



A leafminer mine that has served as a site for a new canker infection.



A leafminer mine with the larva inside; the dark trail in the mine is the frass (fecal material) produced by the miner.

Management of citrus leafminer

By Michael E. Rogers and Philip A. Stansly

The citrus leafminer (CLM) was first detected in Florida in 1993. Shortly after its discovery, pesticide applications were made to both young and mature citrus to prevent leaf damage caused by CLM. It was later determined that controlling CLM populations on mature trees was not economically justified since the new flush constitutes a small portion of the tree canopy with minimal impact on overall tree health. Since that time, controlling CLM has focused only on young trees where damage to the new flush by CLM significantly reduces tree growth.

While CLM does not transmit or spread citrus canker, leaf damage caused by the mining activity of CLM predisposes leaves to canker infection by creating wounds in the leaf tissue for the canker bacteria. The significance of CLM in facilitating canker infection through leaf damage has been documented in Florida, Brazil and other countries where canker is endemic. The importance of leafminer in facilitating canker spread was emphasized as a factor in the creation of the "1,900-foot rule" of the canker eradication program. With the end of the canker eradication program in Florida and the anticipation that canker will become widespread throughout the state, managing CLM populations and the associated damage caused by this pest is important.

LIFE CYCLE AND SEASONAL ACTIVITY

The adult is a tiny moth that hides within the canopy during the day and emerges at night to lay eggs individually on young, emerging leaf flushes. The egg first appears as a tiny dew drop, usually alongside the midvein on the underside of an unexpanded leaf. The larva emerges directly into the leaf tissue, mining first along the midvein, then back and forth as it makes its way to the leaf margin where pupation occurs.

Populations of CLM decline to their lowest levels during the winter, due to cool temperature and the lack of flush to serve as a substrate for larval development. CLM populations build rapidly on the spring flush, although their pres-

ence is not apparent until late spring as populations increase while the amount of new foliage decreases.

Throughout the ensuing warm seasons, leafminer populations vary with the flushing cycles and subsequent flushes are often severely damaged. The summer period of high leafminer damage coincides with the rainy season when canker spread is most likely. However, damage potential is mitigated by the activity of natural enemies such as predators and parasitic wasps that together account for 60 percent to 80 percent mortality of leafminer populations during this time.

BIOLOGICAL CONTROL

Shortly after CLM was discovered in Florida in 1993, the parasitoid *Ageniaspis citricola* was released for biological control of CLM. Massive releases of this parasitoid were made statewide, resulting in the eventual establishment of the parasitoid throughout the citrus growing regions of the state, where it joined a number of native parasitic wasps in attacking the pest.

A. citricola lays its egg inside the leafminer egg, but does not complete development until larval feeding has been completed and the pupal cell is made, usually on the leaf margin. The parasitoid larvae then pupate inside the skin of the host, appearing as a string of sausages, whereas native parasitoids appear as black pupae inside the mine or leafminer pupal cell. Studies have shown that *A. citricola* is the most abundant parasitic wasp attacking CLM, and builds to its highest levels in fall.

Nevertheless, predators such as spiders and especially ants usually account for the majority of leafminer mortality. Their effect can be assessed by noting the number of incomplete mines, with the leafminer cadaver either present, indicating a spider or host feeding parasitic wasp, or absent, usually indicating ant predation.

CLM populations still reach high levels throughout the year in spite of this complex of natural enemies. The slow buildup of *A. citricola* during the dry season indicates the need for a more drought-resistant parasitoid such as *Citrusitchus phyllocnistoides*, a species originally from Asia

that has provided excellent control of CLM in the Mediterranean region. *C. phyllocnistoides* is presently in quarantine at DPI in Gainesville awaiting final approval from USDA-APHIS-PPQ for release in Florida.

NONBEARING CITRUS/RESETS

On young trees, use of the soil-applied systemic insecticide imidacloprid is the most effective means of preventing mining damage on the new flush and has little direct effect on natural enemies. In university research trials, soil drenches directly to the base of the tree with imidacloprid have been shown to provide at least eight weeks control of pests of new flush including leafminer, psyllid and aphids. Injection through the irrigation system is less effective because a large portion of the material falls beyond the root zone.

Compared to soil applications of imidacloprid, foliar-applied insecticides provide a shorter duration of protection lasting only about two to four weeks depending on weather conditions and the uniformity of flush pattern. Soil applications of imidacloprid should be made about two weeks prior to leaf expansion to allow time for the pesticide to move from the roots to the canopy. Avoid applications 24 hours prior to significant rainfall events which will result in movement of the product out of the root zone before it can be taken up by the plant.

Because of limits on the amount of imidacloprid that may be applied on a per acre basis each season, only one application in the spring and possibly one in the fall are recommended. When the residual effects of the spring application have worn off — typically during the mid-summer rainy season — foliar sprays can be used on small trees to reduce CLM damage. Reapplication of imidacloprid is not recommended during this season because of the likelihood of the material being washed away by frequent summer rains.

Foliar sprays should be timed to coincide with the appearance of the first visible leaf mines, which occur immediately following the feather leaf stage or about 13 days after bud-break. At this time, insecticide applications will provide protection for most of the leaves in the new flush.

MATURE TREES

Where canker is present in a grove (or in a nearby grove), healthy trees with leafminer-damaged leaves are more likely to become sites for new canker infection. The only products currently available for CLM control on large trees are foliar insecticide sprays.

Soil applications of imidacloprid are not effective for CLM control on large trees due to use rate restrictions that limit the usefulness of the product on trees greater than 6 to 8 feet in height. Another soil applied product that has been demonstrated to suppress psyllid populations on large trees — aldicarb (Temik) — does not provide control of leafminers.

While there are a number of products that are effective for controlling CLM, use of foliar sprays on large trees for CLM suppression is difficult due to the unsynchronized flush typically encountered during the summer period. Furthermore, the economic benefit, in terms of canker reduction, of sprays directed against CLM on mature trees is unproven, and may prove counterproductive due to impacts on beneficial insects and mites, depending on the products used. Thus, foliar applications to control CLM are not recommended as a stand-alone treatment.

With some planning, properly timed sprays made for other pests can provide some benefit in reducing CLM populations and damage during the critical times for canker spread. For example, during the early summer when foliar sprays are made for rust mite control, selection of a product that will also control CLM (such as Agri-mek or Micromite) will simultaneously prevent CLM damage without the need for an additional spray. Similarly, oil applications made for greasy spot control will also provide some control of CLM if applications are made during the time when new flush is present. To be effective, applications should be timed to coincide as closely as possible with the presence of new flush showing the first signs of CLM damage.

Refer to the 2006 Florida Citrus Pest Management Guide for more information on citrus leafminer management, including information on recommended pesticides.

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