be purchased from Trece Inc., 635 S. Sanborn Rd., Suite 17, Salinas, CA 93901. A change in trap texture to extend the ridges above the window is not recommended since it would require significant time and expense and the ridges make the trap more difficult to examine for eggs.

These improvements in the egg trap will permit more accurate determination of peak egg deposition and more rapid monitoring of traps. The cost of the modifications is quite nominal.

Table 1

Seasonal Comparison of Improved and Standard Navel Orangeworm Egg Traps in Various Counties, CA. 1984

Orchards	Mean* seasonal eggs/trap/day: Improved trap	Mean* seasonal eggs/trap/day: Standard trap	Increase over standard trap
Kern 1	3.9 a	2.9 a	1.3
2	5.4 a	3.9 b	1.4
Fresno 1	3.5 a	1.3 b	2.7
2	2.8 a	1.3 b	2.2
Butte	8.2 a	4.8 b	2.0
San Joaquin	2.0 a	1.0 b	1.7

*Means followed by the same letter in a horizontal line are not significantly different at the 1% level (Student's "T" Test).

Fig. 1

Comparison of Improved vs. Standard Navel Orangeworm Egg Traps, Orchard 1, Kern, CA, 1984.

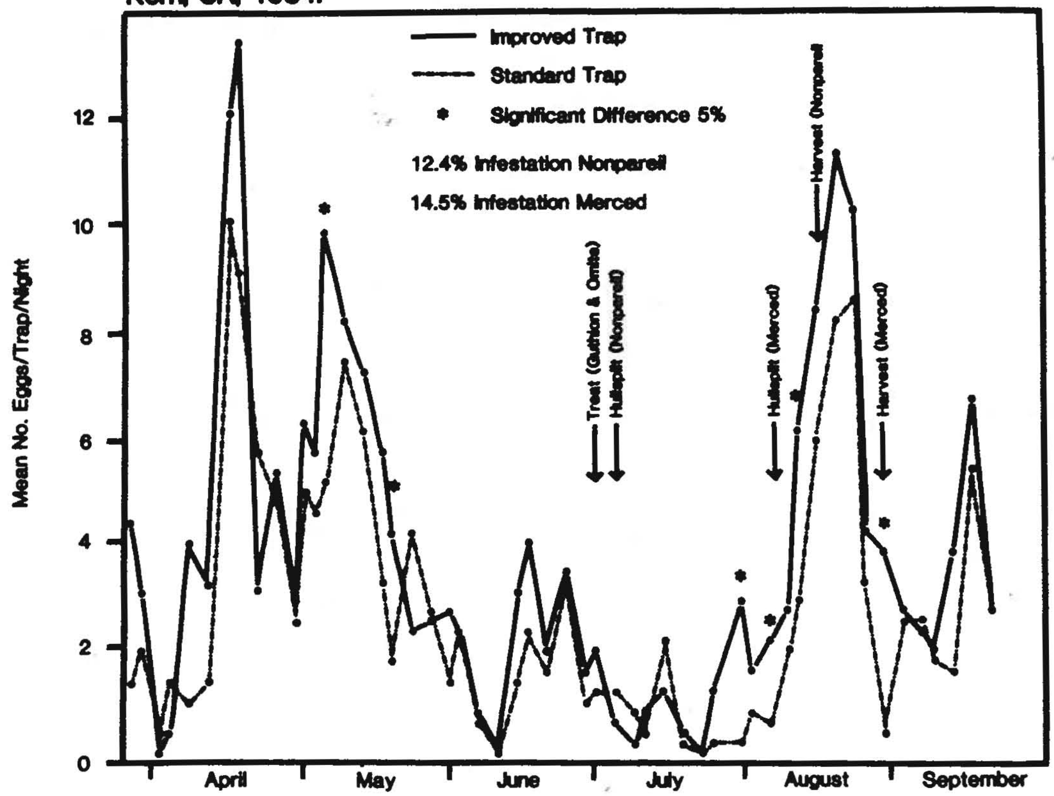


Fig. 2

Comparison of Improved vs. Standard Navel Orangeworm Egg Traps, Orchard 2, Kern, CA, 1984.

