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College of Agricultural, Consumer and Environmental Sciences

report on
PLANT
DISEASE

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POWDERY MILDEW OF GRAPE

Powdery mildew is caused by the fungus *Uncinula necator*. This fungus was reported in North America in 1834. Powdery mildew occurs in most grape growing areas of the world. If not managed effectively on susceptible cultivars, the disease can reduce vine growth, yield, quality, and winter hardiness. Cultivars of *Vitis vinifera* and its hybrids (French hybrids) are generally much more susceptible to powdery mildew than are native American cultivars such a Concord.

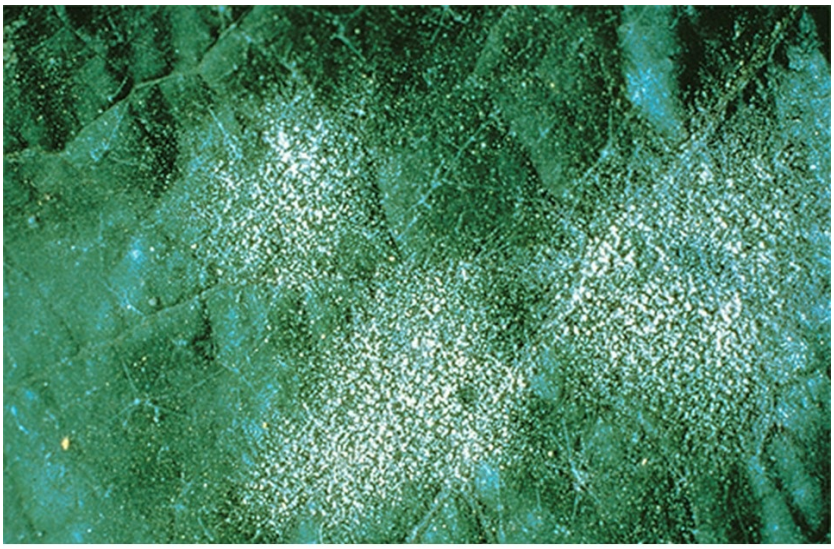

Figure 1. *Powdery mildew fungus on the surface of a grape leaf eft* (*Courtesy APS, J. Schlesselman*).

Symptoms

Uncinula necator can infect all green tissues of the grapevines. The fungus penetrate only epidermal cells, sending haustoria into them to absorb nutrients. Although haustoria are found only in epidermal cells, neighboring noninvaded cells may become necrotic. The presence of mycelia with conidiophores and conidia on the surface of the host tissue gives it a whitish gray, dusty or powdery appearance. Both surfaces of leaves of any age are susceptible to infection (Figure 1).

Figure 2. *Distortion and stunting of young leaves of grape affected by powdery mildew* (*Courtesy APS, J. Schlesselman*).

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 at Urbana-Champaign.

Young expanding leaves that are infected become distorted and stunted (Figure 2).

Petioles and cluster stems are susceptible to infection throughout the growing season. Once infected, they become brittle and may break as the season progresses. When green shoots are infected, the affected tissues appear dark brown to black in feathery patches (Figure 3), which later appear reddish brown on the dormant canes.

Figure 3. *Blackened tissue on grape shoots infected with the powdery mildew fungus* (*Courtesy APS, R. C. Pearson*).

Cluster infection before or shortly after bloom may result in poor fruit set and considerable crop losses. Berries are susceptible to infection until their sugar content reaches about 8%, although established infections continue to produce spores until the berries contain 15% sugar. If berries are infected before they attain full size, the epidermal cells are killed, and growth of the epidermis is thus prevented. As the pulp continues to expand, the berry splits from internal pressure. Split berries either dry up or rot. Berries of nonwhite cultivars that are infected as they begin to ripen fail to color properly and have a blotchy appearance at harvest (Figure 4). A netlike pattern of scar tissue develop on the surface of infected berries (Figure 5).

Disease cycle

Figure 4. *Blotchy ripening of grape berries infected with the powdery mildew fungus* (*Courtesy APS, R. C. Pearson*).

The powdery mildew pathogen may overwinter as hypae inside dormant buds of the grapevine, as cleistothecium on the surface of infected tissue (Figures 6 & 7), or both. Developing buds are infected during the growing season. The fungus grows into the bud, where it remains in a dormant state on the inner bud scales until the following season. Shortly afer budbreak, the fungus is reactivated and covers the emerging shoot with white mycelium. Conidia are produced abundantly on these infected shoots (Figure 8) and are readily disseminated by wind to neighboring vines.

Temperature appears to be the major limiting environmental parameter for the development of powdery mildew. Temperatures of 68-81°F (20-27°C) are optimal for infection and disease

development, although fungal growth can occur from 43-90°F (6-32°C). Temperatures above 95°F (35°C) inhibit germination of conidia, and above 104°F (40°C) they are killed. Free water often result in poor and abnormal germination of conidia as well as bursting of conidia. Rainfall can be detrimental to disease development by removing conidia and disrupting mycelium. Atmospheric moisture in the range of 40-100% relative humidity is sufficient for germination of conidia and infection.

