Shining bright in Waianae: How bees and reflective mulch can improve vegetable production in Hawai'i

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Just by looking at it, one would never suspect the Tolentino's small, unassuming farm to be one of the front-runners of agricultural reform. At first glance, it looks almost indistinguishable from the other nearby Waianae farms: a small tract of land at the end of a short dirt road on Oahu's leeward coast. Neat rows of eggplant, pumpkin, and winter melon stretch back in the direction of the ocean, punctuated every so often by papaya plants. The farm, at less than five acres, seems deceptively sleepy, misleadingly quiet: all in all, just another modest piece of farmland tucked between countless others.

Nothing could be further from the truth. Contrary to its inconspicuous appearance, this farm is a working model of what can only be called a kind of 'agricultural re-thinking.' It is the response to an island-wide crisis, a direct answer to an unforeseen collapse of traditional farming methods.

To the left of the first rows of winter melon, a series of modest wooden boxes raised several feet off the ground, sit surrounded by a clump of scraggly milkweed. From a distance, it is almost impossible to see the frenzy of activity around the small hole in the side of the box that faces the field. In fact, with their slightly peeling paint and nondescript exteriors, Dory and Lito Tolentino's apiaries make a humble first impression. And yet these boxes and the honeybee colonies that utilize them as hives are one of the key reasons why this farm is so critically different from its neighbors.

Four years ago, if you were to stand in the same place above the same patch of ground, feral bees from wild hives would have assumed the largely thankless role of pollinator. There would have been no apiaries, no carefully maintained colonies, and the presence of wild bees would have been a given. However, with the arrival of new bee parasites and diseases to the islands, feral bee populations have suffered tremendous losses. In response, farmers have turned to managed honeybees, those kept in hive boxes and managed by beekeepers, to fill the vacant role.

Lito and Dory Tolentino tending to one of their honeybee colonies.

And yet, it would almost be an understatement to say that there exists a disconnect between farming as a livelihood and beekeeping as a profession in the Hawaiian Islands. The common sentiment is that the two are separate ways of making a living and are, in and of themselves, distinct occupations. Fruit and plant, honey and wax. With the feral hives doing the lion's share of the pollination for bee-dependent crops, there was no environmental pressure on the islands to promote a hybridization of the two professions. The notion of a 'beekeeping-farmer' is still a novelty in the Hawaiian agricultural world and it shouldn't be.

Here's the logic.

Converting land into a farm entails the planting of thousands of crops where there were none before. And although space is severely limited in the Hawaiian Islands, the Big Island boasts several large-scale macadamia nut farms, each of which contains thousands of trees. From an ecological standpoint, that's not so much 'farming' as complete environmental 'reconstruction.' Even with perfectly healthy feral hives working at the peak of their efficacy, the sheer number of bee-dependent crops, would prove too vast to be pollinated by wild bees exclusively. Due to their overwhelming scale, the Big Island macadamia farms have been forced to work in conjunction with beekeepers to ensure that their trees are well pollinated. However, they have had no interest in buying and maintaining hives of their own. In contrast, local farms, by virtue of their small size, did not need to resort to managed bees, relying instead on the feral bee populations for routine and guaranteed pollination of their fields and the continuance of their livelihoods.

A feral honeybee colony living on a tree crevice.

It was the traditional way of thinking and doing agriculture for local farmers, and it all came crashing down sometime in 2008 when a tiny but deadly mite arrived. *Varroa destructor* bears a rather telling scientific name. Like many other mite species, *Varroa destructor* is an external parasite and can be found attached, vampire-like, to the bodies of bee pupae, and adults almost twenty times its size. A notorious transmitter of a deadly viral disease called Deformed Wing Virus (DWV), the mite found its way onto local bees on Oahu, into wild hives, and across some 200 miles of ocean to the Big Island, eradicating the majority of the feral pollinators in less than a year.

To make matters even worse, in the wake of the mite and the spreading virus, a second pest arrived on the islands when the bee populations were still reeling - the small hive beetle

(*Aethina tumida*). Although appearing innocuous enough and only about the third the size of an adult bee, this beetle, wreaked havoc on wild and managed hives alike. It is an efficient parasitic intruder , and is an expert at locating, tracking, and infiltrating bee colonies. Once inside the hive, female beetles lay thousands of eggs that quickly hatch into mobile larvae. Both the larvae and the adult beetles have voracious appetites, consuming not only infant bees but also the hive's entire store of honey and pollen.

The devastating toll the mite, beetle, and virus took on feral hives was not evident to farmers like the Tolentinos until, one day, their bee-dependent crops began to suddenly fail.

"We knew something was wrong," commented Dory. "It got so bad that before we owned our own hives, my husband had to go out at four in the morning and pollinate everything by hand. He was our bee."

With wild pollinators effectively crippled and out of the picture, local farmers like the Tolentinos had two choices: hand pollinate everything or learn to manage their own honeybee colonies. So it's no wonder that, given the alternative, Dory had such enthusiasm for learning how to keep bees. When I asked her how she felt about her thousands of hard working pollinators, stinging potential and all, she replied, "I love them. They are my babies."

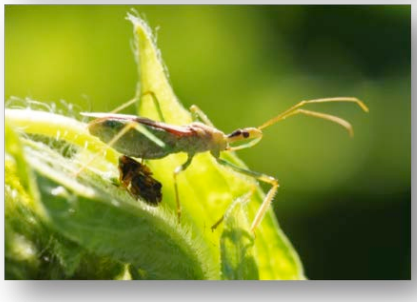
The thing that strikes you about Dory is her sincerity. She wasn't just being humorous: she was dead serious. A local farmer buying into beekeeping is progressive enough, but to have that farmer form a personal and affectionate relationship with her hives is another thing entirely. It's just another indication of how unique the Tolentinos are. Despite the investment, the risks, and the uncertainty of beekeeping, they have bonded with their colonies. They have made it a priority to know their bees.

