# NYWGF RESEARCH PROGRAM RFP TEMPLATE

**Funding for fiscal year:** April 1, 2025 – March 31, 2026

## SECTION 1:

**Project title:** Evaluating Osmotic Protectant, Glycine Betaine, as a Multifaceted Approach to Enhance Grapevine Stress Tolerance and Productivity

**Principal Investigator with contact info**: Jennifer Phillips Russo, Viticulture Specialist, Lake Erie Regional Grape Program (716) 792-2800 jjr268@cornell.edu

**Co-PI Collaborators with contact info**: Jeremy Schuster, Viticulture Specialist, Eastern New York, Cornell Cooperative Extension (845) 372-4780 **jds544@cornell.edu** and Alice Wise, Viticulture Educator, Long Island Horticultural Research and Extension Center Cornell AES avw1@cornell.edu, and Dr. Jason Londo's lab

**New Research** ☐ **Continued Research** ☒ (CHECK APPROPRIATE BOX)

**Amount Requested $ 25,633.00**

## SECTION 2:

**Project Summary:**
(Maximum 5 sentences)

Grape growers face the risk each season in their vineyards withstanding injury and loss of production from biotic and abiotic stresses whose severity is dependent on the current season's weather conditions. Frost, disease, water availability, and extreme temperatures are just a few of the challenges grapevines face with climate change. The Lake Erie Grape region experienced frost/freeze events and damage in vineyards for the last five growing seasons, with 2024 requiring a disaster declaration in the Lake Erie Grape Region do to approximately 16,000 acres of early bud-breaking grape cultivars with 70% damage. The average Concord yield across the Lake Erie Grape belt in 2023 was 9.3 tons/acre and 2024 is projected to be 1-2 tons/acre. The Finger Lakes Grape Region experienced a frost/freeze event in the spring of 2023 that damaged crop potential. Glycine Betaine, an osmotic protectant, and other products use methods existing in nature for the prevention of plant diseases and pests and may improve plant productivity and vitality without releasing undesirable pesticide residues into the environment. Through foliar applications, this bio-stimulation product improves plant resistance to stress, but also stimulates natural processes to improve crop yield and quality.

## SECTION 3

**Objectives:**

1. In research/commercial vineyards, determine the relationship of foliar applied Glycine Betaine and other products on overall grapevine production using viticulture measurements.

2. Determine the relationship of reduced disease infection levels in *Vitis Vinifera* Cultivars
3. Test frost protection response on grapevines in the Lake Erie, Finger Lakes, Long Island, and Hudson Valley grape growing regions.
4. Determine if there is a cold hardiness response with the application of Glycine Betaine.

**Justification of Research:**

New York grape growers have faced and continue to deal with challenges and one of the biggest is climate change. The Earth's rising temperatures are affecting everything about grape, wine, and juice production from the impacts of extreme weather events, frost, wet/humid environments encouraging disease incidence, and cold hardiness. Our grapevines face the risk each season of withstanding injury and loss of production from biotic and abiotic stresses. Our region has experienced frost/freeze events and damage in vineyards for the last five growing seasons, with 2024 requiring a disaster declaration in the Lake Erie Grape Region do to approximately 16,000 acres of early bud-breaking grape cultivars with 70% damage. The average Concord yield across the Lake Erie Grape belt in 2023 was 9.3 tons/acre and 2024 is projected to be 1-2 tons/acre. The Finger Lakes Grape Region experienced a frost/freeze event in the spring of 2023 that damaged crop potential.

Osmolytes and plant hormones, are small organic molecules that help cells cope with environmental stressors. The synthesis of osmolytes is considered a protective plant response to stress, as these compounds play a crucial role in maintaining cell stability and protecting against damage caused by various stress factors. Glycine Betaine is one of these osmolytes known to accumulate in plants under stress conditions, providing cellular protection without disrupting essential cellular functions. It helps plants to withstand extremes of temperature (hot and cold), extremes of water availability (drought and fooding), salinity, heavy metals, atmospheric pollution, toxic chemicals (fertilizers, pesticides, herbicides), and a variety of living organisms, especially viruses, bacteria, fungi, nematodes, insects, arachnids, weeds, etc. Glycine betaine is a natural secondary product that has been seen to help increase cuticle strength in other fruit crops, like cherries.

