Final Report

This is year __2__ of a __2__year proposed project.

For the Washington State Grape & Wine Research Program

Date: 25 May 2017

Project Title: Phosphorus Nutrient Management and Comparative Studies Between P-Deficient and Virus Affected Grapevines

Principal Investigator(s): Joan R. Davenport

Collaborator(s): Dr. Naidu Rayapati, Ste. Michelle Wine Estates, Mercer Canyon Ranches

Project Budget Number: 13C-3319-4596

I. Project Summary: Non-technical, 1 - 3 succinct paragraphs that cover the following points:

1. What is the current issue and why does it need researched?

2. What are the basic methods and approaches used to collect data that are used to inform target audience?

3. What ultimate goals does the project hope to achieve?

Red wine grapes in Washington State often show red discoloration in leave which could be the result of low phosphorus (P) in the vine, a nutritional disorder, or a virus infection with either Leafroll [GLRD] or Red Blotch [GRBD].

When a vineyard is low in P, there are two approaches to applying fertilizer to increase the amount of P in the vines: either soil or foliar application. Because of the chemical make-up of soils used for vineyard production in irrigated Washington, it is unclear if soil applications would be effective, thus this study is designed to compare not only the amount of P needed to remediate a low P vineyard, but also to see if soil or foliar application are equally effective. Although there is no research that links the red leaf discoloration in virus infected red wine grapes, supplemental P fertilizers are being tested on these vineyards to see if it alleviates some or all of the symptoms.

The ultimate goal of the project is to provide guidelines for P fertilizer management in wine grapes in irrigated Washington.

II. Materials, Methods and Experiments Conducted to Meet Stated Objective(s):

Vineyards that had been soil and tissue tested for P status and virus were chosen for this experiment. There were four vineyards in the study, a non-infected Cabernet Sauvignon plus one with Leafroll, and a non-infected Merlot and one with Red Blotch. Using guidelines

from studies on P content of grapevines, P was applied either through direct spray to the foliage (foliar application) or direct application to the soil (simulated as a drip fertilizer application) three times during the growing season (bloom, late fruit set, and veraison) for seasonal total applications of 0, 12, 25 and 37 lbs/A P in replicated plots.

Leaf and soil samples were collected to monitor plant P status at veraison. At harvest, fruit was hand-picked and clusters counted to estimate yield as well as the yield component cluster weight. A fruit subsample was retained to analyze quality parameters as well as fruit P concentration. All vineyards were harvested in 2014, however in 2015, Cabernet Sauvignon site 2 was commercially harvested prior to our harvest.

This was year two of what was intended to be a three year project. While the intent was to conduct this project for three years, the project was conducted on 4 different fields for two growing season, giving a total of eight site years which we have concluded is sufficient to address this trial.

III. Major Research Accomplishments – include the following points:

1. *Explain major activities completed (include timeline)*
2. *Describe specific objectives that were met.*
3. *Describe significant results achieved and any conclusions (both positive and negative).*
4. *Discuss key outcomes realized from this project.*

Project Timeline:

Activity	pre-July 2014	July 2014 - June 2015	July 2015 - June 2016	July - May 2017
Contact growers and field people to identify low P vineyards as well as GLRD infected sites for trials	completed			
Set up plots for P rate and source field study	completed			
Apply in season P fertilizers		2014 applications completed	2015 applications completed	

Activity	pre-July 2014	July 2014 - June 2015	July 2015 - June 2016	July - May 2017
Collect and analyze bloom and veraison leaf tissue samples from plots; in-season measurement of canopy vigor; soil sampling and analysis.		completed	completed	
Test for Red Blotch and Leaf Roll 3 by plot.			completed	
Harvest plots and determine yield; evaluate quality parameters of fruit.		completed	completed	
Analyze data and report/ publish				completed

In 2015, leaf tissue samples were collected from each plot for analysis for viral infection to verify the initial bulk sample results from the vineyards. The results showed that all of the vineyards had some level of virus.

Table 1: Results of PRC testing of grapevine leaves collected on a by plot basis, reported as percentage of plots (32 plots/site) testing positive for Leaf Roll-3 or Red Blotch virus.

Vineyard ID	Expected Virus Status	% of Plots with Leaf Roll	% of Plots with Red Blotch
Cabernet Sauvignon 1	None	9	0
Cabernet Sauvignon 2	Leaf Roll	16	9
Merlot 1	None	25	0
Merlot 2	Red Blotch	0	13

Figure 1: Average yield of Cabernet Sauvignon (Cab Sauv) and Merlot, each from different blocks, in 2014 and 2015.

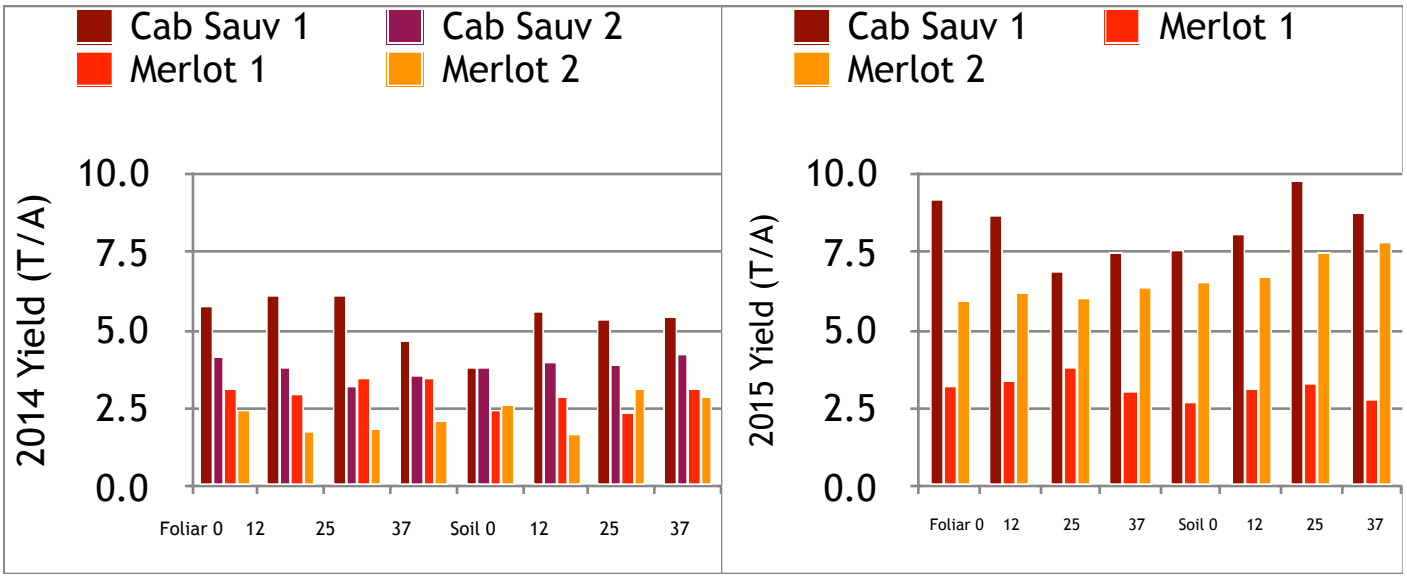
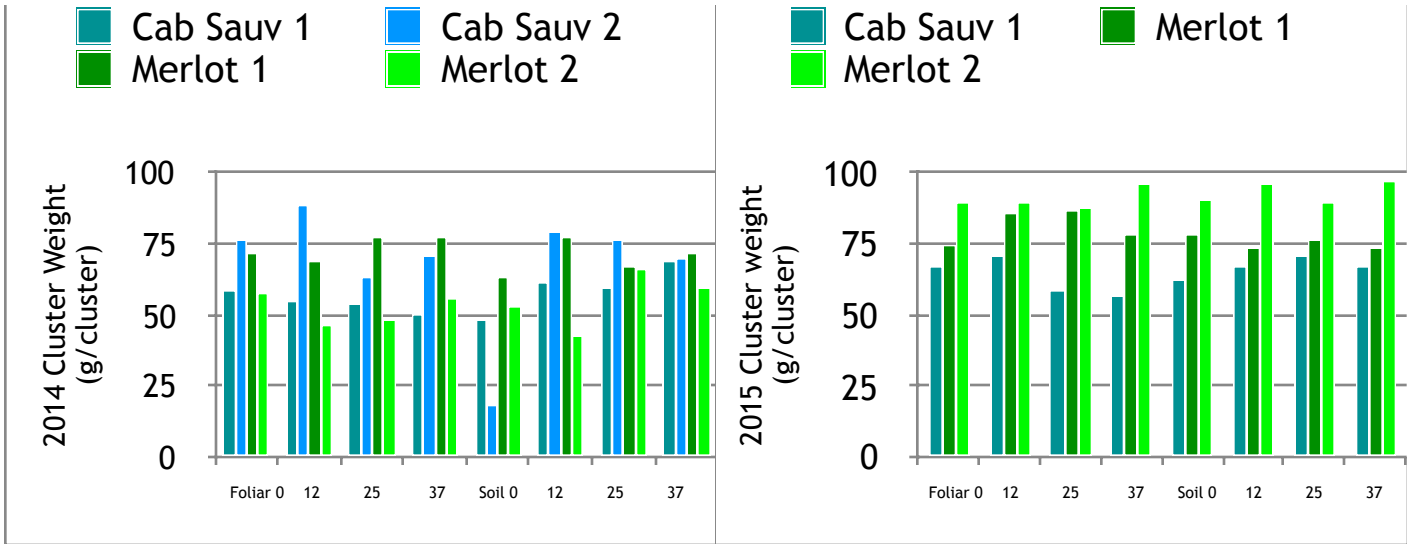


Figure 2: Average cluster weight of Cabernet Sauvignon (Cab Sauv) and Merlot, each from different blocks, in 2014 and 2015.



Yield and the yield component average cluster weight were lower in 2014 than in 2015. Cabernet Sauvignon yields were higher than Merlot yields in both years, but the Merlot vineyard with higher yields in 2014 (Merlot 1) had lower yields in 2015. Cluster weight was lower in Cabernet Sauvignon, despite higher yields, and in 2014, the higher yielding vineyard

had lower cluster weight. The opposite was found in Merlot - when yield was higher, cluster weight was higher.

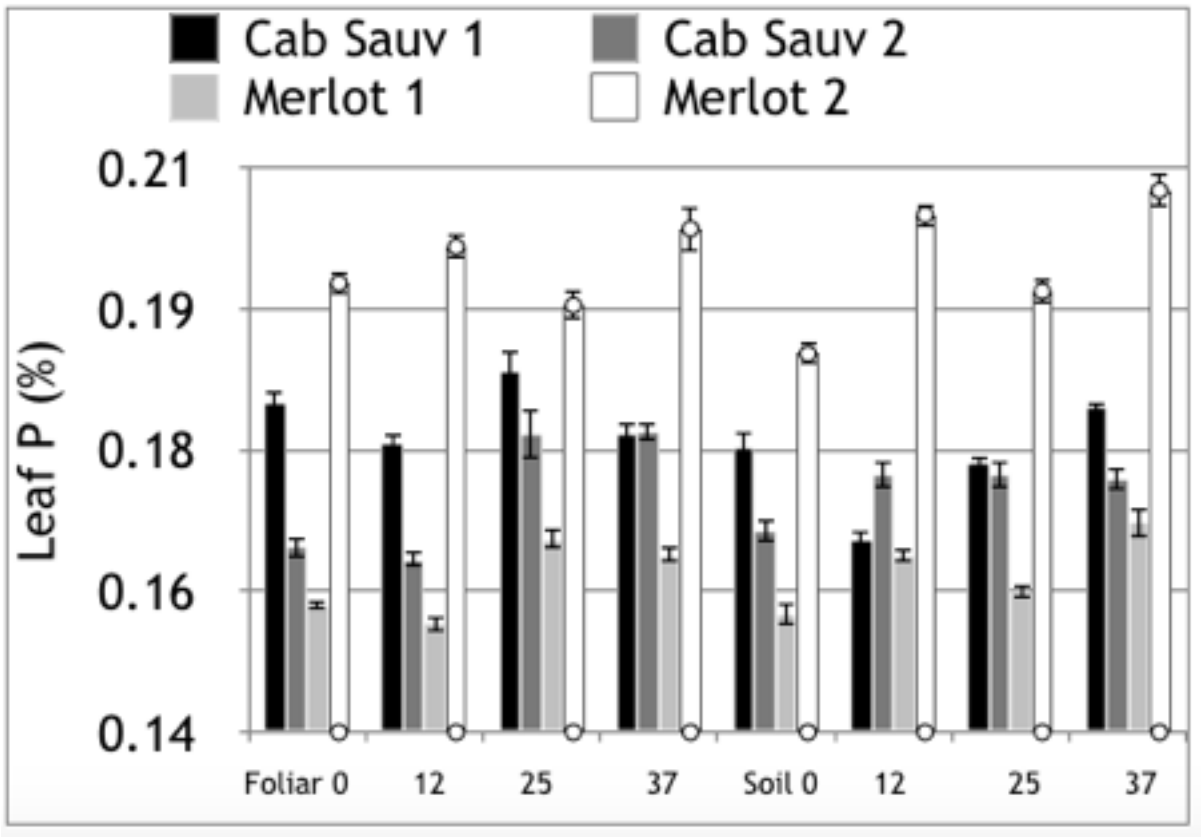
Fruit was analyzed for standard quality parameters (pH, Soluble Solids [Brix], titratable acidity (TA), and color (anthocyanins). These varied by year and vineyard but, with the exception of fruit pH (data not given), were not responsive to fertilizer treatment (Table 2).

Table 2. Fruit quality factors by vineyard in 2014 and 2015.

	pH	Brix	TA	Anthocyanins
		2014		
Cabernet Sauvignon 1	3.45	23.08	3.68	0.8254
Cabernet Sauvignon 2	3.88	23.56	4.47	0.9404
Merlot 1	4.04	22.88	3.73	0.8094
Merlot 2	4.18	25.04	3.61	1.0391
		2015		
Cabernet Sauvignon 1	3.90	24.72	5.58	0.8223
Cabernet Sauvignon 2	4.07	25.67	5.62	0.9812
Merlot 1	3.97	24.92	5.14	0.8832
Merlot 2	4.01	24.67	5.42	0.9812

After two years of the same fertilizer treatments, there were increases in leaf tissue P levels (Fig. 3) in the blocks that were low in P at the beginning of the experiment, Cabernet 2 and Merlot 1. There were some slight differences in response between the two vineyards that were initially low in P, Cabernet 2 and Merlot 1. In Cabernet 2, leaf P reached to desired > 0.15% with all treatments, but was slightly higher with the foliar fertilizer applications than the soil applications. In Merlot 2, all P was increased to the desired level except in the lowest (12 lbs/A) foliar rate. Overall these results suggest that either foliar or soil applied P can correct a P deficiency in vineyards. It should be noted that we did, see leaf burning in the first growing season with all foliar treatments (even the lowest rates), suggesting that since both soil and foliar applied P are effective, and in one case (Merlot 2), soil applied was effective at a lower rate, that soil applied P is the better option. The results also suggest applying

P at a rate of 25 lbs/A split three times over the course of the growing season for two years



will increase the leaf tissue P from deficient to sufficient.

Figure 3: Average leaf tissue P concentration of Cabernet Sauvignon (Cab Sauv) and Merlot, each from different blocks in 2015 after two years of P fertilizer supplements.

While leaf burning was evident in the first year of the study (2014) in the foliar treatments, particularly in Cabernet Sauvignon 2, which has both both viri present, none was apparent in the second year (2015) despite higher temperatures. Since the results do not show a clear difference between soil or foliar application responses, it may be concluded that soil application through the drip system is sufficient to correct a low P situation in the vineyard.

IV. How have results been or expected to be disseminated to grape and wine industry stakeholders and audiences of interest?

List publication's (peer-reviewed journal articles, extension publications, industry trade journals, newspaper, etc.), Include industry presentations, posters, field days, and other events with dates and venues.

The results from this project have been presented as a poster presentations at the Washington State Grape Society Annual Meeting in November 2014 and Washington Association of Wine Grape Grower's Annual Meeting in February 2015 and 2016. The results were also published in WSU's Spring 2016 Viticulture and Enology Newsletter (http://wine.wsu.edu/research-extension/files/2016/04/2016-VEEN-SPRING-FINAL.pdf). In addition, the results are incorporated in currently in revision nutrient guideline for Washington grape production which is expected to be published in 2017.

V. **Project Budget Status:**

Include timeline, any changes, developments, problems or delays that may have significant deviations from original budget rate of expenditure.

All of the funds allocated to this project have been spent.

VI. Other Sources of Funding:

From August 2013 - January 2015 this project involved the work of a self-funded MS Ag Student, Nathan Brugnone. Mr. Brugnone was funded with a Teaching Assistantship in fall 2014. The contributions to the project in terms of tuition expense are estimated as $45,000.