Welcome to the Fall 2013 Newsletter

This edition includes articles from various OWRI team members ranging from viticulture to enology and sensory. The OWRI’s Extension Specialists contributed articles focused on timely topics related to the 2013 vintage. Dr. James Osborne, OSU Enology Extension Specialist, provides an article on methods by which to reduce the impacts of off odors caused by sulfur compounds post-fermentation. On the viticulture side, Dr. Patty Skinkis, OSU Viticulture Extension Specialist, summarizes research comparing manual and mechanized leaf removal and impacts for vineyard management in Oregon. Dr. Paul Schreiner and Dr. Inga Zasada, USDA-ARS researchers, provide a comprehensive summary of current and past research conducted on ring nematode in western Oregon vineyards. Dr. Laurent Deluc, OSU Assistant Professor, provides a general summary of genomic research into berry ripening synchronization and future applications for the winegrape industry. Dr. Elizabeth Tomasino, OSU Assistant Professor, presents a brief summary of her latest research in sensory analysis with an update on the OWRI Sensory Panel. This edition also includes a news brief on David Adelsheim, who was inducted into the College of Agricultural Sciences 2013 Hall of Fame, and concludes with recent happenings from the OWRI interim director, Dr. Bill Boggess. As always, be sure to explore the list of various publications and resources available for you to read and expand your knowledge in viticulture and enology. Finally, consult the end of the newsletter for upcoming events, including the 2014 Grape Day where we will feature research of the OWRI faculty!

Cheers,
The OWRI Team

If you are interested in reading this newsletter online, visit the OWRI blog at http://blogs.oregonstate.edu/owri and bookmark for future editions.

Development of sulfur off-odors post-fermentation
Dr. James Osborne, Associate Professor & Extension Enologist, OSU

One ongoing concern during winemaking is the formation of volatile sulfur compounds (VSCs) that may negatively impact wine aroma. These compounds are either produced during primary fermentation or during wine aging. The most common of the VSCs produced during wine production is hydrogen sulfide (H2S) which imparts a distinctive “rotten egg” character to the wine and is a product of yeast sulfur metabolism (Rauhut 1993). Hydrogen sulfide may be produced by Saccharomyces cerevisiae during fermentation by a number of mechanisms including degradation of sulfur containing amino acids as nitrogen sources,
reduction of elemental sulfur used as an antifungal treatment on grapes, and/or reduction of sulfate or sulfite present in the juice (Guidici and Kunkee 1994, Moreira et al. 2002). Due to the potential negative impact of H$_2$S on wine quality and the fact that H$_2$S formation occurs relatively frequently, a number of research studies have focused on understanding the formation of H$_2$S and ways to prevent its formation. Many of the major factors influencing H$_2$S formation are better understood thanks to these studies. Grape nutrient deficiencies and yeast strain are two of the dominant influences (Rauhut 1993, Spiropoulos et al. 2000).

While H$_2$S formation occurs mainly during primary fermentation, additional VSCs can be formed at later stages during winemaking. The formation of these compounds can be difficult to predict, and their formation is not necessarily related to H$_2$S issues during the primary fermentation. This may mean that even though sulfur odors were not noticed during primary fermentation, there may still be problems with sulfur compounds during barrel aging. The VSCs involved include mercaptans and disulfides that have distinctive aromas such as skunky, rubbery, garlic, onion, or cabbage-like. Often the problems occur soon after wine is placed in barrel. Some of this is triggered by the wine environment becoming increasingly reductive as it ages, particularly at the bottom of the barrel and in the wine lees. In addition, problems with sulfur off-odors may be more prevalent in one year versus another or in grapes from one vineyard block but not the adjacent block, despite identical vineyard management practices. Many factors contributing to this problem are not well understood and make developing strategies to prevent VSC formation difficult.

To understand this further, my laboratory began collaborating with Dr. Michael Qian’s flavor chemistry lab to conduct a research project investigating factors impacting VSC formation during post-fermentation. Our initial goal is to understand the link between grape composition, wine lees composition, and the development of VSC during aging. It is currently known that these sulfur off-odors often arise from degradation of sulfur-containing compounds in the yeast lees or from the re-release of chemically-bound sulfide during aging (Rauhut 1993, Moreira et al. 2002). For this reason, lees management may play a role in minimizing the formation of sulfur off-odors. In particular, wine should be removed from heavy lees as early as possible. Heavy lees are defined as those that precipitate within 24 to 48 hours after the completion of the primary fermentation. Wines should be separated from these lees as they can promote the production of sulfides and mercaptans. It is advised that you smell and taste your wine and lees frequently as sulfur off-odors may occur rapidly, and this will allow you to take quick action. Be sure to obtain a sample of your lees from the bottom of the barrel and monitor for the formation of sulfur off-odors. The lees may sometimes smell bad but the wine is not yet affected. The earlier the detection, the greater ability you have to take appropriate action to minimize further damage.

You may be wondering about the appropriate actions to treat sulfur-off odors in your wine. Well, while large amounts of H$_2$S may be produced during fermentation, much of this H$_2$S is usually volatilized from the wine along with CO$_2$ during active fermentation. However, residual H$_2$S can pose a problem due to its low sensory threshold and its potential reactivity. In particular, the formation of mercaptans and disulfides during cellar aging can be very problematic as these compounds are more difficult to remove. After fermentation, when H$_2$S alone is present, aeration and splashing may dissipate the odor. If H$_2$S aromas persist, then it may be necessary to treat the wine with copper sulfate. Treatment of wines with copper sulfate is a common practice used to remove H$_2$S and mercaptans. Copper ions combine with H$_2$S and mercaptans to form complexes with no offensive smell. After treatment with copper, the wine can then be racked off the lees. Copper sulfate is normally added to the wine, but bench top trials MUST be conducted to determine the appropriate dose. Results from lab-scale trials do not always transfer directly to larger volumes of wine, so you will need to reevaluate the wines after treatment and before conducting further cellar activities. Keep in mind that reactions may take longer to occur in the cellar than in the lab set-up, so allow extra time before determining whether sufficient copper has been added or whether additional additions should be made. Concentrations of between 0.05 and 0.3 mg/L of copper are commonly added. It is important to be careful with the amount of copper added to your wine, as TTB regulations allows...
additions of up to 6.0mg/L copper and residual levels of no more than 0.5mg/L. Copper should not be added to the wine until the fermentation is complete and the amount of yeast material is reduced by racking. Yeast cells can bind with copper and reduce effectiveness. Also, addition of copper during fermentation may promote H₂S production by yeast.

