Spring 2013

Oregon Wine Research Institute
Viticulture & Enology Technical Newsletter

Welcome to the Spring 2013 Newsletter

Welcome to the spring edition of the OWRI Technical Newsletter. This edition showcases several articles and resources that will help you to prepare for the 2013 season. Dr. James Osborne, OSU Enology Extension Specialist, opens this edition with a timely article about *Brettanomyces* and winemaking. You will also find an article summarizing a 4-year trial where the labs of Dr. Patty Skinkis, OSU, and Dr. Paul Schreiner, USDA-ARS, investigated the impacts of cover crop use and mulching in an establishing vineyard. An invited article by Dr. Jay Pscheidt, OSU Extension Plant Pathologist, contains a comprehensive overview of how to properly scout for grape powdery mildew, which is a very timely topic. Dr. Bob Martin, USDA-ARS Research Virologist, provides us with a critical update regarding Grapevine Red Blotch Disease and its detection in Oregon vineyards. Please read the article written by Clark Seavert on AgTools and other valuable resources he developed to assist in business operations. Updates on current research programs are provided by Dr. Elizabeth Tomasino, OSU, for the OWRI Sensory Panel and by Dr. Patty Skinkis, OSU, for the Statewide Crop Load Project. We wrap up this edition with a few words from OWRI interim director, Dr. Bill Boggess. Don't forget to check out the list of new research publications, Extension documents, other valuable resources, and mark your calendars for upcoming events offered by the OWRI!

Cheers,
The OWRI Team

Barnyard with a Hint of Band Aid®—Brettanomyces and Winemaking

Dr. James Osborne, Enology Extension Specialist, OSU

As we head into spring, the 2012 red wines are likely going through malolactic fermentation or have completed this process. It is at this point that your wine is most susceptible to the major spoilage yeast encountered during winemaking *Brettanomyces/Dekkera bruxellensis*. This yeast can produce a range of compounds that impact wine quality, leading to off-flavors described as 'horsey,' 'smoky,' 'medicinal,' 'Band Aid®,' and 'burnt plastic.' Because of the potential impact on wine quality and economic losses, advances in characterization, detection, and control of *Brettanomyces* has been the focus of recent intensive research efforts. This article explores current knowledge of *Brettanomyces* and some recent research findings regarding this spoilage yeast.

Brettanomyces is a yeast that has historically been associated with food and beverage spoilage and was named due to its connection to the English brewing industry (British brewing fungus). Although five distinct species of *Brettanomyces* are now recognized, only *B. bruxellensis* is thought to be associated with grape and wine contamination. Until recently, it was thought that *Brettanomyces* was not present on the surface of wine grapes and that contamination occurred in the winery through importation of spoiled wine, poor sanitation of hoses, tanks,

IN THIS ISSUE

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barrels, and contamination by fruit flies. However, a recent study utilizing specific enrichment medium reported that *B. bruxellensis* can be present on grapes but usually in very low numbers (Renouf and Lonvaud-Funel 2006). There are also a number of reports suggesting a connection between increased *Brettanomyces* populations on *Botrytis*-damaged fruit. Still, the most frequent place where *Brettanomyces* is found in the winery is wood cooperage. Oak barrels have a porous microstructure which allows a small influx of oxygen and the presence of cellobiose can serve as a sugar resource (Fugelsang and Edwards 2007). In addition, barrels are very difficult to sanitize and *Brettanomyces* has been found up to 8 mm deep in staves. This is not to say that *Brettanomyces* is only found in barrels. The yeast has also been isolated from white and sparkling wine as well as wine processing equipment including pumps, presses, transfer lines, tank valves, bottling lines, floor drains, and even air samples obtained from wineries (Fugelsang and Edwards 2007). *Brettanomyces bruxellensis* is probably the most well-adapted yeast species specific to dry red wines. It is somewhat resistant to SO_2, high ethanol content, and both oxygen and nutrient depletion. It can be particularly active during sluggish alcoholic malolactic fermentations but can also grow during wine aging despite the presence of SO_2. Furthermore, *Brettanomyces* has been found in bottled wines many years after the wine has left the winery (Coulon et al. 2009).

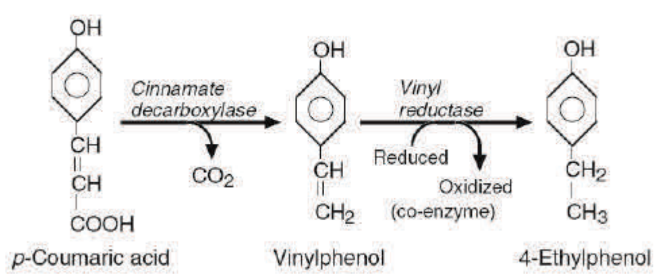

Figure 1. Pathway for 4-ethyl phenol production from *p*-coumaric acid by *Brettanomyces* (Fugelsang and Edwards 2007)

The major spoilage problem associated with *Brettanomyces* is the production of the volatile phenols: 4-ethylphenol (4-EP), 4-ethylguaiacol (4-EG), and 4-ethyl catechol (4-EC). All of these compounds are produced by *Brettanomyces* from the precursor compounds coumaric acid, ferulic acid, and caffeic acid, respectively (Figure 1).

These compounds are naturally present in red wine, but their concentrations may vary depending on a number of factors including grape variety, grape growing conditions (cool vs. hot climate), and winemaking practices. In addition to volatile phenols, *Brettanomyces* can produce large amounts of acetic acid from glucose and can produce isovaleric acid, a compound described as 'rancid' or 'vomit'. It is thought that there are a number of additional unidentified compounds that contribute to "Brett" taint in wine. Depending on the concentrations of these various compounds, numerous descriptors have been used to describe *Brettanomyces* character. Elevated levels of 4-EP in red wine are associated with aromas described as 'horsey,' 'smoky,' 'medicinal,' or 'leather' while 4-EG has been described as 'clove' or 'spice'. The combination of these compounds provides the wide variety of descriptors associated with Brett taint. In fact, in some cases winemakers consider that some *Brettanomyces* character provides a positive attribute to wine. However, it is not fully understood why *Brettanomyces* spoilage in one wine may result in subtle aromas, while in another wine overpowering 'barnyard' and 'Band-Aid®' aromas are produced. Part of this may be due to the difference sensory thresholds of compounds in wine. Although the reported sensory threshold of 4-EP and 4-EG in red wine is 605 μg/L and 110 μg/L respectively, the concentration at which these compounds become objectionable in wine can vary greatly (Curtin et al. 2005). This variation is due primarily to the type of wine and the relative concentrations of the two compounds. For example, the detection threshold of 4-EP in a Tempranillo wine is reported to be much lower than a Cabernet Sauvignon wine. In addition, researchers have noted that the sensory threshold of 4-EP is lower when both 4-EP and 4-EG were present in the wine together. Strain differences also play a large role in creating much of the sensory variation reported. Studies in California and Australia have reported large differences between the amount of 4-EP and 4-EG produced by different strains of *Brettanomyces* from the same concentrations of precursor compounds (Curtin et al. 2005). Recent research has also demonstrated that oxygen concentration can impact production of 4-EP from coumaric acid, with the highest concentrations of 4-EP being found under anaerobic conditions (Joseph et al. 2013). Aside from the production of objectionable spoilage products, *Brettanomyces* infection can also result in the loss of varietal and fruity/floral aromas, a loss of color, and an increase in bitterness.

So what can you do as a winemaker to control

Brettanomyces in the winery? Since *Brettanomyces* yeast are a natural part of the winemaking process, they cannot be entirely eliminated. Spoilage will occur if conditions are favorable for their growth and precursor compounds are present in the wine. However, there are a number of preventative steps you can take to minimize the likelihood of *Brettanomyces* taint. These steps should be viewed from a holistic point of view rather than as individual and unrelated actions. First, although there is still dispute as to the significance of the contribution of *Brettanomyces* from grapes, we do know that damaged grapes may contain higher microbial loads than healthy grapes. Removal of damaged grapes should be considered along with SO_2 use. In addition, long maceration periods and use of enzymes for color extraction and clarification that may contain cinnamic esterase activity can increase the pool of available precursor compounds (hydroxycinnamic acids) for ethylphenol production (Gerbaux et al. 2002). During alcoholic fermentation *Brettanomyces* populations usually remain low as they are poor competitors for nutrients with *Saccharomyces cerevisiae*. However, if you have a problematic or stuck fermentation, *Brettanomyces* can grow to high numbers and cause spoilage at that stage. This is also true during the malolactic fermentation and is one reason ensuring a quick and problem-free MLF can reduce the risks of *Brettanomyces* spoilage.