The Glycine Betaine product that this research is using is a natural derivative from beets, which is used a cryoprotectant by the vegetable. Biosynthesis of GB in plants is often triggered by abiotic stress. The extreme drought and commonly associated heat and salinity stress can promote synthesis of GB in higher plant chloroplasts where it plays a role in protection of the photosynthetic apparatus from dehydration stresses. The GB product we plan to test is a foliar spray that is 97% Glycine Betaine from Lallemand, called Lalstim Osmo. Therefore, enhancing the content of glycine betaine in grapevines during stress conditions is seen as a suitable strategy to address at least one aspect of the stress factors affecting plant cells. This information underscores the importance of osmolytes in the plant's response to stress and suggests that manipulating their levels could be a potential approach for enhancing stress tolerance in grapevines. This approach aligns with the growing emphasis on environmentally friendly and sustainable agricultural practices.

**Plant Protection or Biocontrol:**

- As an osmotic protectant, it is possible that GB may strengthen the plant's ability to thwart Downy mildew from entering the cuticle.
- By harnessing these natural benefits of osmolytes, growers can reduce the reliance on chemical pesticides, promoting a more sustainable and ecologically

balanced approach to pest management.

2. **Biostimulation:**
    - Biostimulation aims to enhance plant resistance to stress, thereby improving overall crop yield and quality.
    - This method stimulates natural processes within the plants, making them more robust and better equipped to handle adverse environmental conditions.
    - By supporting the plants' natural mechanisms, growers can potentially reduce the impact of abiotic stresses mentioned earlier, ensuring healthier and more resilient vineyards.

Overall, the adoption of these microbial products offers a holistic and sustainable approach to agriculture. It not only addresses the immediate concerns of pest control and stress resistance but also contributes to the long-term health and productivity of vineyards while minimizing environmental impact. This aligns with the broader trend in agriculture towards practices that prioritize ecological balance and sustainability.

**Materials & Methods:**

The outlined objectives reflect a comprehensive research plan focused on understanding the impact of foliar applied Glycine Betaine on grapevine health and exploring its potential benefits in various aspects of viticulture.

1. **Relationship of Foliar Applied Glycine Betaine on Grapevine:**
    - Conduct research in both research and commercial vineyards to evaluate the effects of timely foliar applied Glycine Betaine.
    - Utilize viticulture measurements to assess grapevine health, considering parameters such as yield, juice quality, and overall plant vigor.
    - Collect data over multiple seasons to account for variations in weather conditions and to observe any long-term effects.
2. **Relationship of Reduced Grapevine/Cluster Infection Levels in Different Grape Cultivars:**
    - Investigate the impact of Glycine Betaine on reducing grapevine/cluster infections in different grape varieties, including Vitis Labrusca, Vitis Vinifera, and Hybrid Cultivars.
    - Employ testing methods to quantify and compare infection levels in treated and untreated vines.
    - Analyze the data to identify potential variations in the effectiveness of Glycine Betaine across different grape cultivars.
3. **Testing Frost Protection Strategies with Glycine Betaine:**
    - Focus on frost protection strategies using Glycine Betaine in specific grape growing regions, namely Lake Erie, Long Island, and the Hudson Valley.
    - Implement controlled experiments under frost conditions and assess the efficacy of Glycine Betaine in mitigating frost damage.
    - Consider variables such as application timing, concentration, and frequency to optimize frost protection strategies.
4. **Bud Hardiness Response with Glycine Betaine Application:**
    - Investigate the impact of Glycine Betaine on bud cold hardiness, especially in the context of frost/freeze events.
    - Conduct controlled experiments to assess the response of grape buds to Glycine

Betaine application in terms of cold tolerance and recovery after frost events.