The formation of disulfides during wine aging can be more problematic, mainly because they are more difficult to remove. They will not be removed by copper. If you aerate wine to remove sulfide aromas, you may oxidize mercaptans present to disulfides. Initially, you will notice a loss of the offensive mercaptan aromas as disulfides have a much higher sensory threshold than mercaptans and may not be detected even with the disulfides still present. When conditions in the wine become more reductive (during barrel aging or in the bottle) the disulfides can be reduced back to mercaptans resulting in a reappearance of sulfide aromas. Sulfide aromas may also reappear even after a copper treatment initially seemed to remove them; this is due to the presence of disulfides that were not removed by copper being reduced back to mercaptans. Since disulfides are difficult to remove from wine, the best approach is taking early preventative measures to minimize the production of H₂S during fermentation and the formation of mercaptans. These measures include providing sufficient yeast nutrients for a healthy fermentation, using low H₂S producing yeast strains, early removal of wine from heavy lees, and monitoring wine lees for sulfur off-odors during barrel aging. These strategies will help minimize the formation of the more troublesome mercaptans and disulfides.

**Literature Cited**


**Determining impact of hand or machine leaf removal on fruit quality**

*Dr. Patty Skinkis, Associate Professor & Viticulture Extension Specialist, OSU*

Back in July, our vision of the 2013 growing season was one of easy success. We had limited rain and advanced grape development across the state, something that had been rare in recent years. However, September proved challenging due to shifts in weather which led to berry cracking and increased fruit rots across much of western Oregon. Questions poured in from industry professionals seeking information on *Botrytis* bunch rot management and more. Most growers were already using proper preventative measures—appropriately timed fungicide applications combined with judicious cluster-zone leaf removal. As harvest neared and rains began to fall, heightened concern over fungicide use and pre-harvest intervals (PHI) developed, leading to discussions about cultural management techniques such as leaf removal and culling damaged fruit.

Leaf removal has been well-studied in Oregon and worldwide by numerous researchers, including my lab at Oregon State University. Those studies varied from the impacts of leaf removal on vine growth to impacts on fruit ripening, berry composition, wine quality, and disease potential. A trial where we compared manual and mechanical leaf removal was of particular interest to industry this season for several reasons: sunburn/heat damage, disease management, and labor shortages. Many growers in Oregon have shifted to mechanical leaf removal over the past few years because it can reduce costs. We estimate manual leaf removal to cost approximately $270 per acre on average density vineyards (1,245 vines per acre) (Julian et al. 2008). Vierra (2005) reported mechanical leaf removal costs of $25 per acre compared to $130 per acre for manual leaf removal in California’s Central Coast vineyards with vine densities ranging from 908 to 1,089 vines per acre. Drawbacks to mechanical leaf removal, which may be either real or perceived, include damage to
clusters, reduced precision compared to hand-removal, and the potential for leaves to remain lodged in dense canopies. Development of new leaf removal technology and equipment has reduced many of these concerns.

However, applied research is needed to determine how mechanical leaf removal affects key aspects of vineyard production so that growers can make informed management decisions when shifting practices from manual to mechanical methods. This article summarizes salient findings of a trial conducted to compare manual and mechanical leaf removal in Pinot noir during 2011, one of our coolest and wettest years in recent history. Prior to 2011, research was conducted across several commercial vineyards in the Willamette Valley (2008 to 2011) to determine impact of early season leaf removal on powdery mildew (Erisyphe necator) and Botrytis bunch rot (Botrytis cinerea). Results showed that early season leaf removal reduced powdery mildew and Botrytis incidence and severity of clusters when compared to no leaf removal (Skinkis and Mahaffee, unpublished). That research evaluated manual leaf removal only. Since many growers are switching to mechanical leaf removal, concerns have been raised about applicability of mechanical leaf removal early in the season (bloom or fruit set) without resulting in cluster and berry damage. This led us to evaluate whether hand and mechanical leaf removal would cause cluster damage, and influence fruit set, yield, fruit composition, and disease incidence when applied at different time points during the 2011 season.

Mechanical and manual (hand) leaf removal methods were compared in a commercial vineyard in the Dundee Hills AVA. The vineyard was planted to Pinot noir (clone 777) grafted to Riparia Gloire rootstock in 1997 at a vine density of 3,015 vines per acre. Vines were oriented in north-south rows and trained to a vertically shoot positioned canopy. Leaf removal was conducted at three time points: bloom, pea-size, and bunch closure. Leaves were removed from both the east and west side of the cluster zone at each of the three time points by using hand labor or mechanically using an Avidor leaf puller attached to an over-the-row tractor. Treatments were applied to plots of 12 vines in a randomized complete block design with six replicates. Due to the nature of the season and the commercial vineyard’s management policy restricting the use of specific fungicides for Botrytis control, a non-leaf removal treatment was not implemented. However, a third treatment where leaves were removed at bunch closure from only the east side of the cluster zone was implemented for comparison (an industry standard practice), and leaves were removed either manually or mechanically. Leaf removal was performed at the start of each time point with clean-up passes to remove new leaves or laterals produced in the cluster zone during each successive time point in the study. Vine growth parameters were monitored including fruit set, leaf area, yield, yield components (cluster weights, berries per cluster, etc.), and pruning weights. Fruit maturity, berry phenolics, and incidence of Botrytis bunch rot at harvest were also measured.

Results
Results from this one-year trial indicate that there is little difference between hand and mechanical leaf removal in terms of level of disease incidence on fruit, vine productivity, and fruit quality. Beginning leaf removal too early in the season raises concerns about reduced fruit set resulting from potentially lower carbohydrate availability to developing flowers or from mechanical damage to inflorescences. Mechanical leaf removal conducted at bloom reduced fruit set by 11% compared to hand leaf removal at bloom and all other time points using either method. This was not a major concern as fruit set was generally high across all treatments, and yield at harvest did not differ among any treatments. Despite similar yields across the trial, average cluster weight was lower for treatments where mechanical leaf removal was conducted at bloom (125 g) compared to manual leaf removal at bloom or later time points of leaf removal by either method (137 g and 140 g for both hand and mechanical leaf removal at pea-size and bunch close, respectively). When comparing the timing of leaf removal conducted on both sides of the canopy, there was no difference in the percent of clusters with Botrytis or the percent of berries within the cluster with Botrytis infection. This suggests that earlier leaf removal did not help reduce the presence of the disease. When comparing the impact of side (east only versus east and west) and method (hand versus mechanical) of leaf removal at bunch closure, method of leaf removal had greater impact on the incidence of
Botrytis at bunch closure (p=0.0436) than the leaf removal on a particular side of the canopy (p=1.0000). Hand leaf removal resulted in 10% lower incidence than mechanical leaf removal at that time point. However, when looking within infested clusters, there was no difference in the percent of berries within cluster that were damaged when comparing between hand and mechanical leaf removal. On average, both hand and mechanical leaf removal treatments had 13% of berries showing signs of Botrytis infection at harvest.

