Monitoring peach twig borer in almonds with sex pheromone traps

A total first-flight trap catch of 155 moths is suggested as the economic threshold of nut damage at harvest.

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The peach twig borer, *Anarsia lineatella* Zell., causes two types of injury to the tree and crop of almonds as well as other stone fruits: it damages and kills new shoots by feeding on newly emerged leaves and shoots, and it feeds on new crop nuts. Peach twig borer (PTB) also indirectly causes greater distribution of nut damage by navel orangeworm, *Amyelois transitella* Walker: navel orangeworm is often attracted to PTB-damaged hulls, where it lays its eggs.

PTB larvae may visit several new leaf clusters before settling down to feed on a newly formed terminal. Summer-brood larvae feed on shoot tips or on nuts, or may form a temporary hibernaculum (chamber within the bark).

At the time of hullsplit, PTB larvae begin feeding between the hull and shell. Later, some, but not all, larvae move into the kernels. What causes movement from hull to kernel is not known, but it is thought to be related to the moisture content of the hull and kernel at the time of infestation.

Peach twig borer populations can be monitored in orchards by using sex pheromone traps during the spring and summer. Traps should be placed in the orchard in early April. Several traps are required to monitor the population adequately within an orchard, but no trap should be closer than 300 feet to another trap. Traps are hung 6 to 7 feet high in the northeast quadrant of the tree, 1 to 3 feet from the outside of the canopy. Male moths are attracted and caught in the sticky liner. Moths should be counted and removed at least twice weekly during major flight activity. Pheromone caps should be replaced every four to six weeks and sticky liners should be replaced after 200 moths are caught, when soiled or dirty, or every six weeks, whichever comes first.

Peach twig borer data have been collected during the past three years from joint U.C.-grower integrated pest management demonstration almond orchards throughout California's Central Valley from Kern County in the south to Butte County in the north. Pheromone trap catches and damage to the nuts were monitored in seven orchards in 1978 and six in 1979. The untreated check area in each orchard consisted of two blocks of approximately 10 to 12.5 acres each.

Three pheromone traps were hung 180 feet or more apart in each 10- to 12.5-acre block in 1978. The number of traps used in 1979 was reduced to two per block, more than 300 feet apart, because catches were reasonably consistent within each block, and some interaction between traps in the 10-acre blocks was suspected.

Traps were placed and serviced as indicated. Peak moth catches are reported as moths per trap per day and were computed by dividing the trap catch by the number of days between observations.

The first and second flight periods were determined by field data and also by using a day-degree formula suggesting about 1060 D° per generation for peach twig borer. Temperatures were collected within each orchard by a continuous recording thermograph.

Percentage of damage at harvest was derived from four to twelve 100-nut samples per block, which were hand cracked; the damage percentage was then multiplied by the total yield per acre. These harvest samples were evaluated in late August when the type of feeding damage could be identified. Peach twig borer damage is a typical pattern of surface feeding with very

shallow channels, little frass (dark red in color), and no webbing. Many times the damage rated as being caused by PTB decreased during September because of the masking effect caused by navel orangeworm. Therefore, the damage reported is the amount that would result from peach twig borer if no navel orangeworm damage occurred in the orchard.

The relationship between pounds of damaged nuts and number of moths trapped (fig. 1), as described by the regression equation, y = 2.05 + 0.16X (black line), where y is the pounds of nuts damaged and X is the male moth catch, is highly significant as indicated by the coefficient of correlation (r) value of 0.78. Therefore, each moth caught in the spring flight represents approximately 0.16 pound of nut meat damage at harvest (technically, 2.05 pounds of damage would be observed before any moths are caught in the traps and is a constant that should be added to X).

The r value of 0.81 calculated for the second flight (fig. 2) is also highly significant. The regression equation, as defined by y = 4.85 + 0.11X, shows a slightly different slope than in figure 1.

The two orchards in 1978 where traps were only 180 feet apart caused considerable change in the data (broken line in fig. 1 and 3). If the data from these traps were dropped and the other 11 sites analyzed, the values of r would be 0.84 and 0.92 for figures 1 and 3 respectively. The regression equations for figures 1 and 3 (broken lines) are represented by the formulae y = 4.76 + 0.16X and y = 7.33 + 2.90X, respectively. From these data the sphere of influence from each trap appears to be greater than 90 feet, and it is quite possible that the traps were competing with each other when only 180 feet apart. The 1978 traps in the other orchards were spaced farther apart with most traps between 250 and 300 feet apart. Further work on trap spacing and placement within an orchard appears to be warranted.

