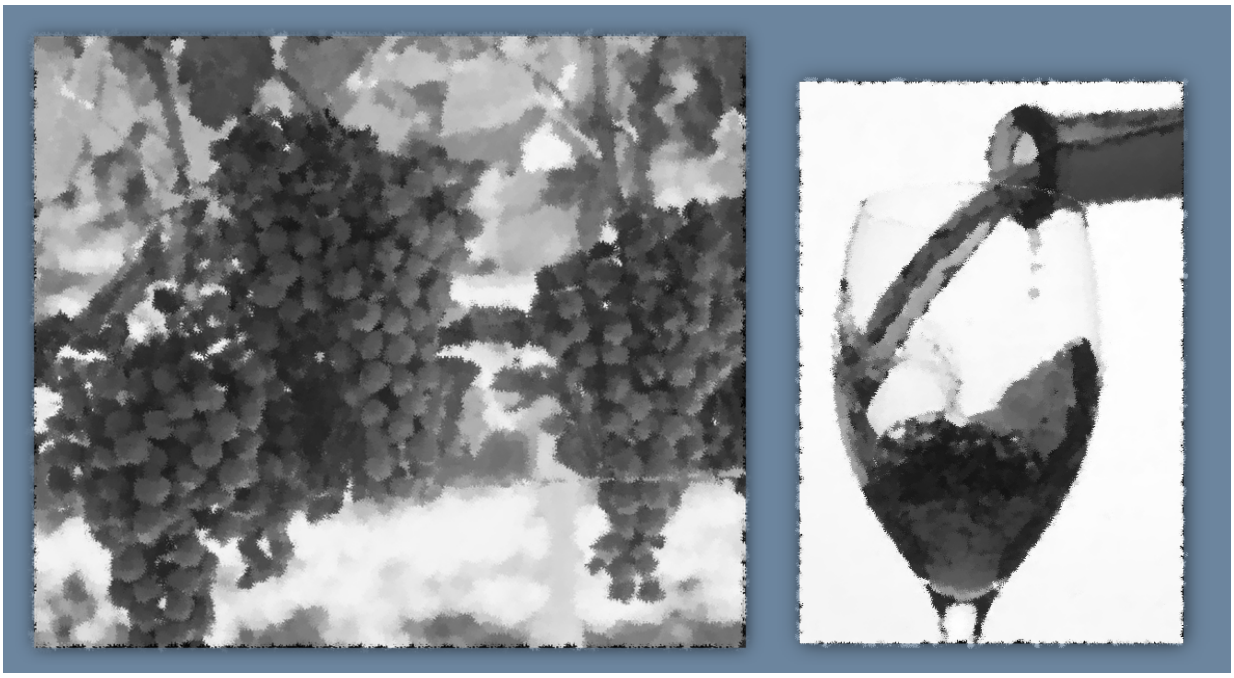
Oregon Wine Research Institute

2016 Grape Day

Wine & Grape Quality, Sensory & Perception, and Nutrient Management
LaSells Stewart Center, OSU Campus, Tuesday, March 29



Abstracts of Presentations and Posters

Oregon State University OSU College of Agricultural Sciences

Program Schedule

8:30 - 9:00 AM: Registration and Refreshments

9:00 - 9:05 AM: Introduction and Welcome;
Mark Chien, Program Coordinator

9:05 - 9:50 AM*:* ***Objective Measures of Quality for Chardonnay Grapes***
Dr. Bruce Pan, Research Scientist; E&J Gallo

The relationship between grape composition and wine quality has been a continual area of focus in the wine industry. Development of objective chemical specifications for estimation of fruit quality enables relative comparison of vineyards across a consistent set of parameters and serves as valuable tool for matching grapes to desired wine-style targets. Results from a large-scale statewide chemical profiling of California Chardonnay grapes over several vintages are presented.

10:00 - 10:45 AM*:* ***Beyond Aroma: Drinking with Full Senses***
Dr. Juyun Lim, Associate Professor;
OSU Department of Food Science and Technology

When evaluating wine quality, aroma is not the only important component. Appearance, odor, taste, and tactile sensations (or even the sound of opening up the bottle) influence our perception of wine. More importantly, as much as these sensations are mediated by separate sensory systems (e.g. gustation and olfaction), evidence suggests that they are integrated at many levels of sensory processing. During this session, Dr. Lim will discuss the basics of flavor modalities and how sensory information is processed. She will also provide perceptual evidence of multisensory interaction and integration, and discuss what that means in wine evaluation.

10:45 - 11:45 AM: ***Interactive Poster Session***

11:45 – 12:20 PM: ***Wine Sensory; Interactions and Direct Effects on Perception***
Dr. Elizabeth Tomasino, Assistant Professor;
OSU Department of Food Science and Technology

Sensory perception of wine is a combination of direct effects and interactions with aroma and mouthfeel. Aroma compounds have a direct effect; the higher the concentration, the stronger the perception of the aroma. However, many of the positive sensory qualities associated with wine do not behave in a similar fashion. Instead, other compounds in wine may alter sensory perception through interactions. This presentation describes the work conducted in Chardonnay and Pinot noir investigating both aroma and mouthfeel interactions.