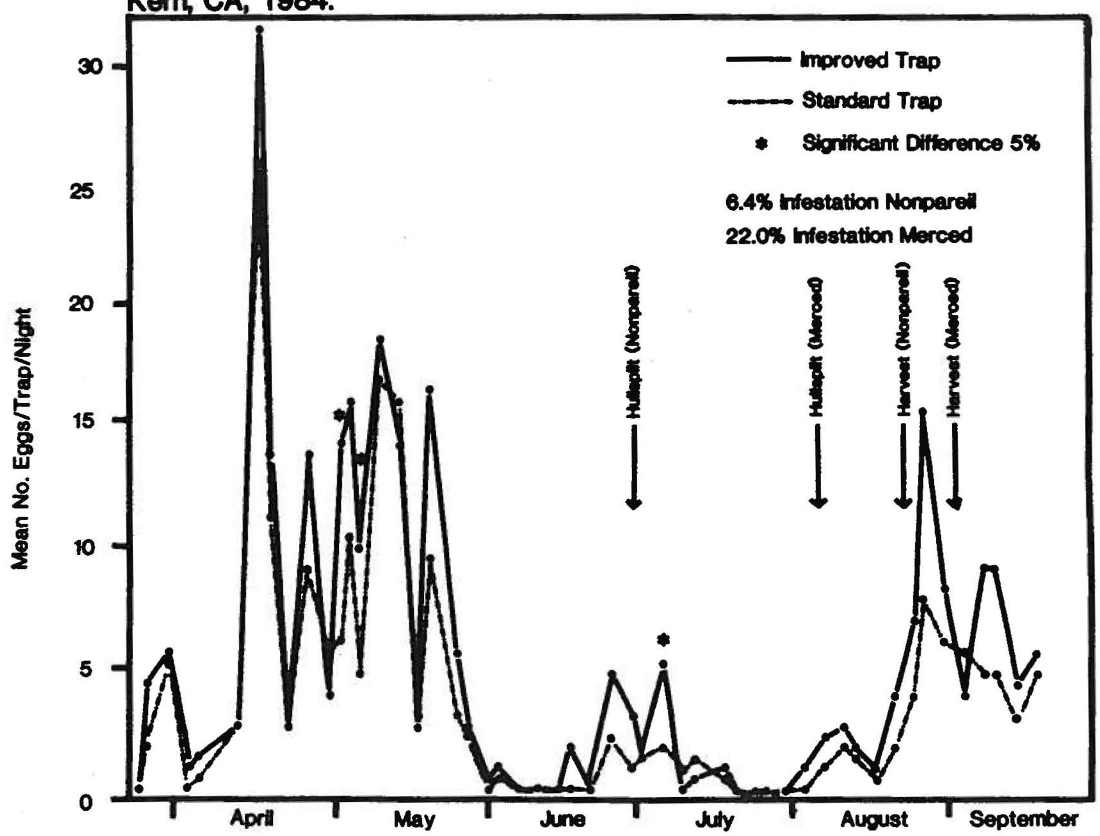


Fig. 3

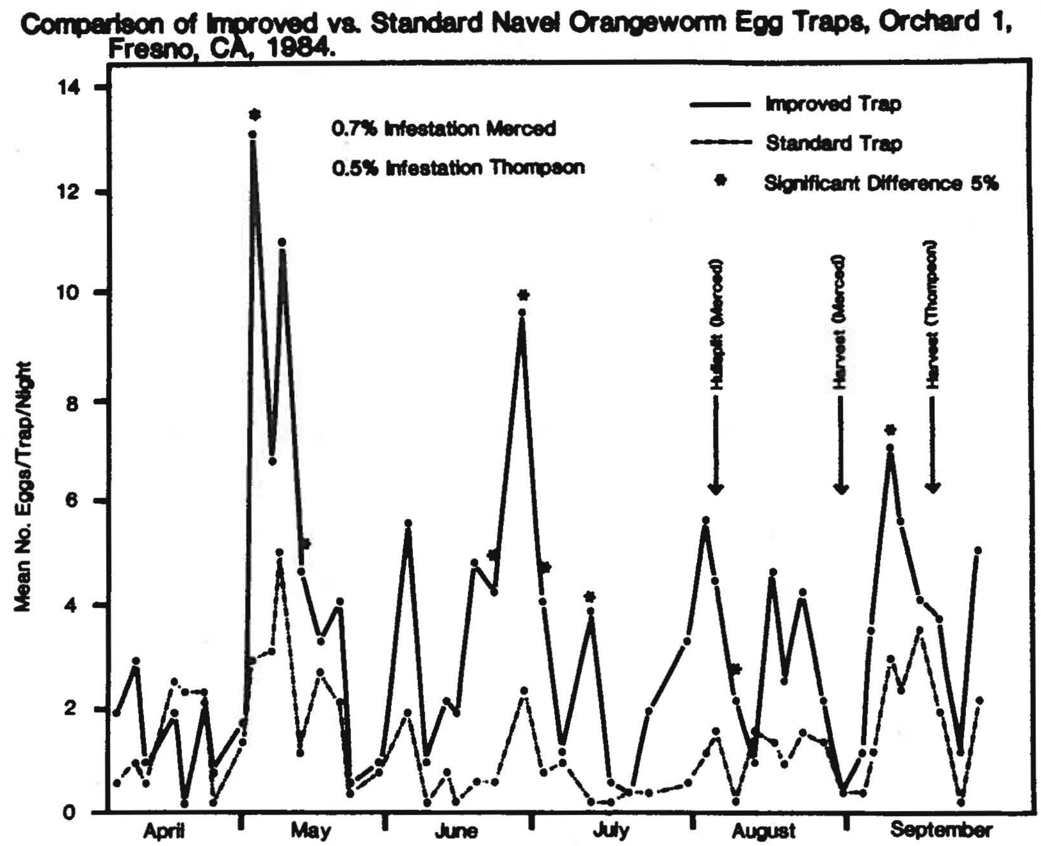

Comparison of Improved vs. Standard Navel Orangeworm Egg Traps, Orchard 1, Fresno, CA, 1984.
0.7% Infestation Merced
0.5% Infestation Thompson
Improved Trap
Standard Trap
Significant Difference 5%
Hullsplit (Merced)
Harvest (Merced)
Harvest (Thompson)
Mean No. Eggs/Trap/Night
April
May
June
July
August
September

