College of Food, Agricultural, and Environmental Sciences, Department of Plant Pathology

Grape Powdery Mildew

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Powdery mildew is a significant disease of grapes worldwide. It is also a recurring problem in Ohio and the Midwestern United States. The fungal pathogen that causes powdery mildew, *Erysiphe necator* (syn. *Uncinula necator*), can infect green tissues, including leaves, young shoots, rachises, flowers, and berries. The disease reduces vine growth, yield, fruit quality, and winter hardiness. While powdery mildew is considered less economically impactful in Ohio than black rot or downy mildew, it can cause significant crop losses on susceptible varieties if it is not managed or if the pathogen has developed fungicide resistance.

Disease Development and Symptoms

In the Midwestern United States, the powdery mildew fungus primarily overwinters as fungal-survival structures called chasmothecia in bark crevices on the grapevine. In the spring, the chasmothecia release spores (ascospores) when average temperatures are 50 degrees Fahrenheit and there has been at least 0.1 inches of rain. The ascospores are spread by wind to newly emerged green tissue where they initiate primary infections. After primary infection, the fungus produces a second spore type (conidia) on infected tissue. These conidia are the main secondary inoculum and can drive repeated infection cycles throughout the growing season. Secondary disease development does not require free water. In fact, rainfall can be detrimental to conidia, while warm temperatures (75–77 F), moderate humidity (40%–60% relative humidity), low diffuse light, and shaded canopies encourage sporulation and infection. Cold temperatures (36–38 F) in the early and end part of the growing season deter spore development. These environmental conditions are referred to as the Goldilocks Principle (Figure 1).

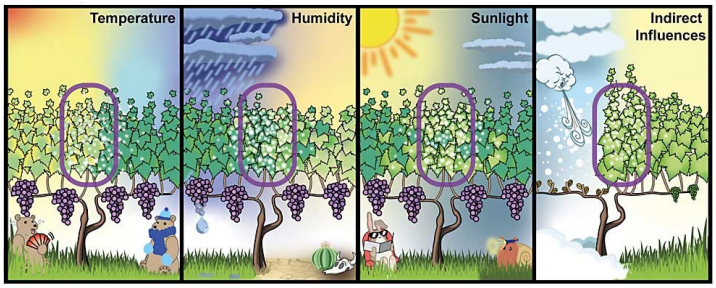

Figure 1. The Goldilocks Principle refers to environmental conditions that are "just right" for the powdery mildew fungus to grow and produce secondary spores (conidia). Temperature: 75–77 F. Humidity: 40%–60%. Sunlight: low light intensity. Canopy: dense. Image from Moyer, et al., 2019.

The fungus infects green tissues, including leaves, young shoots, rachises, flowers, and berries. White to gray-colored, powdery fungal growth can appear on either leaf surface, on cluster stems, or on berries (Figure 2 and 3). Severe infections can distort expanding leaves, reduce fruit set, cause berry russeting or splitting, and interfere with color development of red or purple cultivars. Berries are most vulnerable to infections from bloom until several weeks after bloom. Leaves and rachises remain susceptible later in the season. In the fall, fungal survival structures may be visible on infected leaves (Figure 2) before they detach and lodge in bark crevices.

Management

Early Detection and Testing

Powdery mildew on grape can be easily confused with downy mildew of grape, particularly on the berries. Accurate diagnosis is critical because these diseases require different management approaches and fungicide products.

