Powdery Mildew Disease of grapevines

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POWDERY MILDEW DISEASE OF GRAPEVINES

Powdery mildew is one of the most important and widely distributed diseases of grapevines in California vineyards. This fungus disease occurs in all of the grape-growing regions of the state, develops and spreads very rapidly under favorable weather conditions, and can destroy entire crops in any season. However, sulfur treatments can prevent powdery mildew, and drenching the diseased vine with water and wetting agent can eradicate it.

Although treatment is effective, the factors that influence the development of the disease or keep the disease from developing are largely unknown. For example, even though weather conditions in some seasons seem to be unfavorable, powdery mildew will form.

Powdery mildew on the fruit or stems of table grapes will lower fruit grade. The mildew spots on white grapes turn dark and often form scar tissue. On colored grapes these darkened spots fail to color normally. Scar spots will develop even if the powdery mildew fungus is killed. In the fall, powdery mildew may grow on the stems of late-maturing grapes and be a problem in such table grape varieties as Emperor and Calmeria. On wine grapes, powdery mildew will flavor wines.

The disease

The fungus appears as a white, powdery, web-like growth on the surface of most any green tissue, that is, leaves, shoot stems, grapes, and cluster stems (fig. 1). Young, succulent, rapidly growing tissue is most susceptible. Old, mature leaves do not usually develop powdery mildew until late in the season or early fall.

Powdery mildew on young tissue will deform and dwarf the leaves, shoots, and grapes (fig. 2). On young grapes it results in small, stunted berries, formation of scar tissue, and low sugar content (fig. 3). Scar tissue may crack open when they enlarge by growth, and the grapes will rot. In the fall, the fungus may develop on old leaves, petioles, and on cluster stems.

Grape canes that had powdery mildew when they were green will show a red speckled stain on the bark. In the wintertime, the amount of red stain on the canes is an indication of the amount of powdery mildew that developed in the vineyard the prior season.

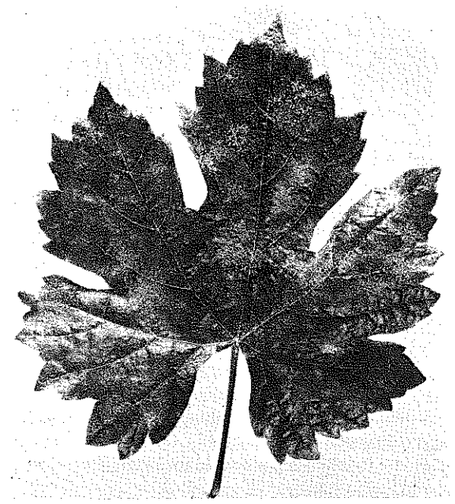

Fig. 1. Powdery mildew on leaf of Thompson Seedless. White powdery colonies are composed of fungus mycelium and numerous conidia in chains.

Fig. 2. Carignane shoots. Center shoot, infected in the bud the previous season, has powdery mildew. Shoots are dwarfed and leaves deformed by disease. Shoots are primary source of conidia, from which the disease spreads.

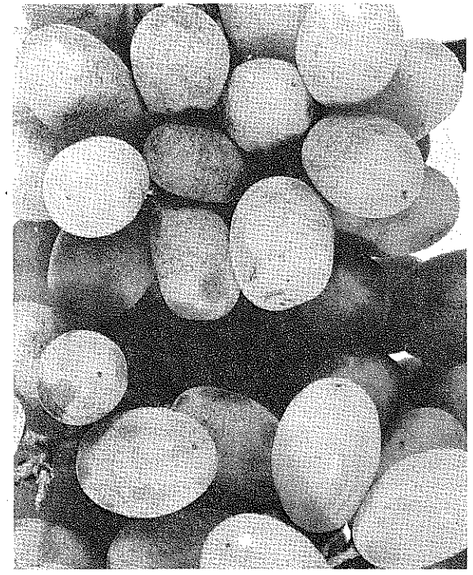

Fig. 3. Powdery mildew on Thompson Seedless grapes. Many berries are badly scarred, and some show white powdery colonies of active fungus.

