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report on
PLANT
DISEASE

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POWDERY MILDEW OF ROSES

Powdery mildew is caused primarily by the fungus *Sphaerotheca pannosa* var. *rosae*. The disease occurs wherever roses are grown. Powdery mildew is very destructive, affecting plants grown out of doors and in greenhouses. Under conditions that are favorable for disease development, powdery mildew can cause complete defoliation. Epidemics can be expected any time during the growing season when the rainfall is low or absent, the days are warm and dry, and the nights are cool and damp.

Nearly all species and cultivars of roses are susceptible under conditions that are favorable for disease development Most climbers and small-flowered ramblers, some floribundas, polyanthas, and hybrid tea roses are very susceptible. Wichurainas are reportedly more resistant.

Losses from powdery mildew occur through a reduced aesthetic value that is seen in fewer flowers of poorer quality, a lowered photosynthetic efficiency that results in reduced plant growth, a greater likelihood of winter injury, and a reduced salability for roses as cut flowers.

Figure 1. Powdery mildew on young rose leaf (courtesy C.T. Schiller).

Symptoms

On garden roses, new shoots in the spring are dwarfed, distorted, and covered with a whitish gray mildew growth. On expanding leaves, mildew first appears on the upper leaf surface as irregular, light green to reddish, slightly raised blisterlike areas. The typical dense, powdery white growth (mycelium, conidiophores, and spores) of the mildew fungus soon appears (Figure 1). Severely infected young leaves become curled or irregularly twisted (Figure 2) and are usually covered with enlarged, whitish gray, powdery, mealy, or feltlike patches of the fungus. These leaves often turn reddish purple, under the mildew growth, then yellow, dry, and drop prematurely. Older, infected leaves are not usually distorted, but develop round-to-irregular areas covered with the flourlike mildew growth (Figure 3). On highly susceptible rose cultivars, the buds, young stems (canes), thorns, peduncles, fruit sepals, and even flower petals may become infected and entirely covered with the typically dense, flourlike growth. Flower petals may be discolored, dwarfed, and may fail to open properly; the flowers may also die early (Figure 4). The

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growing tips and flower buds may be malformed and killed, but the death of an entire plant is rare. Plants can be severely stunted if they are heavily infected early in the growing season. Rose tissue becomes more resistant to infection as it ages.

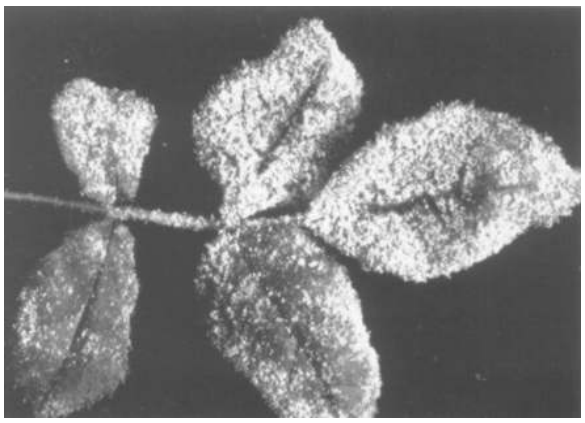

Figure 3. Severe powdery mildew on an older rose leaf.

Some resistant rose cultivars may show a hypersensitive reaction where invaded dead cells appear as black-to-rusty specks on the leaf surface, with little evidence of mildew growth. Under certain conditions, extensive infection of the lower leaf surface may occur with sparse mycelial growth of the fungus and little, if any, production of spores. Such undetected infections sporulate readily when conditions become favorable. An apparent overnight outbreak of the disease may then occur.

Figure 4. Severe powdery mildew on rose flowers. The outer petals have been crippled by the mildew fungus. Such flowers will not open normally (Illinois Natural History Survey photo).

Disease Cycle

The powdery mildew fungus overwinters as dormant mycelium in bud scales and rudimentary leaves within the dormant buds. Infected buds break open in the spring and develop into systemically infected shoots. The fungus sporulates on these shoots, producing large numbers of microscopic spores (conidia) in chains that are carried by the wind or other means to healthy rose tissue where they infect the upper and lower leaf surfaces, thus initiating a new disease cycle.

The fungus survives in the Midwest in the winter as cleistothecia, which appear as black specks embedded in the mealy or feltlike mildew growth on rose stems, thorns, and fallen leaves. The minute cleistothecia are formed within the mycelial mat at the end of the growing season. During warm and humid weather in the spring, a cleistothecium absorbs water and cracks open to discharge a single small sac or ascus containing 8 spores (ascospores). The microscopic ascospores are carried by the wind or splashing rain to healthy rose tissue and are capable of causing infection.

Cleistothecia almost never form on some rose cultivars, especially floribundas and hybrid teas.

In greenhouses or mild climates, where roses and powdery mildew both grow continuously throughout the year, cleistothecia are absent and only conidia are formed. New infection cycles are produced more or less continuously.

