UNIVERSITY OF FLORIDA
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Citrus Rust Mite[1]

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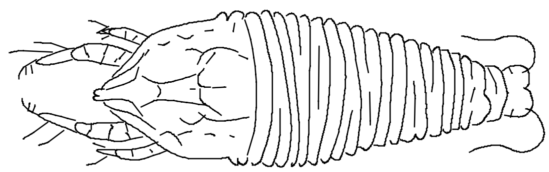

Figure 1. Adult Citrus Rust Mite

The citrus rust mite, *Phyllocoptruta oleivora* (Ashmead), is one of three mite species found on Florida citrus, belonging to the family Eriophyidae. This mite is a serious pest of citrus in most humid regions of the world and is currently considered the most economic arthropod pest of Florida citrus, based on incurred damage and annual cost of control. It infests twigs, leaves, and fruit of all citrus species and varieties, but its order of preferences is lemons, grapefruit, oranges, and tangerines.

PHYSICAL DESCRIPTION

The adult citrus rust mite has an elongated, wedge-shaped body about three times as long (1/200 of an inch or 0.13mm) as wide. Their color varies from light yellow to straw color. The mite has two pairs of short, anterior legs and a pair of lobes on the posterior end which assist in movement and clinging to plant surfaces, (Figure 1).

The eggs of the citrus rust mite are spherical with a smooth regular surface ranging in color from transparent to pale translucent yellow. The eggs are about one-fourth the size of the adult mite.

There are two nymphal stages, each of which resembles the adult except for the smaller size.

LIFE HISTORY

Citrus rust mite egg deposition begins within a day or two after the female reaches maturity and continues throughout her life, about 20 days. The eggs are laid, both singly and groups, on the surface of leaves, fruit, and small twigs. The female lays one to two eggs a day or as many as 20 to 30 eggs during the summer months.

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Immature mites undergo two molts before becoming adults. During the summer, each nymphal stage lasts from 1 to 3 days. During the months of May, June and July, a life cycle from egg to egg can be completed in 7 to 10 days, (Figure 2). This time is increased to 14 days in the winter, depending upon the temperature.

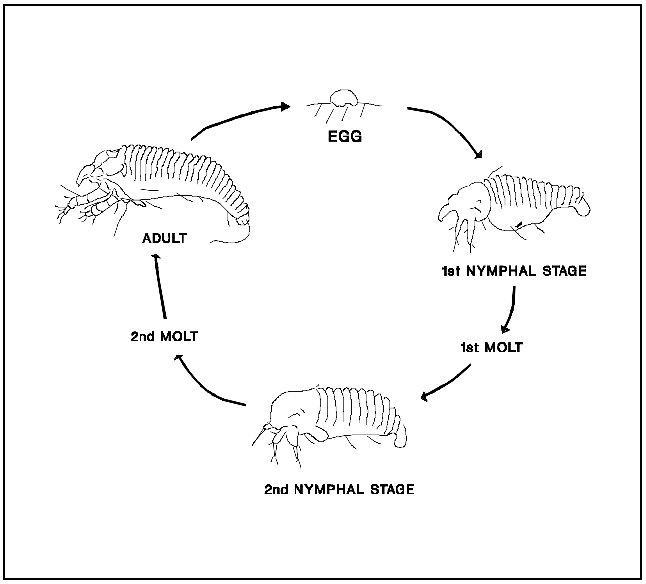

Figure 2. Citrus Rust Mite Life Cycle

BEHAVIOR AND POPULATION DYNAMICS

Citrus rust mite (CRM) populations usually begin to increase from April to May on new foliage, reaching a peak in mid-June to mid-July under typical weather conditions. However, the peak may occur from early May following an early bloom, or as late as July, especially in years following freezes. CRM population densities usually decline in late August, but increase again in the fall; however, fall levels rarely approach those occurring earlier in the summer, (Figure 3).