Applying mechanical leaf removal early in berry development is a concern, as it may cause physical damage to clusters, particularly in early development stages such as bloom. To address this concern, we quantified the number of damaged clusters following each leaf removal pass. The type of damage caused by the mechanical leaf puller varied with the timing of leaf removal. Bloom leaf removal resulted in the removal of tips of some clusters, and leaf removal at pea-size or bunch closure resulted in berry splitting on only the smallest clusters. No clusters were completely removed by the mechanical leaf puller. Damage to clusters appeared to be lower when leaf removal was initiated at later stages of development, but this was not statistically significant (p=0.1607). Physical damage was greater in the mechanical leaf removal treatments with 6.9% of clusters per vine damaged on average than in hand removal treatments which had only 0.5% of clusters damaged (p<0.0001). At most, only two clusters per vine were damaged in the mechanical treatments which we considered to be of little practical concern.

When visually comparing vineyards that are mechanically and manually leaf removed, the two often appear quite different with respect to the openness of the cluster zone, particularly when trying to clear both sides of the canopy. However, when we quantified the amount of leaf area remaining on vines after each time point of leaf removal in our study, there was no difference in hand versus mechanical leaf removal except during the earliest time point (bloom). Hand leaf removal vines had 28% lower leaf area per shoot (p=0.0109) than vines receiving mechanical leaf removal at the bloom time point (Figure 1).

The leaf removal method and timing did not influence berry ripening in 2011. There were no differences in basic maturity indices (TSS, pH, or TA) or in berry anthocyanin, phenolic, or tannin concentrations at harvest. Other leaf removal studies conducted from 2008 to 2012 found similar results with respect to fruit maturity. Results of the 2011 trial highlighted here did not show differences in anthocyanins (color) with earlier leaf removal. Research conducted by Lee and Skinkis et al. 2013 where leaf removal was conducted at different time points on both sides of the canopy showed greater anthocyanins with bloom time leaf removal when compared to removal at bunch closure. Differences may be due to vine canopy differences, season, or clone.

Considerations
Leaf removal is an important practice in vineyard management. However, the best use of this technique depends on production goals and site-specific characteristics of the vineyard. Based on four years of leaf removal research conducted in the Willamette Valley, it is apparent that conducting leaf removal earlier in the season can keep fungal pathogens at bay (Skinkis and Mahaffee, unpublished). The greatest impact on fungal diseases was found in years with high disease pressure (2010 and 2011). In years like 2013 where we started out dry and warm, less aggressive leaf removal was generally
applied to avoid berry sunburn or heat exposure. This may have made conditions for Botrytis worse later in the season with reduced fungicide penetration or airflow into the cluster zone. While hand leaf removal still seems to be the preferred method for clearing the cluster zone by premium winegrape producers, realities of labor shortages have become a major concern to getting these practices done in a timely fashion, if at all. Alternatively, some growers who utilize both mechanical and manual leaf removal reported that labor crews were less willing to harvest fruit from vineyards or blocks where mechanical leaf removal was used, as it was harder for them to see clusters and efficiently work compared to blocks where hand leaf removal resulted in better exposed fruit. The combined results from numerous leaf removal projects conducted over the last four years indicate that there is flexibility in the timing of leaf removal based on achieving desired fruit parameters at harvest. However, initial leaf removal should be conducted no later than bunch closure to avoid late season sunburn issues and to enhance disease management.

This experiment was part of a larger project funded in part by the Oregon Wine Board and the Viticulture Consortium-West.

Literature Cited

in western Oregon vineyards
Dr. Paul Schreiner, Research Plant Physiologist, USDA-ARS
Dr. Inga Zasada, Research Plant Pathologist, USDA-ARS

Figure 1. Ring nematode (Mesocriconema xenoplax) is the most common plant-parasitic nematode found in western Oregon vineyards.

The ring nematode (Mesocriconema xenoplax) is the most common plant-parasitic nematode found in western Oregon vineyards (Figure 1). It is an ecto-parasite, as it feeds from outside of the root by inserting a stylet into an individual root cortical cell. Ring nematode does not disrupt the cell membrane during feeding, but alters the sink strength of the punctured cell and those cells surrounding it, allowing for greater metabolic activity (Hussey et al. 1992). The elaborate modification of the feeding site may explain why grape roots show little damage when fed upon by ring nematode (Schreiner and Pinkerton 2008).

A survey conducted in 1994 to 1995 in over 200 blocks from 70 vineyards in the Willamette Valley and southern Oregon (Douglas, Josephine, and Jackson counties) found ring nematode in 81% of vineyards. More than 40% of vineyards had infestation densities of >0.5 ring nematode per gram of soil, and 14% of vineyards had densities of 2.0 per gram of soil (Pinkerton et al. 1999). The suggested damage threshold for ring nematode is 0.5 per gram of soil (McKerny 1992), as this level leads to significant yield loss in California vineyards. Despite the high populations found in the Oregon survey, there was no clear relationship between ring nematode populations and vine vigor or yields based on grower records. The survey work also...
found ring nematode to be more prevalent on sites that had been planted to orchard crops prior to vineyards (Pinkerton et al. 1999). These findings led to continued research to better understand the impact of ring nematode on vine productivity in Oregon.

An experiment was conducted from 1997 to 2000 to determine vine growth responses to ring nematode. Microplots (similar to a pot-in-pot system) were planted with own-rooted Chardonnay or Pinot noir and inoculated with ring nematode or kept nematode-free (Pinkerton et al. 2004). The pruning weight of both Chardonnay and Pinot noir was reduced by approximately 60% after four years of exposure to ring nematode (Figure 2).

Chardonnay yield was reduced by approximately 30% in year four, but Pinot noir yield was not affected. The reduction in vine growth was associated with ring nematode populations of between 6 to 11 nematodes per gram of soil. In addition to altering above-ground vine growth, ring nematode reduced the fine root density of both Chardonnay and Pinot noir and reduced the extent of fine roots with arbuscules formed by symbiotic, arbuscular mycorrhizal fungi (AMF). Arbuscules are specialized mycorrhiza structures where the plant and fungus exchange nutrients. These results led to the hypothesis that ring nematode competes with AMF for root carbohydrates, thereby reducing the function of mycorrhiza fungi.

