Virginia Wine Board
Grant Report Template

1.0 INSTRUCTIONS

Use this grant report template to communicate progress on your project objectives to the Virginia Wine Board and its administrative agents.

This simplified form focuses attention on the intended and achieved results of the project, including how project results are separately shared with their intended beneficiaries. This report is not the place for a detailed technical discussion of research methodology or results.

- During the proposal stage, applicants complete the first (WHITE) sections to summarize the project's objectives, deliverables, and intended impact plus planned communication to stakeholders.
- At the midpoint of the project (December 1, due December 15), Research and Education grantees complete the center (GRAY) sections to note progress as well as expenditures to date.
- Finally, upon project conclusion (May 31, due June 30), all grantees complete the final (BLUE) sections to describe the project's results and communication, as well as the final expenditures.

2.0 GRANTEE INFORMATION

Project Title	Improve the efficacy of grape downy mildew management in Virginia		
Organization	Virginia Tech		
Proposal # *(if needed)*	25-20	Award # *(if needed)*	PIADT75W

Project Lead		Mailing Address	Research	X
Name	Mizuho Nita	595 Laurel Grove Rd	Education	◊
Title	Associate Professor	Winchester, VA 22602	Marketing	◊
Email	Nita24@vt.edu		Continuing?	X
Phone	540-232-6047		Year	1 of 3

3.0 PROJECT OBJECTIVE, PROGRESS, AND IMPACT

3.1 PROPOSAL (February)

Summarize the project objective, the intended deliverable or result, and expected impact. (1-5 sentences or bullets)

1. Conduct greenhouse and field fungicide spray trials based on biopesticides, calendar-based, and model output (objective 2) approaches to seek better approaches for the future.
2. Deploys a grape downy mildew risk assessment model with an email-based delivery system using previously published models, R language, OpenWeatherMap data, and a web server.
3. Validate the system with a sentinel plant study
4. Improve the model by
    a. conducting a controlled environment study
    b. detecting downy mildew using special sensors mounted on an aerial drone and a molecular tool.

Deliverable

- Information on the efficacy of currently available biopesticides.
- Grape downy mildew risk model (will be delivered via Nita's blog for 2024-25).
- Data on early downy development to improve the existing model (or for the new model).

Impact

- Better understanding of downy mildew infection.
- Improved downy mildew management.
- Information to prepare us when we lose mancozeb and captan.

Summarize the project's workplan (1-5 sentences or bullets)

Year	GH exp	Field trials	Sensor	Model
0: Winter	Cane propagation		Workflow design	Email test
1: Spring	Single product rep 1	Set up field		Email delivery
1: Summer	Single product rep 2-3	Test run with the model	Weekly scans	Sentinel trial
1: Fall	Two products rep 1	Data analysis	Mapping	Data analysis
1: Winter	Two products rep 2-3	Purchase vines	Data analysis	Modify model, recruit users
2: Spring	RH experiment rep 1	Set up trials	Re-check workflow	User feedback
2: Summer	RH experiment rep 2	Treatments (rep1)	Weekly scans	Sentinel trial
2: Fall	RH experiment rep 3	Data analysis	Mapping	Data analysis, modify model
2: Winter	Data analysis		Data analysis	Host the model on a server
3: Spring		Set up trials		User feedback, Recruit users
3: Summer		Treatments (rep 2)	Weekly scans	Sentinel trial
3: Fall		Data analysis	Data analysis	Data analysis
3: Winter		Extension delivery, publication	Extension delivery, publication	Extension delivery, publication

How will you know your project has been successful? What project indicators will measure progress or success? (1-5 sentences or bullets)

Indicators

- Data from field and greenhouse trials on biopesticides
    - Disease incidence and severity
- Delivery of model outputs
    - Risk index
- Data from inoculation studies
    - Disease incidence and severity, time of spore development
- Data from sentinel vine studies
    - Disease incidence and severity
- Data from areal imaging
    - Seasonal vineyard maps

3.2 Mid-Year Report (December)—Research and Education Grants only

Provide project indicator status information. Describe project/workplan progress. Include any obstacles the project has encountered and the plan to overcome them.