Figure 5. *Netlike pattern of scar tissue on ripe grape berries infected with the powdery mildew fungus* (*Courtesy APS, J. Schlesselman*).

Disease management

Cultural practices reduce severity of powdery mildew disease of grape and can increase the effectiveness of chemical control. Cultural practices include: planting in sites with good air circulation and sun exposure and orienting rows to take advantage of these factors are helpful, and the use of training systems that allow good air movement through the canopy and preventing excess shading is also beneficial. An open canopy not only maintains a microclimate less favorable for disease development, but also allows better penetration of fungicides.

Grape cultivars differ in their susceptibility to powdery mildew. The reactions of grape cultivars to powdery mildew and other major grape diseases are given in Table 1.

Management of powdery mildew in commercial orchards is generally achieved by the use of

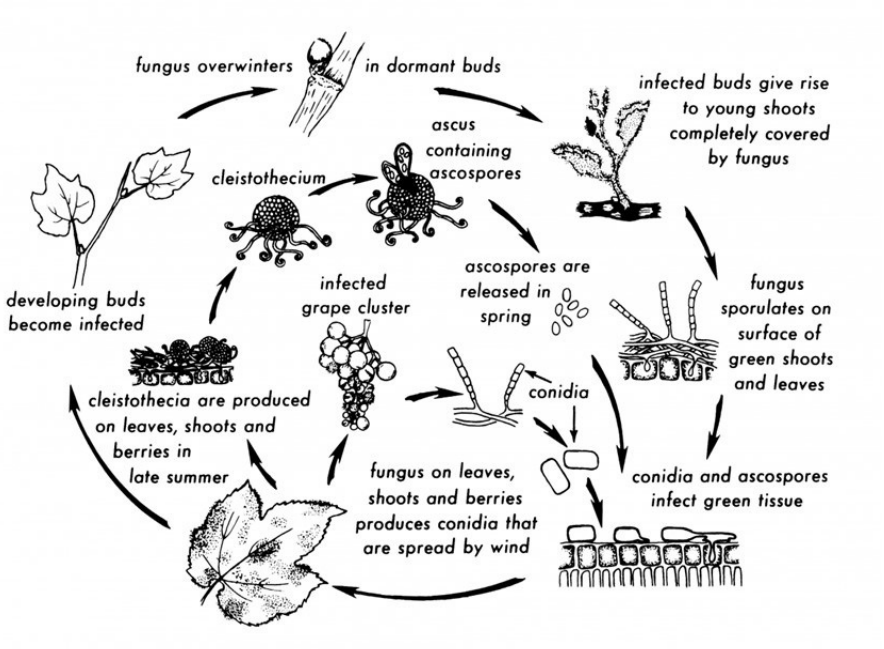

Figure 6. *Disease cycle of powdery mildew of grape* (*Courtesy APS; drawing by R. Sticht*).

fungicides. Sulfur was the first effective fungicide used to control powdery of grape and it is still widely used fungicide for this purpose. Sulfur is applies as a dust or as a wettable powder. In dry climates, sulfur dust is preferred, whereas in regions with plenty of rainfall during the growing season, the use of wettable powder or flowable formulations are preferred.

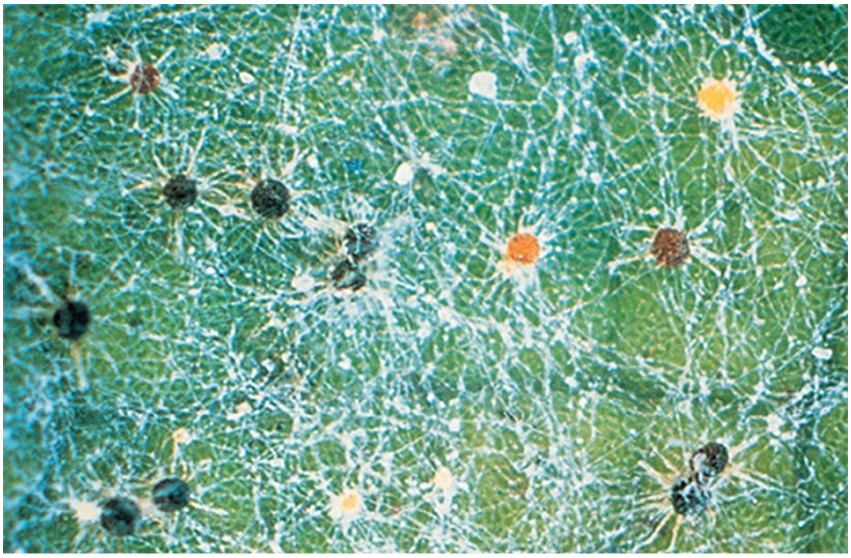

Figure 7. *Cleistothecia of the powdery mildew fungus in various stage of maturity on a grape leaf* (*Courtesy APS, W. Gartel*).