This hypothesis was tested and confirmed in a series of experiments conducted in the greenhouse using own-rooted Pinot noir grapevines grown in Jory soil (Schreiner and Pinkerton 2008, Schreiner et al. 2012a). The experiments focused on the impact of ring nematode on overall vine growth, root growth, AMF colonization of roots, and carbohydrate and nutrient status of vines. Results indicated that ring nematode alters vine physiology primarily by reducing carbohydrate reserves in roots and woody tissues needed to support growth, nutrient uptake, and AMF symbionts in future years. However, own-rooted vines had a strong capacity to tolerate feeding by ring nematode, as evidenced by total vine biomass being unaffected after exposure to high ring nematode populations for a single growing season. Some vines used for these experiments had 75% of their leaves removed and others were grown at 15% of full sunlight, as compared to the control with no leaf removal grown at full sun. Only the added stress of growing vines at 15% of full sunlight for three years, which further reduced vine carbohydrate status, resulted in eventual vine death (Schreiner et al. 2012a). The population of ring nematode in these experiments was between 22 to 30 ring nematode per gram of soil. This was 2 to 3 times higher than the populations in the field microplot experiment and about 10 times greater than actual vineyard populations.

Work was also conducted to understand how different rootstocks vary in their susceptibility to ring nematode. Numerous rootstocks were evaluated for resistance to ring nematode in two greenhouse experiments and in a vineyard rootstock experiment at OSU’s Woodhall Research Vineyard. Results indicated that the rootstocks 420A and 101-14 were highly resistant to ring nematode, 110R was moderately resistant, and the highly susceptible list included own rooted Vitis vinifera (numerous cultivars), 3309C, and 1103P rootstocks (Pinkerton et al. 2005). Five rootstocks and own-rooted vines were further evaluated.
in a second field experiment using a microplot pot-in-pot system to test the durability of resistance to ring nematode and further explore the physiological effects of ring nematode on vines (Schreiner et al. 2012b). The key finding was that the two rootstocks previously classified as resistant, 101-14 and 110R, did not fare well; ring nematode populations skyrocketed on these rootstocks after three to four years of exposure (Figure 3).

Only the rootstock 420A remained resistant to ring nematode over the four-year trial. Nematode populations reached levels of 30 to 40 ring nematode per gram of soil in own-rooted vines and each of the four rootstocks (101-14, 110R, 1103P, 3309C). Ring nematode had differential effects on above-ground vine growth, root growth, and colonization by AMF among the different rootstocks that generally matched their a priori classification of resistant or susceptible to ring nematode. For example, fine root growth and AMF colonization were reduced as early as the second growing season in the ‘susceptible’ group (own-rooted, 3309C, 1103P). Root growth and AMF colonization was not altered by ring nematode in any of the three ‘resistant’ rootstocks (420A, 101-14, 110R), even after four years. However, vesicle formation in roots (indicative of carbon storage by AMF) was reduced in all four rootstocks and own-rooted vines that promoted high ring nematode populations. Vesicles were unaffected in the rootstock 420A. Ring nematode also reduced vine shoot growth and pruning weights by year three or four only in the ‘susceptible’ group. Ring nematode did not alter vine water status (leaf water potential or stomatal conductance) in any year nor did it influence rates of leaf photosynthesis in any rootstock. These findings led us to wonder if resistance to ring nematode may be overcome in commercial plantings of 101-14 grapevines in the region. Focus was placed on 101-14 because it is widely planted in Oregon vineyards. A survey of the oldest 101-14 plantings in the Willamette Valley was conducted in Fall 2012 to examine ring nematode populations. Populations were also assessed in older 3309C vineyards since 3309C is more susceptible to ring nematode. Fifteen vineyards with either 101-14 or 3309C rootstocks were sampled, including six vineyards that had both rootstocks planted in the same year. The oldest site was planted 18 years ago, and the average age of vines sampled was 14 years. Ring nematode was found in six of the nine vineyards planted to 101-14 and in three of six vineyards planted to 3309C. However, populations of ring nematode were low averaging 0.12 and 0.23 ring nematode per gram of soil in 101-14 and 3309C vineyards, respectively. Ring nematode populations did not differ significantly between 101-14 and 3309C rootstocks in the six vineyards with matching plantings of both. Results from this rather small survey also revealed that prior land cropping history was a key driver of ring nematode presence. Ring nematode was only found if the site was previously planted to orchard crops or grapevines (Figure 4), similar to findings from the prior survey (Pinkerton et al. 1999).

Figure 3. Influence of different rootstocks on ring nematode (Mesocriconema xenoplax) populations over 4 years in field microplots (25 gallon pot-in-pot microplots). All vines were Pinot noir (Wadenswil clone) grafted to 5 rootstocks or own-rooted and grown in Jory soil. (Schreiner et al. 2012b).

Figure 4. Impact of previous land use on ring nematode (Mesocriconema xenoplax) populations in Fall 2012 in six vineyards of the same age grafted to 3309C or 101-14 rootstock. Ring nematode is expressed as the number per 250 grams of soil. (Zasada and Schreiner, unpublished).
These findings indicate that ring nematode populations in commercial vineyards are not reaching levels known to be damaging based on field microplot and greenhouse experiments. However, own-rooted, 101-14, and 3309C rootstocks are certainly harboring ring nematode in commercial vineyards, similar to our findings from the rootstock experiment in field microplots. At this time, only the rootstock 420A has been shown to have durable resistance to the western Oregon population of ring nematode.

After these studies, we questioned why ring nematode reaches high populations in field microplot or greenhouse trials but not in commercial vineyards. This is important to understand so that appropriate practices to avoid high populations can be identified and used. We suspect that the answer to this question lies in fine root density, which equates to the availability of food for the ring nematode. Grapevines in commercial vineyards do not achieve high fine root densities in the range of what occurs in field microplot or potted vines. The typical fine root length density in commercial vineyards in western Oregon is about 0.5 mm fine root per gram of soil (Schreiner 2005), while fine root length reached 17.0 mm per gram of soil in field microplots (Schreiner et al. 2012b) and over 50 mm per gram of soil in greenhouse trials (Schreiner and Pinkerton 2008, Schreiner et al. 2012a). The ring nematode does not have to spend nearly as much energy foraging for a suitable fine root feeding site in confined conditions of a microplot or greenhouse container as it would need to spend foraging in actual vineyards. Imagine how much more energy you would use if you had to drive 50 miles to the nearest grocery store! Another factor which may contribute to higher populations of ring nematode in microplot or greenhouse studies is the increased frequency of irrigation applied to these systems. Prolonged dry conditions encountered in commercial vineyards may trigger ring nematode to become dormant or quiescent, reduce feeding, and hinder population increase.

