

NYWGF 2024 FINAL REPORT

SECTION 1

Funding for fiscal year: FY24-25

Project title:

Plant Protection Sensing to Improve Sustainable Grape Disease Management

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New Research **Continued Research**

Amount Funded: \$41,090.60

SECTION 2

Project Summary Impact Statement:

This project delivered foundational advances in precision fungicide sensing for the New York grape industry. We demonstrated that both synthetic and biological fungicides can be detected and quantified non-destructively on grapevine foliage using hyperspectral sensing, with accuracy ranging from 65–90% depending on product class and sensor type. We developed and validated the Hyperbird, a new robotic imaging system capable of high-throughput hyperspectral analysis of fungicide residues. Our models successfully predicted both presence and dose of contact (e.g., sulfur), systemic (e.g., Quadris), and biological (e.g., Lifegard) fungicides across multiple datasets. We conducted a successful first year of our biofungicide timing study in our NYWGF funded Traminette vineyard.

Stakeholders were engaged through >200 contact hours at four field demonstrations, and two postdoctoral trainees supported by this project (Drs. Gambhir and Hosseinzadeh) were hired into permanent roles at FMC and Bayer. These efforts directly address grower needs for fungicide application optimization amid tightening EPA regulations and provide a blueprint for more strategic, sustainable disease management. The work sets the stage for future USDA-NIFA and NASA-supported efforts to integrate disease and fungicide sensing into vineyard decision-making systems.

Objectives:

1. Evaluate hyperspectral capacity to detect and quantify bio- and conventional fungicides under lab and field conditions.
2. Deploy and validate the Hyperbird robot for high-throughput fungicide quantification.
3. Conduct a biopesticide timing study in a NYWGF-funded Traminette vineyard.
4. Develop predictive models linking hyperspectral data to fungicide residue and longevity.
5. Engage stakeholders via field demonstrations and prepare for future scale-up.

Materials & Methods:

We conducted three lab experiments and >25 field campaigns assessing the hyperspectral detectability of defense-activating, microbial extract, and plant extract biofungicides alongside systemic and contact chemistries. Foliar samples were analyzed using both handheld spectroradiometers and the Hyperbird robotic imaging system. Spectral data were processed using PCA, random forest classification, and partial least squares regression to model residue concentration. GC-MS assays from the Duplais Lab were used to validate sensor predictions. Additionally, we ran a replicated biopesticide rotation trial in a Traminette vineyard to determine optimal timing for biofungicide use.

Results/Outcomes/Next Steps:

Fungisense

- **Proof of Concept & Practice:** Hyperspectral sensors successfully detected sulfur (82%), Quadris (73%), and Flint (65%), and Lifegard (73%) treatments, even without visible residue.
- **Instrument Innovation:** We developed and operationalized the Hyperbird robot, which improves hyperspectral scanning efficiency by 1000× over handheld methods.
- **Predictive Modeling:** Our machine learning models reliably predicted fungicide dose and longevity, informing a USDA AFRI proposal to model environmental drivers of degradation.
- **Field & Extension Impact:** We reached >280 stakeholders through NASA Space4AgNY, NYWGF Board tours, and multiple youth and workforce events, totaling ~200 contact hours.
- **Workforce Development:** Dr. Saeed Hosseinzadeh and Dr. Nikita Gambhir transitioned into industry discovery scientist roles, and over 25 students and staff participated in fieldwork.
- **Next Stage:** Our findings support a path toward sensor-guided spray decision systems. A USDA-NIFA AFRI proposal with collaborator C. Chen is in development to expand this work to model real-world fungicide longevity under diverse environmental conditions.

Traminette Biofungicide Study:

A replicated biopesticide timing and rotation trial was conducted in a top-wire cordon-trained, 3-year-old Traminette vineyard in Geneva, NY. The experiment evaluated five treatments—four integrating biological and conventional fungicides, and one untreated control—applied across seven timings from May 16 to August 21, 2024. Disease assessments were conducted on 20 clusters and 20 leaves per plot on August 28. Percent control was calculated relative to the untreated control for black rot, downy mildew, and powdery mildew. All four treated programs significantly reduced disease incidence and severity compared to the untreated control, with no statistical differences observed among treatments for powdery mildew (0% in all treated plots). For black rot and downy mildew, percent control ranged from 55–76% across foliage and clusters. For example, Treatment 1 achieved 76% control of black rot on clusters and

74% on foliage, and Treatment 3 achieved 76% and 76% control, respectively. These results provide practical validation that integrated, mixed programs—those that alternate conventional fungicides with a range of biofungicides including defense activators, microbial and plant extracts—can provide effective season-long control of major grapevine diseases regardless of rotation method.

Technology Transfer Plan:

Results were shared via live demos, field days, and stakeholder events, including a NYWGF Board field tour and the NASA Space4AgNY stakeholder event. Summaries were incorporated into Gold's Annual Disease Control Update and regional extension newsletters. Manuscripts are in preparation (Hosseinzadeh et al. in prep A & B), and published work (Gambhir et al. 2024) is already influencing national dialogue on fungicide stewardship. Results will be incorporated into the NY/PA Grape Guidelines and used to inform future remote sensing and digital pathology research funded by NASA and USDA.

SECTION 3

Project summary and objectives (5 sentence max):

We developed a non-destructive, sensor-based method to detect and quantify fungicide residues on grapevine leaves, including both conventional and biological products. The project validated the Hyperbird robot for high-throughput lab analysis and used machine learning to model residue levels from spectral data. We ran three lab experiments and a field trial to assess fungicide longevity and detection thresholds. Findings were shared through live demonstrations and extension events. Results provide insight for timing fungicide applications more precisely in New York vineyards.

Importance of research to the NY wine industry (5 sentence max):

As EPA regulations tighten and resistance risks increase, New York grape growers urgently need smarter fungicide application tools. This work lays the foundation for precision disease management by enabling growers to verify fungicide presence and coverage in the field. Better timing reduces costs, improves efficacy, and supports sustainable practices. The technology can also facilitate biofungicide integration by giving growers confidence in their performance. Ultimately, these tools will help ensure regulatory compliance and competitiveness of the NY wine industry.

Project results/next steps (5 sentence max):

We proved that hyperspectral sensing can detect multiple fungicide types and estimate their residual presence on grape leaves with high accuracy. Our new robotic imaging system, Hyperbird, increases throughput and consistency of data collection. We developed predictive models for residue longevity and engaged over 280 stakeholders through four major events. The next step is to scale this work to real-world variability and develop decision-support tools that incorporate both disease and fungicide detection. A USDA-NIFA AFRI proposal is underway to advance this work in collaboration with atmospheric modeling experts.
