



DOWNY MILDEW OF GRAPE

Downy mildew, caused by *Plasmopara viticola*, is a major disease of grapes in the Midwest. The pathogen attacks all green parts of the vine. The disease occurs worldwide wherever the weather during the growing season is humid and rainy. Only a few of the older leaves may develop symptoms if the growing season has been hot and dry. Direct yield losses are caused by rotting inflorescences and clusters. Indirect losses can result from premature defoliation of vines due to foliar infections. This premature defoliation is a serious problem because it predisposes the vine to winter injury.

The downy mildew pathogen attacks all common species of cultivated and wild grapes (*Vitis* species). The European grape varieties (*V. vinifera*) are more susceptible than cultivated American grape types and the French hybrids, which have derived from native species. Among the other hosts of this pathogen are species of the closely related genus *Parthenocissus*, which includes Virginia-creeper (*P. quinquefolia*) and Boston ivy (*P. tricuspidata*).

SYMPTOMS

Leaves. Infected leaves develop yellowish-green, and translucent “oily” lesions on their upper surfaces. As lesions expand, the affected areas turn brown, necrotic or mottled (Figure 1). On the corresponding underleaf surface sporulation of the pathogen, – a delicate, dense, white to grayish, cottony growth–occurs (Figure 2). The lesions may be so numerous on the upper leaf surface that they merge to cover a large portion of the leaf. Infected tissue gradually becomes reddish brown to dark brown, irregular, and brittle (Figure 3). Affected leaves eventually turn brown, wither, curl, and drop early, exposing

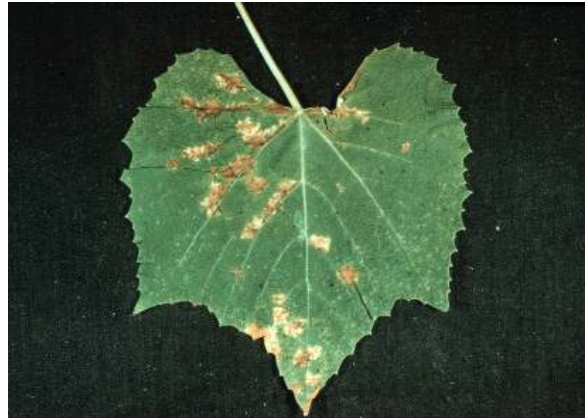


Figure 1. Downy mildew on upper side of grape leaf.



Figure 2. Appearance of infection on underside of a leaf.



Figure 3. Symptoms on upper surface of a leaf in autumn (R. Lafon).

For further information concerning diseases of small fruits, contact Dr. Mohammad Babadoost, Extension Specialist in Fruit and Vegetable Pathology, Department of Crop Sciences, University of Illinois, Urbana-Champaign (Phone: 217/333-1523; email: babadoos@uiuc.edu).

the immature berries to direct sun. If a vine loses its leaves before the fruit ripens, the berries do not mature normally and are of inferior quality.

Shoots and Tendrils. Symptoms appear as water-soaked, shiny depressions on which a dense growth of whitish mildew appears. When young shoots, petioles, tendrils, or cluster stems are infected, they often become distorted, thickened, or curled (Figure 4). Such infected shoots and tendrils turn brown and die.



Figure 4. Downy mildew symptoms on a shoot (R.C. Pearson).



Figure 5. Downy mildew on young grape berries.

Fruit. Two periods of fruit infection may occur during a growing season. The first is when the berries are about the size of small peas. If infected at this stage, the young fruit turns light brown and soft, shatters easily, and in damp weather is frequently covered with the white downy growth of the pathogen (Figure 5). During the hot summer months, little fruit infection normally occurs.

When the nights become cooler in the late summer and early autumn, a second infection period may develop. Berries infected at this time generally do not soften or form the downy mildew growth (Figure 6). Instead, they stop growth, become leathery, turn a dull green, then dark brown to brownish purple, wrinkle somewhat, and shatter easily leaving a dry stem scar. In severe cases, the entire fruit cluster may decay.

Infected berries may shrivel into "mummies" and turn black and hard. In the Midwest, downy mildew symptoms do not appear until after bloom.

DISEASE CYCLE

The pathogen overwinters as oospores in fallen leaves. In the spring, the oospores germinate in water as soon as temperatures reach 52° (11°C) to produce sporangia. The sporangia liberate small swimming spores, called zoospores, when free water is present. The zoospores are disseminated by rain splash onto grape tissue where they swim to the vicinity of stomata and encyst. Encysted zoospores infect grape tissue by forming germ tubes that enter stomata and from there invade inner tissues of the plant by growing between the cells. The pathogen masses within the grape tissue; and when the nights are cool and damp, structures form on the underleaf surfaces and on stems that are delicate, branched, miniature, and treelike, called sporangiophores or conidiophores (Figure 7). They grow out singly or, more often, in clusters of 4 to 6 (but up to 20) through stomata. On the young fruit the sporangiophores emerge through lenticels. Each sporangiophore produces four to six branches at nearly right angles to the main stem, and each side branch produces two, sometimes three, secondary branches. Single, lemon-shaped sporangia (conidia) are formed at the tips of the secondary branches. The sporangia are easily disseminated by wind, rain, and by handling infected plants.