After more than a decade of research, we now have a good understanding of the occurrence of ring nematode in Oregon vineyards and its impact on vine productivity. Based upon this knowledge, we provide considerations with respect to risks for ring nematode causing economic damage to grapevines in western Oregon:

- The greatest risk is planting on sites with previous vineyard or orchard crops. Testing for ring nematode is recommended in such cases. If high ring nematode populations are found, consider planting to 420A rootstock, as this is the only rootstock we have found to possess durable resistance to high ring nematode pressure.
- A small risk may be encountered in vineyards that are planted at high density, require frequent irrigation, or carry a high crop load. High fine root density that increases the food supply for ring nematode will likely result from high density plantings and frequent irrigation, particularly on shallow soils. A higher crop load may reduce vine carbohydrate reserves and increase the potential for ring nematode to cause damage to vines.

At the present time, there is little concern about ring nematode causing significant damage in Oregon vineyards. However, it is possible that ring nematode populations could reach levels observed in our controlled experiments as more acreage is planted, particularly at high vine density. Whether these population increases and/or vine damage occurs or not should be reevaluated with another survey in about ten years. This will be appropriate to gauge whether greater concern about ring nematode is warranted in the future.

**Literature Cited**


**Ripening synchronisation research conducted to understand berry uniformity at harvest**

**Dr. Laurent Deluc, Assistant Professor, OSU**
**Dr. Satyanaryana Gouthu, Post-doctoral Research Associate, OSU**

Grape berry development involves natural biological programs that occur in succession during the growing season. These biological programs are what direct cell division, growth, and fruit ripening. Environmental factors such as light, temperature, water, and nutrient status of the vine affect the development of berries in this process. Within the grapevine, many hormones interact in response to environmental stimuli and coordinate the processes of fruit ripening. However, all berries within a cluster do not go through the ripening process at the same rate. At any given time, some berries will be more developed than others. This phenomenon of uneven ripening is called “asynchrony,” and the variability among berries is most noticeable during mid-véraison.

To understand this phenomenon of asynchrony, we conducted research in Pinot Noir across four years (2010 to 2013). Berries were classified into four groups based on their level of development at mid-véraison as measured by color and softness. These classes include green-hard, green-soft, pink-soft, and red-soft. These berries were at different ripeness states and represented the transition of berries during véraison. Those green berries that were lagging behind in development had transitioned through pink and then red stages at a later time.

To determine ripening development, we monitored individual berries as they advanced from the various stages to the red-soft stage on intervals of 6, 10, and 13 days for pink-soft, green-soft, and green-hard berry classes, respectively. We found that once the lagging berry classes reach their corresponding red-soft stage, they develop at a faster rate during the two weeks following mid-véraison than their riper counterparts. This enhancement in the ripening rate of lagging berries resulted in reduced variability within a cluster at harvest with respect to sugar and pigments (color). This mechanism is known as “ripening synchronicity,” and it involves changes in gene expression and hormones involved in ripening, suggesting that a coordinated mechanism of control is occurring at the genetic level (Gouthu et al., in progress).

Vineyard management practices such as cluster-zone leaf removal, cluster thinning, and deficit irrigation have been used for decades to improve fruit quality and achieve more uniform ripening. Several genomic studies focused on understanding the changes in gene expression of berries within a cluster due to selective defoliation (Pastore et al. 2013), cluster thinning (Pastore et al. 2011) and water deficit (Deluc et al. 2009). However, no study has investigated the naturally occurring changes in gene expression associated with the reduction of uneven ripening without modifying viticulture practices in the vineyard. We believe that uniform ripening is potentially important for grape growers and winemakers, and understanding the plasticity of grape berry ripening could be beneficial in adapting cultivars to a specific growing region, vineyard management practice, or wine style. From an ecological point of view, the grapevine benefits from having a more coordinated ripening of the berries to entice birds and other animals to feed and disperse seeds. As a result, cool climate cultivars may have adapted to complete this process more quickly to survive. Short growing seasons and advanced phenological stages have been reported in several regions across the world (Fraga et
The ability to ripen more quickly is an interesting genetic trait to research as we seek better methods for grape production and face climate change. Identifying developmental and environmental factors that control synchronized ripening through genomic research will increase our knowledge of ripening processes within grape berries. This information may allow us to combine applied and basic research methods to determine if there are viticulture practices that can be used to improve cluster ripening uniformity and wine quality. For example, since we know hormones play a critical role in the ripening process, we may be able to conduct more detailed research on the use of plant hormone sprays during véraison to achieve more uniform berry composition at harvest. Also, we can study the genomic and physiological response of berry ripening synchronicity with traditional vineyard management practices (canopy management, regulated deficit irrigation, and fertilization). These types of partnered applied and basic studies have not been conducted to date. Future short-term research projects to be conducted at OSU will focus on determining specific contributions of ripening-related hormones in the control of this mechanism. We hope to determine field applications that prevent or eliminate uneven ripening in the vineyards. Basic research will focus on the identification of the genes responsible for this regulatory mechanism within such applied projects. Finally, these findings may be helpful in developing large-scale genetic studies to determine the genetic makeup of cultivars such as Merlot, Cabernet Sauvignon, and Zinfandel that exhibit persisting levels of ripeness heterogeneity at harvest.

**Merlot variability at harvest affects wine composition**

*Amanda Vondras, Ph.D Student, OSU*  
*Dr. Elizabeth Tomasino, Assistant Professor, OSU*  
*Dr. Laurent Deluc, Assistant Professor, OSU*

The grapevine has a certain capacity to buffer itself in a changing environment without disrupting normal developmental processes. How different cultivars of *Vitis vinifera* respond to changing environmental conditions and viticultural practices beyond their buffering capacity are interesting research questions. It is complicated to consider these effects during a multi-dimensional developmental process like ripening. One approach to describe grape berry ripening is to treat whole clusters as a unit, aggregating all the berries within a cluster together for measurements, resulting in data that represents the average contribution of genes or metabolites during berry ripening. This approach overlooks dimensions of the ripening process at the berry level.

Research that we have conducted in the Deluc Lab found different ripening rates of berries within the same cluster. There is inherent variability within the cluster, the vine, and between vines. However, this is reduced as berries approach maturity in some cultivars. In examining how vineyard practices and changing environments affect fruit composition, we may be able to consider ripening within the cluster and the potential impact on ripening uniformity toward harvest, which we believe to be an indicator of increased quality. Within the Deluc Lab, we are researching the variability of individual berries during ripening to determine if this provides a more accurate depiction of the ripening process. We are collaborating with Drs. James Osborne and Elizabeth Tomasino to further study the effects that persistent berry variability has on fruit and wine composition and perceived wine quality.

