1976 Annual Report

California Almond Board

Project No. 76-H

Correct Project Number 76-H3

Title: Navel Orangeworm Field Research, Application and Time of Chemicals

Prepared by: Dr. R. E. Rice

University of California

Objectives: To develop methods and techniques for chemical control of navel orangeworm which will serve as an alternate or supplemental system to cultural controls.

Interpretive Summary: Field research conducted during the past 3 years on the biology and chemical control of navel orangeworm in almonds has led to the conclusion that insecticides may often become an economical, integral part of the total pest management program directed against this pest.

The primary component of any navel orangeworm control program is good sanitation and clean-up, during both harvest and winter periods. The winter cultural control program should include tree knocking during wet weather to remove mummy or sticktight nuts, followed by complete destruction of mummy nuts on the ground by shredding or discing prior to March 15. The most minimal NOW control program should at least include the elimination of ground nuts, even though tree knocking was not done for some particular reason. In addition to killing a high percentage of the NOW population, removal of the mummy nuts on the ground shortens the moth emergence period in the spring, and thus permits better detection of peak egg laying periods.

Following the cultural control phase, a grower can decide whether or not chemical controls should be applied to supplement the cultural program. Based on current production economics, chemicals would usually be indicated as part of the control program if total worm damage to nut meats has been in excess of 8-10% annually over the past 2 or 3 years. Chemical applications might also be indicated where worm damage has been less than this, but where cultural controls are expected to be less than optimum (such as during dry winters when trees don't knock clean, or wet years when orchard entry is limited). Complete reliance on chemicals in the absence of any attempts at cultural control is not a recommended approach to optimum, economical NOW control.

Data from throughout California has shown that a single early season spray directed against the beginning of NOW egg hatch, usually sometime in May, can provide 60-80% reductions in worm damage to nut meats at harvest. These results include combined NOW and peach twig borer control, since twig borer damage is also markedly reduced by the May spray. Data from 1976 only indicates that effective chemical controls can also be applied at the beginning of the 2nd period of NOW egg laying during late June or early July. However, much greater care must be taken during this period not to apply chemicals too close to harvest.

Accurate timing of chemical applications to the onset of maximum NOW egg hatch can be achieved during either May or June by the use of NOW egg traps. These traps should be placed in the field during late March or early April and inspected at least twice weekly for NOW eggs. No fewer than 3 egg traps should ever be used in any monitoring program. Initial oviposition during the spring will usually be sporadic, i.e., a few eggs laid on a trap(s) one night, followed by several nights with no oviposition.

Once oviposition becomes consistent, with eggs laid every night or two (usually during the first prolonged warm period in the spring), several traps with eggs of known oviposition date (age) can be isolated and the eggs marked for observation. When these eggs begin to hatch, usually 7-10 days after being laid, given normal May weather, then the chemical treatment should be applied. The same procedure should be followed for timing the June or July treatment, with the only major difference being a much shorter (3-5 day) interval between egg laying and egg hatch. By knowing when eggs are being laid and approximate interval for hatching, growers can anticipate timing of sprays, and thereby program other orchard operations reasonably well.

