

**Virginia Wine Board Grant
Final Report**

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Title: Maintain fungicide resistance testing capabilities for grape diseases, and follow-up tests on cane-infecting fungi-IV.

Proposal Number: PU4C6M7L

Project Type: ☒ Research ☐ Education ☐ Marketing

Original Funding Amount: \$11,771

Remaining Balance: \$0

Objectives and Corresponding Achievements:

I. Objectives

1. Testing of grape pathogens for **fungicide resistance** to determine distribution of known resistance types, and as new issues may arise.
2. Further investigation of variability of **phosphite sensitivity** among grape downy mildew isolates
3. Follow-up testing of **cane- and bud-infecting fungi** of proven pathogenicity for ability to infect flower clusters and canes, including a stress treatment.

1. Since we had a large number of downy mildew isolates collected in 2020 and especially 2021 that had not been tested yet, we have focused on working through this group; 34 isolates were tested, usually 3-5 isolates at a time, in 40 bioassays between June and November. QoI (strobilurin) resistance and CAA (Revus) resistance were common, as in recent years.

One 2021 isolate showed very slight ability to grow on leaf tissue treated with a label rate of Ridomil. It may represent a case of slightly reduced sensitivity but doesn't appear to be the full-blown resistance that has been documented in Europe and Australia. It is currently in frozen storage, and we will try to revive it in spring to do additional testing with lower concentrations to see if it indeed differs from the mean.

Relatively little work has been done with powdery mildew. Not many samples were collected since 2020, and powdery mildew isolates are harder to maintain for later testing because, unlike with downy mildew, frozen storage has not proven successful.

One central Virginia vineyard experienced a significant Botrytis bunch rot outbreak and, through Nelson County Cooperative Extension agent Grace Monger, samples were provided in mid-July. All isolates tested were completely resistant to fluopyram (Luna), which was most likely why the spray program failed.

There was also considerably reduced sensitivity to related compounds (FRAC group 7) such as isofetamid (Kenja) and benzovindiflupyr (Aprovia), while resistance to boscalid (Endura) has been prevalent for a number of years. A set of Botrytis samples from another Central Virginia location also showed the prevalence of resistance to fluopyram, benzovindiflupyr, and isofetamid. In the same group (FRAC group 7), we also have fluxapyroxad (a component of Merivon where the other component (pyraclostrobin) faces widespread resistance) and pydiflumetofen (which is sold as Miravis Prime in a mixture with fludioxonil) – the two isolates tested against these materials were resistant to fluxapyroxad, but not pydiflumetofen. Oddly, one of them was also resistant to fluopyram, benzovindiflupyr, and isofetamid, while the second one was not. Another set of samples from a third vineyard had the historically common resistance to boscalid but was sensitive to all of the other group-7 materials, highlighting the complicated nature of group 7 resistance.

Table 1. Partial results of 2022-23 resistance testing of selected Botrytis isolates, with focus on FRAC group 7.

Trade name	Elevate Fenhex- amid	Medallion Fludio- xonil	Endura Boscalid	Luna Fluo- pyram	Aprovia benzovin- diflupyr	Kenja iso- fetamid	Part of Merivon fluxa- pyroxad	Part of Miravis pydiflu- metofen
Ingredient								
FRAC group	17	12	7	7	7	7	7	7
"Typical" isolates		s	R	s	s	s		
K5	s?	s?	s	R	s	s	R	s
K6	s	R	s	R	s	s		
K7	s	s	R	R	R	R		
K12	R	s	R	R	R	R		
K13	s	s	R	R	R	R		
R3	s		R	s	s	s		
R4	s	s	R	s	s	s		
R6	s	s	R	s	s	s		
R7	s	s	R	s	s	s		
V1	s	s	s	s	s	s		
V3	s?	s	R	R	R	R		
V4	s	s	R	R	R?	R	R	s
V5	s	s	s	s	s	s		
C1	s	?	R	s	s	s		

