Oregon Wine Research Institute

2017 Grape Day

Management of Trunk Disease, Grapevine Viruses and Fungicide Resistance
LaSells Stewart Center, OSU Campus, Thursday, April 6

Abstracts of Presentations and Posters

Oregon State University OSU College of Agricultural Sciences

Program Schedule

8:30 AM – 9:00 AM	Registration and Refreshments
9:00 AM – 9:05 AM	Introduction and Welcome; *Mark Chien, Program Coordinator*
9:05 AM – 9:50 AM	**Management of Grapevine Trunk Diseases; a difficult but not impossible task** *Dr. José Ramón Úrbez-Torres, Agriculture and Agri-Food Canada; Summerland Research and Development Centre, British Columbia*
10:00 AM – 10:45 AM	**Red Blotch in Oregon** *Dr. Vaughn Walton, Associate Professor, Horticultural Entomologist: Department of Horticulture, OSU*
10:45 AM – 11:45 AM	**Interactive Poster Session** This session will provide you the opportunity to interact one-on-one with scientists and students conducting research at the OWRI. These posters will feature research findings that are in-progress for various research projects being conducted across a wide array of topics within viticulture, enology, and economics.
11:45 AM – 12:30 PM	**An Integrated Multi-Omics Approach to Understand the Impact of Grape Leafroll Disease on Berry Ripening** *Dr. Laurent Deluc, Associate Professor, Grape Genomics, Department of Horticulture, OSU*
12:30 PM – 1:30 PM	**Lunch**
1:30 PM – 2:15 PM	**Grape Powdery Mildew Management: An Integrated Approach** *Brent Warneke, OSU Botany and Plant Pathology Graduate Student of Dr. Walter Mahaffee, USDA-ARS Research Plant Pathologist*
2:15 PM – 2:45 PM	**Break/Poster Session**
2:45 PM – 3:30 PM	**Impact of Grapevine Red Blotch- Associated Virus on Grape and Wine Composition** *Dr. Anita Oberholster, Cooperative Extension Specialist in Enology, Department of Viticulture and Enology, University of California, Davis*
3:30 PM – 3:45 PM	Final Q&A and program wrap-up

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Impact of Grapevine Red Blotch-Associated Virus on Grape and Wine Composition

Anita Oberholster[1]*, Raul C. Girardello[2], Sean S. Eridon[3], Larry A. Lerno[4], Charles Brenneman[5], Hildegarde Heymann[6], Martina Sokolowsky[7], S. Kaan Kurtural[8], Vanessa Rich[9], Cassandra Plank[10], Monica L. Y. Cooper[11], Rhonda J. Smith[12]

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Abstract

Grapevine red blotch-associated virus (GRBaV) was identified in grapevines in 2011 and is the causal agent of grapevine red blotch disease (GRBD). Research indicates that GRBD results in a decrease in sugar accumulation in affected fruit compared to fruit from healthy vines irrespective of cultivar or clone. For the last 3 years the impact of GRBD on both grape and wine composition have been investigated and results indicate that grape berries from symptomatic Cabernet Sauvignon, Chardonnay and Merlot vines also have in addition to lower sugar, lower anthocyanin concentrations in the red varieties, with variable impacts on other phenolic compounds such as flavan-3-ols and their polymers (tannins) when compared to fruit from healthy vines. Untargeted metabolomic profiling indicates a separation among grapes and wines produced from diseased and healthy/asymptomatic vines based on primary and secondary metabolites using partial least square discriminant analysis (PLS-DA). The separation was mostly driven by increased concentrations of amino and carboxylic acids in fruit and associated wines from vines with GRBD and higher concentrations of monosaccharides and polyols in fruit and associated wines from healthy/asymptomatic vines. Findings indicate that the impact of GRBD on grape and wine composition is not variety but site specific with significant seasonal effect.

Descriptive sensory analysis showed that the wines could be distinguished from each other based on disease status due to aroma, taste and mouthfeel differences. The difference in sugar concentration at harvest resulted in significantly higher ethanol concentrations in wines made from fruit from healthy/asymptomatic vines compared to symptomatic vines, which strongly affected sensory properties. Current studies are utilizing sequential harvesting to evaluate grapes and wine at similar sugar and ethanol content irrespective of disease status.