- Monitor bud survival rates and potential improvements in overall vine resilience once a month during the dormant season.

Glycine Betaine Spring Spray Schedule

Goal- to reduce frost damage, lower freezing point of vines.

1. At the 4”-6” shoots length, foliar apply 2lbs/acre onto plant tissue until saturation point of runoff. Spray three panels of each cultivar with panel buffer in between treatment panels minimum of 24 vines per spray. If spraying Concord, typically 3 vines per panel would require 8 panels of Sprayed vines with buffer vines in between panels. This will need to be duplicated for the Spring + Mid-Season combination treatment (Spring_Spray and Spring_Veraison).
2. In the threat of spring frost event - 2-7 days prior to frost event, (if any) foliar apply 2lbs/acre (Increase to 4lbs/acre) of Glycine Betaine product onto green plant tissue until point of saturation runoff. Spray same type of set up as Spring Spray setup, but different set of vines (Frost_Spray).

Mid-Season Veraison Spray – At veraison

1. Foliar apply 2 lbs/acre (Increase to 4lbs/acre) of GB on canopy until saturation and runoff to target later season expansion of berries to see if it fruit growth, fruit color, and relative cracking of berry cuticle. Spray three panels of each cultivar with panel buffer in between treatment panels minimum of 24 vines per spray. If spraying Concord, typically 3 vines per panel would require 8 panels of Sprayed vines with buffer vines in between panels.
2. Spray the Spring_Veraison vines from the Spring for the Spring + Veraison combination treatment (Veraison_Spray and Spring_Veraison).
3. Collect petioles from the Spring Sprayed vines and the Control Vines for tissue analysis.

Harvest Collection

1. Collect three 100 berry samples from each treatment and control for final berry weight and juice analysis.
2. Collect yield from each treatment and control for comparison.

Fall Glycine Betaine Spray Schedule

Goal- to induce cold hardiness, reduce budbreak frost damage.

1. After harvest approximately 2-4 weeks prior to estimated dormancy, apply 2lbs/acre (Increase to 4lbs/acre) 5of Glycine Betaine product to canopy until saturation and runoff. Spray three panels of each cultivar with panel buffer in between treatment panels minimum of 24 vines per spray. If spraying Concord, typically 3 vines per panel would require 8 panels of Sprayed vines with buffer vines in between panels.

Cold Hardiness Monitoring – Dormant Season

1. Collect two canes per treatment replicate bud number 3-7 per treatment replicate for Differential Thermal Analysis of Lethal Thermal Exotherms to assess cold hardiness.
2. Collect three replicates of Pruning weights for each treatment of Spring, Spring+Veraison, and Frost if applicable.

This product helped reduce cracking in cherries.

This research aims to address three different seasonal concerns.  One set just spring, one set just veraison, one set just fall, and one set a Spring + Veraison.

In executing these objectives, it is crucial to design well-controlled experiments, gather comprehensive data, and analyze results rigorously.

**Expected Outcomes:**
Considering the regional differences in grape growing conditions, this research can provide valuable insights into the potential benefits and limitations of using Glycine Betaine in diverse viticultural settings.  Enhancing the content of glycine betaine in general and during stress conditions is seen as a suitable strategy to address at least one aspect of the stress factors affecting plant cells and could be a potential approach for enhancing stress tolerance in grapevines.  This will lead to increased profitability by limiting crop loss from abiotic stresses and disease complexes.  This approach aligns with the growing emphasis on environmentally friendly and sustainable agricultural practices,

**Communication of Results:**
Information will be provided to growers through on-site visits, small group meetings, Zoom videoconference events, newsletter articles, text blast notifications, the NEWA website (newa.cornell.edu) and ongoing communications put out both by LERGP and the New York State Integrated Pest Management Program.  Results of this Glycine Betaine spray product on growth, development, juice quality, water use, and infection incidence will be summarized and deployed to grape producers through the project lead’s extension program, through Cornell Cooperative Extension professionals and local industry meetings.

