



AMERICAN SOCIETY FOR
ENOLOGY AND VITICULTURE
Eastern Section

DIGITAL Nelson J. Shaulis
Symposium
VITICULTURE

New Tools for Precision Management

American Society for Enology and Viticulture-Eastern Section and

Nelson J. Shaulis Symposium

Digital Viticulture: New Tools for Precision Management

Geneva, New York

July 16-18, 2019

Email: info@asev-es.org

Website: <http://www.asev-es.org/>



N.J. Shaulis Symposium Support

DIGITAL Nelson J. Shaulis
Symposium
VITICULTURE

New Tools for Precision Management



AMERICAN SOCIETY FOR
ENOLOGY AND VITICULTURE
Eastern Section



John Brahm III



Nelson Shaulis, Bob Anderson,
John Brahm, and Shaulis Scholar
Glen Creasy

We dedicate this program to the memory of [John Brahm III](#), who directed the [Nelson J. Shaulis Fund for the Advancement of Viticulture](#) until early this year. The Shaulis Fund supports summer students with interests in viticultural research, and symposia for growers and researchers.

Thanks to the N. J. Shaulis Fund for supporting speaker travel for the Digital Viticulture tour and workshop

Additional major support was provided by:



The **Efficient Vineyard Project** is funded by the USDA's Specialty Crops Research Initiative Program of the National Institute for Food and Agriculture, Project #2015-51181-24393

Cornell AgriTech
New York State Agricultural Experiment Station

Cornell Initiative for Digital Agriculture
Connecting world-renowned researchers across academic boundaries with multidisciplinary practitioners to solve agri-food systems challenges.



Conference and Symposium Overview

Locations

Scandling Center, Hobart and William Smith Colleges, 300 Pulteney, Geneva, NY 14456
Ramada Geneva Lakefront, 41 Lakefront Drive, Geneva, NY, 14456

Tuesday, July 16, 2019

Registration, Breakfast, and Poster Setup	Scandling Center	7:00-8:00 am
Welcome	Scandling Center	8:00-8:10 am
Outstanding Achievement Award	Scandling Center	8:10-8:30 am
Student Presentation Competition	Scandling Center	8:30-10:00 am
Break and Poster Viewing/Judging	Scandling Center	10:00-10:30 am
Technical Sessions	Scandling Center	10:30-11:30 am
Student Flash Talk-Poster Summaries	Scandling Center	11:30 am-12:00 pm
Business Meeting and Awards Lunch	Scandling Center	12:00-1:30 pm
Student Presentation Competition	Scandling Center	1:30-2:30 pm
Technical Sessions	Scandling Center	2:30-3:30 pm
Break and Poster Viewing/Judging	Scandling Center	3:30-4:00 pm
Student Presentation Competition	Scandling Center	4:00-5:00 pm
Oenolympics & Wines of East Reception	Scandling Center	5:00-7:00 pm
Hospitality Suite	Geneva Room, Ramada	9:00-11:00 pm

Wednesday, July 17, 2019

Registration	Lobby, Ramada	7:00-8:00 am
Vineyard Tour and Digital Ag Demos	Keuka and Seneca Lakes	8:00 am-6:00 pm
Hospitality Suite	Geneva Room, Ramada	9:00-11:00 pm

Thursday, July 18, 2019

Registration and Breakfast	Scandling Center	7:00-8:00 am
Welcome	Scandling Center	8:00-8:10 am
Vine Balance and Precision Viticulture	Scandling Center	8:10-9:40 am
Break	Scandling Center	9:40-10:10 am
Session 1: Measurement	Scandling Center	10:40 am-12:00 pm
Lunch	Scandling Center	12:00-1:00 pm
Session 1: Measurement	Scandling Center	1:00-1:40 pm
Session 2: Modeling	Scandling Center	1:40-3:00 pm
Break	Scandling Center	3:00-3:30 pm
Session 3: Management	Scandling Center	3:00-5:00 pm
Symposium Wine Reception	Scandling Center	5:00-6:00 pm
Hospitality Suite	Geneva Room, Ramada	9:00-11:00 pm

ASEV-ES Conference Sponsors

Sponsors are recognized throughout the program.

2019 ASEV-ES Outstanding Achievement Award

Timothy Martinson, Senior Extension Associate, Cornell University

Tim Martinson has been involved in grape extension and research with Cornell University since 1991. After completing his MS and PhD degrees in Entomology at Cornell University, Tim was research associate with the grape entomology program at the NYS Agricultural Experiment Station in Geneva. In 1997, Tim became grape extension specialist for Cornell Cooperative Extension's Finger Lakes Grape Program, serving a diverse clientele of 230 growers and 90 wineries in the Finger Lakes region, with a vineyard base of 10,000 acres. He led development of the *VineBalance* sustainable viticulture program, and production of the *The New York Guide to Sustainable Viticulture Practices Grower Self-assessment Workbook*. In 2007, Tim was appointed senior extension associate to develop a Statewide Viticulture Extension Program. He led the USDA-funded Northern Grapes Project from 2011-2017, and currently edits the *Veraison to Harvest* weekly newsletter distributed statewide in New York, and *Appellation Cornell*, a quarterly publication highlighting research, extension, and teaching programs in Viticulture and Enology at Cornell. He currently serves as outreach coordinator for the *VitisGen2* project, funded by the USDA Specialty Crops Research Initiative, and as a member of the National Clean Plant Network's outreach committee. Tim has been a member of the ASEV-Eastern Section since 1997, serving as chair in 2009-2010.



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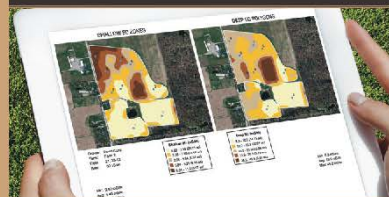
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Sponsor of Shaulis Symposium

Tuesday, July 16, 2019

Conference Registration and Continental Breakfast 7:00-8:00 am

Welcome 8:00-8:10 am

Chris Gerling, Cornell University and ASEV-ES Chair

Paul Read, University of Nebraska-Lincoln and ASEV-ES Vice Chair

ASEV-ES Outstanding Achievement Award 8:10-8:30 am

Tim Martinson, Cornell University

Student Presentation Competition (15 minutes each) 8:30-10:00 am

Release of Hydrogen Sulfide In Wine During Storage - Investigating the Stability of Copper-Sulfhydryl Complex Precursors of Sulfur-Like Off-Aromas Rachel B. Allison and Gavin L. Sacks

Efficacy of Mycorrhizal Inoculation Differs between Root Systems

Mariam P. Berdeja, Qiuhong Ye, and Justine E. Vanden Heuvel

Effect of Sun Exposure on the Evolution and Distribution of Anthocyanins in Interspecific Hybrid Red Winegrapes

Catherine Dadmun, Anna Katharine Mansfield, and Hans Walter-Peterson

Evaluating Tannin Retention in Chambourcin through the Lens of Protein-Tannin Interactions

Alex Fredrickson and Misha T. Kwasniewski

Severity of Early Defoliation Adjusts Grüner Veltliner Grape Composition and Cluster Qualities

Andrew Harner, Maria Smith, Marielle Donohue, Andrew Poveromo, Stephanie Keller, Helene Hopfer, and Michela Centinari

Defining Typicity of Pennsylvania-grown Grüner Veltliner Wines using Instrumental and Human Sensory Methods

Stephanie Keller, Helene Hopfer, and Ryan Elias

Break and View/Judge Posters 10:00-10:30 am

Technical Sessions (15 minutes each) 10:30-11:30 am

The Challenge of Canned Wines: Corrosion and Off-aromas

Luna Maslov Bandic and Gavin Lavi Sacks

Rootstock Effect on Yield and Fruit Quality of 'Chardone1' and 'Norton' Grapes in Alabama

Elina Coneva, Enfeng Xu, Andrej Svyantek, J. Raymond Kessler, Jr., and Edgar Vinson

Do Rootstock Genotype, Soil Depth, and Root Traits Structure Community Composition of Bacteria Associated with Grapevine Roots?

Suzanne Fleishman, David Eissenstat, Terrence Bell, and Michela Centinari

Delayed Pruning Delays Basal Bud Break but Reduces Crop Yield in Georgia-Grown Chardonnay

Cain C. Hickey, Rachael White, Clark MacAllister, Nathan Eason, and Steven Patrick

Student Flash Talks-Poster Summaries (3 minutes each) 11:30 am-12:00 pm

Investigating Dicamba Resistance in Vitis Interspecific Hybrid 'Chambourcin' - Bryce Bentley, Li-Ling Chen, and Chin-Feng Hwang

Enhancing Vine Health with Commercial Arbuscular Mycorrhizal Inoculants in Vineyards - Mariam P. Berdeja, Qiuhong Ye and Justine E. Vanden Heuvel

Causal Factors of Macrophoma Rot Observed on Petit Manseng Grapes - Nicole Encardes, Tony Wolf, Diana J. McHenry, and Mizuho Nita

Yeast Influence on Petite Pearl and Crimson Pearl Wine Sensory Attributes - Jacob Lachowitz, Andrej Svyantek, John Stenger, and

Harlene Hatterman-Valenti

Impact of Foliar Inactive Dry Yeast Application to Chambourcin Grapevines on Wine Anthocyanin Content - Sarah E. Mayfield and Renee T. Threlfall

Potential Insect Vectors of Grapevine Red Blotch-Associated Virus in Missouri Vineyards - Harper Smith, Dean Vollenberg, and Debbie Finke

Early Manual and Mechanical Leaf Removal as a Strategy to Improve Ripening and Lower Bunch Rot Disease in Pinot Grigio - Joshua VanderWeide,

Tommaso Frioni, Zhongli Ma, Manfred Stoll, Stefano Poni, and Paolo Sabbatini

Exogenous Abscisic Acid's Impact on Grapevine Physiology and Sugar Metabolism during Natural Cold Acclimation - Hongrui Wang, Joshua Blakeslee,

Michelle Jones, Laura Chapin, and Imed Dami

Rachis Elongation with Palissage: Is it a Sink or Source-mediated Response? - Qiuhong Ye and Justine E. Vanden Heuvel

ASEV-ES Business Meeting and Awards Lunch 12:00-1:30 pm

Student Presentation Competition (15 minutes each) 1:30-2:30 pm

Implicating Early Fruit Fly Life Stages in Sour Rot and Disease Progression in Absence of Adults
Patrick Kenney and Megan Hall

Zoning the Cabernet Franc Vineyards by NDVI Data from Unmanned Aerial Vehicles (UAVs) and Mapping Variability and Virus Titer of the Vineyards
Hyun Suk Lee, Andrew G. Reynolds, Briann Dorin, Ralph Brown, and Marilyne Jollineau

Impact of Foliar Grapevine Application of an Inactive Dry Yeast on Chambourcin Grapes from Veraison to Harvest
Sarah E. Mayfield and Renee T. Threlfall

Can Two Frost Avoidance Strategies Delay Grapevine Budburst without Negative Effects on Wine Quality and Vine Health?
Meredith Persico, Donald Smith, Helene Hopfer, and Michela Centinari

Technical Sessions (15 minutes each) 2:30-3:30 pm

Optimization of Chambourcin Grape Breeding Using Marker-Assisted Selection
Chin-Feng Hwang, Li-Ling Chen, Bryce Bentley, and Sadie Land

Insecticide Resistance in *Drosophila melanogaster* (Diptera: Drosophilidae) is Associated with Field Control Failure of Sour Rot Disease in a New York Vineyard
Haina Sun, Greg Loeb, Hans Walter-Peterson, Timothy Martinson, and Jeffrey G. Scott

Impacts of Dormant Pruning Methods and Nitrogen Fertilization on *Vitis vinifera* 'Pinot Noir' Bud Fruitfulness and Yield
Miranda R. Ulmer, R. Paul Schreiner, Patricia A. Skinkis,

Mapping the Distribution of Mealybug, Scale, and Ants in Vineyards
Faruque Zaman and Alice Wise

Break and View/Judge Posters 3:30-4:00 pm

Student Presentation Competition (15 minutes each) 4:00-5:00 pm

Leaf Removal Practices Alter Cluster Morphology and Soluble Solid Content of North Dakota Grown Marquette
Andrej W. Svyantek, John Stenger, Collin Auwarter, Nickolas Theisen, Matthew Brooke, and Harlene Hatterman-Valenti

Pre-bloom Leaf Removal Differentially Impacts Cabernet Franc Crop Yield and Fruit Composition on Opposite Sides of a Lyre Trellising System
Annie R. Vogel, Clark McCallister, Nathan Eason, and Cain C. Hickey

Introduction to the Athena Trellising System Developed by the University of Georgia
Rachael White, John Scaduto, and Cain Hickey

Adjourn 5:00 pm

Oenolympics & Wines of the East Reception 5:00-7:00 pm

Oenolympics, comprised of student and faculty/industry teams, is a competition designed to promote fun, fellowship, and creative thinking with enology and viticulture-themed games!