Fig. 4

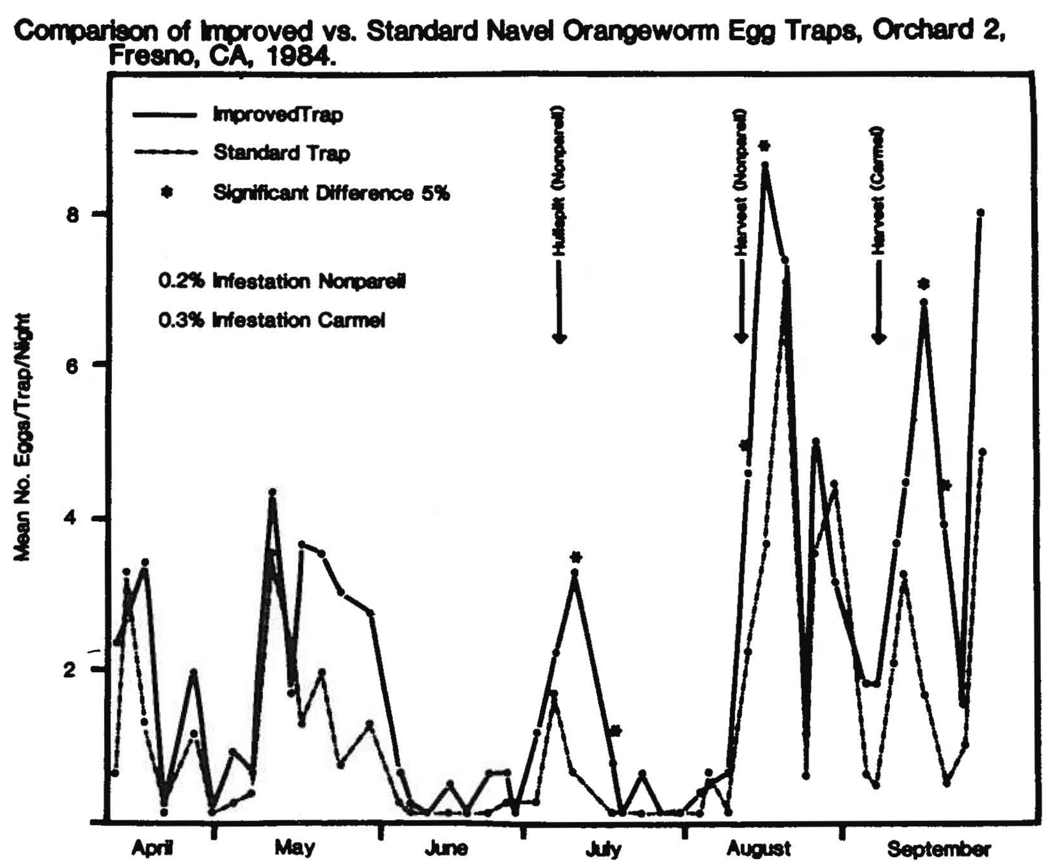

Comparison of Improved vs. Standard Navel Orangeworm Egg Traps, Orchard 2, Fresno, CA, 1984.
ImprovedTrap
Standard Trap
Significant Difference 5%
0.2% Infestation Nonpareil
0.3% Infestation Carmel
Hullsplit (Nonpareil)
Harvest (Nonpareil)
Harvest (Carmel)
Mean No. Eggs/Trap/Night
April
May
June
July
August
September

Fig. 5 **Comparison of Improved vs. Standard Navel Orangeworm Egg Traps, Butte, CA, 1984.**

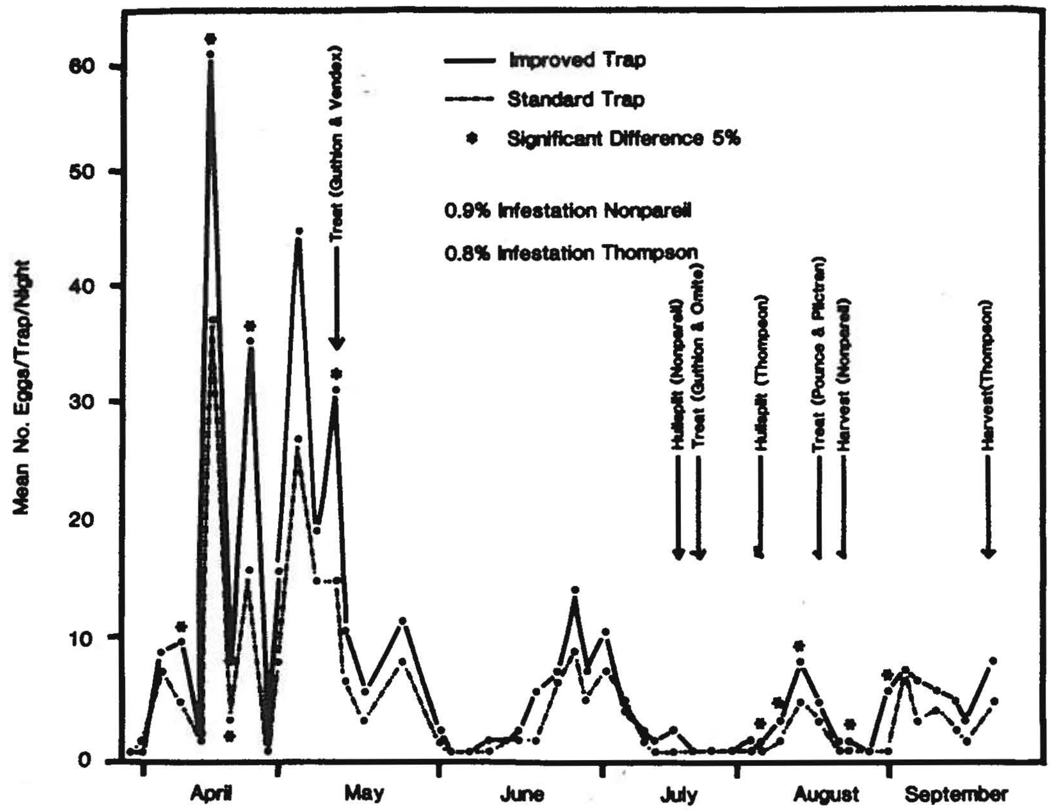
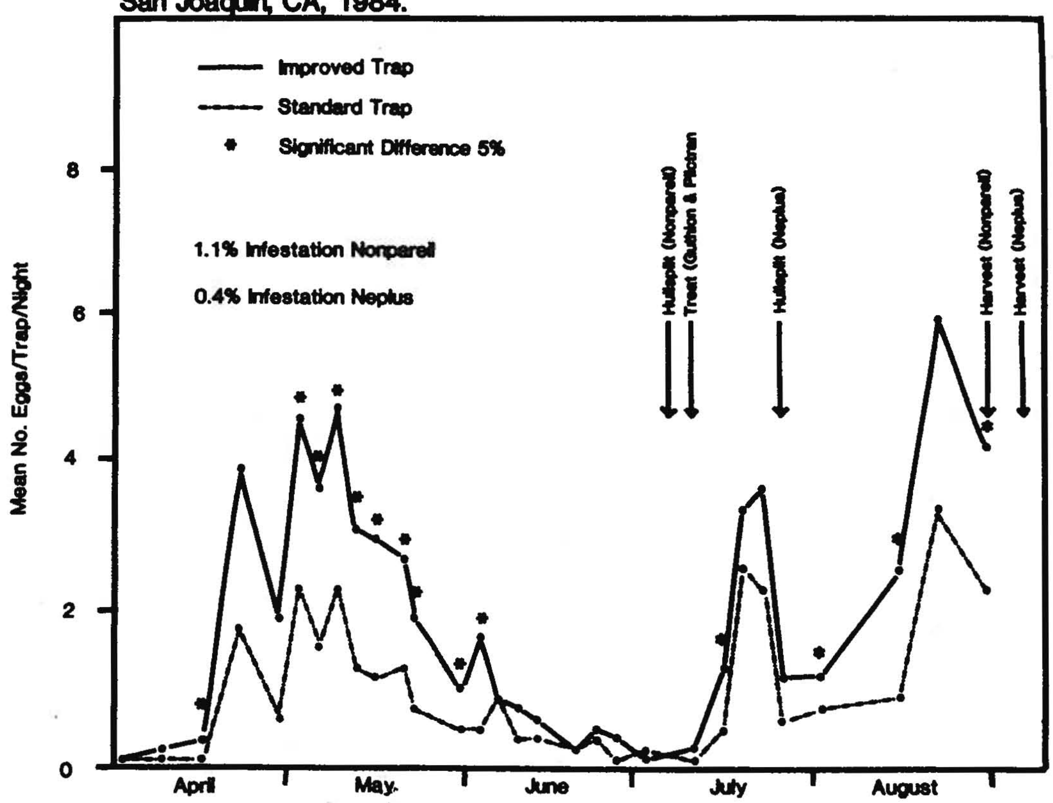


