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

New monitoring methods for the walnut husk fly

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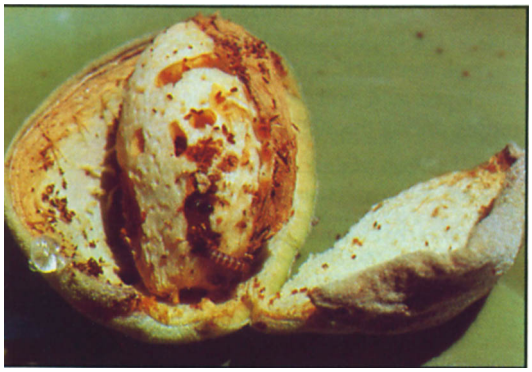


Peach twig borer feeding between hull and shell leaves characteristic red frass.

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 several-fold 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,

colors, and chemical attractants, three trap-attractant combinations were chosen for further field-testing: a yellow rectangle (14 × 23 cm) coated with adhesive and baited with 3 grams of ammonium carbonate in a screen-covered plastic tube; a sticky green sphere; and the commercially available yellow Pherocon AM rectangle (14 × 23 cm) with an adhesive-bait mixture of casein hydrolysate and ammonium acetate. The Pherocon AM trap was originally developed for the apple maggot, *Rhagoletis pomonella,* and has been successfully employed for several other fruit flies, including the walnut husk fly. The purpose of these tests was to compare the efficiency of the three trapping methods throughout the season and to evaluate their usefulness in indicating the onset and time course of egg-laying and damage.

Orchard tests

Similar experiments were conducted in six walnut orchards in Butte, Fresno, Napa, San Benito, and San Joaquin counties. Five traps of each type were set up in a grid pattern before husk fly emergence and left in the orchard until hull split. Traps were placed above eye level, well within the foliage in the north quadrant of the tree.

After every weekly inspection of the catches, traps were rotated to another location to minimize the effect of distributional differences in the husk fly population. Two weeks after the first flies were caught, about 400 nuts were inspected for fresh stings and damage. Nut sampling continued every two weeks until harvest. None of the experimental orchards was sprayed for husk fly during the period of study.

Results and discussion

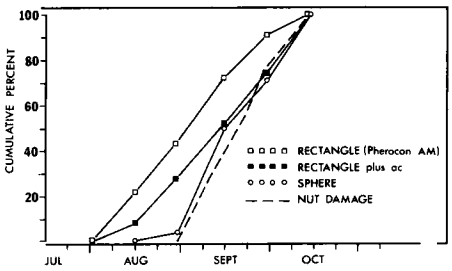
The yellow rectangle baited with *ac* was the most efficient trap in all six tests throughout the season. (Results from three tests are shown in the table and graph.) Over the whole season the *ac*-baited rectangle caught from 8 to 14 times as many flies as the Pherocon AM rectangle and from 6 to 38 times as many flies as the unbaited sticky green sphere. Few flies responded to the spherical traps before the middle or end of August. Once flies began to respond to these traps, the spheres were as attractive as the AM traps.

Data from the orchard in San Joaquin County are graphed as cumulative curves to show temporal relationships between catches in the three traps and damage. Catches in the two rectangular traps began to increase several weeks before female husk flies started to lay eggs. Catches in the spherical traps followed egg-laying activity much more closely. The increase in catches in these traps coincided with the onset of egg-laying. This pattern was similar in the other orchards.

Because of its high trapping efficiency at low population density, the yellow rectangle baited with *ac* may find use not only in monitoring but also for control in mass trapping programs. Preliminary experiments with small walnut trees suggest that it may be possible to remove enough flies from a population with these traps to reduce damage and achieve a measure of control.

Despite their trapping efficiency, the rectangular traps may not be as reliable as spherical traps for timing control measures since the latter were better indicators for the onset of egg-laying. However, additional experiments are necessary to confirm these results.

Trapping efficiency of the green spheres was low, particularly in orchards with low husk fly populations. These traps could possibly be improved by an adjustment in color to more closely mimic walnut foliage and husks. One advantage of the green spheres is their selectivity. Baited yellow rectangles caught several other species of flies, often in large numbers, in addition to husk flies; the green spheres were more species-specific.



Seasonal catches (cumulative percent) in three trap types in relation to 'Serr' walnut damage, San Joaquin County, 1980.

Our research has shown that both the *ac*-baited yellow rectangles and the green spherical traps may have a place in monitoring programs for the walnut husk fly, since each trap type provides different information. However, the value of these traps will be enhanced if they are used in conjunction with a sampling program for husk-fly-infested walnuts to establish the best timing and need for control measures. Such a program is being developed and will be available for field-testing during the 1982 season.

Seasonal Catches of Walnut Husk Flies on Baited Yellow Rectangles and Green Spheres and Development of Nut Damage at Two Locations

Trap	Attractant	Average husk fly catch per five traps during periods indicated*					
HOLLISTER, San Benito County, 'Payne', 1980		**7/4–7/18**	**7/19–7/31**	**8/1–8/14**	**8/15–8/28**	**8/29–9/12**	**9/13–10/2**
Yellow rectangle†	Adhesive-bait mixture†	2.1 b	3.7 b	2.4 b	0.1 b	0.2 c	0.4 b
Yellow rectangle‡	*ac*§	22.0 a	46.0 a	29.1 a	20.1 a	4.7 a	3.8 a
Green sphere	None	0 c	0.8 c	0.8 c	0.6 b	1.0 b	0.1 b
Percent nut damage	—	0	0	0	8.1	9.0	12.1
FRESNO, Fresno County 'Hartley', 1980		**7/1–7/14**	**7/15–7/28**	**7/29–8/12**	**8/13–8/30**	**8/31–9/13**	**9/14–10/5**
Yellow rectangle†	Adhesive-bait mixture†	0.2 b	0.7 b	1.7 b	0.7 a	5.3 b	16.9 b
Yellow rectangle‡	*ac*§	2.6 a	3.4 a	20.9 a	1.2 a	46.1 a	129.0 a
Green sphere	None	0 c	0 c	0.3 c	0 b	6.7 b	26.8 b
Percent nut damage	—	0	0	0	0	0.8	1.4

*For each orchard, means in each column with the same letter are not significantly different at P = 0.05 according to Duncan's multiple range test.
†Commercially prepared Pherocon AM trap with adhesive-bait mixture of casein hydrolysate and ammonium acetate.
‡Same color cardboard as Pherocon AM.
§*ac* = ammonium carbonate in screen-covered plastic vial.

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