



**Cooperative Extension Service**  
College of Tropical Agriculture and Human Resources  
University of Hawai'i at Mānoa

**Plant Disease**  
**Aug. 2008**  
**PD-46**

## Mango Powdery Mildew

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Two fungal diseases of mango (*Mangifera indica* L.) flowers and young fruits, mango powdery mildew and mango anthracnose, are the primary causes of the widespread problem of poor mango fruit set and yield in Hawai'i.

Worldwide, mango powdery mildew is a sporadic but very severe disease of mango leaves, panicles, and young fruits; up to 90 percent crop loss can occur due to its effect on fruit set and development. Mango powdery mildew was present in India before 1874; it was first reported in Hawai'i in 1983.

Mango powdery mildew is an easily recognizable problem; the symptoms are very apparent and are diagnostic. However, it is not easily controlled with cultural practices alone. If susceptible mango cultivars are grown in mildew-prone areas, growers should expect the disease to recur yearly or seasonally. To achieve good yields, such growers must act with control measures during flowering, before it is too late to prevent the loss of the current season's crop.

In Hawai'i, powdery mildew tends to occur yearly in areas where this disease predominates and must be controlled in order to obtain acceptable fruit yields. Powdery mildew is more common in lower-rainfall areas than in higher-rainfall areas. For example, it is the predominant disease of mango in lower-rainfall West Hawai'i (South and North Kona), whereas anthracnose is the predominant fruit disease of mango in higher-rainfall East Hawai'i (Hilo area, Puna district).

### Host

Mango (family Anacardiaceae) is a perennial, branching, evergreen tree approximately 30–40 feet tall at maturity. The mango fruit is a large, fleshy drupe that contains a laterally compressed stone. Among the several hundred

named mango cultivars worldwide there is considerable variation in fruit size, color, shape, flavor, texture, and taste. Often called “the king of fruits,” mango grows throughout the tropics and subtropics and is one of the world's most important fruit crops.

### Pathogen

*Oidium mangiferae* Berthet (a fungus), causing powdery mildew of mango, is widely distributed throughout the Pacific region. It infects panicles, fruits, and leaves. Mango is the only known host of the mango powdery mildew pathogen (i.e., only mango can be infected by the fungus).

### Symptoms on panicles

Infected panicles (flowers, flower stalks, and young fruits) become coated with the whitish powdery growth of the pathogen (photo, below). Infected flowers and fruits eventually turn brown and dry. The dead flowers can easily crumble in one's hand. Infection often causes flowers



**Mango panicles with powdery mildew**

All photos by S. Nelson



**A whitish-gray haze covers a normally reddish mango panicle.** This haze is the diagnostic symptom of mango powdery mildew, caused by *Oidium mangiferae*. This fungus can infect and colonize all parts of the panicle, including flowers and young fruits. Infected young fruits may have a purplish haze. Here, the disease is so advanced that it may be too late for any control measures to have an effect upon poor fruit set and yield. All photos by S. Nelson



**Symptoms of mango powdery mildew and mango anthracnose compared.** Left, powdery mildew caused by *Oidium mangiferae*: panicles have a whitish-gray haze; killed flowers turn brown and gray. Right, anthracnose caused by *Colletotrichum gloeosporioides*: black, pin-prick spots on flowers and panicles; killed flowers turn inky black.



**Table 1. Mango flowering stages and their susceptibility to infection by powdery mildew (*Oidium mangiferae*)\***

<i>Flowering stage</i>	<i>Description of stage</i>	<i>Susceptibility</i>
Bud swell to bud break	Initial stage	No
Mouse-ear	Elongation of basal bracts and emergence of inflorescence	No
Protected	Elongation of inflorescence still protected by bracts	Yes
Green-colored	Further elongation of inflorescence and opening of secondary rachi, flowers still in bud stage	Yes
Red-colored	Final elongation of inflorescence and reddening of rachi	Yes
Red-open	Individual flowers start opening from base	Yes
Full-bloom	All individual flowers and inflorescence open	Yes (most susceptible)
Fruit-set	First visible fruits	Yes
Pea-sized fruit	Fruits approx. 8 mm diameter	Yes

\*After: Schoeman, M.H., and B.Q. Manicom. 1995. Epidemiology of powdery mildew on mango blossoms. *Plant Disease* 79:524–529.

and small fruits to abort and fall off. Fruits that become infected after they have set have purple-brown blotchy lesions that crack and form corky tissue as the fruitlet enlarges. The full-bloom stage is the most susceptible to infection (Table 1).

