

MEALYBUGS

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Ferrisia gilli Gullan is a new mealybug that is spreading throughout pistachio production regions of California. This pest feeds within the pistachio cluster where it causes losses in both the quality and quantity of harvested nuts.

F. gilli first showed up in commercial pistachio orchards in the late 1990s near the town of Tulare in Tulare County. Initial infestations remained localized for several years and then began to spread rapidly. It is estimated that infested acreages in California have gone from 20, to around 200, to about 2,000 and then to over 3,000 acres during 2002 through 2005, respectively. *F. gilli* has also been found infesting almond, stone fruits, persimmon, and grapes as well as several types of ornamental trees and shrubs such as fruitless mulberry, *Morus alba*. In 2005, *F. gilli* is known to be present in at least nine different counties representing all major pistachio growing regions statewide.

DESCRIPTION

Adult female *F. gilli* are between 2-5 mm in length and are covered in a white mealy wax (Plate 25A). They have two dark areas or stripes on top that run the length of the insect along with two white tails. When females remain in one location for a period of time they produce long, glossy white wax filaments that extend over the top of the body. These threads can reach a centimeter in length and distinguish mealybugs in the genus *Ferrisia* from most other mealybugs. Large numbers of filaments from aggregations of adult females, particularly in the winter, can give the trunk and main scaffolds a white bearded appearance (Plate 25B).

Adult male *F. gilli* are about one half the length of the females, have wings, and have the

appearance of tiny wasps with two long tails. They are rarely noticed in the field.

Immature mealybug stages, called nymphs, look like adult females but are smaller. They have two white tails and feed in aggregations. They often have a shinier appearance than the adult females due to a reduced amount of white mealy waxes and filaments.

In addition to *F. gilli*, another mealybug species, grape mealybug, *Pseudococcus maritimus* (Ehrhorn) is sometimes found in pistachios (Plate 25C). It does not, however, cause any harm and can easily be distinguished from *F. gilli*. Grape mealybug has four slender tails (two long ones and two short ones), whereas *F. gilli* has two broad white tails. Grape mealybug also has short lateral projections that extend from the sides of the body whereas *F. gilli* has none. Immature grape mealybug hatch from egg sacs and are usually distributed in a scattered pattern whereas *F. gilli* have live birth with immature stages remaining aggregated around their mother. Lastly, when poked, grape mealybug extrudes a bright red liquid through structures called ostioles towards the rear end of the top of the adult female. *F. gilli* do not extrude such a liquid.

SEASONAL BIOLOGY

F. gilli have three discrete generations per year. The overwintering generation begins during or just after harvest in September or October. At this time adult females migrate from the clusters into cracks, crevices, and knotholes on the undersides of the main scaffolds and on the main trunk. Adult females produce large numbers of first-instar nymphs, called crawlers, that seek out protected areas to hide for the winter.

In the spring, when temperatures begin to warm up, the small percentage of overwintering nymphs that survived the winter emerge from their hiding locations and migrate to the tree canopy. This migration is well synchronized to the period of bud swell around March. During March and April the mealybugs feed on woody areas at the interface between old and new growth. By May the mealybugs develop into adults and begin feeding on the rachis (Plate 25D).

The first in-season generation begins during late May through early June when adult females on the rachis give live birth to crawlers that move to the pistachio hulls. During the next 6 weeks mealybugs feed on the pistachio hull and complete another generation. The second in-season generation begins around mid-July when adult females produce large numbers of crawlers that can be seen aggregating around their mother. It is this generation that has the highest number of mealybugs and is recognized to cause the most damage to the crop (Plate 25E). Mealybugs of this second generation reach the adult stage at about the same time that nuts are harvested and the tree no longer pushes carbohydrates into the clusters. Adult females then migrate to the trunks and produce crawlers that will become the next overwintering generation.

INJURY

Mealybugs use their straw-like proboscis to feed from the phloem tissue of their host. They extract plant juices, digest portions of the fluids, and excrete the remainder as honeydew. Honeydew is primarily composed of sugars which can completely cover the surface of tree limbs, leaves and clusters. Honeydew supports the growth of black sooty mold that renders the leaves photosynthetically inactive.

The greatest impacts of *F. gilli* on pistachio are from its affinity to feed on hulls within clusters. Mealybug feeding reduces kernel size and the percentage of split shells by intercepting carbohydrates and other nutrients intended for kernel development. Feeding on the hull also increases the amount of hull breakdown and shell staining, and infested hulls are typically covered in thick layers of

honeydew and sooty mold (Plate 25F). Harvestability is also affected when severe hull damage causes nuts to dry up and shrivel on the tree. These nuts often remain on the tree during harvest.