Project Name:

Evaluating Osmotic Protectant, Glycine Betaine, as a Multifaceted Approach to Enhance Grapevine Stress Tolerance and Productivity

Contract Period: From: 04/01/25

To: 03/31/26

| CATEGORY OF EXPENSE | GRANT FUNDS |
|---|---|
| 1. Personal Services | |
| a) Salary | $9,369.00 |
| b) Fringe | $6,184.00 |
| Subtotal | $15,553.00 |
| 2. Non Personal Services | |
| a) Contractual Services | $2,380.00 |
| b) Travel | $690.00 |
| c) Equipment | $0.00 |
| d) Operating Expenses | $3,100.00 |
| e) Other | $3,910.00 |
| Subtotal | $10,080.00 |
| TOTAL | $25,633.00 |

| SALARY | | | | | |
|---|---|---|---|---|---|
| POSITION TITLE (Exempt) | ANNUALIZED SALARY PER POSITION | | PERCENT OF EFFORT FUNDED | | TOTAL |
| Research Support Specialist | $62,582.00 | | 5.000% | | $3,129.00 |
| Extension Associate | $0.00 | | 0.000% | | $0.00 |
| Other | $0.00 | | 0.000% | | $0.00 |
| | | | | | |
| | | | | | |
| Graduate Research Assistant Stipend | $0.00 | | 0.000% | | $0.00 |
| | | | | Subtotal | $3,129.00 |
| POSITION TITLE (non-Exempt) | HOURLY PAY RATE PER POSITION | STANDARD WORK HOURS PER | | NUMBER OF WEEKS FUNDED | TOTAL |
| Temp Labor (4 people) | $0.00 | 0 | | 0 | $0.00 |
| Technical Support (5 people) | $20.00 | 2 | | 52 | $2,080.00 |
| Technical Support (5 people) | $20.00 | 2 | | 52 | $2,080.00 |
| Technical Support (5 people) | $20.00 | 2 | | 52 | $2,080.00 |
| Other | $0.00 | 0 | | 0 | $0.00 |
| | | | | | |
| | | | | | |
| Undergraduate Support | $0.00 | 0 | | 0 | $0.00 |
| | | | | Subtotal | $6,240.00 |

| TOTAL FRINGE | |
|---|---|
| Fringe Benefit rate @ 66% | $6,184.00 |
| | |
| Subtotal | $6,184.00 |

| CONTRACTUAL SERVICES - TYPE/DESCRIPTION | TOTAL |
|---|---|
| Long Island Horticultural Research and Extension Center Cornell AES Technician @ $20/hr, 2 hours/week, 52 weeks | $2,080.00 |
| Travel (fleet/mileage reimbursement) to field sites, meet with growers, and present extension workshops. | $300.00 |
| CONTRACTUAL TOTAL | $2,380.00 |

| TRAVEL - TYPE/DESCRIPTION | TOTAL |
|---|---|
| Travel (fleet/mileage reimbursement) to field sites, meet with growers, and present extension workshops. | $690.00 |
| Conference expense (hotel, per diem, transportation (airline ticket/mileage) | |
| | |
| | |
| | |
| TRAVEL TOTAL | $690.00 |

| EQUIPMENT - TYPE/DESCRIPTION | TOTAL |
|---|---|
| | $0.00 |
| | $0.00 |
| | $0.00 |
| EQUIPMENT TOTAL | $0.00 |

| OPERATING EXPENSES - TYPE/DESCRIPTION | TOTAL |
|---|---|
| Materials & Supplies - Field and lab supplies | $1,500.00 |
| Cornell fuel costs via CU Fleet Services | $100.00 |
| Geneva Farm Crew Charges | |
| Leaf analysis and fruit analysis | $1,500.00 |
| Publications | |
| Summer Scholar/Intern Housing | |
| Graduate Research Assistant Tuition & Health Insurance | |
| Dernay Services | |
| HVRL Facility Use Fee (5% of $xxxx) | |
| Other | |
| OPERATING EXPENSES - TOTAL | $3,100.00 |