Other microorganisms present during winemaking may also impact the growth of *Brettanomyces* and the production of volatile phenols. A recent study considered whether the conversion of coumaric acid to 4-vinylphenol (4-VP) by some strains of *Saccharomyces cerevisiae* would reduce 4-EP production by *Brettanomyces*. This was because 4-VP can combine with anthocyanins in red wine to form the color compounds pyranoanthocyanins and may be unavailable for *Brettanomyces* to convert to 4-EP (Benito et al. 2009). Recent work in our laboratory has investigated interactions between *Brettanomyces* and the spoilage bacteria *Pediococcus*. Specifically, we investigated whether the ability of *Pediococcus* to convert coumaric acid to 4-VP would be beneficial to *Brettanomyces*. As illustrated in Figure 1, the production of 4-EP is a two-step process. Although some microbes can perform the first step, only *Brettanomyces* is capable of performing the second step in wine, and producing any significant amount of 4-EP. However, is it beneficial to *Brettanomyces* to have the first step performed by another microorganism? Our results demonstrated that 4-EP production by *Brettanomyces* was accelerated if *Pediococcus* had previously converted coumaric acid to 4-VP. We are continuing our work in this area, including research into interactions between *Oenococcus oeni* and *Brettanomyces.*

The most common ways to control *Brettanomyces* in wine are to maintain proper pH, SO_2, and temperature during the wine aging process. Like most wine spoilage microbes, *Brettanomyces* prefers higher pH, so a pH below 3.50 is recommended to discourage growth. The pH also impacts the effectiveness of SO_2, with SO_2 being much more potent at lower values. The sensitivity of *Brettanomyces* to SO_2 is strain-dependent, and some studies show a five-fold range in SO_2 tolerances (Curtin et al. 2012), but most strains are controlled at 0.65 mg/L molecular SO_2. It is recommended that SO_2 additions be made in larger, less frequent additions rather than many small additions. This will help prevent unintentional build-up of more resistant strains, and recent studies have also suggested that the exposure of *Brettanomyces* to moderate levels of SO_2 may induce a viable but non-culturable state (VBNC) (Serpaggi et al. 2012). In the VBNC state, microorganisms do not grow on conventional microbiological medium but still remain intact and viable. At a later stage when growth conditions are favourable, these microorganisms may begin growing again. This makes detection of *Brettanomyces* by traditional plating methods difficult. Additional tools to control *Brettanomyces* include maintaining wine at lower temperature (below 55˚F is recommended), racking, and minimizing oxygen exposure.

Oxidative conditions encourage *Brettanomyces* growth, and excessive amounts of oxygen have been shown to enhance the production of acetic acid. Racking and fining have been shown to reduce *Brettanomyces* populations. *Brettanomyces* is spread around the winery through poor sanitation practices. Topping wines should always be confirmed free of *Brettanomyces* and sampling thieves should be rinsed in ethanol between barrel sampling to prevent cross-contamination. In addition to these preventative measures, a regular monitoring protocol should be in place so at the earliest possible time you detect when you have a problem and can take appropriate early action.

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How *Mulch* Do You Want to Know about Cover Crops?

A study of vineyard floor management in a pre-production vineyard

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Dr. Patty Skinkis, Viticulture Extension Specialist, OSU
Dr. Paul Schreiner, Research Plant Physiologist, USDA-ARS

It is common practice to consider different vineyard floor management options several years after planting a new vineyard. Before this time, vineyards are often clean-cultivated or sprayed with herbicide to avoid competition. This is done with good reason--competition is stressful to young vines when their root systems are small. This practice may not be the best option for the vines or the environment. Repeated cultivation can cause plow pans to form, increase susceptibility to erosion, and harm surface roots. Herbicides can cause problems due to drift contact on young leaves and shoots, and the surfactants can be harmful to aquatic life if they runoff into streams. We agree that competition, either from weeds or cover crops, can reduce establishment of young vines, and there is a large body of research that supports this. How can we bring cover crops into the vineyard system in the early years of establishment without harm? Our research team at the Oregon Wine Research Institute conducted a trial to look at this subject. We examined alternative ways to optimize cover crop management by exploiting the biomass produced as a vine row mulch.

The research project was designed to measure the impact of cover crops and mulch from the time of vineyard planting to production. The first year of treatments was initiated in 2009 in a first-leaf commercial planting of Chardonnay (96 clone on 3309 rootstock). The vineyard was planted in an Amity silt loam soil with less than 3% slope, and vines were spaced 7 ft. x 5 ft. The vines were dry-farmed and no fertilizer was applied except foliar boron for the duration of the study. One set of plots had no cover crop and was kept free of vegetation in the vine row with herbicides and in the alley with cultivation. A cover crop of crimson clover and cereal rye was planted each September in all other plots, grown over the winter, and mowed in May when the clover was near 90% flowering (Figure 1). The four cover-cropped treatments differed by how cover crop residues were managed. In one set of plots, the residue was put back into the alley and tilled in. In another, the residue was removed from the plots and not incorporated. In the last two treatments, the residue

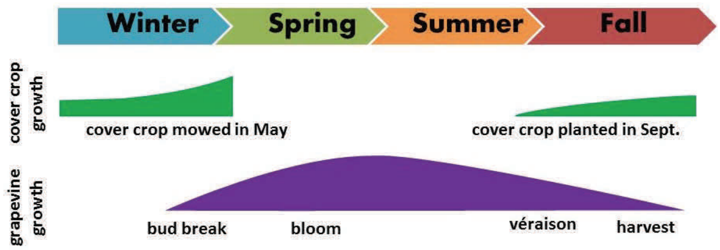

Figure 1. The management schedule for winter annual cover crops, showing the discrete growth periods of the two crops in the system.

was transferred to the vine row as a mulch layer at two different rates: 1) mulch layer equivalent to the quantity produced in adjacent alleys, mimicking what would be applied by a side discharge mower (Figure 2), or 2) mulch layer equivalent to three times this amount. All plots were kept free of weeds by cultivating alleys in the summer.

The idea behind these treatments was that the unplanted plots would act as a standard pre-

Figure 2. Mulch applied to the vine row at the 1-alley rate in May 2011.

production practice. The plots that were mown and tilled-in would evaluate the benefits of the cover crop being turned into the soil every year, including the addition of nitrogen from the clover. The treatment where residues were removed from the vineyard plots was designed to test for effects due solely to cover crops without incorporation. The two mulch treatments were designed to evaluate the benefits of using the cover crop residue and the quantity of mulch required to obtain a vine response.