12:30 - 1:00 PM: **Lunch**

1:00 - 1:45 PM: ***Grape Water Content***
Dr. Steve Price; ETS Labs

Grape water content is not a standard grape analysis tool although water is the primary component of grape and wine. It was left off the analytical list. The effects of variation in water content are wide ranging. Soil effects on grape water content are a key variable in terroir. An understanding of irrigation effects on cell growth and water content are essential for managing irrigation to hit target wine styles. Change in grape water content during maturation effects concentration of all other measured grape parameters. At harvest, water content can be used to predict potential tannin, adjust saignées and predict press yields. The ease and utility of the analysis suggest that wider use of grape water content as a management tool and quality metric could be beneficial in vineyards and wineries.

2:00 - 2:30 PM: Break/Poster Session

2:30 - 3:15 PM: ***Impacts of Nitrogen (N), Phosphorous (P) and Potassium (K) Supply on Pinot noir Productivity and Berry and Wine Aroma Composition***
Dr. Paul Schreiner, Research Plant Physiologist; USDA-ARS
Dr. Michael Qian, Professor; OSU Department of Food Science and Technology

Dr. Paul Schreiner will summarize the impact of N,P,K supply on Pinot noir productivity and physiology from two research trials, where they manipulated N, P and K supply using a controlled pot in pot system. Dr. Michael Qian will discuss the effects of N,P,K on aroma composition of grape and wine. Research found that nitrogen had the dominate effect on grape volatile compounds and lower nitrogen resulted in lower concentration of C6 compounds which are associated with riper fruit. Lower nitrogen also resulted in lower total β-damascenone in grapes but had no consistent effect on terpenoids. Similar trends were observed for the wine.

Poster Abstract Table of Contents

Cultural Practices Have Little Impact on Bud Fruitfulness and Yield in Vines of Varying Vigor

Alison L. Reeve[1], Patricia A. Skinkis[2*], and R. Paul Schreiner[3]

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Abstract

The impact of canopy management practices on bud fruitfulness has not received much research attention. Two experiments were conducted in 2014 and 2015 using cluster zone leaf removal and lateral shoot removal to better understand their effects on bud fruitfulness, integrated fruitfulness index (IFI – the sum of diameters of inflorescence primordia within a bud), actual fruitfulness, and harvest yield. The first experiment quantified the impact of leaf pulling at three time points (bloom, fruit set, and the pea-size stage) as compared to no leaf removal as applied within vines of three vigor levels created through floor management treatments (*Grass*- perennial red fescue (*Festuca rubra* L.) in the flanking alleyways, *Tilled*- flanking alleyways were cultivated, or *Alternate*- one alleyway had grass, while the other was cultivated). The second experiment also used vines within the floor management trial but vines had either no laterals removed or lateral shoots removed at three time points (fruit set, pea-size, or bunch closure) from the first catch wire (approximately node 11) to the shoot tip. Dormant buds were dissected following each growing season. Bud dissections revealed fewer inflorescence primordia and a lower IFI in basal nodes when leaves were not removed, but there were no differences in actual fruitfulness the following growing season. Reduced IFI was also found in basal nodes of Grass versus Tilled vines. Leaf pulling at bloom and fruit set resulted in 10 to 20 g smaller clusters by harvest. There was no difference in bud fruitfulness or IFI averaged over nodes 11 to 17 due to either treatment in the lateral removal trial and no differences in actual fruitfulness or yield, as only ten basal buds were retained at pruning. The first year of this work suggests leaf pulling does not reduce fruitfulness of basal nodes, which is important for considering spur-pruning.

Grape Anthocyanin Altered by Absolute Sunlight Exclusion

Jungmin Lee[1*]

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Abstract

This research was conducted to clarify anthocyanin accumulation within 'Merlot' grapes in response to microclimate, specifically to light incidence, temperature, and humidity. Treatment grape clusters were light-excluded during ripening by opaque white polypropylene enclosures, during which light intensity, temperature, and humidity were continually measured. There were two controls and two treatments: control-shaded (Ctrl-SH; ambient), control-exposed (Ctrl-EX), light-excluded (Trt-LE), and aspirated light-excluded (Trt-ALE). All 15 'Merlot' grape anthocyanins (previously reported) accrued in control and treatment clusters, indicating no accumulations were terminated from light exclusion during ripening. Treatment groups (both Trt-LE and Trt-ALE clusters) had less anthocyanin accumulation (86.8 mg/100g berry) than control clusters (160.2 mg/100g). The proportions of the individual anthocyanins were also altered by light exclusion. While Trt-ALE clusters had the lowest total anthocyanins (75.4 mg/100g), they did have a higher percentage of acylated anthocyanins (52% of the total) when compared to the other treatments (Ctrl-SH-36%, Ctrl-EX-37%, and Trt-LE-42%).