### Symptoms on leaves

On some cultivars, new flushes of growth and younger leaves are highly susceptible and may curl up and become distorted. Older leaves are more resistant to infection. Grayish, necrotic lesions or large, irregularly shaped

spots may form on leaves (photo below, center). On very susceptible cultivars, the youngest leaves may become completely covered with fungal spores and mycelium, and eventually die (photo below, left). On some cultivars, the whitish residue of the fungus tends to appear on the lower leaf surface, along the leaf midrib (photo below, right).

### Pathogen dissemination

Conidia of *O. mangiferae* are wind-disseminated from other mango trees or from within an infected tree's canopy.



Characteristic symptoms of mango powdery mildew on mango leaves

**Table 2. Some fungicides registered in Hawaii for controlling powdery mildew of mango** (source: Hawaii Pesticide Information Retrieval System)

<i>Example of product name*</i>	<i>Active ingredient(s)</i>	<i>Formulation</i>
70% Neem Oil (other products contain this ingredient)	Clarified hydrophobic neem oil (70%)	Soluble concentrate
Bi Carb Old Fashioned Fungicide	Carbonic acid, monopotassium salt (82%)	Soluble concentrate/solid
Biocover MLT	Kerosene (petroleum) hydrodesulfurized (98%)	Oils, no added pesticide
Biocover UL	Aliphatic petroleum solvent (98%)	Oils, no added pesticide
Drexel Sulfur 90W	Sulfur (90%)	Wettable powder/dust
Kaligreen	Carbonic acid, monopotassium salt (82%)	Soluble concentrate
Rally 40 WSP	Myclobutanil (40%)	Water-soluble pouch

\*Other products with the same or similar active ingredient may be available, these are only examples.  
Source: Hawaii Pesticide Information Retrieval System.

The environmental conditions for spread of powdery mildew occur across a broad daily range of temperature (50–88°F, 10–31°C) and relative humidity (60–90%). These conditions commonly coincide with mango flowering in Hawai‘i, which explains why powdery mildew is such a widespread and entrenched problem in the state.

For infection (the penetration of host tissues by germ tubes of the pathogen) the optimum condition is approximately 73.4°F (23°C) plus high relative humidity followed by an abrupt reduction of relative humidity. This can occur in Hawai‘i where cool nights are followed by warm days.

Airborne conidia of *O. mangiferae* land upon susceptible host organs, the spores produce germ tubes, and the germ tubes infect the tissues. The fungal mycelium of the pathogen ramifies within and upon host tissues, eventually killing host cells and absorbing their contents. The fungus produces spores abundantly all over the surface of affected tissues (it is the abundant fungal mycelia and the conidia and conidiophores on the surface of host tissues that creates the typical “powdery mildew” appearance of mildewed plants).

*O. mangiferae* survives on infected plants and for a period of time as conidia on fallen mango plant debris. Populations of *O. mangiferae* can build up rapidly during seasonal flushes of new mango leaves and flowers. The conidia can be transported long distances by winds.

### **Integrated disease management practices**

Integrated management of mango powdery mildew in Hawai‘i consists of four general approaches:

- choice of mango cultivars
- cultural practices
- plant nutrition
- fungicide sprays.

### **Cultivar selection**

Mango cultivars vary in susceptibility to powdery mildew (Table 2). The use of less susceptible cultivars is the best control measure for this disease. For the very susceptible cultivars, most of the flowers, very young fruits, and young leaves can become severely diseased. Check with your neighbors to learn which cultivars perform well in your area.