Fig. 6 **Comparison of Improved vs. Standard Navel Orangeworm Egg Traps, San Joaquin, CA, 1984.**



II. Control of American Plum Borer Complex

Borers, which we are calling the American plum borer complex (APBC), are serious pests of young almond trees (2 to 4 leaf) from Merced County north. They damage the young trees by feeding in the cambium tissue at the junction of the trunk and main scaffold limbs. When the borers attack at this site, they weaken or kill the scaffold limb, causing the tree to become less productive and necessitating its removal. When trees are heavily infested, all the scaffolds may die or become weakened to such an extent that they break off the tree. We therefore initiated a research project to develop methods to control APBC. The results of this research are reported here.

A. Effect of Various Insecticides Combined with White Paint

1. Methods and Materials

Six insecticide and interior white latex paint combinations along with an untreated control were tested on 3rd leaf Carmel and Price almond varieties in Merced County. The insecticide-paint combinations and rates of application were:

Materials	Lbs Ai/Ac
Sevin 80S + 4:1 water:paint*	3.0
Sevin 80S + 6:1 water:paint	3.0
Sevin 80S + 4:1 water:paint	1.5
Sevin 80S + 6:1 water:paint	1.5
Diazinon 50WP + 4:1 water:paint	3.0
Diazinon 50WP + 6:1 water:paint	3.0

*For all treatments, paint was white interior latex (Dutch Boy)

Trees were inspected before the application. Only trees with active feeding sites, indicated by frass piles, were included in the study. The treatments and untreated control were replicated ten times in a randomized complete block design. The entire trunk up to the branching of the secondary scaffolds was treated on June 6. After application, trees were inspected at weekly intervals from June 12 through Sept. 7, and the number of frass piles were counted. We did not dig into the trees to find the larvae. The frass piles were removed from the trees so that fresh feeding sites could be observed. Also, for a two man-hour search period on May 22 and at approximately weekly intervals from June 6 through Sept. 7, larvae were extracted from active feeding sites in trees outside the test plot. These larvae were identified.

2. Discussion

All materials and rates of paint tested caused an immediate suppression of feeding activity, as evidenced by the absence of frass piles on June 12 (Table 2). The materials seemed to kill the larvae within the cambium, thus preventive applications do not appear to be necessary. The suppression continued through the study (Sept. 7). However, this lengthy suppression period may have been due to a lack of movement of adult moths from the untreated trees or untreated surrounding area to the treated trees rather than to the effectiveness of the materials.

Table 2

Effect of Various Insecticides and Paint Concentrations on the American Plum Borer Complex, Merced Co., 1984

Material		Mean* number of frass piles per tree on:												
Insecticide and lb ai/ac	Water: paint	6/12	6/20	6/26	7/3	7/10	7/17	7/27	8/2	8/9	8/23	8/30	9/7	Season total
Sevin, 3.0	4:1	0.0 a	0.2 a	0.0 a	0.4 a	0.3 a	0.0 a	0.0 a	0.0 a	0.2 ab	0.0 a	0.0 a	0.0 a	1.1 a
Sevin, 3.0	6:1	0.0 a	0.3 a	0.0 a	0.0 a	0.0 a	0.0 a	0.2 a	0.0 a	0.0 a	0.3 a	0.2 a	0.0 a	1.0 a
Sevin, 1.5	4:1	0.0 a	0.1 a	0.2 a	0.1 a	0.0 a	0.1 a	0.4 a	0.0 a	0.2 ab	0.6 ab	0.0 a	0.0 a	1.7 a
Sevin, 1.5	6:1	0.0 a	1.2 a	0.1 a	0.2 a	0.5 a	0.4 a	0.9 a	0.1 a	0.1 a	0.4 a	0.3 a	0.4 a	4.6 a
Diazinon, 3.0	4:1	0.0 a	0.3 a	0.0 a	0.1 a	0.0 a	0.0 a	0.0 a	0.0 a	0.3 ab	0.0 a	0.0 a	0.0 a	0.7 a
Diazinon, 3.0	6:1	0.0 a	0.0 a	0.1 a	0.2 a	0.0 a	0.0 a	0.0 a	0.0 a	0.1 a	0.1 a	0.1 a	0.0 a	0.6 a
Control		2.4 b	3.4 b	1.2 b	2.2 b	4.4 b	1.9 b	1.9 b	0.6 b	0.7 b	1.2 b	1.4 b	1.4 b	22.7 b

*Means followed by the same letter in a column are not significantly different at the 5% level (DMRT).

When the seasonal total of larvae found is considered (Table 2), it appears that Diazinon at 3.0 lb ai/ac or Sevin at 3.0 lb ai/ac at either 4:1 or 6:1 (water to paint) gave excellent results. The least effective control was Sevin at 1.5 lb ai/ac with 6:1 (water:paint).

When larvae were collected from boring sites in trees outside the test plot, a number of species besides American plum borer were found. The most predominant of these was the plum limb borer. The various larvae found and their numbers were:

Plum limb borer (*Bondia comonana*)	32
American plum borer (*Euzophera semifuneralis*)	14
Peach twig borer (*Anarsia lineatella*)	7
Carpenterworm (*Prionoxystus robiniae*)	2

B. Timing Control Measures

1. Methods and Materials

Five treatment timings of a combination of Sevin 80S at 3.0 lb ai/ac and a 1:4 interior white latex paint to water mixture, along with an untreated control, were tested on 4th leaf Carmel and Price almond varieties in Merced County. The treatment timings were replicated 10 times in a randomized complete block design. The timings of treatments were:

	April 11	June 6	July 27
Treatment 1	X	X	X
2	X	X	
3	X		
4		X	
5		X	X
Untreated 6			

Trees were inspected on April 11 (precount) and 24; May 10 and 22; June 6 and 20; July 10, 19 and 27; Aug. 9 and 23; and Sept. 7 by counting the number of frass piles, or active feeding sites, per tree. We did not dig into the trees to find the larvae. The frass piles were removed from the trees so that fresh feeding sites could be observed.