Management of Grapevine trunk diseases: a difficult but not impossible task

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Abstract

Grapevine trunk diseases (GTD) are caused by a wide range of fungal pathogens and include black foot and Petri Disease, responsible for the decline of young vines, and esca, Botryosphaeria dieback, Eutypa dieback, and Phomopsis dieback, which cause decline and eventual death in mature vines. Though GTD have long been known, their impact on vine health has significantly increased during the last 20 years. After the prohibition and/or phased out of effective control products against GTD in early 2000 due to human health risks and environmental concerns, no management strategies were available for grape-growers to control these diseases. Currently, GTD occur wherever grapes are grown and are considered the main biotic factor limiting both vineyard longevity and productivity with economic losses estimated in hundreds of millions of dollars worldwide. Therefore, the development of effective control strategies against GTD has been the main priority for industry and researchers during the last decade around the globe. Moreover, knowledge of GTD epidemiology at a regional level has been shown to be of critical importance to assist in the implementation of effective control strategies. Accordingly, the goal of this presentation is to give an overview of some of the research conducted in the last years to find solutions against GTD. Control strategies to be discussed will include the use of appropriate cultural practices, remedial control strategies and application of preventative fungicides and/or biological agents to wounds.

Red Blotch in Oregon

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Abstract

During 2016 we found three potential virus vector insects in Oregon vineyards. *Spissistilus festinus* was found in Southern Oregon and was recorded in all production regions throughout Oregon during the last 100 years (data from OSU insect collection). We additionally found the treehopper species (Membracidae) *Tortistilus wickhami* and *T. albidosparsus* in Oregon vineyards. *Tortistilus wickhami* was predominantly found in Southern Oregon, with lower numbers of *S. festinus* and *T. albidosparsus*. *Tortistilus albidosparsus* was predominantly found in the Willamette Valley. The seasonal population levels of *T. albidosparsus*, feeding and egg-laying levels in relation to temperature were described for the Willamette Valley. All suspected vector insect species were consistently found in vineyards where GRBaV spread year over year. The spread of GRBaV is alarming, with observed doubling and 10X increases in study sites from 2014-2016. Treehoppers are believed to be the most likely species moving Red Blotch between vines.

The patterns of virus spread within vineyards closely link feeding symptoms of treehoppers. Our data indicate that GRBaV-infected plants are concentrated and spread from the edge of the sampled vineyard blocks. Virus transmission biology work is currently ongoing (3 months post-inoculation) with more than 600 plants in greenhouse trials. During 2016 we reached ~800 growers though the different channels as part of the extension objective.

Grape Powdery Mildew Management: An Integrated Approach

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Abstract

In order to improve grape powdery mildew (GPM, causal agent *Erysiphe necator*) management, fungicide mobility was examined in both field and lab experiments. All fungicides tested had protective vapor mobility in the lab and five of them were confirmed in the field. In addition, xylem and translaminar protective mobility were assessed and six had some degree of both attributes. The most critical time to protect berries from GPM infection is during bloom and shortly thereafter, when inflorescence architecture and abundance of susceptible tissues may facilitate spore deposition and infection. We examined how to integrate concepts of plant phenology, tissue susceptibility and fungicide mobility to reduce GPM incidence on fruit. Field experiments indicated that timing some mobile fungicides to late bloom and early berry development significantly reduced disease incidence on berries. However, the presence of fungicide resistance in Oregon *E. necator* populations can negate otherwise effective applications and further complicates disease management. We conducted surveys of vineyards in 2015 and 2016 to elucidate if quinone outside inhibitor (QoI) and sterol biosynthesis inhibitor (SBI) resistance was present by collecting a total of 120 field samples, yielding 87 GPM isolates. qPCR analysis showed that 72% of the isolates were resistant to QoI fungicides which was confirmed with a conidia germination bioassay. DMI resistance testing using a leaf disc bioassay showed that of the 46 isolates collected in 2015, 50% were classified as moderately resistant and 33% were classified as very resistant to two commonly used SBI fungicides.

