Improved NOW egg traps

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Spraying traps black increases egg laying by navel orangeworm moths

Although the navel orangeworm is primarily a scavenger that feeds on damaged, mummified, or decaying fruit on a wide range of plant species, in California it can become a serious pest of sound almond, walnut, and pistachio nuts after hull-split. Larvae of this insect, *Amyelois transitella* (Walker), infest sound nuts only after hull-split, because females do not lay eggs on green nuts.

The most suitable device for monitoring navel orangeworm populations has been a trap upon which female moths lay eggs. The effectiveness of the egg trap decreased after hull-split, apparently because newly split nuts competed with the trap in attracting egg-laying females. We conducted studies from 1982 to 1984 to improve the trap so that it would more accurately reflect the navel orangeworm population late in the season and thus be more useful in determining the need and timing for an insecticide application.

The standard trap, developed by Dr. R. E. Rice, Entomologist, University of California, and now manufactured commercially, is a clear plastic vial with two large windows covered with polyester screening. The body of the trap is smooth except for an area of concentric ridges above and below the trap windows where the screening is attached. Females lay eggs primarily between the ridges in this roughened area. Originally, the trap was baited with a formulation of bran, honey, glycerol, and water and, more recently, with 15 grams of ground almond press cake.

Features investigated in 1982 and 1983 were trap color and texture, kind and amount of bait, and length of time the bait remained effective in the field. The experiments were conducted in almond orchards near Fresno. In 1984, we compared the performance of an improved egg trap developed during the previous two years with that of the standard trap in several almond orchards in Kern, Fresno, San Joaquin, and Butte counties. Unless stated otherwise, we monitored traps in the replicated experiments twice a week, and rotated trap position and changed bait once a week.

Trap color

In 1982, standard egg traps painted yellow, black, lime green, dark green, or blue and an unpainted standard trap were baited with 15 grams of ground almond press cake. We placed the traps in the orchard on August 19 and monitored them through September 22.

Significantly more eggs were deposited on the black traps than on those of any other color (table 1). In general, more eggs were laid on traps painted with less reflective colors (black and dark green) than on those painted with more reflective colors (yellow). Approximately 3.5 times more eggs were laid on the black traps than on unpainted standard traps. The white or pink navel orangeworm eggs were also more visible on the black traps, reducing counting time. The navel orangeworm, which infests mummy nuts that are black or sound split nuts that are green, apparently is attracted to traps painted these colors.

In 1983, egg traps were black, white, blue, yellow, light green, dark green, light gray, and dark gray. The blue traps were much lighter than those in the 1982 study and the light green traps were darker and less yellow than the 1982 lime green traps. Painted traps and unpainted standard traps baited with 15 grams of ground almond press cake were placed in an orchard on April 27 and monitored through September 15.

As in the previous year, significantly more eggs were deposited on black traps than on those of any other color; there were about 1.8 times more eggs on black than on unpainted standard traps. Again, females laid more eggs on traps of less reflective colors (black and dark green) than on those of more reflective colors (white and light gray). The black and dark green traps had 2.7 and 2.1 eggs per trap per night, respectively, and light gray and white had 1.1 and 1.

Trap surface

Additional ridges for egg-laying were created between the windows and the top of the trap. The added surface was similar to the roughened surface already on the trap and was made of silicone clear glue. We baited unpainted rough traps and standard traps with 15 grams of ground almond press cake, placed them in an orchard on April 27, and monitored them through June 9.

Significantly more eggs were deposited on the rough traps (3.5 eggs per trap per night) than on the standard traps (2.8 eggs). Although the added roughened surface provided about twice as much area, egg deposition increased by only one-fourth. The increased area for egg-laying added to the time needed to inspect the traps and made them more difficult to handle. The slight increase in trap effectiveness was not sufficient to offset the increased searching time per trap.

Bait formulation

In 1982, we tested six baits in standard egg traps: 15 grams ground almond press cake (the bait used in commercially available traps), 13.5 grams ground almond press cake mixed with 1.5 grams either refined or crude almond oil (10 percent oil by weight), a 25 mm dental wick soaked with 1.5 grams refined or crude almond oil, and a 10-gram bran formulation (bran, 24 parts; honey, 2; glycerol, 2; water, 1). Baited and empty traps were placed in an orchard on August 19 and monitored through September 22.

There were significantly more eggs on traps baited with almond press cake mixed with either crude or refined almond oil than on those baited with the bran formulation (table 2). More eggs were laid on traps baited with almond

press cake mixed with either crude or refined almond oil than on those baited with press cake, alone, but the differences were not significant. Few eggs were deposited on traps baited with crude or refined oil alone, and the difference between these and unbaited traps was slight.

In 1983, we baited standard traps with five different proportions of crude almond oil to ground almond press cake by weight (0, 2, 5, 10, and 25 percent oil), using 15 grams of each bait. Traps were monitored from placement in an orchard on April 27 through June 1.

Significantly more eggs were deposited on traps baited with almond press cake and 10 and 25 percent crude almond oil than on those with press cake alone (table 3). Egg deposition did not change with the increase in oil from 10 to 25 percent. Baits containing more than 25 percent oil became very oily and difficult to handle and were not tested.