A musty, mildew-like smell in the vineyard is another sign of the disease and also an indication of extensive infection.

The causal organism (fig. 4)

Powdery mildew is caused by the fungus, *Uncinula necator,* which grows over the outside surface of green tissue of the grapevine. As it grows, hyphal strands of the fungus produce appressoria that fasten the hyphae to the surface cells. Infection pegs (small, thread-like structures) develop at the center of the appressorium and penetrate the outer layer of cells. Upon entry into the lumen of the cells the infection thread enlarges to form a global structure called a haustorium. The haustoria obtain nutrients for the fungus from the grapevine cells. Early in fungus growth the hyphal strands produce conidiophores, short stalks that grow perpendicular to the surface. Conidia (spores) are produced on the top of the conidiophore, one each day. Often conidia will pile up in chains on top of the conidiophore. It is the large number of conidiophores with chains of conidia that give the mildew colony its white powdery appearance. After infection, the fungus grows rapidly over the surface of the host from the center, where a conidium germinated and infection started.

Weather and disease

If conditions are favorable, powdery mildew will spread and develop very rapidly in vineyards. In the early season when temperatures range from 70 to 80°F the fungus repeats its life cycle about once a week; conidia will germinate, infect the tissue and form new conidia which are wind-blown to other parts of the grapevine or to other plants. The disease spreads most rapidly from an infection center in the direction of the prevailing wind. In early season, secondary spread has already occurred, and the fungus is most likely in the third or fourth generation by the time the disease is first noticed. However, it is usually noticeable in the first to the middle of June with most varieties. With a variety such as Carignane, where the mycelium overwinters under the bud scales, the disease may be seen on new shoots in the early spring.

Powdery mildew is a cool, dry-weather disease. It develops most rapidly at temperatures from 70 to 80° but grows also at temperatures as low as 45°F. At 100°F, however, growth stops. In temperature chambers held at 55°F, it took 12 days

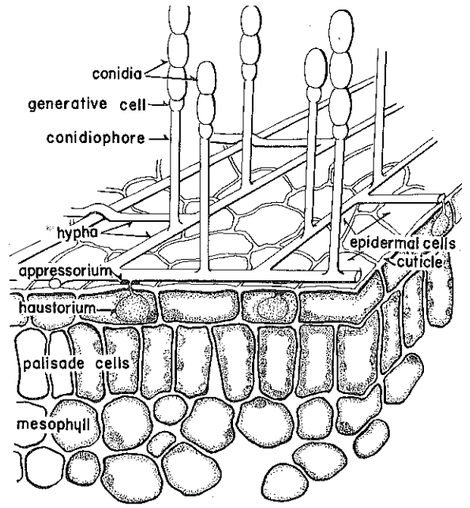

Fig. 4. A diagram of part of grape powdery mildew fungus colony on the upper epidermis of a cross section of grape leaf. It illustrates the relationship of the powdery mildew fungus to the grape leaf upper epidermis, the way in which the fungus spreads on grape tissues, the production of conidia on tall conidiophores, and how the fungus obtains food from the host by extending the growing haustoria in the epidermal cells.

from the time of seeding with conidia on grape leaves until the resulting colonies produced new spores, while at 78°F, the cycle was completed in only five days. At temperatures about 98°F, conidia formed but did not germinate. In these same experiments the maximum leaf temperature for infection was about 92°F. Conidia germinated at higher temperatures but did not infect the leaves. Vigorously growing mildew colonies that had developed under optimum conditions were killed within six hours when placed in a chamber at 104°F.

Moisture has little effect on the germination, infection, and development of powdery mildew fungus. Contrary to general belief, the disease will develop in dry weather, but it will not develop in hot weather. Studies showed that at temperatures from 70 to 90°F conidia germinated at relative humidities approaching zero.

Powdery mildew will also develop much more abundantly in the shade or diffused light than in bright or direct sunlight.

