



Powdery Mildew of Garden Vegetables in Hawai'i

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The powdery mildew pathogens infect a wide range of vegetable crops grown in the gardens of Hawai'i (Table 1). The foliar symptoms develop rapidly, causing yield loss, defoliation, and premature plant death. These ubiquitous fungal diseases are easy to recognize, but they are difficult to manage in areas where the environments favor the pathogen and the sudden onset and rapid progress of the diseases. It is also hard to manage powdery mildew on susceptible varieties when the disease is in the advanced stages of development. Here we describe the powdery mildews and suggest integrated management practices to minimize their damage in home gardens.

Hosts

Powdery mildew infects a wide range of garden vegetables in many plant families in Hawai'i (Table 1). Some weed species may also be hosts to these pathogens.

Symptoms and Signs

Patches of white, powdery growth develop on the upper and/or lower leaf surfaces. On some vegetable types the growth also appears on the petioles and fruits. The patches may expand and coalesce to engulf an entire leaf. Severely infected leaves turn brown, curl, and fall from the plants prematurely.

Pathogens

The powdery mildew pathogens belong to several fungal genera (Table 1). In Hawai'i, the pathogens generally reproduce asexually (in the anamorphic stage); no sexual stages have been reported.



Powdery mildew symptoms on zucchini.

Epidemiology

Cool days and warm nights favor infection and disease development. The spores produced by the pathogen are dispersed readily by wind. Although high relative humidity favors powdery mildews, wet leaves inhibit infection. This is unusual for plant-pathogenic fungi; their spores usually need a thin film of water in which to germinate. However, since the powdery mildew can grow at all but the lowest relative humidity, the disease can thrive in even the driest areas of Hawai'i. Once an infection is established, the disease develops and spreads rapidly. In some vegetable crops, high yield losses are common. Premature death of plant organs and entire plants is possible.

Disease Management

For effective management of powdery mildews, integrate the following practices.

- Learn to recognize the symptoms of powdery mildew and to distinguish powdery mildews from pests having a similar whitish appearance (whiteflies and downy mildews). Scout the garden twice every week for symptoms to allow for timely management practices. Stopping powdery mildew in its earliest stages of development provides the best control.
- Practice sanitation. Remove and destroy infected leaves or other plant parts.
- Eliminate unwanted weed hosts growing near the garden or on the property. Cut or pull all weeds showing symptoms of powdery mildew.
- Reduce relative humidity in the canopy by performing the following actions:
 - Control weeds.
 - Ensure that the garden soil is well drained.
 - Do not over-irrigate; avoid watering plants in late afternoon or with overhead sprinklers.
- Grow vegetable varieties with tolerance or resis-

Table 1. Garden vegetables widely grown in Hawai'i and the pathogens that cause powdery mildew on them.

Host	Pathogen(s)
Crucifers (<i>Brassica</i> and <i>Raphanus</i> spp.)	<i>Erysiphe polygoni</i>
Examples: <ul style="list-style-type: none"> • Cabbage, broccoli (<i>Brassica oleracea</i>) • Mustard (<i>Brassica juncea</i>) • Radish (<i>Raphanus sativus</i>) 	
Cucurbits (<i>Citrullus</i> spp., <i>Cucumis</i> spp., <i>Cucurbita</i> spp., and other genera)	<ul style="list-style-type: none"> • <i>Sphaerotheca fuliginea</i> • <i>Erysiphe cichoracearum</i>
Examples: <ul style="list-style-type: none"> • Zucchini (<i>Cucurbita pepo</i>) • Cucumber (<i>Cucumis sativus</i>) 	
Legumes	
• Pea (<i>Pisum sativum</i>)	<i>Erysiphe pisi</i> (anamorph: <i>Oidium</i> sp.)
• Bean (<i>Phaseolus vulgaris</i>)	<i>Erysiphe polygoni</i> (anamorph: <i>Oidium balsamii</i>)
• Soybean (<i>Glycine max</i>)	<i>Microsphaera diffusa</i>
Solanaceous crops	
<ul style="list-style-type: none"> • Tomato (<i>Solanum lycopersicum</i>) • Pepper (<i>Capsicum</i> spp.) 	<i>Oidiopsis sicula</i> (teleomorph: <i>Leveillula taurica</i>)
Leafy greens	
• Lettuce (<i>Lactuca sativa</i>)	<i>Erysiphe cichoracearum</i>
Onion (<i>Allium cepa</i>) and garlic (<i>Allium sativum</i>)	<i>Leveillula taurica</i> (anamorph: <i>Oidiopsis sicula</i>) = <i>O. taurica</i>

Reference: <http://www.apsnet.org/publications/commonnames/Pages/default.aspx>

Terms: Anamorph is the asexual stage of a pathogen, whereas teleomorph is the sexual stage.



Powdery mildew symptoms on tomato.



Powdery mildew symptoms on collards.





Powdery mildew symptoms on zucchini.

tance to powdery mildews. For more information about seeds from locally developed vegetable varieties available for purchase, contact the University of Hawai'i at Manoa: <http://www.ctahr.hawaii.edu/seed/seeds.asp>. Some resistant varieties exhibit powdery mildew symptoms, but disease development is delayed, progresses more slowly, or both. In either case, the disease is not as severe as on highly susceptible varieties.

- 'Manoa Sugar' is a variety of edible-podded Chinese pea that is resistant to powdery mildew and Fusarium wilt.
- 'Lani' and 'Milo' are hybrid slicing (American) vine and bush cucumbers, respectively. They were both bred for resistance to the *Cucumber mosaic virus* and tolerance to the *Watermelon mosaic virus* and powdery mildew.
- Search online for powdery mildew-resistant seeds of specific vegetables. For example, browse tomato varieties at <http://vegetablemndonline.ppath.cornell.edu/Tables/TomatoTable.html> and other vegetable varieties, including squash and pumpkin, at http://extension.unh.edu/resources/representation/Resource000617_Rep639.pdf
- Apply fungicides registered for powdery mildew to the foliage. Use the products as a preventative (before

symptoms develop) for vegetables in your garden that are usually infected by powdery mildews. Apply the sprays every 7 to 10 days, or as required by the pesticide label.

- Wettable sulfur. Sulfur, a safe and naturally occurring element, is an inexpensive and very effective fungicide for control of all powdery mildews. Some sulfur products are approved for use on organic farms. To avoid "burning" the foliage with the sulfur, keep the spray container agitated while spraying so the sulfur will stay suspended and not settle to the bottom of the sprayer. Test the product on a small amount of foliage first to see if it causes damage. Begin sulfur treatment before the symptoms of powdery mildew appear, or immediately thereafter. Apply the spray every 7 to 10 days, or as directed by the product label. Ensure that you achieve good coverage of the foliage.
- Potassium bicarbonate products (e.g., Kaligreen®)
- Petroleum oils
- Other oils (vegetable, neem)
- Other products may be available for some crops

Check the labels of products to ensure that each is registered for use on the intended crop in Hawai'i. Home remedies may be effective, but they are not registered by the Hawai'i Department of Agriculture.



Powdery mildew symptoms on cucumber.



Powdery mildew symptoms on pepper.



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