

THE CITRUS BLACKFLY IN FLORIDA, ITS EDIBLE FRUIT HOST PLANTS AND CONTROL OF ITS DISSEMINATION

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Abstract. Citrus Blackfly, *Aleurocanthus woglumi* Ashby, was found in Fort Lauderdale, Florida on January 28, 1976. Twenty-five plant species that bear edible fruit have since been found to support its life cycle in Florida. Various measures have been implemented to stop the spread of the pest into non-infested areas. Primarily, movement of host plants has been controlled by quarantine procedures. Several pesticides have been found effective against the blackfly. Three parasites of citrus blackfly, *Amitus hesperidum* Silv., *Prospaltella opulenta* Silv., and *P. clypealis* Silv., have been released. Eradication efforts are underway in Palm Beach, Dade, and Broward counties.

The citrus blackfly, *Aleurocanthus woglumi* Ashby, was simultaneously reported in India by Maxwell-Lefroy, the Philippine Islands by Compere and in Ceylon by Woglum, in 1910 (4). It has since been reported to occur in all regions of tropical Asia.

In the western hemisphere, the citrus blackfly was first reported in Jamaica in 1913. The blackfly has spread to other tropical and subtropical regions including Cuba, Haiti, the Bahama Islands, Mexico, and Central America (9, 13). In 1931, it was reported in Key West and was successfully eradicated in 1937 (7). A localized infestation occurred in Texas in 1955. This infestation of citrus blackfly was eradicated in one year (11). Texas became reinfested in 1971, and eradication has not been accomplished to date. On January 28, 1976, a Division of Plant Industry Plant Specialist found the second Florida citrus blackfly infestation in Fort Lauderdale. Surveys revealed it to be generally infesting Broward county and parts of Dade and Palm Beach counties.

The citrus blackfly in the western hemisphere is a classic example of the ability of a minor pest in its native habitat to become a major pest in a foreign environment where its natural parasites and predators are absent. In Asia, where it originates, it has been observed as only an occasional minor pest. In all localities of Southeast Asia, it was observed to prefer garden or dooryard trees over field or grove trees (3). This was attributed to the more stable parasite and predator populations in larger plantings.

The first dramatic demonstration of the economic impact of uncontrolled citrus blackfly populations occurred in commercial plantings of citrus in Mexico. A 2 year infestation resulted in an almost total crop failure (14). At Las Mochis, orange production dropped from 200 to 300 fruit per tree to no fruit at all. A similar report (6) tells of a crop of 345,396 grapefruit grown in one year followed 3 years later by a crop of 826 fruit. Lime production in the Colina, Mexico area suffered a crop reduction of 70% (15). Infestation of less than one year meant a crop loss of as much as 50% as well as a loss in fruit quality (11). No information is available on probable loss in production of avocado, mango or other tropical fruits when infested by citrus blackfly.

Life Cycle

The life cycle of citrus blackfly has previously been described (5, 13). This homopterous insect has a rather long

life cycle lasting from 6 weeks to 4 months. The length of the cycle is shortest under conditions of high humidity, relatively high temp, and a comparatively high and uniformly distributed rainfall (3).

Eggs are laid in a distinct spiral pattern on the underside of the leaves with about 30 to 50 eggs per spiral. The eggs are yellowish when laid and turn light brown with age. Three larval stages or instars follow the eggs. The first instar is elongate, measuring 0.3 x 0.15 mm and is dusky in color. The second instar is 0.4 x 0.2 mm and dark brown to pale black. The third instar is more ovate than those preceding and measures 0.87 to 0.74 mm and is black. The fourth instar or pupal stage is ovate, shiny black, and surrounded by a white waxy secretion. The pupal stage is 1.0 to 1.25 mm in length. At rest, the adult fly appears a metal gray-blue. Light markings on the wings form a band across the wings over the middle of the abdomen. The abdomen is bright red. Adult females are 1.7 mm in length and males 1.3 mm.

The larval and adult stages feed on cell sap by a piercing and sucking action common to homopterous insects. Honeydew is excreted by the larval stages resulting in the growth of sooty mold on the upper surfaces of the leaves below them.

Hosts

In its native habitat, the blackfly has few hosts other than citrus. After 2 years of observations in Southeast Asia and the Philippine Islands, Clausen (3) found not more than 20 clusters of larva or pupa on 4 species of plants. It was observed on 5 plant species in India and Ceylon (3).

