Facing the Challenge of Powdery Mildew

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During Oregon's 2007 harvest, 423 tons of winegrapes were lost due to disease which was nearly a three-fold greater loss than in 2006 (NASS 2008). Powdery mildew and botrytis were the major culprits to the diseased fruit after a particularly difficult growing season in 2007. In particular, the pressures were most pronounced for the Willamette Valley while Southern Oregon, Columbia Gorge and Eastern Oregon grape growing regions were not significantly higher in their disease pressures in 2007. Despite the location in Oregon, powdery mildew (*Erisyphe necator*) remains the most important fungal pathogen for grapevines. The importance of the damages in 2007 warranted a one-day workshop featuring powdery mildew research and control options. OSU Viticulture Extension presented "Vineyard Disease Management Workshop: A Closer Look at Powdery Mildew and Botrytis" in March of this year. Invited speakers to this event were Dr. Wayne Wilcox, plant pathologist at Cornell University, Geneva, NY and Dr. Walt Mahaffee, research plant pathologist with the USDA-ARS Horticulture Research Unit, Corvallis, OR. Each provided information and research results on their studies with powdery mildew. The topics of the seminars were reinforced by an industry panel that discussed their disease management programs and the efficacy, successes and failures they have had with them. The take home message was that an adequate fungicide spray program and canopy management methods were needed to prevent infection throughout the entire growing season. Some of the key features of the conference are outline here.

Susceptibility and Damage

Powdery mildew can infect all green, growing parts of the grapevine and cause damage. The symptoms vary throughout the season as both the vines and fungal pathogen advance to different stages of development. In early spring, all growing tissues are highly susceptible to infection by powdery mildew. During this time, the grower must monitor the weather and grape phenology to determine when to apply fungicides. See the OSU Grape Pest Management Guide for 2008 for more information on spray programs (http://extension.oregonstate.edu/catalog/html/em/em8413-e/) or contact your local crop advisor. The potential for infection continues throughout the entire growing season from primary infection to secondary infection by conidia. While all growing parts of the vine can be readily infected by powdery mildew, some organs are less prone at different times. The flowers and berries are highly susceptible to infection from flower formation through fruit set and until the berries reach 8° Brix. Newly formed and expanding leaves are most susceptible to infection with little new development on mature leaves. The rachis and pedicels of the fruit, petioles of the leaves, and shoots are susceptible throughout the entire season. Infected tissues result in a mycelial mat formatting on the epidermal layer of the various vine parts. The fungus feeds on the cells of the tissues to grow and reproduce. This results in visible white colonies. Infected berries often have a distinct scarring on the surface and may result in cracking. Besides general losses of fruit, infected clusters result in poor quality fruit and wines off aromas and bitterness (Ough and Berg 1979). Throughout the growing season, newly formed buds can become infected, creating a source of innoculum for the following season. In severely infected vines, these buds grow out as flag shoots that have mycelial growth covering them in the following season. Therefore, it is important to ***prevent*** infection beginning early in the season so that a viscous cycle of the disease doesn't perpetuate year after year. The impacts of powdery mildew are detrimental to bud formation, shoot development and of course, berry quality. Commonly, vineyards with powdery mildew infections result in poor regrowth the following season. This is due to the reduced photosynthetic capacity of severely infected vines, resulting in low carbohydrate assimilation and storage that are needed for early season growth the following year (Nail and Howell 2005). Powdery mildew, when not adequately controlled, can become an epidemic in the vineyard and contribute to infection of surrounding vineyards. Spores can be carried in the wind and can be particularly problematic for vineyards that lie downwind and in areas with many contiguous acres of vineyard. As more vineyard acreage is planted in close proximity to other vineyards, it is becoming an increasing concern regarding proper control of the epidemic.