Hospitality Suite 9:00-11:00 pm

ASEV-ES Conference Planning in New York

Chris Gerling, Cornell University
Tim Martinson, Cornell University
Paul Read, University of Nebraska-Lincoln

Wednesday, July 17, 2019

Vineyard Tour and Digital Ag Demonstrations

Registration at Ramada Inn Lobby	7:00-8:00 am
Meet in Ramada Inn Lobby or Scandling Center, Hobart	8:00 am
Bus Leaves from Ramada Inn	8:20 am
Bus Leaves from Scandling Center	8:30 am
Demonstration of Technology used in SCRI Efficient Vineyard Project at Clearview Vineyards/Steuer Hill Winery	9:15 am
Soil sensing as a base layer for vineyard mapping (DualEM)	
Proximal canopy reflectance of grapevine canopies (CropCircle, Green Seeker)	
Grape yield monitoring during harvest (OXBO and Advanced Technology Viticulture)	
On-the-fly juice soluble solids monitoring (Cornell AgriTech and Misco)	
Variable-rate vineyard mechanization technology (AgLeader and VMech)	
Wines of Keuka Lake Tasting/Lunch at Clearview Farms	11:45 am
Depart for Anthony Road Vineyards	1:30 pm



Demonstrations on Vinifera at Anthony Road Vineyards	1:50 pm
Simple, networked Monarch weather stations (Adams, Cornell University)	
UAVs in the vineyard-Drone demonstration (Meyers, Cornell Cooperative Extension)	
3D cluster imaging (Kantor, Carnegie Mellon University)	
Cell-phone cluster imaging/crop estimation (Vanden Heuvel and Programs, Cornell University)	
Microtensiometer to measure vine water status (Lakso, Cornell University)	
Variable rate fertilizer applicator (Helena AgriEnterprise)	
Variable rate sprayer and auto-steer apparatus for tractor (Monroe Tractor)	
Wines of Seneca Lake Tasting and Reception	4:00 pm



Return to Geneva	5:30 pm
Arrive in Geneva	6:00 pm
Hospitality Suite	9:00-11:00 pm

Thanks New York State Women for Pouring Wine at Tastings



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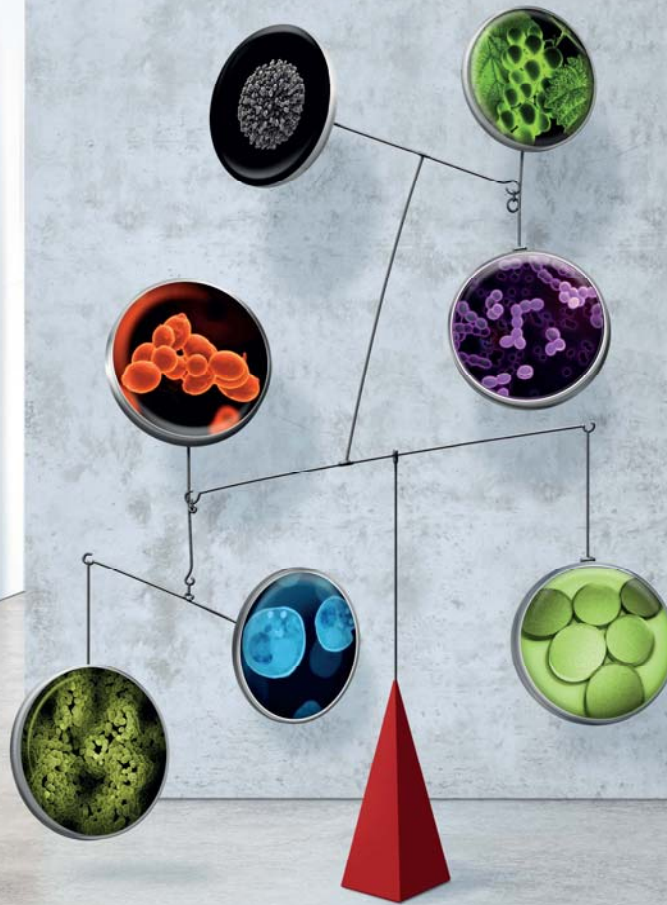
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Nelson J. Shaulis Symposium

Digital Viticulture: New Tools for Precision Management



Symposium Registration and Continental Breakfast 7:00-8:00 am
Welcome 8:00-8:10 am

Jan Nyrop, Director, Cornell AgriTech and Cornell Institute for Digital Agriculture
Tim Martinson, Sr. Extension Associate, Cornell Agritech

Session 1: Vine Balance and Precision Viticulture 8:10-10:40 am

The concept of balancing vegetative growth and cropping levels for sustained production – is a key organizing principle of viticulture and vineyard management. Growers have lacked the tools to apply this principle on a vine-by-vine basis to manage variable vineyards. New tools are converging to give growers the capacity to address variability through three steps: Measurement, Modeling, and Management.

What Nelson Shaulis Taught Us 8:10-8:30 am
Andy Reynolds, Professor of Viticulture, Brock University

The Physiology of Vine Balance 8:30-9:00 am
Justine Vanden Heuvel, Associate Professor, School of Integrative Plant Science, Cornell University

New Metrics: Examining Grapevine Response to Crop Load through a Different Lens 9:00-9:40 am
Nick Dokoozlian, Vice President, E & J Gallo

Break 9:40-10:10 am

The Promise of Precision Agriculture 10:10-10:40 am
James Taylor, Senior Researcher, IRSTEA, Montpellier, France

Session 2: Measurement 10:40 am-12:00 pm and 1:00-1:40 pm

New metrics from sensors, UAVs (Drones), satellites, and analytical technologies are becoming available to growers. What do they measure, and how can growers and buyers use the information?

Sensors for Assessing Soil and Canopy Attributes
From NDVI to Multispectral Sensors for Canopy Metrics Including
Early Disease Detection 10:40-11:00 am
Katie Gold, University of Wisconsin, Madison

Mapping Vineyard Soils using Proximal Sensors 11:00-11:20 am
Jackie Dresser, Efficient Vineyard Project, Cornell University

Imaging for Crop Estimation
3-D Image Processing for Cluster and Berry Counts 11:20 am-11:40 am
George Kantor, Sr. Systems Scientist, Carnegie Mellon University

What's in a Pixel: Satellite and Drone Imagery for Crop Estimation 11:40 am-12:00 pm
Jim Meyers, Cornell Cooperative Extension, Eastern NY Commercial Horticulture Program

Nelson J. Shaulis Symposium

Digital Viticulture: New Tools for Precision Management



Lunch 12:00-1:00 pm

Other Sensor Applications
Nanotensimeters for Measuring Vine Water Status 1:00-1:20 pm
Alan Lakso, Cornell University

Ultrasonic Sensors for Variable Rate Spray Applications 1:20-1:40 pm
Andrew Landers, Cornell University and Tim Martinson, Cornell University

Session 3: Modeling 1:40-3:00 pm
How to translate a flood of information and data into management decisions.

How We Process Spatial Data to Validate Sensors Measure and Convert Spatial Data to Management Zones 1:40-2:20 pm
James Taylor, Senior Researcher, IRSTEA, University of Montpellier, France

Making It User-friendly: Platforms for Integrating Information into Decision-support Systems with Software-defined farming 2:20-3:00 pm
Hakim Weatherspoon, Associate Professor of Computer Science, Cornell University

Break 3:00-3:30 pm

Session 4: Management 3:30-5:00 pm
How mechanization and varying management within blocks will save labor and increase profitability and/or quality.

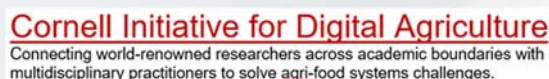
A Year in the Life of a Highly Mechanized Washington State Vineyard 3:30-4:15 pm
Richard Hoff, Director of Viticulture, Mercer Ranches, Prosser WA

Efficient Vineyard Project: Integrating Spatial Crop Load & Soil Mapping into Practical Management Plans 4:15-5:00 pm
Terry Bates, Director, Cornell Lake Erie Research and Extension Laboratory, Cornell University

Symposium Wine Reception 5:00-6:30 pm



Hospitality Suite 9:00-11:00 pm



Nelson J. Shaulis Symposium

Digital Viticulture: New Tools for Precision Management Speakers

Terry Bates joined the Horticulture Department at Cornell in January 1998, conducting research on plant nutrition and root biology in Concord grapevines at the Fredonia Vineyard Laboratory. In 2009, Terry became director of the newly-constructed Cornell Lake Erie Research and Extension Laboratory (CLEREL). Since 2015, Terry has been the Director of the USDA Specialty Crop Initiative Research Program-funded Efficient Vineyard project.



Nick Dokoozlian is the Vice President of Viticulture, Chemistry and Enology at E&J Gallo Winery in Modesto, CA. Prior to joining E&J Gallo, Dokoozlian was a member of the Department of Viticulture and Enology at the University of California, Davis, where his research focused on the effects of cultural practices and environmental factors on grape and wine composition. Dr. Dokoozlian received his PhD in Plant Physiology from the University of California, Davis.



Jackie Dresser has served as research technician with the Efficient Vineyard project since July 2016, first with the Spatial Data Technology Group based at Newcastle University in the United Kingdom and most recently with Terry Bates, project leader at Cornell's Lake Erie Research and Extension Laboratory (CLEREL) in Portland, NY.



Katie Gold is a PhD candidate in Plant Pathology and MS candidate in Biometry at the University of Wisconsin-Madison. Katie's research combines precision agriculture, remote sensing, data science, and fundamental plant pathology to develop innovative disease detection and management tools that support the profitability and sustainability of stakeholders. She will be joining the Cornell Agritech Faculty as assistant professor for grapevine disease ecology and epidemiology in February 2020.



Richard Hoff, Director of Viticulture at Mercer Ranches in Prosser, WA, is a native of Wisconsin and U.S. Navy veteran. He received his bachelor's degree in horticulture from the University of Wisconsin - River Falls and his master's degree in horticulture from Washington State University. Since then, he has worked as a viticulturist for Ste Michelle Wine Estates and is currently the director of viticulture for Mercer Ranches.



George Kantor is a researcher and educator at the Robotics Institute at Carnegie Mellon University. His technical interests lie in position estimation and mapping for mobile robots, control of robotic systems with nontrivial dynamics, and wireless networks for distributed sensing and control. His work translates ideas related to these technical interests into rugged systems that reliably solve real-world problems, especially in the application areas of agriculture and mining.



