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Citrus Scab

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In 2006, Hawai'i imported more than 240,000,000 pounds of citrus fruits. That year, Hawaii's market share for citrus fruits was less than 5 percent, on average, for grapefruits, lemons, limes, and tangerines. The Hawai'i market share for oranges is also very low, but their numbers are not reported individually in the Hawai'i Department of Agriculture's annual Statistics of Hawai'i Agriculture for 2006. Therefore, Hawai'i agricultural statistics roughly indicate that about 90–95 percent of the citrus appearing in Hawai'i markets is grown outside of Hawai'i.

Although Hawai'i's climate is suitable for growing citrus, insect pests and plant diseases reduce citrus tree health and production and result in blemished fruits. Despite these drawbacks, a large and unrecorded quantity of locally produced citrus is sold in farmers' markets throughout the state. Further, citrus trees are present in residential landscapes and yards, providing fruits for home consumption.

The most severe diseases of *Citrus* spp. in Hawai'i include a viral disease known as citrus tristeza, a root and stem disease caused by the oomycete pseudofungus *Phytophthora*, and a blight disease of unknown etiology. Other common fungal diseases of foliage and fruits also impact fruit quality and appearance. One of these diseases is citrus scab, caused by the plant-pathogenic fungus *Elsinoe fawcetti*. In order for Hawai'i to be more self-sufficient in citrus production, these citrus diseases must be more effectively recognized and managed.

One way to manage these diseases is to become familiar with their symptoms and control strategies. This publication describes citrus scab disease and some integrated management practices for use before and during fruit formation.

Symptoms of citrus scab disease on a tangelo fruit in Hawaii. When the pathogen infects young fruits, light brown, raised, rounded, warty scabs appear on the rind surface in large numbers. Extensive scabby areas may form as individual pustules coalesce. Photos: S. Nelson

The hosts

About 11 species of *Citrus* (plant family Rutaceae) are native to Southeast Asia. They are evergreen trees and shrubs cultivated for their edible fruits and as ornamentals. From these 11 species, many varieties, forms, and fertile hybrids have resulted. They have dark green, shiny, oval, alternate leaves. Their flowers are fragrant. The globose fruits have thick skins, oil glands, and segmented, juicy, edible pulps.

Citrus is grown throughout the world where air temperature does not cause freezing sufficient to kill the trees, and where rainfall or irrigation water is sufficient to support plant growth. The disease reduces the aesthetic quality of fresh fruits for the market, although it does not affect edibility. Fruits for processing

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Scab on lime fruits

are not significantly affected.

The hosts of citrus scab include rough lemon, sour orange, Rangpur lime, Carrizo citrange, some tangerines, lemons, limes, tangelos, and Temple orange. Worldwide, citrus scab is a severe problem on many tangerines and tangerine hybrids.

The UH-CTAHR Waiakea Research Station in Hilo, which receives 170 inches of annual rainfall, is an ideal climate for scab disease development. The station has a large collection of citrus cultivars and some rootstocks commonly used in citrus cultivation. Observed susceptibility of citrus scab caused by the fungus *E. fawcetti* is outlined below (the author made these observations in 2007–2008).

Highly susceptible citrus types

Some tangerine (*C. reticulata*) varieties such as Fremont, Clementine and Murcott
Rough lemon (*C. jambhiri*)
Tangelo (*C. reticulata* x *C. paradisi*) (variety Orlando)
Tahitian lime (Persian lime, *C. latifolia*)
Rangpur lime (Mandarin lime, *C. limonia*)
Frost Satsuma mandarin (*C. unshiu*)

Not susceptible or immune citrus types

Sweet orange, navel orange (*C. sinensis*)
Pummelo, shaddock (*C. grandis*)
Grapefruit, pomelo (*C. paradisi*) (however, grapefruit is reported as a host of the disease in Florida)
Some lime and tangerine varieties at Waiakea are not symptomatic.

Scab on young rough lemon fruits

Citrus rootstock plants at a USDA research facility near Hilo

Heen Naran (*C. reticulata*, tangerine or Mandarin): not susceptible

Cleo (*C. reticulata*, tangerine or Mandarin): susceptible

Poncirus trifoliata (trifoliate orange): not susceptible

The pathogen

The fungal pathogen is *Elsinoe fawcetti* Bitancourt & Jenkins (the teleomorph or sexual stage of the pathogen is *Sphaceloma fawcetti* Jenkins). Two biotypes of this pathogen have been reported from Florida. They each attack different citrus hosts. Another strain is present in Trinidad, suggesting considerable diversity within this fungal species.

The pathogen affects the leaves, twigs, and fruits of a wide range of citrus types or species, including plants used for rootstocks and fresh fruits for human consumption or use. Most damage occurs during wet seasons or in high-rainfall areas.

Disease symptoms

Twigs, petioles or newly emerging shoot apices. Infection may cause distortion on highly susceptible citrus cultivars (i.e., some tangerines). Pustules develop on the invaded side of young leaves, producing corresponding depressions on the non-invaded side of leaves. Light brown, raised, circular scabs appear on young stems or green twigs.

Leaves. Light brown pustules or scabs develop on leaves, and are sometimes visible on both upper and lower surfaces. Leaves are more susceptible to pustules when they are young, and develop some resistance to scab with age. The scabs consist of the body of the fungus, or stroma, plus swollen, hyperplastic host tissues.

Scab on tangerine fruits, leaves and stem

Scab on a ripening rough lemon fruit

Fruits. When the pathogen infects young fruits, light brown, raised, rounded, warty scabs appear on the rind surface. Extensive scabby areas may form as individual pustules merge into each other.

Note on color of scabs: Scab color may range from pink to light brown after infection and from grey to black later in the season.