An integrated Multi-Omics approach to understand the impact of Grape Leafroll Disease on berry ripening

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Abstract

Grapevine Leafroll Disease is still one major threat to the worldwide production of wine grape with a major impact on fruit composition and wine quality. For the past two decades, major research accomplishments have focused on improving methods for virus detection. More recently, a better understanding of the biology, ecology and management of the disease was emphasized. By contrast, the molecular mechanisms associated with the impact of the virus on fruit ripening are still poorly understood. Targeted attempts to mitigate the effects of the virus will benefit from a complete understanding of the virus impact on the molecular mechanisms responsible for normal fruit development such as *the regulation of gene expression*. Transcription factors, micro-RNA molecules and alternative splicing events are known to regulate gene expression during plant development and stress conditions. Using Next-Generation Sequencing, we developed a project aimed *to integrate* the effects of GLRaV-3 on these different "regulators" in order to identify the major regulatory nodes for grape berry gene expression that are altered by the virus during the ripening. From this holistic approach, we observed that the majority of the changes in gene expression between healthy and infected fruits mostly occurred during the beginning of the ripening phase with a significant enrichment of genes involved in essential metabolic (primary and secondary metabolisms) and stress-related functions. We found that the virus-induced expressed genes tend to be under the control of different classes of transcription factors in infected berries. We revealed the accumulation of ~180 micro-RNAs that were predicted to target ripening-, stress-, and epigenetic-related genes. Some of these micro-RNAs accumulate differently between healthy and infected berries and target genes that were also found differentially expressed in both conditions. Finally, we found that a significant number of genes differentially alternatively spliced between healthy and infected berries were associated with various regulatory processes such as plant hormone signaling and epigenetic mechanisms known to influence gene expression.

Exploring Relationships Between Site, Yield, and Vintage Variability in Willamette Valley Pinot noir Vineyards

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Abstract:
The majority of Oregon Pinot noir vineyards are cluster thinned to reduce yields to a target of 2 – 2.75 tons/acre despite variable vineyard productivity and seasonal climate. To determine the impacts of yield on vine health, fruit composition, and wine quality, a cluster thinning experiment was conducted in more than 10 vineyards over a 5-year period (2012 – 2016). Most vineyards applied cluster thinning (1 cluster/shoot) and a non-thinned control. Thinning to 1 cluster/shoot affected basic fruit ripeness at harvest (pH, titratable acidity, and total soluble solids) but effects were not consistent across vineyards or seasons. Between 10-21% of vineyards had differences in at least one component of basic ripeness at harvest in all years, and the differences found in each vineyard were not the same each year. These results prompted the examination of variability in vineyard productivity and seasonal heat units between vineyards and years. Yield per linear foot was highly variable between vineyard sites despite similar cluster thinning treatments used. In 2015, the highest yielding year, the lowest crop level in the most productive vineyard had greater yield than the non-thinned treatment of the least productive vineyard. Seasonal heat unit accumulation (growing degree days, GDD_{50}) between 1 April and 1 November ranged from 2080 GDD_{50} to 2717 GDD_{50} in 2016, and was not related to the elevation of the vineyard. Despite a higher mean GDD_{50} between véraison and harvest in 2016, heat units for each vineyard were not consistently greater during this time period in 2015 or 2016. The variability of productivity and environmental conditions across vineyards and years in the Willamette Valley suggests that a site specific yield management approach is needed to achieve fruit quality and that standardized yield targets applied across vineyards and seasons are no guarantee for fruit or wine quality.

Leaf Blades versus Petioles for Diagnosing Nutrient Status in Pinot noir

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Abstract

A comparison of leaf blade and petiole nutrient concentrations was carried out to investigate which tissue better relates to vine responses of Pinot noir grapevines to varying levels of nitrogen (N), phosphorus (P), and potassium (K) supply using data from a pot-in-pot vineyard over 4 years. Leaf blades and petioles were collected at bloom and veraison in each year and N, P, and K concentrations were assessed as predictors of leaf area at veraison, pruning mass at dormancy, yield, and must YAN, P, and K concentrations at fruit maturity. Data from commercial vineyards were also used to investigate the relationship between leaf blade and petiole N concentrations with must YAN levels. Results showed that leaf blades were superior to petioles in predicting vine growth, yield, and must YAN responses across a wide range of vine N status at both sampling times. Leaf blade N was a better predictor than petiole N in predicting YAN using datasets from both the pot-in-pot vineyard and commercial vineyards. Relationships between leaf blade and petiole concentrations of P and K and vine response variables generally did not differ and both tissues appeared to be equally effective in predicting P and K effects on growth, yield, and must P or K levels. Although, petiole P was slightly better than leaf blade P at bloom in predicting must P levels; and models including both leaf and petiole K simultaneously as predictors relied only on leaf K. For all three nutrients, sampling at bloom and veraison had a similar predictive strength for response variables. Based on these findings, we recommend using leaf blades as opposed to petioles for diagnosing the N, P, and K status of Pinot noir.