Statewide Crop Load Project: The Influence of Cluster Thinning on Pinot Noir Anthocyanin Concentration

Patricia A. Skinkis[1]* and Michael Kennedy[2]

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Abstract

A large grower-collaborative study was designed to determine the impact of yield on fruit composition across seasons. More than ten vineyards were part of the study each year from 2012 to 2014, and each site was cluster-thinned to two or more yield levels at lag phase in a completely randomized block design. The majority of vineyards had cluster thinning treatments comparing 1 cluster/shoot, 2 clusters/shoot, and full crop (non-thinned). Fruit composition measured at harvest revealed few similarities across all sites and years for basic ripening parameters, fruit nitrogen, and phenolics. However, the most consistent yield effect was on anthocyanin. A negative linear regression for yield and polymeric anthocyanin was found in 20%, 29% and 42% of vineyards in the study from 2012, 2013 and 2014, respectively. Significant regressions were found for total anthocyanin at 10% of sites in 2012 and 30% of sites in 2013 and 2014. The mean difference in anthocyanin concentration across years and sites was 2 mg/L lower polymeric anthocyanin and 162 mg/L lower total anthocyanin in full crop fruit compared to those that were thinned. Only two vineyards had consistent relationships between yield and anthocyanin for multiple years of the study. Fruit from both sites revealed relationships between yield, anthocyanin and quercetin, a flavonoid that is found elevated in sun-exposed fruit. Preliminary results suggest that the increase in anthocyanin with lower yields may be related to sun exposure of the fruit after removal of overlapping clusters during the thinning process rather than a physiological impact related to an increase in the ratio of vine canopy leaf area to fruit weight.

Defining Critical Values for N, P, and K in Pinot noir

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Abstract

Critical values for Pinot noir leaf blade nutrients at véraison for vines managed with one cluster per shoot are presented based on data from four years using our pot-in-pot system. Nitrogen (N), phosphorus (P), and potassium (K) were each independently manipulated while holding all other nutrients constant beginning in 2012 when vines were four-year-old and producing their first full crop. All treatments were maintained for four growing seasons except for the lowest N rate, which was boosted back to the Control level in 2015 to examine recovery from very low N status. Vine responses to varying N, P, or K supply were unique, but in all cases the most sensitive impact of nutrient status on vine responses was expressed in the levels of nutrients (YAN, P, or K) in the juice or must. Nitrogen reduced yield only when leaf N at véraison was below 1.75% for 2 years, or below 1.50% for a single year. Vegetative growth was more sensitive to N supply than yield, with pruning weights reduced when leaf N was below 1.90%. Since wine quality appears to be improved by low N status, it is possible to reduce vegetative growth before harming yield and enhance both efficiency of N use and quality. However, this comes at the expense of lower YAN's. Phosphorus reduced yield and growth simultaneously when leaf P was below 0.10%. There has been no consistent impact of P thus far on wine quality or berry chemistry. Potassium also reduced yield and growth at the same time when leaf K was below 0.40%. However, juice or must pH was altered at leaf K levels below 0.50%, and leaf and fruit symptoms also began to appear near this threshold. The impact of K on wine quality will most likely be related to effects on pH.

Temperature-dependent Life Table Statistics for *Halyomorpha halys*

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Abstract

Temperature-dependent studies were conducted on survival and reproduction of brown marmorated stink bug (BMSB), *Halyomorpha halys*, in relation to temperature from 15 to 32˚ C. Two bug dorms with 50 newly emerged adults were placed in environmentally controlled cabinets at seven different temperatures. Oviposition increased with an increase in temperature, peaking at 25˚ C, with no eggs being laid at 15˚ C. Overall survival rates were lower at 15˚ C and temperatures above 25˚ C. This data is preliminary due to incomplete temperatures, and additional analyses are needed.

Grape Powdery Mildew Management – A Fungicide Timing and Selection Conundrum

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Abstract

Grape inflorescences are highly susceptible to infection by Grape Powdery Mildew and recommendations are to use the strongest fungicides and shortest intervals during bloom and the beginning of fruit set. Optimization of fungicide timing and selection during this stage may lead to better disease control and reduced fungicide usage. Fungicide mobility within and around the cluster may further enhance disease control. Five commonly used fungicides were selected based on their widespread usage and mobility for a small plot experiment using 17 year old vines of Pinot Noir 2A on 420A rootstock. Fungicides were applied during three highly susceptible growth stages: inflorescence elongation (BBCH 55), 50% bloom (BBCH 65), and end of bloom (BBCH 69). These treatments were applied in a 3x5 factorial design with additional controls of a calendar based sulfur applications and a water only treatment. To assess fungicide mobility and redistribution, just prior to fungicide application, 10 clusters per plot were covered with a plastic bag while the rest were left uncovered during fungicide application. Clusters were harvested just before veraison and frozen until analysis for cluster severity by stereomicroscopy. Leaf disease incidence and severity data was taken over the course of the season to monitor disease progress. Leaf incidence Area Under Disease Progress Curve (AUDPC) values showed that fungicide application based on growth stage provided significantly better control than the calendar sulfur spray and the no-treatment control and suggested that there is an interaction between timing and fungicide selection. Analysis of grape clusters is ongoing and will further elucidate the relationship between timing and fungicide selection while providing practical information about the mobility and redistribution of fungicides in a field setting.