During mid-véraison, there is significant variability of the berries within the cluster. Berries differ in size, softness,
sugar content, and color. As grapes develop color near harvest, it may appear that variability is reduced. It is not clear whether or not variability is gone by harvest as this has not been researched extensively. A study conducted by Long (1987) revealed that the quality and complexity of a wine was dependent upon the average berry composition. Cluster heterogeneity at maturity was found to increase green characteristics from less ripe berries or jam-like characteristics from over-mature berries in wines produced. Likewise, this diversity of ripening states of berries within a cluster influenced phenolic maturity and wine composition at commercial harvest (Kontoudakis et al. 2012). In theory, we believe uniform cluster composition to be desirable for winemaking (Keller 2010). However, few studies have defined metrics for a “uniform” cluster. This is no simple task given that there are thousands of metabolites that comprise a grape berry and potentially contribute to fruit and wine quality.

The Deluc and Tomasino Labs conducted a research project in 2012 at OSU’s Woodhall Vineyard to estimate the influence of berry variability on Merlot wine composition. At mid-véraison, 100 clusters were used to monitor the progression of berries that were either green or red at that time point. The pedicels of these two berry classes were tagged with paint. Each cluster was harvested six weeks after mid-véraison, and berries were sorted based on the initial tagging as the green or red groups. Non-tagged berries that represented the intermediate ripening stages between green and red berries were used as the control group. Each group of berries was fermented separately using micro-ferments.

Chemical analysis of wine esters showed significant differences between the red and green berry groups as well as differences to the control. The wine made from the green group contained lower concentrations of some esters, and wine made from the red group contained higher concentrations of different esters. Differences in esters correspond to red- and black-berry aromas in Merlot (Pineau et al. 2009). Wine sensory analysis also resulted in significant differences with control wines having more intense floral, jam, and spice aromas, and greater in-mouth fruit density. Wines from the green berry class had more intense herbal and green aromas, and wines of the red berry class had more intense dark fruit, red fruit, and spice aromas. When wines were assessed for quality using a scale of 1 (low) to 3 (high), control and green berry wine were ranked as higher quality than the red berry wine. We concluded that berry variability present in Merlot at harvest affects the sensory characteristics and chemical composition of the wine. Further experiments to quantify non-volatile compounds (anthocyanins, tannins, and other phenolic compounds) will be performed on these wines using the OSU Mass Spectrometry Facility to complement our sensory and volatile chemical data.

To better understand the mechanisms of grape ripening, we are faced with a myriad of questions about the source, regulation, and mediation of asynchronous ripening. Although we assume that homogeneity of berries is best and that a heterogeneous crop (more variably ripe berries) would result in poorer wines, the interpretation of what level of variability is acceptable for optimum wine quality is unknown. There are many avenues to pursue in this research, as cultural practices and environmental factors may exacerbate or reduce the amount of variability during berry development. Furthermore, the amount of berry variability within the cluster at harvest may differ among cultivars.

**Literature Cited**


Application of Multidimensional Gas Chromatography (MDGC) technology for wine research

Dr. Elizabeth Tomasino, Assistant Professor, OSU

You may often wonder how one determines the complex composition of wine. There are various technologies developed to allow researchers to break up the various compounds and investigate each individually. One of the common techniques to determine aroma composition of wine is known as head space solid phase micro extraction gas chromatography mass spectrometry (HS-SPME-GCMS).

Aroma compounds that can volatilize are absorbed onto a fiber and then injected into a gas chromatography mass spectrometer (GCMS). High temperatures are applied to the fiber and remove the volatile compounds which move through a column that separates out each individual compound based on temperature, molecular weight, polarity, and other factors. Once the compounds reach the mass spectrometer, a unique spectrum is produced for each compound. This is similar to an person’s fingerprint (Figure 1).

![Figure 1. An example of a “fingerprint” of limonene.](image)

Depending on the research question, it is possible to obtain both qualitative and quantitative information using a GCMS. However, there are limitations to this equipment as some compounds cannot be properly identified because they come out at the same time and do not separate, requiring other separation techniques. A technology that has emerged to provide greater separation is the multidimensional gas chromatography (MDGC). This technology was first developed in 1989 and has been used extensively in the petrochemical industry, and only recently has this been applied to wine science. When comparing the two methods, GC can identify about 150-200 compounds with one dimension of separation while up to 400 compounds can be identified and measured using MDGC with two dimensions of separation.

Multidimensional gas chromatography allows researchers to fine-tune compound separation by “cutting” areas that may consist of multiple compounds. The instrument consists of a GC connected to a GCMS by a heated transfer line (Figure 2).

![Figure 2. The Tomasino Lab at OSU is equipped with an MDGC instrument.](image)

Within my research lab at Oregon State University, I have a MDGC that can perform “heart-cutting,” where only specific portions of the compound spectrum (or chromatogram) are cut and transferred to a second GC. Flavor and fragrance analysis is commonly done using “heart-cut” MDGC. I used this technology during my PhD studies in New Zealand, and I am excited to apply it to a number of projects here. I will be focusing on correlating the new analytical information of specific compounds generated from MDGC to wine sensory data. Despite significant advancements in the determining of wine composition, our understanding of how individual compounds impact the sensory properties of a wine is still limited.

Currently we are using MDGC to measure chiral terpenes present in aromatic white wines. Terpenes are a class of aroma compounds responsible for floral, pine, and citrus-fruit aromas that are found in many plant essential oils. Terpenes can have significant impact on wine aroma, but they are difficult to measure since the various terpenes are closely related. The main issue in identification is due to the fact that these are chiral compounds that have the same atomic formula but a different three-dimensional arrangement of atoms that form mirror images that are not superimposable. Your left and right hands are examples of non-superimposable mirror images. Why do we care about chiral compounds? Well, these compounds
may smell differently and be perceived at different concentrations. For example, limonene is a terpene that is found in the rind of citrus fruit. The isomers of limonene have different aroma activities; R\(+\)-limonene, smells like fresh oranges and the odor threshold is 200 ppb. S\(-\)-limonene, smells like turpentine and lemon with an odor threshold of 500 ppb (Figure 3). (Boelens et. al 1993, Friedman & Miller, 1971).

\[
\text{Figure 3. Limonene has chiral isomers that are mirror images of each other but are not superimposable, resulting in different aromas and sensory thresholds.}
\]

Depending on the amount and type of different isomers present, the wine may smell very different. A study is being conducted to measure a range of different chiral terpenes in wine to determine if different varieties, place of origin, or other winemaking processes impact the ratio of chiral terpenes. These data will be paired with sensory trials to determine concentration thresholds for compounds impacting aroma.