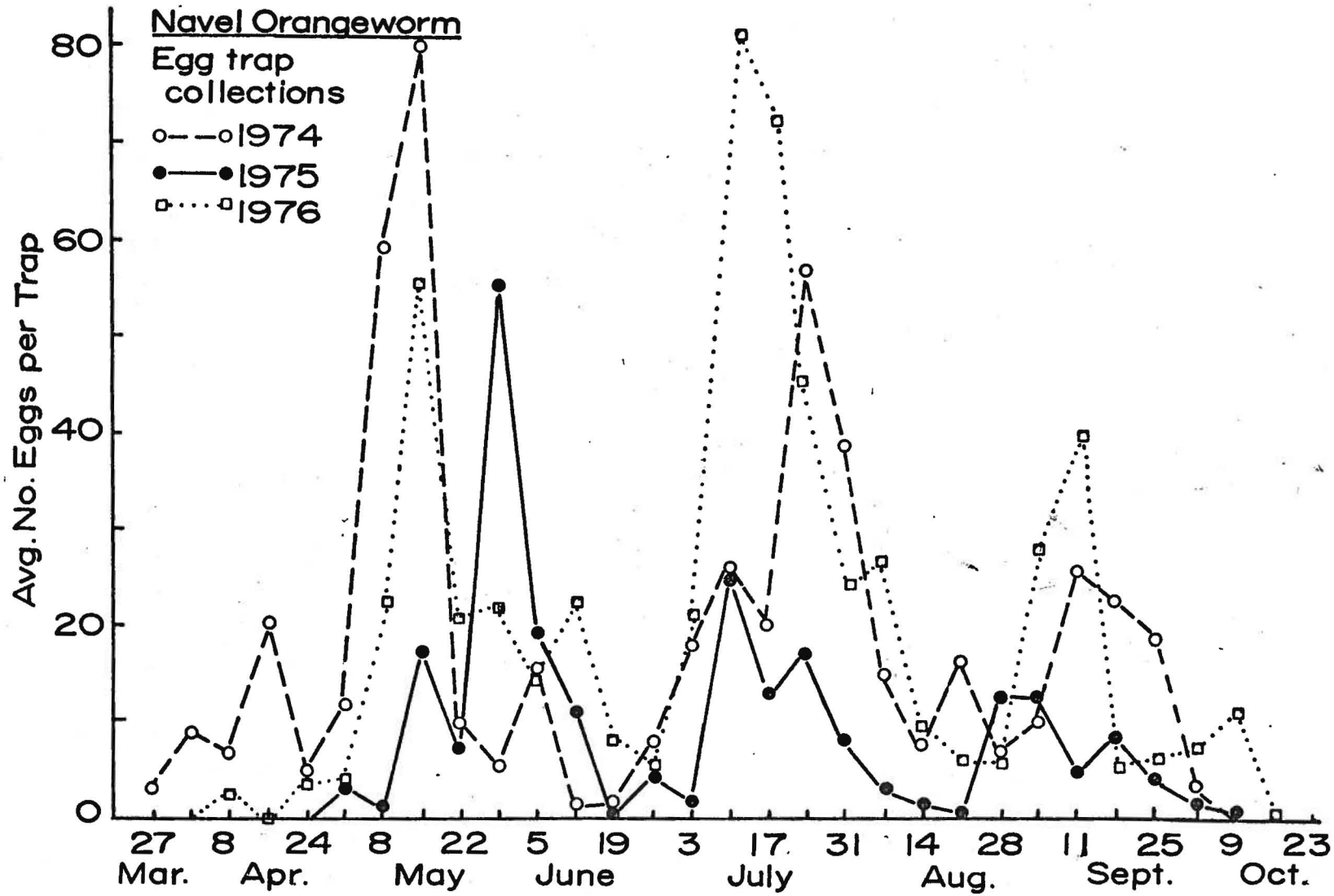
Methods of chemical application can be either dilute at 400 gallons or more per acre, or concentrated at 100 gallons per acre. These rates have proved effective when applied and timed accurately. Application of chemicals by aircraft for NOW control is not recommended at this time.

Results and Discussion of 1976 Research:

I. Seasonal Monitoring

Data from the 1976 season confirmed the seasonal egg laying patterns observed on egg traps in almonds in 1974 and 1975 (Fig. 1). Egg laying began in 1976 during the first week of April and continued at low levels until the first week in May. Oviposition peaked ca. May 15, then declined slowly until late June. The second major period of egg laying began in early July, and as in previous years, coincided closely to the beginning of hull split on early varieties.

As hull split progressed, efficiency of the egg traps declined (mid-July to early Sept.) until most hulls had dried and the trees had been knocked. Once the new crop nuts were removed from the trees, oviposition


Navel Orangeworm
Egg trap collections
1974
1975
1976
Avg. No. Eggs per Trap
0
20
40
60
80
27 Mar.
8 Apr.
24
8 May
22
5 June
19
3 July
17
31
14 Aug.
28
11 Sept.
25
9 Oct.
23

on the traps again increased briefly, and then continued at declining levels into October.

II. Chemical Control Tests

Chemical control trials were conducted during 1976 to try and improve on the control results of previous years. Azinphosmethyl (Guthion®) was applied to a 40 acre block of mature almonds at Caruthers, Fresno County, on May 10, and to a 2nd 40 acre block of trees on July 1, 1976. Application rates were 4.0 lbs. of Guthion 50 W in 100 gals. water per acre. These treatments were applied to trees that had been culturally cleaned (hand-poled) during February, and mummy nuts blown from berms and disced under prior to March 15 when NOW moths were expected to begin emerging.