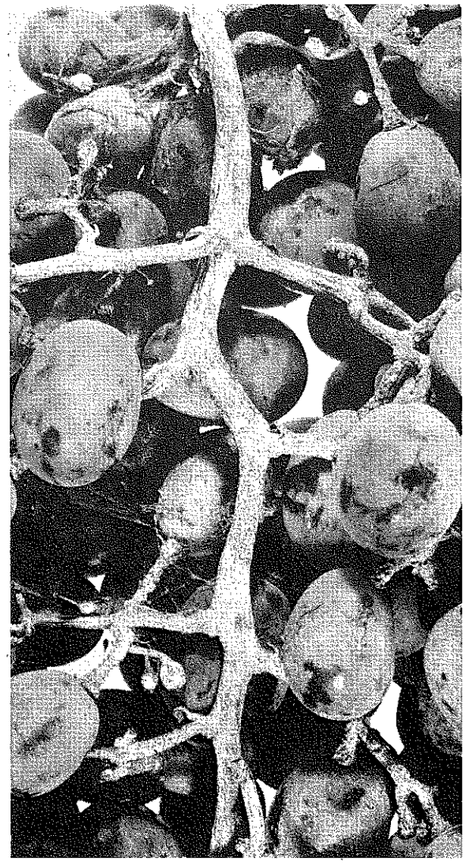

Fig. 5. Late-season growth of powdery mildew on cluster stems and pedicels of Emperor grapes. Numerous black specks on cluster stems are cleistothecia in which the asci and ascospores develop. They are the sexual overwintering form of the fungus.

Survival overwinter

The fungus survives overwinter as fungus mycelium in the bud or as overwintering spores called cleistothecia (fig. 5). In the summertime, as the fungus is rapidly growing over green tissues, the mycelium may grow in between bud scales and infect the developing bud tissue. It remains dormant in the bud overwinter, and in the spring it grows with the new shoot. The variety Carignane is highly susceptible to bud infection. Infected shoots growing out of the bud are usually dwarfed and covered with the fungus. They serve as infec-

tion centers from which the fungus will spread. Cleistothecia, the other form in which the powdery mildew fungus may overwinter, are spherical fungus cases in which the perfect spore stage of the fungus are formed. They are called ascospores. They are the sexual spores of the powdery mildew fungus, and are formed in cleistothecia when conditions are favorable. In the spring they are dispersed into the air (fig. 5). Various biotypes of the fungus may develop from these ascospores. It is not known how important the cleistothecial structures and ascospores are in the development of powdery mildew in California vineyards. However, they do occur, and it is probable that they are involved at least during some seasons in the overwintering of powdery mildew. Throughout the winter, cleistothecia remain on infected tissues of canes, cluster stems, leaves, and leaf petioles.

Control

A well-trained observer spotting the first signs of powdery mildew can judge when to apply control measures. It is not necessary to apply sulfur, except when there is need. However, grape growers often do not have time, and many do not have the training, to observe the onset of powdery mildew. It is recommended, therefore, that preventive measures be followed to assure control of the disease.

Eradication measures are usually taken when the grower has not followed the preventive schedule, has omitted one of the first three dust applications, or for some reason has failed to control the disease.

Prevention

Prevention is the most effective means in controlling powdery mildew. Sulfur dust properly applied to cover the green tissue of the grapevines will prevent powdery mildew from developing. If a sulfur particle contacts a germinating conidia, the new powdery mildew fungus is killed before it will infect and establish itself on the plant surface. This action occurs under all temperature conditions. The degree of prevention will depend upon the timing of the dust applications with sulfur and the thoroughness of coverage. A good dusting machine is essential—one that mixes the sulfur dust with air and provides a uniform distribution of sulfur particles over the grapevine foliage. Both sides of the grapevine should be dusted with sulfur. The dusting machine should be driven through the middles between each row of grapevines, and driven slowly enough so that the sulfur-air volume discharged by the machine displaces the air surrounding the vines. Each application will take from 5 to 10 pounds of dusting sulfur per acre depending somewhat on the machine and the size of the grapevines.