Nelson J. Shaulis Symposium

Digital Viticulture: New Tools for Precision Management Speakers

Alan Lakso is a fruit crop physiologist at Cornell University with expertise in the physiology and management of apple and grape growth and development, environmental responses, and the integration with cultural practices. He collaborated with Dr. Abraham Stroock in developing a microtensiometer that offers continual measurement of vine water status, which has been licensed and commercialized.



Jim Meyers has been working with wine grapes for 10 years, first as a Viticulture Ph.D. student at Cornell then as a research associate. He is currently Area Extension Viticulture specialist with the Eastern NY Commercial Horticulture Program. His viticultural research has focused on using computational tools for mapping canopy and vineyard variability, quantifying relationships between variability and fruit chemistry, and optimizing efficiency of vineyard operations.



Andy Reynolds is Professor of Viticulture at Brock Universities Cool Climate Oenology and Viticulture Institute (CCOVI). His research areas include viticultural practices and their influences upon wine and juice quality, characterization of impact of terroir on the sensory properties of Niagara wines and impact of irrigation and vine water status. Andy was a student of Nelson Shaulis.



James Taylor, with IRSTEA, Univ. Montpellier, France, received his Bachelor of Science in Agriculture at The University of Sydney and then completed a PhD in Precision Viticulture in 2004. James' expertise is in spatial agricultural data analysis and interpretation. James has held precision viticulture research positions in both France and the USA. In all cases, James' research is strongly aligned with end-user requirements and ensuring that Agri-tech is accessible and informative to agronomists and producers.



Justine Vanden Heuvel is an Associate Professor in the Horticulture Section at Cornell University and actively involved in both research and teaching. Her research focuses on optimizing flavors and aromas in wine grapes and improving both the environmental and economic sustainability of wine grape production systems in cool climates. She teaches several undergraduate courses in Viticulture.



Hakim Weatherspoon is an associate professor in the Department of Computer Science at Cornell University. His research interests cover various aspects of fault-tolerance, reliability, security, and performance of large internet-scale systems such as cloud computing and distributed systems. He is Associate Director of the Cornell Initiative for Digital Agriculture.



Who We Are

The National Grape Research Alliance brings together American grape **growers, processors, wineries** and representatives of **research institutions** and **cooperative extension organizations** to **improve our industry through science**



Our Vision

To **achieve game-changing research** for the U.S. grape and wine industry that **protects against pests and diseases, fuels competitiveness and enables agility** in response to shifting consumer tastes, changing climate and evolving resource availability

Our Mission

To **align the priorities for research** nationwide and across all U.S. grape sectors and to **actualize scientific advances** in the areas of greatest industry need, right now



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Joint 71st ASEV National Conference and 45th ASEV Eastern Section Annual Meeting

June 15–18, 2020

Marriott Portland Downtown
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AMERICAN SOCIETY FOR
ENOLOGY AND VITICULTURE
Since 1950



AMERICAN SOCIETY FOR
ENOLOGY AND VITICULTURE
Eastern Section

About ASEV-Eastern Section

Mission

To provide forums for the presentation, discussion, and publication of research and technology developments for the advancement of wines and the solution of problems of specific interest to the enology and viticulture of grapes grown in the Eastern United States and Canada.

ASEV-Eastern Section Regions

The ASEV-Eastern Section's geographical area includes all U.S. states and Canadian provinces with territory east of the Continental Divide.

AMERICAN SOCIETY FOR ENOLOGY AND VITICULTURE



EASTERN SECTION

Established 1975

2019 ASEV-ES Scholarship Recipients



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Andrew Harner, Penn State University

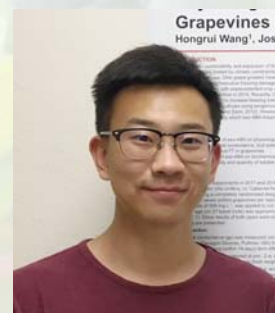
Stephanie Keller, Penn State University

Sarah Mayfield, University of Arkansas

Conor McCaney, Penn State University

Joshua VanderWeide, Michigan State University

Hongrui Wang, Ohio State University



2019 Scholarship Fundraiser Raised \$16,000

Thanks Scholarship Donors

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Thank you Eastern Winery Exposition, Wines & Vines, Wine Industry Suppliers, Scholarship Auction Bidders, and Scholarship Donors.

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Student Presentation Competition Abstracts

Release of Hydrogen Sulfide In Wine During Storage - Investigating the Stability of Copper-Sulphydryl Complex Precursors of Sulfur-Like Off-Aromas

Rachel B. Allison and Gavin L. Sacks*

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The appearance of hydrogen sulfide (H₂S) and related sulfur-like off-aroma (SLO) compounds during wine storage presents a significant challenge to winemakers. Recent work has established that there are multiple pools of SLO precursors in wine, including soluble copper-sulphydryl complexes. Due to their low concentrations and instability, these complexes are challenging to measure directly in wine. However, copper-sulphydryl complexes are disrupted in the presence of strong brine, and complexes can be indirectly quantified by measurement of H₂S or other sulphydryls after dilution of a sample in a concentrated NaCl solution. The concentration of copper-sulphydryl complexes also correlates with sulphydryl release during storage, particularly for H₂S. The correlation is imperfect, leading to the reasoning that different components of the brine-releasable H₂S pool differ in their stability during wine storage. In this work we have demonstrated the differences in the stability of copper-sulphydryl complexes formed in varying wine and model wine solutions, using a brine dilution assay as the basis for analysis. The hypothesis that the amount of H₂S released by brine dilution is affected by the type of brine, temperature, and the incubation time prior to dilution, has been evaluated. Real and model wines were treated with copper and sulfide to form metastable copper-sulphydryl complexes, brine dilution assay parameters were varied, and quantification of H₂S was performed using commercial gas detection tubes. The presence of glutathione (GSH) in the wine solution was observed to have a significant effect on the H₂S released by brine dilution.

Efficacy of Mycorrhizal Inoculation Differs between Root Systems

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Mycorrhizal inoculation enhances plant growth and represents an alternative to reduce the dependence of winegrape growers on agrochemicals. This study assessed the ability of five arbuscular mycorrhizal fungi (AMF) inoculants to improve vine growth and to increase AMF root colonization in 2 years old *Vitis vinifera* L cv. Cabernet Sauvignon (own-rooted) and rootstock 3309C under greenhouse conditions. The experiment was established in a randomized block design, plants were grown in field-collected soil containing resident AMF and commercial AMF inoculants. 155 days following inoculation, fine absorptive roots were sampled and stained to assess the AMF root colonization under a compound microscope. Plant biomass, nutrient uptake and root morphology were also evaluated. The proportion of roots colonized with arbuscules and the total root length colonized with AMF differed between cultivars. In Cabernet Sauvignon, 45.7% of roots in the control treatment were colonized with arbuscules compared to 33.8% in 3309C. Commercial inoculants increased root length colonized by AMF by up to 83.5% in Cabernet Sauvignon but up to only 65.8% in 3309C. Maximum total root length colonization was 88.6% in Cabernet Sauvignon compared to 73.0% in 3309C. Commercial inoculants increased trunk dry weight by 83%, shoot dry weight by 165%, and root dry weight by 96%. Using AMF inoculants to replace chemical fertilizers may be a good strategy to improve grapevine productivity and health in cool climates, however the impact of inoculants in the vineyard may differ among rootstocks.

Effect of Sun Exposure on the Evolution and Distribution of Anthocyanins in Interspecific Hybrid Red Winegrapes

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Traditional viticultural and winemaking techniques for color optimization have proven ineffective for interspecific hybrid grapes, as their anthocyanins vary in type and concentration from those in *Vitis vinifera*. Because the chemistry of hybrid grape anthocyanins is largely unknown, the reactions they undergo during ripening, wine production, and aging are poorly understood. To clarify the effect of vine microclimate on red hybrid wine color, anthocyanin profiles were assessed for shaded and unshaded fruit from three economically significant NY cultivars: Marquette, MarÃ©chal Foch, and Corot Noir. Berry samples were collected at three different points over the course of ripening and skin extract anthocyanins were characterized via HPLC analysis. Light exposure and berry and air temperature were monitored throughout the season to elucidate their relationship to anthocyanin development. By better defining the evolution of anthocyanin profiles during interspecific hybrid grape ripening, this work will help optimize viticultural and wine production methods for high-quality red hybrid wines.

Evaluating Tannin Retention in Chambourcin through the Lens of Protein-Tannin Interactions

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Tannin extraction and retention in red wines remains poorly understood, as tannin precipitation is attributed to both cell wall material and protein. To examine the reason for tannin loss while trying to increase retention, exogenous tannin additions were made at eight time points from crush to three months post-press to *Vitis* interspecific hybrid cv. Chambourcin, a low tannin cultivar. Retention rates were measured at six months post-pressing. Additions made at must or during fermentation were, on average, three-fold higher than the control (47mg/l), those made after pressing and one-week after were 5.6 times higher, and those at one to three months after pressing were 11 times higher. Skin fragmentation through blending must at crush was three-fold higher. To better understand the role specific proteins in juice and wine have on tannins, 6 treatments were analyzed by acetone precipitation, trypsin digestion, and UPLC-TIMS-TOF. Over 1,000 different proteins were identified in juice and/or wine with different proteins being the most prevalent in wine than in juice.

564 proteins had a maximum relative intensity >1,000. Of those, 61 were present in juice, but not in wine. Appreciable levels of proteins, including a chitinase implicated in tannin precipitation, were still present even after addition of large amounts of sacrificial tannin to juice. Juice fined with bentonite and then fermented on skins did not increase tannin concentration, although total protein was reduced. Our studies demonstrate that later tannin additions significantly increase tannin retention and that substantial protein changes occur between juice and wine.



Student Presentation Competition Abstracts

Severity of Early Defoliation Adjusts Grüner Veltliner Grape Composition and Cluster Qualities

Andrew Harner*, Maria Smith, Marielle Donohue, Andrew Poveromo, Stephanie Keller, Helene Hopfer, and Michela Centinari

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Leaf removal applied at or just before bloom (ELR) is an innovative technique for regulating crop load in wine grape systems, as compared to traditional methods like cluster thinning. There is not a consensus, however, regarding how increasing levels of ELR affect yield components, cluster morphology, and compositional qualities. To investigate these effects, we compared Grüner Veltliner fruit at harvest from six ELR treatments for two years (2017-2018) at a commercial vineyard in central Pennsylvania. Treatments were implemented at full bloom and included a no-ELR control and five levels of ELR: three-leaves, six-leaves, eight-leaves, ten-leaves, and twelve-leaves. For each treatment and year various cluster characteristics were measured, including the percent of fruit-set, berry total soluble solids, pH, titratable acidity, berry and cluster weights, yield, and grape aromatic composition. Treatment effects on bud winter survival were evaluated in February 2019. Regression analysis indicated that increasing ELR severity significantly and linearly decreased yield and berry titratable acidity, while increasing total soluble solids and pH. Moreover, percent fruit-set, average cluster and berry weights decreased with increased ELR intensity. Grape berry volatile composition was analyzed via headspace SPME-GC-MS, and aroma compounds were identified via retention indices and mass spectral library matches and authentic standards, when available, and quantified as internal standard equivalents. These results indicate that cropping can successfully be managed by ELR, and that a grower could use defoliation to help target a cropping level for Grüner Veltliner vines to produce quality grapes for wine.