One of the key findings from this trial was the effect of the mulch layer on soil moisture. Every year the mulch was applied, the upper foot of soil in the vine row had higher moisture retention throughout the summer (Figure 3). Greater soil moisture under mulch is most likely due to the shading and insulating effect of the mulch, effectively reducing evaporation from the soil surface. Despite these differences in soil moisture content between mulched and non-

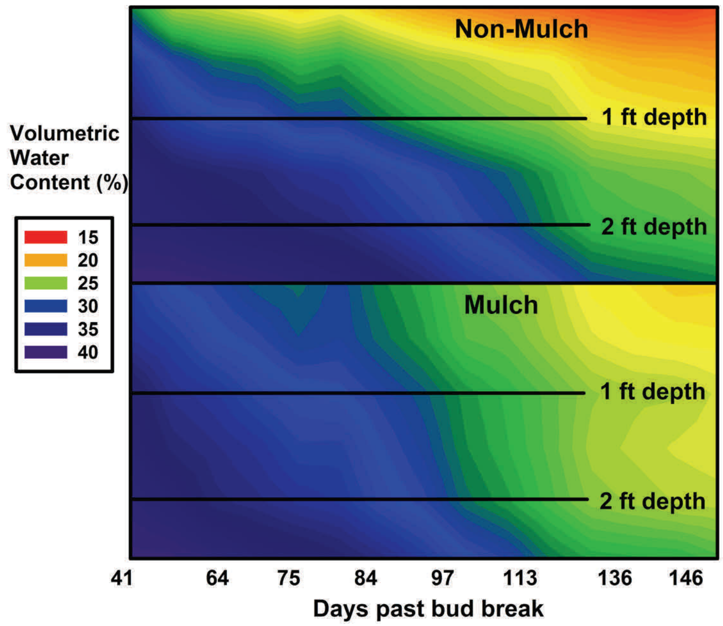

Figure 3. Soil moisture over the 2011 season in the vine row of mulched and non-mulched treatments. Red is the lowest soil moisture and blue/purple is the highest soil moisture.

mulched treatments, vine water status (measured via stem water potential) did not differ at any time over the course of this trial. Rather, the increase in soil moisture in the mulched treatments stimulated vine growth, consistently increased fruitfulness, often increased vine N status, and enhanced leaf chlorophyll concentrations in some years. For example, leaf area the first year (2009) was 40% higher, and pruning weight was 25% higher in year two (2010) in mulched vines compared to the average of all non-mulched treatment vines. Shoot length in the mulched treatments in years two (2010) and three (2011) were increased by 22% on average over non-mulched vines. Leaf chlorophyll, a measure of the greenness of leaves influenced by nitrogen, was higher for 2010 through 2012 at bloom time. However, leaf N did not differ until year three, possibly due to N being used to increase vine growth.

Fruitfulness, indicated by the number of clusters per shoot, was higher with mulch in each year measured. Fruitfulness has been shown to increase with greater vine fertility. By year two, there were 93% more clusters in the high rate of mulch than in the unplanted treatment. This increase would have led to yield differences in year two (2010), but fruit yield data was lost due to intense bird damage that fall. Overall, vine responses to these cover crop treatments were most apparent within the first two years of vine development. To test this, we planted own-rooted cuttings into spaces between vines in 2009 and 2010 and destructively harvested them at the end of each season to quantify vine biomass production. The difference was striking; there was up to 236% more leaf and shoot mass produced by vines grown in mulched vine rows as compared to vine rows without mulch.

The positive effects of mulch on above-ground vine performance were related to differences in the spatial root development in mulched and non-mulched treatments. The addition of mulch to the vine row increased fine root proliferation in the vine row, even though it reduced fine root growth in the alley. Mulch addition clearly altered the vine row soil environment, thereby making the soil more conducive to root development. It is unclear exactly what caused this because numerous soil attributes were altered by placing mulch on the surface, including increased soil water content, decreased soil compaction, decreased soil temperature, and presumably an increase in soil nutrients (particularly N) as the mulch decomposed. While we assume that greater soil moisture was the key driver of increased root growth under the mulch, this also would have allowed vines greater access to nutrients released from cover crop residues.

Vine growth differences were not as apparent as the vines got older and developed larger root systems. Despite all of the growth benefits observed in the early years of this trial, the difference in fruit yield and juice chemistry was minimal during the first cropping years of the trial (2011 and 2012). During those years, there were no differences by treatment in vine yield, soluble solids, pH, titratable acidity (TA), and yeast assimilable nitrogen concentrations (YAN) at harvest. The lack of differences may be due to high variability at this stage of production. Except for the higher fruitfulness in 2010, there was no evidence that the cover crop practices compared here provided for earlier yield productivity at this site. The impact of mulches may be greater at other sites where soil water and/or nutrients are more limiting.

There were several other findings from this study that are beneficial for growers. The first is that the cover crop used in this study did not compete with the vines when grown as a winter annual. While we designed the study to avoid competition, this work shows that using winter annual cover crops in alleys has no negative impact in young vineyards when summer vegetation is controlled. Secondly, despite the obvious benefits of maintaining a cover crop during winter months (soil erosion, increased biodiversity, etc), there was no measured benefit of the cover crop to vine growth and productivity without mulching. Lastly, the high rate of mulch did not increase soil moisture or vine growth more than the low rate (the high rate of mulch was more effective at increasing growth only when the root system was very small, i.e. in the interplanted cuttings). This is despite a three-fold increase in the volume and thickness of the mulch layer at the high rate, which had the potential to provide three times more plant available nutrients as the residues decomposed. This is good news for those who want to use mulch in the vineyard because it means that a sufficient quantity of residue can be produced in alleys from winter cover crops to utilize as a vine row mulch (i.e. no need to obtain residue from off-site.)

The decision of whether or not to implement a cover crop mulching practice is still not an easy one. There are costs associated with buying cover crop seed, preparing the seedbed, and planting. Additional labor is involved in mowing and spreading the residue onto the vine row. In addition, there can be difficulties in consistently growing a good stand of cover crop without added irrigation or fertilization, which we found especially true in one of the four years of this trial. There is also the added cost in machinery to transfer the cover crop residues onto the vine row. On the other hand, there are other vine growth and environmental benefits which are difficult to fully quantify. During the first two years, there was a reduction in weed density in mulched vine rows (Fredrikson et al. 2011). There are benefits to having a cover-cropped surface in winter for traction. In some cases, the increased soil moisture from applying mulch could be sufficient to allow dry-farming where it would otherwise not be viable. This study shows that cover crops can be effectively managed to enhance growth in young vineyards. The key is to manage competition and consider mulching for the added benefits to soil moisture and nutrition.

This study was funded by the Northwest Center for Small Fruits Research, USDA-ARS, and the Oregon Agriculture Research Foundation. For further details on this study, please contact Patty Skinkis at: skinkisp@hort.oregonstate.edu.

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Scouting for Powdery Mildew:

A Merit Badge in Plant Disease for Grape Growers

Dr. Jay Pscheidt, Extension Plant Pathologist, OSU

Have you ever gone on a “snipe” hunt? The kids in-the-know take unsuspecting new kids out at night to hunt for a mythical critter called a “snipe” just to see how long it takes them to catch on that there is really nothing to find. I suspect many grape growers begin to feel like those new kids when scouting for powdery mildew. How on earth are you supposed to find a microscopic fungus that, by definition, you can’t see? Unlike the “snipe,” powdery mildew is a real threat to your business and can get away from your management tactics before you realize it is there.

Scouting for powdery mildew can be an important part of your overall management plan. Finding the first occurrence of this disease can help you start or adjust your fungicide program and determine where to concentrate your resources. There are several important factors depending on your management style, vineyard situation, and canopy management.

Why look for trouble?

There are several tactics used to manage powdery mildew including fungicides and methods of canopy management. Finding the first signs of powdery mildew can determine when to initiate your fungicide program. Rather than starting too early and wasting unnecessary applications, you can simply wait until disease is found and then begin your spray program. This is often a tactic used in other cropping systems such as ornamental plants susceptible to powdery mildews in the greenhouse. To make it work, one has to be thorough and vigilant to find those first few powdery spots (called colonies). This tactic can be risky since fungicides work best when applied **BEFORE** this fungus gets started in your vineyard. It is more suited for smaller vineyards or vineyard blocks that can be thoroughly scouted.

Even after your fungicide program is started, finding that first powdery mildew colony can help you make important adjustments to your management plan. You can begin to use stronger fungicides, higher rates, slower sprayer speeds and/or shorter application intervals. It may indicate problems in your application system such as poor sprayer calibration or vine coverage.

Finding powdery mildew can help focus limited resources to situations where and when they are needed. Powdery mildew is often first found in high vigor areas of your vineyard or in shaded riparian areas. Making that first find of disease can allow you to make timely adjustments in pre-bloom shoot thinning, sucker removal, shoot positioning or fruit-zone leaf removal. Each of these practices can combine to reduce canopy density, allow better spray penetration, and increase air circulation, all of which will aid in your management success.

Knowing where powdery mildew was out of control last year can help you change your overall management or determine methods to limit vine vigor. Adjustments can be made at pruning to alter bud number or to make changes to your fertility program.