2. Discussion

This plot did not develop a large American plum borer complex. However, when the Sevin + paint combination was applied, it seemed to suppress the borer complex for at least three months (Table 3). For example, very few frass piles were observed in treatments 1, 2, or 3 from April 11 through June 6, while treatments 4, 5, and 6 (all untreated at that point) had a fair amount of borer damage. After June 6 only treatments 3 and 6 remained untreated. Thus, based on this study and the previus study, the timing of treatment does not appear to be critical. Under low population pressure only one or two applications would be warranted. The first application should be made in early spring (April) and the second in late June or when boring activity begins to appear.

Table 3

Effect of Various Timings of Insecticide Application

on Control of American Plum Borer Complex, Merced Co., 1984

Treatment timing	Mean* number of frass piles per tree on:											
	4/11	4/24	5/10	5/22	6/6	6/20	7/10	7/19	7/27	8/9	8/23	9/7
1	0.0 a	0.0 a	0.0 a	0.2 a	0.0 a	0.0 a	0.1 ab	0.1 ab	0.0 a	0.0 a	0.0 a	0.1 a
2	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.1 ab	0.0 a	0.0 a	0.0 a	0.0 a	0.1 a
3	0.1 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.3 ab	0.2 ab	0.0 a	0.2 ab	0.3 a	0.0 a
4	0.3 a	0.1 a	0.5 a	0.7 a	0.6 a	0.0 a	0.2 ab	0.0 a	0.0 a	0.0 a	0.4 a	0.2 a
5	0.2 a	0.3 a	1.6 a	0.8 a	0.9 a	0.0 a	0.0 a	0.0 a	0.2 a	0.0 a	0.0 a	0.1 a
6 (untreated)	0.1 a	0.0 a	0.3 a	0.3 a	0.6 a	0.7 b	0.5 b	0.3 b	0.0 a	0.3 b	0.3 a	0.3 a

*Means followed by the same letter are not significantly different at the 5% level (DMRT).

C. Conclusions

After two years of study on the American plum borer complex, a number of conclusions can be made. They are:

(1) The American plum borer complex consists of a number of pest species. They are American plum borer, plum limb borer, peach twig borer and carpenterworm. However, only American plum borer and plum limb borer do extensive damage.

(2) Carmel and Price varieties are more seriously affected and have higher populations of the borers than other varieties. However, all varieties may become infested to some degree.

(3) Damage is more severe on young almonds (2nd to 5th leaf). However, American plum borer complex can be found on trees of any age. When young trees are infested, the larve mine at the junction of the trunk and main scaffold limbs. The limbs become weakened and will break in high winds or when the first heavy crop is set. Because of this, the trees must be removed.

(4) American plum borer complex will first infest any damaged (mechanical or wind) tree, and high infestation levels will be found on injured trees.

(5) A number of insecticides in combination with interior white latex paint at 1:4 to 1:6 (paint to water) can be used to control American plum borer complex. We recommend Sevin or Diazinon because they are currently registered for use on almonds, are reasonably safe to handle, are inexpensive and provide excellent control

for three months when combined with paint. Insecticides without paint provide some control, but it is not long lasting. Paint without insecticide provides little or no control.

(6) Insecticide and paint combinations do not have to be applied in a preventive manner but can be applied once boring activity is observed. Usually two to three applications should be adequate for control.

III. Ovipositional Disruption of Navel Orangeworm

Ovipositional disruption is similar in concept to mating disruption in that the purpose of both is to permeate the air with the odor of an object in order to make it impossible for the insect to locate the object by flying toward its odor. To disrupt navel orangeworm oviposition, the air surrounding the almond tree could be permeated with the odor of almond nut, the ovipositional stimulant, by spraying the tree with materials such as crude almond oil or powdered almond press cake plus crude almond oil. The female then would not be able to "smell" the nut (mummy or sound-split) on which to oviposit. Such materials could be applied early in the spring during the first ovipositional period, when the available ovipositional sites and populations are low, to make it difficult for the navel orangeworm to reproduce. They could also be applied at hull-split to protect the sound nuts and lessen the severity of infestation.

Research conducted during 1983 indicated the possibility of emulsified crude almond oil or a wettable powder formulation of powdered almond press cake and crude almond oil causing a disruption of the nut-finding ability of NOW. Reported here are the results of large-scale field trials of crude almond oil used to disrupt the nut-finding ability of NOW.

A. Methods and Materials

Four orchards (10 to 40 acres in size) in Fresno and Madera counties were split into two equal parts. On one part 5 gal of crude almond oil with 2% emulsifier (Triton X-363M) per acre and

100 gal water per acre were applied with a commercial air blast sprayer. The other part was left untreated. The orchards were treated with the oil between April 23 and May 1. No insecticides were applied to any of the orchards during the entire season.

Eight standard Zoecon NOW egg traps which were painted black and baited with 15 g of ground almond press cake + 10% crude almond oil by weight were placed in a uniform manner through each side of each orchard. Traps were placed in the orchards on March 29 and monitored twice a week until June 4-7. The bait was changed once a month. Mummy nuts were sampled on May 30 - June 1 by searching each side of each orchard for a maximum of 8 man-hours, and at commercial harvest 1000 nuts from each side of each orchard were inspected for damage.

Orchards:

No. 1: The orchard was a 40-ac block of 10-year-old Thompson and Merced. The southern portion (ca. 20 ac) was treated on April 23. For the first two tanks, about 2 gal oil/ac rather than 5 gal/ac was applied because of improper calibration of equipment. In the last two tanks, the oil formed an inverse emulsion, thus very little oil was applied with these tanks. This orchard was not used in the analysis because of the application problems.

NOW egg traps were placed in the orchard on March 29 and monitored until June 4. Mummy nut samples were collected on May 30, and final harvest samples were collected on Sept. 11.

No. 2: The orchard was a 40-ac block of 10-year-old Nonpareil and Carmel. The northern portion (20 ac) was treated on April 30.