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Student Presentation Competition Abstracts

Defining Typicity of Pennsylvania-grown Grüner Veltliner Wines using Instrumental and Human Sensory Methods

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Grüner Veltliner (*Vitis vinifera*), an Austrian grape variety, is a relatively new grape to wine growers and producers in the northeast United States including Pennsylvania, which is the focus of this study. While climatic conditions are favorable to its growth, the Pennsylvania wine industry is still becoming familiar with the varietal characteristics of Grüner Veltliner grown and produced in this region. Defining typicity, described as the “perceived representativeness” of a wine produced from a designated area, has been of interest to the industry, as it helps identify environmental, viticultural, and sensory factors that can improve marketing strategies to wine consumers. The aim of this study was to characterize the chemical and sensory factors that drive typicity of Pennsylvania-grown Grüner Veltliner wines. Grüner Veltliner grapes were sourced from multiple regions across the state in 2018 and wines were made using a standardized vinification method. Wines were characterized by volatile aroma profiling with headspace solid phase microextraction gas chromatography, as well as phenolic profiling. In addition, the sensory fingerprints of the wines were evaluated by a trained descriptive analysis panel. Preliminary results show significant differences ($p < 0.05$) were found in numerous fruity and floral aroma compounds of wines vinified from grapes grown in the northwest, northeast, and southeast regions of Pennsylvania. Ongoing phenolic and descriptive analyses are providing further insight into how these wines differ. Results from this study will be useful in developing recommendations for wine producers to identify specific flavor compounds and attributes that contribute to perceived Grüner Veltliner quality.

Implicating Early Fruit Fly Life Stages in Sour Rot and Disease Progression in Absence of Adults

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Sour rot is a disease which affects susceptible red and white varieties of *Vitis* spp. during the final weeks of the growing season. Signs and symptoms include browning of the berry skin, liquefaction of berries, the pungent smell of acetic acid, and the presence of fruit flies (*Drosophila* spp.). To determine the role of various fruit fly life stages on symptom development, undamaged ripe berries of *Vitis* interspecific hybrid cv. Chambourcin were surface-sterilized, wounded, and co-inoculated with causal organisms *Metschnikowia pulcherrima* and *Gluconobacter cerinus*, then exposed to either axenic *D. melanogaster* eggs, 24hr-old larvae, or adult life stages. Symptoms were rated daily based on severity scale of 0-4.

After recording disease progression over nine days, all life stages eventually scored the highest rating level (4), implicating prepupal fruit flies as a critical component in the development of sour rot. To understand the effect of the fruit fly larval stages on sour rot development in the field, clusters of various cultivars with sour rot symptoms were collected from commercial vineyards throughout Missouri during harvest 2018. Infected clusters of varying severities were individually placed in plastic cups, and adult fruit flies were excluded. At one and two weeks post-harvest, severity was rated and hatched flies were anesthetized and counted. In the end, severity increased an average of 50% with a mean total of 92 emerged fruit flies, showing that a combination of adolescent life stages present in clusters were responsible for spreading sour rot.

Zoning the Cabernet Franc Vineyards by NDVI Data from Unmanned Aerial Vehicles (UAVs) and Mapping Variability and Virus Titer of the Vineyards

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The hypothesis was that the maps based on remotely-sensed images would create clear zones of different vigor, yield, water status, winter hardiness and berry composition and the wines from the unique zones would show different chemical and sensorial profiles. A second hypothesis was that virus titer (GLRaV) could be correlated spatially to NDVI and other spectral indices. Result: Year 1 (2015) and year 2 (2016) results showed several direct correlations between UAV-based NDVI and vine size, berry weight, yield, cluster number, titratable acidity, SWC, leaf $\bar{\chi}$, Gs, and NDVI from GreenSeeker. Inverse correlations included thermal data, Brix, color anthocyanins phenols, and LT50. The pattern of UAV-based NDVI and other variables corresponded to the PCA results. Thermal scan and GreenSeeker were useful tools for mapping variability in water status, yield components, and berry composition. There were spatial patterns between NDVI and GLRaV that suggested high titer (low Cq) in low NDVI zones. Wine composition analysis showed that in 2016, there was a tendency for high NDVI wines to be higher in anthocyanin, ethanol and pH and lower in TA. In 2017, high NDVI wines tended to be higher in ethanol and pH and slightly lower in TA. There was also a tendency for high NDVI wines to have higher anthocyanins and higher phenols. Wine sensory analysis (sorting test) confirmed that tasters were able to successfully separate the wines into two distinct groups. This strongly suggests that NDVI might be a useful tool for delineation of quality zones. Use of UAVs may be able to delineate zones of differing vine size, yield components, and berry and wine compositions, and its sensory attributes, as well as areas of different virus status and winter hardiness. Descriptive analysis (DA) of 2016 wines will finish soon, 2019. DA of 2017 wines will perform in 2020.



Student Presentation Competition Abstracts

Impact of Foliar Grapevine Application of an Inactive Dry Yeast on Chambourcin Grapes from Veraison to Harvest

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LalVigne® (Lallemend, Inc.) is an inactive dry yeast that is rehydrated and when applied to grapevines as a foliar spray has been shown to increase skin thickness and anthocyanin content of *Vitis vinifera* wine grapes. The foliar grapevine application of LalVigne® was evaluated on grape berry composition, physical properties, and anthocyanin content of Chambourcin, a French-American hybrid. Chambourcin grapevines (8-10 years old) were grown on a single bilateral cordon trellis system (200-m rows) at a commercial vineyard in Arkansas (cold hardiness zone 6b). Four rows of Chambourcin were sprayed with LalVigne® MATURE at 5% veraison and 10 days after veraison (sprayed) and four rows were left unsprayed (control), with a six-row buffer between the rows. Two-hundred grapes were hand-harvested from the grapevines in triplicate from each treatment once per week in 2018 from veraison (July 20) to harvest (August 27). The grapes from both treatments ripened as expected, but there were differences between sprayed and control grapes prior to and at harvest. Grapes from both spray treatments had commercially acceptable harvest composition for wine production. At harvest, there was no difference between grapes from sprayed and control grapevines for soluble solids (21.1% or titratable acidity (0.58% as tartaric), but control grapes had higher pH (3.64) than sprayed grapes (3.52). Grapes from sprayed grapevines had greater skin elasticity (7.07 mm) and lower berry weight (2.05 g) than control grapes (6.38 mm and 2.11 g, respectively) across all sample dates. At harvest, grapes from sprayed grapevines had greater total anthocyanins (302.7mg/100 g), malvidin-3-glucoside (82.4 mg/100 g), and petunidin-3-glucoside (67.7mg/100 g) than control berries (265.8, 67.5, and 58.5 mg/100 g, respectively). Application of LalVigne® inactive dry yeast to Chambourcin grapevines produced grapes with lower pH, potentially thicker, more flexible skins, and higher amounts of red-colored anthocyanin compounds.

Can Two Frost Avoidance Strategies Delay Grapevine Budburst without Negative Effects on Wine Quality and Vine Health?

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Spring frost events pose a significant economic threat to yield and fruit quality in cool-climate winegrowing regions. Bud and green tissue vulnerability to below freezing temperatures increases with advanced phenological stage; therefore, delaying grapevine budburst is a promising solution for spring frost avoidance. This study compared two methods to delay grapevine budburst: 1) the application of a vegetable oil-based adjuvant (Amigo®) at 8% and 10% (v/v) to buds during dormancy and 2) delayed winter pruning until after budburst. Treatments were applied in 2018 and 2019 to Riesling and Lemberger (*V. vinifera*) at a vineyard in Pennsylvania and compared to untreated control vines. The main goal was to evaluate treatment effects on the grapevine growth stages, berry ripening, and chemical and sensory wine properties. Furthermore, effects of delayed budburst on vine carbohydrate reserves and bud freeze tolerance were assessed. In 2018, Riesling vines treated with Amigo 8% and 10% reached 50% budburst three and five days later than the control, respectively, with no effect on yield. Delayed winter pruning delayed budburst by 10 days, and vines averaged 35% lower yield than the control. In Lemberger, Amigo-treated vines reached 50% budburst seven days later than the control, regardless of concentration, and delayed winter pruning delayed budburst by 10 days. Treatments did not affect yield in Lemberger. In both cultivars, treatments had no effect on berry chemical composition (pH, titratable acidity, total soluble sugars) at harvest. Results from carbohydrate analysis, bud freeze tolerance, and wine sensory triangle discrimination test will also be discussed.

Leaf Removal Practices Alter Cluster Morphology and Soluble Solid Content of North Dakota Grown Marquette

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In North Dakota's Red River Valley, brief growing seasons are marked by limited growing degree day accumulation; this cool-climate perpetually generates annual harvests that confront the grape and wine industry with atypical fruit technological maturity, specifically in the form of high titratable acidity (TA). Regional farmers have limited access to research-based knowledge concerning the effects of viticultural practices on hybrid cold-hardy grapes in North Dakota's formidable grape growing climate, thus restricting the capacity for informed decision making. To examine the effects of fruit zone leaf removal (LR) on ripening of Marquette, an interspecific cold-hardy red wine grape, a 3 × 2 factorial composed of 3 LR timings (trace-bloom [TBLR], fruit-set [FSLR], and onset of veraison [VRLR]) and 2 LR severities (50% and 100% fruit zone LR) was employed within an experimental plot located at a commercial vineyard near Buffalo, ND. LR factors timing and severity significantly altered fruit chemistry with minimal interactions observed. In 2018, the main effect of LR timing for FSLR reduced TA by nearly 5% relative to untreated, control vines, yet no LR treatment succeeded in reducing TA below 10.0 g/L. Among LR levels, in both years, TBLR accumulated more soluble solids (SSC) than VRLR with no observed treatment impact on fruit pH. TBLR vines also yielded less compact clusters with smaller single cluster mass leading to lower yields in TBLR compared to VRLR. Yield was not significantly reduced in either year by severity of LR, but in 2018 single cluster mass decreased with 100% LR. Presently, preliminary results indicate it may be economically unjustifiable to commit substantial resources towards LR solely for the purpose of acid reduction in North Dakota Marquette grapes. Regional growers may, however, consider utilizing earlier season LR as part of management efforts to increase SSC accumulation, reduce cluster compactness, or regulate yield.



Student Presentation Competition Abstracts

Pre-bloom Leaf Removal Differentially Impacts Cabernet Franc Crop Yield and Fruit Composition On Opposite Sides of a Lyre Trellising System

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Fruit zone leaf removal is used to decrease rot incidence and enhance varietal character. If implemented to extremes, leaf removal before bloom can create a source: sink imbalance that limits berry number per cluster and thus crop yield. A divided canopy trellising system offers a unique platform to question if leaf removal implementation in the treated fruit zone produces variable responses in the opposite, non-treated fruit zone. The aim of this work was to evaluate if pre-bloom removal of seven fruit zone leaves from only the east side, only the west side, both canopy sides, and neither canopy side (no leaf removal) of a lyre system would differentially impact crop yield and fruit composition of Cabernet franc grapes harvested from both canopy sides. Pre-bloom leaf removal from both canopy sides reduced crop yield on both canopy sides relative to no leaf removal. Pre-bloom leaf removal from the east or west canopy sides tended to depress crop yields on the treated canopy side but not the untreated canopy side. Pre-bloom leaf removal resulted in lower titratable acidity exclusively on the canopy side in which it was implemented. Pre-bloom leaf removal from the east or west canopy sides also tended to increase total grape anthocyanins and phenolics on the treated canopy side but not the untreated canopy side. Trends show that pre-bloom source tissue removal generally affects source-sink dynamics and secondary metabolites on treated shoots but not untreated shoots on the opposite side of a divided canopy system. Thus, whole vine source-sink dynamics may not necessarily apply to source limitations imposed on spatially separated vegetative tissues.