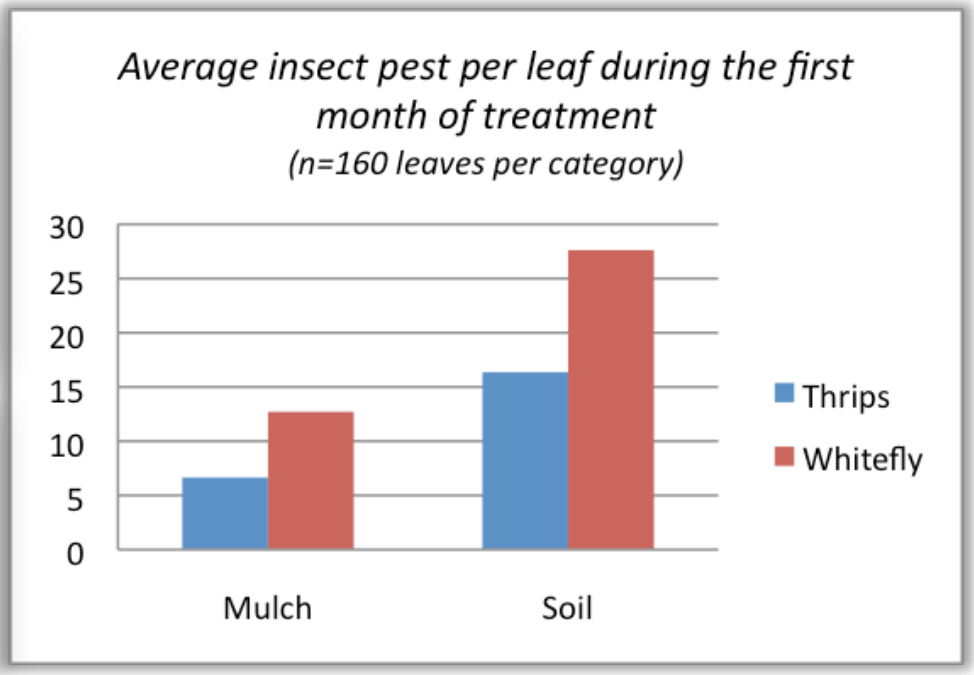
But beekeeping isn't as simple as constructing boxes, buying a queen bee, and letting her progeny have free reign among the crops. The efficacy of bees as pollinators and the health of the colonies are dependent on farm-wide agricultural practices. Put more simply: bees don't appreciate pesticides. The chemicals in the industrial strength pesticides used by farmers are, by their nature, toxic to insects and although they do not kill bees outright like they would aphids or whiteflies, the toxins can have adverse effects on bee health and their navigational and foraging abilities. It seems like the worst kind of paradox: spray for a pest-free crop but cripple your pollinators, or don't spray and leave the hives to flourish but let pests run rampant. For most farmers, not spraying or spraying with milder pesticides isn't an option. For the Tolentinos, the paradox was just another puzzle to solve.

The solution, 'reflective mulch', shines under the leaves of the now well-developed winter melon. This thin film of metallic material is spread over the soil of the field and the irrigation lines before crops are planted. The seedlings are grown in containers until they reach 3-4' tall

and then are planted through slits in the foil at careful intervals. Like a mirage on a hot road, the mulch shines brightly in the fields; tiny plants protrude from its surface and cast reflections over this metal sea. The undersides of the seedlings' leaves receive large amounts of reflected UV light that bounces up to them from the mulch's surface. Not only is this ideal for plant growth but the dazzling intensity of the mulch in full sun also deters many pest insects, including aphids, whiteflies, and thrips from the crop as well.

Not only were Dory and Lito game to install the reflective mulch in their own fields but they also agreed to work in collaboration with the UH Honeybee Project to conduct a field test on the impact of reflective mulch on winter melon production. The trials involved planting two sets of seedlings, one set in reflective mulch and the other directly on bare soil, and comparing the number of pests and the resulting crop yield among the two groups to see if there was a significant difference. Preliminary results indicated that the mulch's blinding glare was doing the trick. Melons planted in the mulch had significantly lower densities of insect pests, especially whiteflies and thrips, while the seedlings left in bare soil fared less well and had much higher pest density per leaf. The numbers don't lie: on average bare soil plants had 2.1 times more whiteflies and 2.4 times more thrips per leaf compared to plants whose leaves were bathed in the UV reflection.





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As the plants matured, became leafier, and cast more shade onto the mulch, the trial indicated that the protective effect of the reflective film was reduced. In fact, just a month into the trial, the melons had grown so much that their shadows were effectively covering most of the material. However, by that point in time, the crops' fruits and flowers were already developing and the plants were strong and able to produce many large fruits. The Tolentinos happily noted that although pests had not been completely eradicated, their levels seemed lower and plants required less chemical input. An added bonus was the appearance of beneficial insects on their fields possibly due to reduced pesticide spraying.

Finally, the Tolentinos were delighted with the yield increase on the mulch plots, where more and heavier fruits were produced. From the growers point of view this means more "Grade A" fruits that will demand a higher market price.

Success stories are always fun to share, but this one has the potential to be useful to many farmers wishing to increase production of bee pollinated cucurbit crops. The Tolentino family has been able to learn sustainable beekeeping and introduce pest control techniques that reduce the need for chemical input, thus making their lands a bee friendly farm. Kudos to Lito and Dory and to the many farmers seeking sustainable options to food production.

Lito Tolentino harvesting winter melon during the reflective mulch trial.

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