These plots were compared to a 40 acre block that received only the cultural clean-up (check), and to a large adjacent block of trees that received removal of ground mummies only (trees not cleaned in Feb.) plus an application of Guthion @ 4.0 lbs. 50 W in 80 gal. water/acre on May 15 (Growers plot). Harvest samples of nuts were taken from each of these four treatments on Sept. 15 by knocking 10 selected Nonpareil trees and removing at random ca. 3000 nuts from each tree. From each of these field samples, 250 nuts were hand cracked and examined for damage by navel orangeworm, peach twig borer, and other worms (oriental fruit moth, omnivorous leaf-roller, etc.). The Sept. 15 harvest date was later than initially anticipated due to rain in early September.

The results of these tests (Table 1) show that both the May 10 and July 1 sprays significantly reduced NOW damage (Sept. 15 harvest) by 61% and 80% respectively, compared to the check. Control of "other worms", primarily peach twig borer, was also significantly improved by the chemical sprays. There were no statistical differences between the May 10 and July 1

Table 1. 1976 NOW control plots, L. D. Properties, Caruthers.

	Percent damaged nonpareil meats[1/]							
	Sept. 15 samples				Oct. 22 samples			
Treatment[2/]	NOW	Other worms	Total	% Reduction	NOW	Other worms	Total	Damage increase
Guthion, July 1	2.5a[3/]	0.4a	2.9a	83.5	18.6	0.2	18.8a	6.48X
Guthion, May 10	5.0a	0.6a	5.6a	68.2	32.3	0.9	33.2 b	5.93X
Growers	11.5 b	1.9a	13.4 b	23.9	43.1	-	43.1 c	3.22X
Check	12.8 b	4.8 b	17.6 b	-	33.6	2.2	35.8 bc	2.03X

1/ Nuts mechanically knocked Sept. 15, 1976. Ten 250 nut samples taken from each treatment.

2/ All plots culturally cleaned. Guthion 50W applied at 2.0 lbs. A.I./acre in 100 gal. H_2O/ acre. Growers plot treated 5/15 w/ Guthion 50W @ 2.0 lbs. A.I./acre; 80 gpa.

3/ Means followed by the same letter are not significantly different at the .05 level, Duncan's multiple range test.

Guthion sprays for NOW alone, other worms, or total damage. The Growers plot was not statistically different in NOW damage or total damage from the check, probably due to the very high numbers of mummies left in this block (avg. 75+/tree). The Guthion treatment did result in a noticeable reduction in twig borer damage in the Growers plot.

Table 1 also shows the effects of leaving new crop nuts in the orchard past the earliest possible harvest date. Following the first rain in early September, nuts in the trees and on the ground were again approaching dryness for knocking and/or pick-up when a 2nd period of heavy rain occurred from Sept. 28 - Oct. 1. This storm again delayed nut removal from the field until ca. Oct. 20, with the resulting extreme increases in NOW damage as shown in Table 1 (October 22 samples). Analysis of these data showed that the July 1 treatment had gained a statistical advantage over the May 10 spray, although magnitudes of increased damage were 6.5X and 5.9X respectively. It was also shown that delaying harvest for ca. 5 weeks resulted in the loss of control from the May 10 spray compared to the check. Comparison of these data graphically illustrates the need for early harvest in navel orangeworm control programs, even where good sanitation and chemical controls have provided an initial advantage and benefit. In other words, all of these efforts go together to make the optimum control package for NOW.

III. Timing of Chemical Sprays

Timing of the May 10 Guthion spray in 1976 was based on an approximate 7-10 day "hold" period after the beginning of the first major egg laying period was identified on ca. May 1. This short delay in treatment was programmed into the timing schedule to allow the eggs laid on mummy nuts during late April and the first week in May to reach their immediate pre- or post-hatch stage. It should also be pointed out that destruction of nuts on the

ground appears to help in identifying this first oviposition period by reducing the amount of earlier egg laying in April. The May 10 timing placed the chemical application into the heaviest oviposition period (May 8-15).

The July 1 spray was timed by two primary factors: 1) the beginning of the 2nd oviposition period expected (and observed) during late June/ early July, and 2) the required 60 day interval for Guthion between last application and harvest on almonds. A Sept. 1 harvest date had been anticipated for Nonpareils, prior to the unusually cool August weather followed by the September and October rains.

IV. Biological Studies

1. Egg trap bait modifications. Field comparisons during 1976 of several modified bait formulations indicated that it is not necessary to autoclave the standard wheat bran bait prior to use. Non-autoclaved bait was more attractive than autoclaved bait. There are also some indications that honey is not a required ingredient for the bait to be attractive to NOW females.