Understanding Nitrogen Fertilization Impacts on Pinot Noir Bud Fruitfulness

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Abstract

Nitrogen (N) is one of the most important mineral nutrients for grapevines, as it influences vine vegetative growth, floral development, and yield. The effect of N fertilization on bud fruitfulness (number of inflorescence primordia per node) of *Vitis vinifera L*. 'Pinot noir' was quantified in a commercial vineyard located in Oregon's Willamette Valley during January 2017. Buds were dissected from vines that received one of the following: 1) fertilization with 40 to 60 lbs of N/acre or 2) Control – no fertilization in the two prior growing seasons (2015 and 2016). Bud fruitfulness (FFL) was determined by visual microscopy of dormant buds to determine number of inflorescence primordia in both the primary and secondary buds within compound buds. Inflorescence size was measured and the integrated fruitfulness index (IFI) was calculated, which is the sum of the diameters of all inflorescence primordia per bud. Bud FFL and IFI were influenced by increases in average cane weight which was associated with N fertilization. Nitrogen fertilization led to 6.7% higher cane weights, and there was greater IFI with greater cane weights. Also, an increase in the diameter of the internodes was related to increased fruitfulness of the primary bud (FFLprim), suggesting a potential impact of N on fruitfulness. Node position along the cane influenced FFL, IFI, and IFIprim. Basal nodes 2 and 3 had lower fruitfulness (2.1 inflorescences/node) than more distal nodes 5, 9, 10 and 12 (2.8 inflorescences/node). Inflorescence primordia in basal node 1 were smaller than those at more distal nodes 4-12 by 33%. This is the first evidence from this vineyard trial to suggest that N use may increase potential yield. Fruitfulness (clusters per vine) will be determined post-bud break along with other yield components to understand yield effects, and this research will continue for two additional growing seasons.

Comparing Nitrogen Fertilization in the Vineyard versus Supplementation in the Winery on Pinot noir and Chardonnay

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Abstract

This study was conducted on Pinot Noir and Chardonnay to investigate the effect of nitrogen (N) fertilization on vineyard productivity and wine properties as well as the influence of N supplements in the winery on wine properties. Four treatments with four replicates each were set in randomized blocks for each variety in 2016. Treatments included: A) no N addition in vineyard or winery as control; B) No N in vineyard + DAP supplement in winery; C) No N in vineyard + Organic-N supplement in winery; D) N fertilization in vineyard + No N in winery. Vineyard fertilization increased N status in both varieties, but had no influence on vine growth, level of fruit exposure, and vine water status. Yield of Pinot Noir was unaffected by vineyard N addition, whereas yield of Chardonnay was higher for N fertilized vines (D), compared to + Organic-N (C). Total soluble solids, titratable acids, and pH at harvest was unaffected by vineyard N fertilization. Must YAN improved with vineyard N addition, and the increase of YAN in Chardonnay (from 99 to 189 NOPA YAN) was more significant than that in Pinot Noir (from 176 to 243 NOPA YAN). After N addition in the winery, must YAN in Pinot Noir was the same among the three treatments with N additions in either vineyard or winery (B, C, and D). Must YAN in Chardonnay was the highest in + DAP (B) and + vineyard N fertilization (D), lower in the + Organic-N (C), and was the lowest in the control (A). Pinot Noir musts completed fermentation one day sooner in treatment D than the other treatments. The Rate of fermentation was unaffected by treatments in Chardonnay. The sensory attributes of wines will be evaluated in the summer of 2017.