Citrus rust mites over winter on all tree parts. In the spring, the mites migrate to the spring flush where they feed and begin to reproduce on the leaves. They move to young fruit as it becomes available, usually in mid-April. Throughout April and May CRM populations remain higher on leaves, but in June, higher populations become predominant on fruit.

During the summer, citrus rust mites are more abundant on fruit and foliage on the margins of the canopy. Generally, the north bottom quadrant of the tree is preferred and supports the highest mite populations. The least favorable conditions for CRM buildup are found in the south top quadrant.

The CRM does not like full shade and moves toward light, but avoids direct sunlight. This avoidance of direct solar exposure results in non-injured fruit areas commonly called "sun spots".

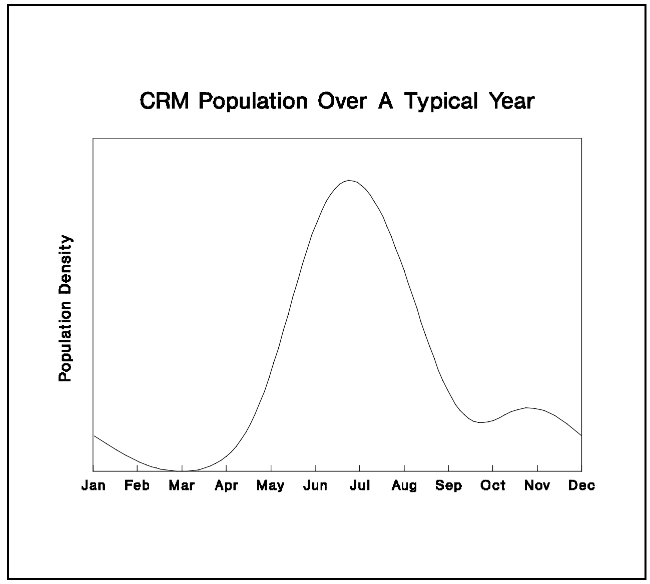

Figure 3. Citrus Rust Mite Population Curve

INJURY TO CITRUS

Citrus rust mites have piercing-sucking mouthparts. They feed by penetrating the first epidermal layer of cells. There is significantly more ethylene produced by fruit showing high citrus rust mite injury than by fruit with no visible injury. Citrus rust mites seem to prefer to feed on immature fruit.

Injury to Twigs and Leaves

Citrus rust mite feeding on twigs results in a "bronzing" of the green twigs. Such damage may contribute to a loss of vitality in the tree.

Feeding on the upper leaf surface (Plate 3, Plate 4, Plate 5) results in small brown spots referred to as russeting. The greatest damage to the leaf occurs when feeding occurs on the lower leaf surface. Extensive injury to the lower epidermis results in subsequent mesophyll collapse. Damage to the guard cells can result in an increase in the transpiration rate. Damage to the lower leaf can result in some leaf drop especially in late fall or winter during dry periods.

Injury to Fruit

All citrus fruit varieties are susceptible to citrus rust mite (CRM) damage. Newly formed fruit lacks cellular fluids necessary to support a CRM population. As the fruit enlarges and the weather warms up, CRM populations become more abundant. CRM infestations on the fruit are of particular economic importance in that injury from extensive mite feeding causes surface blemish which can reduce the grade of fresh fruit, reduce fruit size, and increase fruit drop.

Visible characteristics of peel injury differ according to the variety and maturity of fruit. Injury to grapefruit, lemons, and limes during early fruit growth causes "silvering" of the peel and, if severe, may result in a condition known as "shark skin" (Plate 7, Plate 8). Injury to oranges during this early growth phase results in a brown cracking of the surface. At maturity, this early damage to the peel is called "russeting" (Plates 9, 10, 11). Late injury to oranges occurring in the fall after the fruit has terminated growth appears as a smooth brownish staining. On grapefruit, this late injury occurs near the stomata between the oil glands. This late injury on the fruit is referred to as "bronzing" and takes a high polish since the waxes of the epidermis remain intact.

