PP257

UF UNIVERSITY of FLORIDA
IFAS Extension

Powdery Mildew of Gerbera Daisy[1]

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Introduction

Powdery mildew, caused by *Erysiphe cichoracearum* or *Podosphaera fusca (Sphaerotheca fusca)*, is an important fungal disease of gerberas in Florida. This disease can affect all parts of the plant. Reduced plant growth and lesser plant quality contribute to economic losses due to this plant disease (Figure 1).

Figure 1. Gerbera daisy plant severely affected by powdery mildew

The fungus that causes powdery mildew is an obligate parasite; it can only infect living tissue. Powdery mildew reproduces prolifically by spores (conidia) (Figure 2), which can germinate in the absence of free water and are spread by air currents and water splash.

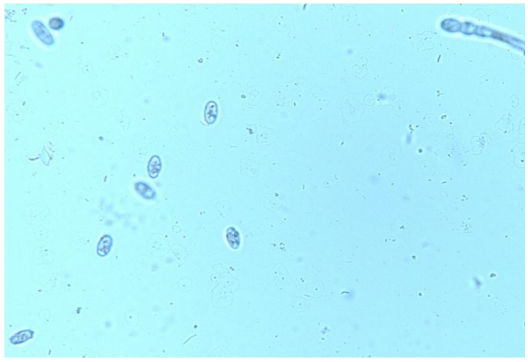

Figure 2. Microscopic view of powdery mildew conidia

Symptoms

Powdery mildew is easy to identify since noticeable white spots or white patches appear on the upper and lower surfaces of the leaf (Figure 3A). These spots gradually enlarge to form a white, powder-like mat, which can spread to flowers and stems (Figure 3B). The spots are a combination of body of the fungus – thread like (hyphae) (Figure 4A) -- and upright structures, the conidiophores,

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which bear the conidia (Figure 4B). Severely infected leaves turn pale yellow or brown and eventually die.

Figure 3. A) Early symptoms of powdery mildew on gerbera daisy leaves B) Advanced powdery mildew symptoms on gerbera daisy

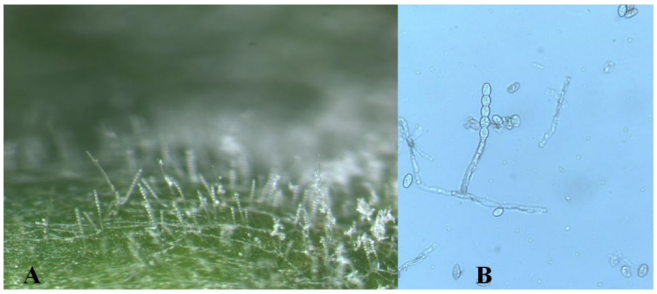

Figure 4. A) Macroscopic view of conidiophores, conidia and hyphae on gerbera daisy leaf B) Microscopic view of conidiophore from gerbera daisy leaf

Disease Development

High humidity (80% - 90%) and moderate temperatures (68 - 82°F) contribute to the development of powdery mildew. Overcrowding and shading of plants will also favor development of this disease.

The powdery mildew fungus reproduces through sexual spores (ascospores), which serve primarily for survival of the fungus. It also reproduces through asexual spores (conidia), which are responsible for most of the spread of the disease.

The initial infection typically occurs when conidia from infected transplants are carried by air currents to other plants or plant parts. The conidia then germinate and produce an elongated structure (germ tube), which enlarges and penetrates the leaf epidermis to feed on the host plant. Other specific fungal structures are developed within the plant tissue to establish a biotrophic (symbiotic) relationship necessary to absorb nutrients. The germ tube continues to grow and spreads across the leaf surface, producing more hyphae and conidia.

Management Practices to Control Powdery Mildew

Cultural Control

Only plantlets that are free of powdery mildew should be used, or the plantlets should be disinfested before transplanting. In addition, plants should be grown in sunny areas with good air ventilation and without excessive fertilization. Overhead irrigation may reduce powdery mildew since it washes conidia from the surfaces of leaves. However, overhead irrigation may contribute to other disease problems, such as crown rot

Chemical Control

In Florida, labeled fungicides to control powdery mildew in gerberas include the following: Compass (trifloxystrobin), Eagle (myclobutanil), Heritage (azoxystrobin), Milstop (potassium bicarbonate), Spectro (chlorothalonil + thiophanate-methyl) and Strike (triadimefon). Additional fungicides to control powdery mildew in ornamentals are listed in Table 1.

However, chemical control may not always be completely effective since the fungus may be resistant to some chemicals. Powdery mildew goes through many short cycles per season, and this process increases potential for development of resistance, especially when only systemic fungicides are used to control this disease. Resistance of powdery mildew has already been confirmed with the fungicides benomyl (Benlate) and triadimefon (Bayleton).

Biorational or Biofungicidal Control

Biofungicides are naturally based microbial or biochemical products derived from animals, plants, bacteria, and certain minerals. Biofungicides can affect fungal organisms directly or may stimulate the plant's own defense against the organisms. These products are generally narrow-spectrum, and they decompose quickly. As a result of these characteristics, biofungicides are considered to have little potential for negative impact on the

environment. Biofungicides that have been effective for the control of powdery mildew include biological control agents (BCAs), oils, phosphorous acid, and potassium bicarbonate.

