Assessing Oxidate and Percarb Effectiveness in Reducing Conventional Pesticide Use on American Grape Hybrids

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Biopesticides are a promising alternative to conventional pesticides for sustainable disease management in grape production. Moyer et al. (2016) demonstrated that combining biopesticides with fruit-zone leaf removal and the addition of a synthetic fungicide during the window of ontogenic susceptibility in clusters significantly reduces powdery mildew. Avan et al. (2023) reported effective control of powdery mildew using *Brevibacillus brevis* strain CP-1. Other studies (Malviya et al., 2022; Vicente-Díez et al., 2023) highlight microbial and volatile-based approaches that limit fungal diseases without synthetic pesticides. However, managing downy mildew (*Plasmopara viticola*), an oomycete, remains difficult in organic systems because the most effective organic pesticides they can rely on are copper fungicides, which pose environmental and phytotoxicity concerns (Dagostin et al., 2011; La Torre et al., 2018; Lamichhane et al., 2018). Growing pesticide resistance and environmental regulatory limits have accelerated the adoption of biopesticides and disease-resistant American hybrids such as Frontenac and Chardonel to reduce chemical inputs. For detailed information on disease susceptibility and chemical sensitivity of different grape varieties, refer to the UMass Extension Fruit Program guide.

This study aims to evaluate the effectiveness of a disease management program that substitutes several conventional fungicides with biopesticides compared to a fully conventional program. The biopesticides used include PerCarb, a peroxycarbonate-based contact fungicide that releases hydrogen peroxide to disrupt fungal cell membranes, and OxiDate, a hydrogen peroxide-based oxidizing agent that rapidly kills fungal spores on contact. The evaluation quantifies the program's impact on disease management, yield, and juice quality on two American hybrid grapes, Chardonel and Frontenac.

Materials and Methods

Location and plant material. This trial was conducted during the summer of 2025 at the University of Massachusetts Cold Spring Orchard in Belchertown, Massachusetts (42.28° N, 72.35° W). The experimental vineyard spans approximately 0.7 acres and is planted with two cold-hardy hybrid grape varieties [Frontenac and Chardonel] selected for their contrasting disease resistances. Vines were trained to a high-wire cordon system with 8 ft between rows and 6 ft between vines. The soil is a well-drained loam typical of the region. Standard vineyard management practices were applied, including annual pruning, chemical weed control, and canopy management.

Treatments. Prior to the trial, all vines received the same pesticide applications (see Table 1). Beginning on June 6, 2025, the vineyard was divided into two treatment groups, a conventional program with a mix of conventional and biopesticide treatments and (2) a biopesticide program, exclusively using biopesticides (Oxidate and PerCarb).

Spray schedules for both programs are detailed in Table 2. All treatments included NuFilm (16 oz/A) except those involving PerCarb.

hoc test was used for pairwise comparisons. Statistical significance was determined at $p < 0.05$. Results are presented as treatment means in Table 3.

Table 1. Pre-trial spray schedule and cost per acre

Date	Products applied (All)	Cost per acre (USD)
04/24/2025	NuCop 3 lb/A; Damoil (1%) 1 gal/A	$31.93
05/09/2025	Captan 2.5 lb/A; Manzate 3 lb/A	$16.95
05/15/2025	Rampart 3 pt/A; Movento 7 oz/A	$62.22
05/21/2025	Revus Top 7 oz/A; Ph-D 6.2 oz/A	$65.88
		Total: $176.98

Table 2. Spray schedule starting 6/6/2025 and cost per treatment. All used NuFilm (16 oz/A) except PerCarb.

Date	Conventional treatment	Cost (USD/A)	Biopesticide treatment	Updated Cost (USD/A)
06/06/2025	ProPhyt 3 pt/A; Aprovia 9.5 oz/A	$51.14	OxiDate (1%) 1 gal/A	$27.50
06/13/2025	Pristine 10 oz/A; Captan 2.5 lb/A	$34.83	PerCarb 2 lb/A	$15.00
06/20/2025	OxiDate (1%) 1 gal/100 gal	$23.66	OxiDate (1%) 1 gal/A	$27.50
06/26/2025	Inspire Super 18 oz/A; Revus Top 7 oz/A	$49.06	PerCarb 2 lb/A	$15.00
07/07/2025	Ph-D 6.2 oz/A; ProPhyt 3 pt/A	$50.25	OxiDate (1%) 1 gal/A	$27.50
07/16/2025	PerCarb 1.5 lb/A	$9.36	PerCarb 1.5 lb/A	$11.25
07/28/2025	OxiDate (1%) 1 gal/100 gal	$23.66	OxiDate (1%) 1 gal/A	$27.50
08/06/2025	Pristine 10 oz/A; Revus Top 7 oz/A	$48.93	PerCarb 1.5 lb/A	$11.25
		Total: $290.89		**Total: $162.50**