Introduction to the Athena Trellising System Developed by the University of Georgia

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The vertical shoot positioned (VSP) trellising system is a single canopy system commonly used for wine grape production. The VSP system confines leaf area and fruit production between trellis catch wires that are typically spaced ≤ 15 cm apart which limits exposed leaf area and fruit production. We investigated the effects of retrofitting an already-established, single-canopy VSP trellis in a Petit Manseng vineyard by comparing (1) a retrofitted, divided canopy trellising system (DVSP) to a single canopy system (VSP), and (2) bilateral (Cane) or quadrilateral cane (Double Cane) pruning versus industry standard spur pruning (Spur) over 2017 and 2018. We hypothesized that Double Cane would increase crop yield and that dividing the canopy would improve the source: sink ratio in that treatment. DVSP decreased mid-canopy leaf density by an average of 56% when compared to VSP. Double Cane increased crop yield by an average of 42% compared to both Spur and Cane. DVSP increased crop yield by 31% relative to the single- canopy VSP, but only in the second season. In 2018, the combination of DVSP with Double Cane pruning increased crop yield by 79% compared to the industry standard, VSP with Spur. The treatment combination of Double Cane with VSP produced an average crop load of 14.5 while the treatment combination of Double Cane with DVSP produced an average crop load of 10.0. These trends are indicative that canopy division is an important tool to increase the efficiency of source tissues and counterbalance the presence of excess sinks when retaining high bud densities. The novel combination of Double Cane with DVSP will be documented in an extension publication as the “Athena” trellising system.

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Technical Session Abstracts

The Challenge of Canned Wines: Corrosion and Off- aromas

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This report will present a review of the challenges associated with wines packaged in aluminum cans. Although canned wine dates from the time of WWI, there have been few commercial examples until the last two decades. In recent years, growth in canned wines has outpaced other packaging types for several reasons, including changes in consumer acceptance, and their convenience and sustainability as compared to glass or plastic. However, over the last 80 years, reports on canned wines in the scientific and patent literature have noted several challenges with storing wines in contact with aluminum – wines are more corrosive than typical beverages, and their storage in aluminum can result in hazes and off-aromas, particularly H₂S. The high corrosivity of canned wines is likely due to a combination of its low pH and relatively high concentrations of bisulfite and Cl⁻, all which can degrade the alumina coating on the Al(0) interior; the reductive environment of wine, which prevents regeneration of the alumina coating; and to the presence of Cu(I), which can undergo galvanic pitting reactions with exposed Al(0). Although aluminum cans have an interior polymeric liner to prevent direct contact between the wine and alumina layer, these problems continue to occur, either due to degradation of the liner or defects in the coating. These problems may be increasing due to recent shifts away from the use of synthetic epoxy coatings containing Bisphenol A (BPA) that may adversely affect humans to new types of liners. Wine stored in contact with aluminum is reported to develop reduced aromas due to the formation of H₂S. Potential precursors and mechanisms responsible for H₂S formation will be discussed.

Rootstock Effect on Yield and Fruit Quality of ‘Chardone’ and ‘Norton’ Grapes in Alabama

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Interest in grape production is expanding in Alabama and the southeast, yet very little is known about the grape rootstock performance in the region, and the potential cultivar response to various biotic and abiotic challenges common to the southeastern environment. The main objective of the present study was to determine the best-suited rootstocks for enhanced sustainability of hybrid bunch grape production in Alabama and the Southeast. A field experiment was established at the Chilton Research and Extension Center near Clanton, AL. Hybrid bunch grape cultivars ‘Norton’ and ‘Chardone’ either grown on their own roots or grafted to ‘Paulsen 1103’ (‘1103P’), ‘Kober 5BB’ (‘5BB’), or ‘Teleki 5C’ (‘5C’) were planted in a generalized randomized complete block design comprised of seven replications. Variables measured during 2016-2018 included vine dormant pruning weight, phenological development, total yield/vine, number of fruit clusters, cluster weight, berry weight, soluble solids content (SSC), fruit pH and titratable acidity (TA). Our results suggest ‘Norton’ grafted on ‘1103P’ had the highest pruning weight per vine. ‘1103P’ grafted ‘Chardone’ vines produced higher yield and larger cluster size as compared to own-rooted ‘Chardone’. No differences were found in titratable acidity and soluble solids content among rootstocks. ‘Norton’ grafted on ‘5BB’ had low survival rate in Alabama environment. Research will continue to more fully evaluate the rootstock effect on grapevine performance. Outcomes of this study will provide viticulture industry in the region with research-based decision making tool for proper scion- rootstock grape selection and contribute to enhanced viticultural sustainability in the region.

Do Rootstock Genotype, Soil Depth, and Root Traits Structure Community Composition of Bacteria Associated with Grapevine Roots?

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Grapevine root systems associate with thousands of microbial taxa. These microorganisms can range from beneficial, promoting grapevine health, to pathogenic, contributing to vine decline.

Despite their importance, we are still limited in our ability to apply management practices that direct microbial assemblages for improving plant growth or biocontrol. Sampling techniques which pay little regard to microbiome variation across the grapevine root system contribute to this limitation. Our study aims to understand root- and soil-mediated effects on abundance and diversity of root-associated bacteria to optimize sampling protocols and vineyard management practices. In a vineyard in Pennsylvania, we used root observation boxes (0.6 x 0.6 m and 1 m deep) to monitor root systems of Noiret (*Vitis* hybrid) vines grafted to a low vigor (*Riparia Gloire*) or medium vigor rootstock [101-14 Mgt (*V. riparia* x *V. rupestris*)]. During a mid-season flush of root growth, grapevine roots were sampled and analyzed separately based on age (0-45 days), root type (first, second, or third order), soil depth (0-30 cm vs 31-60 cm), and activity (alive vs dead). Rhizoplane (root-adherent soil) and roots were separately examined for bacterial diversity and composition (16S rRNA gene sequencing). Results from preliminary sampling show that the bacterial diversity of roots decreases with increasing soil depth and root order. This study calls attention to the need for standardized sampling techniques in vineyard microbiome studies. The relative importance of rootstock genotype, root type, and sampling depth will be discussed.

Delayed Pruning Delays Basal Bud Break but Reduces Crop Yield in Georgia-Grown Chardonnay

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Spring frost damage to grapevine tissues is a perennial threat. Active and passive frost mitigation methods have been evaluated and developed due to the negative fiscal impact of spring frost damage on vineyard and winery enterprises. Delayed pruning is a frost avoidance practice in which dormant canes with several buds are left unpruned well into the spring in order to force bud break on apical positions and delay bud break on the basal positions that will ultimately be retained after final pruning. Delayed pruning is currently implemented in Georgia vineyards. However, delayed pruning could benefit from refinement to identify the optimal length in which spurs should be pruned and the optimal time in which the final prune should be made. We evaluated if delayed pruning to variable bud numbers on dormant canes would differentially impact Chardonnay basal bud break, crop yield, or fruit composition. Treatments were final pruning during dormancy (FINAL), or delayed pruning until the spring on four-, seven-, or ten-bud canes (FOUR, SEVEN, TEN) or on canes pruned to one foot above the top trellis catch wire (NO). All delayed pruning treatments delayed basal bud break percentage from 3 April to 17 April 2018 when compared to FINAL. However, longer canes (TEN, NO) delayed basal bud break by a greater percentage relative to shorter canes (FOUR, SEVEN). Crop yield was reduced by NO when compared to FINAL, and FOUR, SEVEN, and TEN produced intermediate crop yield values. Primary fruit composition was unaffected by treatment. Due to our inability to predict frost occurrence, it would be most judicious to delay prune to four- or seven-bud canes in order to delay basal bud break and maintain crop yield.

Technical Session Abstracts

Optimization of Chambourcin Grape Breeding Using Marker-Assisted Selection

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Vitis interspecific hybrid 'Chambourcin' is a popular red wine grape in mid-Atlantic and Midwestern states including Missouri. It is a cultivar of largely unknown parentage which exhibits greater cold hardiness and disease resistance than *V. vinifera* cultivars. In view of this, a mapping population was constructed including 319 individuals from a cross between Chambourcin and *V. vinifera* 'Cabernet Sauvignon'. A haploid Chambourcin genetic map has been constructed with 318 simple sequence repeats (SSR) markers clustered in 19 linkage groups. The results from this study will also allow for the comparison of this population with a *V. aestivalis*-derived 'Norton' and Cabernet Sauvignon population for disease resistance, cold hardiness and berry quality. However, the ability to produce novel grapevine cultivars by conventional breeding is hampered by the high degree of heterozygosity found in grapes and the long juvenile period before grape seedlings produce fruit. The advantages of marker-assisted selection in plant breeding are well documented and have already been applied to grape breeding. Careful genetic mapping of this population provides the foundation and tools to associate molecular markers with favorable traits of Chambourcin. The ultimate goal of this project is to use genetic markers to rapidly deploy favorable alleles and accelerate breeding cycles for new cultivar releases.

Insecticide Resistance in *Drosophila melanogaster* (Diptera: Drosophilidae) is Associated with Field Control Failure of Sour Rot Disease in a New York Vineyard

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Sour rot is a complex disease of grapes caused by an interaction of yeast, acetic acid bacteria, and *Drosophila* spp. Recent research has found that the use of insecticides that target *Drosophila*, such as zeta-cypermethrin, can provide substantial control of sour rot in winegrapes in New York vineyards. During the harvest season of 2018, a control failure of sour rot and high populations of *Drosophila*, mostly *Drosophila melanogaster*, were observed in a Finger Lakes vineyard, despite repeated applications of zeta-cypermethrin. To determine if resistance was responsible for the control failure, we quantified the toxicity of zeta-cypermethrin and the four other insecticides registered for *Drosophila* control in NY vineyards to both field-collected flies and those from a known susceptible strain. Flies collected from the field were found to be resistant to zeta-cypermethrin (Mustang Maxx), acetamiprid (Assail), and malathion, but not to spinosad (Delegate) and spinetoram (Entrust). This study provides strong evidence that insecticide resistance of *Drosophila* is associated with control failure of sour rot in some vineyards, and reemphasizes the importance of chemical rotation in pest management programs.

Impacts of Dormant Pruning Methods and Nitrogen Fertilization on *Vitis vinifera* 'Pinot noir' Bud Fruitfulness and Yield

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Cool climate wine grape regions often report low or inconsistent yields. Bud fruitfulness is an important predictor of yield, yet impacts of vineyard practices on fruitfulness are not well studied. Two experiments were conducted in commercial 'Pinot noir' vineyards in Oregon with practices thought to influence yield potential, including dormant pruning methods and nitrogen (N) fertilization. Cane pruning is predominant in 'Pinot noir' vineyards due to a presumed lack of basal bud fruitfulness. Dormant bud fruitfulness, vine growth and yield were assessed in cane and spur pruned vines. Results show that the primary buds had similar bud fruitfulness for both pruning methods. Spur-pruned vines had more adventitious shoot growth early season; however, there were no differences by pruning method for véraison leaf area, yield, and fruit composition by harvest. Nitrogen fertilization is often avoided to prevent excess vegetative growth and improve wine quality; however, N status may influence fruitfulness and yields. The N trial evaluated control and N fertilization (45-67 kg N/ha/yr), and there was greater early season shoot growth and dormant pruning weights with N+ but no differences in yield or fruit ripeness. The N+ vines had greater bud fruitfulness, inflorescence primordia size of the primary bud and whole bud, and actual fruitfulness in spring. Increased bud fruitfulness and inflorescence primordia size was associated with greater bloom tissue N concentrations after two years of N application. In both experiments, basal buds were fruitful, and greater cane size was related to higher bud fruitfulness.