Biological Control Agents: BCAs are organisms that suppress pests or plant pathogens. BCAs that have been used successfully for the control of powdery mildew include the following: *Ampelomyces quisqualis* (AQ10), *Tilletiopsis spp*, *Pseudozyma flocculosa* (Sporodex, Plant Products Co., Brampton, Ontario, Canada) and Bacillus *subtilis* QST 713 (Serenade® or Rhapsody®, AgraQuest, Inc. Davis, California). The major impediment to BCA effectiveness is their requirement for high humidity.

Oils: Petroleum or plant oils have not only been effective in controlling powdery mildew, but also have been useful in reducing the development of resistance to fungicides. Reduction of the severity of powdery mildew through use of oils has been reported in other ornamental crops, as well, including roses, apples, cherries, cucurbits, and grapes. In some cases, the efficacy of oils to reduce powdery mildew is comparable to or even superior to results obtained through use of standard fungicides.

Phosphorous Acid: Phosphorous acid (H_3PO_3) is the active ingredient in phosphonate, used in agriculture for disease control. However, H_3PO_3 is not a nutritional source of P for plants. Nonetheless, H_3PO_3 is often confused with phosphoric acid (H_4PO_4) or phosphates, which are effective nutritional sources of P.

Phosphite-based products are marketed under the following trade names: AGRI-FOS, BioPhos or Vital (Agrisel USA, Inc., Brookfield, Connecticut), Aliette or Fosetyl-Al (Bayer CropScience, North Carolina), K-phite (Plant Food Systems, Inc., Zellwood, Florida), ProPhyt (Luxembourg Industries Ltda., Tel Aviv, Israel), and Resist 57 (Actagro LLC., Biola, California). These products have all been found effective in reducing the severity of powdery mildew on gerbera daisy and on other crops, such as grapes and muskmelons.

Potassium Bicarbonate: Some potassium-bicarbonate-based products are labeled as fungicides and have been approved by the U.S. Environmental Protection Agency (EPA). Armicarb 100 (Helena Chemical Company, Collierville, Tennessee), Kaligreen (AgBio Inc., Westminster, Colorado), MilStop (BioWorks, Inc. Fairport, New York), and Remedy (Bonide Products, INC., Oriskany, New York) are trade names for potassium-bicarbonate-based fungicides labeled for control of powdery mildew in conventional systems. Kaligreen, Armicarb and Milstop, in particular, have been used successfully to reduce powdery mildew of gerbera daisy.

Disease Management Summary

Powdery mildew inoculum is carried by air. When conditions are favorable, this inoculum can rapidly spread over gerbera plants, creating a severe epidemic. When disease pressure is low, the biorational measures discussed above can provide a satisfactory level of control. When disease pressure is moderate or high, chemical measures may be more effective. The best strategy for managing fungicide resistance is to use various products with different modes of action. Fungicide mode-of-action groups are listed in Table 1. (All fungicides within the same group -- with same number or letter -- indicate the same active ingredient or similar mode of action.)

Table 1. Fungicides Registered to Control Powdery Mildew on Ornamentals

Trade name	**Active ingredient**	Fungicide group[a]
Heritage	azoxystrobin	11
Rhapsody	*Bacillus subtilis* strain QST 713	Biological
Spectro 90 WDG	chlorothalonil + thiophanate-methyl	M5 + 1
Sporan EC	clove oil + rosemary oil + thyme oil	NC
Champ DP Dry Prill	copper hydroxide	M1
Champ Formula 2 Flowable		M1
Champion Wettable Powder		M1
Kentan DF		M1
Nu Cop 50 WP, Nu-Cop 3 L, Nu-Cop 50 DF, Nu-Cop HB		M1
Badge StateSC	copper hydroxide + copper oxychloride	M1
COC DF, COC WP	copper oxychloride	M1
Nordox, Nordox 75 WG	cuprous oxide	M1
Eagle 20EW, Eagle 40WP	myclobutanil	3
Prokoz Hoist		3
Trilogy	neem oil (clarified hydrophobic extract)	NC
Saf-T-Side	petroleum oil	NC
Armicarb 100 Fungicide	potassium bicarbonate	NC
Kaligreen		NC
Milstop		NC
Banner Maxx	propiconazole	3
Propensity 1.3ME		3
Prev-Am	sodium tetraborohydrate decahydrate	NC
Dusting Sulfur-Iap	sulfur	M2
Micro Sulf		M2
Microthiol Disperss		M2
Sulfur 6 L , Sulfur 90W (Drexel)		M2
That Flowable Sulfur		M2
Yellow Jacket Wettable Sulfur		M2
3336 F , 3336 WP	thiophanate-methyl	1
OHP 6672 4.5L , OHP 6672 50W		1
Strike 50WDG	triadimefon	3
Bayleton 50 T&O-WSP		3
Compass	trifloxystrobin	11
Terraguard 50W	triflumizole	3

[a] Fungicide group (FRAC Code): Numbers (1-37) and letters (M) are used to distinguish the fungicide mode-of-action groups. All fungicides within the same group (with same number or letter) indicate same active ingredient or similar mode of action. This information must be considered in making decisions about how to manage fungicide resistance. M = Multi-site inhibitors, fungicide resistance risk is low; NC = not classified. Source: http://www.frac.info/ (Fungicide Resistance Action Committee, FRAC). Be sure to read a current product label before applying any chemicals.