Sulfur dust should be applied as follows when: 1) the shoots average about 6 inches long; 2) the shoots average about 12 inches; 3) the shoots average about 18 inches long; and additional applications are made every 14 days until the fruit reaches maturity. When cultural practices permit dusting only in every other middle between grapevine rows, then applications should be made in every other middle, every other seven days to give a 14-day interval between dusting.

Apply sulfur even under poor conditions (spring seasons with wind or rain) rather than not at all—or apply as soon as possible following bad weather. Re-apply if the sulfur has been washed off. Extra sulfurings will not damage the plants when properly used and may prevent powdery mildew losses.

If any of the first three regularly scheduled dustings are omitted, the grapevines should be drenched with a spray including wettable sulfur. Use the spray described in this publication under "Eradication." Or, if problems with mildew have been encountered during the previous season, try an eradicant spray when the shoots are 6 to 12 inches long.

During hot weather, sulfur is capable of burning leaves, shoots and fruit. No more than 10 pounds of sulfur should be applied per acre per application. With maximum daily temperatures over 100°F, apply only with caution, or postpone until cooler temperatures are forecast. Serious burns usually are the result of abrupt temperature increases to which the vines are not acclimated.

In wine or raisin grape vineyards, dust with sulfur until the fruit begins to ripen (turns soft or begins to color). Then if the fruit is free of mildew, the sulfur program may be discontinued.

In table grape vineyards, powdery mildew can result in fruit cullage. Table grapes are sulfured regularly until harvest. Many growers follow a 7- to 10-day schedule, especially during the spring and early summer. With the onset of higher summer temperatures and the beginning of ripening, the schedule may be reduced for summer grapes. Powdery mildew may develop on cluster stems of late-maturing grapes during the cooler temperatures in the fall. Applications of sulfur should be made in the fall to prevent powdery mildew from developing on cluster stems.

Eradication

Powdery mildew fungus is difficult to eradicate after the disease develops. Established colonies of the fungus, however, can be eradicated by a combination of water, wettable sulfur, and wetting agent, but only the colonies contacted by the spray will be killed. During the cool spring weather until about mid-May, use 1½ to 2 pounds of wettable sulfur per hundred gallons of water and 1 to 2 ounces of a good wetting agent, such as Triton B-1956®. Wet all the foliage and flower clusters thoroughly with this spray. Rate per acre required varies from 100 to 300 gallons per acre, depending upon the stage of growth.

About mid-May, or when the day temperatures exceed 100°F, it may be best to reduce the dosage of wettable sulfur to one-half pound per 100 gallons of water. This would minimize chances for foliage burn. Eradication becomes more difficult as the season progresses, because complete coverage is necessary to kill the fungus. Powdery mildew is often more serious in dense, heavily-foliaged vines. It may be necessary to open the vines. The canes may be thrown over the crossarm trellis on the east or north side and leaves removed around the clusters before spraying is attempted. Wash the fruit thoroughly and obtain as complete coverage as possible. Rate of spray required ranges from 400 to 600 gallons per acre. Apply sulfur dust at the next interval time after spraying.

Powdery mildew development slows down in temperatures over 100°F. Mild cases of the disease where vines are open and aerated may be killed with combinations of high temperature and sulfur dust, but with severe cases of disease and heavy foliage, the eradicant spray should be used.

Table grapes should be sprayed before much of the fruit shows scarring, or the fruit cannot be packed even if the mildew is eradicated. If the fruit is more than one-third grown, the spray alters the bloom of the berry and leaves a whitish residue on the bottom of the berry where spray droplets collect and dry. Both effects reduce the attractiveness of the fruit.

Wine or raisin grapevines may not be trellised with a crossarm making it difficult to open up the vines for the necessary spray coverage. The fruit may be massed and further protected by leaves. However, the vines should be opened and the fruit exposed before spraying, if at all possible.