Experimental design. Each grape variety was planted in six rows. Each row was divided into two blocks of 10 vines. Treatments were randomly assigned to blocks within each row.

Vine maintenance. Shoot thinning was conducted on May 20–21, 2025, maintaining approximately six shoots per foot of linear canopy. Leaf pulling and shoot positioning were performed uniformly across all treatments.

Disease assessment. Disease incidence (percentage of plants infected) and severity (percentage of foliage affected) were recorded each time before spraying but here we report them for the end of the season on August 19, 2025, two weeks after the last spray. The following grape foliage diseases were evaluated: black rot, downy mildew, powdery mildew, Phomopsis. Phytotoxicity (leaf burn from pesticide treatments) was assessed using the same criteria.

Yield and fruit quality. Yield per vine was measured at harvest. Soluble solids (°Brix) and pH were recorded for each treatment. Frontenac was harvested on September 2, 2025. Data for Chardonel were inconclusive due to significant bird damage, possibly linked to exceptional drought conditions.

Cost analysis. Total chemical costs were calculated for each treatment group to quantify economic differences.

Statistical analysis. Data were analyzed using one-way ANOVA in R to evaluate treatment effects on disease, yield, and juice quality. Tukey's HSD post hoc test was used for pairwise comparisons. Statistical significance was determined at $p < 0.05$. Results are presented as treatment means in Table 3.

Results and Discussion

Weather conditions. Average air temperatures from May to September 2025 (Fig. 1) were close to long-term means. In contrast, precipitation was highly uneven: rainfall in May was exceptionally high whereas June and August were markedly dry, reflecting drought periods which could explain the extreme bird feeding.

Disease, juice quality, and yield. Disease pressure during the 2025 growing season was generally low, particularly in August, likely due to drought conditions that suppressed disease development. As a result, no significant differences were observed between the conventional and biopesticide treatments for disease severity in either cultivar. However, phytotoxicity was notably higher under the conventional program for Frontenac (Table 3), indicating potential leaf damage from synthetic fungicides. Phytotoxicity was recorded after the 6/26 conventional treatment which used Inspire Super and Revus top, known to cause phytotoxicity in some grape variety. In contrast, the biopesticide program showed no significant phytotoxic effects.

Brix (sugar content) and yield per plant were statistically similar between treatments for Frontenac, suggesting that biopesticide use did not compromise productivity.

Juice pH was significantly lower in the biopesticide treatment ($p=0.022$), indicating slightly higher acidity (Table 3).

Cost analysis. Pre-trial sprays applied to all vines (see Table 1) totaled $176.98 per acre. Once the trial began on June 6, the seasonal spray cost for each program was