Development of a Mechanistic Vineyard Simulation Tool to Support Improved Management Decisions

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Abstract

Each growing season, a vineyard manager makes a set of interconnected decisions (e.g., watering schedule, pruning, pesticide application, fertilization) that guide their crops throughout the year. Growers use their expertise to make these decisions in reaction to current conditions and predictions of what will develop. These decisions are usually made based on incomplete information, as there are too many variables than can be feasibly considered by a given manager. While there are guidelines and `rules of thumb' that can provide assistance, most of their expertise comes through trial-and-error since every vineyard is unique. This means that the adoption of improved management strategies is usually slow and often based on anecdotal evidence. Growers would benefit from the development of a comprehensive simulation tool that can be used to analyze current and proposed management strategies that reduce water use, control diseases and pests, adapt to climate change, or optimize yields. Current agricultural models are either too simplistic to accurately simulate conditions and subsequent development, or they are too computationally expensive to simulate field- and seasonal-scales. This work is aimed at overcoming these limitations by combining sophisticated engineering models for radiation transfer, convection, turbulent dispersion, etc. with the efficiency afforded by graphics processing unit (GPU) technology. The resulting modeling tool is unprecedented in terms of its physical realism and computational efficiency, and has the potential to change the way that management decisions are made in the industry.

Investigations of Red Blotch Epidemiology and Potential Vectors in Oregon

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Abstract

Following the identification in 2012 of Grapevine Red Blotch-associated Virus (GRBaV), substantial efforts have been made to investigate the occurrence and spread of the disease in Oregon vineyards. Leaf collections were made in the fall of 2013-2015, nucleic acid extracts were obtained, and PCR methodologies were applied to detect presence or absence of GRBaV in collected materials. Sticky cards and sweep net samples were collected to capture potential insect vector species. Distribution of insects and virus-infected vines were assessed using a spatial analysis statistical program and visually plotted using a contour-mapping program. Our studies have allowed us to determine: 1) baseline incidence of GRBaV in select Oregon vineyards; 2) whether GRBaV is spreading in these sites; 3) potential insect vectors that may be present in Oregon vineyards. PCR analysis showed that GRBaV is present in most surveyed vineyards and appears to be spreading rapidly in some locations. Several candidate vector species of leafhoppers were present in the sticky cards or sweep net samples. Studies are ongoing to confirm whether any of the collected insect species can transmit GRBaV.

Detection of Quinone Outside Inhibitor Resistant Isolates of *Erysiphe necator* in Oregon Vineyards

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Abstract

Grape Powdery Mildew (*Erysiphe necator* (*En*)) is the most persistent disease in west coast viticulture due to a long and dry growing season which favors infection, reproduction and spore dispersal. GPM control failures in 2015 led to the exploration of the possibility of quinone outside inhibitor (QoI) fungicide resistance present in Oregon *En* populations. A survey of spatially distinct vineyards in Oregon was performed in which leaf and fruit samples infected with *En* were collected. Isolation and DNA extraction of *En* samples and subsequent quantitative PCR analysis using competitive TaqMan probes detected the presence of the G143A mutation in the cytochrome B gene of the fungal mitochondria. Conidia germination bioassays using Trifloxystrobin and Kresoxim-Methyl in 1.5% water agar confirmed genetic results of 28 isolates examined. Of the 28 isolates examined, 22 were resistant to both QoIs (EC_{50}>100µg/ml), while 6 were sensitive (EC_{50} from 0.004 to 0.06µg/ml). Using a discriminatory dose of 0.1ug/ml, 19 of 19 more isolates were resistant to QoIs and agreed with results from the qPCR assay. Isolates with the G143A mutation should be considered resistant to QoIs.

Development of an Ascospore Release and Germination Risk Assessment for *Erysiphe necator* Infections on *Vitis vinifera*

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Abstract

Grape powdery mildew, caused by *Erysiphe necator*, is a polycyclic disease of grapevine, whereby the epidemic is initiated by ascosporic infections. To determine when and under what conditions ascospore release occurs within the Willamette Valley of Oregon, cleistothecia were collected from several vineyards and embedded into artificial bark that was suspended over custom impaction spore traps. Ascospores were collected biweekly from leaf drop until ascospore release was exhausted. Impaction spore traps were also placed in a naturally infested vineyard and monitored biweekly from leaf drop until *E. necator* colonies were observed in the field. Concurrently, environmental conditions were recorded every 15 minutes throughout the duration of the experiment. Previously developed ascospore release models from other regions do not accurately predict ascospore release in this region. This prediction failure is likely due to the correlative nature of the models to regionally specific weather conditions. An ascospore infection model was developed that consisted of ascospore release and germination severity sub-models; ascospore release predictions were validated using field collected ascospores. Temperatures above 40°F, precipitation above 0.1 inches, relative humidity above 80%, and wetness duration of at least 24 hours during the sampling period were most important for ascospore release. The combination of ascospore release and ascospore germination may be used to more accurately time fungicide applications.

