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Development of alternative dispensing technologies for management of navel orangeworm

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Research was funded by the Almond Board in August 2000 to examine the potential of different pheromone dispensing technologies as part of a comprehensive management program for navel orangeworm. Pheromone mating disruption programs have now been successful developed for a series of key pests of deciduous tree crops. To date, the most widely implemented program in the United States appears to be for codling moth in apples and pears with 30-50% of the total acreage in the western US currently under mating disruption, based on informal surveys. Since the first areawide project in 1993 in Sacramento pears, 3 additional areawide mating disruption projects have started in California pears. Dr. Harry Shorey, Roland Gerber, and Paramount Farming using a different dispensing technology, the "Paramount Puffer", pioneered similar efforts with pheromone mating disruption for navel orangeworm.

Other dispensers include a wide range of devices including paraffin emulsions, sprayable microbead formulations, and aerosol based dispensers. Research in my lab conducted in 1999 and 2000 for codling moth using single aerosol emitters in pears and walnuts demonstrated that the active plume from a puffer would travel up to 1500 feet or more downwind under specific conditions. Similarly, the lateral spread of pheromone was more than anticipated with trap suppression being documented for 200-300 feet on either side of an aerosol emitter ("puffer). Many questions remain unresolved though about how plume structure and mating disruption may be influenced by the following factors: a) row orientation b) time of release and travel through the orchard c) re-emission from foliage d) effects on moth behavior (single point source with high dose versus multiple small dose emitters e) the effects of overlapping plumes f) edge versus non-edge placements g) effect of wind breaks on pheromone dispersion or h) effects of rate of emission per "puff".

The need for understanding how the levels of pheromone vary between different parts of the orchard has direct application to more than just to the aerosol emitter. For example, how do the functional areas differ between the sprayable formulations of 3M and the aerosol? Are they operating on the same principle? Attempts to transfer information directly from the hand-applied Isomate system to other dispensing technologies has already presented some problems for one research program

Objectives:

1. Determine the effects of the following variables on the active space of the puffer plume
   a. Row orientation
   b. Rates of travel down the orchard after initial delivery in a day
   c. Effect of "ghost" plumes from previously exposed foliage on orchard pheromone levels
   d. Spatial mapping of plume size under different wind conditions
   e. Edge versus non-edges
   f. Effect of emission rate per puff
2. Developing a means to rapidly cross-compare dispenser technologies using a portable electroantennagram s
   (EAG) in orchards under various mating disruption regimes.
3. Design of field implementation strategies for various technologies as delivery systems.

Preliminary Progress and Plans

The research proposed for the 2001 growing season will focus on understanding the effects of pheromone plumes on the mating of navel orangeworm using several different measures. Initial studies will rely on grids of traps baited with the navel orangeworm pheromone placed in an array downwind of the aerosol emitters. Rates of trap recapture are mapped relative to the source and indirect estimates of plume size, distance of carry, and width can be estimated. This approach has already been used successfully for codling moth. The pragmatic outcome of these data will hopefully be the optimization of

emitter locations, number per acre, and ultimately production of a less expensive management program. These data will be corroborated with the use of field portable device (an EAG or electroantennogram) that provides indirect measures of pheromone levels by recording the responses of a detached navel orangeworm. The electrical signals from the antennae are used as a proxy for pheromone levels with the sites with the greatest antennal activity being synonymous with highest levels of pheromones. Finally, the use of mating status of females placed in various locations will be correlated with both trap suppression and EAG data. All of these data will need to be corroborated in later studies with direct nut injury estimates since trap suppression has been shown in many cases to not always be followed with fruit injury suppression. Additional variables such as orchard row orientation, canopy development, or wind speed will be examined in the context of how they influence the dispersion of the pheromone from the emitters.

Since the growing season was essentially over on receipt of the grant, the field trials will be conducted this next growing season. To date, our work has focused on establishing an active navel orangeworm colony at UC Berkeley and the preliminary work with the EAG. Currently we are working on establishing appropriate reference doses for the EAG using antenna of lab reared navel orangeworm and working through the protocols for interpretation of antennal activity relative to pheromone signal strength.