Developing a Model System to Understand Nitrogen Responses in Grafted Pinot noir grapevines

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Abstract

Understanding the relationships between root and shoot growth in the context of nitrogen (N) driven vine vigor is a critical step to identify scion/rootstock combinations for improved vineyard sustainability in Oregon. Rootstocks are well known to alter the vigor of the scion and this in turn is affected by the level of N in soil. In addition, the genotype of the scion influences root development by modulating carbon allocation below ground. A complex relationship involving root-to-shoot and shoot-to-root signaling governs the coordinated development of roots and shoots, but the physiological basis of this control is poorly understood. The goal of this research is to develop a model system using different scion/rootstock combinations to gain a deeper understanding of how vigor and root to shoot balance is regulated in grapevines. An experiment is underway to examine vine root and shoot responses among 12 scion/rootstock combinations that were selected based on known variation in vigor for both the scion and rootstock components of the grafted vine. Three Pinot noir clones (FPS 106.1, FPS 46.1 'Dijon 114', and FPS 91.1 'Pommard') and four rootstocks (Riparia Gloire, 3309C, 101-14Mgt, 1103P) will be evaluated over two seasons with low and high N supply. Plant shoot and root growth characters, various components of vine water relations, gas exchange, and biomass and nitrogen allocation patterns will be measured to provide the baseline data needed to begin model development based on N response. Other factors including soil type and water availability will be integrated into the research as model development continues. This project will provide a deeper knowledge of the physiology of vine balance in order to better guide future vineyard planting and management decisions.

Implicated Vectors and Spread of Grapevine Red Blotch-associated Virus in Oregon Vineyards

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Abstract

Grapevine viruses have detrimental consequences for wine grape production, as is known for Grapevine leafroll-associated viruses (GLRaVs) and Grapevine red blotch-associated virus (GRBaV). From 2013-2016, vineyards in three wine grape production regions of Oregon were surveyed for the presence of GRBaV. Leaf tissues in study vineyards were collected and assayed using qPCR for GRBaV. Results were assessed to determine the rate of spread of GRBaV and to compare infection patterns with those of GLRaV-3. Virus-positive grapevines were subjected to spatial analysis to identify hotspots of virus infection, spatial distribution and patterns of spread within vineyard blocks. The findings indicate that GRBaV is present in the Willamette Valley and in Southern Oregon, and the spatial mapping strongly suggest that the virus is spread by insect vectors. Previous studies indicate that GRBaV is vectored by a membracid insect, *Spissistilus festinus*. In Fall 2016, leaf girdling and treehopper insects were observed in some study sites. The patterns of insect feeding damage were plotted and spatially analyzed in order to indicate the areas that have high levels of feeding symptoms. The patterns in all studied sites indicated significantly higher levels of feeding symptoms along the edges of the vineyard blocks. The membracid treehopper species *Tortistilus albidosparsus* and *T. wickhami* were collected in both regions in Oregon. We initiated greenhouse bioassays on these two species to determine whether they could vector GRBaV. The greenhouse studies are ongoing, and we will also determine the virus status of vines found in 2016 to have treehopper feeding damage.

Do you have a mildew management problem? Fungicide resistance in Oregon

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Abstract

Grape Powdery Mildew (GPM) has developed yet another way to circumnavigate our best laid plans…fungicide resistance. *Erysiphe necator* populations resistant to both quinone outside inhibitor (QoI, FRAC Group 11) and demethylase inhibitor (DMI, FRAC Group 3) fungicides are widespread in Oregon and California grape growing regions. GPM infected field sample were collected from vineyards across Oregon in 2015 and 2016, yielding 87 GPM isolates and 120 infected field samples for analysis. Of these isolates, 72% were resistant to QoI fungicides based on quantitative PCR (qPCR) analysis, and confirmed with a conidia germination bioassay. Of the infected field samples, 80% were colonized by a measurable amount of QoI resistant GPM. Analysis of air samples collected from commercial vineyards from 2013-2016 showed that resistance was detected 2 years prior to control failures. DMI resistance testing is ongoing and development of molecular markers is in progress. Of the 46 isolates collected in 2015, 50% were characterized as moderately resistant and 33% were characterized as very resistant to Rally (myclobutanil) and Elite/Toledo (tebuconazole). There is, however, a ray of hope. In fields that experienced very high populations of QoI resistant GPM at the beginning of the 2016 growing season, and where QoI fungicides where not used in the 2016 growing season, the relative abundance of QoI resistant GPM dropped to near detection limits by the end of the growing season. This trend indicates that we may be able to restore the efficacy of these fungicides through fungicide rotation and monitoring.

