

Extension Toolkit Notes

Roots of Peace • University of California—Davis
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Powdery Mildew in the Vineyard

Notes Compiled from—

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Vocabulary

ascocarp: a tiny (about the size of a fleck of ground pepper) fungal structure that contains asci.

ascospores: sexually produced fungal spores.

ascus (plural- asci): a microscopic fungal sac that contains ascospores.

cleistothecium (plural- cleistothecia): a spherically shaped ascocarp produced by the powdery mildew fungus. It contains asci.

conidium (plural-conidia): asexually produced fungal spores.

spores: These are the dispersal units of fungi; they are analogous to seeds in higher plants.

sporulate: to produce spores

The four most widely recognized classes of plant pathogens are bacteria, fungi, nematodes and viruses. Grape powdery mildew (PM) is caused by the fungus Uncinular necator. This fungus originated in Eastern North America, although it is now found worldwide. In many regions it is the causal agent of the most economically damaging disease to grapes.

1. Biology

PM belongs to the taxonomic division of Ascomycota. Members of this division are known as the Sac Fungi and are fungi that produce ascospores in a microscopic ascus (Greek for a "bag" or "wineskin"). Fungal spores serve a similar function as seeds in plants; they are the means by which a fungus is dispersed throughout its environment. The asci are contained within a structure called an ascocarp. PM produces cleistothecia, which are spherical-shaped ascocarps and are about the size of flecks of ground pepper (this gives you an idea of just how small the spores are). Late in the season cleistothecia appear as black specks on the surface of infected areas. PM also produces another type of spore called conidium. Conidia are asexually produced spores.

Powdery mildews produce mycelium (fungal threads) that grow only on the surface of the plant. They never invade the tissues themselves. The fungi feed by sending haustoria, or root-like structures, into the epidermal (top) cells of the plant.

The PM fungus overwinters as a group of thin threads called hyphae inside the vine's dormant buds. These buds germinate to form mildewed "flag shoots" of the grape vine in the spring. PM also can overwinter as minute cleistothecia that lodge in the bark on the vine. They then release ascospores to infect new foliage and young clusters in the spring. The subsequent spores (conidia) produced on infected tissues are the

same as those produced on flag shoots, so further spread throughout the season is the same regardless of the initial source of infection. Of course, any program that provides good disease control on the fruit and foliage during one growing season will limit the production of both cleistothecia and flag shoots that produce PM the following spring.

Buds on new shoots can be infected 4 to 6 weeks after shoots start growing. These new infected buds remain dormant until the next growing season. The fungus infects developing buds during the growing season. Shortly after budbreak, the fungus becomes active and covers the emergent shoot with a large white mass of threads or mycelium ("flag shoots").

Cleistothecia on exfoliating bark release sexual spores during rainy weather above 10°C from budbreak through bloom. This weather also favors infection that results in individual powdery spots, called colonies, on the surface of leaves growing close to the bark.

Many conidia are produced on the surface of powdery mildew colonies. Under optimal conditions of mild temperatures (growth is "explosive" at temps from ~18°C to ~30°C) and high humidity, a single spore can germinate, infect the plant, and produce a new colony and a new crop of spores in 3 days. Temperatures over 30°C inhibit conidia germination. In fact, some spores and colonies are killed after relatively short exposures above 35°C.

Although cleistothecia do require at least a brief rain to release their ascospores, neither these spores nor the conidia require moisture in order to germinate and cause infection. Free water from rain and/or irrigation can wash conidia off of a colony, burst conidia, or result in poor or abnormal germination of the conidia and slow down disease development. Therefore, the primary factor that controls the spread of PM is temperature.

2. Crop susceptibility

Powdery mildew is a disease of young, juvenile tissues. Leaves are highly susceptible to infection while they are expanding, but become resistant soon after they're fully expanded. Grape berries are highly susceptible from just before bloom to about 2 weeks after bloom when berries are about pea size. Susceptibility of the fruit drops rapidly after that time. Grapes do not get new infections on fruit after 8° Brix but can still have sporulation up to 15° Brix. Leaves and canes, however, can be infected up to and past harvest.

3. Symptoms

Powdery mildew can attack all aboveground plant parts. In early stages, whitish or grayish patches are on leaves and, if severe, eventually cover both surfaces. Colonies are more easily detected in full sunlight. Later in the season, the mildew darkens and is peppered with tiny black dots (cleistothecia). On fruit, the fungus at first may look grayish or whitish but later has a brownish appearance. Infected fruit cracks and drops from the cluster. Even blossoms sometimes can be infected, causing them to dry up or fail to set fruit. When green shoots and canes are infected, the affected tissues appear dark brown to black in feathery patches. Patches later appear reddish brown on the surface of dormant canes.

