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Project Title: Mating Disruption of Lepidopteran Pests (NOW and PTB)

AES/CE MAR 84 Workgroup/Department Entomology, UC Riverside

University of California
Division of Agricultural Sciences

Report to the Almond Board of California
for the period ending July 31, 1998

Project title: Pheromone-based monitoring and mating disruption of lepidopteran pests

Project leader: Harry Shorey
Department of Entomology, University of California, Riverside, CA 92521

Cooperating Personnel: James Brazzle
UC Cooperative Extension, Kern County

BACKGROUND AND JUSTIFICATION:

We have conducted research on a variety of lepidopterous pests directed toward permeating the atmosphere with synthetic pheromone so as to cause male moths to be incapable of finding pheromone-releasing females for mating. We have found that in some species it doesn't matter how close together or far apart the synthetic pheromone evaporators are placed, as long as a critical concentration of pheromone is maintained in the mating environment of the moths. Following this lead, we have developed a method for releasing relatively massive quantities of pheromone from mechanical devices which we call "puffers".

Puffers are time-clock-activated machines for dispensing periodic puffs from aerosol canisters charged with predetermined blends and amounts of the desired pheromone components. Compared to conventional pheromone-release devices, puffers have important potential advantages. These include the following:

1. Blends of pheromone components can be precisely loaded in the canisters so the optimum quantities of each component are released into the mating environment of the moths. This allows the mating of multiple pest species to be disrupted simultaneously.
2. The release rate of each component in each puff remains constant, from the first to the last puff from the canister (up to 200 days later, with our present technology); this release rate is not affected by temperature or wind.
3. Highly reactive chemicals such as the navel orangeworm (NOW) pheromone are protected from chemical breakdown, since they are not exposed to oxygen or light while in the canister.
4. The massive release rates of pheromone chemicals from the puffers means that puffers can be spaced at great separations in the field - approximately one per acre, giving considerable savings in application labor expense.

In small plot studies using puffers in 1995, we demonstrated the feasibility of using these devices to disrupt natural pheromone communication between male and female moths of peach twigborers (PTB) and NOW. In 1996 and 1997 research, we shifted to large, commercial scale attempts to control PTB in peaches and almonds and

NOW in walnuts, pistachios, and almonds by permeating orchards with the respective pheromone odors during the entire growing season. As a result of that research, we have concluded that the puffer method has promise for effective reduction of both PTB and NOW damage to the nuts and fruit.

RESULTS OF 1997 RESEARCH

GENERAL METHODS

Puffer machines were equipped with hooks for fastening to the limbs of trees, with machines being positioned at about 2/3 of tree height. The aerosol canisters within the machines had been filled in our Kearney Agricultural Center aerosol can filling facility.

Puffers deployed in almonds were set so they released one PTB/NOW pheromone puff per 15 min during the dark period of each day. Those deployed in pistachios were set to release one puff of NOW pheromone only during the dark period of each day. Those deployed in walnuts were set to release one puff of codling moth/NOW pheromone at 25-min intervals through the entire 24-hr period of each day.

After puffers were deployed in the field, their efficacy in disrupting communication among male and female moths within the protected areas was monitored continuously by the use of sticky traps that were baited with PTB or codling moth synthetic pheromone lures or with living, virgin NOW female moths. Numbers of male moths captured in such traps deployed in an equal number of untreated control orchards served as an index of ability of males of each species to orient to the source of pheromone (which is normally a female ready for mating), and lesser numbers of males captured in pheromone-permeated orchards were used in calculating the amount of communication disruption obtained.

Monitoring traps were positioned in transects in both north-south and east-west directions through the blocks, to determine possible communication disruption problems with edge effects. NOW egg traps were similarly placed, to determine the occurrence and distribution of egg-laying females of this species in treated and control orchard blocks. In addition, sampling for PTB, CM, and NOW larval infestations developing in nuts on the ground following shaking was conducted along transects, to similarly interpret larval suppression and the likelihood of problems with edge effects (higher incidence of damage), especially near the upwind border.

NAVEL ORANGEWORM

In 1997 research directed toward whole-season mating disruption of NOW, we obtained consistently effective control of larval infestations in the three cases in which puffers releasing NOW pheromone were maintained in the orchards, starting at least one generation prior to that generation which causes damage to the nuts. A summary of the 1997 whole-season NOW testing in almonds, pistachios, and walnuts follows:

1. Walnuts, 40-acre block, Blaine Farming Company, Tulare County, CA.
   80 puffers, releasing 0.2 mg NOW pheromone plus 7.5 mg codling moth pheromone/puff, 57 puffs/24-hr day.
   Trapping NOW males - 0.0 moth/trap/wk/20 weeks in puffer block vs 0.5 in control (which received 3 applications of Confirm per acre).
   NOW eggs laid on egg traps - 0.0/trap/week in puffer block and 1.0 in control.
   Nut damage inspection at harvest, 8/28/97, 0.0% NOW in puffer block and 1.6% in the control block.
2. Pistachios, 40-acre block, Kevin Herman - cooperator, Madera County, CA.
   40 puffers, releasing 0.4 mg NOW pheromone/puff, about 40 puffs/day during hours of darkness only.
   Trapping NOW males - 0.3 moth/trap/wk/13 weeks in puffer block vs 4.4 in control. Neither puffer nor control blocks received any insecticides.
   NOW eggs laid on egg traps - 0.0/trap/week in puffer block and 0.3 in control.
   Nut damage inspection at harvest, 8/25/97, 0.4% NOW in puffer block and 3.3% in control.
3. Almonds, 80-acre block, A&P Ranch, Kern County, CA.
   65 puffers, releasing 0.4 mg NOW pheromone plus 15 mg peach twigborer pheromone/puff, about 40 puffs/day during hours of darkness only.
   Nut damage inspection at harvest, 8/25/97, 1.2% NOW in puffer block and 11.3% in control. Both puffer and control block received one application of Guthion spray at early hull split.

PEACH TWIGBORER

A summary of our 1997 whole-season (mid-March through harvest) PTB testing - from smallest to largest block size - follows:

1. Almonds, 40-acre block, Paramount Farming Co., Kern County, CA.
   40 puffers, each releasing 15 mg PTB pheromone /puff, 57 puffs/ 24-hr day.
   Trapping PTB males - 1.6 moths/trap/wk in puffer block vs 45.4 in control.
   PTB-infested Nonpareil almonds at harvest - 1.0 % in puffer block vs 5.3 % in control.
2. Almonds, 80-acre block, A&P Growers, Kern County, CA.
   65 puffers, each releasing 15 mg PTB pheromone /puff, 57 puffs/ 24-hr day.
   Trapping PTB males - 0.2 moths/trap/wk in puffer block vs 8.0 in control.
   PTB-infested Nonpareil almonds at harvest - 1.2 % in puffer block vs 7.1 % in control.
3. Almonds, 160-acre block, AmCal, Kern County, CA.
   105 puffers, each releasing 15 mg PTB pheromone/puff, 57 puffs/ 24-hr day.
   Trapping PTB males - 2.9 moths/trap/wk in puffer block vs 93.4 in control.
   PTB-infested Nonpareil almonds at harvest - 2.8 % in puffer block vs 5.0 % in control.

4. Almonds, 640-acre block, Paramount Farming Co., Kern County, CA

256 puffers, each releasing 15 mg PTB pheromone/puff, 57 puffs/ 24-hr day.
Trapping PTB males - 0.1 moths/trap/wk in puffer block vs 1.5 in control.
PTB-infested Nonpareil almonds at harvest - 2.0 % in puffer block vs 0.5% in control.

DISCUSSION AND CONCLUSIONS

Over-all, the NOW whole-season mating disruption results are very promising, indicating that commercially acceptable control of this pest can be accomplished with the application of less than 4 grams of pheromone per acre per season. Although PTB infestations were not reduced to acceptable levels in all cases, we believe that the results over-all indicate that the PTB pheromone also is approaching readiness for commercial development.

Some conclusions have emerged from our puffer research on these and other crops which we feel will make this method even more successful in future work. Especially, it appears that the method will not successfully prevent infestations in blocks smaller than 40 acres (square), probably due to the inflight of mated females from surrounding non-pheromone-protected areas. Under some circumstances, even a 40-acre block may suffer some lack of control of infestation due to mated female inflights, especially on the prevailing upwind block edges, where pheromone coverage may be at the lowest level (a problem that is noted with conventional as well as puffer pheromone blocks). In addition, it appears from some 1997 research results that doubling the number of puffers per acre (to 80 per 40-acre block instead of the present 40 per 40-acre block), while cutting the pheromone emission rate in half, may under some situations give more effective pest control.

Our 1996- and 1997-model puffer machines suffered technological problems due to machine failure and breakage (they were designed for indoor use) and lack of an ability to time pheromone release so as to maximize the amount of material available during moth mating time. With our new 1998 Paramount PTB/NOW Puffers, considerable improvements are available, which should greatly improve the efficacy of the machines. The puffer "cabinets" are weather, chemical, and impact resistant; both inter-puff interval and puff times during each 24-hour cycle can be programmed allowing a maximum amount of pheromone to be dispensed precisely at those times of day when it is most useful; pheromone release can be suspended at temperatures lower than 50 degrees F, when moths are not flying; puffers will operate up to 200 days without replenishing the aerosol cans or other servicing, allowing full season and postharvest protection of the orchards; and puffer monitoring is done remotely by use of a hand-held programmer.