

## Powdery Mildew

### Introduction

Powdery mildew is the name given to a group of diseases caused by several closely related fungi. Their common symptom is a grayish-white, powdery mat visible on the surface of leaves, stems, and flower petals. There are many hosts; and although this disease is not considered fatal, plant damage can occur when the infestation is severe.

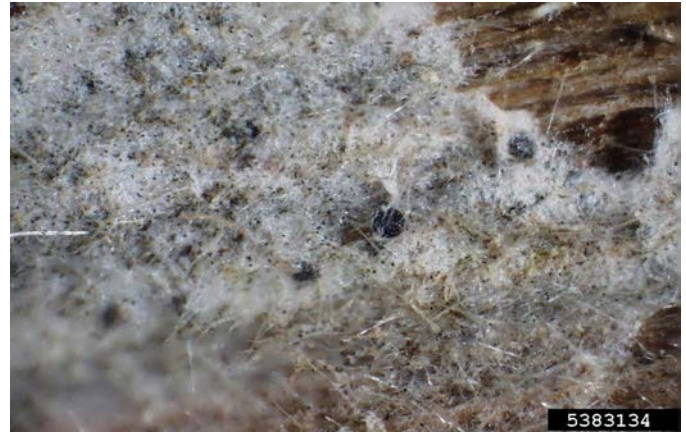


Powdery mildew symptoms on rose leaves.  
Jody Fetzer, New York Botanical Garden,  
[www.forestryimages.org](http://www.forestryimages.org)

### Disease Cycle

In spring, as daytime temperatures rise above 60 °F, the fungi responsible for powdery mildew begin to produce spores (conidia) which are dispersed into the air. Infections occur when they contact a suitable host and environmental conditions are favorable. Initial symptoms are small, circular, powdery, white spots which expand and eventually join as infections progress. Infections spread as spores produced in these white patches move by wind and splashing rain to other locations on the plant or nearby plants.

The fungus survives the winter attached to plant parts and plant debris such as fallen leaves. As weather warms in spring, the process begins again.



Close up view of powdery mildew mycelium mat and spore producing bodies.

Elizabeth Bush, Virginia Polytechnic Institute and State University, [www.forestryimages.org](http://www.forestryimages.org)

### Favorable Conditions

Humidity is an important factor related to the onset and spread of powdery mildew. Unlike most fungi, these do not require free water to germinate; only high levels of relative humidity. High relative humidity favors spore formation, and low relative humidity favors spore dispersal, which explains why powdery mildew tends to be a problem when the days are cool and the nights are humid. Temperature is also a factor. Although powdery mildew can occur all season long, it is less common during the heat of the summer.

### Hosts

Powdery mildew is caused by several different species of fungi, and they each have a limited host range. In other words, observing powdery mildew on oak leaves should not be cause for concern for nearby zinnias. Plants that commonly become infected with various powdery mildews include; azalea, crabapple, dogwood, phlox, euonymus, lilac, snapdragon, dahlia, zinnia, crape myrtle, rose, pyracantha, rhododendron, spirea, wisteria,

delphinium, oak, English ivy, photinia, blueberry, pecan, cucumber, and squash.



Powdery mildew on zinnia leaf.  
R.K. Jones, North Carolina State University,  
[www.forestryimages.org](http://www.forestryimages.org)

### Symptoms

As powdery mildew fungi grow over the plant surface, they develop structures that are inserted into plant cells enabling them to extract nutrients necessary for growth and spore production. This results in a general decline in growth and vigor of the host, as well as the common visible symptoms.

Abnormal growth, such as leaf curling, twisting, and discoloration, may be noticed before the white signs of the fungus are visible. On dogwood, for example, leaves may take on a yellowish or reddish cast in summer or may develop reddish blotches or dead, scorched patches. The white powdery growth is not always apparent.



Advanced powdery mildew on pumpkin with leaf distortion, yellowing and browning.  
Howard F. Schwartz, Colorado State University,  
[www.forestryimages.org](http://www.forestryimages.org)

When visible, the powdery fungal growth can usually be found on the upper surface of the leaves, and tends to begin on lower leaves. As the disease progresses, leaves become dwarfed, curled and generally distorted. In severe cases, leaves will turn yellow or even dried and brown.

Powdery mildew fungi will also infect flowers, causing them to develop abnormally or fail to open. On azaleas and rhododendrons, small areas of dead tissue are often seen.



Powdery mildew damage on rose flower buds.  
Clemson University - USDA Cooperative Extension Slide Series, [www.forestryimages.org](http://www.forestryimages.org)

Powdery mildew creates other effects that are not readily visible. For example, a severely infected plant may have a reduced level of winter hardiness. Trees have also been observed to leaf out later in the spring after being infected the previous season.