Field observations indicate that fruit frequently maintains high mite populations 2 to 3 weeks before visible injury appears. In many cases, fruit with high populations never develop visible injury symptoms. Where mites were extremely abundant, injury appears quickly on the areas of the fruit. Since mites feed constantly and cells are receiving multiple puncture wounds without adverse effect, it would appear that injury and healing is a continuous process.

Injury and Fruit Growth

Citrus rust mite damaged fruit may increase in size at a slower rate than undamaged fruit, resulting in a smaller fruit at harvest; however, the amount of injury to the surface must be severe. Damaged fruit with the corresponding smaller size yields lower juice volumes with slightly increased Brix due to water loss. The Brix/acid ratio remains about the same.

Injury and Fruit Drop

Measurements of water loss from on-tree Valencia oranges have indicated higher water loss from damaged than non-damaged fruit with a resulting increased fruit drop. The rate of drop increases slightly with an increase in temperature. A similar pattern is exhibited by grapefruit and Pineapple oranges.

Injury and Internal Fruit Quality

In addition to the size effects of citrus rust mite damage, there is a slight increase in percentage of soluble solids and percentage of acids for damaged fruit with negligible change in the solids/acid ratio. The increase in solids is on the order of 1%, and therefore this gain does not offset the volume loss from size reduction which can be 25%.

In addition, juice from damaged fruit may contain higher concentrations of acetaldehyde and ethanol than normal fruit. Off-flavors were detected only in juice extracted from fruit with extensive surface bronzing and peel shrinkage where the acetaldehyde and ethanol concentrations were highest.

Fruit Surface Damage

In determining citrus rust mite damage to the fruit surface, you must allow for an increasing fruit sensitivity to damage with age of the fruit. Fruit are five to ten times more sensitive to mite damage from late season (December) feeding than from early season (June) feeding.

Effect of Population Density

A simple example for illustrating the effect of citrus rust mite population levels on surface damage is that 10 mites feeding for ten days will produce as much damage as 100 mites feeding for one day. Also 10 mites feeding for twenty days should produce twice as much damage as 100 mites feeding for one day. Since fruit is more sensitive to damage with age, then 1 mite feeding later in the season has more effect on surface damage than 1 mite feeding earlier in the season. However, long term cumulative feeding has a greater effect on surface damage than short term feeding.

MONITORING TECHNIQUES

The pattern of fruit sampling for citrus rust mite (CRM) is not important; however, representative areas of the entire block should be sampled. Do not emphasize known "hot spots". Also avoid sampling trees within three to five trees of the borders. The fruit sampled should be collected at random regardless of its location on the tree. The main consideration in fruit selection for CRM determination is to avoid a biased sample.

In each 10-acre block, fifty fruit (no leaves) should be examined on two random areas of the fruit surface with a 10X hand lens. Record the number of lensfields that show one or more CRM. The number of citrus rust mites is not important. From these observations (one hundred per 10-acre block) calculate the percentage of CRM infested fruit; i.e., fifteen infested lensfields is equal to 15% infested fruit. This procedure is very labor efficient because it does not require any counting of mites and is utilized for both fresh and process fruit.

Using a 20X hand lens, examine the same sites for Hirsutella-killed citrus rust mites. Record the number of Hirsutella-killed rust mites per lensfield. This information will help the grower determine if chemical controls are needed.

ECONOMIC THRESHOLDS

The first step in planning the annual pest management program is to decide whether citrus from a given block will be marketed as fresh fruit or will be processed. In some years, windscarring on your fruit will prevent the fruit from qualifying for the fresh fruit market, before any pest damage has occurred.

Fresh Fruit

Fruit grown for the fresh fruit market should not exceed five percent average surface area damage by citrus rust mites. If fruit is to be grown for the fresh market, the following monitoring and spray application guidelines should be followed:

1. The postbloom melanose spray can be delayed, in most years, until late April or early May. A material for controlling citrus rust mites should be added at this time in addition to foliar nutritionals if necessary.
2. A treatment to control greasy spot is applied in June or July. A material to control citrus rust mite is added at this time.
3. Grove monitoring for citrus rust mites should begin as soon as fruit is evident in the grove. This monitoring should be repeated every two weeks.