Conidia and ascospores that land on the surface of a rose germinate and form a holdfast structure (appressorium) on the leaf or stem surface. From the bottom of the appressorium, a fine penetration tube or hypha pierces the cuticle and enters the epidermal cell where a globose feeding structure, or haustorium, is formed. With further growth on the plant surface, the fungus develops a dense, branched network of hyphae. Many additional haustoria form in other epidermal cells. Short, erect branches, or conidiophores, develop at the same time from the surface hyphae, producing a barrel-shaped conidium at the end of each conidiophore. Successive conidia, with one formed each day, commonly remain attached in chains (Figure 5), giving the characteristic powdery white appearance. The conidia eventually break away and

are carried by air currents, splashing water, or other means to new infection sites. Handling rose plants, insects, mites, and snails also helps spread conidia. As many as 3 million spores may be formed on one square inch of infected tissue over a period of several weeks.

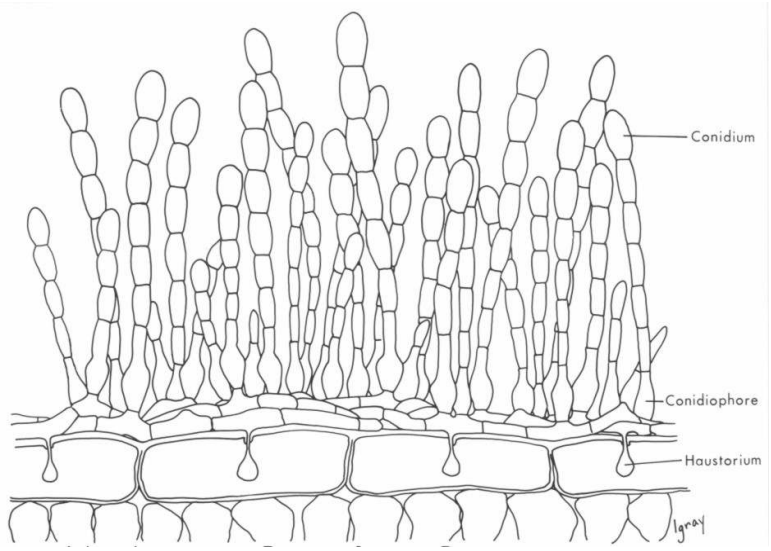

Figure 5. The powdery mildew fungus (Sphaerotheca pannosa var. *rosae) as it appears under a high-power microscope (drawing by L. Gray).*

Epidemiology

When conidia or ascospores fall on a plant surface, they start to germinate in 2 to 4 hours, reaching a maximum number in about 25 hours. The optimum temperature for germination is about 71°F (22°C); the minimum, about 42°F (5°C) and the maximum is close to 95°F (35°C). Spore germination occurs on the surface of a rose over a range of relative humidity from 23 to 99 percent. Free moisture is detrimental to spore germination of the powdery mildew fungus.

Once released from the conidiophores, the thin-walled conidia do not live long. At 90°F (32°C), and a relative humidity of 70 percent or less, germination reaches 95 to 100 percent in 2 hours and drops to 8 to 20 percent after 5 hours. At 70°F (21°C), and a relative humidity of 70 percent or less, germination is only 20 to 40 percent after 5 hours. Although conidia remain viable longer at a relative humidity of 80 to 90 percent, essentially all conidia are dead after 48 hours at 70°F (21°C) and after 24 hours at 90°F (32°C).

The environment most favorable for conidial production, maturation, release and spread, germination, and infection include repeated day-night cycles where the nights are cool (about 60°F, or 16°C) and damp with a relative humidity of 90 to 99 percent, and the days are warm (about 80°F, or 27°C) and dry with a relative humidity of 40 to 70 percent. When spring and summer rainfall is high, epidemics of powdery mildew are most common during the late summer or fall.

The disease cycle–production of conidia, release, germination, infection, and production of conidia–can be as short as 72 to 96 hours. If left uncontrolled, powdery mildew can quickly become epidemic when cool, damp nights are followed by warm, dry days.

Control

1. **Purchase only top-quality, disease-free plants of resistant cultivars and species from a reputable nursery**. Roses with thick, leathery, glossy leaves, for example, wichuraiana hybrids, have fair-to-good resistance. Few of the reported resistant cultivars escape infection in seasons that are favorable to the mildew fungus. The presence of different physiologic races in an area greatly complicates the breeding of rose cultivars that are highly resistant or immune to powdery mildew. Most rose climbers, small-flowered ramblers, some floribundas, grandifloras, and hybrid teas are very susceptible.

2. **Prune roses in the fall and in early spring, according to type and cultivar. All dead wood**

should be removed and burned. Drastic pruning to within 1 to 2 inches of the bud union greatly reduces the carryover of powdery mildew and other disease-causing fungi.