Early Occurrence of Grape Powdery Mildew in Western Oregon

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Abstract

The Fruit and Ornamental Disease Management Testing Program has annually provided Oregon growers with relative efficacy of fungicides, fungicide schedules or cultural practices for control of plant diseases since 1989. Testing has been conducted at the Botany and Plant Pathology Research Farm, Corvallis, OR. Among many crops, 5 acres of vineyards were established to test for grape powdery mildew (*Erysiphe necator*) or bunch rot (primarily *Botrytis cinerea*) management. Vineyards were managed for weeds, insects, cane or spur pruned and trained with vertical shoot positioning. Weather conditions were favorable for powdery mildew development such that non-fungicide treated plots frequently developed 100% incidence on leaves and/or clusters each year. Vineyards were surveyed intensively most years for the first occurrence of powdery mildew to determine fungicide program initiation. The first symptoms were recorded either as flag shoots (infected buds from the previous year), first individual colonies or both. The first symptoms did not always correspond to non-fungicide treated plots and occurred in multiple cultivars at the same time but were widely scattered through various vineyards. The date of first occurrence in any one year was as early as 26 April (2016) or as late as 30 June (1993). Powdery mildew occurred an average of 21 days prior to Pinot Noir bloom ranging from 1 to 45 days before bloom. Flag shoots occurred in 9 out of 22 years surveyed (from 1993 to 2016) and in 5 out of the last 6 years (2011 to 2016). Overall trends from 1993 to 2016 indicate that powdery mildew has occurred earlier in the calendar year, prior to Pinot Noir bloom and more often as flag shoots. Growers in western Oregon are advised to begin fungicide management programs well before bloom (no later than BBCH 57) especially when not monitoring for spores of the fungus.

Functional Characterization of Auxin Response Factor 4 in Grape Berry ripening

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Abstract

Auxin-response factor 4 (*ARF4*) mediates auxin-induced negative regulation of ripening, mainly during ripening transition stage. Shift in berry ripening features such as fruit softening, increase of sugars, and pigment development coincide with the decline of *ARF4* expression. Further, this decline also precedes the increase in ripening promoting hormone, abscisic acid. Whether ARF4 directly inhibits the expression of sugar and ABA-related gene transcription is not known. To functionally characterize its role in ripening, we are using a 'microvine model system'. This is a grapevine model system suitable for rapid forward and reverse genetic studies in small controlled environments. It is based on the Vvgai1 mutant allele that confers a dwarf stature, short generation cycles and continuous flowering. As our aim is to characterize the function of *ARF4* during ripening transition, we are using an inducible expression system in microvines that enables us to control the time of *ARF4* induction or repression. Through this approach, we will confirm the role of VviARF4 during ripening 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.

The Impacts of Two Viticultural Practices on the Dynamic Spatiotemporal Hormone Accumulation in Pinot Noir Berries

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Abstract

Two common, yet expensive, practices used in viticulture are cluster-thinning (CT) and cluster-zone leaf removal (LR), 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 and abscisic acid in order to understand the physiological effects of cluster-thinning and leaf removal on the dynamic accumulation of these compounds in the berry. Clusters were thinned to 0.5 clusters/shoot for the cluster-thinned vines; one-hundred percent of the cluster-zone leaves were removed from the leaf-removal vines. Similarly-developing berries were identified at eight time points during the growing season using each individual berry's developmental profile and multivariate analysis tools. The tissues of the berries were separated (seed, pulp, and skin) and pooled according to their vine of origin in preparation for metabolite extraction. Phytohormones were extracted using a targeted method developed within our laboratory and analyzed using HPLC-MS/MS under selective reaction monitoring mode. Data collected over two growing seasons indicate a clear spatial and temporal distribution of the bioactive and conjugate forms of the analytes, most of the accumulation of which were correlated with major developmental transitions. The analysis of the precursors, conjugates, and catabolites of the bioactive analytes revealed specific regulatory pathways utilized in grape berries. We were successful in quantifying the effects of the two practices on the two hormones which are responsible for ripening initiation. The most notable effect was consistent reduction of ABA in seeds of the LR vines which was highly correlated with an elevated accumulation of the conjugated form, ABA-GE. The data might suggest an impact of either light or temperature in modulating the conversion of ABA into its glycosylated form.