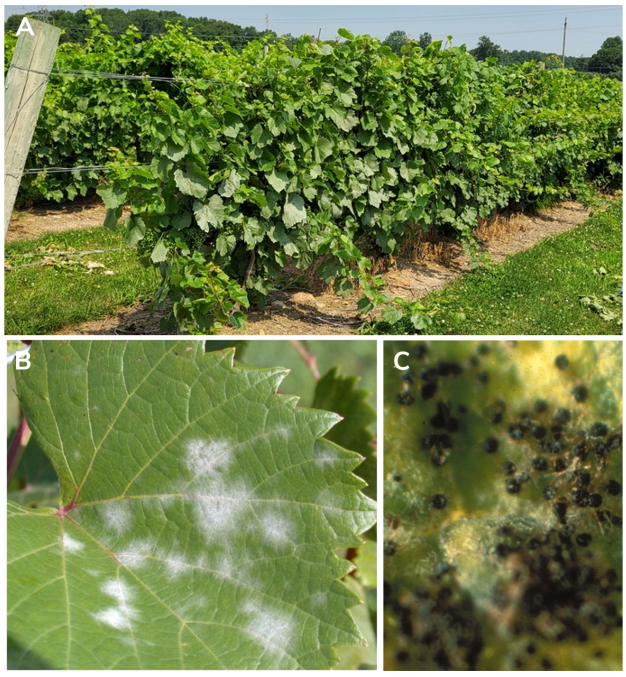

Figure 2. Powdery mildew on grape leaves. (A) Powdery mildew on leaves in a dense canopy. (B) Close-up of powdery mildew patches on a leaf. (C) Close-up of chasmothecia (fruiting bodies) on a leaf. Photo A by M. L. Lewis Ivey. Photo B by T. Miles, Michigan State University, Department of Plant, Soil and Microbial Sciences. Photo C by University of Georgia, Bugwood.org.

Misidentification can lead to ineffective fungicide applications, unnecessary production costs, increased disease pressure, and significant yield losses. Growers are encouraged to contact local extension personnel or plant disease diagnostic clinics for assistance, such as The Ohio State University C. Wayne Ellett Plant and Pest Diagnostic Clinic (ppdc.osu.edu).

Variety Selection

All cultivated grapes should be considered potential hosts, but susceptibility varies widely. *Vitis vinifera* cultivars and many vinifera-derived hybrids are generally more susceptible than North American cultivars. Highly susceptible varieties commonly grown commercially in Ohio and the Midwest include Cabernet Franc, Cabernet Sauvignon, Chambourcin, Chancellor, Chardonnay, Gewuerztraminer, Jupiter, Lemberger, and Vignoles. Several new cold-hardy hybrid varieties with resistance to powdery mildew and downy mildew have been released and are commercially available in the United States (Table 1). Although these varieties have resistance to powdery mildew (or downy mildew), they must still be managed for other diseases.

Figure 3. Powdery mildew on grape berries. Photo by M. L. Lewis Ivey.

Cultural Practices

Canopy management is the single most important cultural practice to prevent and manage grape powdery mildew. Pruning, leaf pulling in the cluster zone, and shoot positioning and thinning improves airflow through the canopy, lowers humidity, and increases sunlight penetration, all of which discourage powdery mildew from producing spores. These practices also increase spray penetration and improve spray coverage. Leaf removal is most effective when done from full bloom until the berries are pea-size (0.3–0.6 inches or 4–7 millimeters). However, leaf removal should be judicious as increased sun exposure can increase the risk of berry sunburn.

Avoid excess nitrogen fertilization or applications during bloom to limit rapid growth of vegetative

tissue, which is very susceptible to powdery mildew infections. To avoid over fertilizing with nitrogen, a nutrient analysis using petioles during veraison is recommended (see Timing of Nitrogen Fertilization for Midwest Vineyards, Iowa State University, and Viticulture Practices, The Ohio State University in Additional Resources). The best time to apply nitrogen is before new growth begins in the spring.

Chemical and Biological Control

Effective chemical and biological control of powdery mildew rely on properly timed applications of effective fungicides or biological control products. Applications should begin at 1–3 inches of new shoot growth and be repeated every seven to ten days, or according to label instructions and environmental conditions. The most critical period for berry protection is immediate pre-bloom until four to five weeks after bloom (Figure 4). At four to five weeks post bloom, most berries will be pea-size and resistant to new infections. The leaves and rachises (cluster stems) remain susceptible for the entire season so applications may be required through harvest.

Biological control products and biopesticides are useful components of a powdery mildew program, particularly when used preventively, under low to moderate pressure, and in rotation or alternation with conventional fungicides. Recent research indicates that integrating biological control products into a fungicide spray program can reduce the risk of fungicide resistance development in local pathogen populations. However, when used alone, biological control products and biopesticides may only provide suppression when disease pressure is high.

