Artificial sex pheromones could reduce pest infestation

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(Phys.org) -- A University of California, Davis, discovery that male navel orangeworms respond more readily to artificial or "deceitful" female sex pheromones than to natural sex pheromones could lead to a better mating disruption approach, resulting in a reduced larval infestation of California's multibillion almond, pistachio and walnut crops.

The research, published July 20 in PLoS ONE, a peer-reviewed, open-access journal from the Public Library of Science, also found that the deceitful sex pheromone or paraphermone is more chemically stable than the natural sex pheromone, said chemical ecologist Walter Leal, professor and former chair of the UC Davis Department of Entomology.

"Sex pheromones can be used as an environmentally safe alternative to control insect population without the need of hard chemicals like pesticides," he said. "Unfortunately, the constituents of the natural navel orangeworm sex pheromones are chemically unstable and, therefore, readily degraded in the field.

"Our research is aimed at identifying more stable analogs (parapheromones) for practical application," Leal continued. "We're working on how this compound, discovered years ago, interacts with the olfactory system. We found that a formate analog of the pheromone is so deceitful that it 'tricks' the moth olfactory system. The formate has been known since 1982 but it was unknown how it works.

"The moth sense of smell cannot distinguish the natural sex pheromone from the parapheromone to a point that the odorant receptors tuned to the reception of the sex pheromone are even more sensitive to the synthetic alternative," he explained.

The larvae of the navel orangeworm (Amyelois transitella) infest unharvested or "mummy" nuts left on the tree or on the ground. The infestations also can lead to fungal diseases.

The UC Davis-based research suggests that the stronger response to the formate analog might be a "common feature of moth pheromone receptors," Leal said, "and could be used as a replacement for chemically less stable aldehyde pheromones."

Ultimately, the research aims to identify a chemically stable replacement for the natural sex pheromone, which can be used in the field to disrupt male-female communication.

The scientists cloned odorant receptors (ORs) and then tested them in the antennae of the male navel orangeworm.

"Insects achieve their prominence through successful reproduction, which in turn relies heavily on an acute olfactory system, " wrote the eight-member team comprised of seven scientists from the Leal lab and a researcher from the Agricultural Research Service, U.S. Department of Agriculture. "Thousands of finely tuned pheromone sensors in the antennae enable male moths to follow the trail of a pheromone scent remotely released by conspecific (same species) females when they overtly advertise their readiness to mate."

"The acuteness of the insect's olfactory system is clearly manifested in the selective and sensitive detection of sex pheromone by male moths," they wrote. "Although a single molecule of the natural sex pheromone is

estimated to be sufficient to activate a neuron in male antennae, pheromone analogs with minimal structural modifications may have very little or no activity. One noticeable exception to this 'lock-and-key' tight selectivity of the receptor-pheromone system is that formate analogs are 'deceitful' to detectors of aldehyde pheromone."

The navel orangeworm (NOW) is the primary pest of California's 800,000 acres of almonds, reducing yield and increasing processing costs. NOW females lay their eggs in the mummified nuts. The larvae consume most of the nut meats and produce large amounts of webbing and frass.

The research team included Pingxi Xu, Elizabeth Atungulu, Zain Syed, Young-Moo Choo, Diogo Vidal Caio Zitelli and Leal from the UC Davis lab, and Stephen Garczynski of the Yakima Agricultural Research Laboratory in Wapato, Wash., an ARS/USDA lab. Syed is now with the University of Notre Dame.

Provided by UC Davis