NOW egg traps were placed in the orchard on March 29 and monitored until June 7. Mummy nut samples were collected on May 29, and final harvest samples were collected on Aug. 17.

No. 3: The orchard was a 30-ac block of 10-year-old Nonpareil and Carmel. The southern portion (ca. 15 ac) was treated on April 30.

NOW egg traps were placed in the orchard on March 29 and monitored until June 7. Mummy nut samples were collected on May 29, and final harvest samples were collected on Aug. 2.

No. 4: The orchard was a 10-ac block of 15-year-old Thompson and Mission. The eastern portion (ca. 5 ac) was treated on May 1. Because of the inverse emulsion problem, additional emulsifier, about 1 pt (Joy soap), was added to each 250 gal tank.

NOW egg traps were placed in the orchard on March 29 and monitored until June 7. Mummy nut samples were collected on May 30, and final harvest samples were collected on Aug. 29.

B. Results

In all orchards except No. 1, there was nearly complete suppression of oviposition of NOW for the entire spring after the oil application (Figs. 7-10 and Table 4). When the percent eggs/trap/day (without orchard No. 1) was analyzed, there was no significant difference in the percentages before treatment while there was a significant decrease of 82% after treatment (Table 5).

There was a corresponding decrease of about 83% in the number of infested mummy nuts (Tables 6 and 7). This decrease probably would have been more dramatic had the oil been applied earlier in the spring or had two applications been made.

In the final nut harvest, there was no difference in percent infestation between the treated and untreated portions of the orchards (Table 8). However, very few NOW were found at harvest in either the treated or untreated portions of the orchards.

C. Discussion

The four orchards were selected because all had high mummy nut infestations and the growers would not treat during the spring. However, a high wind storm on about April 26 caused a large drop in the number of mummy nuts. Thus, mummy nuts in all orchards but No. 4 were quite low and we had to search for a considerable period of time to collect even a low number.

In the application of the oil, we had a very difficult time with orchard 1. First, the spray rig was not putting out the volume of spray that it should (low pressure when both sides were open). Thus, the first two tanks applied were at about one-half the rate of oil. Then on the last two tanks an inverse emulsion formed. We believe the emulsion was created by severe agitation of the residual oil and water in the tank at the end of the run. When more oil and water were added, the entire tank formed the emulsion. To get around this problem, we cleaned the tank thoroughly and added additional emulsifier. The application on orchards No. 2 & 3 went very well with a proper delivery rate and no additional emulsifier added. At orchard No. 4, an inverse emulsion again formed, but by adding more emulsifier we broke up the emulsion and the application went on well.

In all orchards we noticed a phytotoxic burn of the foliage and some leaf drop. The phytotoxicity was not observed in the 1983 study. It appears that the application of large quantities of oil to very young foliage was the cause of this problem. Further studies are needed in this area.

D. Conclusions

The disruption of NOW nut-finding ability with the application of crude almond oil was demonstrated to be feasible. The oil suppressed oviposition for a number of weeks after application, with a corresponding suppression in the number of NOW-infested mummy nuts. The use of crude almond oil ($.50/lb) or a wettable powder of reject almonds ($.07/lb) to suppress NOW appears to be a promising area of research which might result in the adequate control of NOW at a very low cost and without disruptive effects on predators and parasites. Thus, mite problems which sometimes result from the use of insecticides such as Sevin, Guthion or Pounce might be eliminated and the parasites of the NOW might become more firmly established.