Figure 6. Downy mildew on a developed cluster (R.Lafon).

The sporangiophores, with their large numbers of terminally borne sporangia, make up the downy mildew growth. If water is present on grape tissue, the sporangia quickly germinate to produce large numbers of motile zoospores that can result in secondary infections throughout a vineyard and thus rapidly spreading the disease. Young lesions can be seen 7 to 12 days after infection. The zoospore initiate infections which can occur in two hours of wetting at 77°F (25°C) and up to 9 hours at 43°F (6°C). The optimal temperature for growth and sporulation of the pathogen is 64-77°F (18-25°C). The sporangiophores and sporangia of the downy mildew pathogen are usually formed at night and are most visible in early morning while the leaves, fruit, and other infected parts are still damp. Toward the end of the growing season, oospores are formed in the old diseased leaves. The formation of the overwintering oospores completes the disease cycle.

CONTROL

Downy mildew is comparatively easy to control on most grape cultivars when the foliage and fruit are kept protected by fungicide sprays. From midseason on, downy mildew increases in importance while black rot becomes less important.

1. Properly space vines, and choose a planting site where the vines will be exposed to all-day sun and good air circulation. Keep the vines off the ground and properly tied.
2. Prune vines each year during the dormant period. Select only strong, healthy canes of the previous year's growth to produce the following season's crop. Remove the prunings, excess growth, overwintering berries, leaves, and tendrils from the vineyard and, where possible, burn them.
3. Keep the fruit planting and surrounding areas free of weeds and tall grass.
4. Grape cultivars differ in their susceptibility to downy mildew and several other diseases. The reactions of 47 grape cultivars to downy mildew and seven other diseases are given in Table 1. Cultivars with large, juicy berries are the most susceptible ones.
5. Fungicide sprays are needed in wet seasons to protect the developing new growth. Follow the grape spray schedule outlined in the "Illinois Commercial Small Fruit and Grape Spray Guide" (ICSG-1) (website: <http://www.hort.purdue.edu/hort/ext/sfg/>). Thorough coverage of all aboveground plant parts with each application is essential for control of the disease and for successful fruit production. The important sprays for downy mildew control are (1) when the new shoots are about 1/2 inch long; (2) just before bloom (new shoots 12 to 18 inches long); and (3) just after bloom, when the fruits have set. After these three crucial sprays, applications should continue at about 10-day intervals as long as the weather is rainy and muggy. If it turns dry, the sprays may be discontinued. Several fungicides, including Abound, Captan, Copper compounds, (fixed coppers and Bordeaux mixture), Mancozeb, Ridomil/MZ, Ridomil/Copper, Sovran, and Ziram are effective against downy mildew of grape. Always follow the label directions.

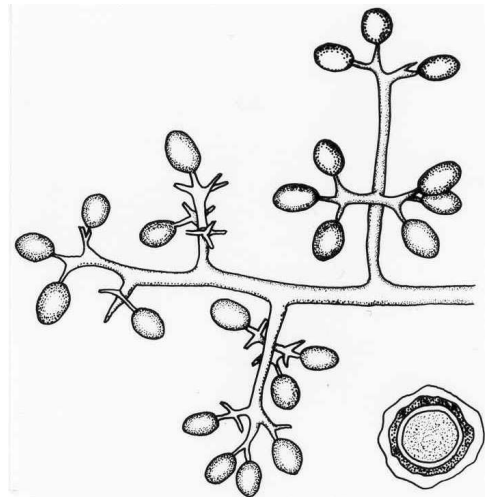


Figure 7. *Plasmopara viticola*, the grape downy mildew pathogen, seen under a high-power microscope. Thick-walled oospore (lower left). Remainder, branched sporangiophores bearing terminal, lemon-shaped sporangia (L. Gray).

For more information on downy mildew of grape, refer to the “Midwest Small Fruit Pest Management Handbook (website: <http://www.ag.ohio-state.edu/~ohioline/b861/index.html>) and “Compendium of Grape Diseases,” published by the American Phytopathological Society, St. Paul, Minnesota.

The above mentioned publications are available from the University of Illinois Ag Services, P345, 1917 South Wright St., Champaign, IL 61820 (1-800-345-6087).

Table 1. Relative Disease Susceptibility and Chemical Sensitivity of Grape Cultivars

The relative ratings in this chart apply to an average growing season under conditions usually favorable for disease development. Any given variety may be more severely affected.