Quick action

Scouting for the disease and identifying it requires you to react quickly. Under favorable conditions, this fungus can go through a generation in as little as five days. Frequent scouting and quick management decisions followed by timely action are required. Once powdery mildew gets ahead of your management plan, it may be impossible to control.

Worse than a needle in a haystack

Finding a handful of millimeter-sized colonies somewhere in several acres of vineyard can be a daunting task. However, knowing something about the fungus itself can help limit the search to a few key places and times.

Generally, *Erysiphe necator*, the powdery mildew fungus, overwinters as small black bodies (cleistothecia) on the exfoliating bark of the vine (Figure 1). Cleistothecia release sexual ascospores during rainy weather above 40˚F from bud-break through bloom, but infection generally does not occur until daily averages are above 50˚F (Figure 2). This weather also favors infection that results in individual colonies on the surface of leaves growing close to the bark. During the early stages of epidemics, symptomatic leaves are often confined to the canopy interior, close to trunks or cordons.

Knowing this, you can focus your search to leaves that are closest to trunks, cordons and head regions of the vine (Figure 3). A quick stop in a high vigor area of your vineyard to search basal leaves may be all that is needed. Go straight to the head region and turn over a few leaves that are in tight groups close to the bark. Repeat this process for several vines in the area, and you may catch the start of the epidemic.

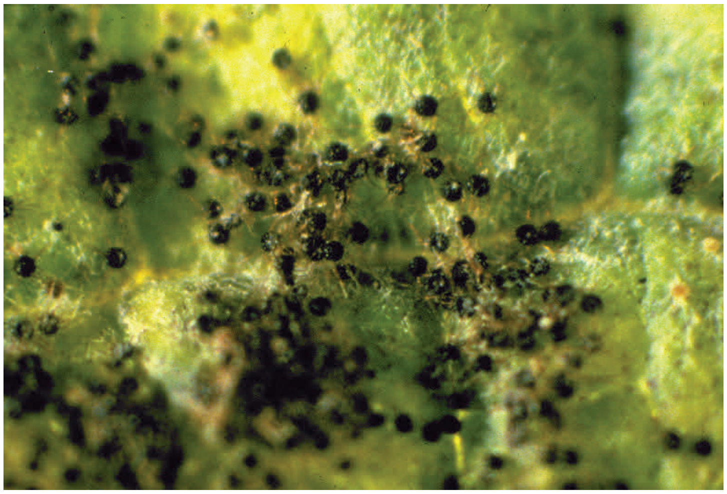

Figure 1. Cleistothecia of grape powdery mildew on the surface of a leaf. Photo by David Gadoury, Cornell University.

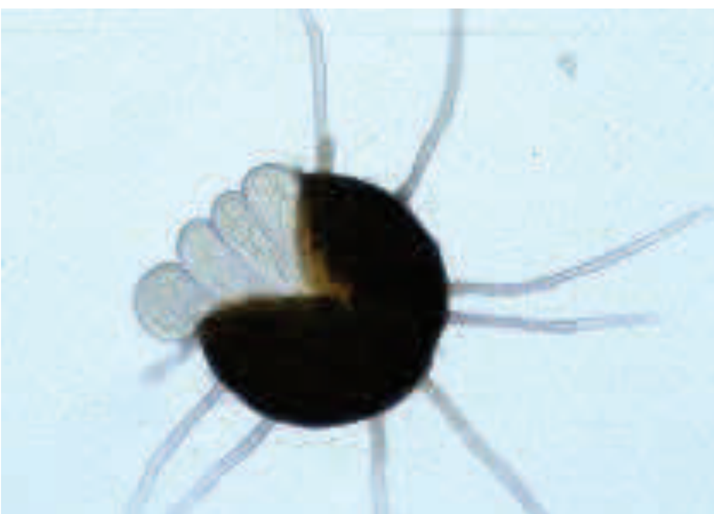

Figure 2. Cleistothecium squashed open to show several asci with ascospores. Photo by Melodie Putnam, OSU Plant Clinic.

They don't glow in the dark!

Typically, the first colonies will occur on the underside of a leaf since the ascospores are coming from the bark below. There may or may not be an effect or symptom of this infection on the other side (top side) of the leaf (Figure 4). These colonies may appear as whitish or grayish patches on leaves when observed with the naked eye. Some pathologists have also described them as tiny red-to-brown areas on the bottom of basal leaves. Colonies are more easily detected in full sunlight with the sun over your shoulder. Searching mid-morning or mid-afternoon will increase your chances of finding the first colonies.

Figure 3. Trunk and cordon with exfoliating bark where cleistothecia of powdery mildew overwinter. Photo by Jay W. Pscheidt, OSU.

The side of the leaf opposite the colony may have no symptoms at all or may be discolored. Typically, a diffuse yellowing (chlorosis) may be seen. Some people are overly focused on any yellow spot on a leaf. Scattered bright yellow spots on leaves in vineyards (due to a variety of other problems) are not unusual for this time of the year. A close look with a hand lens will help distinguish these problems from powdery mildew.

Flower clusters before, during, and after bloom can be infected as well. Be sure to look at a few emerging flower clusters while scouting for this disease. The flower buds, rachis or pedicel of the berry can all be infected and may show symptoms.

Magnification

The confirmation of the earliest stages of powdery mildew requires the use of a hand lens. Most of the powdery mildew fungus remains on the outside of leaves or stems. The threads of the fungus (hyphae) remain close to the surface on the epidermal plant cells until sporulation. New hyphae, called conidiophores, grow up from the surface and bear the asexual dispersal spores of the fungus. These spores are barrel-shaped and form in chains at the tip of these conidiophores.

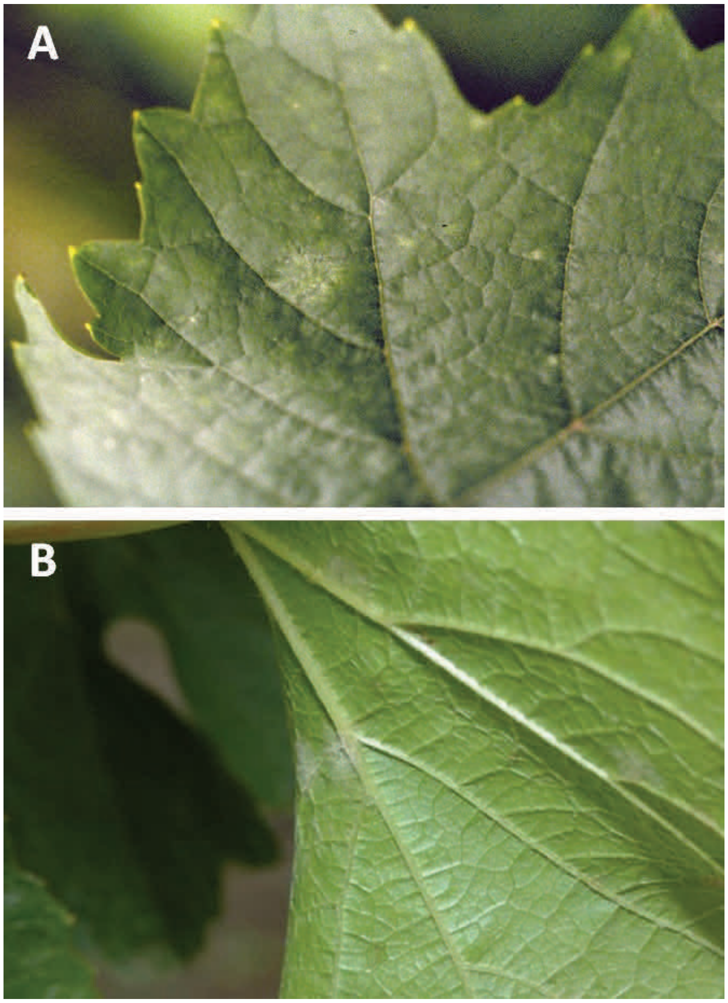

Figure 4. Individual colonies of powdery mildew on the top surface (A) and bottom side (B) of the leaf. Photos by Jay W. Pscheidt, OSU.