### **Cultural disease management practices**

Choose hot, dry areas for mango cultivation; if possible, avoid areas that consistently have rain during the flowering season. Prune plants to keep flowers within the range of spray equipment and to improve air circulation in the canopy. Pick up fallen mango foliage and destroy it, remove severely infected panicles. Intercrop mango with other fruit trees or forestry species. Keep tall weeds away from mango trees. Cut back or prune unwanted or competing adjacent tree species, allowing more sunlight

**Table 2. Susceptibility of some mango cultivars to mango powdery mildew****Slightly**

Carrie	Gondo
Sensation	Banana
Tommy Atkins	

**Moderately**

Haden	Rosa
Mabroka	Graham
Lippens	Divine
Smith	Peter
Keitt	Hilacha
Glenn	Bocado
Pico deLoro	Edward
Martinique	Mango criolla
Springfels	Fresca

**Very**

Zill	Alphonso
Kent	Amini
Bullock's Heart	Labich
Mistakawi	Apple
Pairee	Blackman
Faizanson	

Adapted from Nishijima, W. 1994. Mango diseases and their control. p. 20–24 in: Proceedings: Conference on Mango in Hawaii. March 9–11, 1993, College of Tropical Agriculture and Human Resources.

and air circulation. Fertilize the tree as required to promote vigorous growth.

**Plant nutrition practices**

Foliar applications of phosphate fertilizer solutions (i.e., monopotassium phosphate, 0.5%  $\text{KH}_2\text{PO}_4$ ), alone or in combination with conventional powdery mildew fungicides, is reported to provide economical and effective results in Israel and South Africa.

**Fungicides**

The most effective way to control mango powdery mildew on very susceptible cultivars is to apply well timed fungicide sprays. Most of the fungicides registered for powdery mildew control on mango in Hawai'i can be effective.

The first spray application should occur no later than at 50% of full flowering, and spraying should continue

**Mango cultivars that have been recommended by UH-CTAHR for Hawai'i based on their horticultural properties**

Ah Ping  
Fairchild  
Gouveia  
Harders  
Keitt (MS)  
Momi K  
Pope  
Rapoza

All of these cultivars are productive and have superior quality fruit. Flowering occurs from December to April in Hawai'i, but off-season flowering is common. Growers may have to use fungicide sprays to control powdery mildew on these varieties in some locations.

every 7–14 days thereafter until fruit set.

The fungicides registered for control of mango powdery mildew in Hawai'i fall into several groups based upon their active ingredients: clarified hydrophobic neem oil; mono- and dipotassium salts of phosphorous acid; carbonic acid, monopotassium salt; kerosene (petroleum) hydrodesulfurized; aliphatic petroleum solvent; sulfur; mancozeb; and myclobutanil.

Sprays of wettable sulfur or sulfur dusts provide reasonable control of powdery mildew, but may cause phytotoxicity (“burn”) to flowers and young fruit where sprays are applied during sunny, warm conditions.

A systemic fungicide, Rally 40 WSP (myclobutanil), was labeled for use in Hawai'i in 2008 for mango powdery mildew. This is a supplemental label, which growers and applicators must obtain from the pesticide distributor and have in their possession when applying the product. It is very important to follow label instructions and to practice fungicide resistance management practices.

Where a grower is spraying to control mango anthracnose caused by *C. gloeosporioides*, the products used for that may provide some incidental control of powdery mildew, while not being labeled for that use.

Baking soda (sodium bicarbonate) mixed with water is an old home-remedy spray for powdery mildew. However, because baking soda is not labeled as a fungicide, it may not legally be used for disease control, according to Hawai'i Department of Agriculture regulations. Some growers report that foliar sprays of milk can be effective against powdery mildew, but the same use restriction may apply.

### Managing large trees

A reasonable goal is to protect the panicles within harvesting reach from mildew. A problem faced by many backyard growers is how to deliver a fungicide spray to flowers that are high on the tree. They may lack the high-pressure equipment and training needed to deliver the spray past a certain height. One should always be careful when applying pesticides, and also should seek professional assistance if there is any question about doing the spraying work or renting equipment related to pesticide applications.

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### Acknowledgments

Fred Brooks, UH-CTAHR, and Brian Bushe, UH-CTAHR, for reviews of this manuscript.