In Mexico, immature forms of blackfly have been reported on 155 species of plants with an additional 74 plant species sustaining the entire life cycle (10). The edible fruit, producing species found infested are listed on Tables 1 and 2.

In Florida, 129 plant species have been recorded by the Florida Department of Agriculture & Consumer Services, Division of Plant Industry, as hosts of blackfly. Of this group, 37 have been observed to sustain the blackfly to the pupal stage. Species bearing edible fruit are listed in Tables 3 and 4. Of all the species listed, only citrus and mango have been observed with heavy populations of blackfly. Generally, new leaves are infested first but older leaves may become infested when the citrus blackfly population on new leaves is heavy. Heavily infested trees cease flowering and are unable to withstand unfavorable soil and weather conditions. Mango exhibits effects similar to citrus from heavy feeding but generally has not been observed to be as heavily infested, particularly when citrus is available. Occasionally, mango trees within a few feet of moderately infested citrus have no detectable blackfly infestation. The other species listed have not been observed supporting blackfly populations that result in the debilitatory effect observed on citrus and mango, although black sapote (*Diospyros digyna* Jacq.), wampi (*Clausena lansium* (Lour.) Skeels), and surinam cherry (*Eugenia uniflora* L.) have been observed to support heavier populations than other secondary hosts, but these populations are relatively light compared with those on citrus. Most of the secondary hosts are capable of maintaining the blackfly through the pupal stage and are therefore a source of infestation when infested plants or leaves are transported to uninfested areas. Infestation of species other than citrus and mango appears to be a "spillover" from

Table 1. Edible fruit species found in Mexico that support the entire life cycle of citrus blackfly (Shaw (10)).

Botanical Name	Common Name
<i>Anacardium occidentale</i> L.	Cashew
<i>Annona cherimola</i> Mill.	Cherimoya
<i>Artocarpus altilis</i> (Park) Fosberg	Breadfruit
<i>Citrus aurantiifolia</i> (Christm.) Swingle	Lime
<i>Citrus aurantium</i> L.	Sour orange
<i>Citrus limon</i> Burm. F.	Lemon
<i>Citrus maxima</i> (Burm.) Merrill	Shaddock
<i>Citrus medica</i> L.	Citron
<i>Citrus x paradisi</i> Macfady	Grapefruit
<i>Citrus reticulata</i> Blanco	Mandarin
<i>Citrus sinensis</i> (L.) Osbeck	Sweet orange
<i>Cydonia oblonga</i> Miller	Quince
<i>Diospyros digyna</i> Jacq.	Black sapote
<i>Diospyros kaki</i> L.f.	Japanese persimmon
<i>Diospyros</i> sp.	Persimmon
<i>Fortunella</i> sp.	Kumquat
<i>Mammea americana</i> L.	Mammee apple
<i>Mangifera indica</i> L.	Mango
<i>Manilkara zapota</i> (L.) Van Royen	Sapodilla
<i>Monstera deliciosa</i> Liebm.	Monstera
<i>Musa</i> sp.	Banana
<i>Persea americana</i> , Mill.	Avocado
<i>Pouteria campechiana</i> (HBK) Baehni	Yellow sapote
<i>Pouteria sapota</i> (Jacq.) H. E. Moore	Sapote
<i>Prunus domestica</i> L.	Plum
<i>Psidium sartorianum</i> (Berg.) Niedenzu	Guayabilla
<i>Psidium littorale</i> Raddi	Strawberry guava
<i>Punica granatum</i> L.	Pomegranate
<i>Pyrus communis</i> L.	Pear
<i>Spondias mombin</i> L. (<i>S. lutea</i> L.)	Yellow mombin
<i>Syzygium jambos</i> (L.) Alston	Rose apple
<i>Vitis</i> sp.	Grape

surrounding citrus and mango trees. Often, hundreds or thousands of adult flies have been observed on new, yellowish green foliage. Later examination indicated that only a small percentage of the flies actually remained on the leaves to lay eggs.

Chemical Control

When citrus blackfly was found in Key West, Florida, in 1931, the only effective pesticide available was an oil spray which was used to eradicate the pest from that area (7). Since that time, several insecticides have been tested for effectiveness in controlling and eradicating the citrus blackfly (2, 8, 10, 12, and J. O'Neal, APHIS, USDA, unpublished data). Of those tested, Guthion, malathion, Trithion, Dimethoate, and Orthene have proven most effective. Preliminary testing of Ethion and oil has yielded favorable data. Labeling for use of Ethion and oil and Orthene for the control of citrus blackfly in Florida is presently under

Table 2. Edible fruit species found in Mexico that have not been observed to support the entire life cycle of citrus blackfly (Shaw (10)).