Interactions between *Brettanomyces bruxellensis* and *Oenococcus oeni*

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Abstract

This study investigated the impact of *Oenococcus oeni* on wine hydroxycinnamic acid content and *Brettanomyces bruxellensis* growth. A number of commercial malolactic bacteria cultures as well as non-commercial *Oenococcus oeni* strains were assessed for their ability to hydrolyze tartaric ester-bound hydroxycinnamic acids (THCAs). Of the thirteen cultures assessed, two strains hydrolyzed THCAs including one of the non-commercial strains. This resulted in an increase in the amount of the free hydroxycinnamic acids in the wine. Changes in p-coumaric acid at other stages in the winemaking process were also examined. Pinot noir wines were produced using a *Saccharomyces cerevisiae* strain with (OSU-2) or without (CSM) phenolic acid decarboxylase activity (PAD). *O. oeni* strains with or without the ability to degrade THCAs were also used to conduct MLF either simultaneously or sequentially. Use of a yeast strain with PAD activity in combination with an *O. oeni* strain with THCA degradation activity reduced the total amount of 4-ethyl phenol precursor compounds (free and tartaric ester-bound p-coumaric acid), as free p-coumaric acid released by *O. oeni* was subsequently degraded by the PAD positive yeast. The impact of timing of *B. bruxellensis* infection relative to the completion of malolactic fermentation (MLF) was explored by inoculating Pinot noir wine with *B. bruxellensis* 0, 14, 30, and 100 days after the completion of MLF conducted by three different *O. oeni* strains. No growth of *B. bruxellensis* occurred when inoculated into wine 0 and 14 days post-MLF. However, *B. bruxellensis* grew well 30 days post-MLF in wine where *O. oeni* Beta had conducted MLF. 100 days post-MLF *B. bruxellensis* grew well in wine where MLF was conducted by *O. oeni* Beta and *O. oeni* Alpha but growth did not occur in wine where *O. oeni* VP41 had conducted the MLF.

Impact of pre-fermentation cold soak conditions on microbial populations and consequences for wine aroma

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Abstract

This study investigated the effect of cold soak conditions on yeast populations, wine volatile aromas, and wine color. Pinot noir wines were produced from grapes cold soaked for six days at two different temperatures (6 or 10°C) with the addition of 0, 50, or 100 mg/L SO_2. Wine was also produced from grapes that did not undergo cold soak. Grape musts were inoculated with six non-*Saccharomyces* yeast, commonly isolated from grapes. Yeast populations were monitored throughout the cold soak process. Temperature and SO_2 concentration impacted the growth of non-*Saccharomyces* yeast during the six-day cold soak in a species-specific manner. The highest populations observed were in the cold soak at 10°C when no SO_2 addition had been made. Here, *H. uvarum* increased in population from approx. 10^3 cfu/mL to almost 10^8 cfu/mL by the end of the cold soak. As increasing concentrations of SO_2 were added to the cold soak, the growth of non-*Saccharomyces* yeast, including *H. uvarum,* decreased. When 50 mg/L SO_2 was added, only low populations of *H. uvarum, T. delbrueckii,* and *L. thermotolerans* were detected at the end of the 6°C cold soak, while at 10°C only *H. uvarum* was detected. When 100 mg/L SO_2 was added, there were few culturable yeast present in the cold soaks at either 6 or 10°C. All wines made from grapes that underwent cold soak had significantly higher color and polymeric pigment content than wine made from grapes that did not undergo cold soak. Only small differences in color and polymeric pigment content were noted between wines made from grapes cold soaked under different SO_2 and temperature conditions. Ester concentrations differed significantly in wines made from grapes that were or were not cold soaked. In particular, wines made from grapes cold soaked with no SO_2 additions had lower concentrations of certain ethyl esters.