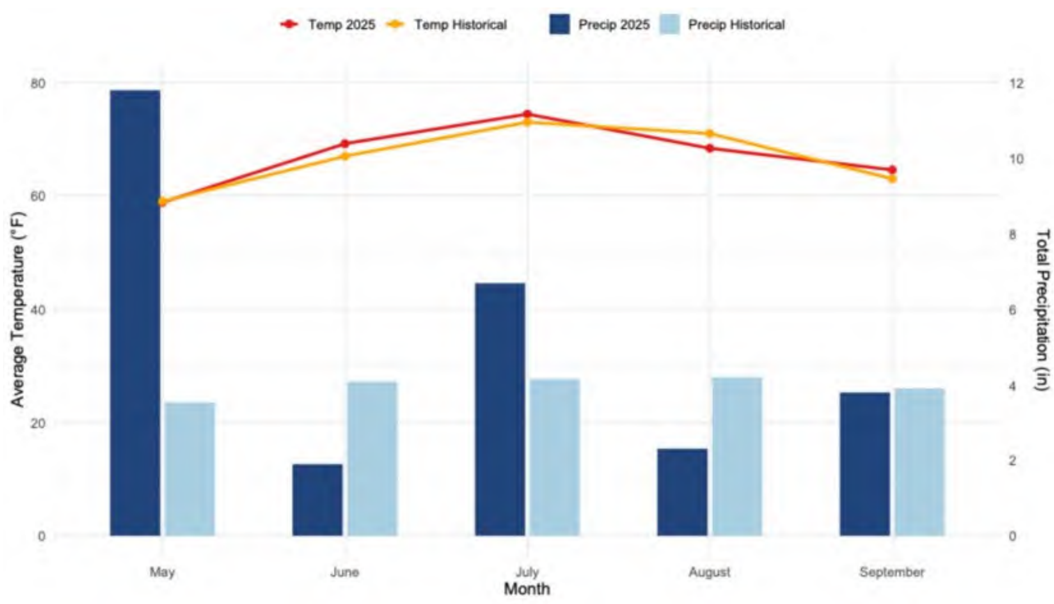

Figure 1. Average air temperature and total precipitation in summer 2025 compared to historical data at the UMass Cold Spring Orchard (Belchertown, Massachusetts).

$290.89 per acre for the conventional program and $162.50 per acre for the biopesticide program.This represents a 44% reduction in spray costs under the biopesticide program. The savings were primarily due to replacing higher-cost conventional fungicides (e.g., Aprovia, Revus Top, Pristine) with more affordable alternatives like PerCarb and Oxidate. Despite the lower input costs, disease control remained comparable between programs (see Table 3), supporting the economic viability of biopesticide-based management under the 2025 conditions.

Acknowledgements

This project was supported by the Mass Fruit Growers' Horticultural Research Fund 2025,

Table 3. Averages and P values showing statistical differences in diseases, burnt foliage, Brix (sugar), pH, and yield are presented. P values indicating statistical differences are marked with an asterisk in the results. When no disease was visible, statistical analyses were not conducted, and the P value was recorded as "NA" (not applicable). Yield in Frontenac was lower than expected due to bird damage. Fruit data (Fruit rot, °Brix, pH, Yield per plant) in Chardonel were lost due to bird damage. Disease data were taken on August 19, 2025 and fruit rot and yield data at harvest on September 2d, 2025.

Variable	Chardonel			Frontenac		
	Conventional	Biopesticide	*p*-value	Conventional	Biopesticide	*p*-value
Downy mildew (%)	0.55 ± 0.33	0.98 ± 1.06	0.365	0 ± 0	0 ± 0	NA
Phomopsis (%)	0.72 ± 0.15	0.67 ± 0.10	0.511	0.97 ± 0.15	0.82 ± 0.25	0.234
Black rot (%)	0.014 ± 0.006	0.011 ± 0.006	0.432	0.013 ± 0.009	0.009 ± 0.006	0.378
Anthracnose (%)	0.001 ± 0.002	0.002 ± 0.003	0.718	0 ± 0	0 ± 0	NA
Powdery mildew (%)	0 ± 0	0 ± 0	NA	0 ± 0	0.033 ± 0.082	0.341
Phytotoxicity (%)	0 ± 0	0.003 ± 0.008	0.341	0.733 ± 0.082	0.002 ± 0.004	8.7×10^{-10} *
Fruit rot (%)	NA	NA	NA	0.40 ± 0.17	0.73 ± 0.45	0.31
°Brix	NA	NA	NA	18.87 ± 1.33	19.30 ± 0.79	0.66
pH	NA	NA	NA	2.95 ± 0.03	2.87 ± 0.02	0.022 *
Yield per plant (lbs)	NA	NA	NA	10.01 ± 1.09	9.43 ± 1.12	0.56

CAFE scholar 2025 and Biosafe Systems. Special thanks to the vineyard staff and collaborators who contributed to the fieldwork and data collection.

Where brand names for chemicals are used, it is for the reader's information. No endorsement is implied, nor is discrimination intended against products with similar ingredients. Please consult pesticide product labels for rates, application instructions and safety precautions. The label is the law. Users of these products assume all associated risks.

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