Much of the fungicidal activity of sulfur is associated with its vapor phase. The production of vapors and their effectiveness depend on the type of sulfur as well as on environmental factors, primarily temperature. The optimal temperature range for sulfur activity is 77-86°F (25-30°C), and sulfur may not be effective below 64°F (18°C). Above 86°F (30°C), the risk of phytotoxicity increases greatly and applications at 95°F (35°C) or higher are not recommended. Sulfur is less active at in humid air than in dray air.

Several other fungicides are also available for control of powdery mildew of grape. For the up-to-date information on chemical management of powdery mildew and other diseases of grapes, refer to the Midwest Fruit Pest Management Guide, University of Illinois Extension - ICSG (https://ag.purdue.edu/hla/hort/documents/id-465.pdf).

Figure 8. *Conidia of the powdery mildew fungus on infected grape tissues* (*Courtesy APS, W. Gartel*).

Table 1. Relative Susceptibility and Sulfur and Copper Sensitivity of Grape Cultivars

Cultivar	Susceptibility								Sensitivity	
	BR	DM	PM	Bot	Phom	Eu	CG	ALS	Sulfur[1]	Copper[2]
Aurora	+++	++	++	+++	+	+++	++	+++	No	++
Baco Noir	+++	+	++	++	+	++	+++	++	No	?
Cabarnet Franc	+++	+++	+++	+	?	?	+++	?	No	?
Cabernet Sauvignon	+++	+++	+++	+	+++	+++	+++	?	No	+
Candice	+++	++	+	++	?	?	++	++	?	?
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	++	+++[3]	++	+	+++	+	+	+	No	+
Dutchess	+++	++	++	+	++	+	++	+	No	?
Elvira	+	++	++	+++	+	+	++	++	No	++
Einset Seedless	+++	++	+++	+	?	?	+	?	?	?
Foch	++	+	++	+	?	+++	+	+	Yes	?
Fredonia	++	+++	++	+	++	?	+	+	No	?
Frontenac	++	+	++	++	+	?	?	?	No	?
Gewüztraminer	+++	+++	+++	+++	?	?	+++	+	No	+
Himrod	++	+	++	+	?	?	?	+	No	?
Ives	+	+++	+	+	?	++	+	+	Yes	?
Jupiter	++	+	+++	+	+	?	?	?	?	?
LaCrosse	+++	++	++	+++	++	?	?	?	?	?
Leon Millot	+	++	+++	+	+	+	?	?	Yes	?
Limberger	+++	+++	+++	+	?	+++	+++	?	No	?
Marechal Foch	++	+	++	+	?	+++	?	+	Yes	?
Marquis	+	+++	+	+	+++	?	?	?	?	?
Mars	+	+	+	+	+	?	+	?	?	?
Melody	+++	++	+	+	?	?	?	?	No	?
Moore's Diamond	+++	+	+++	++	?	++	?	?	No	++
Muscat Ottonel	+++	+++	+++	++	?	+++	+++	?	No	?
Niagara	+++	+++	++	+	+++	+	++	+	No	?
Pinot Blanc	+++	+++	+++	+++	+++	+++	+++	+++	No	+
Pinot Gris	+++	+++	+++	++	?	+++	+++	?	No	?

Table 1. Relative Susceptibility and Sulfur and Copper Sensitivity of Grape Cultivars - Continued

Cultivar	Susceptibility								Sensitivity	
	BR	DM	PM	Bot	Phom	Eu	CG	ALS	Sulfur[1]	Copper[2]
Pinot Meunier	+++	+++	+++	+++	?	+++	+++	?	No	?
Pinot Noir	+++	+++	+++	+++	?	?	+++	+	No	+
Reliance	+++	+++	++	+	++	?	?	?	No	?
Riesling	+++	+++	+++	+++	++	++	+++	+	No	+
Rosette	++	++	+++	+	++	++	++	++	No	+++
Rougeon	++	+++	+++	++	+++	+	++	+++	No	+++
Saint Croix	?	++	++	++	?	?	?	?	?	?
Sauvignon Blanc	+++	+++	+++	+++	?	?	+++	?	No	+
Seyval	++	++	+++	+++	++	+	++	++	No	+
Steuben	++	+	+	+	?	?	+	++?	No	?
Traminette	+	++	+	+	?	?	++	?	?	?
Vanessa	+++	++	++	+	+	?	+	?	?	?
Ventura	++	++	++	+	+	?	+	+++	No	?
Vidal Blanc	+	++	+++	+	+	+	++	+	No	?
Vignoles	+	++	+++	+++	++	++	++	++	No	?
Villard Noir	?	+	+++	+	?	?	?	?	?	?

Key to susceptibility: BR = Black rot; DM = Downy mildew; PM = Powdery mildew; Bot = Botrytis; Phom = Phomopsis; Eu = Eutypa; CG = crown gall; ALS = angular leaf scorch.

Key to rating: + = slightly susceptible or sensitive; ++ = moderately susceptible or sensitive; +++ = highly susceptible or sensitive; Not = not sensitive; Yes = sensitive; and ? = relative susceptibility or sensitivity not established.

[1] Slight to moderate sulfur injury may occur even on tolerant cultivars when temperatures are 85ºF (30ºC) or higher during or immediately following the application.

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

[3] Berries not susceptible.