Mapping the Distribution of Mealybug, Scale, and Ants in Vineyards

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Grape mealybug (GMB) and European fruit lecanium scale (FLS) are known vectors of grapevine leafroll virus, a debilitating disease found throughout NYS vineyards. *Vinifera* winegrapes, hybrids and native varieties are all affected. Infected vines suffer losses in fruit quality and yield, as much as 50%. These insects are common in Long Island vineyards but their incidence and distribution have not been characterized. In 2018, geospatial technologies were used for seasonal monitoring and determining the risk-areas for GMB and FLS populations in five representative commercial vineyards. Grape mealybug populations in vineyards ranged from 11 – 35% infested vines. Thus, some blocks were infested well above the tentative management threshold of 20% or more infested vines. However, our ArcGIS program-based mapping showed that high populations were not evenly distributed throughout the vineyard blocks. Strong spatial co-occurrence was found between GMB and ant populations. Independent vineyard scouting is necessary to determine the exact population status. Spatially based scouting and geospatial analysis may define the target area precisely and can be used as tools for management zoning and decision making. Vineyard managers can use the distribution maps for area specific management, targeting treatments in areas where populations exceed threshold rather than treating the entire vineyard.

Student Poster Competition Abstracts

Investigating Dicamba Resistance in Vitis Interspecific Hybrid 'Chambourcin'

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Dicamba is a selective herbicide which has become increasingly commonplace for weed control in commercial agriculture since the introduction of dicamba-resistant, transgenic soybean and cotton. Dicamba may be better acknowledged by growers of specialty crops, like grapes, for its capacity to drift miles away from the site of application and deposit on fields, remaining potent enough to cause significant crop damage and yield loss to vulnerable plants. Grapes are among the most susceptible crops to dicamba, showing visible injury at rates less than 1% of standard commercial applications. To counter the threat dicamba poses to the grape and wine industry, this study investigates the potential for the *Vitis* interspecific hybrid 'Chambourcin' to be utilized as a source of resistance to dicamba in future grape breeding efforts. Few reports on dicamba tolerance in grapes exist; however, previous field studies have implicated 'Chambourcin' as resistant. 'Chambourcin' and susceptible cultivar *V. vinifera* 'Cabernet Sauvignon' will be subject to sub-lethal, spray drift simulating treatments of dicamba as well as lab-based detached leaf assays that mimic the vapor drift of dicamba while simultaneously mitigating the effect of confounding environmental factors. Injury status will be determined in vivo by tracking shoot length to several weeks after treatment and by visual assessment of dicamba's distinctive leaf cupping damage. In vitro, injury will be observed through leaf cupping and water loss status. Contingent upon the results of these experiments, this phenotyping protocol will help evaluate dicamba resistance in a mapping population developed by crossing 'Chambourcin' x 'Cabernet Sauvignon'.

Enhancing Vine Health with Commercial Arbuscular Mycorrhizal Inoculants in Vineyards

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In a randomized complete block design, four commercial arbuscular mycorrhizal fungi (AMF) inoculants were evaluated to determine their ability to promote formation of arbuscular mycorrhizae and to improve vine health in a mature Pinot noir/3309 commercial vineyard in Hector, NY. Five months after inoculation fine roots from the vineyard were sampled and stained. Vesicles, hyphal coils, and arbuscules were counted using a compound microscope. The proportion of fine roots colonized by arbuscules increased from 23.4% in the control to as high as 29.6%. The proportion of fine roots colonized by vesicles increased from 18.2% in the control up to 25.4%, while the proportion of fine roots containing hyphal coils increased from 58.9% to 72.4%. Grapevine petiole nutrient N, P, K, Ca, Mg, B, and Zn were all significantly increased in plots treated with commercial inoculants. These preliminary results highlight the use of AMF to promote plant health as an eco-friendly alternative to conventional fertilization practices.

Causal Factors of Macrophoma Rot Observed on Petit Manseng Grapes

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Macrophoma rot is a general term for fruit rots of *Vitis* spp. caused by the fungus *Neofusicoccum ribis* (syn. *Botryosphaeria ribis*) or closely related or renamed taxa, including *Botryosphaeria dothidia*. While mainly observed as a fruit pathogen of muscadine grape, the disease has recently been observed on bunch grapes in Virginia. Isolates (N = 629) were collected from Petit Manseng fruit clusters from seven Virginia vineyards in 2018. A subset of these isolates was sequenced using three primer sets (ITS, RPB2, and EF). The preliminary result showed a single taxonomic strain of *N. ribis*. A controlled inoculation study of Petit Manseng clusters verified that infection could occur anytime between bloom and 2 weeks post-veraison; however, both the mean cluster incidence and the severity of Macrophoma rot were greatest when clusters were inoculated at "pea-berry" size (~7mm dia). A season-long cluster exposure experiment showed that any amount of sun exposure significantly increased Macrophoma rot severity compared to shaded clusters, and that full sun exposure was associated with greatest rot severity. This finding contravenes current management recommendations for Macrophoma rot, and it raises yet unanswered questions as to why exposed clusters are more susceptible to Macrophoma rot than are shaded clusters.

Yeast Influence on Petite Pearl and Crimson Pearl Wine Sensory Attributes

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The primary role of yeast (*Saccharomyces cerevisiae*) is to convert grape sugars into alcohol. However, yeast metabolites are also known to influence the sensory attributes of wine through the production of esters, higher alcohols, carbonyl compounds, volatile acids, volatile phenols, and sulfur compounds. Unfortunately, little research has been conducted to evaluate some of the premium yeast strains with new cold-hardy grape introductions. Our research objective was to assess yeast-induced fermentative aroma and taste differences when using 'Petite Pearl' and 'Crimson Pearl', two full-sibling cold-hardy grapes. Grapes were harvested the past two years with similar pre- and post-crush soluble solids, pH, and total titratable acid measurements. Twelve yeasts: 71B, Alchemy 4, BM4X4, CLOS, D21, D254, ICV GRE, RBS 133, RC 212, and VRB were provided by Scott Laboratories, the final two yeasts, provided by wineries in California and North Dakota, were considered native wine strains. Fermentations consisted of sequential inoculation of the yeast followed by inoculation of the malolactic bacterial within 24 hr of the initial inoculation. After fermentation was complete, wines were stabilized and bottled in 750 mL wine bottles. For sensory descriptor characterization, a panel of four wine experts identified aroma and taste descriptors for the 24 wine samples. The intensity of these descriptors along with other sensory attributes were then rated by a 12 person trained panel each year. No cultivar by yeast interactions were detected. For aroma characteristics, wines fermented from Crimson Pearl grapes were perceived to have more almond, cherry, and plum character. Only the perception of anise aroma was impacted by yeast strain, with highest levels of anise aroma detected in Alchemy fermented samples. Earthiness was more pronounced in the aromas of Petite Pearl wines. Crimson Pearl wines were perceived as more tannic and fruity, compared to Petite Pearl.

Student Poster Competition Abstracts

Impact of Foliar Inactive Dry Yeast Application to Chambourcin Grapevines on Wine Anthocyanin Content

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LalVigne® (Lallemand, Inc.), an inactive dry yeast rehydrated and applied foliarly to grapevines, has been shown to increase anthocyanin content of *Vitis vinifera* wine grapes. The impact of foliar LalVigne® application to Chambourcin grapevines on wine anthocyanin content was evaluated. Chambourcin grapevines were grown in a commercial vineyard in Arkansas. Four rows of Chambourcin were sprayed with LalVigne® MATURE at veraison and 10 days later (sprayed), four rows were unsprayed (control), and six rows were between as a buffer. Grapes were hand harvested August 2018 in four 50-kg lots from each spray treatment. The grapes from both treatments had commercially acceptable soluble solids (21.1%), pH (3.6), and titratable acidity (0.58%) at harvest. The eight 50-kg lots of grapes were crushed separately. Tannin (800 mg/L) and oak chips (8 kg/tm) were added to two 50-kg lots of must from each spray treatment and two were without additions (additions and no additions, respectively). The wines were fermented on the skins for five days and pressed, then fermentation was completed at 15°C. The wines had final pH levels of 3.36-3.50 and titratable acidity of 0.70-0.74%, with an ethanol content of 10.5% (v/v). Wines were evaluated at bottling in February 2019 for the predominant anthocyanins (malvidin-3-glucoside and petunidin-3-glucoside) and total anthocyanins. Wines from sprayed grapes had greater malvidin-3- glucoside (21.3 mg/100 mL) than wines from control grapes (20.4 mg/100 mL). For wines with additions, wine from sprayed grapes had greater petunidin-3-glucoside (8.90 mg/100 mL) and total anthocyanins (108.4 mg/100 mL) than wine from control grapes (8.23 and 102.9 mg/100 mL, respectively). For wines without additions, there was no difference in wine from sprayed or control grapes for petunidin-3- glucoside (7.2 mg/100 mL) or total anthocyanins (100.6 mg/100). Application of inactive dry yeast to Chambourcin grapevines produced wines with greater amounts of red-colored anthocyanins.

Potential Insect Vectors of Grapevine Red Blotch-Associated Virus in Missouri Vineyards

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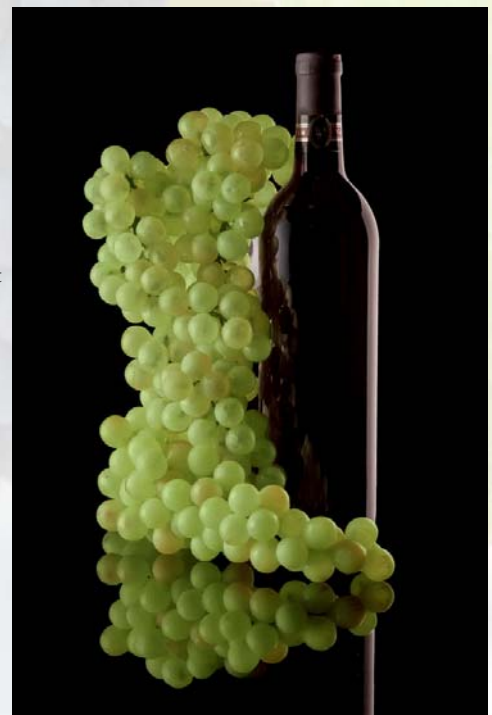
Red blotch disease was recently confirmed in grapevines in Missouri. This disease affects the profitability of vineyards by reducing fruit quality at harvest as well as decreasing vine health over time. Currently, there is no information about the potential vectors of Grapevine red blotch-associated virus (GRBaV) in Missouri. Researchers in California have confirmed one insect vector of GRBaV, the three-cornered alfalfa treehopper, *Spissistilus festinus* (Hemiptera: Membracidae). Some genera of leafhoppers (Hemiptera: Cicadellidae) have been implicated as potential vectors as well. Our objective was to identify the potential vectors of GRBaV in Missouri vineyards. We sampled insect communities from bud break until harvest at four vineyards with confirmed GRBaV infections. Insects were sampled weekly using unbaited yellow sticky card traps. Card traps were placed at the edge habitat surrounding the vineyard, and in the interior of the vineyard to quantify the movement of insects into vineyards. We did not find the confirmed vector, *S. festinus*, in our survey but previously implicated vectors were abundant. We have also identified two new potential treehopper vectors, *Micrutalis calva* and *Entylia bactriana*, which were found in high numbers in our survey. Interestingly, *Micrutalis calva* is a congener of the confirmed vector of Tomato-Pseudo Curly Top Virus, the virus most closely related to Red Blotch. Future research will include identification of other treehoppers and leafhoppers to species when possible and these will be assayed using polymerase chain reaction for the presence or absence of viral DNA of GRBaV.