Grape Leafroll Virus: A Systems Approach to Understand its Interaction with the Plant and its Effect on Fruit Ripening

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Abstract

Regulation of gene expression by transcription factors and post-transcriptionally by small RNAs and alternative splicing are essential components of plant development and responses to stress. The present study used RNA and small RNA sequencing to assemble a holistic view of these regulatory agents during ripening in *Vitis vinifera* and in response to GLRaV-3 infection. mRNA and small RNAs from healthy and GLRaV-3 infected Pinot noir fruits were measured from the ripening onset to fruit maturity. We observed approximately 1,700 differentially expressed genes when comparing healthy and infected fruits over time, with the largest number occurring at the ripening onset and declining towards harvest. We identified how the virus impacts gene expression patterns by performing triclustering analyses and whether genes that experienced behavioral changes have functions and regulatory elements in common by assessing enriched gene ontology classes and *cis*-regulatory elements. In addition, some genes that were not differentially expressed were alternatively spliced due to the virus, showing that the virus not only affects gene expression but the composition of transcripts. Upon analyzing the small RNA sequencing data, we observed 1-3% of small RNA reads were virus-derived, which is consistent with a targeted plant anti-viral defense response. Ripening, stress, and chromatin remodeling-associated genes were predicted as targets of the miRNAs found in our data. Of the ~180 miRNAs identified, ~50 were previously annotated in grape. Finally, we used genes differentially expressed between healthy and infected plants for the construction of a correlation-based network to understand how the virus disrupts the normal ripening program and to identify core nodes through which the presence of the virus potentially induces widespread changes in the berry transcriptome via transcription factors, alternative splicing, and small RNAs.

The Impacts of Cluster-thinning and Cluster-zone Leaf Removal on the Hormone Dynamics of Ripening Pinot noir Grape Berries

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Abstract

Two common, yet expensive, practices used in viticulture are cluster-thinning and cluster-zone leaf removal, which are intended to alter the environmental conditions in hopes of causing the vine to respond in a favorable manner (e.g. improved fruit quality or disease management). Because the vine's response to environmental changes is principally hormone-mediated, we have profiled the active forms, conjugates, and precursors of auxin, cytokinin, gibberellin, abscisic acid, brassinosteroid, jasmonic acid, and salicylic acid in order to understand the physiological effects of cluster-thinning and leaf removal on the dynamic accumulation of these compounds in the berry. For the cluster-thinned treatment, clusters were thinned to 0.5 clusters/shoot; one-hundred percent of the cluster-zone leaves were removed for the leaf-removal treatment. Phytohormones were extracted using a targeted method developed within our laboratory. Our preliminary findings from the first year's data are consistent with literature, but revealed a clear tissue-specific distribution of the bioactive forms of hormones at critical phases of berry development. We also observed new patterns of accumulation for gibberellic acids and brassinosteroids during the pre-ripening stages in skin and pulp suggesting their likely implication in ripening initiation. The significant treatment effects were observed to cause a reduction in hormone concentrations in most cases. Leaf-removal treatment effects include a decline in abscisic acid during pre-véraison, and both treatments resulted in a decline in the concentrations of indole-3-acetic acid (auxin), trans-zeatin (cytokinin), and castasterone (Brassinosteroid) in both pericarp tissues. Though the trend of the effects of both treatments were similar, the leaf-removal treatment effects were more significant than those of cluster-thinning. A second year's data is expected to clarify the trends identified here.

Functional Characterization of Auxin Response Factor 4 in the Timing of Ripening Initiation of Grape Berries

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Abstract

Individual berries in a grape cluster enter the ripening phase at different times leading to an asynchronous cluster. Differences in seed content and the resultant quantitative or qualitative differences in the hormone signals from seed to pericarp likely influence the relative timing of ripening initiation among berries of the cluster. By monitoring the low and high seed-containing berries in the cluster from pre-veraison stages, we observed that the pericarp of high seed-containing berries maintains higher and persisting level of the ripening inhibiting hormone, auxin compared to that of low seed-containing berries. Interestingly, increased local auxin biosynthetic activity was not observed suggesting the import of additional auxin from seed. *Auxin-response factor 4* (*ARF4*) mediates auxin-induced negative regulation of ripening, delaying the ripening-initiation in high seed-containing berries. On the other hand, in low seed-containing berries, the expression of *ARF4* declines earlier allowing the increase in ripening promoting hormone, abscisic acid. Our studies indicate that differences in the seed content among berries contribute to uneven ripening-initiation of berries in the grape cluster.

To functionally characterize the role of *ARF4*, we are using a 'microvine system' suitable for genetic engineering in combination with an inducible expression system that enables us to control the time of the induction. Through this approach, we will confirm the role of VviARF4 in the timing of ripening initiation and its direct or indirect influence on fruit quality aspects. Development of practices able to alter the timing of ripening initiation and identification of genetic materials associated with this trait will be of great value in cool climate regions where growing season is usually short. Translation of the basic knowledge from this research will be useful to develop field-based genetic assays to validate viticulture practices intended to advance or delay the ripening process.