| OTHER EXPENSES - TYPE/DESCRIPTION | TOTAL |
|---|---|
| Indirect Costs - Direct Costs x 18% | $3,910.00 |
| OTHER EXPENSES - TOTAL | $3,910.00 |

| | |
|---|---|
| **TOTAL REQUEST** | **$25,633.00** |

## SECTION 4: BUDGET

**Please provide a brief description and fill in the linked excel sheet with the details.**

**Budget Justification:**

**Wages** **$**9,369: 10% FTE of Support Specialist and three technician at $20/hr., 2 hr./week, and 52 weeks/year Extension Technician for project implementation, monitoring and analysis in the Lake Erie, and Hudson Valley regions.

**Fringe Benefits** $6,184: calculated at the Cornell rate of 66%.

**Mileage** $690: 000 miles per month is requested for travel to field sites, meet with growers, and present extension workshops. 100 miles per month X $0.575 per mile X 12 months
**Contract Services $2,380 -** Long Island Horticultural Research and Extension Center Cornell AES Technician @ $20/hr, 2 hours/week, 52 weeks = $2080; travel to field sites, meet with growers, and present extension workshops $300

**Supplies** $3,100 – backpack sprayer $400/each = $1,200, flagging tape, sprayer materials, ziplock bags, paper bags, pens, journals, etc. = $300; $100 Cornell fuel cost via CU Fleet Services, Leaf and fruit analysis = $1.500.

**Indirect Costs $ calculated at Cornell's rate of 18%.**

**Additional Funding:** Please include in this section any information regarding additional private sector funds expected from outside sources. Please identify if these funds will run through NYWGF or go directly to your employer.

**Lallemond has committed to donate the Glycine Betaine product for this research. That is an in kind contribution.**

**Commitment Letter Template** **Budget Template [excel file]**

**Final Report Draft**
**Evaluating Glycine Betaine as a Multifaceted Approach to Enhance Grapevine Stress Tolerance and Productivity**

**Project Overview**

This project evaluated Glycine Betaine (GB), also referred to in the field notes as the "Beet Juice" treatment, as a potential tool to improve grapevine stress tolerance, cold hardiness, fruit quality, yield, and disease outcomes across several New York grape-growing regions. Data were collected from Lake Erie, Long Island, Hudson Valley, and Geneva/Finger Lakes sites, using different cultivars and trial structures. The project included assessments of dormant bud cold hardiness, disease severity, berry weight, fruit chemistry, yield, cluster number, and harvest performance.

Across the full dataset, GB did not produce a consistent positive response across all cultivars, sites, and measurements. Instead, the clearest project-wide finding is that GB responses were highly context-dependent. Some promising responses were observed, particularly in cold hardiness at selected dormancy stages and in Long Island Riesling where a canopy-applied GB program including a veraison timing showed the best disease/yield balance. However, other datasets showed no benefit or even unfavorable responses, particularly in Lake Erie Chardonnay fruit condition and Hudson Valley Gamay Noir yield.

**Major Trends Across Sites**
1. GB showed the most promise for cold hardiness, but the response was not consistent
The Lake Erie cold hardiness data showed that GB-treated vines sometimes achieved biologically meaningful improvements in bud cold hardiness, especially during certain dormancy windows. Chardonnay showed the clearest positive response during early acclimation and mid-winter, with GB-treated buds reaching up to 3.4°C greater cold hardiness than the untreated control. Concord showed a more variable response, but GB-treated vines were notably more cold hardy on several mid- to late-winter dates, including February 3, February 16, and March 11.