Fig. 7

DISRUPTION OF NAVEL ORANGEWORM OVIPOSITION USING CRUDE ALMOND OIL--FRESNO, CA, 1984. ORCHARD NO. 1

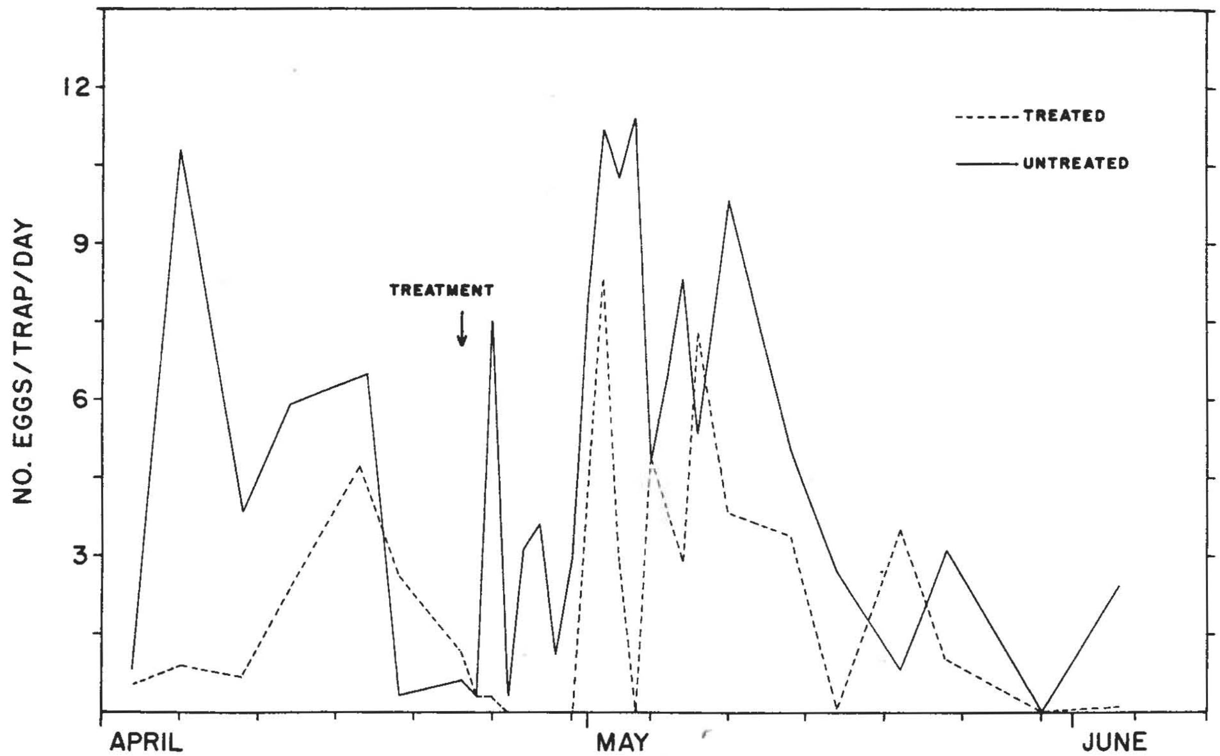


Fig 8

DISRUPTION OF NAVEL ORANGEWORM OVIPOSITION USING CRUDE ALMOND OIL-- MADERA, CA, 1984. ORCHARD NO. 2

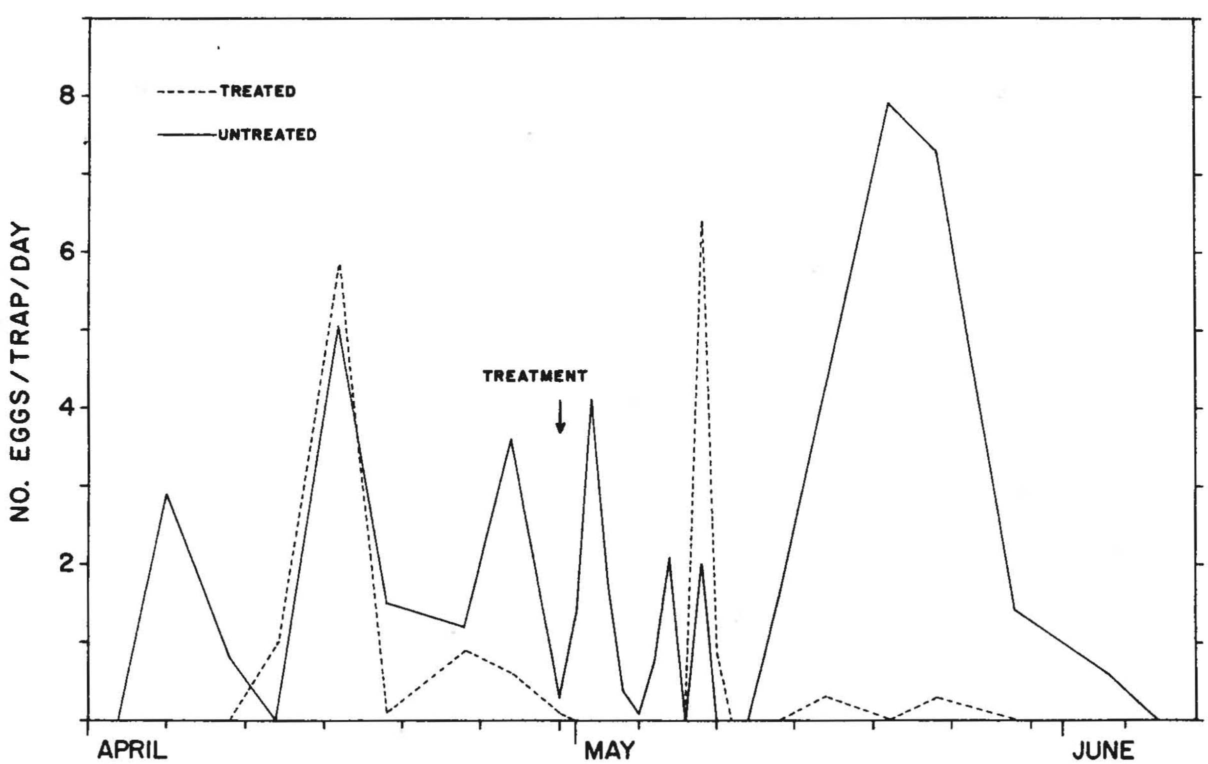


Fig. 9 **DISRUPTION OF NAVEL ORANGEWORM OVIPOSITION USING CRUDE ALMOND OIL--MADERA, CA, 1984. ORCHARD NO. 3**

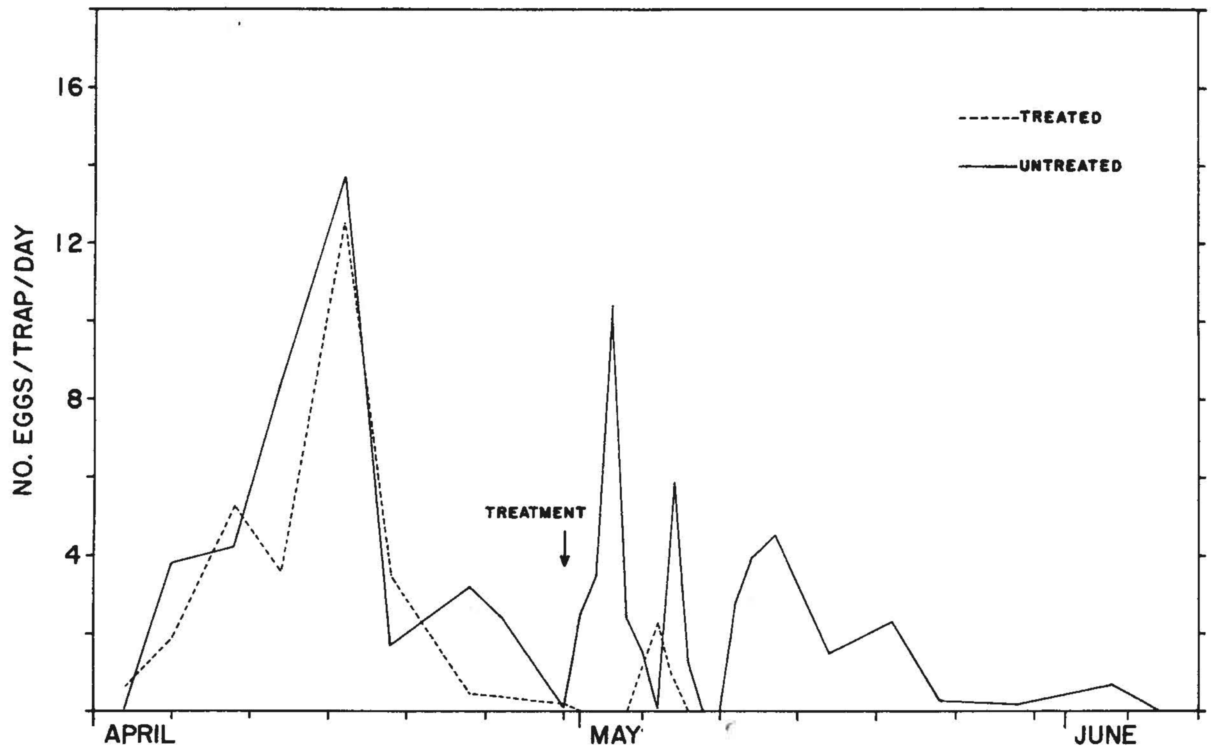


Fig. 10 **DISRUPTION OF NAVEL ORANGEWORM OVIPOSITION USING CRUDE ALMOND OIL--FRESNO, CA, 1984. ORCHARD NO. 4**

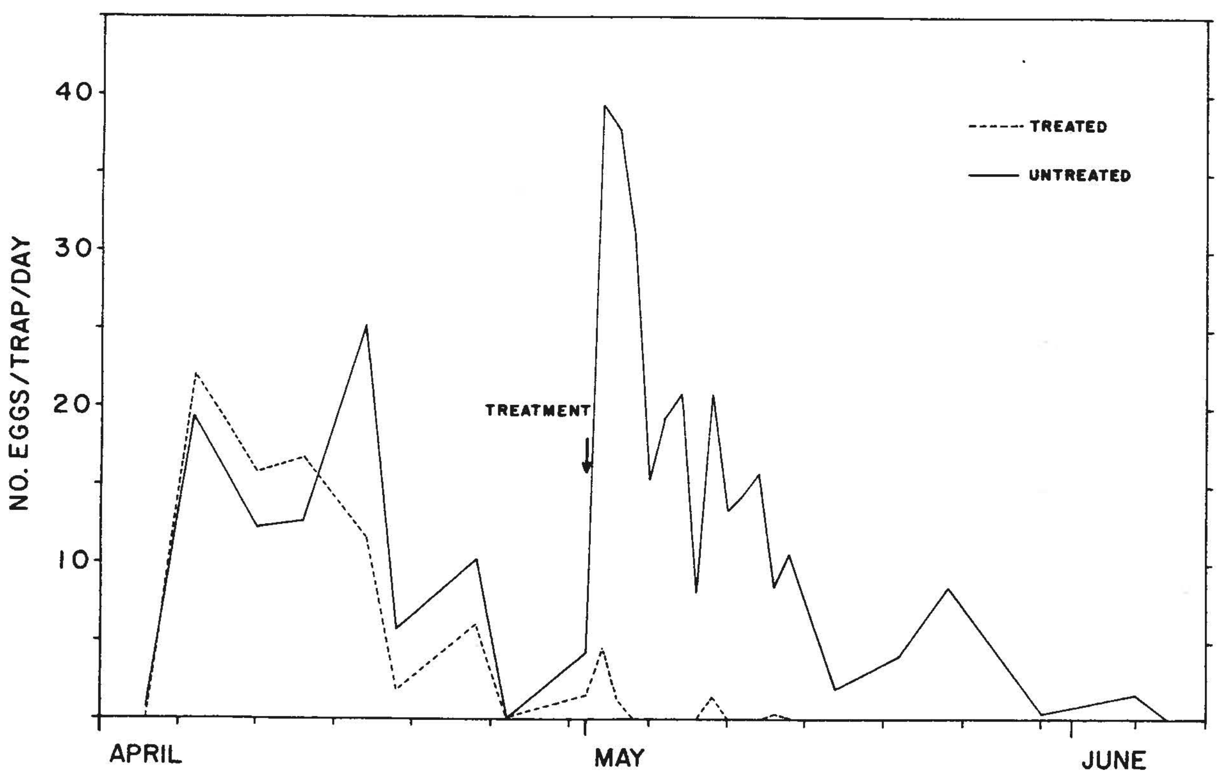


Table 4

NOW Oviposition on Traps in Almond Orchards treated with crude almond oil

	Mean number of eggs/trap/day			
	Before treatment		After treatment	
Orchard	Treated	Untreated	Treated	Untreated
1	1.9	4.1	1.9	4.9
2	0.9	1.7	0.4	1.9
3	3.2	4.3	0.2	2.3
4	8.4	10.1	0.4	14.3

Table 5

NOW Oviposition on Traps in Almond Orchards Treated with Crude Almond Oil (without Orchard No. 1)

	Mean* percent eggs/trap/day	
	Before treatment	After treatment
Treated	41 a	9 a
Untreated	59 a	91 b

*Data analyzed with the arcsin transformation. Means followed by the same letter are not significantly different at the 5% level (Student's Paired T-test).

Table 6

Infested Mummy Nuts in Almond Orchards

Treated with Crude Almond Oil