The fact that more eggs were deposited on traps when almond oil was added to the press cake in all experiments leads us to speculate that the oil contains an attractant and/or egg laying stimulant that is absent or less abundant in the press cake. The missing component may be more abundant in crude than in refined almond oil, since more eggs were deposited on traps baited with press cake and crude oil than on those baited with the cake and refined oil (table 2).

Bait longevity

We placed 10 standard egg traps baited with 15 grams of ground almond press cake and 10 percent crude almond oil in an orchard each week for eight consecutive weeks. After eight weeks, bait that had aged eight weeks was replaced with fresh bait every week. For the first eight weeks, we rerandomized the trap position once a week and, after that, rotated the position once a week. We placed the traps in the orchard on June 1 and monitored them through September 1.

Navel orangeworm populations were quite low during the first 10 weeks of this experiment, with 92 percent of the weekly trap catches from June 1 through August 11 averaging fewer than 1 egg per trap per night. Between August 17 and September 1 the number of eggs deposited increased; 50 percent of the weekly catches averaged more than 1.5 and 33 percent averaged more than 2.5 eggs per trap per night. Even at the higher egg-laying levels, there was no indication that bait of any one age was consistently more attractive than that of any other age. It thus appears that almond press cake with 10 percent crude almond oil will remain as biologically active as fresh bait for at least eight weeks.

Amount of bait

We baited standard egg traps with three amounts of ground almond press cake with 10 percent crude almond oil: 30 grams (to top of trap windows), 15 grams (middle of windows), and 10 grams (bottom of windows). Baited and empty traps placed in an orchard on June 9 were monitored through September 15.

The number of eggs deposited increased with increasing amounts of bait, from an average of 0.9 egg per trap per night at the 10-gram level, to 1.1 at 15 grams, to 1.3 at 30 grams. The unbaited traps had an average of 0 eggs trap per night.

The difference in egg counts between traps with 30 grams and those with 10 grams of bait was statistically significant ($p \leq 0.05$). The previous assumption that bait up to the middle of the trap windows would be most effective because of air flow through the windows does not appear to be correct. Instead, the amount of egg-laying stimulant produced by the trap appears to be directly related to the amount of bait.

TABLE 1. Navel orangeworm egg-laying on traps of various colors, Fresno, California, 1982

Color	Mean No. eggs/ trap/night*
Black	11.4 a
Dark green	7.2 b
Blue	6.0 bc
Lime green	4.7 cd
Standard (clear)	3.3 de
Yellow	2.0 e

* Means followed by the same letter are not significantly different by Duncan's Multiple Range Test ($p \leq 0.05$). Treatments were replicated five times in a randomized complete block design.

TABLE 2. Navel orangeworm egg-laying on traps containing various baits, Fresno, 1982

Bait	Mean No. eggs/ trap/night*
Almond press cake + crude almond oil	6.8 a
Almond press cake + refined almond oil	5.5 a
Almond press cake	4.1 ab
Bran formulation	2.6 bc
Crude almond oil	0.8 c
Refined almond oil	0.7 c
Unbaited	0.6 c

* Means followed by the same letter are not significantly different (DMRT, $P < 0.05$). Treatments were replicated five times in a randomized complete block design.

TABLE 3. Navel orangeworm egg-laying on traps baited with various percentages of crude almond oil to almond press cake, Fresno, 1983

Percentage crude almond oil to almond press cake	Mean No. eggs/ trap/night*
25	4.0 a
10	4.0 a
5	3.2 ab
2	2.5 b
0	2.6 b

* Means followed by the same letter are not significantly different (DMRT, $P \leq 0.05$). Treatments were replicated 10 times in a randomized complete block design.

Trap comparisons

In 1984, we compared two types of egg traps: one was painted black, had added rough area above the trap windows, and was baited with 30 grams of ground almond press cake plus 10 percent crude almond oil by weight; the other was a standard trap baited with 15 grams of ground almond press cake. The study took place in two orchards in Kern County, two in Fresno County, one in San Joaquin County, and one in Butte County. We alternated 10 traps of each type 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.

In all orchards, navel orangeworm females laid significantly more (1.3 to 2.7 times) eggs on the improved than on the standard traps. The average seasonal eggs per trap per night ranged from 1 to 4.8 on the standard traps and from 2 to 8.2 on the improved traps. Peak egg-laying periods were more discernible with the improved trap.

Conclusions

Effectiveness of the standard navel orangeworm egg trap increases with changes in color, texture, bait formulation, and amount of bait, most of which can be made easily and inexpensively. Spraying standard traps with black enamel paint increases egg laying and enhances the visibility of the light-colored eggs, thereby reducing counting time. The bait formulation of almond press cake and 10 percent crude almond oil should extend above the trap windows. A change in trap texture to extend the ridges above the windows is not recommended, since it would require significant time and expense and the ridges would make the trap more difficult to examine for eggs.

These improvements in the egg trap will permit more accurate determination of peak egg-laying and more rapid monitoring of traps.

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