This MDGC technology is being used in a number of studies measuring wine volatile compounds and linking them to sensory impacts. I collaborated with Dr. Laurent DeLuc’s lab to determine the effects of berry variability at harvest on Merlot wine quality. The MDGC was also used in collaboration with an entomology project with Dr. Vaughn Walton to measure the volatile compounds associated with Brown Marmorated Stink Bug taint in wine. This method is being used in conjunction with winemaking and sensory research to determine threshold levels of Brown Marmorated Stink Bug taint. We will also look at the processing steps in winemaking that impact the taint expression.

Another study that is being conducted involves understanding the role of important volatile aroma compounds in Pinot noir. The MDGC technology is well-suited for this project, as Pinot noir aroma is difficult to characterize due to many closely-related compounds which impart specific aromas but are present at very low concentrations. In spring 2014, we will investigate the impact of two key norisoprenoids, ß-ionone and ß-damascenone, on Pinot noir aroma in Oregon wines. Future work will attempt to tie Oregon’s regional Pinot noir wine styles to chemical composition and sensory data. This equipment, combined with the already extensive analytical equipment available in various labs at the OWRI, will serve as another tool to increase the knowledge of wine science for the Oregon winegrape industry.

**OWRI winemaker sensory panel update**

*Dr. Elizabeth Tomasino, Assistant Professor, OSU*

The OWRI Winemaker Sensory Panel successfully met in summer of 2013 to determine which tests are most appropriate for future sensory evaluation of wines from the Statewide Crop Load Project led by Dr. Patty Skinkis, OSU Viticulture Extension Specialist. Panelists participated in sorting, ranking, preference and descriptive analysis tasks with Pinot noir wines. From the tastings, we determined the best array of sensory tests to answer the question: “how does crop load impact wine quality?” Panelists used descriptive analysis to characterize differences among the wines. They provided information on aroma and mouth-feel parameters and how these parameters relate to quality. Panelists also participated in a range of tasks evaluating Merlot wines from a collaborative project between the Deluc and Tomasino Labs.

The OWRI Winemaker Sensory Panel will meet once every two months from December to September each year but not during harvest from September to November. In the coming year, the Panel will evaluate wines from the Statewide Crop Load Project, develop thresholds for terpenes in wine, and evaluate wines from other research trials from the OWRI. The dates for 2014 will be provided in December 2013. Please contact me if you have any questions (email: Elizabeth.tomasino@oregonstate.edu, phone: 541-737-4866).

For those of you who are unable to participate in the OWRI Winemaker Sensory Panel, you can participate in other sensory analyses investigating regional differences in Oregon Pinot noir during winter and spring from 2014 to 2016. Stay tuned for more opportunities to be involved with wine sensory analysis!
David Adelsheim inducted into the OSU College of Agricultural Sciences 2013 Hall of Fame

Dr. Bill Boggess, Interim Director, OWRI

The College of Agricultural Sciences at Oregon State University recently recognized David Adelsheim, president of Adelsheim Vineyard, with its highest honor — induction into the College’s 2013 Hall of Fame. Early wine pioneers David and Ginny Adelsheim founded Adelsheim Vineyard in 1971. Beyond leading the remarkable success of the vineyard, David has had an unparalleled impact on Oregon’s wine industry over the past 40 years. David was instrumental in efforts to pass land use legislation in the 1980's that enabled protection of agricultural land, importation of Dijon clones of Pinot noir and Chardonnay to the U.S.A., the establishment of the Willamette Valley's six distinct appellations and wine labeling regulations, and the creation of the Oregon Wine Board. David was recognized with the industry’s highest honor, the Lifetime Achievement Award, by the Oregon Wine Board in February 2012. David’s role in the history and prospects of Oregon wine is truly unequalled.

Over the past 40 years, David has collaborated extensively with the College of Agricultural Sciences at Oregon State University. Early collaborations included setting up a grapevine clonal importation program and supporting viticulture research efforts focused on Oregon’s unique growing conditions. More recently, David contributed significantly toward the formation of the Oregon Wine Research Institute (OWRI), which is the region's first multi-disciplinary and comprehensive program dedicated to addressing the research and outreach needs of the wine industry in Oregon. The OWRI has garnered more than $2 million toward Oregon wine research and supports eight OSU faculty members. Development of such pivotal programs within industry, government, and the university is not possible without the strong support of industry partners. We are sincerely thankful for the efforts of David Adelsheim and proudly offer him this prestigious honor at Oregon State University.

OWRI Director’s Corner

As we approach the end of 2013, I want to highlight two important matters: one to acknowledge and extend our appreciation to a colleague and, second, to celebrate the consequences of growing state support for the work of the Oregon Wine Research Institute (OWRI).

First, I thank Dr. Gabriel Balint for his many contributions to the wine industry in southern Oregon. Gabriel will be leaving his viticulture position at the Southern Oregon Research and Education Center (SOREC) at the end of the year, but he will continue to be employed in early 2014 to finish work on his Oregon Wine Board project. SOREC and the Rogue Valley Winegrowers Association are hosting an open house at the Center from 4:00 to 7:00 p.m. on December 11, 2013, recognizing Dr. Balint for his service to OSU, SOREC, and the Southern Oregon winegrape industry. I invite you to attend.

Second, in probably the biggest news this year, the 2013 Oregon legislature approved recurring funding of $310,000 per year to enhance OWRI’s ability to serve the needs of Oregon’s rapidly growing wine industry. Over the past few months we have begun investing these funds in a variety of ways:

Enhanced analytical capacity: Analyzing components of wine flavor is difficult due to the complicated matrix and low concentrations of some of the most important odor-active compounds. This new funding enabled us to purchase a piece of state-of-the-art equipment for advanced flavor chemistry research.
Enhanced support for faculty research programs:
Recognizing the need for continued support to southern Oregon's winegrape industry, we recently hired a tenure-track viticulturist who will work at the Southern Oregon Research and Extension Center in Central Point. The new funding also will allow us to hire a research assistant to support the new viticulturist in working with grape growers in southern Oregon.

Rapid research response capacity: Grapevine red blotch-associated virus has recently been reported in California (Napa Valley) and in the Finger Lakes Region in New York. In both cases, the virus caused leaf reddening and a reduction in fruit ripeness (3-6°Brix) at harvest. The virus has been detected in Oregon, but the extent of the presence and risk of spread is unknown. This new funding enabled initiation of research while still in the 2013 growing season. Researchers are working to identify potential vectors present in Oregon vineyards and assessing the risk of the virus in all major production areas in Oregon.