1. Conduct greenhouse and field fungicide spray trials based on biopesticides, calendar-based, and model output (objective 2) approaches to seek better approaches for the future.

    a. A field trial of four replications was performed on 5-year-old Chardonnay vines to evaluate four conventional fungicides (Captan, Cueva, Ranman, and phosphorous acid) and nine biopesticide products. Spray applications were performed bi-weekly at the Winchester AREC from June through August. The conventional pesticides resulted in significantly lower ($P < 0.05$) downy mildew incidence and severity, aside from phosphorous acid. (Fig. 1 at the end of this document, where downward lines with red circles indicate significant reduction in disease incidence compared with the control). Among the biopesticides, Zonix, Howler, and Stargus treatments significantly reduced downy mildew incidence. Disease severity data was not clear as incidence where Zonix ($P = 0.14$) provided weak evidence for suppression.

    b. A second Field trial of four replications was performed on 5-year-old Chardonnay vines to examine Cueva, Lifegard, Actigard, Howler EVO, and Zonix. Of those, Cueva and Zonix significantly reduced ($P < 0.05$) downy mildew severity and incidence when compared to the control (Fig. 2, showing the severity data). Actigard and Lifegard showed numerically low mean severity and incidence when compared to the control, but they were not significant at 95% confidence level.

    c. A greenhouse biopesticide trial of three replications was performed on grafted Vidal blanc cuttings. The same biopesticides used in the first field trial were applied to the Vidal plants. Preliminary results showed a similar trend to the field trial results. The conventional products significantly reduced ($P < 0.05$) downy mildew severity, but Prophyt failed to do so. Kendal was the only biopesticide product with a significantly lower disease severity. We will continue the trial throughout the winter.

2. Deploys a grape downy mildew risk assessment model with an email-based delivery system using previously published models, R language, OpenWeatherMap data, and a web server.

    a. The goal for this season was to run the model throughout the season to check for bugs and potential issues. The resulting risk information was posted in my blog (http://ext.grapepathology.org) weekly from April to August.

    b. One hiccup we encountered was a new API (a snip of codes to retrieve data from the OpenWeatherMap), which was not compatible with our current codes. After tweaking the codes, we worked on the visualization of the data (Fig. 3). We also found some redundancies in coding during the process. The next step is the code optimization and the email distribution feature.

3. Validate the system with a sentinel plant study

    a. From June through September, 13 sets of ten potted chardonnay vines were placed in random locations of a 5-year-old Chardonnay block at the Winchester AREC for 5 days during June and July, and for 1 day from August onwards. After outside exposure, vines are stored in a protected environment. Then, we visually estimated downy mildew incidence and severity data one and two weeks after the exposure.

We will tie the results to the accumulated risk data to investigate whether what we see on these vines matches with what the model predicted during the exposure period.

4. Improve the model by

    a. conducting a controlled environment study

        i. We are currently conducting the first rep of the experiment. We are using 80 greenhouse-grown Chardonnay vines. We tag shoots and leaves to monitor the leaf age. We inoculate leaves with downy mildew ($5x10^4$ spores/mL) with an atomizer, keeping the leaves wet for 24 hours to ensure the infection. After a seven-day incubation period, we placed the infected vines in a growth chamber at a set temperature and relative humidity.

At a specific time point, we will cut three leaf disks with a no.7 cork punch. We will visually estimate spore counts (both viable and non-viable). We are collecting the first round of data as of December 2024, and it will take another month or two to complete the experiment. However, one notable observation made was that downy mildew sporulation with our isolate occurred at four hours, which was much quicker than the other literature sources.

    b. detecting downy mildew using special sensors mounted on an aerial drone and a molecular tool.

i. We obtained data every week throughout the season. We will work on visualization of the data over the winter months.

Problems and Delays: The weather data source, OpenWeatherMap changed their coding (API) in August, which forced us to revise our codes. The process was completed, and we will work to improve the revised codes.

Summary and future plans

Objective 1: Fungicide tests

Despite the dryer weather two years in a row, we found high levels of downy mildew in our trials, indicating the difficulty of managing this disease once established in the vineyard.

