Factors Influencing the Development of Cuban Laurel Thrips on *Ficus Retusa*

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The Cuban laurel thrips *Gynaikothrips ficorum* was introduced into Southern California in 1959. It infests *Ficus microcarpa* varieties *retusa* and *nitida*, popularly known as Indian laurels, which are very common landscape trees. The gardeners' practice of shearing the outer surface of the *Ficus* canopy to create a dense and compact sculptural form results in a large synchronous flush of young leaves susceptible to rolling by the thrips.

Although there are reports of defoliation of another *Ficus* species in Hawaii, in California rolled leaves can remain on trees for as long as a year. It is not well understood whether thrips' feeding causes reduced growth of landscape trees, but the primary concern in California is aesthetic injury. Such damage is particularly important in nursery-grown trees that will be offered for sale.

Feeding by adult thrips on young leaves as they begin to expand causes the leaves to roll into a leaf gall, allowing the thrips to mate and lay eggs within the protection of the rolled leaf. After the eggs hatch, the nymphs feed on the leaf cell contents. Populations within the galls can reach up to 500 individuals with overlapping generations. Adults may either leave the galls and begin feeding on new young leaves, or they can remain within the mature galls and begin another generation of thrips. Even if the thrips' feeding cannot successfully create leaf roll, there will be production of feeding scars that can be red to purple-brown in color.

At the beginning of this project there was surprisingly little known about the biology of Cuban laurel thrips. The purposes of this study were to describe when the populations were active, determine when leaf rolling occurred relative to thrips population increases, characterize the developmental rate of thrips at different temperatures and identify the temperature thresholds, estimate the effects of some of the naturally occurring biological control agents, test whether insecticide applications had any value in protecting landscape trees from injury, and develop recommendations for integrated pest management of this insect in landscape environments.

Adult thrips appearing on *Ficus* leaves when growth stage of leaves makes them susceptible to rolling.

Young thrips and fullly galled *Ficus* leaves.

Seasonal Abundance of Thrips and Galls

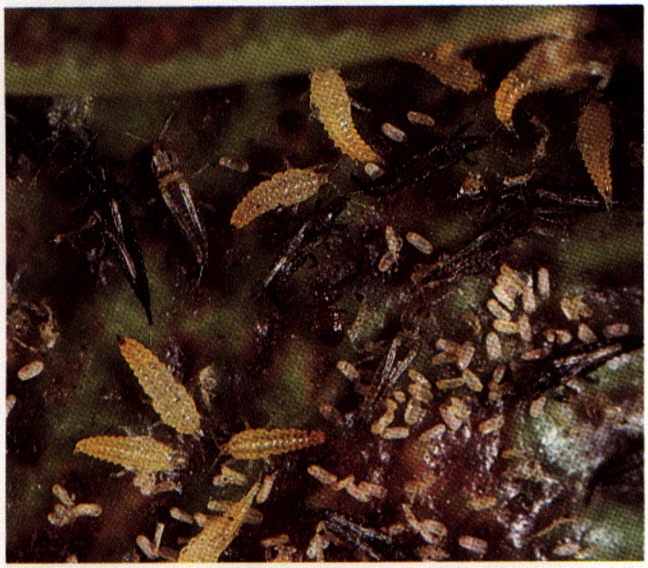
The population cycles of Cuban laurel thrips were followed by removing 20 mature leaf galls and 20 young unhardened leaf galls weekly from trees growing in an Orange County coastal location and a Riverside County inland location beginning in May, 1987, and continuing through June, 1989. The galls were brought back into the laboratory where the eggs, nymphs and adults were counted. To determine the changes in the populations of leaf galls on the trees, 10 branch terminals (approximately 30 centimeters long) from five trees in each location were removed weekly between June, 1988, and June, 1989, and we counted the number of young galls, old galls and normal leaves.