The most important trend is that GB may have value as a cold stress mitigation tool, but only under certain timing, cultivar, and dormancy conditions. The treatment did not consistently improve cold hardiness on every date. In some cases, the untreated controls were equal to or more cold hardy than GB-treated vines. Therefore, GB should not yet be described as a reliable or universal cold hardiness enhancer. Instead, the data support continued evaluation, especially around mid-winter maximum hardiness and late-winter deacclimation, when even a 1–3°C difference could be meaningful for grower risk management**.**

**Final-report interpretation:**
The Lake Erie cold hardiness results suggest that foliar-applied GB may enhance bud cold hardiness during specific dormancy windows, but the effect varied by cultivar and sampling date. The strongest responses occurred in Chardonnay during early to mid-winter and in Concord during mid- to late-winter. These results are promising but preliminary and should be interpreted alongside weather conditions, vine condition, and additional site-year replication.

**2. Disease suppression was inconsistent and site-specific**

Disease-related responses were mixed. At the Lake Erie Chardonnay site, GB did not reduce disease severity. In fact, GB-treated Chardonnay clusters had substantially higher disease ratings than controls. GB-treated Chardonnay averaged a disease rating of 6.86, compared with 3.25 for the untreated control, and approximately 57% of GB clusters were in the high disease category compared with 10% of control clusters. This is one of the clearest negative responses in the project dataset.

In contrast, the Long Island Pindar Riesling trial showed a more favorable disease response for one GB timing. Treatment 2, which consisted of a 4–6” shoot canopy spray followed by a veraison canopy spray, had the lowest mean Botrytis severity and the greatest number of clean clusters. This suggests that GB timing and spray target may matter. The Long Island data did not support all GB programs equally; the early-season plus prebloom canopy program was weaker, and the cluster-zone veraison program was intermediate.

At the Geneva Riesling site, disease ratings were essentially identical between GB-treated and control vines, averaging approximately 8.65% in both groups. At the Hudson Valley Gamay Noir site, no disease incidents were observed in either treatment, so disease suppression could not be evaluated.

**Final-report interpretation:**
GB did not provide consistent disease suppression across sites. The strongest disease-related result was negative in Lake Erie Chardonnay, where GB-treated clusters had greater disease severity than controls. However, the Long Island Riesling trial suggests that an early-season plus veraison canopy GB program may reduce Botrytis under some conditions. These contrasting outcomes indicate that GB should not be considered a stand-alone disease control product, but specific application timings may warrant further study as part of an integrated canopy and fruit-zone management program.

**3. Yield responses varied by region and cultivar**
Yield results were also inconsistent across sites.

At Long Island, Treatment 5 had the highest yield and largest berries, but Treatment 2 had the best overall combination of lower Botrytis, strong yield, and the highest weighted mean cluster weight. This suggests that the strongest Long Island GB program was not necessarily the highest-yielding treatment, but it may have offered the best balance of disease reduction and productivity.

At Geneva, GB-treated Riesling vines had a modest numerical yield advantage. GB-treated vines averaged 54.4 clusters and 10.84 lbs of fruit per vine, compared with 47.0 clusters and 10.00 lbs per vine in the control. However, control vines had slightly heavier estimated cluster weight, suggesting the GB yield advantage was driven primarily by more clusters rather than larger clusters.

At the Hudson Valley Knoll site, the non-treated Gamay Noir vines clearly outperformed GB-treated vines. Non-treated vines averaged 124.4 lbs net harvest weight per replicate, compared with 71.5 lbs for GB-treated vines. Non-treated vines also had higher cluster counts and greater estimated fruit weight per cluster. No disease was observed in either treatment, so there was no disease benefit to offset the yield difference.

At Lake Erie Chardonnay, the 100-berry sample was substantially lower in GB-treated fruit than in the control. GB-treated Chardonnay had a 100-berry weight of 52.58 g, while the control weighed 158.58 g, suggesting substantially reduced berry size or poor fruit development in the GB-treated sample.

