Sustainable Vineyard Production Systems

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Sustainable Disease Control – Dr. Kendra Baumgartner

Identifying grapevines with resistance to fungal trunk pathogens

The trunk disease Eutypa dieback accounts for $26M in yield losses per year, and this figure is only for winegrapes in CA. As this and other trunk diseases attack grapes in all grape-growing regions of the US, we are focused on developing sustainable trunk disease control for all US growers.

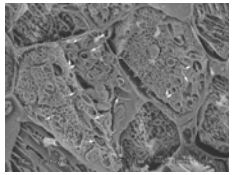
Previously, Merlot was known to be more resistant than Cabernet Sauvignon to Eutypa. We are now evaluating the resistance of 8 grapevine cultivars to Eutypa and to 4 other trunk pathogens (*Phomopsis viticola*, Esca pathogens *Phaeoacremonium* & *Phaeomoniella*, *Botryosphaeria parva*).

Our preliminary results suggest that there varieties that are more Eutypa-resistant (#1) and more Eutypa-susceptible (#8) than Merlot and Cabernet Sauvignon. Also, resistance to Eutypa is not necessarily associated with resistance to other trunk diseases.

Variety	Eutypa dieback	Phomopsis cane/leaf spot	Esca pathogen *Phaeoacremonium aleophilum*	Esca pathogen *Phaeomoniella chlamydospora*	Botryosphaeria canker
Cabernet Franc	2	1	7	1	1
Cabernet Sauvignon	6	3	3	3	3
Chardonnay	5	4	2	6	6
Concord	7	2	8	4	4
Merlot	3	6	1	2	7
Petit Syrah	1	7	4	8	2
Riesling	4	5	5	5	5
Thompson seedless	8	8	6	7	8

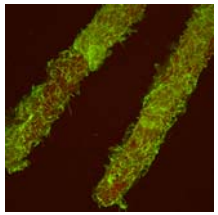
Developing rapid and sensitive pathogen screening technologies for nurseries

Grapevine nurseries and breeders need rapid screening technologies as a study tool for infecting experimental germplasm with grapevine pathogens, in order to identify resistant plants for further testing in the field.



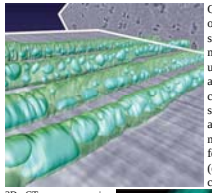
The grapevine root disease *Armillaria* was previously thought to only infect thick, woody roots. We used scanning electron microscopy to prove that the fungus infects fine roots. Arrows at left show the fungal filaments in X-section, snaking through root cells.

The screening method we developed for *Armillaria* infects grapevines in 2 wks, and the infection can be measured using a fungal-specific dye + viewing roots under a regular light microscope.

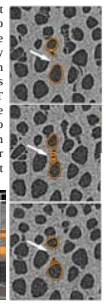


Sustainable Water Use Management for Grapevines and Vineyards – Dr. Andrew McElrone

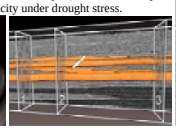
Evaluating the dynamic function of grapevine xylem in response to drought



Grapevine xylem controls the transport of water and nutrients from roots to shoots, and its function must be maintained to assure plant productivity under limited water availability. With advanced visualization techniques common to medicine (MRI and CT scans), we are assessing the availability of grapevine xylem to maintain (prevention of embolism formation and spread) and to repair (embolism repair) water transport capacity under drought stress.

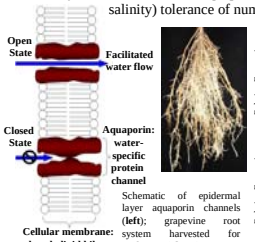


3D CT scan grapevine vessel image with vessel walls & water droplets (**above**); droplet distribution in refilling vessels (**right**); bridge between xylem vessels as seen in CT scan (**middle right**) and MRI (**far right**)

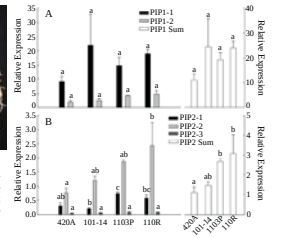


Evaluating rootstock water use physiology and response to stress

Study examines the role of aquaporins in variable vigor and stress (drought and salinity) tolerance of numerous grapevine rootstocks.



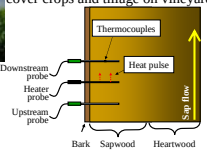
Schematic of epidermal layer aquaporin channels (**left**); grapevine root system harvested for analysis (**above**); PIP aquaporin gene expression findings (**right**)



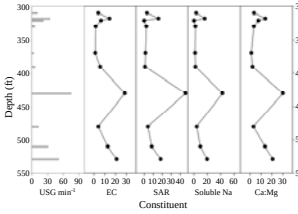
Quantifying grapevine water use & cover crop competition

Measuring vineyard-scale evapotranspiration and vine water use (**above**); schematic of sap flow sensor technology (**right**); cover crop and tillage treatments (**far right**)

Evaluating grapevine transpiration with sap flow sensor and surface renewal technologies to improve irrigation timing and water use, and investigating the effects of cover crops and tillage on vineyard water use competition.



Depth profiling of wells to locate salinity contamination

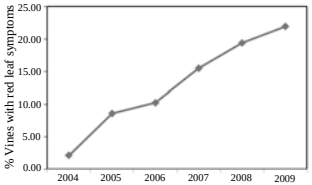


Well profiling at vineyards with known salinity issues to identify where contamination occurs and saline groundwater sources, and to see if a well manipulation could provide a low-cost method of irrigation water improvement.