MANAGEMENT GUIDELINES

Monitoring

In orchards not known to have *F. gilli*, or where the pest is still spreading within a block, the easiest time to survey is after harvest through the end of the year. During this time, look for white tufts of aggregated mealybugs on the trunks and undersides of major scaffolds. Large aggregations give the trunk and scaffolds a white, bearded appearance as if draped in cotton candy. Pruning crews can help facilitate surveys for mealybugs if instructed on how to recognize and report this pest.

In-season monitoring in blocks known to be infested should be conducted at budbreak and in mid to late May. At budbreak, search for mealybugs at the bases of new buds on trees previously known to be infested. This will help determine how well the mealybugs overwintered. Return to these locations in mid May and begin monitoring weekly for crawler emergence. This will facilitate optimal application timing of insecticide treatments where needed.

Chemical Control

Current pest management programs in pistachio require the use of chemical insecticides. This will likely continue until broad spectrum insecticide use for true bugs can be reduced such that biological control programs can become established.

Time insecticide applications in late May through June when crawlers are present. Mealybug populations prior to late May/June do not need to be treated because they do not cause economic damage. Insecticide applications from July through harvest are also not as effective. Post-harvest treatments are not recommended, even when mealybug densities are very high, since adult females on the trunk will all die and more than 99% of the crawlers will not survive the winter. Additionally, adult females on the trunk (which will not survive

the winter anyway) serve as overwintering hosts for parasitoids.

Biological Control

The most common predators of *F. gilli* in pistachios are green lacewings. Lacewing larvae (Plate 25G) feed by piercing the outer shell of their prey and sucking out the body fluids, giving the mealybug a dried out, shriveled appearance. Adult stages of some lacewing species are also predacious. Lacewing development takes approximately one month in the summer and highest populations are observed from mid to late summer through early winter. Lacewings are likely the most abundant predator in pistachio due to their relative lack of susceptibility to pyrethrin insecticides used for the control of true bugs.

A small predatory coccinellid beetle can also be found feeding on mealybugs. Beetle larvae (Plate 25H) are covered in white tufts of hair that allow them to mimic the appearance of a mealybug other soft-shelled insects, pupate, and then develop into small oval-shaped beetles. Adult beetles are approximately 2mm long and have a brown, mottled color. They also prey upon mealybugs.

In other crops where pyrethrins are not used, at least two species of parasitoid wasps reduce mealybug populations. Parasitoids overwinter inside adult mealybugs on the trunks and main scaffolds of the trees. Parasitized mealybugs can be distinguished from those that are not parasitized due to their round, slightly yellowed, bloated appearance. When the weather warms in the spring, adult wasps emerge by chewing a round hole in one end of the mealybug 'mummy' (Plate 25I). Once emerged they mate and lay eggs that hatch and parasitize the overwintering mealybug nymphs that have begun to feed in the tree canopy during the spring. There are several generations of parasites per season, and at least one of the parasite species can produce up to six offspring in a single mealybug.

Ant associations may also play a role in regulating mealybug populations. In many crops, ants can be detrimental by disrupting biological control and by picking up and

spreading mealybugs. In other cases, predation by ants can reduce mealybug populations. At present there have been several observations of ants associated with mealybugs in pistachio, yet no data have been collected to document their beneficial or detrimental effects.

CULTURAL CONTROLS

Mitigating Dispersal to Uninfested Orchards

Equipment plays a major role in the spread of *F. gilli*. Mealybugs are notorious hitch-hikers, and cultural practices, particularly at harvest, can facilitate this movement. During harvest, mealybug populations are at their highest and trees are sticky with honeydew. Equipment passes through every row of an orchard as infested trees are shaken, causing infested nuts and foliage to contact shakers, catch frames, and then bins. Equipment is quickly moved from location to location throughout the state. Once at a new site, mealybugs can easily crawl off equipment and initiate new infestations.

Equipment, particularly during harvest, should be washed prior to leaving an infested orchard. Water from a garden hose with a pressure nozzle should be sufficient since honeydew dissolves easily in water and mealybugs do not hold on to metal surfaces very well. High pressure washers are even more effective. Growers who contract to bring harvest equipment to their orchards should insist that the equipment be cleaned prior to arrival (or clean the equipment themselves prior to letting it enter the orchard). Be sure, however, to wash equipment as far away as possible from the orchard such that any mealybugs that are washed from the equipment are not able to crawl over and initiate a new infestation.

Birds, such as crows that move into orchards after harvest, can also spread mealybugs. Crows are known to pick up and move infested nuts that were left unharvested. Crawler stages of mealybugs can also inadvertently crawl onto the feet and legs of crows and be moved to another orchard or ornamental tree host, such as mulberry trees, which are commonly used as crow roosts and serve as an excellent alternate host of *F. gilli*.