We identified three biopesticide materials (Zonix, Howler, and Stargus) that resulted in significantly lower downy mildew incidence compared to the control. We also found three other biopesticide materials (Lifegard, Actigard, and Kendal) with numerically lower downy mildew incidence. Based on our understanding of the modes of action, some of these shortcomings could be fixed by applying in closer time intervals (e.g., every 7-10 days rather than every 14 days).

We also found phosphorous acid is not effective. This could be due to its mode of action that does not favor protective activity (i.e., works better when applied after initiation of infection) or fungicide resistance. Ranman also showed a relatively weak effect; however, it is known that this product needs to be mixed with another mode of action.

We will 1) repeat the experiment to show the reproducibility and 2) test combinations of better materials to examine potential additive or synergistic effects in 2025. We will also test different spray intervals with some of the materials. We will also re-examine the efficacy of phosphorus acid with greenhouse and lab trials to identify the reason for its failure.

Objective 2: Disease risk model

The current model was used to inform stakeholders with weekly downy mildew infection risks via Nita's blog. Based on the weather conditions of the season, the model reasonably explained the risk. However, we also found room for improvement in coding.

We will use the new API and modified code in 2025. We will also work on the email distribution module.

Objective 3: Model validation

We deployed sentinel vines throughout the season to obtain downy mildew infection data. We also started the first round of experiments in fall 2024. Although we have not completed it, we already found a trend that previous studies did not indicate.

We will continue with the experiments and data analysis in the winter of 2025. We will also expand our study by using a Blackbird system, which is a state-of-the-art imaging system at the USDA Kearneysville to a) increase the number of replications for reproducibility, b) document detailed infection process, and c) evaluate the effect of biopesticides at the cellular level

3.3 Final Report (June)

Compare the project to the objective, workplan, and project indicators. Provide (as a link or attachment) the project deliverable or result. Describe the realized or expected impact of the project.

Please refer the appendix (figures) for the results. I have added Figures 4-6.

As with the 2024 field trials, when we apply these biopesticides by itself, results were not strong in the 2025 trial. I.e., we see some reduction in downy mildew, but not significant in many cases (Figure 4). Thus, as I indicated in FY 2025 proposal, we initiated mixed application (Figure 5). The results showed combination we examined resulted in significantly lower downy mildew, except one (Lifegard and Actigard combination).

In addition, our model and its delivery system is ready to be distributed to beta testers soon. Figure 6 shows actual output (i.e., email message) from the test run. We will internally test it in June, and deploy it to the beta testers in mid-July.

We will still need another year of data to show repeatability of the field test results for the mixed application; however, the outcomes so far are very promising. These options will be useful if/when the EPA enforces tight restrictions on captan and mancozeb in the future. This will also provide more tools for organic grape growers and others seeking more environmentally sustainable options.

4.0 COMMUNICATION WITH STAKEHOLDERS

4.1 PROPOSAL (February)

Summarize how you will share project information or results. For example, will you submit for publication in a peer reviewed journal? Present at a technical conference? Conduct a training? Post on a site? Identify the specific audience/s you will inform. (1-5 sentences or bullets)

Technology transfer

Testing results and other information gained through this research will be communicated to growers through various VCE Extension outlets the Nita lab uses, such as vineyard meetings, VVA meetings, IPM workshops, my blog, etc. For drone-related work, we are publishing a new website for new users who might be interested in using aerial sUAV in viticulture (http://drones.grapepathology.org). At the end of the study, we will publish the results in scientific journals.

4.2 Mid-Year Report (December)—Research and Education Grants Only

Describe communication with stakeholders to date. Note dates and locations of events or publications, as available/relevant.

The model outputs have been posted weekly in Nita's blog (ext.grapepathology.org) throughout the season to inform downy mildew risks stakeholders. Also, the summary of outputs was described at monthly Virtual Viticulture Meeting (6 times through April to September). The blog attracted ~8,000 pageviews and the total number of participants to the virtual meeting was ~ 120 people.