Early Manual and Mechanical Leaf Removal as a Strategy to Improve Ripening and Lower Bunch Rot Disease in Pinot Grigio

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Removal of basal leaves early in the vegetative and reproductive development of the grapevines is a tool widely used to decrease fruit set. In turn, this technique controls yields and lowers cluster rot severity; improving fruit quality. However, the phenological stages near bloom recommended for the application of this practice are short, and the considerable time required for implementation limits utilization by grape-growers. Mechanization can potentially mitigate these issues, but has not yet been compared with manual application in a cool and humid growing region where cluster rot is the major limitation for yield and fruit quality. The goal of this study was to compare mechanical leaf removal with the manual removal of 6 leaves at the pre-bloom (EL17) and after-bloom (EL27) phenological stages over two seasons. Specifically, the ability of mechanical treatments to enhance ripening and control cluster rot compared to manual ones in Pinot Grigio (a tight-cluster cultivar) were assessed. Results indicate that fruit-set and cluster compactness were only reduced in both PB treatments. While the loss of fruit due to grey mold and sour rot was partially lowered in PB-ME and AB-MA, only PB-MA saw a consistent reduction, indicating the importance of a clear fruit zone in addition to a decreased cluster compactness to significantly mitigate cluster rot diseases. For Pinot Grigio, both pre-bloom treatments enhanced fruit quality, likely driven by a similar reduction in fruit set. The results suggest that the implementation of mechanical leaf removal at the pre-bloom phenological stage may be utilized to reduce cluster rot in tight-cluster cultivars and enhance ripening regardless of cluster morphology. This information provides a single approach to alleviate two prominent issues facing cool climate viticulture



Student Poster Competition Abstracts

Exogenous Abscisic Acid's Impact on Grapevine Physiology and Sugar Metabolism during Natural Cold Acclimation

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The potential for cold damage limits the expansion of cold sensitive grapevine cultivars throughout the U.S. Previous studies have demonstrated that the freezing tolerance (FT) of several grapevine cultivars was enhanced by foliar application of exogenous s-abscisic acid (ABA); a treatment which might be further developed and incorporated into cultural practices to mitigate cold damage in vineyards. However, the underlying mechanism by which ABA impacts FT, especially during cold acclimation, remains unknown. To address this issue, a two-year (2017-2018) study was conducted to characterize the effects of ABA (500 mg·L⁻¹) on greenhouse-grown 'Cabernet franc' grapevines regarding physiology, bud sugar composition, and genes involved in raffinose family oligosaccharides (RFOs) metabolism. During the experiments in two years, the physiological changes (deeper dormancy) and biochemical changes (bud sugar accumulation) in control indicate the grapevines were naturally initiating cold acclimation. Compared with control, ABA treatment decreased stomatal conductance after hours and accelerated the transition of grapevine physiology after weeks by increasing the depth of dormancy, decreasing bud water content and enhancing bud FT. ABA treatment also induced the accumulation of raffinose family oligosaccharides (RFOs) on grapevine buds by increasing the expression of raffinose synthase and galactinol synthase genes within 24 hours and increasing the content of the RFO precursor galactinol and several sugars (sucrose and myo-inositol) in RFO biosynthesis pathway. New findings from this study have advanced our understanding of the role of ABA on FT, which will be useful to develop future strategies for crop improvement and protection from cold damage.

Rachis Elongation with Palissage: Is it a Sink or Source-mediated Response?

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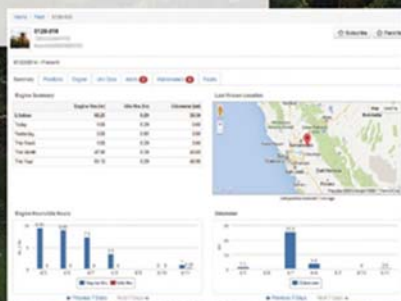
Palissage is a canopy management technique with the potential to replace mechanical hedging in regions where grapevine growth is excessively vigorous. To perform palissage, shoots are wrapped along the top catch wire rather than hedged. Previous studies have determined that when shoots are wrapped, rachis length can increase by up to 2.6 cm, sometimes resulting in reduced cluster compactness. An additional benefit of palissage is reduced lateral emergence in the fruit zone.

To determine whether the presence of the lateral influenced rachis length, we implemented a randomized complete block design in a Riesling (cl.9/110)/3309C vineyard in Lansing NY with four treatments: Shoot wrap with laterals, Shoot wrap without laterals, Hedged with laterals, Hedged without laterals. Rachis length, cluster weight, berry weight, berry number were sampled seven times after treatment application during the season after the canopy management treatments were implemented in early July. Laterals were removed on a weekly basis from the appropriate treatments.



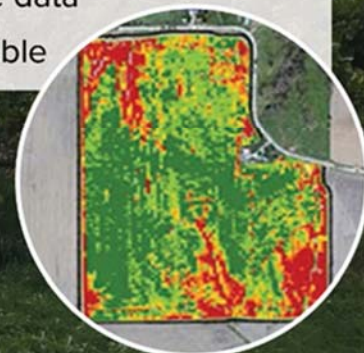
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Poster Session Abstracts

Strategies for Canopy Management for Optimal Juice Quality

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Optimal fruit quality via canopy and crop manipulation is key to successful cold climate wine grape production. Previous studies have accumulated important data on the impact of shoot and cluster thinning regimens. But results can vary depending on the variety, type of thinning (i.e. shoot versus cluster) and year. Here we present our multiyear project started in 2015 on the hybrid Frontenac. We ask the following: (1) What is the effect of shoot and/or cluster thinning on grape quality? (2) Is that effect variable according to the year? Overall, there is a statistically significant increase in pH ($P<0.05$) and Brix ($P<0.001$) due to shoot thinning. But the effect was only significant starting at 4 shoots/foot of cordon but not for 8 shoots/foot compared to a control. It indicates that shoot thinning to improve fruit quality in Frontenac should be done at least at or below 4 shoots/foot to be worthwhile. The effect of cluster thinning (1 cluster/shoot) was only statistically significant on Brix ($P<0.05$) but no effect was visible on the pH. Year changed the intensity of these effects but not their directions.

Impact of Foliar Molybdenum Application in Acutely Deficient Vineyard on Wine Quality

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Molybdenum is a trace element and micronutrient found in soils and involved in plant growth. It functions through enzyme-binding where molybdoenzymes perform a variety of functions, such as production of phytohormones and nitrogen metabolism. In 2017 and 2018, a 5% sodium molybdate solution was foliarly applied on *Vitis interspecific* hybrid cv. Vignoles vines in commercial production after grapevine health and wine quality problems were reported and diagnosed as molybdenum deficiency (in the absence of other nutrient issues). In 2017, berry weight, pH and titratable acidity did not show differences among treated and control vines, however berry Brix was higher in molybdenum-treated vines compared with the untreated control. Molybdenum leaf concentration was also significantly higher in treated vines (8 - 12 ppm) when compared with untreated vines (4 ppm). While the foliar application resulted in a rise in measured Mo, the treated vines are still considered Mo deficient. Wines produced in 2017 from the molybdenum treatment showed higher concentration of D-Limonene, Ethyl Hexanoate, Terpinolene and B-Linalool compared with the untreated control. The same molybdenum treatment was repeated on 2018 on previously treated vines in 2017 and in vines that had not previously been treated. In 2018, no differences were found in berry weight, pH, Brix, titratable acidity, or any wine volatiles between treated and untreated grapevines.

Evaluation of Mechanically Applied Transient Heat in Syrah and Merlot

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In 2013, a heat-pulse machine (Agrothermal Systems) was evaluated for its ability to improve vine growth and fruit quality in commercially-grown *Vitis vinifera* 'Syrah' and 'Merlot' in Paterson, WA. Heat from burning of propane was directed in to vine fruit-zone and canopy, through angled vents. The apparatus was driven down vineyard rows at 4MPH. Rows were treated on a weekly to bi-weekly basis with heat treatments during: (i) bloom only; (ii) véraison only; (iii) both bloom and véraison; (iv) from bud break to harvest; and (v) a no-heat applied control. Data collected included the timing of phenology, percent fruit set, duration and level of heat exposure of the fruit and canopy, and final harvest juice sugar, titratable acidity and pH. There was a substantial heat loss, once the heat reached the canopy from the heating vents, resulting in the typical increase in leaf or cluster temperature of about 5 to 10°C above ambient for only 10 to 20 seconds. Phenology, fruit set, fruit quality measurements were similar in all the treatments. Results indicate that the transient heat application of this form does not enhance vine phenology and in-field measured aspects of fruit quality in climates such as irrigated, eastern WA.

Effect of Rootstocks on Flavonoids Accumulation of *Vitis vinifera* L. Tannat and Cabernet Sauvignon

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Rootstocks have the characteristics of resistance to pests and diseases, stress tolerance, so the grafting technology is widely used in viticulture. In this experiment, the performance of Tannat on 1103P, 110R, 140R, 101-14, 3309C, SO4 and Beta or on own roots as well as the performance of Cabernet Sauvignon on 1103P, SO4, 5A or on own roots were evaluated over two vintages, the parameters of vines, Physico-chemical indices and the content of flavonoids compounds had been detected to study the influence of rootstocks on Tannat and Cabernet Sauvignon grapes quality. The main results are as follows: The rootstocks had effect on parameters of vines of Tannat and Cabernet Sauvignon. The pruning weight and scion diameter of Tannat/110R and Cabernet Sauvignon/1103P were smaller than those on own roots. The soluble solids content of Tannat fruit and the titratable acid content of Cabernet Sauvignon were influenced by the rootstocks. The influence of rootstocks on flavonols was mainly reflected in the proportion of flavonols in the Tannat. As for Cabernet Sauvignon, rootstocks did not have influence on total content of anthocyanin, flavonols and flavanols. Principal component analysis can distinguish different treatments of cabernet sauvignon, the rootstock SO4 and 5A had a promoting effect accumulation on the content of flavonoids. Using OPLS-DA found that the effect of rootstocks with the same parent was consistent with the effect of flavonoids compounds. To summarize, above results provided basic understanding of influence of rootstocks on flavonoids compounds of Tannat and Cabernet Sauvignon.

Poster Session Abstracts

Delayed Pruning Does Little to Mitigate Risk of Late Spring Frost in North Dakota Grown Cold-Hardy Grapevine Cultivars

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In mid-May 2016, a late spring frost damaged regional eastern ND vineyards, reducing yields, delaying ripening, and undermining fruit quality. Consequently, to explore pruning methods as a potential means of delaying grapevine phenology for the purposes of reducing frost risk, a 4×17 factorial arrangement of treatments was examined in 2017. Four pruning methods on a single vine basis and consisted of early spur pruning to retain 15 additional buds beyond a standardized 40 buds (ESP15), early long pruning that retained 40 additional buds (ELP40), late pruning to 30 buds (LP30), and late pruning to 40 buds (LP40) were administered to 17 cold-hardy wine grape varieties grown in the Horticulture Research Farm variety trial near Absaraka, ND. Following budbreak, all vines were adjusted to the target of 40 buds per vines with the exception of the LP30 treatment. For the phenological events monitored (bud break, bloom, and veraison) there were no significant pruning treatment effects, nor were any cultivar by pruning treatment interactions observed; only variety effects were significant. Similarly, virtually no pruning treatment effects were observed for fruit quality attributes such as soluble solids accumulation and titratable acidity. It is possible that pruning strategies were not extreme enough to enable extrapolation of treatment differences. Alternatively, the predominant cultivars grown in the region may not be responsive to pruning timing as a method to impact their overall, annual developmental cycle. This precursory trial indicated that pruning modifications may not alter grapevine phenology to escape spring frost events for regional vineyards. However, pruning modifications also did not delay ripening or alter fruit quality characteristics when a late spring frost did not occur. Pruning trials should be continued to determine which pruning method would provide the most effective and efficient frost avoidance strategy to moderate the hazards of early-season temperature fluctuations.