**Final-report interpretation:**
GB did not consistently improve yield. Geneva Riesling showed a modest yield advantage associated with greater cluster number, and Long Island Treatment 2 showed strong yield with reduced Botrytis. However, Hudson Valley Gamay Noir and Lake Erie Chardonnay did not show favorable harvest responses. Yield effects appear to depend strongly on cultivar, site conditions, treatment timing, and vine/crop status.

**4. Fruit chemistry responses were cultivar- and year-dependent**

Berry chemistry data showed no uniform maturity benefit from GB. In 2025, Chardonnay and Concord responded differently.

For 2025 Chardonnay, GB-treated fruit had lower soluble solids and higher acidity than controls. Chardonnay GB averaged 16.84 °Brix, compared with 18.44 °Brix in the control. GB-treated Chardonnay also had higher acidity and higher malic acid, suggesting delayed maturity or poorer fruit condition at the sampling date. This aligns with the Lake Erie Chardonnay disease and berry weight results, which also showed poorer GB fruit condition.

For 2025 Concord, GB-treated fruit had higher soluble solids than the control, averaging 16.64 °Brix compared with 15.10 °Brix. However, GB-treated Concord also retained higher acidity and malic acid. This suggests that GB may have increased sugar accumulation in Concord without a corresponding decrease in acidity, indicating a more complex cultivar-specific fruit chemistry response.

The 2024 Chardonnay comparison data showed a different pattern than 2025. In 2024, Chardonnay GB had similar Brix to the control but lower acidity and lower malic acid, suggesting a more favorable or advanced maturity profile than observed in 2025. This year-to-year contrast is important because it suggests that GB effects may be influenced by seasonal conditions, disease pressure, crop load, vine stress, or application timing.

**Final-report interpretation:**
Fruit chemistry results were inconsistent across cultivars and years. GB-treated Chardonnay appeared less mature than controls in 2025, while Concord GB showed higher Brix but also higher acidity. The 2024 Chardonnay data showed a more favorable GB chemistry profile than the 2025 Chardonnay data. These results suggest that GB may influence fruit chemistry differently depending on cultivar and season, and that Brix alone is not sufficient to evaluate treatment response.

## Site-Specific Final Report Sections

### Lake Erie Region
The Lake Erie data provided two contrasting pictures of GB performance. Cold hardiness results were promising but variable, while Chardonnay fruit condition and disease results were unfavorable.

Dormant bud cold hardiness data showed that GB-treated vines sometimes achieved greater cold hardiness than untreated controls. Chardonnay had several strong GB responses during early and mid-winter, while Concord showed stronger GB responses during mid- to late-winter. However, these responses were not consistent across all dates. In some cases, untreated controls were more cold hardy than GB-treated vines.

In contrast, Lake Erie Chardonnay disease and fruit quality data did not support a beneficial GB response. GB-treated Chardonnay clusters had substantially higher disease ratings than untreated controls, and the 100-berry sample from GB-treated vines weighed approximately one-third of the control sample. These results suggest that, under the conditions at this Lake Erie Chardonnay site in 2025, GB did not improve fruit condition and may have been associated with greater disease severity, reduced berry weight, or poorer cluster quality.

**Lake Erie conclusion:**
GB showed potential for improving cold hardiness during specific dormancy windows, but did not improve Chardonnay disease or fruit quality outcomes in 2025. The Lake Erie results highlight the need to separate GB's possible role in abiotic stress tolerance from its inconsistent or unfavorable effects on fruit condition and disease.

**Long Island Region: Pindar Riesling**

The Long Island trial was the clearest example of how GB timing and spray target may influence outcomes. This site evaluated multiple application programs rather than a simple GB versus control comparison.