Presentations

1. Nita, M., Murayama, Y., Ohno, S, and Hayashi, K (2024) Developing a grape downy mildew risk assessment system using open resources, Plant Health 2024, American Phytopathological Society, 29 July 2024, Memphis, TN
2. Ames, J., McLellan, I, and Nita, M. (2024) *Development and Validation of a Grape Downy Mildew Disease Risk Assessment System*, Poster, School of Plant and Environmental Sciences Research Symposium, 901 Prices Fork Rd, Blacksburg, VA 24061, September 11, 2024.
3. Ames, J., McLellan, I, and Nita, M. (2024) *Biopesticide Product Trials Against Grape Downy Mildew, Winchester, Virginia, in 2024,* Oral, School of Plant and Environmental Sciences Research Seminar, 101 Garden Lane, Washington St SW, Blacksburg, VA 24061, October 21, 2024.
4. Ames, J., McLellan, I, and Nita, M. (2024) *Biopesticide Product Trials Against Grape Downy Mildew, Winchester, Virginia, in 2024*, Oral, Cumberland-Shenandoah Fruit Workers Conference, 65 Priority Dr, Martinsburg, WV 25403, December 5, 2024.
5. Ames, J., McLellan, I, and Nita, M. (2024) *Biopesticide Product Trials Against Grape Downy Mildew, Winchester, Virginia, in 2024*, Oral, AHS AREC Research Retreat, Winchester, VA, December 13, 2024.

We will present our results at the 2025 VVA Winter Technical Meeting and other Extension Meetings throughout the 2025 season. We will also present our results at American Phytopathological Society Potomac Division meeting in March.

4.3 Final Report (June)

Describe how the technical or material content of the project was or is planned to be shared with stakeholders or beneficiaries. List title, date, type (article, brochure, presentation, or other), purpose, and estimated audience reached. Provide a copy or link if (when) available for inclusion on the virginiawine.org site.

In addition to the presentations above, we made additional presentations related to this project:

1. Ames, J., McLellan, I., and Nita, M. (2025). *Biopesticide Product Trials Against Grape Downy Mildew, Winchester, Virginia, in 2024*, Oral, Virginia Vineyards Association Winter Technical Meeting, 710 South Main Street, Harrisonburg, VA 22801, February 27, 2025.
2. Ames, J., McLellan, I., and Nita, M. (2025). *Virginia field trials: Biopesticide efficacy against grape downy mildew*, oral, APS Potomac Division Meeting, 13100 Dowell Rd, Dowell, MD 20629, March 27, 2025.
3. Ames, J., McLellan, I., and Nita, M. (2025). *Development of a Grape Downy Mildew* Disease *Risk Assessment System*, Poster, APS Potomac Division Meeting, 13100 Dowell Rd, Dowell, MD 20629, March 26, 2025.
4. Ohishi, N., Nita, M., Hayashi, K., and Ohno, S. (2025) Prediction of Grapevine Mildew Risk Using Random Forests, B.S. thesis, Osaka Public University, A21TN009

5. In addition to the list above, the risk information was weekly delivered via Nita's blog https://ext.grapepathology.org/

The estimated number of audience reached are 1,062 for direct (VVA, Extension meetings, conferences, site visits, etc.), and 9,777 for indirect (web activities, such as, blog, X, facebook, lab website, etc.)

5.0 BUDGET

Budget Summary			Mid-Year Research/Education only		Final	
Expense Category	**5.1 Requested**	**5.2 Awarded**	**5.3 Spent**	**5.4 Remaining**	**5.5 Spent**	**5.6 Remaining**
Personnel	33,683	33,683	17,671	16,012	33,026	656.21
Fringe Benefits	3,293	3,293	1,590	1702	3,193	99.73
Travel						
Equipment (Rental)						
Supplies	1,000	1,000	0	1,000	0	1,000
Contractual						
Other	16,970	16,970	8,315	8,654	16,631	339
Total	54,946	54,946	27,577	27,368	53,851	2,094