Many fungicides, biological control products and biopesticides can be used to manage powdery mildew. Commercial growers should consult the "Midwest Fruit Pest Management Guide (Bulletin 506)" or "Developing an effective fungicide spray program for grapes in Ohio (Plant Pathology Series No. 147)" for the most current recommendations. Sulfur is frequently used as an inexpensive and effective chemical option for powdery mildew. Sulfur can, however, cause injury to some varieties. Always check cultivar and other restrictions on the label before using a fungicide, biological control, or biopesticide.

Table 1. New powdery mildew and downy mildew resistant hybrid varieties

Variety	Powdery Mildew Resistance	Downy Mildew Resistance	Cold Hardiness to (F)	Type	Harvest*
Cabernet Volos	Fairly good	Good	-11	Red	Mid-late September
Fleurtai	Excellent	Excellent	-9	White	Late August
Merlot Kanthus	Good	Good	-4	Red	Early September
Sauvignon Kretos	Fairly good	Good	-8	White	Late August
Sauvignon Rytos	Excellent	Good	-9	White	Early September
Soreli	Excellent	Excellent	-11	White	Late August

*Harvest dates are based on field trials conducted in Friuli, Italy. This region of Italy has similar summer conditions to Ohio, but slightly milder winters.

Powdery mildew is one of the grape diseases most prone to fungicide resistance so fungicides should be used only as part of an integrated disease management program and rotated according to Fungicide Resistance Action Committee (FRAC) codes to reduce the risk of fungicide resistance. All fungicide labels list the FRAC codes on the first page. If you are unsure of the risk level associated with a specific FRAC code, consult with your county Extension office or state pesticide safety office.

Backyard grapevines. Grapevine varieties commonly grown by backyard growers such as Catawba, Cayuga White, Concord, Muscadine, and Niagara are slightly to moderately susceptible to powdery mildew. Cultural practices such as canopy management to increase light intensity and reduce humidity are often sufficient to manage powdery mildew in these varieties. For chemical and biological control recommendations, backyard growers can refer to "Controlling Diseases and Insects in Home Fruit Plantings (Bulletin 780)" or "Disease Management in Home Grape Plantings (Plant Pathology Series No. 149)." Similar to commercial vineyards, grapes should be sprayed beginning when the plants exhibit 1 to 3 inches of new growth through post bloom. This spray schedule protects new shoot growth and developing berries.

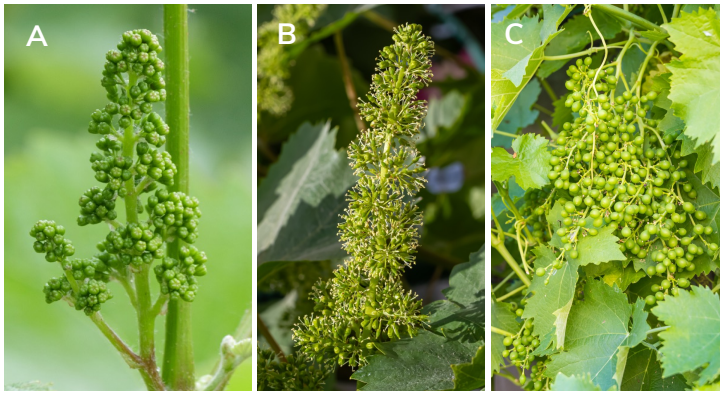

Figure 4. Grow stages of grape clusters. (A) Immediate pre-bloom, (B) bloom, and (C) four to five weeks post-bloom or when grapes are pea-size. Photos by Adobe Stock.

Additional Resources

- Fruit Pathology Lab, Ohio State University Extension (u.osu.edu/fruitpathology/)
- Midwest Grape Production Guide (Bulletin 919), The Ohio State University (extensionpubs.osu.edu/midwest-grape-production-guide/)
- Timing of Nitrogen Fertilization for Midwest Vineyards, Iowa State University (extension.iastate.edu/commercialhort/timing-nitrogen-fertilization-midwest-vineyards)
- Viticulture Practices, The Ohio State University (video series) (ohiograpeweb.cfaes.ohio-state.edu/video-categories/viticulture-practices)

QR code to access the C. Wayne Ellet Plant and Pest Diagnostic Clinic webpage for grapes (ppdc.osu.edu/submit-sample/fruits/grapes)