Online Guide To
GRAPEVINE DISEASES
Virginia Tech

Powdery mildew of grapes

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Introduction: Powdery mildew (PM) can be one of the most destructive diseases affecting Virginia grapes. The causal organism, *Uncinula necator*, is an obligate fungus on the Vitaceae family. Essentially all hybrid and vinifera wine grape varieties in Virginia are either moderately or highly susceptible to powdery mildew. Chardonnay is, perhaps, the most susceptible of the commonly grown varieties. The disease is indigenous to the eastern United States but was only well-known after introduced into Europe in the 1840s causing affected vines and fruit to produce "foul wine" and reducing French wine production by 80%. Once PM is present in a vineyard, it is difficult to bring under control, and it can seriously affect grape and wine quality, as well as yields, and reduce vine growth and cold hardiness.

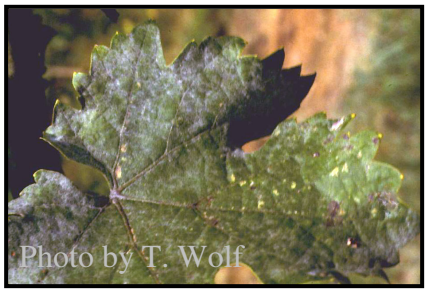

Fig. 1

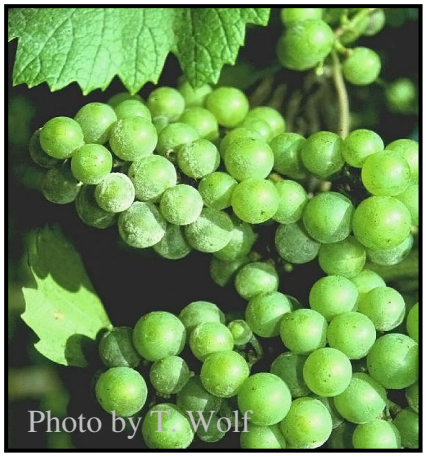

Fig. 2

Symptoms and signs: All succulent green tissues of the vine are susceptible to infection at some time in their development. The fungus penetrates only the epidermal cells, inserting haustoria (specialized feeding structures) inside the cells to absorb nutrients. The presence of fungal mycelia (vegetative structure) with conidiophores (spore-producing structures) and conidia (spores) on the surface of the host tissue give infected vines a whitish gray, dusty, or powdery appearance (Fig. 1). On occasion, the upper surface of infected leaves exhibit chlorotic or shiny spots that are similar in appearance to the oil spots of downy mildew. Young leaves that are infected may become stunted or distorted, and heavily infected leaves may turn dull, dry, and prematurely drop in autumn; infected petioles and cluster stems become brittle and break as the season progresses. When shoots are infected, fungal tissues appear dark brown to black in feathery patches, which later appear reddish brown on the surface of dormant canes.

Cluster infection before or shortly after bloom may lead to poor fruit set and result in considerable crop loss. Berries that are infected before they reach full size frequently split. Split berries either dry up or rot, and often become infected by *Botrytis cinerea*. A netlike pattern of scar tissue may be observed on the surface of infected berries. Fruit infections appear white and powdery when young (Fig. 2), eventually turning dark and dusty with age (Fig. 3). The fungus produces its sexual structures – black spherical bodies called cleistothecia – on the surface of infected leaves, shoots, and clusters in older areas of infection. Cleistothecia wash onto the trunks of vines, where they overwinter.

Fig. 3

Pathogen life cycle and conditions for infection: Primary PM infections result from inoculum that overwinters on the vine as cleistothecia, formed during late summer and washed into cracks and crevices of the bark. Cleistothecia release spores starting near budbreak through the post-bloom period. Primary infections require at least 0.1" of rain and temperatures above 50° F. All green tissues are susceptible to infection. Grape leaves are most susceptible when very young and become resistant shortly after they are fully expanded. Berries are highly susceptible from immediately prebloom until fruit set, and then become less susceptible around 8° Brix; however lesion development from previous infections may continue. Primary infections soon produce the whitish lesions appearing first on shoots near the trunk of the vine where cleistothecia have splashed via rain from the old wood. The whitish lesions are the characteristic that gives the disease its common name. Those lesions produce an abundance of conidial spores which are wind-blown to other susceptible tissue.