### Cultural Controls

As with all diseases, optimum plant health is the first line of defense. This begins with selection of healthy plants that are planted properly and in the proper location, giving attention to requirements for light, soil, and moisture. Space them so they are allowed to grow without being crowded and water thoroughly during establishment, and later during dry periods. Avoid overhead irrigation which raises the level of relative humidity within the plant canopy.

If powdery mildew is noticed on a few leaves, simply removing them will help with control. At the end of the growing season, prune out infected stems and remove fallen leaves which can serve as a source of further infection. Suckers are common on crape myrtle, dogwood and other plants. These should be pruned as they develop because they are especially susceptible and the disease will spread from them upwards to other plant parts.

Fertilize to optimize plant health, but avoid over-fertilization with nitrogen as it stimulates young, succulent growth which is more susceptible to infection.

Plants with a severe infection should be monitored closely the following spring so that if infections reoccur, they can be treated early.

When possible, select plants that show resistance to the disease (see Table 1).

### Chemical Control

**Ornamental Plants:** For fungicides to be effective, they must be applied as soon as symptoms are noticed. Product labels will provide information on how often to spray. When ranges are given, use the shorter interval during cool, damp weather. Be sure

to cover both the upper and lower surfaces of the leaves.

Table 2 lists fungicides labeled for ornamental plants. Myclobutanil, propiconazole, and thiophanate-methyl have systemic properties and can be sprayed less often than chlorothalonil, sulfur or copper-based fungicides. When powdery mildew persists and sprays are repeated, it is recommended to rotate (alternate) fungicides to decrease the chance of fungi developing resistance.

When deciduous plants are infected, consider the season. Generally, foliar diseases occurring in late summer do little damage. The leaves have already produced food for the plant and are going to fall off soon anyway. Just be sure to rake and dispose of them as they fall.

As with any pesticide, read the label and heed all precautions. Sulfur, for example, can damage plants if applied when temperature and humidity are high.

**Vegetable Plants:** For information on vegetable crop disease controls and tolerant varieties, consult the Clemson Extension publication *EC 570, Home Vegetable Gardening*, and other Home & Garden Information Center fact sheets.

**Table 1. Plants with Resistance to Powdery Mildew.**

Species	Cultivars
Kousa dogwood, <i>Cornus kousa</i>	'Milky Way', 'Milky Way Select', 'National'
<i>Cornus florida x kousa</i> hybrids	'Aurora', 'Constellation', 'Celestial', 'Stellar Pink'
Flowering dogwood, <i>Cornus florida</i>	'Cherokee Brave', 'Springtime', 'Pygmy', 'Jean's Appalachian Snow', 'Karen's Appalachian Blush', 'Kay's Appalachian Mist'
Crepe Myrtle: The <i>Lagerstroemia indica x faurieri</i> hybrids	'Apalachee', 'Fantasy', 'Hopi', 'Miami', 'Osage', 'Tonto', 'Tuscarora', 'Tuskegee', 'Wichita', 'Acoma', 'Sioux', 'Natchez'
Phlox	'David', 'Delta Snow', 'Natascha', 'Robert Poore'
Zinnia	Pulcino and African varieties, <i>Zinnia angustifolia</i> , Profusion Cherry, Profusion Orange
Hybrid Tea Rose	'Duet', 'Eiffel Tower', 'Grand Slam', 'Mister Lincoln', 'Tiffany', 'Jamaica', 'Matterhorn'
Floribunda Rose	'Golden Slipper'
Grandiflora Rose	'Camelot', 'Queen Elizabeth', 'John S. Armstrong', 'Pink Parfait'
Rugosa Rose	'Rugosa Alba', 'Blanc Double de Coubert', 'Fru Dagmar Hastrup', 'Topez Jewel', 'Alba', 'Alba Semi-Plena'
Monarda	'Marshall's Delight', 'Cambridge Scarlet'



