

New York State Integrated Pest Management Program

Cornell Cooperative Extension

GRAPES

Grapevine Powdery Mildew

Uncinula necator (Schw.) Burr.

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Introduction

Powdery mildew (PM) is perhaps the most important fungal disease of grapevines worldwide. This disease is native to eastern North America, but gained notoriety when it was introduced into European vineyards in 1845, causing extensive losses as it spread rapidly throughout the continent. Uncontrolled, PM can destroy infected clusters outright or reduce their quality and predispose them to bunch rot infections. Foliar infections can limit photosynthesis, thereby reducing Brix levels, vine growth, and winter hardiness. Generally, cultivars of *Vitis vinifera* and its hybrids are much more susceptible to PM than are cultivars of native American grape species.

Symptoms and Signs

The PM fungus can infect all green tissues of the grapevine. On leaves, it appears as a white or grayish-white powdery covering of the upper and lower surfaces (Fig. 1). Heavily infected leaves may turn dull, dry out, and drop prematurely in the autumn (Fig. 2), whereas very young leaves that become infected may become distorted and stunted as they expand (Fig. 3). When green shoots are infected, the fungus lesions appear dark brown to black (Fig. 4) and remain as brown patches on the surface of dormant canes (Fig. 5). Fruit infections may appear white and powdery (Fig. 6) or dark and dusty (Fig. 7), and sometimes result in shriveling or cracking of the berries (Fig. 8), depending on cultivar, climate, and the time of infection. Beginning in mid- to late summer, the PM fungus produces small black spherical bodies (chasmothecia) on the surface of infected leaves, shoots, and berries (Fig. 9). When they mature, some chasmothecia are washed onto the trunks of the vines, where they survive the winter.

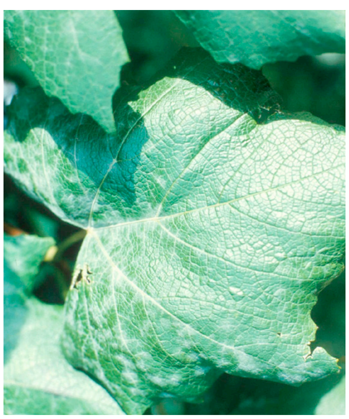
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Fig 1. Whitish powdery coating on leaf.


PHOTO BY W. WILCOX

Fig. 2. Premature leaf drop from powdery mildew.

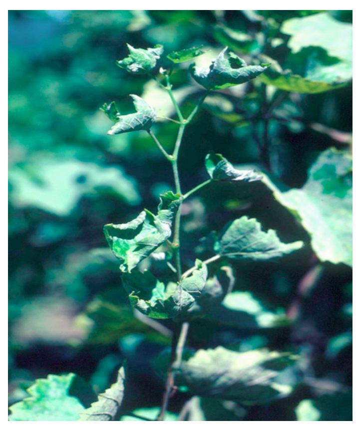
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Fig. 3. Distortion of young leaves.

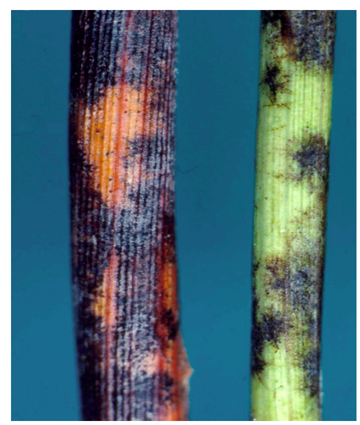
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Fig. 4. Dark lesions on green shoots.


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Fig. 5. Brown patches on dormant canes.


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Fig. 6. White, powdery fruit infections.


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Fig. 7. Dark, dusty fruit infections.


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Fig. 8. Shriveled and cracked fruit.


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Fig. 9. Chasmothecia form on berries.

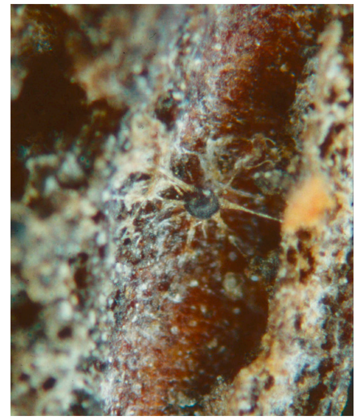
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Fig. 10. A chasmothecium lodged in bark.

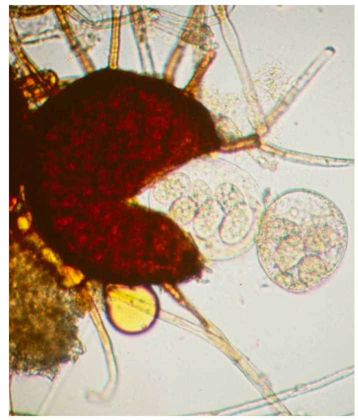
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Fig. 11. Microscopic view of chasmothecium releasing ascospores.

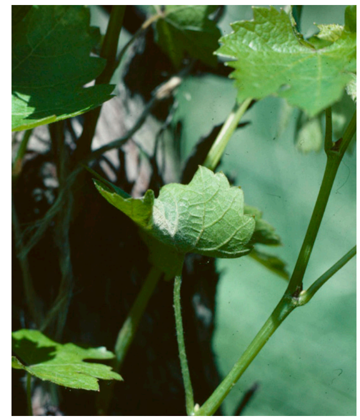
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Fig. 12. Early, inconspicuous lesion on leaf near trunk.

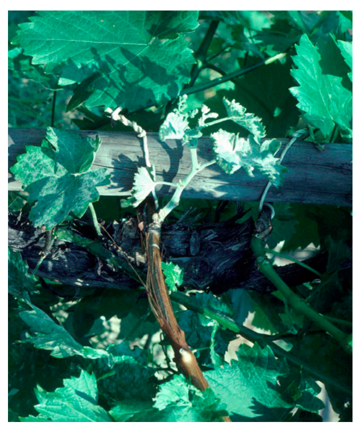
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Fig. 13. Flag shoot in California vineyard.


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Fig. 14. Electron micrograph showing superficial powdery mildew growth habit.

Disease Cycle and Conditions for Development

In New York, the PM fungus is known to overwinter only as chasmothecia lodged within cracks in the bark of the vine (Fig. 10). When rains of approximately 0.1 inch or more occur in the spring, and if temperatures are at least 50°F (10°C), these structures swell with water and discharge their infective spores (ascospores) into the air (Fig. 11). The ascospores are blown to nearby leaves and clusters, where they germinate and start the growth of a fungal colony on the surface of the infected tissue. These first infections of the season (primary infections) are small and inconspicuous, usually occurring on leaves near the trunk of the vine where chasmothecia had overwintered (Fig. 12). Once chasmothecia have hydrated and discharged their ascospores, there is no further requirement that plants remain wet for infection to occur. However, infections by ascospores are significantly more likely at 59°F (15°C) than at the minimum temperature of 50°F (10°C), and temperatures of 68°F (20°C) or higher are optimal. In general, ascospore discharge starts soon after budbreak and is completed by bloom or shortly thereafter.

In climates with moderate winters (e.g., California), the PM fungus also overwinters within infected buds, producing heavily infected "flag shoots" as soon as these buds push in the spring (Fig. 13). Flag shoots have never been observed in New York, presumably because they do not survive the cold winters. However, it is possible that they might survive occasionally during exceptionally warm winters, particularly on Long Island or in other eastern states to the south, although this has not been documented. Fungicidal protection during the early stages of vine growth is more important when flag shoots are present than if they are not.

After colonies from primary infections have developed (or flag shoots have emerged), the fungus produces a mass of white powdery "summer" spores (conidia) that function to spread the disease. Conidia are blown by wind throughout the vineyard and do not require rain for dispersal or infection. New fungal colonies that develop from these secondary infections produce still more conidia, which can continue to spread the disease. This repeating cycle of infection, spore production, spore dispersal, and re-infection can continue throughout the season if susceptible tissue is available, causing disease levels to "snowball" at a rate that is determined primarily by temperature (Table 1). Thus, at optimum temperatures in the mid-60's to mid-80's (°F), a new generation of the fungus can develop every 5 to 7 days, resulting in a severe disease epidemic unless it is managed effectively. In contrast, both cool spring conditions and hot summer temperatures persistently above 90°F greatly restrict PM development. Thus, temperature can be utilized to adjust the intensity of management efforts (e.g., spray intervals and materials) within individual seasons and locations.

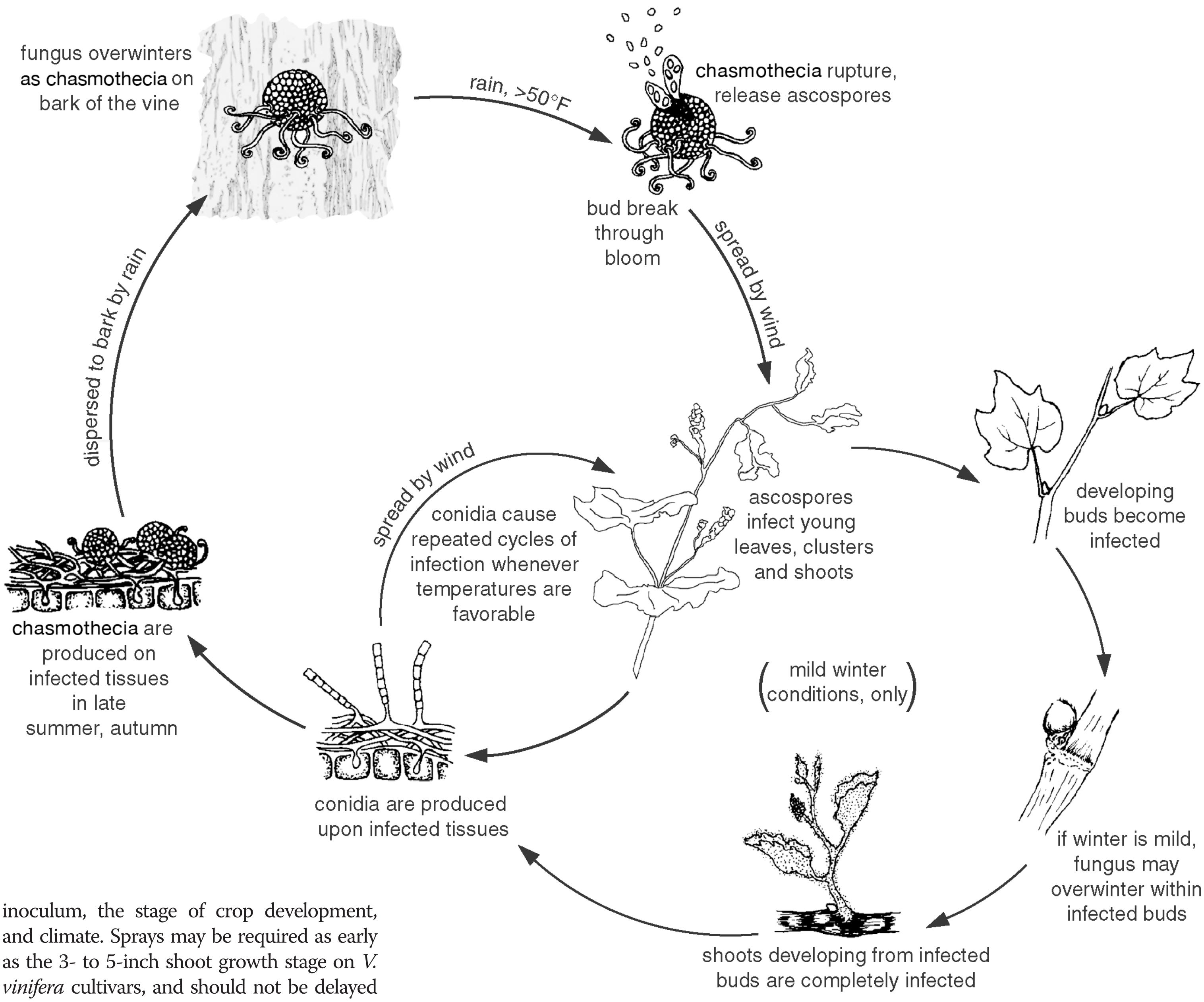
Although spore germination and infection do not require rain and can occur across a wide range of atmospheric moistures, all stages in the growth of the fungus are favored by high relative humidity, with an optimum of approximately 85% RH. Thus, disease pressure is often particularly high in vineyards close to bodies of water or in parts of the planting where air circulation is poor. Direct exposure to intense sunlight is detrimental to the powdery mildew fungus, hence the disease also is favored in shaded sections of the vineyard or within dense canopies where light penetration is poor.

Time of Infection

Berries are extremely susceptible from the immediate prebloom stage through fruit set, and severe disease on the clusters is usually a result of uncontrolled infections during or shortly after this period. Concord berries become virtually immune to powdery mildew infections about 2 weeks after fruit set, whereas fruit of *V. vinifera* cultivars maintain some susceptibility until 4 weeks postbloom. Infections that occur on such berries during their final stage of susceptibility (near the time of bunch closure) are difficult to see with the naked eye. However, they may have serious consequences, since they promote the growth of fungi responsible for bunch rots and other microorganisms that cause spoilage of the wines made from affected grapes. Grape leaves also are most susceptible when very young, and become relatively resistant to infection shortly after they've become fully expanded. Rachises (cluster stems) appear to remain susceptible to infection throughout the summer, at least on some cultivars, although such infections are thought to cause little damage to crops grown for juice and wine.

Management

Cultural practices that reduce humidity within the vineyard, enable good air circulation through the canopy, and provide good light exposure to all leaves and clusters aid in managing powdery mildew. However, maintenance of good vine health and production of high quality fruit also typically requires the application of effective fungicides at the proper times, depending on cultivar susceptibility, the availability of fungal



inoculum, the stage of crop development, and climate. Sprays may be required as early as the 3- to 5-inch shoot growth stage on *V. vinifera* cultivars, and should not be delayed beyond the immediate prebloom stage for any cultivar. High disease levels the previous year increase the importance of the earliest sprays (abundant overwintering inoculum), whereas excellent control the previous season reduces their importance. Similarly, warm temperatures during this early part of the season will increase disease pressure relative to cool temperatures. Management programs should be at their peak from the immediate prebloom stage through 2 weeks ('Concord') to 4 weeks (*V. vinifera*) postbloom, after which fruit become resistant to infection. Subsequent control of foliar infections appears to be of marginal benefit on 'Concord,' except on heavily-cropped vines, but is necessary for proper ripening and vine health on *V. vinifera* and susceptible hybrid cultivars.

Unlike all other pathogens of the grapevine, the PM fungus grows almost entirely upon the surface of infected tissues rather than within them (Fig. 14). Hence, it is subject to topical applications of many materials (e.g., oils, salts, etc.) that have no effect on other diseases, although the efficacy of these "nontraditional" products is variable. In addition to sulfur (phytotoxic on 'Concord' and some other cultivars), PM is controlled by a number of modern fungicides. Because the PM fungus can develop resistance to these new materials, it is important that they be used in accordance with recommended resistance-management practices, such as rotation with unrelated fungicides during each season.

Table 1. Approximate generation time for powdery mildew at different average temperatures

Temperature, °F	Days
44	32
48	25
52	16
54	18
59	11
63	7
74	6
79	5
86	6
90	*

Data of C. J. Delp (University of California, Davis, 1954). * Little or no disease development while temperatures remain above 90°.

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