A low magnification of the colony will show a slight network of small threads (mycelia) on the surface of the leaf. Even more diagnostic would be the presence of upright threads with chains of spores. Under the right lighting, it might look like a row of tiny droplets of water or a short string of tiny elongate pearls (Figure 5). Beware: young leaves will have natural hairs (trichomes) on the surface. These trichomes are more numerous on younger leaves and could be mistaken for the fungus. Trichomes are much larger, have thick cell walls and taper to a point. The fungal mycelia will not have these characteristics.

Flags are bad

In high disease situations, powdery mildew can also overwinter as hyphae inside the vine's dormant buds. Buds on new shoots can be infected 4 to 6 weeks after shoots start growing but not after bud scales become suberized. These newly infected buds remain quiescent until the next growing season. Shortly after bud break, the fungus becomes active and covers the emergent shoot with a white mass of mycelia (flag shoots). Flag shoots have rarely been observed in western Oregon or eastern Washington/ Oregon.

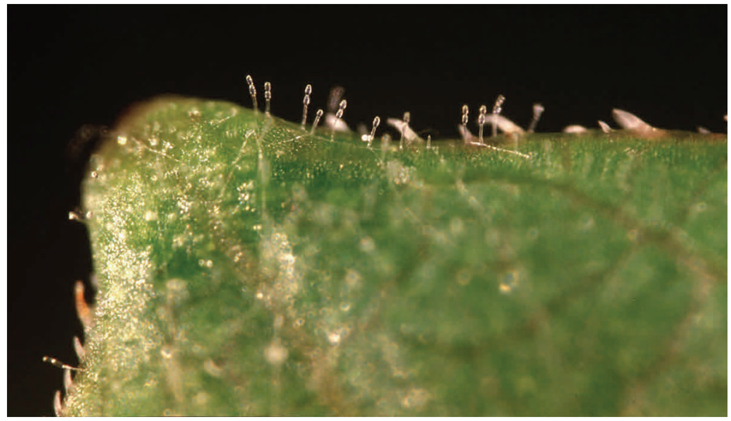

Figure 5. Look for chains of conidia with your hand lens to confirm powdery mildew. Note that the mycelium is very sparse in this colony. Photo by David Gadoury, Cornell University.

These flag shoots are difficult to find. They may be covered with a large white mass of mycelia or only a hint of thin threads on the shoot (Figure 6). Shoots generally are delayed in bud break and appear stunted and somewhat yellowed compared to healthy shoots.

Flag shoots may be found well before you plan to start your fungicide program. This is a serious situation requiring quick action. Remove the shoot and either bury it on-site or place it in a sealable plastic bag so you do not spread spores to other areas of the vineyard. Removal of the flag shoot is good, but spores may already have been distributed and infections may have started that are not yet visible. For this reason, it is important to get your fungicide program started immediately, concentrating on the area where flag shoots were found. Keep watch for continued disease development in this area.

Stains on canes

When green shoots and canes are infected, the affected tissues appear dark brown to black in feathery patches (Figure 7). Patches later appear reddish-brown to black on the surface of dormant canes. You can scout for powdery mildew while dormant pruning by looking for these symptoms (Figure 8). It will indicate where in the vineyard you

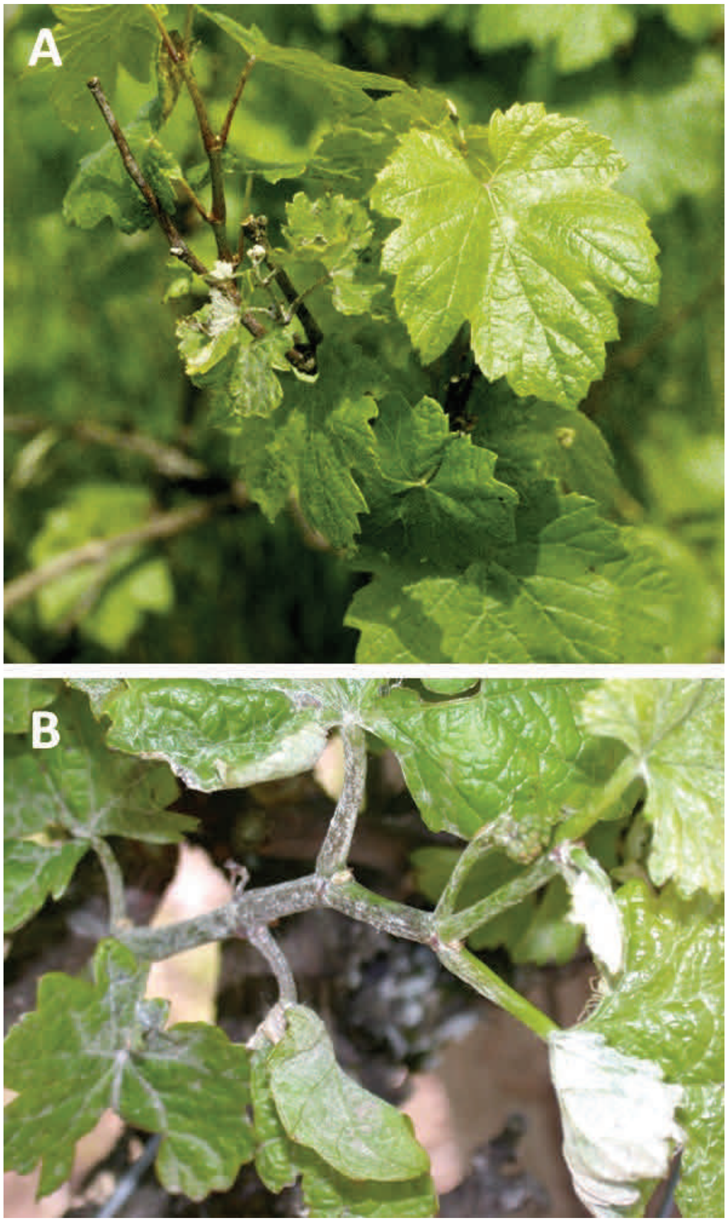

Figure 6. Flag shoots of powdery mildew soon after bud break in the spring. Photos by Jay W. Pscheidt, OSU (A) and Walt Mahaffee, USDA-ARS (B).

need to concentrate scouting and control efforts in the coming year.

There seems to be as many descriptions of the initial infections or colonies as there are writers. Keep in mind that you are looking for something different or unusual while scouting. Keying in on every spot or leaf blemish can be time consuming and frustrating. It takes some experience and training to find these early colonies efficiently. Persistence will be rewarded when you do find the disease and can take swift action.

Training opportunities

OSU offers a training workshop every year where you can see what powdery mildew looks like. The training this year will be offered in Mosier, Oregon on June 11, 2013. If you miss this training opportunity, you may be able to get a first-hand look at disease infestation by contacting Dr. Jay Pscheidt (541) 737-3472/5539 and visiting the Botany and Plant Pathology Field Laboratory located just outside of

Figure 7. Colonies on stems look like dark feathery spots or stains. Photo by David Gadoury, Cornell University.

Figure 8. Shoots heavily infected by powdery mildew during the growing season can still be seen in the dormant season as dark canes. The set of vines in the middle of this row were not sprayed for powdery mildew the year before. Photo by Jay W. Pscheidt, OSU.

Corvallis, Oregon. This field laboratory or “disease garden” has several small vineyard blocks with unsprayed vines where powdery mildew develops every year. You are welcome to call ahead, visit, and try your hand at scouting for this disease (or snipe if you wish). The payoff is an improved powdery mildew management program.

Grapevine Red Blotch Associated Virus Detected in Oregon Vineyards—Now what?

Dr. Bob Martin, Research Virologist, USDA-ARS

Some of the latest buzz in the grape world is the newly identified Grapevine Red Blotch Disease (GRBD). This disease is caused by a virus that was first reported as a new virus in 2012. The pathway to identifying this mysterious disease began back in 2008 when red leaf symptoms were observed and virus testing came back negative for Grapevine Leafroll associated Virus (GLRaV). Researchers from Cornell and the USDA-ARS in California began to investigate this disease in 2009, and they had identified a unique virus by 2012. As a result of their research, they were able to develop PCR primers to assay for the virus, and these methods were quickly adopted by analytical service labs in late 2012. This article provides some basic information on the disease and the current status in Oregon.