Figure 3 shows first flight collections in 1978 and 1979 in relation to harvest damage with an r value of 0.77 and a regression equation of y = 1.46 + 2.73X. Figure 4 shows the second flight peak in 1978 and 1979 in relation to harvest damage with an r value of 0.69 and a regression equation of y = 4.76 + 1.65X. The peak catch represents the highest daily count during the flight period.

The most useful trapping information is from the total moth catch and the peak of the first flight. Appropriate control measures could still be implemented after the first flight threshold levels occurred to prevent economically significant loss to the crop.

Coefficient of correlation values of 0.78 and 0.77 (fig. 1 and 3 respectively) are highly significant, indicating that anticipated PTB damage can be predicted from the first flight. If the adjusted data are used with r = 0.84 and 0.92, an even better correlation is suggested.

If the two orchards in question actually had competition between traps and the data were deleted, the following tentative economic threshold levels could be established to recommend when treatment for peach twig borer is warranted during the spring flight. Assuming an average price of $1.50 per pound for almonds, approximately 20 pounds of kernel damage would be the economic threshold warranting a chemical treatment (chemical and application = $30.00). Therefore, the tentative economic threshold for PTB could be established at either a peak of 9.4 moths per trap per day or an accumulation of 155 moths during the first flight.

In the orchards discussed here plus four orchards observed in 1980, excellent control of peach twig borer was achieved by a spray directed at navel orangeworm in May. PTB damage in all orchards was less than 1 percent: in most cases, the insect caused no damage.

Sprays applied at hullsplit (July) have not prevented damage caused by peach twig borer, and only those applied at very early hullsplit have achieved some control. Observations in orchards showed poor control when chemicals were applied at 5 to 10 percent hullsplit and no control when applied later.

Pheromone traps can be used to determine the effectiveness of a previous dormant treatment, identify problem areas ("hot spots"), time sprays, forecast the need for additional control measures, and predict the amount of damage at harvest if no chemical sprays are applied during the spring. These data suggest that correlations exist between peach twig borer peak flight or total moth catches and pounds of kernel damage occurring at harvest. These correlations exist for both the first and second flights. Data from the first flight can be used to initiate control measures. A tentative economic threshold of 9.4 moths per trap per day or 155 total moths for the first flight is suggested.

Peach twig borer total male moth catch in relation to almond harvest damage.

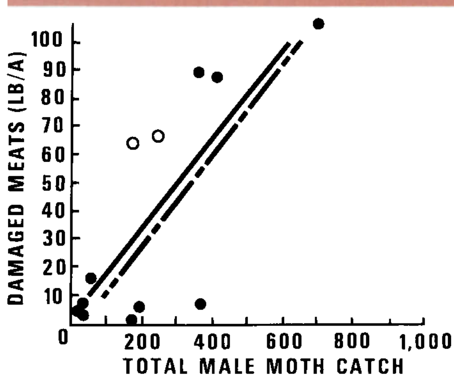

Fig. 1. First flight period April 15 to June 15, 1978 and 1979.

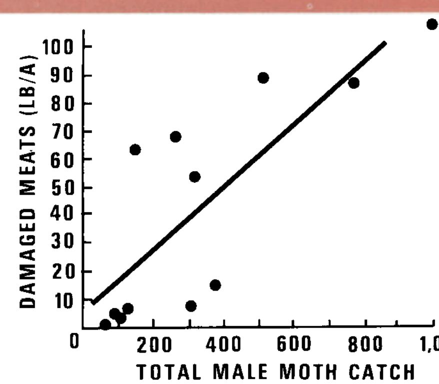

Fig. 2. Second flight period, June 15 to August 1, 1978 and 1979.

Peach twig borer peak daily catch of male moths in relation to almond damage.