Integrated vine-to-wine research support: The OWRI embraces a vine-to-wine research philosophy that entails evaluating the impact of viticulture practices through to wine quality. This new funding will be used to hire a research technician to assist with a growing demand for research wine production and for the sensory analyses required to execute our integrated vine-to-wine research mission.

We greatly appreciate the industry’s effort to gain this added state support. We look forward to your continued counsel and engagement as we invest these resources on your behalf. Stay tuned for more developments, and we will see you at the Oregon Wine Industry Symposium in February 2014!

Regards,

Bill Boggess
Interim Director, OWRI

Practical Guides & 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.

Field Guide for Integrated Pest Management in Pacific Northwest Vineyards
The guide provides practical information about pest and disease management for grape growers and winemakers throughout the Pacific Northwest. It is beautifully illustrated and includes information about specific pests, management techniques (chemical and cultural), and IPM principles. This guide was published in June 2013 by Washington State University, Oregon State University, and University of Idaho through Pacific Northwest Extension Publishing (PNW 644). Edited by M.M. Moyer and S.D. O’Neal, this book is available for purchase online at http://cru.cahe.wsu.edu/CEPublications/PNW644/PNW644.pdf.


Lateral Crop Production: Vine rebellion against imbalance
This article summarizes results from research conducted in Oregon involving secondary crop and its impact on vine growth and fruit composition. The article was published in the August 2013 edition of Practical Winery and Vineyard Journal by authors P. A. Skinkis and A.L. Reeve. www.practicalwinery.com/

Mobile Access to Pesticides and Labels (MAPL) (www.npic.orst.edu/mapl): The National Pesticide Information Center at OSU developed this tool to access federal pesticide labels and information. MAPL retrieves data from two EPA databases and can be queried by product name, pest, site, and registration number. This tool functions on computers but is best displayed on mobile devices. If you want further information or have feedback on this tool, please contact Dave Stone, Associate Professor and Director, National Pesticide Information Center at OSU (Dave.Stone@oregonstate.edu, 541-737-4433).
Pacific Northwest Weed Management Handbook
This is the most comprehensive guide for weed management for the region. It is authored by Extension specialists from throughout the Pacific Northwest, and provides information on weed management strategies, herbicide lists, herbicide resistance, and more. This online handbook is edited by E. Peachey and available through Pacific Northwest Extension Publishing. It is updated quarterly, and the most recent revision was published in September 2013.
http://pnwhandbooks.org/weed/

This is a 22-page guide that provides information on how to manage soil pH for various crops. While grapes are not specifically mentioned in this publication, the concepts for testing, interpreting and managing soil pH for nutrient management are discussed. It also provides helpful information that may be used when considering cover cropping with legumes, grains or grasses in the vineyard. This publication was released in July 2013 by Oregon State University Extension Publishing (EM 9061) by authors J.M. Hart, D.M. Sullivan, N.P. Anderson, A.G. Hulting, D.A. Horneck, and N.W. Christensen. It is available online. https://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/41199/em9061.pdf

Vineyard Canopy Management Publication Series
A series of four articles were published by Dr. Patty Skinkis, Viticulture Extension Specialist in collaboration with co-authors Amanda Vance and Alison Reeve (graduate research assistants) and research colleague Dr. Paul Schreiner. These publications provide information on components of canopy management including the concepts and applications of vine balance, how vine balance is altered by canopy management practices, and two protocols developed for use by industry with information about using these data for decision-making. All articles were published by Oregon State University Extension Publishing in June 2013 and are available online through links provided below:

Understanding Vine Balance (EM 9068) http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/39883/EM%209068.pdf

The Role of Canopy Management in Vine Balance (EM 9071) http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/39968/EM%209071.pdf

How to Measure Dormant Pruning Weight of Grapevines (EM 9069) http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/39902/em9069.pdf

How to Measure Grapevine Leaf Area (EM 9070) http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/39969/EM%209070.pdf

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. The peer-review/refereed process validates the scientific work of the authors. The following articles were released in 2013 and describe research conducted by Oregon State University faculty and other members of the Oregon Wine Research Institute at Oregon State University.

Viticulture


Insect, Disease, and Pest Management
Research Publications (cont.)

Enology


Upcoming Events

**Reception in Honor of Dr. Gabriel Balint Ph.D.**
*Wednesday, December 11, 2013 4:00-7:00 PM*
Southern Oregon Research & Extension Auditorium

Join us for a reception in appreciation Gabriel’s service to OSU, the southern Oregon winegrape industry and the Oregon Wine Research Institute.

**Use and Management of Barrels in the Winery**
*Tuesday, January 28, 2014*
S. Oregon Research and Extension Center, Central Point
*Thursday, January 30, 2014*
Food Innovation Center, Portland

Join us for a one-day enology/sensory workshop covering all aspects of barrel use during winemaking including: barrel cleaning and storage, sanitation and microbial issues, selection, alternatives and oak aromas. Tastings will highlight the various impacts of oak and barrel use on wine sensory properties. A winemaker panel will discuss their approach to barrel selection and use. visit [http://owri.oregonstate.edu/content/use-and-management-barrels-winery](http://owri.oregonstate.edu/content/use-and-management-barrels-winery) for more information.

**Oregon Wine Research Institute Seminar Series**
*Winter and Spring 2014*

The OWRI will host a four-part seminar series designed around various issues in labor, labor law, and labor management during both the winter and spring terms of 2014.

These seminars will be held on the OSU Campus in Corvallis and broadcasted online. All seminars are archived for later viewing. To find out more, contact Danielle Gabriel, OWRI Program Administrator, at [danielle.gabriel@oregonstate.edu](mailto:danielle.gabriel@oregonstate.edu), or visit [http://owri.oregonstate.edu](http://owri.oregonstate.edu) for a full schedule.

**Oregon Wine Industry Symposium**
*Tuesday February 25, and Wednesday, February 26, 2014*  
Oregon Convention Center, Portland

The Oregon Wine Board will be sponsoring the annual Oregon Wine Industry Symposium in Portland to provide the wine industry with education, up-to-date information, and techniques for grape growers and winemakers alike. This event gathers people from Oregon’s various wine regions together to network and share ideas to improve their businesses. Visit: [http://oregonwine.org/industry/symposium.aspx](http://oregonwine.org/industry/symposium.aspx) for more information.

**2014 OWRI Grape Day**
*Tuesday, April 1, 2014*
The LaSells Stewart Center

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 Integrated Pest Management. Mark your calendar now! Also, be sure to check out the abstracts from the 2013 Grape Day by visiting: [http://owri.oregonstate.edu/content/seminars-oregon-wine-research-institute](http://owri.oregonstate.edu/content/seminars-oregon-wine-research-institute)