Disease cycle

Dispersal. Spores are produced in scab pustules on diseased fruits, leaves and twigs and spread to other tissues by splashing rain or irrigation water.

Infection. Approximately 3 to 4 hours of surface wetness on susceptible plant tissues is required for infection to occur.

Symptom development. Fruits remain susceptible to infection and disease development until about 3 months after petal fall. Growing leaves are the most susceptible and become resistant just before reaching full size.

Pathogen survival. The pathogen survives on diseased leaves, twigs, and fruits within the tree canopy and in citrus plant debris.

Integrated management practices

Choice of cultivar. Select a resistant species, hybrid, or cultivar.

Choice of planting location. Plant in a sunny, drier location.

Cropping system. Intercrop citrus with other types of non-citrus plants or trees that are not prone to infection. Grow young plants under cover in nurseries and avoid overhead irrigation.

Fungicides (Table 1). Depending on location and disease severity, up to three fungicide applications per season may be required to control the disease, especially if leaves are heavily infected from the previous season. Start spraying before flowering, during the seasonal flush of leaves, with a second application at petal fall, and a third several weeks later during fruit formation.

Irrigation. Reducing or eliminating overhead irrigation of susceptible varieties during the active growth

Table 1.Some fungicides registered in Hawai'i for management of leaf and fruit scab diseases on citrus caused by *Elsinoe*.

Product name	*Active ingredient(s)*	*Formulation*
70% Neem Oil (plus other similar neem oil products)	Clarified hydrophobic neem oil (70%)	Oils - no added pesticide
Abound Flowable Fungicide	Azoxystrobin (22.9%)	Flowable concentrate
Amistar Fungicide	Azoxystrobin (80.0%)	Water dispersible granules
Armicarb (DISC)	Carbonic acid, monopotassium salt (85%)	Soluble concentrate
Badge SC	Copper hydroxide (16.4%), copper oxychloride (17.6%)	Emulsifiable concentrate
Basic Copper 53	Basic cupric sulfate (98%)	Emulsifiable concentrate
Bonide Liquid Copper Fungicide Concentrate	Octanoic acid, copper salt (10.0%)	Flowable concentrate
Champ Formula 2 Flowable Agricultural Fungicide/Bactericide (plus other Champ product)	Copper hydroxide (37.5%)	Flowable concentrate
Champion Wettable Powder Agricultural Fungicide (plus other Champion product)	Copper hydroxide (77%)	Wettable powder
DuPont Kocide 101 Fungicide/Bactericide (plus other DuPont Kocide products)	Copper hydroxide (77%)	Wettable powder
Greenclean Broad Spectrum Algaecide/ Bactericide Liquid (plus other similar hydrogen peroxide products)	Hydrogen peroxide (27%)	Soluble concentrate
Griffin Kocide 101 Fungicide Wettable Powder (plus other Griffin Kocide products)	Copper hydroxide (77%)	Wettable powder
Headline Fungicide	Pyraclostrobin (23.6%)	Emulsifiable concentrate
Heritage Fungicide	Azoxystrobin (50%)	Water dispersible granules
Kentan DF	Copper hydroxide (61.3%)	Water dispersible granules
Lilly Miller Kop-R-Spray Concentrate	Tetraaminecopper (2+) (8%)	Emulsifiable concentrate
Monterey Liqui-Cop Copper Fungicidal Garden Spray	Tetraaminecopper (2+) (31.4%)	Emulsifiable concentrate
Natural Guard Copper Soap Liquid Fungicide	Octanoic acid, copper salt (10%)	Flowable concentrate
Nu-Cop 3L (plus other Nu-Cop products)	Copper hydroxide (37.5%)	Flowable concentrate
Quadris Flowable Fungicide	Azoxystrobin (22.9%)	Flowable concentrate
Serenade Max	QST 713 strain of *Bacillus subtilis* (14.6%)	Wettable powder
Sonata	*Bacillus pumilus* strain QST 2808 (1.38%)	Emulsifiable concentrate
Tenncop 5E Fungicide/Bactericide	Copper salts of fatty and rosin acid (58%)	Emulsifiable concentrate

*Source: Hawaii Pesticide Information Retrieval System (HPIRS). Always follow pesticide label instructions and allowances exactly. Refer to label or HPIRS, the University of Hawaii or the Hawaii Department of Agriculture to see if products may be used as foliar, delayed dormant, and nursery stock applications. Over-application of some fungicides may enhance the development of resistance in the pathogen populations. Other product names with similar active ingredients are not displayed in this table. Lower label rates can be used on smaller trees. Do not use less than the minimum label rate.

period of the fruit inhibits infections and reduces the severity of disease.

Weed control. Do not allow tall weeds to grow around citrus plants as they increase the relative humidity in the citrus tree canopy. High relative humidity favors infection and disease development.

Pruning. Periodically thin trees to increase air circulation. Foliage will dry more rapidly after a rainfall and fungicide sprays can penetrate the canopy more efficiently.

Other citrus fruit problem with similar appearance to citrus scab

- Citrus melanose
- Bacterial canker (the disease does not exist yet in Hawai'i but does exist elsewhere in the Pacific, including the Federated States of Micronesia)
- Wind injury (leaves and branches rubbing against fruits can cause scab-like symptoms or scars)
- Mite feeding injury (this tends to occur mainly during drier seasons or in lower rainfall regions of Hawai'i, causing scarring of fruits).

Fungicide applications

Where three fungicide sprays are needed to control citrus scab, a suggested set of sprays is as follows:

1. Abound®. Apply the first spray to leaves before flowering, or at about ¼ expansion of the leaf flush before flowering. To prevent fungicide resistance. development in the pathogen population, do not use Abound twice in succession.
2. Headline®. This second spray is applied at flower petal fall.
3. Copper fungicide. The third spray is applied about three weeks after second application.

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