Forecasting the Disease

Forecasting of the infection risk is necessary for development of an effective control program. This requires an understanding of the parameters required for sporulation, or release, of the fungal spores. There are two different forms of the spores produced by Erisyphe necator during its life cycle: ascospores and conidia. Fungal spores survive winters on the vine in a fruiting structure called a chasmothecia. This fruiting structure forms during late summer and overwiners on the vine. In spring, ascospores, the spores produced within fruiting bodies known as chasmothecia, are released when facilitated by precipitation, providing the primary innoculum for infection in spring (Pearson and Gadoury 1987). After the primary infection occurs, powdery mildew can form secondary infections by releasing conidia, asexually produced spores. The production and release of these spores follows temperature and environmental conditions that allow forecasting to be developed for pathogen control. There are several forecasting models that are used by growers to determine when an infection period has occurred which warrants the application of a fungicide spray. One of these, the Pearson-Gadoury Model, forecasts ascospore release at an average daily temperature of 50°F and 0.10" rain. In general, release of ascospores requires precipitation or other form of water for germination and infection. Another model commonly used throughout California and the Pacific Northwest is the Gubler-Thomas Model which forecasts sporulation and potential infection using leaf wetness hours and temperature. It projects disease development with a minimum of 6 hours leaf wetness at temperatures between 43-90°F. Other powdery mildew forecasting models have been developed and are being validated for use in different regions. The Gubler-Thomas Model, for example, was developed for use in California but may not be best suited for all regions. Currently, Walt Mahaffee, suggests that the Pearson-Gadoury Model is best suited for Western Oregon. While rainfall is needed to facilitate release and spread of ascospores during bud break and early shoot growth, rainfall is not a promoting factor of conidia spore release. Temperature is the most critical factor determining infection risk when considering conidia spore release (43-90°F). In general, temperatures over 95°F are detrimental to spore survival on tissue surfaces. Care must be taken when considering the air temperature as the temperatures within a canopy or cluster are usually lower due to shading and may be within the range to promote continued growth of powdery mildew. Mild summers can be particularly difficult to manage powdery mildew as the temperatures are maintained in the optimum range for the fungal pathogen, as was observed in 2007. Furthermore, overcast skies have been more detrimental than rainfall in promoting powdery mildew development (Wilcox 2008).

Impacts of Sunlight and Temperature

It is known that managing canopies for increased airflow can reduce disease pressures and allow for better spray penetration. To answer the specific results of canopy microclimate on disease infection and severity, Wayne Wilcox conducted applied research trials to examine specific components of temperature and sunlight. A whole vine shading study to investigate its impact on powdery mildew severity and sporulation. When comparing differences in microclimate in the canopy of exposed and shaded vines, the temperature and relative humidity within the canopies did not differ; however, there significantly lower severity of powdery mildew on sun exposed leaves in comparison to shaded canopy leaves. This severity difference was due to temperature. Sun exposed leaves were between 2-23°F higher than shaded leaves, decreasing the survival rate of fungal spores on sun exposed leaves (Wilcox 2008). An additional study was conducted by Wayne Wilcox et al. to determine the potential impact of UV rays on powdery mildew spores. Results indicate that there was a 2-fold increase in the incidence of disease in vines with the UV-filter in comparison to vines in full sun, indicating the importance of UV light in preventing infection. These studies reinforce the importance of vine canopy exposure and management to reduce shoot density and leaf layers.

Advancements…

Powdery mildew can be difficult to control in the vineyard. However, with adequate spray chemistries, formulations, spray coverage and spray scheduling, a crisis can often be averted. The most current research efforts are in fine tuning the forecasting methods of infection that can be used in decision making to prevent disease. Research programs conducted by Walt Mahaffee currently focus on the development of a stronger disease modeling system for the grape grower in Oregon and the Pacific Northwest. Mahaffee is currently working on a multi-state collaborative project to develop an online system to provide disease forecasting with weather modeling that includes institutions throughout the Pacific Northwest. In the future, there is likely to be a better suited and more efficient method for determining pathogen risk for a quick response!

For more information on powdery mildew spray programs, please check out the following resources:
OSU Grape Pest Management Guide 2008
Authors: Patty Skinkis, Jay Pscheidt, Vaughn Walton, Amy Dreves, Nancy Allen
http://extension.oregonstate.edu/catalog/html/em/em8413-e/

Vineyard Disease Management Proceedings
Proceedings from the Vineyard Disease Management: A Closer Look at Powdery Mildew and Botrytis held March 5, 2008 are now available online for viewing at http://wine.oregonstate.edu/outreach.
Gubler-Thomas Model for Grape Powdery Mildew
http://www.ipm.ucdavis.edu/DISEASE/DATABASE/grapepowderymildew.html
http://www.apsnet.org/online/feature/pmildew/Top.html

Resources Used
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57-62. Nail, W.R. and G.S. Howell. 2005. Effects of Timing of Powdery Mildew Infection on Carbon Assimilation and Subsequent Seasonal
Growth of Potted Chardonnay Vines. Am. J. Enol. Vitic. 56:220-227.
National Agriculture Statistics Service, 2008. 2007 Oregon Vineyard and Winery Report. <http://www.nass.usda.gov/Statistics_by_State/Oregon/Publications/Vineyard_and_Winery/index.asp>.
Ough, C.S. and H.W. Berg. 1979. Powdery Mildew Sensory Effect on Wine. Am. J. Enol. Vitic.. 30: 321.
Pearson, R.C. and D.M. Gadoury. 1987. Cleistothecia, the Source of Primary Innoculum for Grape Powdery Mildew in New York.
Phytopath. 77: 1509-11514.
Wilcox, W. Powdery Mildew Research. Vineyard Disease Management: a Closer Look At Powdery Mildew and Botrytis, 5 Mar. 2008, OSU Viticulture Extension. 5 Apr. 2008 <http://wine.oregonstate.edu/files/files/Powdery_Mildew_Research-Wayne_Wilcox.pdf>.