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

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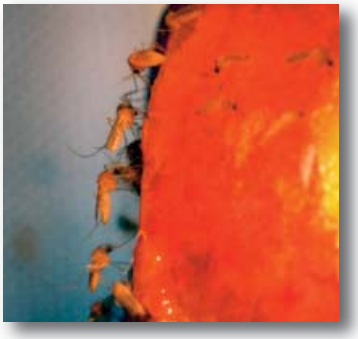
Attractive Toxic Sugar Baits for Vector Control

— by Karl Malamud-Roam, IR-4 Public Health Pesticides Program Manager

What do mosquitoes eat? If you've been bitten recently by a mosquito, the answer seems obvious – they feed on us! But when we realize that only female mosquitoes take blood meals, and only a few times during their lives, it looks like the answer must be wider. In fact, feeding behavior by mosquitoes is relatively complex, and recent work on this topic is beginning to point toward a range of potentially useful new mosquito control strategies. In particular, the concept of mixing feeding attractants with sugar and a pesticide is reaching maturity, and attractive toxic sugar bait (ATSB) products are now beginning to enter the vector control market, both in the U.S. and globally. IR-4 is working closely with inventors, product developers, and regulators to help bring these new tools to households and organized vector control programs.



Over-ripe nectarine attracts sugar-seeking Culex mosquito

ATSB works by exploiting the "sweet tooth" of adult mosquitoes, which feed often on plant sugars to satisfy their energy needs. Very soon after emerging from their pupal cases, both male and female mosquitoes seek sugar, and they continue to feed frequently on plant nectars and other sugar sources for the rest of their lives (see Foster & Hancock 1994 ncbi.nlm.nih.gov/ pubmed/8965081). This observation led to several novel experimental approaches to mosquito surveillance and control, including sugar baits used to distribute biopesticides (*Bacillus sphaericus*) to oviposition sites, and sugar-baited traps. The most productive results were from Yosef Schlein, Rue-De Xue, and Gunter Muller, who sprayed mixtures of sugar and food dye, both with and without a gut toxin (boric acid), on flowering plants and then counted the local mosquitoes. The dyes were visible in the guts of mosquitoes exposed to both toxic and non-toxic sugar solutions, but the really exciting observation was a rapid and prolonged crash in populations where boric acid was included with the sugar.

Culex mosquitoes feeding on flower nectar

Attractive toxic sugar bait sprayed on vegetation, with male Anopheles (malaria mosquito)

Mosquitoes after eating dyed sugar bait

While it was encouraging that mosquitoes could be killed with toxic sugar baits, it was impractical to rely on flowering plants for attracting the mosquitoes, as flowers may not occur when and where mosquito control is needed. Therefore, these researchers began to look for the cues that bring sugar-seeking mosquitoes to plants,

with the hope that effective and stable attractants could be added to the sugar and toxicant, resulting in effective attract-and-kill products. Flowers were the first targets, as mosquitoes had been seen eating floral nectars, but it soon became clear that some tropical fruits, wine, brown sugar, and mixtures of these were all effective, and potentially much more effective mosquito attractants than flowers.

While many of the most effective fruit-based attractants spoiled rapidly, this team eventually discovered and patented a shelf-stable attractant, and the stage was set for product development. In the last three years, a use patent for the concept has been issued in the U.S. and other countries, an ATSB station was registered with EPA, and a 25(b) foliar spray product based on microencapsulated garlic oil has been launched for both the household and organized vector control market.

The potential for this "new paradigm" in vector control seems very promising. Not only has data been presented on efficacy vs. all major genera of disease vector and nuisance mosquitoes in the U.S., but field trials in Mali have shown promise against the major malaria vector mosquitoes, and preliminary work shows potential vs. sand flies. Since the mosquitoes come to the ATSB and eat the product, proponents expect minimal impact to non-target species, as most respond to different attractants. In particular, recent data has shown that honey bees and other pollinators ingest very little of the sugar bait, apparently because of their reliance on visual rather than olfactory cues for finding food.
The IR-4 Public Health Pesticides Program has worked over the last year with ATSB developers to help ensure that their U.S. activities meet regulatory requirements. We are also exploring with them some additional ways to turn mosquitoes' taste for sugar into effective vector control tools.

Wall-hung ATSB station in Mali