History as of 2012

In recent years, this new graft-transmissible disease has been recognized as an emerging problem in winegrape production in California (Sudarshana and Wolpert 2012). In red winegrape cultivars, these symptoms appear as small, irregular red-colored areas between major veins on mature leaves at the basal portion of the canopy of affected vines. The discolored areas on the leaves expand and coalesce with time to become reddish or reddish-purple blotches that are strikingly apparent towards the end of the season (Figure 1. A and B). The symptoms of GRBD can be confused with Grapevine Leafroll Disease (Figure 1. C and D) and may now explain cases where we observed red leaf symptoms in Oregon vineyards that were negative for leafroll viruses. Research conducted at UC-Davis, CA, and Cornell University-Geneva, NY, has implicated a distinct geminivirus, designated as Grapevine Red Blotch-associated Virus (GRBaV), in the production of GRBD symptoms. GRBaV is a distinct member of the family *Begomoviridae.*

What is happening with GRBaV in Oregon and the Pacific Northwest?

Our preliminary survey in Oregon and Washington vineyards has indicated the presence of GRBD in many winegrape cultivars. Testing a limited number of samples collected from symptomatic grapevines of cvs. Merlot, Cabernet franc, Pinot noir, Cabernet sauvignon, Malbec, Viognier, Chardonnay, Roussanne, Semillon and others from a few commercial vineyards in eastern WA, southern OR, the Columbia Gorge, and the Willamette Valley, using a PCR-based diagnostic assay indicated the presence of GRBaV. In order to assess impacts of GRBD, Dr. Rayapati, WSU virologist, compared fruit yield from symptomatic and adjacent non-symptomatic vines of Merlot and Cabernet franc in a commercial vineyard near Prosser, WA. The results obtained in the 2012 season indicated 22% and 37% lower yields in GRBD-affected Merlot and

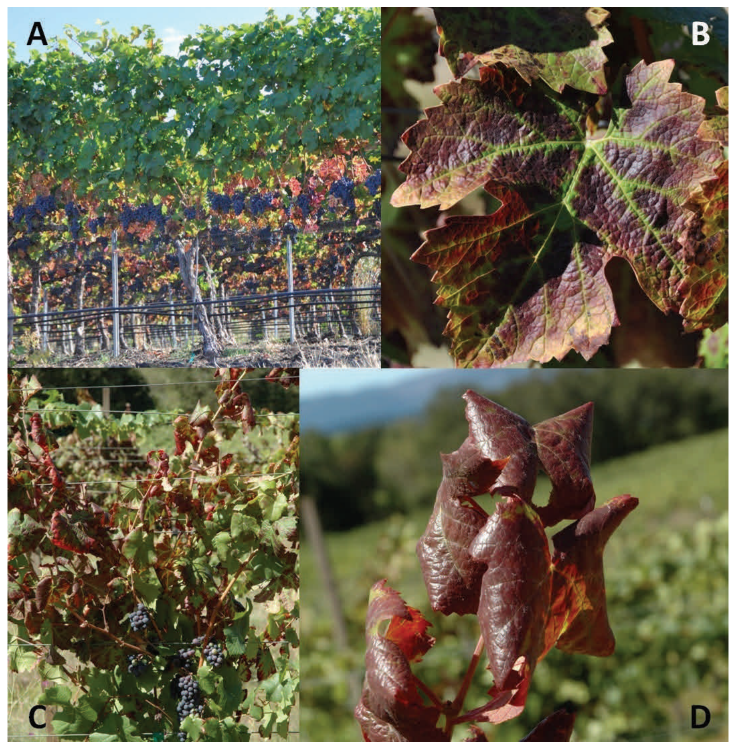

Figure 1. Symptoms of vines infected with Grapevine Red Blotch Disease. **A.** Merlot showing reddening of lower leaves. **B.** Single leaf showing leaf blotch symptoms that look similar to leafroll symptoms but lack the downward rolling often seen with GLRaV. **C.** Symptoms in Pinot noir; notice most of the reddening on the upper part of the canopy, and **D.** Pinot noir showing severe leaf rolling, negative for GLRaV but positive for Grapevine Red Blotch Disease. **The take-home message:** Do not rely on symptoms for virus identification. Analysis of tissues by an analytical lab is required to verify infection.

Cabernet franc grapevines, respectively, compared with corresponding non-symptomatic grapevines. An analysis of fruit quality attributes indicated that berries from GRBD-affected grapevines of both cultivars had reduced Brix and skin anthocyanins, but higher titratable acidity compared to berries from non-symptomatic vines. In contrast, no significant difference was observed in pH of juice extracted from berries of symptomatic and non-symptomatic grapevines of both cultivars. These results clearly indicated negative impacts of GRBD on fruit yield and key berry quality attributes.

We have been able to detect GRBaV across Oregon. Archived samples that had been collected from 2009 to 2012 and were previously found to be systematic but not infected by leafroll virus were analyzed this winter. The disease has been found in the Willamette Valley, Columbia Gorge and southern Oregon. We have not yet tested any samples from eastern Oregon. So far, GRBaV has been detected in both red cultivars (Pinot noir, Cabernet sauvignon, Cabernet franc, Merlot, Malbec, and Barbera) and white cultivars (Chardonnay, Roussanne, Semillon, and Viognier). The white cultivars did not exhibit the symptom of reddening of leaves but were sampled because they were adjacent to blocks of red cultivars that showed the characteristic symptoms.

Plans for GRBaV in 2013 in Oregon and the Pacific Northwest

Research is needed to further understand this disease and its impact on the grapevine and vineyard sustainability. The objectives of this work will be to develop methods to be used by analytical service labs, provide information to nurseries, and develop management strategies for growers. Plans for research on GRBaV in Oregon and the Pacific Northwest include the following objectives:

1) Examine virus diversity to ensure that all isolates are being detected in analyses.
2) Develop a serological assay (ELISA) that can be readily scaled up to handle large (1000s) numbers of samples.
3) Identify vector(s) of GRBaV across the state's grape growing regions.
4) Determine if the virus is surviving in native vegetation within or adjacent to vineyards.
5) Determine the impact of the virus on red and white grape cultivars grown in the Pacific Northwest.

This work will be carried out on a regional basis across OR, WA and ID with the goal of developing management plans for GRBaV. The research team includes plant virologists, entomologists, and food technologists/enologists, and they are currently seeking funding from the Department of Agriculture Specialty Crop Block Grant Programs between WA, OR, and ID. Additional funding is being sought from the National Institute of Food and Agriculture-Pest Management Alternatives Program. For more information on the virus and its status in Oregon, contact Dr. Bob Martin, bob.martin@ars.usda.gov or 541-738-4041.

Resources

Sudarshana, M.R. and J.A. Wolpert. 2012. Grapevine Red Blotch Disease. USDA-ARS Bulletin: http://iv.ucdavis.edu/files/157508.pdf

For further information on Grapevine Red Blotch Disease, please see the resources listed below.

- Fact sheets and useful information on the disease are available online at the UC Integrated Viticulture website: http://iv.ucdavis.edu/Viticultural_Information/?uid=284&ds=351.
- Webinar "Grapevine Red Blotch Disease: An Emerging Issue" hosted by the National Clean Plant Network. http://grapesandwine.cals.cornell.edu/cals/grapesandwine/outreach/viticulture/ncpn-red-blotch.cfm.

If You've got Questions, AgTools may have the Answers!

Clark Seavert, Professor of Agricultural & Resource Economics, OSU

How many times have you questioned if you could change a management practice or purchase a new piece of equipment? You may have questioned whether you can make a profit from making a change and whether you can justify spending the money. Whether you are growing grapes or making wine, these might be questions you ask yourself over and over. Fortunately, there may be a way to answer your financial questions with AgTools™. The AgTools™ suite of software programs was developed through the leadership of agricultural economist at Oregon State University to help agricultural producers conduct capital investment analysis. In addition to software, the program provides supporting documents and educational programs for producers, including those in the winegrape business.