Appendix

Figures

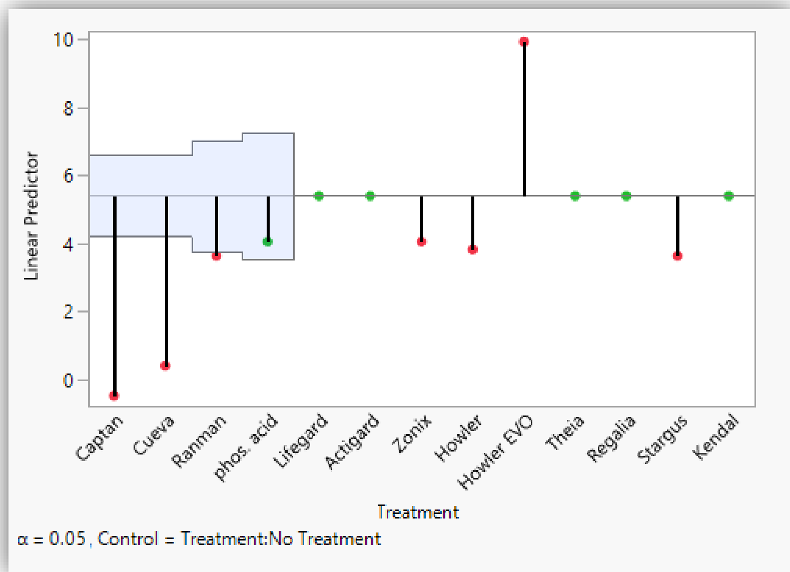

Figure 1: Results from the field trial conducted in July 2024. A Dunnett test comparing downy mildew incidence from conventional fungicides and biopesticide treatments against the control of no spray. The red and green dots beneath the horizontal grey line are the mean values of each treatment standardized around the control mean: red dots are statistically significant (P < 0.05), while green dots are not. Among the biofungicide options, Zonix, Howler, and Stargus resulted in significantly lower downy mildew.

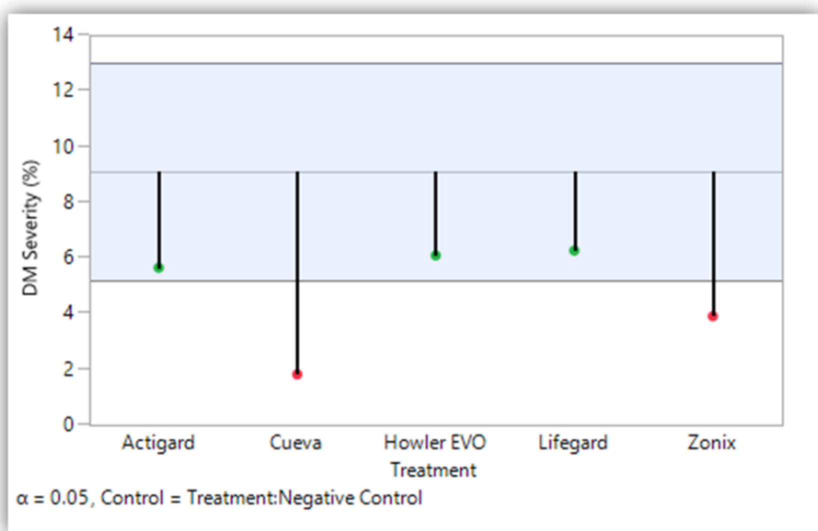

Figure 2: Results from a field trial conducted in August 2024. A Dunnett test comparing copper (Cueva) and biopesticides against the control of no spray. The red and green dots beneath the horizontal grey line are the mean values of each treatment standardized around the control mean: red dots are statistically significant ($P < 0.05$), while green dots are not. Zonix treatment resulted in a significantly lower downy mildew than the control.