There were two peaks in egg, immature and adult populations within mature leaf rolls that were apparent at the inland site in 1987-1988, but there was no corresponding mid-winter and early spring peak in immatures and adults at the coastal location during the same 12-month period. There were mid-summer peaks in immatures and adults in both locations in 1988, although there did not appear to be a distinct increase in egg populations at the same time in the coastal site. The population peak extending from mid-winter through early spring was greatly reduced in both locations during the 1988-1989 sampling period. Even though the trees produced young leaves most of the year, rolling of those leaves began in late spring or early summer. Populations of all life stages were similar in both locations during the time young galls were forming, which was in part a result of our sampling the young leaf rolls before overlapping generations could be produced. However, we did not observe young galls that served as only feeding or resting sites.

Comparison by percentage of the number of galled leaves to normal leaves on branch terminals indicated that there was a large increase in the relative proportion of mature galls in the coastal site at the end of August and a secondary increase in mid-December. In contrast, while there may have been a small increase in the percentage of mature rolled leaves at the end of August at the inland location, there was a broad general rise peaking at the end of November. However, there were no leaf rolls produced from about December until about the middle of May among the *Ficus* in either location.

Temperature-Dependent Development Rates

Rather than measuring individual development rates, we measured the total development rate (first egg to first



All life stages of thrips – adults, immatures and eggs – within leaf roll.

adult) of *G. ficorum* populations within leaf rolls. Opening the leaf to examine the development of the insects within irreversibly damaged the gall tissue and prevented further normal development. Therefore, a population of thrips was started at one time, and sets of infested leaves were subsampled at regular intervals to determine the stages of thrips development.

To begin the process, container-grown *Ficus nitida* approximately 30 centimeters tall were placed in front of west-facing windows. Large numbers of adult thrips were released on a bench opposite the plants. The adults flew toward the window, landed on the plants, initiated feeding on the young leaves, and caused the leaves to roll. The trees were then placed in environmental control cabinets maintained at one of six constant temperatures (12°, 15°, 20°, 25°, 30° and 35°C). A subsample of leaf rolls was removed from the plants at regular intervals and opened to determine the development of the individuals within the rolls. That process was destructive, but it was the only way to assess when the first eggs were laid and when the first adults were present in rolls on each plant.

The thrips populations failed to develop at 12°C and at 35°C under constant temperature conditions. The development times at the remaining four temperatures were 49 days at 15°C, 32 days at 20°C, 22 days at 25°C, and as little as 16 days at 30°C.

The observation that there is very limited new leaf roll production by *G. ficorum* for almost half of the year in Southern California, even though the trees flush new foliage for much of that period, stimulated the diverse aspects of the study presented here. The insect is tropical in origin and the cooler temperatures in the more temperate California climate might be expected to be a factor in the appearance of new leaf rolls. However, the lower developmental thresholds for Cuban laurel thrips was similar to that of western flower thrips, a broadly distributed polyphagous thrips native to California and many other areas of North America. Thus, the temperature conditions in California are probably not a major factor delaying development from egg to adult. Temperature may influence the host plant since it is also native to the tropics, and this might alter the development of the thrips within the leaf rolls.

Biological Control by Natural Enemies

Macrotrachiella nigra, an anthocorid, and *Chrysopa carnea*, the green lacewing, were frequently found within the mature infested leaf rolls. Feeding rates of *M. nigra* were examined by placing one adult predator in a small culture dish with five immature thrips. The number of live thrips was counted after 24 and 48 hours. A second test sought to determine the preferences of the two predators for nymph or adult thrips. In one phase of this test, 75 adult and 75 immature thrips were placed in vials with an adult *M. nigra*, and the number of live individuals in each developmental class was determined after 24 hours. The test was then repeated using a third or fourth *C. carnea* instar placed in a vial with 100 thrips nymphs and 100 adults. Predation by *C. carnea* was also tested in culture-dish arenas supplied with combinations of thrips life stages (10 nymphs, 10 adults, 5 nymphs and 5 adults, 20 nymphs, 20 adults, 10 nymphs and 10 adults, 30 nymphs, 30 adults, or 15 nymphs and 15 adults) and one predator.