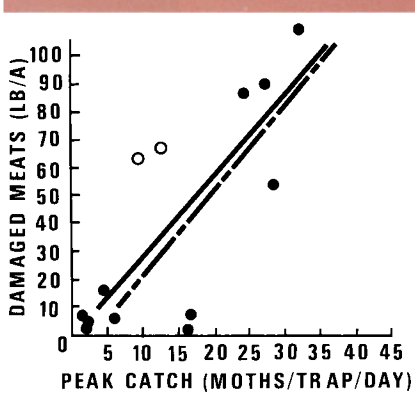

Fig. 3. First flight period, April 15 to June 15, 1978 and 1979.

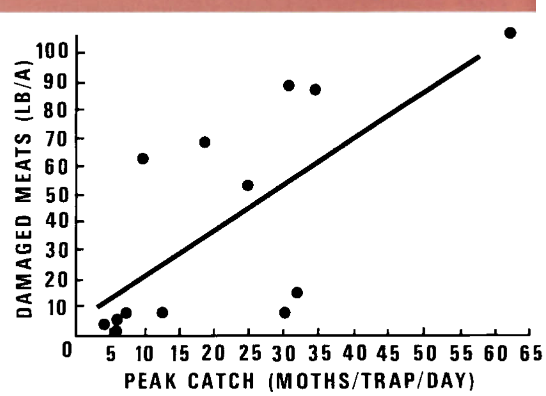

Fig. 4. Second flight period, June 15 to August 1, 1978 and 1979.

Yellow rectangle baited with ammonium carbonate was more attractive to husk flies than Pherocon AM trap (center) or green sphere.

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New monitoring methods for the walnut husk fly

Since its introduction in the mid 1920s into southern California, the walnut husk fly, *Rhagoletis completa* Cresson, has spread throughout the state's walnut-growing areas. This mid- to late-season pest is reportedly a less serious problem in the interior valleys than in coastal regions. Larval feeding inside the walnut husk can injure the nut by staining the shell or by damaging the kernel itself. As with any other pest, practical and efficient monitoring methods are prerequisites for management of the husk fly. Monitoring provides the information on which control decisions are based, thus ensuring the most effective and judicious use of the measures available.

One of the first means of monitoring adult husk flies was a liquid-bait trap containing a solution of 2 percent glycine, an amino acid, and 3 percent sodium hydroxide. In spite of their efficiency, these traps were never very popular. They were difficult to maintain and even dangerous to use because of the alkaline nature of the bait solution.

Like other *Rhagoletis* species, the walnut husk fly is also strongly attracted to ammonia-releasing compounds. Pint-size food-carton traps baited with one such compound—dry ammonium carbonate (*ac*)—and coated on the inside with adhesive were widely used for survey work in the 1950s to follow the advances of the walnut husk fly into new areas. Although these sticky food-carton traps were more practical than the liquid-bait traps for general orchard use, their trapping efficiency was relatively low.

Since both of these established monitoring techniques for the walnut husk fly had drawbacks, we attempted to develop trapping methods more suitable for field use. Recent studies of the visual responses of adult husk flies to various colors and trap shapes revealed strong attraction to yellow when combined with a rectangular trap shape, and to green when combined with a spherical shape.

Response to chemical attractants varied with the trap design with which they were tested. For instance, catches on visually attractive yellow rectangles increased severalfold when *ac* was added but increased only slightly with hydrolyzed protein. However, both chemicals were equally attractive in the white food-carton trap, which by itself had no visual attraction. Fresh *ac* charges ranging from 0.4 to 24 grams attracted the same number of flies. There was also no difference in catches between fresh and up to five-week-old *ac* charges.

From this initial screening of trap shapes,

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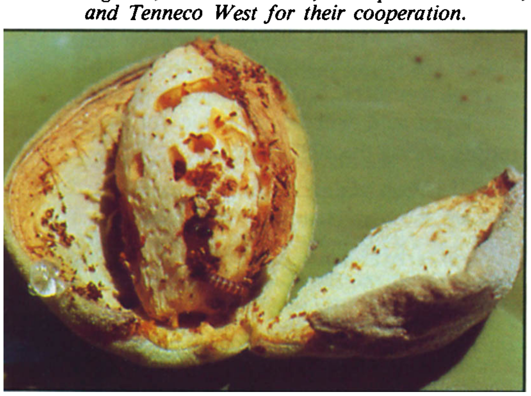

Peach twig borer feeding between hull and shell leaves characteristic red frass.