Project No. 87-A8 - Insect and Mite Research
Navel Orangeworm and Carob Moth Pheromones
Orangeworm Attractants

Project Leaders: Dr. F. Larry Phelan
Department of Entomology
OARDC/Ohio State University
Wooster, OH 44691
(216) 263-3728

Dr. Thomas C. Baker
Department of Entomology
University of California
Riverside, CA 92521
(714) 787-5811 or 787-5427

Personnel/Cooperators: Dr. Robert Van Steenwyk, Dr. Rod Youngman
Ms. Caryn Roelofs

Objectives: (1) Navel orangeworm attractants (Disruption of navel orangeworm [NOW] host finding using almond odors) - (A) Characterize behaviorally and chemically the almond odor components used by NOW females for host-finding and oviposition. (B) Develop formulations of these chemical constituents for either widespread disruption of NOW or for a multiple point-source "attracticide." (2) Navel orangeworm pheromone - Isolate and identify the secondary pheromone components essential for optimal male navel orangeworm attraction. (3) Carob moth pheromone - Isolate and identify the sex pheromone of the carob moth.

Interpretive Summary: NOW Adult Female Attraction and Disruption

Considerable progress has been made in our ability to monitor field activity of NOW adult females. We found it possible to attract NOW females to black sticky traps baited with various blends of crude and acidulated almond oil under both wind tunnel and field conditions. The traps that we used were constructed entirely from 15-mil black vinyl with their design similar to that of the standard (white) Pherocon 1C trap. Our initial goal in conducting wind tunnel bioassays was to identify the proper amount of acidulated almond oil necessary for evoking complete behavioral response in NOW female moths. It soon became apparent, however, from observations in trials based on the standard 1C trap that, while female NOW moths would respond to the windborne odor of crude or acidulated almond oil by flying upwind to within a few inches of the downwind side of the trap, they would not enter. Therefore, just as past research has demonstrated that NOW oviposition could be increased significantly on black vs. white egg traps, we decided to test adult female response to our black "1C-style" traps. Results based on subsequent wind tunnel bioassays indicated a much higher tendency of NOW females to enter and become stuck in the black trap as compared to the standard 1C trap. It was decided that our next step should involve comparing the trap-catch response between similarly baited black and white traps under field conditions. We accomplished this by performing a mark-release-recapture trial involving the release of ca. 2,600 NOW females which had been marked internally with a red dye. A commercial almond orchard in Kern Co. was chosen for the test site. The experimental layout, which required about two-thirds of an acre, consisted of trap lines radiating out from the release point at eight directions and three distances making up a total of 24 different trapping locations. At each location, a pair of black and white traps were hung at the same height on the north side of the tree with the pair of traps in each tree separated by 3-5 feet from one another. All traps were baited with 60 mg of a 1:1 blend of crude and acidulated almond oil. Two additional, unbaited Pherocon 1C traps were hung near the release point to serve as a control. The moths were released on Sept. 29 immediately following the harvest of all varieties. The results of the trap-catch data, recorded one week later on Oct. 6, were striking. Over 4% of the marked females (112) were recaptured after seven days. Of more importance, however, was the fact that 98.2% of the marked females were recovered from black traps. In addition, six times as many wild NOW females (i.e., 29 vs. 5) were recovered from black traps as compared to white traps. Statistically, these differences were very highly significant (P ≤ 0.001). Also, no moths were recovered from the two unbaited control traps.
In previous work, we had identified 16-18 carbon fatty acids as major behaviorally active constituents of crude almond oil (CAO); however, in wind tunnel studies, we were not able to duplicate NOW female response to CAO by using synthetic fatty acids. This situation has been clarified by this year’s research, which has demonstrated that suboptimal response to synthetics was due to impurities. In wind tunnel studies using highly pure (> 99.5%) fatty acids, NOW response to CAO could be matched. In fact, behavioral activity appeared to be due to oleic acid alone. Tests with short chain (i.e., C4-C8) fatty acids also found in CAO, did not enhance NOW response and may in fact have been somewhat repellent. Work on disruption of NOW oviposition using acidulated almond oil, a waste product of vegetable oil processing, continues in an attempt to provide a product that: 1) utilizes a controlled-release substrate that provides longevity in the field; 2) uses conventional spray equipment, yet is not washed off by rain; and 3) minimizes leaf burn. To this end, extensive wind tunnel testing has produced candidate formulations that balance maximal attraction with water solubility. Field testing of these formulations for phytotoxicity proves somewhat more troublesome, but nevertheless instructive. These studies carried out by Dr. Bob Van Steenwyk initially using single branches and then whole trees yielded similar findings. Concentrations of ≥ 10% acid oil caused significant leaf burn or drop, and in the case of one water-stressed orchard, some phytotoxicity was observed at the 5% level, although this was not routinely the case. A problem uncovered by this work was that dilution of the formulated concentrate to a working concentration resulted in separation of the oil from the controlled-release carrier. Improved formulations to overcome these problems have been developed, but were too late to be field tested this season. In a final series of wind tunnel bioassays, we measured the relative attractiveness of alternative sources of acidulated oils. Consistent with our findings from bioassays of synthetic fatty acids, oleic acid content in these acidulated oils correlated well with behavioral activity, with acid peanut oil evoking a response equivalent to acid almond oil.