Flowering Time and Seed Content Contribute Asymmetrically to Uneven Ripening Initiation Among Fruits in Vitis vinifera

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Abstract

Ripening in *Vitis vinifera* is notably asynchronous among fruits within clusters. Why this occurs is not entirely understood, though differences in seed content and unequal developmental durations that arise from asynchronous flowering within a cluster have been proposed. This study examined the extent to which both factors contribute to individual fruits' ripening progress by mid-véraison, when half of berries in a cluster have initiated ripening, and whether either or both factors affect the timing of characteristic, ripening-initiation associated changes in abscisic acid and auxin before, at, and after véraison. The decline of auxin and increase in abscisic acid are key components of ripening initiation in fruits, therefore differences in the timing of this “switch” should correspond to differences in ripening initiation among individual fruits. Ultimately, developmental duration and flowering time did not sufficiently explain how far berries had progressed into the ripening stage because fruits did not require a fixed amount of time to initiate ripening. Fruits from early and late flowers with similar seed content were able to initiate ripening at the same time in spite of differences in chronological age. This suggests either an early developmental enhancement occurred for late-initiated fruits or that flowering time is an inappropriate "day zero" and may be a consequence of some underlying source of variation. Only seed content was linked to the timing and magnitude of ripening-related hormone changes, supporting that seeds have a comparatively larger influence than flowering time on the ripening initiation of individual berries. More specifically, if the fraction of berry weight occupied by seed was relatively high, then the initiation of ripening for that berry and its associated hormone changes were delayed.

Can Natural Sulfite Formation by Wine Yeasts Substitute for Sulfite Additions Disallowed in Organic Wine Production?

Garrett Holzwarth[1,2], James P. Osborne[3,4] and Alan T. Bakalinsky[2,3,4*]

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Abstract

U.S. standards for making organic wine prohibit winemakers from adding sulfites during processing. This prohibition does not apply to organic wines produced in the European Union, which puts U.S. winemakers entering this growing market at a disadvantage. Because U.S. regulations do not forbid the presence of naturally-occurring sulfites, we are evaluating the possibility that certain commercial wine yeast strains may produce enough sulfite during fermentation to substitute for additions normally made by winemakers. While most wine strains of *Saccharomyces cerevisiae* produce some sulfite during fermentation, the environmental and genetic factors that control production are not known well enough to be predictable. We are determining such factors for a limited number of commercial strains known or presumed to produce higher-than-average levels of sulfite. The initial application is for production of white wines that do not undergo the malolactic fermentation or post-fermentation aging. We are analyzing factors that control sulfite formation, utilization, and excretion, and potential winemaker interventions that could increase sulfite production but which are compatible with accepted winemaking practices and organic wine production. Two potential complications: 1) the risk of high levels of hydrogen sulfide in a strain that produces high levels of sulfite; and 2) the recognition that winemakers typically choose starter cultures for reasons other than sulfite production. Clearly, high levels of sulfite production cannot compromise other desirable strain characteristics.

Formation of Volatile Sulfur Compounds in Pinot noir Wine Pre and Post-fermentation: Role of Nitrogen Composition and Elemental Sulfur.

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Abstract

This study examined the impact of interactions between nitrogen concentration, composition, and elemental sulfur (S^0) on VSC content of Pinot noir wine. Fermentations were conducted using Pinot noir grapes where yeast assimilable nitrogen (YAN) was adjusted from 110 mg N /L to 250 mg N/L with either diammonium phosphate (DAP) or an amino acid mixture matching a typical Pinot noir grape composition. 10 μg/g S^0 was also added to some treatments. DAP additions increased the production of H_2S by *Saccharomyces cerevisiae* UCD522 while amino acid additions decreased H_2S formation regardless of S^0 addition. Fermentations with both DAP and S^0 produced the highest amount of total H_2S with 35-45% more H_2S being produced compared to ferments where only S^0 or DAP additions were made. YAN concentration and composition as well as S^0 also impacted the concentration of other VSCs in the wine post-fermentation. In particular, the addition of S^0 increased the concentration of methyl thioacetate (MeSOAc) in the wines as did higher YAN concentrations. The type of nitrogen added (ammonium vs. amino) had less of an impact on MeSOAc concentration than the increase in YAN did. This suggests that while the presence of S^0 is one factor impacting the concentration of VSCs post-fermentation, high YAN concentrations may also play a role. Experiments were also conducted to reduce the amount of residual S^0 on Pinot noir grapes prior to fermentation. Pinot noir grapes received an application of S^0 (wettable or microthiol) one week prior to harvest. Cold soaking (pre-fermentation) the grapes followed by draining off the juice reduced the amount of S^0 remaining on the grapes and resulted in significantly less H_2S production during fermentation. Cold settling the juice that was drained off decreased the concentration of S^0 below detection and allowed the juice to be added back to the original grapes.

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The effect of Wine Processing on Brown Marmorated Stink Bug (BMSB) Taint and its Management

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Abstract

Brown marmorated stink bug (BMSB), an invasive species currently found in US, Canada, Hungary, Greece, Europe; is a new threat to the grape and wine industry. BMSB presence in grape clusters can result in wine with "stink bug taint", which can be detrimental to its quality. The main components of this taint are tridecane and trans-2-decenal resulting in a green, cilantro like aroma. With growing levels of BMSB in the vineyard, our focus in this study was to determine critical stages of wine processing that effect stink bug taint, BMSB tolerance levels, and efficacy of remedial treatments on taint reduction.