**Table 2. Fungicides for Powdery Mildew Control on Ornamental Plants.**

Active Ingredient	Examples of Brand Names & Products
Myclobutanil	Spectracide Immunox Multi-Purpose Fungicide Concentrate
Sulfur <sup>1</sup>	Safer Brand Garden Fungicide Concentrate; & RTU Hi-Yield Wettable Dusting Sulfur Southern Ag Wettable or Dusting Sulfur Bonide Sulfur Plant Fungicide Lilly Miller Sulfur Dust (also wettable for spray)
Propiconazole	Ferti-lome Liquid Systemic Fungicide II Concentrate; & RTS Bonide Infuse Concentrate; & RTS Bonide Fung-onil Lawn & Garden Disease Control RTS Banner Maxx Fungicide Monterey Fungi-Fighter Fungicide Concentrate
Thiophanate-methyl	Cleary's 3336-WP Turf & Ornamental Fungicide Southern Ag Thiomyl Systemic Fungicide
Chlorothalonil	Ortho Max Garden Disease Control Ortho Disease B Gon Garden Fungicide Garden Tech Daconil Fungicide Concentrate Hi-Yield Vegetable, Flower, Fruit & Ornamental Fungicide Southern Ag Liquid Ornamental & Vegetable Fungicide Tiger Brand Daconil Ferti-lome Broad Spectrum Landscape & Garden Fungicide Conc. Monterey Fruit Tree, Vegetable & Ornamental Fungicide Conc.
Horticultural Oil <sup>2</sup>	Ferti-lome Horticultural Oil Spray Concentrate Lilly Miller Superior Type Spray Oil Concentrate Monterey Horticultural Oil Concentrate Southern Ag ParaFine Horticultural Oil Bonide All Seasons Spray Oil Concentrate
Neem Oil Extract	Southern Ag Triple Action Neem Oil Concentrate Ferti-lome Rose Flower & Vegetable Spray Concentrate Green Light Neem Concentrate Garden Safe Fungicide 3 Concentrate Safer Brand Concern Garden Defense Multi-Purpose Spray Conc.
Copper-based Fungicides	Bonide Liquid Copper Concentrate Camelot Fungicide/ Bactericide Concentrate Monterey Liqui-Cop Fungicide Concentrate Natural Guard Copper Soap Fungicide Concentrate; & RTU Southern Ag Liquid Copper Fungicide
Tebuconazole	Bayer Advanced Disease Control for Roses, Flowers & Shrubs Conc.
Potassium Bicarbonate	Bonide Remedy
<i>Bacillus subtilis</i>	AgraQuest Serenade Garden Disease Control Concentrate

Note: These active ingredients are listed in approximate order from most efficacious (best control) to least, but this also depends upon the plant and species of powdery mildew fungus. Be sure to check the product label for which plants can be sprayed with that product. For many vegetable crops, sulfur, copper-based products, chlorothalonil, horticultural oil, potassium bicarbonate and *Bacillus subtilis* can be used for powdery mildew control.

<sup>1</sup> Do not apply sulfur if temperature is greater than 90 °F or to drought stressed plants. Do not use sulfur in combination with, or within 2 weeks before or after the use of horticultural oil treatments. Sulfur will also control mites.

<sup>2</sup> Do not apply horticultural oil if temperature is greater than 90 °F. Horticultural oil may injure Japanese, armur and red maples, cryptomeria, junipers, cedars, redbud, smoke tree and hickories. Add 3 tablespoons of horticultural oil to a gallon of water with 3 tablespoons of baking soda for better powdery mildew control.

RTS = Ready-To-Spray (hose-end sprayer). RTU = Small, pre-mixed bottle.

**Caution:** Pollinating insects, such as honey bees and bumblebees, can be adversely affected by the use of pesticides. Avoid the use of spray pesticides (both insecticides and fungicides), as well as soil-applied, systemic insecticides unless absolutely necessary. If spraying is required, always spray late in the evening to reduce the direct impact on pollinating insects. Always try less toxic alternative sprays first for the control of insect pests and diseases. For example, sprays with insecticidal soap, horticultural oil, neem oil extract, spinosad, *Bacillus thuringiensis* (*B.t.*), or botanical oils can help control many small insect pests and mites that affect garden and landscape plants. Neem oil extract or botanical oil sprays may also reduce plant damage by repelling many insect pests. Practice cultural techniques to prevent or reduce the incidence of plant diseases, including pre-plant soil improvement, proper plant spacing, crop rotation, applying mulch, applying lime and fertilizer based on soil test results, and avoiding over-head irrigation and frequent watering of established plants. Additionally, there are less toxic spray

fungicides that contain sulfur or copper soap, and biological control sprays for plant diseases that contain *Bacillus subtilis*. However, it is very important to always read and follow the label directions on each product. For more information, contact the Clemson Extension Home & Garden Information Center.

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Pesticides updated by Joey Williamson, HGIC Horticulture Extension Agent, Clemson University, 02/15. Revised by Joey Williamson, HGIC Horticulture Extension Agent, Clemson University, 11/09. Originally prepared by Chuck Burgess, HGIC Horticulture Extension Agent, Clemson University. (New 09/05. Images added 05/09.)

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