Process Fruit

Fruit grown for processing should not exceed fifteen percent average surface area damage by citrus rust mites. If the fruit is to be grown for the process market, the following monitoring and spray application guidelines should be followed:

1. Citrus rust mite populations should not be considered as an economic problem on fruit grown for processing until the summer greasy spot spray.
2. The summer spray should be timed to control greasy spot (mid-June through mid-July). An acaricide should be added at this time.
3. Begin monitoring of citrus rust mites one week after the initiation of the summer spray.
4. Monitor every four weeks.
5. Diseased citrus rust mites can be observed with a 20X hand lens. If three dead or diseased mites are observed per lensfield, a natural decline of citrus rust mites will occur within a week and control measures should be delayed.

MANAGEMENT GUIDELINES

Certain management practices indirectly affect citrus rust mite populations. Also, management practices aimed at reducing citrus rust mite populations adversely affect the control of other citrus pests. Sulfur destroys a wide range of natural enemies that are effective in controlling several citrus pests. The use of multiple sulfur applications in a citrus integrated pest management program is not recommended considering our dependence on natural controls for Florida red scale, purple scale, citrus snow scale, citrus blackfly, and other pests.

The use of copper and nutritional sprays containing MnO and zinc have caused increases in citrus rust mite (CRM) populations by suppressing the fungus *H. thompsonii* when applied during a season of environmental factors favoring optimum fungal growth. The use of spray oil as a selective fungicide, where effective in controlling greasy spot, and allowing CRM to reach high densities before chemical control measure are applied has significantly increased the natural control of CRM populations.

The choice of fungicide applied to control greasy spot may dictate the choice of the miticide. Some miticides are more effective against low populations of CRM. These materials may not be effective on increased CRM populations brought about by the use of copper or benlate applied for greasy spot control in the summer spray. However, the choice of an effective fungicide is paramount in the summer spray program.

Horticultural practices may have an effect upon CRM populations. The practice of hedging and topping alters the environment in the grove by allowing more solar exposure. This results in a more clustered mite population within the tree leading to greater fruit damage due to aggregation of the CRM.

Work done up until now has shown that there is little or no effect upon CRM populations between trees in cultivated plots and on trees grown in plots having a cover crop.

Biological Control

The most important natural control agent for the citrus rust mite (CRM) is the parasitic fungus, *Hirsutella thompsonii* Fisher. The fungus requires the same warm, humid conditions that favor rapid population growth of the CRM. In addition, *H. thompsonii* is density-dependent, requiring high populations of CRM to facilitate its spread. *Hirsutella thompsonii* is most effective in the summer and fall when such conditions exist. CRM infected with *H. thompsonii* first appear sluggish in movement, and gradually change color from the normal yellow to a dark yellow or even brown.

Hirsutella thompsonii will cause suppression of CRM populations 6 to 8 weeks after the beginning of mite population buildup. During this period, the CRM infestation may reach injurious densities and inflict economic injury. Many times, however, *H. thompsonii* will develop in a CRM population and prevent populations from increasing to injurious levels. If three dead or diseased mites are observed within a 20X lensfield on the fruit surface on a 100 fruit sample, do not spray. Do not rely on *H. thompsonii* to regulate CRM population on fruit grown for the fresh market.

Several other predators of the citrus rust mite have been reported. The immature stage of a cecidomyid fly is an excellent citrus rust mite predator feeding primarily on eggs but will also feed on adults and immature stages. The adult fly lays eggs only on citrus fruit heavily infested with citrus rust mite. Others include the dusty-wing, *Semidalis cicina* (Hagen); and the strawberry mite, *Agistemus floridanus* Gonzalez. The ability of these predators to reduce citrus rust mite populations has not been determined.

Consult the *Florida Citrus Pest Management Guide:* Citrus Rust Mite for more information on commercial chemical and cultural controls of citrus rust mite populations.