Macrotrachiella nigra fed on 3.2 thrips nymphs in 48 hours when confined with five individuals and a small leaf. It is possible that the predator had difficulty in locating an indivdual prey. When provided with an abundance of food items (75 adult and 75 nymphal thrips), individual *M. nigra* consumed an average of 12.6 adults and 8.5 nymphs during a 24-hour period. The green lacewing followed a similar feeding pattern as the anthocorid when presented with an abundance of both adult and nymphal thrips, feeding upon an average of 18 adults and 13.5 nymphs during a 24-hour period. When offered more than 10 thrips, both predators ate fewer individuals in the mixed populations than when given only adults as prey. The results suggest that the green lacewing as well as *M. nigra* are capable of high levels of predation when there are large numbers of prey available, as they would be within a curled leaf. The feeding trials also suggest that both predators prefer to consume adult thrips rather than nymphs. In a leaf roll with large numbers of nymphs and adults, the nymphs may escape predation relative to the adults.

Insecticide Applications for Thrips in Landscape Trees

The thrips are well protected from contact insecticides within the leaf galls. Systemic materials translocated through the leaf tissue to feeding adults and immatures might prove effective to control the populations. However, spraying landscape trees presents a serious problem in achieving full coverage, as well as the problems of drift, worker safety and public exposure.

We compared two insecticides, aldoxycarb at 1 percent and carbofuran at 1 percent, each formulated into fertilizer spikes and placed in the soil at the base of the trees, with an acephate foliage spray. The trees were then sampled bi-weekly for 12 weeks. Branch terminals were removed, the rolled and normal leaves counted, and the leaf rolls dissected to determine the number of eggs, nymphs, and adult thrips.

There were significant differences in the percentage of galled leaves on the trees through time. Aldoxycarb and acephate treatments reduced the amount of leaf damage between 6 and 10 weeks after treatment. However, there were no differences in the population of eggs, live nymphs, dead nymphs, live adults, or dead adults per terminal for any treatment when compared to the untreated controls. The results suggest that the insecticides moved into the new tissue and protected the young leaves as they expanded. Once they had completely expanded, the leaves were no longer susceptible to rolling by the thrips. Protection provided by the pesticide during that critical period resulted in a reduction in aesthetic injury. However, it also appeared that the insecticide did not move into the mature leaf galls, and the thrips that remained in those leaf rolls escaped the effects of the pesticide.

Thus, while the insecticide applications reduced damage to the trees, there was no reduction in the insect population. When the insecticide treatments lost efficacy, adult thrips emerging from the mature galls began to feed on the unprotected foliage and new leaf rolls were initiated. If insecticides were continuously applied to the trees, eventually all the mature galls would fall off and the resident population of thrips would be eliminated. Thrips from other infested trees nearby, however, could recolonize trees when the insecticide treatments were discontinued.

Implications for Integrated Pest Management

The results of the study of Cuban laurel thrips in Southern California suggest that use of insecticides on *Ficus* in landscapes is probably inappropriate under most conditions. Insecticides may be useful in production nurseries where the level of acceptable aesthetic injury is very low, the plants are relatively small, and the sources of reinfestation are limited. In landscape plantings, however, the tolerance for aesthetic injury is generally much greater, and if the insecticides do not control the insect populations in addition to reducing the aesthetic injury, their utility is very limited. The problems with landscape use of pesticides, particularly drift and public exposure, should also enter into the decision as to whether to use this approach. Finally, the results from the natural enemy studies suggest that those agents may have a substantial impact on thrips numbers, and insecticide use may not be compatible with such natural biological control.

While pesticide use is not recommended, cultural management options are available. The thrips do not roll leaves for about half the year (December until late May or June), and they are capable only of rolling young leaves that have not fully expanded. The trees that appear to have the greatest amount of damage are those that are sheared into compact forms. If shaping must be done to meet a specific landscape use, it should be timed to permit new foliage that is subsequently flushed to fully expand before June or July when leaf rolling is usually initiated. The best period for shearing may be from December until March or April. The other advantage of shaping during those months will be the removal of mature infested leaves showing mature galls, which tend to appear in greater numbers from mid-winter through early spring. If they are removed and destroyed, a large source of reinfestation can be eliminated. Cultural control reinforced by naturally occurring biological control can provide the most cost-effective and environmentally sound integrated pest management program.

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