The first software program, AgProfit™, helps producers answer the following question: "Am I able to make money doing this?" This program calculates the net present value and internal rates of return on an investment for up to 20 years. AgLease™ assists growers and landowners with calculating an equitable crop-share or cash rent lease arrangement for up to 40 years based on their contributions to the lease. AgFinance™ is a whole farm budgeting program that uses files from AgProfit™ and AgLease™ to provide the user with 10 years of pro forma balance sheets, financial ratios, and performance measures.

All of these programs are available online free of charge at https://www.agtools.org. While the programs are free to users in the U.S., there is a learning curve in using the software. The most successful users utilize a Windows® platform and are willing to invest the time to learn how to use the program by reading the manual, viewing the help screens, and watching the instructional videos provided.

If you want to take advantage of the the software but do not have the time or computer skills to do so, you may be paired with an Oregon State University student who has successfully completed the Student-Engaged Business Assessment Program (SEBA). Under this arrangement, the student will work with you to create scenarios that outline different financial impacts of decisions you might be considering. If you have questions about the programs, software, or how to get involved with SEBA, contact Clark Seavert at 541-737-1422 or email clark.seavert@oregonstate.edu.

*This program was developed by a team of agricultural economists at Oregon State University. Funding was provided by the Washington Tree Fruit Research Commission program, OSU Extension, USDA Risk Management Education, and the USDA Specialty Crop Research Initiative.

Industry Partnerships in Sensory Evaluation—The OWRI Sensory Panel

Dr. Elizabeth Tomasino, Enology Assistant Professor, OSU

A sensory panel is a group of people who have excellent sensory evaluation skills and describe products based on smell, taste, and feel. The descriptive words used by panelists to evaluate their sensory experience are developed through participation of previous sensory experiences and training.

In wine, many specific parameters may be evaluated, including aroma and flavor, taste, mouth feel attributes, and color. The OWRI Sensory Panel was launched in 2012 as a group of wine industry professionals who meet regularly to evaluate a range of wines from different OWRI research projects. The OWRI Panel meets for a half day to evaluate several flights of wine. The day begins with a short training session and moves into formal evaluation, depending on what wine aspects are being evaluated. Different types of sensory evaluations being conducted by the group include descriptive analysis, difference testing, sorting, and preference testing.

Many enology research programs have wine sensory analysis panels that evaluate wine faults. However, the OWRI Sensory Panel will investigate all aspects of wine. The work of this group will be focused on the main question of interest rather than one specific parameter. Through this panel design, participants receive comprehensive training to allow for analysis of a wide range of sensory components. The added benefit to participants is that they become well-trained tasters and can bring that expertise back to their wineries.

Each year, we will send a recruitment call seeking new members, and training will be provided. Currently, the panel meets at Chemeketa Community College's Northwest Viticulture Center in the Eola Hills. During 2013, we will begin evaluating wines from viticulture projects led by Dr. Patty Skinkis, Viticulture Extension Specialist, OSU, and wines from other research trials. If you are interested in participating, please contact Dr. Elizabeth Tomasino, (Email: Elizabeth.Tomasino@oregonstate.edu, phone: 541-737-4866) for more information.

*Funding for the OWRI Sensory Panel is provided by the Erath Family Foundation.

Statewide Crop Load Project Begins to Define Yield—Quality Relationship

Dr. Patty Skinkis, Viticulture Extension Specialist, OSU

A significant body of research exists for crop management and vine balance. The studies have been conducted on warm and cool climate cultivars in grape growing regions across the world using multiple techniques by which to alter both yield and balance. Due to the complexities of different management methods, cultivars, and regions, the outcomes of those studies have been variable with respect to the impacts of crop level on fruit and wine quality. Despite the fact that published literature does not support the notion that low yields inherently equates to quality, the yield-quality relationship is still pervasive in premium winegrape production. Research generally has not been conducted at the production level to validate or refute research findings, and this provides little evidence to help producers make informed decisions. During 2012, the Statewide Crop Load Project was established using participatory research to investigate yield and vine balance for Oregon Pinot noir on a production scale. The project will be conducted for the next nine years to help define crop load metrics for Pinot noir across different climates, vineyards, and seasons in Oregon.

The main objective of this project is to develop a collaborative model for vineyard-to-winery yield management research to investigate the relationship between yield, vine balance, and fruit and wine quality. Through this model, we will generate a robust data set to address the complex nature of vine balance. From the data, we hope to develop basic vine balance metrics for Oregon Pinot noir. The great benefit of this work is that it is being conducted in-house by collaborators, allowing them to determine personalized outcomes based on their experiences of vineyard economics, vine health, and wine sensory.

The first year of the trial began in 2012. We enlisted ten companies, and the project was conducted across 12 vineyards, spanning five AVAs within the north Willamette Valley. Each collaborator implemented at least two different crop thinning levels in their vineyards during lag phase following experimental design protocols. Collaborators also collected some key vineyard data within each treatment during the study. Protocols were provided for the data collection, and all data were submitted to our research team for analysis. At harvest, fruit samples were collected, processed by the Skinkis Lab and analyzed by ETS Labs (basic juice panel and the rapid phenolic panel). All collaborators produced wine from the 2012 vintage, and care was taken to deliver fruit to the winemaking team without crop level indicators so that wines could be made without bias. Wines will be analyzed both in-house and by the OWRI Sensory Panel. Both Dr. James Osborne and Dr. Elizabeth Tomasino, enologists at the OWRI, are assisting the research team with these protocols.

Results – Year 1

During the first year of the trial, we quantified vine yields, pruning weights, crop load (Ravaz Index), and fruit composition at harvest. Analysis of these data shows that there was little impact of crop level on fruit composition within trial vineyards and across the region. The majority of vineyard sites (75%) had no difference in fruit composition when comparing the different crop levels used within the site. This was likely due to the already low crop level in 2012, making further crop thinning ineffective in enhancing fruit ripening. Most collaborators chose conservative crop thinning treatments, comparing full crop (no crop thinning) to a crop thinning level of one cluster per shoot. The mean for full crop yields was 0.8 lb/ft, and this is considered within optimum range for some producers. Crop load was found to be low (compared to published "optimum" levels of 5-10) across all vineyards with an average of 3.5 for full crop vines. When fruit composition data were analyzed across all sites, Ravaz (yield/pruning weight) had more influence on fruit composition than yield alone. This suggests that vine size and yield are more important indicators of quality than yield alone. More information will be gained from this study when sensory analysis begins.

Participation

The more participation we have from industry collaborators, the greater the information we can gather to understand vine balance impacts on fruit quality. We hope to have more collaborators join the project from across the state in the coming years. There are certain criteria that must be met by all research collaborators:

- Willingness to take an active role in research.
- A healthy, uniform vineyard of Pinot noir must be used for the trial.
- Ability to use the same vineyard in the trial for at least 3 years.
- Ability to implement and maintain crop level treatments.
- Ability to collect data as outlined in research protocols.
- Wine production is not required to be involved in the study, but it is encouraged.

If you are interested in becoming a collaborator in this project, contact Patty Skinkis at skinkisp@hort.oregonstate.edu or 541-737-1411.

OWRI Director's Corner

Dr. Bill Boggess, Interim Director, OWRI

Although we are early into the year, 2013 has been a busy time for OWRI scientists. Efforts have focused on our core mission of conducting and disseminating research aimed at enhancing the quality, market visibility, economic profitability, and sustainability of Oregon's winegrape industry. Institute scientists spent a considerable amount of their time in January analyzing data and writing research reports to summarize last year's experiments. They also were busy planning and preparing research projects and writing grant proposals for funding future research. A total of 19 proposals were submitted by Institute scientists to the Oregon Wine Board (OWB) for consideration of 2013 funding. We greatly appreciate the over $217,000 of OWB competitive research funds provided in 2012 as well as the 11 vineyard and winery businesses that collaborated on research projects this past year. Industry support, both financial and in-kind through collaborative research, is essential to our success. In February, 17 scientists, staff, and students traveled to Portland to participate in the Oregon Wine Symposium hosted by the Oregon Wine Board. The Symposium provides a great opportunity for our scientists to inform the industry about important viticultural and enological research and emerging issues. Perhaps even more importantly, the Symposium provides the opportunity for one-on-one conversations between scientists, students, and industry professionals. Most recently, the Institute hosted the OWRI Grape Day on the Oregon State University campus. This was our 12th Grape Day and our largest with 155 participants, 5 research presentations, and 26 poster presentations. The Grape Day program was headlined by Oregon winegrower, Dr. W. Mark Kliewer, Professor Emeritus, UC-Davis, a well-known researcher in the area of canopy management and vine physiology. We strive to continue to provide top-quality research and outreach to the winegrape industry in Oregon. Thank you for your continued interest in and support of the Institute's work.