Variety	Susceptible or Sensitive to:									
	BR	DM	PM	Bot	Phom	Eu	CG	ALS	S*	C**
Aurore	+++	++	++	+++	+	+++	++	+++	No	++
Baco Noir	+++	+	++	++	+	++	+++	++	No	?
Cabernet Franc	+++	+++	+++	+	?	?	+++	?	No	+
Cabernet Sauvignon	+++	+++	+++	+	+++	+++	+++	?	No	+
Canadice	+++	++	+	++	?	?	++	++	?	?
Cascade	+	+	++	+	++	++	+	?	No	?
Catawba	+++	+++	++	+	+++	+	+	+	No	++
Cayuga White	+	++	+	+	+	+	++	++	No	+
Chambourcin	+++	+	++	++	?	?	++	?	Yes	?
Chancellor	+	+++	+++	+	+++	+	+++	+++	Yes	+++
Chardonel	?	++	++	++	?	?	++	++	No	?
Chardonnay	++	+++	+++	+++	+++	++	+++	++	No	+
Chelois	+	+	+++	+++	+++	+++	++	+++	No	+
Concord	+++	+	++	+	+++	+++	+	+	Yes	+
Cynthiana/Norton	+	++	+	+	+	?	+	?	Yes	?
DeChaunac	+	++	++	+	+++	+++	++	+++	Yes	+
Delaware	++	+++***	++	+	+++	+	+	+	No	+
Dutchess	+++	++	++	+	++	+	++	+	No	?
Elvira	+	++	++	+++	+	+	++	++	No	++
Einset Seedless	+++	++	+++	+	?	?	+	?	?	?
Foch	++	+	++	+	?	+++	+	+	Yes	?
Fredonia	++	+++	++	+	++	?	+	+	No	?
Frontenac	++	+	++	++	+	?	?	+	No	+
Gewü rztraminer	+++	+++	+++	+++	?	?	+++	+	No	+
Himrod	++	+	++	+	?	?	?	+	No	?
Ives	+	+++	+	+	?	++	+	+	Yes	?
Jupiter	++	+++	+++	+	+	?	?	?	?	?
LaCrosse	+++	++	++	+++	++	?	?	?	?	?
Leon Millot	+	++	+++	+	+	+	?	?	Yes	?
Limberger	+++	+++	+++	+	?	+++	+++	?	No	?
Melody	+++	++	+	+	?	?	?	?	No	?
Merlot	++	+++	+++	++	+	+++	+++	?	No	++
Marechal Foc	++	+	++	+	?	+++	?	+	Yes	?
Marquis	+	++	+	+	+++	?	?	?	?	?
Mars	+	+	+	+	+	?	+	?	No	?
Moore's Diamond	+++	+	+++	++	?	++	?	?	No	?
Muscat Ottonel	+++	+++	+++	++	?	+++	+++	?	No	?
Niagara	+++	+++	++	+	+++	+	++	+	No	+
Pinot blanc	+++	+++	+++	++	?	?	+++	?	No	+
Pinot gris	+++	+++	+++	++	?	+++	+++	?	No	?
Pinot Meunier	+++	+++	+++	+++	?	+++	+++	?	No	?
Pinot Noir	+++	+++	+++	+++	?	?	+++	+	No	+
Reliance	+++	+++	++	+	++	?	?	?	No	+
Riesling	+++	+++	+++	+++	++	++	+++	+	No	+
Rosette	++	++	+++	+	++	++	++	++	No	+++
Rougeon	++	+++	+++	++	+++	+	++	+++	Yes	+++
Saint Croix	?	++	++	++	?		?	?	?	?
Sauvignon blanc	+++	+++	+++	+++	?	?	+++	?	No	+
Seyval	++	++	+++	+++	++	+	++	++	No	+
Steuben	++	+	+	+	?	?	+	++	No	?
Sunbelt	+	++	++	+	+	?	?	?	?	?
Tarminate	+	++	+	+	?	?	++	?	?	?
Vanessa	+++	++	++	+	+	?	+	?	?	?
Ventura	++	++	++	+	+	?	+	+++	No	?
Vidal Blanc	+	++	+++	+	+	+	++	+	No	?
Vignoles	+	++	+++	+++	++	++	++	++	No	?
Villard noir	?	+	+++	+	?	?	?	?	?	?

Key to susceptibility or sensitivity: BR = Black rot; DM = Downy Mildew; PM = Powdery Mildew; Bot - Botrytis; Phom = Phomopsis; Eu = Eutypa; CG = Crown gall; ALS = Angular leaf scorch; S = Sulfur; C = Copper.

Key to ratings: + = Slightly susceptible or sensitive; ++ = Moderately susceptible or sensitive; +++ = Highly susceptible or sensitive; No = Not sensitive; Yes = Sensitive; ? = Relative susceptibility or sensitivity not established.

[1] Slight to moderate Sulfur injury may occur even on tolerant varieties when temperatures are 85°F or higher during or immediately following the application.

[2] Copper applied under cool, slow-drying conditions is likely to cause injury.

[3] Berries not susceptible.

(Taken from Illinois Commercial Small Fruit and Grape Spray Guide)