2. Sex ratio of NOW moths responding to bait traps. Standard, baited egg traps were placed through the tops of Zoëcon I-C sticky traps and the sex of NOW moths trapped was studied between April 30 and Nov. 5, 1976. During this period a total of 354 female and 39 male NOW moths were collected, giving a ratio of 9.1 females:1 male, or 90.1% females responding. This compares to a similar study in 1975 which showed a sex ratio of responding moths of 11.6 females:1 male, or 92.1% females. During the 1976 study, a total of 11 raisin moths (all females) were collected in the traps.

3. Egg trap design modification. Comparisons of the egg trap commercially manufactured by Zoëcon Corp. to other traps with rougher exterior

surfaces showed that more eggs were laid as surface irregularities increased. However, the designs tested and compared to the present Zoecon trap would preclude efficient mass production.

4. Oviposition height studies. A test first conducted in 1973 was repeated in 1976 to determine at which height(s) within almond trees NOW females prefer to lay their eggs. This study indicated that there are no statistical differences in oviposition at heights between 3 and 15 feet. Significantly less oviposition occurred at 18 feet (top of tree canopy) and at 0 feet (ground level). These data confirm the 1973 test data, and again show that some slight oviposition (1.3% of total) can occur at ground level, even though other oviposition sites are readily available in the trees.

5. Mechanical destruction of ground mummies as a control measure. Large, screened emergence cages (.001 acre size) were placed in two almond orchards to determine the effects of discing or shredding of mummy almonds on subsequent survival and emergence of NOW moths. In the first orchard, cages were placed over nuts laying on herbicide treated berms. In adjacent areas of the orchard row, nuts were disced under on March 12, and cages were then placed over the disced areas. Each cage area (replicate) initially contained 72 mummy nuts collected at random from the test orhcards. The results of the discing study showed an average of 40.25 moths emerging per cage on the berms between March 15 and June 25, while only 1.88 moths emerged per cage in the areas that were disced. This was a reduction in moth emergence of 95.3% as a result of discing.

In the second orchard identical procedures were followed, except that the nuts in the orchard row were shredded on March 10, 1976, with a flail shredder set at ground level. Moth emergence in this test averaged 21.71 per cage on berms, and 0.43 moths per cage in the shredded areas, giving an

emergence reduction of 98%. Clearly, destruction of mummy nuts by either discing or shredding prior to March 15 is a valuable aid in reducing the total overwintering NOW population in an orchard.

6. Identification of NOW oviposition attractants. The cooperative research project with Dr. Kay Ryugo designed to identify the volatile NOW attractants produced by various maturity classes of almonds was continued during 1976. Field testing of ca. 30 different solvent extracts of fresh or frozen almond material failed to give any positive leads toward attractant identification. Consequently, a shift in emphasis in this program seemed warranted. Attempts are now being made, in cooperation with the Department of Food Science and Technology, U.C., Davis, to identify the volatile components of the wheat bran egg trap bait. This effort will initially emphasize gas chromatography and mass spectrophotometry for identification of the volatile materials given off by the bait.

Advantages in working with the wheat bran bait rather than almonds themselves are that the standard bait material is readily available throughout the year in large quantities, and changes in production of volatiles through time by the bait can be readily measured both quantitatively and qualitatively.

Publications:

Rice, R. E. 1976. A comparison of monitoring techniques for the navel orangeworm. Jour. Economic Entomology 69(1):25-28.

Rice, R. E., L. L. Sadler, M. L. Hoffmann, and R. A. Jones. 1976. Egg traps for the navel orangeworm, Paramyelois transitella (Walker). Environmental Entomology 5(4):697-700.

Rice, R. E., and L. L. Sadler. 1977. Egg traps for monitoring navel orangeworm in almonds. Calif. Agric. (in press).

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SECTION I

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December 27, 1976

Mr. Dale Morrison
Director, Special Projects
Almond Board of California
P. O. Box 15920
Sacramento, California 95813

Dear Dale:

Enclosed are the 1976 project report and new project proposal for navel orangeworm research under Project 76-H. In the new proposal for 1977, you will note that I have referred to Dr. Walt Jennings as playing an integral role in this proposal. Dr. Jennings will submit his own proposal and budget, through Warren Micke, for his part of this cooperative research.

Best wishes for the New Year, and see you on the 25th.

Sincerely yours,

Dick

Richard E. Rice
Associate Entomologist

RER:sf

Enclosures