Regulated Deficit Irrigation on Malbec and Syrah Grape and Wine Volatiles

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Abstract

The concentrations of volatile compounds and precursors in grape berries are highly influenced by viticultural practices. Among these cultural practices, regulated deficit irrigation, aimed at improving water use efficiency and reducing canopy vigor, is an important practice for sustainable agriculture, especially in arid and semi-arid areas. Imposing a water deficit to the vine during berry development is an important vineyard management strategy to alter grape and wine quality. Previous studies have shown that water deficit influenced physiological parameters of the vine, changed berry composition and improved sensory attribute of wines by increasing fruity aroma and decreasing vegetal aromas. The objective of this study is to determine water stress on 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 2014, 35/35 treatments with 1x frequency resulted in highest trans-β-damascenone concentration, vitispirane and TDN concentration in Malbec grapes but not in Syrah grapes. In year 2015, the 35/35 treatments with 3x irrigation frequency led to a higher vitispirane and TDN level in Syrah grapes, but no differences were found in Malbec grapes. Wine volatile analysis showed 35/35 treatments resulted in higher linalool, ethyl butanoate, ethyl hexanoate in Malbec and higher ethyl butanoate, ethyl acetate and propanol in Sarah wine in 2015. In 2016, 70/35 irrigation amount with 3x irrigation frequency and 35/70 irrigation amount with 1x irrigation frequency resulted in higher level of total esters, while the 70/70 irrigation amount with 3x irrigation frequency lead to a lower total esters concentration in Malbec. But no differences were observed between treatments in total esters for Syrah. The results demonstrated that the effect of irrigation on grape and wine volatile composition might be vintage and variety dependent.

Sensory Evaluation and Non-Targeted Volatile Profiling for Vine Stressed Induced Off-flavor

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Abstract

One of the increased concerns of Oregon wine industry is related to vine stress. Although the off-flavor descriptors vary from winery to winery, the frequent descriptors used in the wineries include "tequila", "shellfish", "peanut", "ashtray", "dry weed", "herbaceous", "flint" and other descriptors. In young wine, the taint smells like "bay leave", and the wines do not age well. There were observations from wineries that taint could be related to compromised or nutritionally imbalanced fruits from stressed vines, induced by drought, nitrogen deficit, or a combination of many factors, but the exact cause(s) have never been studied or documented. This research is aimed at identifying the chemical nature of these off-flavors.

Off-flavored wines were obtained from industrial collaborators from Willamette Valley, and the stressed vine off-flavor was characterized by a sensory panel consisting of winemakers familiar with stressed vine off-flavor and OSU researchers. The panel was able to characterize the stressed vine off-flavor from the wines collected from industry.

Non-targeted volatile analysis was performed on the eight off-flavor wines obtained from industry. Twenty normal Pinot wines were also analyzed for comparison. Volatiles including higher alcohols, esters, volatile phenols and TDN (kerosene aroma) were analyzed by solid phase micro-extraction-GC-MS and stir bar sorptive extraction-GC-MS (EG and PDMS). The result showed that the off-flavor and normal wine had different concentrations of many compounds, and TDN, 4-vinylphenol, 4-vinylguaiacol, 3-ethylphenol, ethyl propionate, ethyl 2-methylpropanoate and 2-methylpropanoic acid can be used to distinguish the off-flavor and normal wines, however, the extract chemical nature of off-flavor is still a mystery.

Monoterpene Isomer Profiles of *Vitis Vinifera* L. cv. White Wines

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Abstract

While much work as focused on monoterpene content of white wine, little has investigated the different isomers of monoterpenes. These isomers may have an important effect to the aroma and flavor of wines. One hundred and forty-eight wines from eight grape varieties, Chardonnay, Gewürztraminer, Muscat, Pinot gris, Riesling, Sauvignon blanc, Torrontes and Viognier, were collected from 2012 and 2013 vintages. Seventeen monoterpene isomers were identified and quantitated by HS-SPME-MDGC-MS. Results obtained from general linear models showed significant differences for the compounds among the eight grape varieties. Isomers α-terpineol, linalool and linalool oxides isomers were abundant in Gewürztraminer, Muscat, Torrontes and Viognier wines. Linalool oxide and α-terpineol showed higher concentrations than other isomers in Riesling wines. Linalool oxide isomers were major monoterpenes in Chardonnay, Pinot gris and Sauvignon blanc wines. Interestingly, the isomers of each compound (enantiomer) had very similar profiles in the same varietal wine. A separation between varieties was achieved using discriminant analysis in spite of the high variability from region and wine style. The difference in monoterpene isomer profile and enantiomeric percentages from the varietal wines could contribute to the sensory differences in these wines.

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