Results of constituents measured by depth in a well with salinity issues (**left**)

Identify and Characterize Viral and Graft-Transmissible Agents of Grapevine – Dr. Mysore Sudarshana

- Leafroll disease is caused by several genetically distinct viruses and causes ~23% annual yield reduction and results in significant reduction in berry sugar content, affecting wine quality.
- Planting virus-free material is the most desirable and sustainable production option.
- We have identified two new diseases caused by graft-transmissible agents: necrotic union of 110R and necrotic stem distortion of 1103P in some Pinot noir clones.
- We have determined graft-transmissibility of the etiological agent with bench graft assays and are currently using deep sequencing to determine the etiology of the agents associated with these diseases.
- Several grapevines in commercial vineyards show leafroll symptoms but test negative for known leafroll-associated viruses; we are currently investigating the nature of the viruses associated with these grapevines.

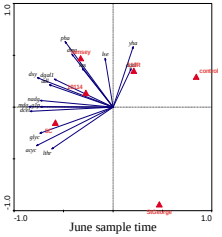


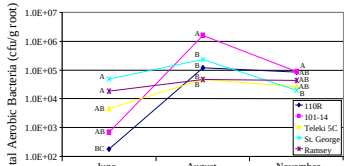
Cabernet Sauvignon grapevine showing leafroll disease symptoms (**top right**); grapevine trunks showing union disorders: stem lesion, necrotic stem distortion, and necrotic union (**middle right**); Pinot noir showing red leaf disease (**lower right**); cumulative disease incidence of grapevine necrotic union in Pinot noir vineyard on 110R. Each data point represents % red leaf incidence (**above**).

The Effect of Rootstock Genotype and Crop Phenology on the Rhizosphere and Endo-Rhizosphere Microbial Communities – Dr. Daniel Kluepfel

Introduction The rhizosphere microbial community significantly impacts plant health, growth, and crop yields. Thus, understanding factors affecting the rhizosphere microbial community are vital to enhancing plant health and production. Since plant-microbe interactions in the rhizosphere of woody perennial crops, like grapevine, occur over decades, the consequence of these interactions is enormous. To answer several fundamental questions, we examined the effect of grapevine rootstock genotype and crop phenology on the rhizosphere microbial community in California vineyards.

Carbon source utilization Rhizosphere community carbon utilization patterns were significantly different between host genotype ( ) on all sample dates. The functional diversity of the microbial community among the CV was due to differences in the ability and rate of metabolism of the different carbon sources, Differences in the microbial functional diversity of the rootstocks has been linked to utilization of specific individual carbon sources.

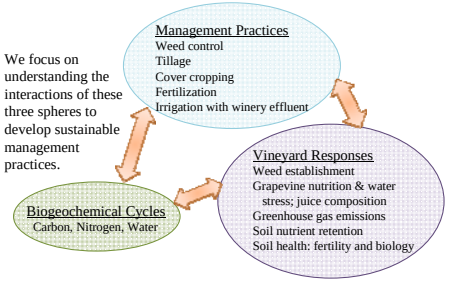




Endo-rhizosphere population dynamics Populations of aerobic bacteria isolated from surface sterilized grapevine roots over time. The population was enumerated on 10% trypticase soy broth agar. The data points represent the means of five replicate samples from five vines of each cultivars.

Developing a Systems View of Vineyard Floor Management – Dr. Kerri Steenwerth

We focus on understanding the interactions of these three spheres to develop sustainable management practices.



Current research projects & collaborators

- Cover crops as a vineyard management tool. K. Baumgartner, A. McElrone (USDA-ARS)
- *Conyza canadensis* (Horseweed): biology and control in California vineyards. A. Shrestha (CSU Fresno), M. Fidelibus, M. Alcorta (UCD)
- Developing practices to minimize greenhouse gas emissions and improve nutrient retention in vineyards. J. Lee (USDA-ARS), L. Bettiga, R. Smith, J. Roncoroni (UCCE)
- Effects of potassium-rich irrigation water on soil properties and grapevine health. S.J. Parikh, G.S. Pettygrove (UCD), A. Pattie, T. Cavagnaro, K. Mosse (U. Monash, AU)
- Managing the agricultural and wildland landscape for crop production, carbon storage, greenhouse gas mitigation and biodiversity. (See project description to the right)

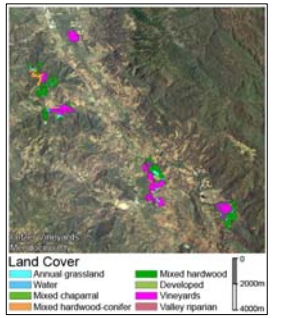
Projects also described in NGWI booklet

Evaluating carbon storage in agricultural and adjacent ecosystems

Background. Only one approved method exists for determining carbon stocks to gain credit in California's impending 'Carbon Market', but it has been developed for forested systems.

Goal. Develop a method for vineyard owners to quickly assess carbon stocks and footprints across the agricultural and wildland landscape, with respect to the Cap and Trade system.

Objectives: 1 – Quantify above- and belowground carbon stocks in vineyards and adjacent wildlands; 2 – Create a Life Cycle Analysis of the carbon and greenhouse gas budget for vineyard systems, including cultural practices (i.e., cultivation, herbicide use, etc.);



Soil pits used to measure soil carbon content to 1 meter

Objectives (cont.): 3 – Identify co-benefits associated with managed and wildland systems, e.g. increased biodiversity, improved water quality, conservation of habitat.

Regions of Study & Collaborators: Mendocino – one grower (Fetzer Vineyards) during the preliminary phase. Napa and Lodi – plan to expand to multiple AVAs. Dr. Louise E. Jackson, Dr. A. Hollander, Dr. J. Williams, Dr. A.T. O'Geen (U.C. Davis), A. Thrupp (Fetzer Vineyards)