Pruning Level Impact on 'Concord' Juice Flavor Development and Optimal Harvest Timing

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Juice processors primarily judge quality and ripeness of cv. Concord by sugar content, with minimum brix levels required to receive premium price or avoid rejection. This system incentivizes limiting crop load to ensure sugar minimums are met and assumes that other quality indicators correlate well with brix accumulation. In 2011 and 2012 a study was conducted in western NY, where cv. Concord vines were pruned to either 60 or 90 nodes. Fruit was differentially harvested over a 9-week period in 2011 and 6-week period in 2012, then processed to mimic commercial juice production. All samples were then analyzed for volatile development. Treatment had minimal impact on brix, which ranged from 5.7-19.1 over the sampling period in 2011 and 5.8-17.2 over the sampling period in 2012. The concentration of many volatiles changed over the course of ripening. Beta-damascenone increased steadily over the ripening period and was in greater concentration in the 60-node relative to 90-node treatment at many points. Methyl anthranilate generally spiked in concentration in the final sample which was weeks after commercial maturity. Several potentially unwanted or "green" aromas increased during ripening with Hexenal, ethyl-hexanoate and nonanal all increasing over time, with the highest hexenal concentrations observed in the 60-node treatment. Results generally indicate that solely using brix as a quality metric may result in increased undesirable flavors in Concord juice and, by some volatile metrics, quality was improved with the 90-node treatment.

Characterization of Key Odor-active Compounds in Sweet Petit Manseng Wine by Gas Chromatography-olfactometry, Aroma Reconstitution, and Omission Tests

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Petit Manseng (*Vitis vinifera* L.) has become a popular variety in China for the production of semi-sweet and sweet wines, as well as in Virginia and elsewhere in the mid-Atlantic region of the eastern US for the production of dry and semi-dry wines. However, few studies focused on investigating the molecular odor code of its key odorants. In this study, the key odor-active compounds of Chinese sweet Petit Manseng wine were identified by gas chromatography-olfactometry (GC-O) and GC-mass spectrometry (MS). Fifty-five aroma compounds were identified by application of aroma extraction dilution analysis (AEDA) on a distillate prepared by liquid-liquid extraction (LLE) and solvent-assisted flavor evaporation (SAFE).

Among them, isoamyl alcohol, ethyl octanoate, isovaleric acid, (E)- β -damascenone, and phenylethanol particularly displayed with highest flavor dilution (FD) factors (above 1024). The quantification of aroma compounds by HS-SPME-GC-MS and GC-QqQ-MS/MS and a calculation of on odor activity values (OAVs) indicated 21 volatiles with OAVs above 1. Among them, furaneol showed the highest OAV with 5011, followed by ethyl hexanoate (OAV: 208), (E)- β -damascenone (OAV: 189), 3-mercapto-hexanol (OAV: 60), and isoamyl acetate (OAV: 45). The aroma of the sweet wine was successfully reconstituted by combining 42 aroma compounds in a model wine solution and evaluated by a well-trained panel through quantitative descriptor analysis (QDA). 3-Mercapto-hexanol, (E)- β -damascenone, furaneol, lactones mixtures, and ethyl cinnamate had an importance influence on the aroma of sweet Petit Manseng wine assessed by omission tests.



Poster Session Abstracts

Effects on Aromatic Profiles of *Vitis Vinifera* cv. Chardonnay by Different Rootstocks

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Grafting grapevines on resistant rootstocks is an effective method to improve the wine grapes quality as can overcome some biotic and abiotic stress. In this paper, the physicochemical parameters and aroma compounds accumulation induced by five different rootstocks, 101-14, 1103P, 5BB Kobel (5BB), Selektion Oppenheim (SO4) and Beta were determined in *Vitis vinifera* cv. Chardonnay vines. Compared to the own-rooted vines, the soluble solids, weight, titratable acid, and pH, in the rootstock '101-14' and '1103P', the titratable acid content increased significantly and the pH decreased. It could be speculated that rootstock '101-14' and '1103P' had a certain delay on the maturity of 'Chardonnay' grape fruit. The accumulation and contents of aroma compounds in Chardonnay vines were remarkably modified by the five rootstocks. The results showed that except the rootstock 'SO4' had no significant effect on the accumulation of free aroma compounds in 'Chardonnay' fruit, the other four rootstocks ('101-14', '1103P', 'Beta' and '5BB') significantly increased the content of the free aroma compounds in the fruit, especially increased the content of C6/C9 compounds. All of the five rootstocks could significantly increase the total glycoside-bound aroma compounds. And the rootstock '1103P' effect on improving the glycoside-bound aroma compounds was the most remarkable in 'Chardonnay'. It is speculated from this result that the rootstock '1103P' is the best choice to increase the free and bound aroma compounds in 'Chardonnay', followed by the rootstock 'Beta' and '5BB'. This research will provide basis for choosing rootstocks for different purposes.

Downy Mildew Fungicide Resistance in *Vitis Vinifera* Wine Grapes in North Georgia

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The Georgia wine grape industry is relatively young and fragile, with significant economic challenges from diseases. Among these, downy mildew (*Plasmopora viticola*) may be the most difficult to manage diseases in Georgia grapes. Downy mildew often lowers yields and can have a substantively negative impact on wine quality due to both direct (infected fruit) or indirect (reduced photosynthates from leaf damage and subsequent poor grape quality) effects. Because of the numerous applications of oomycete-active materials applied annually, resistance can readily develop to different chemical classes. Field studies were conducted in 2018 to determine which fungicide classes were the most efficacious against downy mildew strains found in north Georgia. Efficacy of eight different fungicides and two combinations (10 total treatments) were tested at three locations- the UGA Research Station in Blairsville and two commercial vineyards in Cleveland and Dahlonega. Fungicide applications (Abound, Captan, Pristine, Prophyt, Revus, Revus Top, Ranman, Zampro, Prophyt + Captan, Prophyt + Ranman) were conducted at bloom, post-bloom, bunch closure, and second cover. All treatments were applied to runoff at maximum-labeled rates with a CO₂ backpack sprayer; rates were calibrated to correspond to a 50 gal per acre total spray volume. Experimental design was a randomized complete block with five replications of each treatment, and each plot consisting of a single vine. Fungicides separated into three efficacy categories: (1) high efficacy - Revus, Zampro, Revus Top, Prophyt + Captan, Prophyt + Ranman; (2) good efficacy - Ranman, Captan, Prophyt; (3) no efficacy - Abound, Pristine. Resistance to QoI fungicides was prevalent (confirmed through genetic testing of downy mildew isolates), and use of QoI materials consistently resulted in downy mildew control failures. These trials have provided critical information to Georgia grape producers, which will result in substantively better management of downy mildew, better wine quality, and higher economic returns.

Non-destructive Field Sampling of Volatile Organic Compounds for the Metabolomic Analysis of Grape Cluster Development

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In some hybrid grapes, the presence of a "grassy" or "foxy" aromas are common and results from the presence of a specific, or group of specific volatile organic compounds (VOCs). However, there is a lack of information regarding when these compounds are formed in the berry and if they are already present during blooming. The goal of this study was to identify aroma differences in a hybrid grape population at two phenological stages. The experiment was conducted at the University of Minnesota's Horticultural Research Center using a population of 116 full-sib individuals, including the parents, and grandparents. At full bloom, a cluster on each individual in the field was covered with a perfluoroalkoxy alkanes bag for two hours containing a paper clip holding 3 discs of Polydimethylsiloxane (PDMS) adsorbent to capture volatiles released from the cluster. A paper disk containing 2 μ l of [¹³C₆]methyl anthranilate was used as an internal standard. At harvest, the same materials were used to sample 25 selected individuals to determine if the same compounds were present at both phenological stages. The VOCs were extracted from the discs using 250 μ l of dichloromethane/ethyl acetate solvent mix (50%:50%-v/v), and 20 μ l of this solution was analyzed by gas chromatography-mass spectrometry (GC-MS). The PDMS discs were more efficient at capturing a higher number of VOC from flowers than from the fruit. Using a metabolomics data analysis approach ~ 800 features were identified by GC-MS across all of the samples, ~66% were found only in flowers, including several sesquiterpenoids, pentadecane, α -farnesene, and many others. Interestingly, ~10% of features were present in both stages. This facile and inexpensive approach enables high-throughput evaluation of VOCs in the field, making it possible to analyze these important attributes in large mapping populations or in scoring field trials.



Poster Session Abstracts

American Viticultural Area Boundary Digitization and Analysis

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The Alcohol and Tobacco Tax and Trade Bureau (TTB) is responsible for evaluating American Viticultural Area (AVA) petitions and is the official record keeper of boundaries that require a metes-and-bounds description. There is demand for digitizing and creating a publicly accessible version of these boundaries by industry stakeholders across viticulture, enology, marketing and sales, distribution, and research. Drawing on our prior efforts in digitizing and analyzing AVA boundaries, along with a collaboration of Virginia Tech's Center for Geospatial Information Technology with the U.C. Davis Library's American Viticultural Areas Project, we compare several methods for AVA boundary digitization and metadata creation. The process of heads-up digitization is slow and tedious, while many features referenced in AVA boundary descriptions—roads, railroads, bodies of water, and political boundaries—are available as vector shapefiles from the Census Bureau and other government agencies and can be used to supplement the TTB convention of describing boundaries using USGS maps as the single authoritative map reference. In addition to digitization method analysis, we consider the potential for combining AVA boundaries with other data describing soil, climate, topography, and sense of place indicators to address academic research questions related to terroir within existing or proposed AVAs. The results of this project provide practical guidance—based in data science methods—for groups petitioning the TTB to establish or revise an AVA. We also establish best practices for digitizing a new or existing AVA to make the process more efficient, accessible, and compliant with official descriptions.

Wine Preservation in Aluminum Containers

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The wine market has seen tremendous growth in canned wines, due to numerous advantages including convenience and a greener carbon footprint than other forms of wine packaging such as glass bottles. However, packing fermented products including wines, ciders or other acidic, SO₂ containing products, such as model wines in aluminum beverage cans has met with mixed success. The mixed results are often attributed to measurable and sensorially significant amounts of hydrogen sulfide (H₂S) produced, in some cases, when sulfur dioxide (SO₂) is reduced in the presence of Al (0) under acidic conditions. This work reviews industry best practices of aluminum beverage canning and introduces some new data on a few key chemical reactions in the wines stored within—particularly the relationships among the can, sulfides, sulfites, pH, Al and some potential beneficial complexing factors that winemakers might take advantage of when canning wines to reduce the incidence of forming H₂S.

Relationship between Copigmentation and Covalent Reactions between Anthocyanins and Hydroxycinnamic Acids

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Copigmentation and the covalent reactions between anthocyanins and other substances are two important mechanisms in wine color expression, but their relationship remains unclear. This study focuses on the covalent reactions between anthocyanins and three hydroxycinnamic acids, all of which are common copigments in wine. Thermodynamic experiments were carried out using the transient state theory, and computational simulations were used for comparison. The experimental and theoretical results showed no significant differences in thermodynamic parameters between three hydroxycinnamic acids for the formation of activated complexes. The three activated complexes adopted the perpendicular stacking conformation, suggesting that π - π stacking present in the pigment/copigment complex was destroyed in the first step of the covalent reaction. Hydrogen bonds and van der Waals' forces were also absent due to the distance between the pigments and the copigments. This study therefore disproves the hypothesis that copigmentation is the first step in the covalent reaction between such species



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