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Citrus Melanose

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Melanose disease can affect young leaves and fruits of certain citrus species or varieties when the tissues grow and expand during extended periods of rainy or humid weather conditions. The symptoms of this widely distributed fungal disease vary from small spots or scab-like lesions to patterns of damage referred to as tear-drop, mudcake, and star melanose. This is one of the most commonly observed diseases of citrus fruits in Hawai'i.

Citrus melanose is caused by the plant-pathogenic fungus *Diaporthe citri* (anamorph = *Phomopsis citri*). It can create severe fruit rind blemishes, but the fungus does not normally affect the pulp. On leaves, the small, black, raised lesions are often surrounded by yellow halos and can cause leaf distortion.

The host

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 edible, 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. In Hawai'i, the disease typically attacks sweet orange (*Citrus sinensis*), grapefruit (*C. paradisi*) and pummelo (*C. grandis*). The disease reduces the aesthetic quality of fresh fruits for the market, although it does not affect edibility. Fruits for processing are not significantly affected.

A combination of "mudcake" and tear-staining symptoms on a rind is typical of melanose disease on a *Citrus* sp. This fruit was growing in Hilo, Hawai'i. Photos: S. Nelson

The pathogen

The fungal pathogen *Diaporthe citri* Wolf is the teleomorph or sexual stage, and the anamorph (asexual stage) is *Phomopsis citri* Fawc. A synonym for *D. citri* is *D. medusaea* Nits. The pathogen mostly infects leaves and fruits, but it may also cause a stem-end rot of citrus, and it infests dead twigs as a saprophyte.

The anamorph stage produces two types of asexual spores, the so-called alpha and beta conidia. They form in thick-walled, erumpent pycnidia that develop in dead citrus twigs. The alpha conidia (5–9 x 2.5–4 micrometers) are single-celled, hyaline, and biguttulate. The beta conidia (20–30 x 0.7–1.5 micrometers) tend to appear in older pycnidia and are filiform and bent or hooked at one end. Under humid conditions, the conidia extrude from pycnidia in slimy masses or in tendrils. Most of the spores resist drying and remain viable in the tendrils until they are dispersed by water. The teleomorph stage consists of spherical perithecia that form on twigs and contain sexually produced ascospores.

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These grapefruits with melanose disease symptoms were collected from the Kailua-Kona region of the island of Hawai'i

Symptoms

Infections occur on leaves that are not fully expanded. Darkly colored, raised, corky pustules appear after leaf infection. The pustules may be surrounded by yellowed leaf tissue or yellow halos. The yellow color may later turn green. Severely infected shoot apices may become distorted or die back. Fully expanded, mature leaves resist infection.

On fruits infection appears as darkly colored and usually raised pustules of various sizes. The pustules may coalesce and produce a cracked appearance, known as mudcake melanose, or may spread with flowing water on the fruit surface to form tear-stain symptoms. Pustules may be larger in size when the pathogen infects very young fruits.

Presence of spore tendrils is a sign of the pathogen.

Disease cycle

Dispersal. Rain or overhead irrigation water spreads the anamorph spores over short distances to susceptible tissues in the citrus canopy. The ascospores are dispersed by wind over longer distances. The more dead wood that exists in a canopy, the more ascospores will be produced. Most fruit infections probably start other infections caused by conidia.

Infection. Fruits are susceptible to infection from about 3–5 months after petal drop, depending on the area. Approximately 8–24 hours of continuous moisture on leaf or fruit surfaces is required for infection to occur, depending on air temperature (shorter periods at higher air temperature). Therefore, periods of extended rainfall at warm locations are most likely to initiate rapid and severe melanose disease development.

Cracking and slightly raised, scab-like pustules on sweet orange are symptomatic of melanose disease.

Tear-staining of sweet orange is symptomatic of melanose disease. Pathogen spores were deposited on the rind surface by flowing rain water that was running down the fruit surface.

Symptom development. Symptoms develop as spots or scabby areas on leaves and fruits. Spots are dark in color and slightly raised. On fruits, the spots do not penetrate into the fruit and cause rot. On leaves, yellow areas surround the spots. Spots may coalesce to form large areas of scab-like blight.

Pathogen survival. The pathogen survives saprophytically on dead branches and twigs in the citrus canopy.

Integrated management practices

The disease may not severely impact fruit yield, and if fruits are grown for juicing or other processing, melanose disease management may not be warranted.

Pruning. Periodically prune away dead branches. This will reduce pathogen survival, increase air circulation to dry out the canopy, and allow for more effective fungicide penetration and coverage of the foliage.

Fungicides. Sprays of fungicides to young fruits and leaves may be necessary for disease management. Where the disease tends to be severe, frequent fungicide applications may be required (refer to Table 1). Worldwide, copper fungicides are the most commonly applied. After application of copper sprays to citrus fruits, star melanose symptoms may appear which differ from the symptoms described above on unsprayed fruits. Postharvest treatments and storage conditions of fruits are not effective in reducing melanose disease damage to citrus rinds.

Citrus variety. Avoid planting very susceptible citrus varieties or species (sweet orange, grapefruit, pummelo) in high-rainfall areas.

A grapefruit leaf with typical spotting and yellowing symptoms of melanose near Kurtistown, Hawai‘i

A more advanced stage of pustule development leads to spots and slight cracking symptoms on the rind of a grapefruit growing in Hawai‘i.

Melanose pustules on grapefruit leaf and fruit near Kurtistown, Hawai‘i. Note the yellowing of leaf tissue surrounding the darkly colored, slightly raised, scabby pustules and the discolored and spotted fruit rind.

Tear-staining of pummelo is symptomatic of melanose disease. Pathogen spores were deposited on the rind surface by flowing rain water that was running along the fruit surface.

Choice of planting location. Plant citrus in sunny, low-rainfall regions.

Cropping system. Interplant citrus with non-susceptible hosts (avoid monocrops).

Sanitation. Pick up and destroy plant materials that have fallen from the citrus canopy.

Other similar citrus fruit problems in Hawai‘i are

- citrus scab
- broad mite injury (causes scarring and discoloration of citrus fruit rinds)
- wind damage (citrus foliage rubs against fruits, creating scars or scabs).

Reference

Whiteside, J.O. 1993. Melanose. p. 20–21 In: J.O. Whiteside, S.M. Garnsey, and L.W. Timmer (eds.), Compendium of citrus diseases. APS Press, The American Phytopathological Society, Minneapolis, Minn. 80 p.

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Table 1. Some fungicides registered in Hawai'i for application to citrus for management of leaf and fruit melanose caused by *Diaporthe*.

Product name	*Active ingredient(s)*	*Formulation*
Amistar Fungicide	Azoxystrobin (80.0%)	Water dispersible granules
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
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	Otanoic 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 the pesticide label to find if products may be used for foliar, delayed-dormant, and nursery stock applications. Over-application of some fungicides may enhance the development of resistance in the fungal populations. To slow fungicide resistance, rotate between products with different modes of action. 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.