Flying in the Face of Grapefruit

Wind tunnel bioassays are used to investigate why Mexican fruit flies prefer certain fruits for egg-laying and leave others untouched. Here, entomologists Ivich Frazer (left) and David Robacker measure how attractive an orange is to Mexican fruit flies that are ready to lay eggs.

Keeping Mexican fruit flies out of grapefruit orchards in South Texas is a tough job—despite new findings that when fruit flies hatch, they don't even like grapefruit.

This pest annually infests citrus in Texas, Mexico, and Central America and threatens California and Florida. Female fruit flies lay eggs in the fruit. When the larvae hatch, they feed on the pulp, ruining the fruit for human consumption.

Ten-year losses from the Mexican fruit fly in South Texas and northern Mexico alone have been estimated at almost $7 billion from export sanctions, lost markets, treatment costs, and reduced crop yields.

That Mexican fruit flies are not naturally attracted to grapefruit was a surprising fact uncovered by ARS entomologists David Robacker and Ivich Fraser as they investigated what factors attract the insect to an egg-laying site.

Working at the Kika de la Garza Subtropical Agricultural Research Center in Weslaco, Texas, Robacker is studying how the insect receives basic information about and reacts to its environment. Eventually, this information will help him develop better monitoring and control methods.

In one of their first experiments, Robacker and Fraser measured how attractive a grapefruit was to wild-strain egg-laying Mexican fruit flies compared to a yellow control ball of similar size. They expected to confirm that grapefruit is highly attractive to the Mexican fruit fly, probably because a grapefruit gives off semiochemicals—a type of chemical signature that insects identify by smell.

"But we couldn't get the Mexican fruit fly to come to grapefruit any more than to the yellow control ball—not even a little. That was kind of surprising when most of the literature lists grapefruit as a favorite choice for egg laying," Robacker says. "And if the flies don't like grapefruit, why are they always such a problem in grapefruit orchards?"

Robacker and Fraser also looked at the response of laboratory-raised fruit flies rather than wild-strain fruit flies. Laboratory-raised flies did respond to grapefruit, but still at very low rates, says Robacker. He surmises that being raised in laboratory colonies may have turned the flies into opportunists that react to generalized fruit stimuli.

"We also looked at whether hunger for sugar might increase the flies' tendency to lay eggs on grapefruit," Robacker says. "When flies deposit their eggs, they puncture the surface of the fruit and often feed on the juice that drips out."

But the scientists found that while twice as many starved as satiated Mexican fruit flies landed on grapefruit, there was no difference in their propensity to lay eggs there.

"While this did not explain how the fly makes an egg-laying selection, it looks like we may have identified a behavior that the Mexican fruit fly uses to cut down on its risk of being eaten by predators: It combines egg laying and feeding flights," Robacker says.

But Robacker was more interested in discovering why the Mexican fruit fly annually lays eggs in South Texas grapefruit orchards if grapefruit are not naturally attractive.

At Fraser's suggestion, Robacker placed grapefruit into cages with the flies for several days before the experiments. Once exposed to grapefruit, females were attracted to it 400 percent more than were flies without exposure. In addition, grapefruit-naive Mexican fruit flies were more likely than fruit-experienced flies to lay eggs on the wall of the test chamber.

"Once the fruit flies learned what grapefruit was, they went to it right away in the egg-laying test, even when we kept them away from grapefruit for several days before the test. The results were dramatic, but there's no evidence that the preference can be passed on to the next generation—unless they too receive the learning exposure to grapefruit," Robacker says.

Bolstering the "need to learn" concept is that grapefruit are not native to the Rio Grande Valley; they were introduced there commercially in the early 1900s. The native host of Mexican fruit flies is the yellow chapote, a small, yellow-green fruit that grows in mountain valleys in northern Mexico. But Robacker and Fraser found that fruit flies have to learn to use chapote just as they do grapefruit.

What this suggests to Robacker is that wild-strain, adult Mexican flies are likely to choose whatever is close to them when they emerge from their protective shells, called puparia. Those that emerge in grapefruit orchards learn grapefruit as a food source because it is handy. They are then likely to combine feeding and egg laying.

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Robacker (left) and entomologist Donald Thomas examine fallen grapefruit in an orchard. If the fruit isn't cleared away after the harvest, it gives the next season's female Mexican fruit flies, which are not naturally attracted to grapefruit, an early opportunity to learn that they can lay eggs on the fruit.

Such behavior, Robacker points out, reinforces the positive impact of management techniques that call for growers to remove all grapefruit remaining in trees and on the ground after the harvest is complete. Without the fruit, wild Mexican fruit flies in the area will not have the opportunity to learn about it as a food or egg-laying resource and will leave the orchard to learn to use some other fruit—or die trying.—By **J. Kim Kaplan,** ARS.

This research is part of Crop Protection and Quarantine, an ARS National Program (#304) described on the World Wide Web at http://www.nps.ars.usda.gov.

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