Secondary infections by conidia do not require the presence of free moisture; however, high relative humidity favors disease development. Therefore, vineyards in close proximity to bodies of water or parts of the vineyards with poor circulation may have high disease severity. Repeating cycles of infection, disease and conidial generation occur every 6 to 8 days at temperatures of 60 to 80° F. The rapid generation cycle accounts for PM's destructive, wildfire-like spread. Uncontrolled infections from bloom until shortly after fruit set usually result in severe disease on clusters and may increase the severity of Botrytis and sour rot, as well as *Brettanomyces* on fruit.

Cultural control: Based on reducing humidity and improving air circulation and sunlight exposure.

- Plant in sites with good air circulation and sun exposure (direct exposure to intense sunlight is detrimental to powdery mildew fungus).
- Use training systems that allow good air movement through the canopy and prevent excess shading.
- Plant varieties less susceptible to powdery mildew.

- Practice canopy management that allows good sunlight exposure.
- Scout for primary powdery mildew infections. Be sure to look inside the canopies where decrease sun exposure and increased humidity are favorable for powdery mildew development.

Chemical control: For most varieties, PM management will involve a season-long program of fungicides (2006 VT Pest Management Guide). High levels of disease the previous year will increase the importance of early season sprays. Similarly, warm temperatures and/or prolonged periods of cloudy, humid weather increase disease pressure, affecting initiation of sprays and spray intensity (spray interval, materials, and rates). Unlike other fungal grapevine pathogens, PM grows almost entirely on the surface of tissue. Therefore topical fungicides (oils, salts, etc., described below) that have no effect on other pathogens may be useful in controlling PM. With all of these fungicides it is important to remember that good coverage (by using high gallonage) is required to control this disease.

- Sulfur is relatively cheap and is highly effective, but has its limitations with sulfur-sensitive varieties or when air temperature exceeds 95° F or is below 65°F.
- The sterol-inhibiting compounds (SIs) (Elite, Nova, Rubigan, and Procure) and QoIs (Abound, Flint, Sovran, and Pristine) are highly effective PM fungicides however; precautions must be taken to avoid the development of strains of PM that are resistant to those fungicides. Regardless of which SI or QoI fungicide you choose to use, they should be alternated with unrelated materials in a season-long program. Do not apply the SI or QoI fungicides to sporulating PM-diseased vines without the addition of sulfur. Use the higher end of a recommended product rate per acre and do not exceed the label's recommended interval for repeat applications.
- Horticultural oils do an admirable job of eradicating existing mildew infections if used with sufficient gallonage (100 g/acre); however carry warnings about phytotoxicity if mixed or used near in time to applications of sulfur, captan, and certain other pesticides. Studies have shown horticultural oils may also reduce photosynthesis and decrease berry size.
- Copper has fair activity against powdery mildew, but should not be relied upon for PM control with highly susceptible varieties.
- Quinoxyfen (Quintec) is a fungicide for PM control only. It has no post-infection activity and therefore, should only be used as a protectant. Quintec has been effective against strains that have developed resistance to DMI and QoI fungicides and makes a good rotational partner with these materials.
- Other chemistries, including monopotassium phosphate (Nutrol), hydrogen dioxide (Oxidate), and potassium bicarbonate (Armicarb and Kaligreen), have been developed for PM control that offer no forward protection and are only used in eradicating a young developing PM colonies. Monopotassium phosphate products have fair efficacy at eradication of PM spores. However, are not

effective against a full blown PM infection, requires a spreader/sticker, and cannot exceed the rate of 2.0% concentration of active ingredient in water. Oxidate is also used to eradicate PM spores. The effectiveness of Oxidate has not been scientifically evaluated. Oxidate applications must be made "back-to-back" at a high rate (1-3 consecutive days and continued at 5 to 7-day intervals). Postassium bicarbonate products work on spores and mycelium, should be used at a high rate, and may be tank mixed with sulfur.

- Post harvest sprays should include an effective powdery (and downy) mildew fungicide that will protect foliage through natural senescence or the first fall frost.

Please refer to the 2006 VT Pest Management Guide at http://www.ext.vt.edu/pubs/pmg/hf3.pdf for current information.

Notes: For more detailed information on PM and PM pesticides follow the links at http://www.ext.vt.edu/news/periodicals/viticulture/03january/03january.html

References: see Viticulture Notes Vol Aug 2003, June 1992, Apr 1993, Jun 1994, Aug 1997

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