The IR-4 Project
Pest Management Solutions for Specialty Crops and Minor Uses

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Pheromones in Vector Control

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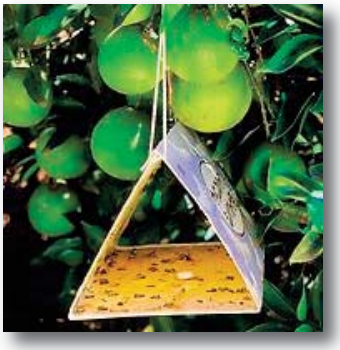
While pheromones – non-toxic chemicals used as reproductive signals or other chemical cues – have long been used in agricultural pest management, their use in the control of disease vectors such as mosquitoes or ticks is a recent development. The IR-4 Project is working to help develop and register several pheromone-based products, and we expect their significance in the marketplace to expand in coming years.

Mosquito mating likely requires chemical cues, although they have not been identified (photo courtesy FL Medical Entomology Lab)

In many insects, including pest species, specific chemicals are used to find potential mates of the right species, sex, and age; these chemicals have been used both to monitor pest populations, to disrupt reproduction, and/or to attract mate-seeking individuals to traps or toxicants. However, the search for specific mosquito sex pheromones has been challenging, and although publications have periodically noted that chemicals probably play a role in the aggregation of mosquitoes into mating swarms, specific usable chemicals of this type have not been identified. While this means that traditional pheromone-based management of mosquito populations have not been developed, other chemical cues are important throughout the life-cycle and are yielding promising control tools.

The mosquito life-cycle includes many transitions, and while some of these are controlled largely by physiological pathways internal to the insect, others also require external chemical cues for their completion. Once an adult mosquito of either sex emerges from its pupal casing, it needs a sugar source to provide energy for flight and other activities, and this requires that the mosquito smells rotting fruit or another source of sugar. They also need water, though this may come from the food source. We have noted that the adults probably use chemical cues as part of their mating process, primarily to assist in aggregation. Once an adult female mosquito has been impregnated, she must find a source of blood, which is used primarily as a supply of protein to assist in egg production, and chemical cues including CO_2 are key in finding blood sources. Once a gravid female has digested the blood meal, she needs to find a safe place for oviposition (egg-laying), and in this she is also heavily dependent on chemical cues.

We can see several opportunities to use pheromones to intercept the adult mosquitoes and trap or poison them – when females or males seek sugar or water, when females and males seek mates, when females seek blood meals, and when they seek oviposition sites. While chemical control of vectors has typically tried to prevent



Sex pheromone used to monitor populations of fruit pests.

Identification of good egg-laying (oviposition) sites also requires chemical cues.

all bites by vectors (thus, killing before the first blood meal) as a sure protection vs. transmission of pathogenic organisms, it is increasingly recognized that any of these interventions can help reduce disease transmission by arthropods. This is because the disease-causing organisms very rarely move directly from mother to daughter, which means that a female mosquito must bite twice to collect germs from an infected host (the first bite) and transmit them to a vulnerable victim (the second bite). Thus, while products that kill mosquitoes seeking food, water, a mate, or blood can all prevent mosquito bites, products that kill female mosquitoes seeking egg-laying sites can also protect vs. disease transmission.

Products have recently been registered by EPA as Attractive Toxic/Targeted Sugar Baits (ATSB) and as Lethal Ovitraps, and new products in both classes are in development. In both cases, the availability of potent and selective attractants will be critical to attracting sufficient insects to impact pest populations. Luckily, sugar-feeding happens frequently and oviposition sites can be sparse enough that the artificial sites in traps can be attractive enough to catch a substantial percentage of the mosquitoes in an area. An additional twist to ovitraps recently has been the addition of Insect Growth Regulators (IGR) rather than direct toxicants, so that females may "autodisseminate" these potent chemicals to habitats where they disrupt development not only of their offspring, but of those of other mosquitoes sharing good egg-laying sites. Regardless of the life stage where pheromones may be used, they need to be potent enough to attract insects that may find many naturally-occurring alternatives.

In addition to pheromones for mosquito control, there has recently been work on ticks, the other major type of arthropod disease vectors. While ticks don't fly or otherwise disperse quickly in response to volatile attractive chemicals, recent work has suggested that sex pheromones and possibly others can effectively disrupt key activities of ticks, reducing their life span or ability to spread disease. While this research is less well-developed than that with mosquitoes, the spread of Lyme Disease and other tick-borne infectious diseases argues strongly for continuing research in this direction as well.