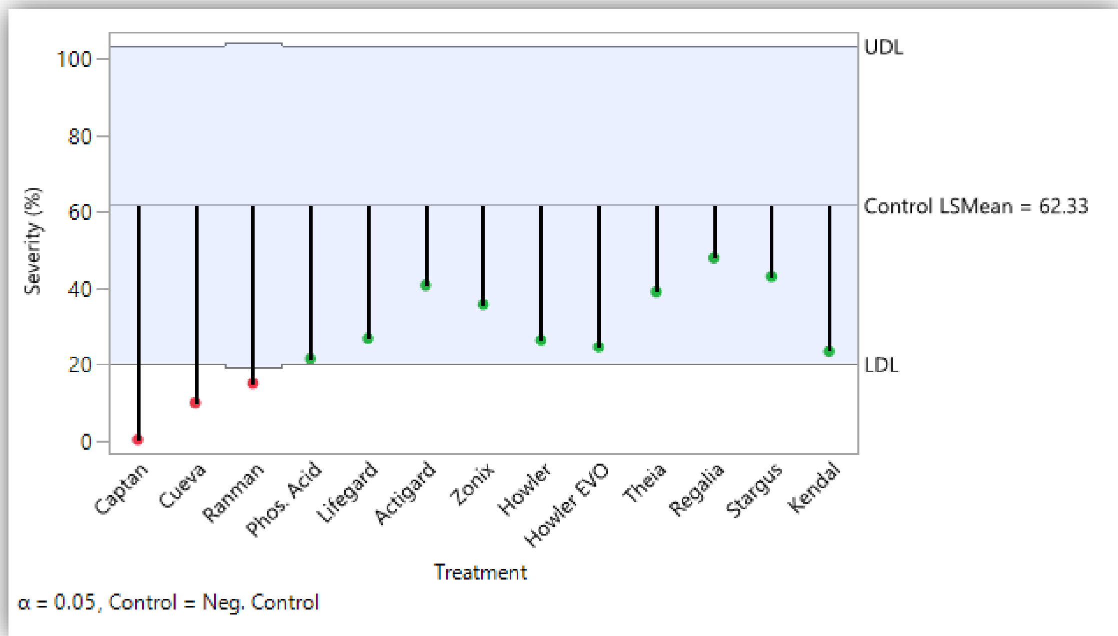

Figure 3: Results from a greenhouse biopesticide trial conducted in December 2024. A Dunnett test comparing downy mildew severity of grapevines treated with conventional fungicides and biopesticide treatments against the control of no spray. The red and green dots beneath the horizontal grey line are the mean values of each treatment standardized around the control mean: red dots are statistically significant ($P < 0.05$), while green dots are not. Among the biofungicide options, none resulted in a statistically significant reduction in downy mildew severity; however, all products reduced severity compared to the control, Lifegard ($P = 0.135$), Howler EVO ($P = 0.097$), and Kendal ($P = 0.081$) have weak evidence to suggest significance.

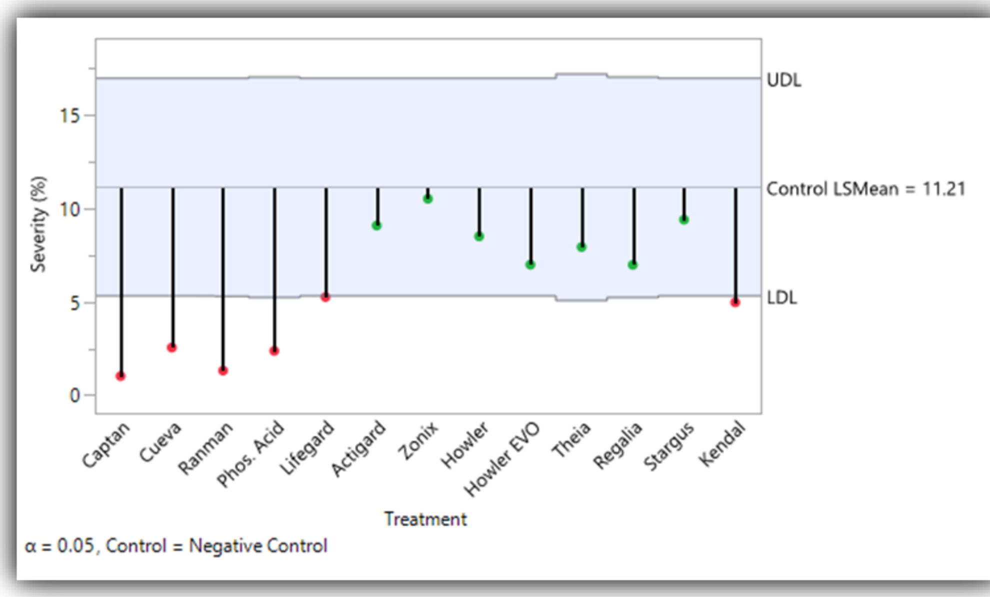

Figure 4: Results from a field trial conducted in June 2025. A Dunnett test comparing downy mildew severity of grapevines treated with conventional fungicides and biopesticide treatments against the control of no spray. The red and green dots beneath the horizontal grey line are the mean values of each treatment standardized around the control mean: red dots are statistically significant ($P < 0.05$), while green dots are not. Among the biofungicide options, Kendal and Lifegard resulted in a statistically significant reduction of downy mildew severity when compared to the no spray control.