Botanical Name	Common Name
<i>Annona muricata</i> L.	Soursop
<i>Carica papaya</i> L.	Papaya
<i>Carissa grandiflora</i> (E.H. Meg.) A.D.C.	Natal plum
<i>Casimiroa edulis</i> Llave & Lex.	White sapote
<i>Eugenia uniflora</i> L.	Surinam cherry
<i>Malpighia glabra</i> L.	Barbados cherry
<i>Passiflora</i> sp.	Passion fruit
<i>Prunus armeniaca</i> L.	Apricot
<i>Prunus capuli</i> Cav.	Capollin
<i>Prunus persica</i> (L.) Batsch.	Peach
<i>Psidium guajava</i> L.	Guava
<i>Sargentia greggii</i> S. Wats.	Yellow chapote

Table 3. Edible fruit species found in Florida that support citrus blackfly development through the pupal stage.

Botanical Name	Common Name
<i>Citrus aurantiifolia</i> (Christm.) Swing.	Lime
<i>Citrus aurantium</i> L.	Sour orange
<i>Citrus maxima</i> (Burm.) Merrill	Shaddock
<i>Citrus limon</i> (L.) Burm.f. (<i>C. jambhiri</i> Lush)	Rough lemon
<i>Citrus limon</i> (L.) Burm.f.	Lemon
<i>Citrus mitis</i> Blanco	Calamondin
<i>Citrus x paradisi</i> Macfady	Grapefruit
<i>Citrus reticulata</i> Blanco	Tangerine
<i>Citrus sinensis</i> (L.) Osbeck	Sweet orange
<i>Clausena lansium</i> (Lour.) Skeels	Wampi
<i>Diospyros digyna</i> Jacq.	Black sapote
<i>Eriobotrya japonica</i> (Thunb.) Lindl.	Loquat
<i>Eugenia uniflora</i> L.	Surinam cherry
<i>Flacourtia indica</i> (Burm.f.) Merrill	Governor's plum
<i>Fortunella</i> sp.	Kumquat
<i>Malus sylvestris</i> Mill.	Apple
<i>Mangifera indica</i> L.	Mango
<i>Manilkara zapota</i> (L.) Van Royen	Sapodilla
<i>Musa x paradisiace</i> L.	Banana
<i>Myrciaria cauliflora</i> (DC.) O. Berg	Jaboticaba
<i>Persea americana</i> Mill.	Avocado
<i>Pourteria campechiana</i> (HBK) Baehni	Egg fruit
<i>Psidium littorale longipes</i> (O. Berg) Fosb.	Strawberry guava
<i>Syzygium cumini</i> (L.) Skeels	Java plum
<i>Syzygium jambos</i> (L.) Alston	Rose apple

review. Under an emergency label, Orthene, malathion, and Guthion have been approved for use by the Florida Department of Agriculture & Consumer Services and the United States Department of Agriculture in their eradication program and where nursery applications are required by Division of Plant Industry Quarantine.

Biological Control

Hymenopterous parasites appear to be the best biological agents for the control of citrus blackfly (1, 3, 5, 8, 13). Several predators have also been found feeding on blackfly, but they are dependent on a large population of the host. Clausen (3) found 5 hymenopterous parasites and 9 insect predators controlling citrus blackfly in Southeast Asia. Certain fungi have also been found that parasitize citrus blackfly.

Parasites of the citrus blackfly are presently being used in the blackfly infested area of Florida to suppress the population until eradication measures are implemented in the heavily infested sections. Three hymenopterous parasites have been introduced, *Amitus hesperidum* Silv., *Prospaltella opulenta* Silv. and *P. clypealis* Silv. These parasites were obtained through the United States Department of Agriculture, Agricultural Research Service laboratory in General Teran, Mexico. In 1976, 27,000 parasites were released. Theoretical calculations indicate a possibility of 5 billion parasites in Florida by June of 1977 according to A. Selhime of the USDA Agricultural Research Service in Orlando, Florida.

Table 4. Edible fruit species found infested with citrus blackfly in Florida on which pupae have not been observed.