Treatment 2, consisting of a 4–6" shoot canopy spray plus a veraison canopy spray, had the strongest overall performance. It had the lowest mean Botrytis severity, strong yield, and the highest weighted mean cluster weight. Treatment 5, the untreated comparison, had the highest yield, largest berries, highest Brix, and lowest acidity, but it also had higher Botrytis than Treatment 2. Treatment 1, the early-season plus prebloom canopy program, had the highest Botrytis and lowest yield. Treatment 3, the pre- and post-veraison cluster-zone program, was intermediate for disease and yield, but had the highest acidity and limited sour rot occurrence.
Shoot counts were similar among the treatments included in disease, berry chemistry, and harvest evaluations, suggesting that yield and disease differences were not primarily caused by differences in baseline vine shoot number.

**Long Island conclusion:**
The Long Island Riesling data suggest that a canopy-applied GB program including a veraison timing may be the most promising treatment strategy from this trial. Treatment 2 provided the best balance of disease reduction and productivity, even though it did not have the highest Brix or largest berries. This treatment should be prioritized for continued evaluation.

**Hudson Valley Region: The Knoll, Gamay Noir**

At the Hudson Valley site, the non-treated Gamay Noir vines outperformed GB-treated vines in both cluster count and harvest weight. Non-treated vines had approximately 40% more clusters per replicate and about 74% greater net yield than GB-treated vines. The non-treated fruit also had higher estimated cluster weight.
No disease incidents were recorded in either treatment, so the trial could not determine whether GB reduced disease at this site. With disease absent, the main comparison was yield, and that comparison favored the non-treated vines.

Hudson Valley conclusion:
Under the conditions observed at The Knoll in 2025, GB did not improve Gamay Noir harvest performance and did not provide an observable disease benefit. This site represents a negative or non-supportive result for GB yield enhancement.

**Geneva/Finger Lakes Region: Riesling**

The Geneva Riesling data showed a modest numerical advantage for GB-treated vines in cluster number and fruit weight. GB-treated vines averaged 54.4 clusters per vine and 10.84 lbs of fruit per vine, compared with 47.0 clusters and 10.00 lbs per vine in controls. However, controls had slightly heavier estimated clusters, suggesting the GB advantage was due mainly to greater cluster number rather than increased cluster size.

Disease ratings were nearly identical between treatments, indicating no clear disease suppression effect at this site. Fruit chemistry differences were modest, with GB-treated fruit showing slightly higher Brix and lower acidity, malic acid, and tartaric acid. This may suggest a slightly more advanced maturity profile, but the differences were small.
The Geneva dataset also included missing vines, uneven panel structure, and strong panel-to-panel variability, so the results should be interpreted as preliminary.

**Geneva conclusion:**
The Geneva Riesling site suggests a possible small GB benefit for crop load and fruit maturity, but not disease suppression. The result is promising enough to continue evaluation, but not strong enough to support firm recommendations.

**Overall Conclusions**

Across all sites and datasets, Glycine Betaine produced mixed and highly context-dependent results. The most promising evidence came from:
1. Lake Erie cold hardiness, where GB-treated vines showed greater hardiness during selected dormancy windows.
2. Long Island Riesling Treatment 2, where a 4–6” shoot canopy spray followed by a veraison canopy spray produced the best balance of lower Botrytis and strong yield.
3. Geneva Riesling, where GB-treated vines had a modest numerical yield and maturity advantage.

However, several results did not support a consistent GB benefit:
1. Lake Erie Chardonnay disease and berry weight were worse in the GB-treated fruit than in the control.
2. Hudson Valley Gamay Noir yield was substantially lower in GB-treated vines than in non-treated vines.
3. Disease suppression was not consistent, with no benefit at Geneva, no evaluable disease pressure in Hudson Valley, and higher disease in Lake Erie Chardonnay.
4. Fruit chemistry responses varied, with 2025 Chardonnay showing delayed or poorer maturity under GB, while Concord showed higher Brix but also higher acidity.

The overall project trend is that GB may have potential as a targeted stress mitigation tool, especially for cold hardiness and possibly for specific canopy-timed applications near veraison, but it should not yet be recommended as a broadly reliable tool for improving yield, fruit chemistry, or disease suppression across all cultivars and sites.