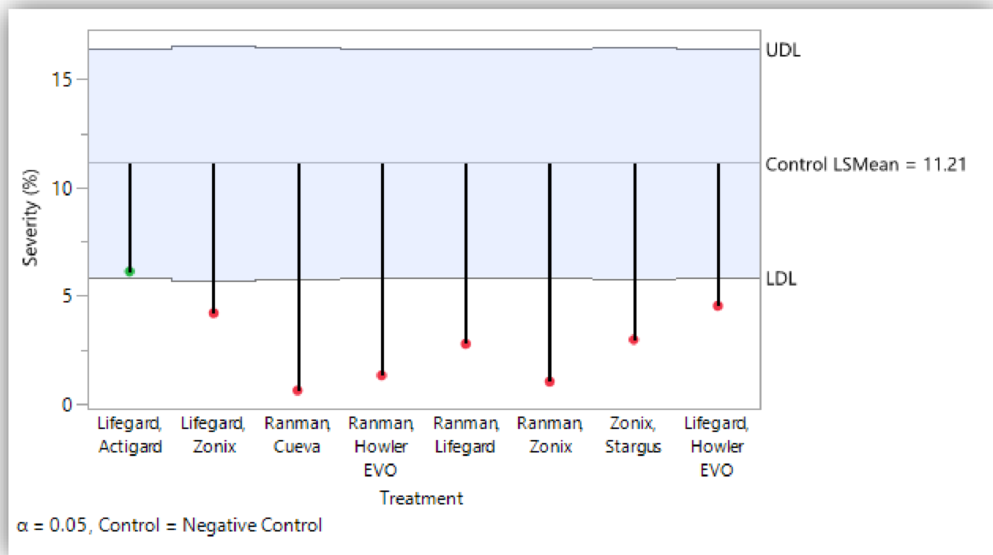

Figure 5: Results from a field trial conducted in June 2025. A Dunnett test comparing downy mildew severity of grapevines treated with combinations of biopesticides and conventional products against the control of no spray. The red and green dots beneath the horizontal grey line are the mean values of each treatment standardized around the control mean: red dots are statistically significant (P < 0.05), while green dots are not. Among the combinations, all but the Lifegard/Actigard combination resulted in a statistically significant reduction of downy mildew severity when compared to the no spray control.

Grape Downy Mildew Risk Assessment for AREC

Mizuho Nita, Jonathan Ames, Naohiro Murayama, Shuichi Ohno, Kazunori Hayashi

Date: 2025-06-25

Thank you for subscribing to the Nita Lab Grape Downy Mildew Risk Assessment beta. The weather data is collected from the OpenWeatherMap.org; please visit their website for more information. Please contact us about bugs through grapepath.vt@gmail.com. We thank you for your continued support.

Infection Risk

Based on the past 7-days of weather, your infection risks within the next 48 hours are as follows (click the table for full screen):

Location	Assessment date	Time	Average Temperature (C)	Max Temperature (C)	Min Temperature (C)	Humidity (%)	Expected Rain (Hours)	Probability of Rain (%)	Infection Risk	Spoluration risk
Winchester	2025-06-25	24h	26.5	35.2	21.2	74.9	4	100	high prob.	High spore risk
Winchester	2025-06-25	25-48h	24.2	30.8	20.2	84.0	6	100	high prob.	High spore risk

Figure 6: Email notification example, including a new color-coded table detailing past downy mildew spore accumulation risk. The redder the parameter, the closer the value is to the accepted optimal conditions for downy mildew. This will be a part of the downy mildew risk assessment system that delivers risk information to growers as a daily email reminder.