Botanical Name	Common Name
<i>Artocarpus heterophyllus</i> Lam.	Jackfruit
<i>Carica papaya</i> L.	Papaya
<i>Passiflora quadrangularis</i> L.	Giant grandilla
<i>Syzygium paniculatum</i> Gaertn.	Brush cherry

Control of Dissemination

In order to stop the spread of citrus blackfly from the infested area in Florida, several regulations have been imposed. A regulated area has been established to control the movement of plant material. The regulated area is bounded on the east by the Atlantic Ocean, on the north extending west from the ocean on the north line of township 44 S. to its interception of State Road 80 (U.S. 98) and continuing west to the interception of Levee L-40. The west boundary starts at the interception of State Road 80 and Levee L-40, then south on Levee L-40 to Levee 36 to Levee L-35A then southwest along Levee 35A to its interception with State Highway 84, west on State Highway 84 to State Highway 25 (U.S. 27) then south on State Highway 25 to its interception with State Highway 25A, then east along Highway 25A to its end, then on a line extending east to the Atlantic Ocean.

All movement of nursery stock and other plant material is regulated. Nurseries in the regulated area are under a 30-day inspection schedule. All nurseries in Palm Beach County within 10 miles of the regulated area are inspected on a 60-day schedule. Nurseries in Palm Beach and Martin counties between 10 and 35 miles of the regulated area are inspected every 90-days. Nurseries in Dade County within 18 miles of the regulated zone are inspected on a 30 day schedule. All nurseries between 18 miles of the regulated zone and the Dade-Monroe county line are inspected on a 60-day schedule. All plant material, other than citrus and mango, is permitted to be moved from nurseries if a visual inspection reveals no blackfly infestation. Citrus and mango stock must be sprayed every 14 days with either Orthene or Guthion before movement is permitted. Plants, other than citrus and mango, found infested must also be sprayed until any possibility of reinfestation is eliminated. All sprays are witnessed by Division of Plant Industry personnel. Nurseries in heavily infested areas with citrus, mango and secondary host stock receive monthly applications of malathion on all infested plants within 300 feet. In addition, all noncommercial movement of plant material out of the regulated area must meet the above requirements.

All commercial fruit movement from the regulated area is allowed under limited permits issued by the Division of Plant Industry. All fruit from groves located within one mile of the citrus blackfly infestation is required to be fumigated with methyl bromide. Currently this involves fruit from 4,599 acres of citrus. There are 6,219 acres of citrus and 171 acres of mango in the remainder of the regulated area. All fumigation is conducted under supervision of Division of Plant Industry personnel.

Noncommercial fruit shipments are required to be inspected and certified free of leaves and twigs by DPI and USDA personnel. All common carriers have been notified not to accept shipments without proper certification.

Recreation vehicle parks in the regulated area are visited monthly to remind managers of the quarantine regulations in force, and they are provided with information sheets for distribution to campers. The parks are then surveyed by DPI personnel to inform any campers with plants of the regulations involving movement of their plants. Trash haulers and lawn maintenance companies are required to transport all plant refuse to approved landfills where rapid covering will prohibit emergence of adult flies. Information sheets, stating the regulations and listing approved landfills, have been distributed by mail and field personnel.

At the present time, a cooperative eradication program between the Division of Plant Industry and United States Department of Agriculture is underway, with the use of

Orthene, in Palm Beach and Dade counties. Groves are sprayed by helicopter while residential and other areas are sprayed with ground equipment. Spraying in Palm Beach county was started one mile south of the Palm Beach-Martin county line and is progressing southward in one mile increments. In Dade county a 3 mile wide buffer zone has been established north of State Highway 94. This zone received 3 applications of Orthene. The buffer zone and all areas south of it are surveyed on a regular schedule. Any citrus blackfly finds in these areas are immediately sprayed. This program involves 32 truck-mounted hydraulic sprayers, 60 ULV mistblowers and one contract helicopter. Approximately 400 Division of Plant Industry and United States Department of Agriculture personnel are involved.

Summary

The citrus blackfly is a serious economic threat to the citrus industry of Florida and to a lesser extent to mango, avocado and other subtropical fruits, if it is not eradicated.

To prevent the spread of citrus blackfly, it is of paramount importance that citrus blackfly hosts or parts thereof, many of which are edible tropical fruits. (see Tables 1, 2, 3, 4) cannot be allowed to be moved from an infested area to a noninfested area without certification of freedom from citrus blackfly.

In a cooperative program, the Division of Plant Industry and the United States Department of Agriculture are pursuing eradication of the citrus blackfly from South Florida by ground spraying.

If eradication attempts are not successful, growers and shippers of host commodities may indefinitely have to meet strict regulation on the movement of these commodities within the state and in certain areas of interstate shipment.

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