2. Phosphite sensitivity has been a concern

A concern about the efficacy of phosphite fungicides has reemerged recently. Investigations in previous years led us to conclude in 2016 that at that time there was no evidence of reduced phosphite sensitivity in Virginia populations. We routinely use 0.3% Prophyt as a test concentration in laboratory leaf bioassays, and historical isolates have shown only slight or no growth on leaf tissue treated with this rate. However, many 2021 isolates have shown fairly good, albeit variable, growth on such treated

leaf tissue (Table 2). We obtained fresh fungicide sample to rule out deteriorated product, and, for direct comparison, have started including in our tests a 2006 isolate (SuD1) that had been stored frozen, but the pattern persisted. Table 1 shows results for 6 recent isolates that have been included in multiple bioassays. Results for some have been variable, but all averaged better growth than SuD1. We have produced a number of small rooted cuttings under greenhouse conditions, and those will be used to test the sensitivity of selected isolates after sprays with label rates or lower rates of phosphite fungicide..

Table 2. Examples of growth of grape downy mildew on grape leaf tissue treated with 0.3% Prophyt as percent of growth on untreated tissue.

2006	Isolate (all from 2021, except SuD1)					
SuD1	Mu4	KR1	SH18	CA3	SJ22	BV2
0	55	25	0	35	93	21
0	14	18	71	15	30	5
0	14	12	0	40	4	26
0	103	0	0	0	79	0
0	22	154	20	81	53	88
0	69		2	40		
0				100		
0				103		
0				114		
0				48		

A potted-plant trial of phosphite application frequencies under field conditions was repeated in 2022 with naturally occurring inoculum. The plants were kept outdoors, without inoculation, and the first downy mildew was noticed on Jul 15. Fungicide applications were started applications on July 23. At a rating on Sep 6, untreated (control) plants were 90% defoliated (Table 3). Precipitation from Jul 23 through Sep 5 was 9.71 inches. Applications were continued through Sep 24. Downy mildew samples were collected from non-sprayed plants early in the season, and later in the season from plants that had receiving weekly phosphite applications; these were stored frozen for comparative testing.

Table 3. Control of grape downy mildew on potted grape plants under field conditions, 2022.

Treatment, Rate per 100 gal	Average number of leaves remaining per plant	Average defoliation %	Average downy mildew on remaining leaves, %
Control	11	90	46
Revus, 8 fl oz	43	55	40
Mancozeb, 3 lbs	68	4	7
Prophyt 7d, 0.5%	64	13	4
Prophyt 10d, 0.5%	53	22	9
Prophyt 14d, 0.5%	55	22	19

A similar trial is being planned for the summer of 2023.

3. Cane fungi - Little progress has been made due to focus on downy mildew bioassays

Overall Benefit for Virginia Wine Industry:

Detection of fungicide resistance does not improve grape production in a direct sense, but it minimizes two risks: continued application of ineffective fungicides causing unnecessary expense and environmental impact, and, even more damaging, unexpected fungicide failures leading to disease outbreaks, crop loss and even crop failure.

Publications and Activities Associated with Project:

Results are used to inform information in the Virginia Cooperative Extension Pest Management Guide Horticultural and Forest Crops (Grapes: Diseases and Insects in Vineyards) and Extension programming.

Future Work:

In the new fiscal year, we will continue to study phosphite sensitivity of recent downy mildew collections in comparison with historical ones in whole-plant tests. With respect to Botrytis testing fluxapyroxad and pydiflumetofen will be tested with additional isolates. Depending on weather and disease developments, collection efforts are planned for summer and fall.

Final Budget and Justification:

Item Type	Original Awarded Amount	Amended budget	Final Amount Spent
Personnel	\$7,280.00	\$9,434.00	\$9,805.51
Fringe	\$291.00	\$110.00	\$99.01
Travel	\$600.00	\$277.00	\$276.65
Supplies & Materials	\$1,000.00	\$600.00	\$384.52
Contractual	\$2,000.00	\$1,350.00	\$1,205.31
Other	\$600.00	\$0.00	\$0.00
Total	\$11,771.00	\$11,771.00	\$11,771.00

More was spent on student wages. Less on fringes (budgeted in case student workers in the summer are not simultaneously signed up for a class; not used if they are signed up for a class). Less on travel (some multi-purpose trips paid from other funds. Same for Supplies and other categories.