Pinot noir and pinot gris with various densities of BMSB were produced. The taint concentration at each processing step and in the finished wine was measured using HS-SPME-MDGC-MS. The effectiveness of fining agents was assessed via chemical analysis and sensory analysis.

Control wines were found to be taint-free and taint levels increased with BMSB densities. The highest taint levels were observed during destemming and pressing. Press type, press fraction and artificial mechanical harvesting also had a negative impact on the taint levels in red wine. Grapes with a contamination level of three BMSB per cluster can potentially result in wine with trans-2-decenal concentrations at or above its sensory rejection threshold. White wine did not appear to be effected by BMSB, due to removal of the bugs early on in the fermentation process. Egg albumin, yeast lees and oak were found to be effective in reducing the taint perception in Pinot noir.

The outcome of this study will allow winemakers to manipulate the winemaking protocol to manage taint levels in the wine, while other methods of pest control in the field are evaluated.

Perception of Chiral Terpenes in Pinot gris Wine and Investigation of Matrix Interactions

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Abstract

Monoterpenes are aromatic compounds that contribute to the characteristic aromas of white wines. Chiral monoterpene profiles were chosen based concentration and combination of the different compounds measured in 50 Pinot gris wines. The majority of these compounds were found at amounts below their known perception thresholds. However these low levels of compounds may impact aroma perception. Therefore it was of interest to determine the impact of chiral monoterpenes to sensory perception of Pinot gris wine. The composition of the matrix has been found to impact aroma perception and this was also investigated. Nine different chiral monoterpenes were chosen including (S)-(-)-limonene, (R)-(+)-limonene, (-)-(2S,4R)-*cis*-rose oxide/(-)-(2R,4R)-*trans*-rose oxide mixture, furanoid (+)-*trans*-linalool oxide/ furanoid (-)-*cis*-linalool oxide/furanoid (-)-*trans*-linalool oxide/furanoid (+)-*cis*-linalool oxide mixture, (-)-linalool, linalool, (-)-α-terpineol, (+)-α-terpineol and (R)-(+)-ß-citronellol. The effect of these profiles was measured in three different "matrices": (1) 13% ethanol, ph 3.5, (2) dearomatized Pinot gris wine and (3) commercial Pinot gris wines. Matrix 1 was chosen to determine if the chiral monoterpenes could influence aroma by themselves. Matrix 2 was chosen to show any non-volatile matrix effects to chiral monoterpene perception and matrix 3 was chosen to determine any volatile aroma compound interactions with the chiral monoterpenes. Regular white wine drinkers participated in triangle tests across 10 different tasting sessions for each wine matrix. The chiral monoterpenes were not found to significantly impact aroma when in Matrix 1 or 2 was used, suggesting that chiral terpenes do not directly impact aroma perception and there were no interactions with non-volatile component of wine. However sensory perception did change when chiral monoterpenes were in matrix 3, showing that in combination with other aromatic compounds, the chiral monoterpenes altered sensory perception. These results support the theory that aroma perception of some wine components are due to interactions even at concentrations below their perception threshold.

Impact of the Timing and Temperature of Malolactic Fermentation on the Sensory Properties of Chardonnay Wine

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Abstract

Malolactic fermentation (MLF) is an important process in the production of red and white wines with the reduction in acidity being particularly important for cool climate produced wines that generally have higher acidity. MLF is typically induced by the addition of *Oenococcus oeni* after the completion of the alcoholic fermentation (AF) but can also occur at the same time as AF by inoculating *O. oeni* simultaneously with the fermentative yeast *Saccharomyces cerevisiae*. This study investigated the effect of this different MLF inoculation timing as well as the temperature of MLF and the presence of the non-*Saccharomyces* yeast *Torulaspora delbrueckii* on Chardonnay wine mouthfeel. Chardonnay wines were produced in 2014 with MLF occurring at different times (simultaneous or sequential inoculation) and temperatures (15 or 21°C) with or without the addition of *T. delbrueckii*. Mouthfeel attributes of the wines produced were assessed by a winemaker panel, and analyzed using correspondence analysis. Significant differences in mouthfeel perception were found based on timing and inoculation conditions, as well as between temperatures. In wines produced at 21°C there were notable sensory differences between sequential, and simultaneous MLF inoculation with *T. delbrueckii*. Sequential MLF wine was described as "round, smooth, and acidic" while simultaneous MLF wines were described as "prickly, salty, balanced, and chewy". Sensory differences between sequential and simultaneous MLF inoculation with *T. delbrueckii* at 15°C were also noted. Wines produced from sequential MLF were discussed as "thin, dry, and astringent" while "smooth, round, and acidic" terms were used for wines produced by simultaneous MLF. Treatment type and temperature also effected the chemical composition of finished wines. These findings demonstrate the usefulness of various fermentation practices to influence the sensory qualities of a Chardonnay wine including mouthfeel qualities.