Flag shoots are difficult to detect. Some young shoots may be covered with a large white mass of threads or mycelium. Others may have only a hint of thin threads on the shoot. Infected shoots generally are delayed in bud break and appear stunted and somewhat yellowed compared to healthy shoots. Extensive splitting of berries and severe fruit damage are almost always the result of infections that occurred during the immediate prebloom through fruit set period when berries are most susceptible.

4. Disease Management

Research has shown that in years when multiple rain events (four or more) have occurred during the period of maximum fruit susceptibility, powdery mildew has been a particularly serious problem regionwide. Thus,

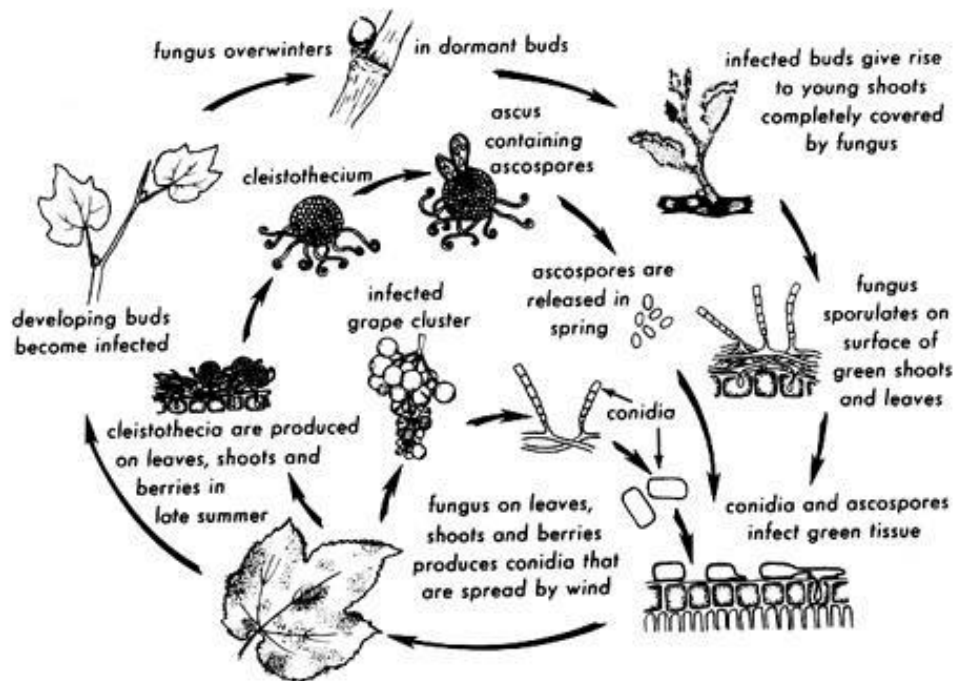
for best results, management programs should be at their peak from prebloom through fruit set, especially if weather is wet. This is when attention should be most sharply focused on control (best materials and application techniques) if temperatures are at all favorable to the disease. Leaf infections that occur beyond the fruit set period are much less serious. However, continued suppression of foliar mildew generally is required at least until veraison to attain maximum fruit quality and avoid early defoliation. Good management of late-season leaf infection also reduces disease pressure the following year by limiting the number of cleistothecia that overwinter and initiate infection in the spring.

A training system (e.g., trellising) that allows good air movement through the canopy and prevents excess shading helps prevent the development and spread of PM.

Sulfur is a traditional material for controlling PM with two major positives: it's cheap and effective. Furthermore, it's been used to control PM around the world for nearly 150 years, with no development of resistance. However, because sulfur acts largely through the vapor phase, its activity is temperature-sensitive. Sulfur is relatively inactive at cool temps below 18°C, and can be phytotoxic at temperatures above 30°C. Although sulfur products have been used effectively under such "suboptimal" conditions, these potential limitations should be recognized.

5. Extension

It is now March and the vineyard of one of your client farmers had a particularly heavy infection of PM last season. What advice would you give him regarding management strategies for the upcoming season? When should he apply sulfur and how frequently? How should he apply it? How can pruning and training the vines help?



Disease cycle of grape powdery mildew.