Publications

Practical Guides and Resources

Various publications are produced by members of the Oregon Wine Research Institute and its partners to meet the needs of the commercial vineyard and winery industry. These publications are developed and delivered through Extension and many are open-access and available online.

2013 Pest Management Guide for Wine Grapes in Oregon

This publication is revised annually by OWRI faculty to include the newest information on pest control for diseases, insects, weeds, and vertebrate pests. Authors: Skinkis, P., J. Pscheidt, A. Dreves, V. Walton, E. Peachey, J. Sanchez, I. Zasada, and R. Martin. This OSU Extension Service Publication (EM841) is available online. https://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/37149/em8413.pdf.

Considerations and Resources for Vineyard Establishment in the Inland Pacific Northwest

This publication was developed and released in 2012 to provide information on vineyard development for those new to the region. Authors: Moyer, M., C. Kaiser, J. Davenport, and P. Skinkis. This Pacific Northwest Extension Publication (PNW634) is available online. http://wine.wsu.edu/research-extension/files/2012/07/WA-Resources-for-Establishment-PNW634.pdf

Estimating Plant-Available Nitrogen Release from Cover Crops. This guide provides methods by which to determine the fertilizer capacity of cover crops for Oregon. Authors: Sullivan, D.M. and N.D. Andrews. This publication (PNW636) is available online through the Oregon State University Extension Service. http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/34720/pnw636.pdf

Grapevine Nutrition Resource

This is an online, interactive information module and diagnostic tool developed by P. Skinkis and R.P. Schreiner. This publication (EM9024) is available online through the Oregon State University Extension Service: http://extension.oregonstate.edu/catalog/html/em/em9024/.

Pest Management Handbooks – 2013
These handbooks are developed for use by commercial producers across Oregon, Washington, and Idaho. They provide a wealth of information on insect pests, diseases, and weeds of many crops, including vineyards. All are available online through the Oregon State University Extension Service.

Pacific Northwest Plant Disease Management Handbook
Edited by J. Pscheidt and C. Ocamb, Oregon State University
http://pnwhandbooks.org/plantdisease.

Pacific Northwest Weed Management Handbook
Edited by E. Peachey, Oregon State University.
http://pnwhandbooks.org/weed/.

Pacific Northwest Insect Management Handbook
Edited by J.C. Hollingsworth
http://pnwhandbooks.org/insect

eViticulture (http://eviticulture.org) is an online resource containing vineyard production articles produced by viticulture specialists in Extension throughout the US. Articles range from topics that are important for beginning grape growers to advanced topics for current professionals in the industry. Members of the OWRI team have authored many articles and other media within the eViticulture website.

OSU- Spotted Wing Drosophila Website
(http://horticulture.oregonstate.edu/group/spotted-wing-drosophila)
This website contains research and Extension resources on how to monitor and manage SWD in Oregon fruit crops. While this pest has limited impact on winegrapes in the Pacific Northwest, grape-specific information is available on the website.

OSU - Brown Marmorated Stink Bug Website
(http://horticulture.oregonstate.edu/group/brown-marmorated-stink-bug-oregon)
This website contains survey information, monitoring guides, and methods by which to report sitings of the pest. The Brown Marmorated Stink Bug (BMSB) is a new invasive pest that has potential impacts for Oregon vineyards and wine quality. Click here for a list of current publications.

Research Publications
Results of research projects conducted in the areas of viticulture and enology are published in peer-refereed academic journals, peer-reviewed reports, or books. This peer-reviewed/refereed process validates the scientific work of the authors. These articles describe research conducted by Oregon State University faculty and other members of the Oregon Wine Research Institute at Oregon State University. The list below provides citations for publications released 2013.

Viticulture

Reynolds, A.G. and G. Balint. 2013. Impact of exogenous abscisic acid on vine physiology and grape composition of Cabernet Sauvignon *Am. J. Enol. Vitic*. 64:74-87. http://www.ajevonline.org/content/early/2012/10/04/ajev.2012.12075.abstract

Schreiner, R.P., J. Lee, and P.A. Skinkis. 2013. N, P, and K supply to Pinot noir grapevines. I. Impact on vine nutrient status, growth, physiology, and yield. *Am. J. Enol. Vitic*. 64: 26-38. http://www.ajevonline.org/content/64/1/26/suppl/DC1

Insect, Disease, and Pest Management

Alabi, O.J., S. Poojari, K. Sarver, R.R. Martin, and N.A. Rayapati. 2013. Complete genome sequence analysis of an American isolate of Grapevine virus E. *Virus Genes*. (published ahead of print) http://www.ncbi.nlm.nih.gov/pubmed/23296875

Flavor Chemistry

Qian, M., J. He, Q. Zhou, J. Peck, and R. Soles. 2013. The effect of wine closures on volatile sulfur and other compounds during post-bottle ageing. *Flavour & Fragr. J*. 28: 118-128.

Upcoming Events

Oregon Wine Research Institute Seminar Series—Spring 2013
The OWRI hosts a variety of seminars during the spring 2013 term. These seminars are held on the OSU Campus in Corvallis and broadcast online. All seminars arearchived for later viewing. To find out more, contact Danielle Gabriel, OWRI Program Coordinator, at danielle.gabriel@oregonstate.edu, or visit http://owri.oregonstate.edu.

OMSI—Science Pub Eugene—May 9, 2013
Dr. Elizabeth Tomasino, OSU, will be presenting, "Crafting a Sense of Place – Understanding Wine Terroir." She will describe the factors that are important to wine terroir, including specific examples from Oregon and how these compare to other famous wine regions. She will also provide insight from a consumer's view of terroir and how it relates to quality. For more information, visit: http://www.omsi.edu/sciencepubeugene/050913

Vineyard Scouting Workshop—June 11, 2013
Join us at Garnier Vineyards in Mosier, for a hands-on workshop focusing on various components of disease, insect, and pest scouting and vine nutrition monitoring. Workshop modules include new and regionally important information based on research findings from OWRI, USDA-ARS and WSU research and Extension faculty. You will receive practical information and hone your vineyard scouting skills while increasing your knowledge of plant health and protection from economically important and pests. More information can be found at http://owri.oregonstate.edu.

Save the Date!

Integrated Pest Management and Wine Sensory Effects—June 2013
Learn up-to-date information on integrated pest management (IPM) for grapes and how these pests impact the product through sensory analysis. Main IPM topics will include Brown Marmorated Stink Bug (BMSB) and other relevant pests. A range of pest-related taints will be evaluated in wine including the consumer rejection threshold determination for BMSB. More information will be posted on the OWRI website in May.

June 18—OSU Southern Oregon Research and Extension Center, Central Point
June 21—OSU Food Innovation Center, Portland

Development of Tannins in the Vineyard and Winery—July 2013
Dr. James Osborne, OSU, will be presenting a comprehensive workshop on the development of tannins and mouthfeel from vine to wine. For more information visit the OWRI website at http://owri.oregonstate.edu.

2014 OWRI Grape Day—April 1, 2014
It's no joke! The OWRI Grape Day is back and here to stay. Join us on the Oregon State University campus on April 1, 2014 for a full day of presentations, posters and discussion about new research findings in viticulture and enology. Mark your calendar now! Also, be sure to check out the abstracts from the 2013 Grape Day by visiting: http://owri.oregonstate.edu/owri-seminars.

Congratulations!

Dr. Bob Martin, Research Virologist, USDA-ARS, was elected Fellow of the American Phytopathological Society. He will be presented with the award in August at their annual meeting in Austin, TX. For more information on Dr. Martin's research, please visit his USDA-ARS webpage: http://www.ars.usda.gov/pandp/people/people.htm?personid=3602