Application of A Simple Lichrolut-EN Resin Based Solid Phase Extraction for Aroma Extract Dilution Analysis of Merlot Wine

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Abstract

Wine aroma is one of the most important attributes for wine quality. To understand compounds responsible for wine aroma, wine is typically extracted by liquid-liquid extraction with an organic solvent, then analyzed by gas chromatography-olfactometry (GC-O) and aroma extract dilution analysis (AEDA to determine the most important compounds. This protocol needs large amount of organic solvent. The extract also contains high levels of alcohols and acids, which interfere with analysis. A simple Lichrolut-EN resin based solid phase extraction was compared with traditional liquid-liquid extraction to study the aroma compounds in Merlot wine. The extracts were passed through a solvent-assisted flavor evaporation device and analyzed by Aroma Extract Dilution Analysis. In general, SPE is comparable with liquid-liquid extraction to obtained aroma extract for GC/olfactometry analysis, and it is faster and uses much less organic solvent. SPE extract had higher flavor dilution values for esters, lactones, but lower for acids and alcohols, phenolic, sulfides than liquid-liquid extraction. AEDA showed ethyl 2-methylpropanoate, ethyl butanoate, ethyl 2-methylbutanoate, ethyl isovalerate, ethyl octanoate, isoamyl acetate, 2/3-methyl-1-butanol, b-damascenone, butanoic acid, 3-methylbutyric acid, hexanoic acid, vanillin, guaiacol, eugenol, 4-vinylphenol, 4-vinylguaiacol, 4-methylguaiacol, cis/trans-whisky lactone, γ-nonalactone, 4-Hydroxy-2,5-dimethyl-3(2H)-furanone, homofuraneol, sotolon, methional, 3-(methylthio)propanol, 3-isopropyl-2-methoxypyrazine, 3-isobutyl-2-methoxypyrazine, 3-hydroxy-2-butanone as the most important odorants for Merlot wine.

Regulated Deficit Irrigation on Malbec and Syrah Grape and Wine Volatiles

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Abstract

Regulated deficit irrigation, aimed at improving water usage efficiency and reducing canopy vigor, is an important vineyard practice for sustainable viticulture, especially in arid and semi-arid areas. Previous studies have demonstrated that Imposing water deficit to the vine during berry development will affect vine physiology, and different grape vines will respond to water stress differently. In addition, both the extent of stress and timing of the stress will affect vine growth and secondary metabolite accumulation in grapes. The objective of this study is to determine water stress on Malbec and Syrah grape secondary metabolites and implication to wine quality. Four irrigation regime (70 % ETc from fruit set to veraison, 35 % ETc from veraison to harvest (70/35), 70% ETc sustained from fruit set to harvest (70/70), 35 % ETc from fruit set to veraison, 70 % ETc from veraison to harvest (35/70), and 35% ETc sustained from fruit set to harvest (35/35)) was applied to the vines with two irritation frequencies (1x= one event per week, 3x=same irrigation amount apportioned into three irrigation events per week). In year 2013, 35/35 treatment with 1x frequency resulted in highest concentration of trans-β-damascenone in Malbec grapes but no significant difference for Syrah grapes. The treatment with 35/35 irrigation region and 1x frequency also resulted in higher vitispirane and TDN in Malbec grapes but not in Syrah. Syrah has higher concentration of C6 compounds compared to Malbec grape. The result demonstrated that the effect of irrigation on grape volatile composition is variety dependent.

Aroma Characterization of Syrah Wines by Gas Chromatography-Olfactometry

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Abstract

Vitis vinifera L. Cv. Syrah is one of the most widely grown red varieties in the world. Syrah can be made to a single varietal wine or blended with other grapes. The aroma of Sarah wines vary greatly based on the climate, terroir and viticultural practices. Blackberry, peppery, smoky attributes are frequently noticed. The aroma characters of Sarah wines were investigated in this study. A solid phase extraction based on Lichrolut-EN resin was used to extract the volatile compounds from two Syrah wines from Oregon. The extracts were passed through a solvent-assisted flavor evaporation device and then analyzed by gas chromatography-olfactometry (GC-O) and aroma extract dilution analysis (AEDA) to determine the aroma-active compounds. Based on the aroma extract dilution analysis, ethyl 2-methylpropanoate, ethyl butanoate, ethyl 2-methylbutyrate, ethyl 3-methylbutyrate, 3-methylbutyl acetate, ethyl hexanoate, ethyl octanoate 2-methyl-1-butanol, isoamyl alcohol, phenylethanol, 3-methylbutyric acid, hexanoic acid, gamma-nonalactone, gamma-decalactone, b-damascenone, trans/cis-whiskylactone, 3-hydroxy-2-butanone, guaiacol, 4-ethylguaiacol, eugenol, 4-vinylphenol, 4-vinylguaiacol, furaneol, sotolon, vanillin, methyl vanillate, ethyl vanillate, methional, 3-(methylthio)propanol were the most important aroma-active compounds. Quantitative data were also compared in Syrah wines from different origins.

Notes: