Pennsylvania Wine Market & Research Promotion Program

Final Report

A financial status report and a project performance report will be required on a semi-annual basis. October and April reports are due. A final report may serve as the last semi-annual report due 30 days after completion of the contract. Grantees shall monitor performance to ensure that time schedules are being met and projected goals by time periods are being accomplished. Please submit reports to: RA-AGCommodities@pa.gov.

SECTION 1 – SUMMARY INFORMATION

Date of Report: June 7, 2021

Contract/PO#: 44208972 Fiscal Year: 2019-2021 Round of Grant: (i.e. Round 1, Round 2, etc) 4

Title of Paper: Survey for Grapevine Leafroll Viruses in Pennsylvania

Organization: Pennsylvania State University

Project Coordinator: Bryan Hed (Principle Investigator)

Organization Address: 110 Technology Center

City/State/Zip: University Park, PA 16802-7000

Business Phone: 814-725-4601 Cell Phone:

Email: Bxh38@psu.edu

Progress Report: ☐ October ☐ April

☒ Final

Area of Focus: ☒ Research

SECTION 2 –OBJECTIVES | TIMELINES | OUTCOMES | BUDGET

(A comparison of actual accomplishments to the objectives for that period?)

The following final report covers the 6-month period from October of 2020 to April of 2021.

OBJECTIVES:

1. Examine and report the spread of grapevine leafroll associated virus 1 and/or 3 (GLRaV-1 and 3) and the presence of potential vectors of these viruses within 5 commercial vineyard sites in Pennsylvania.
2. Examine the effects of GLRaV-1 and 3 on grapevine vegetative growth, yield components, fruit chemistry, vine nutrient status, and bud cold hardiness at each vineyard site.
3. Characterize the influence of inter- and intra-seasonal weather conditions on virus-infected grapevine performance at each site.

TIMELINE: October 2020 to April 2021

- October 2020-April 2021: Collected and organized weather data at all sites (Objective 3).
- <u>October 2020-April 2021:</u> Identified mealybugs collected during summer of 2020 (Objective 1). Assessed effect of grapevine leafroll disease (GLD) on yield components and fruit maturity on vine pairs at harvest for four of the sites. Analyzed petiole nutrient analyses (from sites 1, 3, and 5) to determine effects of the virus on vine nutrient status (Objective 2).
- <u>November 2020-</u>March 2021: Evaluated bud cold hardiness, pruning weights at each site. Analyzed viticultural data collected during the 2020 growing season (Objective 2).

OUTCOMES (since October 2020)

<u>*Objective 1:*</u>

- The presence of grape mealybug (*Pseudococcus maritimus*, Ehrhorn), a known vector of grapevine leafroll viruses, has been confirmed at all four remaining sites. This finding, together with the fact that we detected a higher number of GLRaV infected vines at all sites each year, strongly suggests that these viruses are being spread by insect vectors. Scouting for potential vectors could be used by growers as indication of potential for spread of the viruses in their vineyards.

<u>*Objective 2:*</u>

GLRaVs infection negatively impacted fruit production (cluster weight, yield, yield/shoot; table 1), fruit composition (fruit soluble solids (SS) and titratable acidity (TA; table 2), and bud freeze tolerance (table 3) in Cabernet Franc in some locations.

- *Cluster weight:* GLRaVs infection lowered cluster weight at harvest, at site 1 (by 25%) and 2 (by 20%) in 2020, compared to noninfected vines. This effect appears to be more a function of fewer berries per cluster rather than berry weight. It should be noted that site 2 suffered a serious bout with crown gall development in 2020 that did not discriminate between GLRaVs infected and noninfected vines (among the data vine pairs) with respect to whole vine or cordon collapse. However, cluster weight at site 2, which had hitherto been unaffected by the presence of the virus in 2018 and 2019, was now significantly lower among GLRaVs infected vines, compared to noninfected vines, in 2020.
- *Yield:* GLRaVs infection lowered yield only at site 1 in 2020 (by 24%), compared to noninfected vines. This is the second year in which we observed this effect at site 1 (16% yield drop in infected vines in 2019). In both years, lower yields among infected vines at site 1 are mostly attributed to smaller, rather than fewer clusters. Lower yields were also observed among infected vines at site 3 in 2019 (attributed

to the combined effects of multiple factors; fewer and lighter clusters and fewer shoots per vine, as compared to non-infected vines), but we did not observe this effect at site 3 in 2020.

- *Yield per shoot:* For the second consecutive year, GLRaVs infection lowered yield per shoot at site 1 (by 18%). Yield per shoot was also reduced by virus infection (for the first time in three years) at site 2 in 2020 (by 24%), compared to noninfected vines. As with yield per vine, yield per shoot differences at these sites, are attributed to differences in cluster weight.
- *Vine nutrient status:* Petiole tissue analysis showed that potassium was higher in infected vines at site 3 when compared to noninfected vines (by 10.5%). Interestingly, this coincided with a *slightly* higher pH and lower acidity in the juice of infected vines, compared to noninfected vines at that site, but the differences were not significant. There were no other relevant nutrient differences found across the three sites tested.
- *Fruit composition:* **For the third year, effects on fruit composition (mainly juice soluble solids (SS)) were the most commonly observed negative effects of GLRaVs infection on Cabernet Franc grapevines.** GLRaVs negatively impacted fruit quality at 3 of 4 sites in 2020 (lower SS at site 2 (for the third consecutive year in three years), site 3 (for the second consecutive year in two years), and site 5 (for the first time in two years), and higher TA at site 1, 2, and 5). Though SS and TA values of noninfected *and* infected vines generally fell within the range for ripe fruit, making the difference to fruit and wine quality less relevant, the data are clear that **infection by GLRaVs will generally result in less mature fruit by harvest**.
- *Bud freeze tolerance:* Buds from infected vines at site 3 were more susceptible to colder temperatures during November 2020 (table 3). Interestingly, we observed a similar effect at site 5 in November of 2019. However, there were never significant effects of GLRaVs infection on bud freeze tolerance observed at any site from samples collected in January, February, or March.
- *Pruning weights:* Dormant pruning weights are a reflection of vine growth and vigor in the previous season. At sites 1, 2, and 5, dormant pruning weights have been numerically higher in every year, among noninfected vines, compared to infected vines. However, these effects were never statistically significant. Conversely, we did observe that noninfected vines had a significantly lower pruning weight than infected vines at site 3 in 2020. This effect may be a reflection of problems other than GLRaVs at site 3, as we also observed that pruning weights in 2020 were about half or less, than the weights of 2019 (on the same infected and noninfected vines), a site that has recently experienced issues with spotted lanternfly.
- *Ravaz index (yield/pruning weight):* The Ravaz index is a measure of vine balance determined by the ratio of vine growth (measured as pruning weight) against fruit production or yield. Generally speaking, a ratio of 5-10 is considered good balance for most varieties of *Vitis vinifera* (which includes Cabernet Franc). In this study, there were no significant effects of GLRaVson the Ravaz index. However, it is interesting to note that the site with the most negative yield and fruit composition effects of GLRaVs, is the same site with the consistently highest Ravaz index over the years (site 1). Perhaps this indicates that, when yields are pushed to their limits within (or slightly above) that 5-10 Ravaz index, the negative effects of GLRaVsare most commonly observed. This is not surprising since the presence of GLRaVs is generally thought to create a drag on the photosynthetic activity and resource allocation of infected vines.

<u>*Objective 3:*</u> Weather data continue to be collected for correlation with measured effects of GLRaVson vine performance. Data collected (rainfall, solar radiation, air temperature) are being analyzed to determine seasonal

growing degree days, seasonal rainfall, and cumulative solar exposure. Analysis will be completed by the conclusion of the project.

BUDGET

Financial reporting on this project is provided by the Department of Research Accounting at PSU in accordance with the terms of the grant agreement.

SECTION 3 – SCOPE OF WORK

(Reasons why established objectives were not met, if applicable?)

We are on time performing the scheduled activities.

SECTION 4 – DELAYS/RISKS

(Reasons for any problems, delays, or adverse conditions which will affect attainment of overall program objectives, prevent meeting time schedules or objectives, or preclude the attainment of particular objectives during established time periods. This disclosure shall be accomplished by a statement of the action taken or planned to resolve the situation?)

The arrival of Covid-19 in Pennsylvania has not had a significant impact on the timeline of this project. We have had full access to vineyards located in the Commonwealth of Pennsylvania, and there have been no delays in data collection or analysis and no effect on the overall progress of the program objectives. However, laboratory work took longer than anticipated because of COVID-19 safety regulations and travel to meetings and conferences was eliminated or greatly minimized.

SECTION 5 – SPECIAL NOTES

(What objectives and timetables are established for the next reporting period? Etc.)

NA: This is a final report for this grant period.

Table 1. Impact of grapevine leafroll disease on yield components, pruning weight, and crop load (Ravaz index) for Cabernet Franc vineyards 1, 2, 3, and 5 in 2020. Values in bold font indicate significant differences between healthy and infected vines at $P \leq 0.05$ and 0.10.

Site 1

Vine	Yield (kg/vine)	Clusters/ vine	Cluster wt (g)	Yield/ Shoot (g)	Pruning weight (kg/vine)	Canes/ vine	Ravaz index (yield/ pruning wt.)
Healthy	**6.33 a**	46.2	**137.8 a**	**259.7**	0.64	24.5	10.82
Infected	**4.78 b**	47.8	**103.8 b**	**212.1**	0.53	22.8	9.73
P-value	0.029**	0.734	0.016**	0.082*	0.197	0.293	0.453

*Healthy vines had significantly higher yield per shoot at $P \leq 0.10$.

**Healthy vines had significantly higher yield and cluster weight than infected vines at $P \leq 0.05$.

Site 2

Vine	Yield (kg/vine)	Clusters/ vine	Cluster wt (g)	Yield/ Shoot (g)	Pruning weight (kg/vine)	Canes/ vine	Ravaz index (yield/ pruning wt.)
Healthy	7.40	72.1	**103.0 a**	**160.6 a**	1.14	45.9	6.83
Infected	6.55	78.9	**82.0 b**	**121.8 b**	0.98	52.1	7.32
P-value	0.212	0.541	0.008**	0.014**	0.182	0.176	0.708

** = Healthy vines had significantly higher cluster weight and yield/shoot than infected vines ($P \leq 0.05$)

Site 3

Vine	Yield (kg/vine)	Clusters/ vine	Cluster wt (g)	Yield/ Shoot (g)	Pruning weight (kg/vine)	Canes/ vine	Ravaz index (yield/ pruning wt.)
Healthy	2.51	22.85	126.92	161.39	**0.40**	15.3	6.38
Infected	2.70	20.82	132.28	165.20	**0.60**	15.7	4.74
P-value	0.720	0.555	0.782	0.882	0.017*	0.860	0.352

* = Infected vines had significantly higher pruning weights than healthy vines ($P \leq 0.05$).

Site 5

Vine	Yield (kg/vine)	Clusters/ vine	Cluster wt (g)	Yield/ Shoot (g)	Pruning weight (kg/vine)	Canes/ vine	Ravaz index (yield/ pruning wt.)
Healthy	15.32	134.9	112.8	193.4	2.59	79.0	7.15
Infected	13.87	139.6	101.1	176.4	2.12	79.0	7.14
P-value	0.442	0.768	0.193	0.449	0.321	1.0	0.997

There were no significant effects on these parameters at site 5 ($P \leq 0.05$).

Table 2. Grape juice composition (soluble sugars [SS], titratable acidity [TA] and pH) at harvest 2020 of GLRaVs infected and uninfected Cabernet vines at sites 1, 2, 3, and 5

	Site 1			
Vine	SS (Brix)	TA (g/L)	pH	Avg. berry weight (g)
Healthy	22.5	**.479**	3.62	1.49
Infected	22.5	**.530**	3.67	1.50
P-value	0.938	0.037*	0.141	0.722

* = Fruit from healthy vines had significantly lower TA than infected vines ($P \leq 0.05$)

	Site 2			
Vine	SS (Brix)	TA (g/L)	pH	Avg. berry weight (g)
Healthy	**22.35**	**0.648**	3.56	1.18
Infected	**20.04**	**0.777**	3.51	1.11
P-value	0.015*	0.032*	0.233	0.362

* = Fruit from healthy vines had significantly higher brix and lower TA than infected vines ($P \leq 0.05$)

	Site 3			
Vine	SS (Brix)	TA (g/L)	pH	Avg. berry weight (g)
Healthy	**20.2**	.463	3.93	1.57
Infected	**18.9**	.457	4.04	1.68
P-value	0.054*	0.789	0.107	0.317

* = Fruit from healthy vines had significantly higher brix than infected vines ($P \leq 0.1$)

	Site 5			
Vine	SS (Brix)	TA (g/L)	pH	Avg. berry weight (g)
Healthy	**21.5**	**0.648**	3.61	1.42
Infected	**20.3**	**0.748**	3.58	1.40
P-value	0.001*	0.001*	0.234	0.553

* = Fruit from healthy vines had significantly higher brix and lower TA than infected vines ($P \leq 0.05$)

Table 3. Bud freeze tolerance of GLRaVs infected and uninfected Cabernet vines measured during the 2020-2021 dormant season. Bud freeze tolerance is expressed as low temperature exotherm required to kill 50% of the buds (LT_{50}, °F).

	Site 1			**Site 2**		
Vine	Nov	Jan	Mar	Nov	Jan	Mar
Healthy	1.4	-7.7	-0.2	2.6	-6.8	-0.5
Infected	1.1	-7.2	-0.1	3.6	-7.0	0.6
P-value	0.594	0.464	0.849	0.154	0.860	0.459

There were no significant effects of GLRaVs infection on bud freeze tolerance ($P \leq 0.05$)

	Site 3			**Site 5**	
Vine	Nov	Jan	Mar	Nov	Jan
Healthy	**6.3**	-5.6	2.2	5.0	-5.6
Infected	**8.1**	-4.3	1.9	5.2	-5.7
P-value	0.004*	0.201	0.779	0.725	0.901

*Buds of healthy vines were more freeze tolerant than those of infected vines in November 2020 ($P \leq 0.05$)