3. **Maintain rose plants in high vigor**.

   a. **Plant properly** in well-prepared and well-drained soil, high in organic-matter content, where roses will obtain all-day sun (or a minimum of 6 hours of sunlight daily). If possible, avoid planting near large shrubs or trees that will compete with roses for moisture, light, and soil nutrients.

   b. **Space plants for good air circulation** at the suggested distance for the cultivar, type of rose, and effect desired.

   c. **Do not handle or work among plants when the foliage is wet**.

   d. **Fertilize based on a soil test**. Avoid excessive applications of high-nitrogen fertilizers. Newly planted roses should not be fertilized until they are well established and growing steadily. The soil reaction (pH) should be between 5.5 and 6.5.

   e. **Water thoroughly at weekly intervals during periods of drought**. The soil should be moist 8 to 12 inches deep. Avoid overhead irrigation and syringing the foliage when waterings, especially in late afternoon or evening. Use a soil soaker hose or other methods that will not wet the foliage.

   f. **Protect plants for winter by following local recommendations**. Winter safeguards provide insulation against extremely low temperatures, alternate periods of freezing and thawing, and protection against damage by wind or heavy loads of snow and ice.

   g. **Whenever possible, destroy nearby wild or uncared for roses**. These plants commonly serve as a source of infection.

4. **Thoroughly spray all aboveground parts of each rose plant, including both leaf surfaces, with a suggested fungicide. Start when mildew is first seen or expected**. Spraying is more efficient than dusting. Sprays are required at 7- to 14-day intervals to keep young, susceptible growth adequately covered. If possible, sprays should be applied **before** rains to provide maximum protection of the foliage from spores that may be distributed by splashing water or wind-blown rain. Carefully follow all precautions and directions as printed on the container label.

   The fungicides suggested for controlling powdery mildew are given in Illinois Homeowners Guide to Pest Management, Circular 1354, available at your nearest Extension office or at Ag Services, P345, 1917 S. Wright St., Champaign, IL 61820. When possible, apply combinations of one or more fungicides, insecticides, and a miticide to control a wide variety of diseases and animal pests. Many spray mixes for roses are available. Check the label to be sure that the mix contains one or more of the fungicides listed in Circular 1260. In general, 1 gallon of spray mix will cover 10 to 20 rose bushes. Spray the foliage to the point of run-off (the plants begin to drip). On nursery-size scale, 200 gallons of spray are needed for an acre.
   The mycelium and conidia of the powdery mildew fungus are waxy (or oily) and as difficult as the rose leaves to wet with spray. The spray will be more effective with the addition of a small amount

of household detergent (about ½ teaspoonful per gallon) or a commercial spreader-sticker (surfactant) to the spray mix, following the directions on the container. Commercially available spreader-stickers include DuPont Spreader-Sticker, Bio-Film Spreader-Sticker, Chevron Spray Sticker, Citowett Plus, Filmfast Spreader-Sticker, Miller Nu-Film-P and -17, De-Pester Spreader-Activator, Triton B-1956, Plyac NonIonic Spreader-Sticker, Multi-Film L, and Colloidal Products Spray Modifier spreader sticker.

5. **Vaporized sulfur gives excellent control of powdery mildew in greenhouses**. A slurry made of 1 pint of water and 1 pound of wettable sulfur (**not** flowers of sulfur) is sufficient for each 90,000 cubic feet of greenhouse space. The slurry is painted on two steam pipes in each house, covering sections 3 feet long and leaving equal intervals unpainted. Applications should be made regularly twice a week.

   If steam is unavailable, the sulfur may be vaporized in small homemade or commercially available vaporizers using light bulbs or small heating elements as a source of heat (Figure 6 and 7). One vaporizer should be used for each 1,000 to 1,500 square feet of greenhouse space. Flowers of sulfur (not wettable sulfur) should be used in the vaporizers. The vaporizers should be kept on day and night, with the greenhouse vents open no longer than necessary for proper ventilation. Excessive heat in the vaporizer must be avoided since the fumes of burning sulfur are highly toxic to rose foliage. For homemade vaporizers, a 60-watt bulb should be used. Weaker bulbs will not melt the sulfur. Stronger ones cause the sulfur to ignite. Commercial vaporizers come equipped with bulbs of the proper size. Burned-out bulbs should be replaced by the same size bulb.

Figure 6. Homemade sulfur vaporizer used to control powdery mildew on greenhouse roses. A hole was cut through the side, near the bottom of a tin can, and a 60-watt light bulb inserted in the can and screwed into a suitable socket. Flowers of sulfur, placed in the bottom of the can, will be vaporized by the heat from the light bulb (Illinois Natural History Survey photo).

Figure 7. A commercially made sulfur vaporizer. The sulfur container (left) is over the light bulb and is secured by inserting the bracket into the clamp on the outer container (Illinois Natural History Survey photo).