Orchard	Treated		Untreated	
	No. nuts inspected	% nuts infested	No. nuts inspected	% nuts infested
1	67	31.4	34	47.1
2	10	0	16	6.3
3	14	0	19	10.5
4	88	5.7	130	17.7

Table 7

Infested Mummy Nuts in Almond Orchards

Treated with Crude Almond Oil (without Orchard No. 1)

	Mean No. nuts inspected	Mean* % nuts infested
Treated	37.3	1.9 a
Untreated	55.0	11.5 b

*Data analyzed with the arcsin transformation. Means followed by the same letter are not significantly different at the 5% level (Student's Paired T-test).

Table 8

Infested Sound Nuts in Almond Orchards

Treated with Crude Almond Oil

	% infested nuts*	
Orchard	Treated	Untreated
1	0.7	0.5
2	2.0	1.8
3	0.5	0.4
4	0.5	0.4

*Based on a 1000-nut sample.

IV. Acknowledgments

We greatly acknowledge the efforts of K. Valero, J. Grant, E. Younce and K. Bubrig in the collection of field data and B. Barr and J. Hayashi in data analysis and preparation of this report.

V. Publications

1) Van Steenwyk, R. A., L. C. Hendricks, L. W. Barclay, and E. L. Younce. 1984. American plum borer control on almonds, 1983. Insecticide and Acaricide Tests. 9:64.

2) _______________. 1985. Control of the borer complex on almonds, 1984. Ibid. (In press).

3) Van Steenwyk, R. A., and W. W. Barnett. 1985. Improvement of navel orangeworm egg traps. J. Econ. Entomol. (In press).