SRSFC Project 2025 R-04: Review of silicon for management of powdery mildew of grape

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Abstract. This study investigated the efficacy of a foliar-applied silicon product, Sil-Matrix, either alone or combined with sulfur (Microthiol Disperss) and/or a surfactant (Silwet L-77) for managing powdery mildew in grapevines, a persistent challenge in the southeastern United States due to high disease pressure and increasing fungicide resistance. The trial was conducted on mature 'Chardonnay' vines at the University of Georgia's Blairsville Research and Education Center. Despite unusually high rainfall that substantially delayed disease onset, powdery mildew severity was assessed. Results indicated that sulfur and the surfactant treatments significantly reduced disease severity, while silicon did not provide adequate control. These findings suggest that while silicon may offer physiological benefits, it may lack sufficient standalone or consistent efficacy against powdery mildew under southeastern vineyard conditions.

Objective. Determine the utility of a silicon foliar-applied product for powdery mildew management of grapes

Justification and Description. The southeastern wine grape industry is limited by intense disease pressure from fungal and oomycete pathogens. One impending threat to the economic sustainability of the grape industry is the loss of fungicidal activity due to resistance development in pathogen populations. Throughout the Southeast, this has been reported for demethylation inhibitor (DMI; FRAC 3) and quinone outside inhibitor (QoI; FRAC 11) fungicides when used for powdery mildew management. Growers have traditionally utilized these chemical fungicides due to their significant efficacy and broad-spectrum activity. Though some DMI fungicides are still efficacious, the regulatory environment is becoming unfavorable for DMI fungicides, as well as many others. Elemental sulfur has been used for over a hundred years to control powdery mildew, and though sulfur's activity against powdery mildew is good, it is not as efficacious as many synthetic fungicides, and it can cause damage to some native and hybrid grapes. Silicon is a chemical that may have utility in providing direct efficacy against pathogens or, alternatively, impacting overall plant health (Blaich and Grundhöfer 1998; Zellner et al. 2021) – possibly providing an indirect, positive interaction with fungicides. Based on numerous other reports, silicon has been found to have broad efficacy against a range of pathogens (Zellner et al. 2021). Indeed, silicon has been reported to have activity against powdery mildew, caused by the pathogen *Erysiphe necator*. In an Austrian field trial, only foliar applications, as opposed to soil applied, were found to increase silicon concentrations in leaves, and this also resulted in increased cluster mass and yield, as well as improved sensory qualities in wine (Schabl et al. 2020). Bowen et al. (1992) likewise found activity of silicon against powdery mildew of grape and further concluded that results from foliar applications were much improved over those of soil applications. Silicon has also been reported to change the physiology of plants, sometimes resulting in thicker cell walls and thereby increased pathogen resistance. Our research examined the effects of silicon application on powdery mildew management under conditions commonly observed in the Southeast.

Figure 1. Powdery mildew of grape on leaves (left) and fruit (right). Leaf infections reduce photosynthesis, while fruit infections render grapes of no value for wine production.

Materials and Methods. Efficacy of a silicon product, Sil-Matrix, was tested on a block of 'Chardonnay' *Vitis vinifera* grapes located at the University of Georgia Research and Education Center in Blairsville, GA. Since

some trials have indicated efficacy of silicon against powdery mildew (Bowen et al. 1992), we reviewed efficacy specifically against this disease. The trial was applied in a mature 'Chardonnay' block and included: 1) an untreated control [no powdery mildew material applied], 2) Microthiol Disperss, 3) Sil-Matrix (potassium silicate; Certis Biologicals), 4) Microthiol Disperss + Sil-Matrix, 5) Sil-Matrix + Silwet L-77, and 6) Sil-Matrix + Microthiol Disperss + Silwet L-77. All treatments were applied with a commercial PTO-mounted airblast sprayer at a 50 gal per acre spray volume, and applications were made at pre-bloom (30 Apr and 14 May), bloom (21 May), post-bloom (5 Jun), first cover (16 Jun), and bunch closure (26 Jun). The experimental design was a factorial randomized complete block design with five replications per treatment, and each plot consisted of three vines. The entire vineyard was maintained with a maintenance fungicide program designed to allow only powdery mildew development and testing of powdery mildew-active materials – no other diseases present. However, there was no visible powdery mildew until shortly after 1 Aug. After disease onset, powdery mildew severity (percentage of leaf area affected for 25 leaves per plot) was assessed on 12 and 24 Aug, with both ratings being conducted well over a month after the last treatment applications. Disease incidence levels were generally high across treatments and were not analyzed. Due to excessive deer and turkey damage, treated plots were not tested for grape quality attributes, as no grapes remained by trial completion.

Results and Discussion. Considering the heavy rainfall and the absence of powdery mildew throughout the typical trial period, this was an unusual trial. From the start of treatment applications on 30 Apr until the final disease rating on 24 Aug, there were 77 days with precipitation, totaling 19.6 in. of rain. Due to excessive rainfall, powdery mildew was not visible until quite late in the season. Although the disease was not visible even by 1 Aug, sufficient disease was present by 12 Aug for a first efficacy rating on leaves. This initial rating was ~1.5 months after the last treatment application, yet the leaf powdery mildew severity data still provided valuable insights (Table 1). Epidemiologically, powdery mildew can be active in a vineyard well before it becomes visually apparent, so these treatment results are better understood in the context of their influence on disease development over time, rather than residual chemical activity following the last treatment application. Under these conditions, Microthiol Disperss, applied at the maximum rate, and Silwet L-77 clearly suppressed powdery mildew. Sil-Matrix did not. Previous research has demonstrated a clear benefit when combining the Silwet L-77 surfactant with Microthiol Disperss, even demonstrating a synergistic effect. Silwet L-77 has also shown direct, independent activity against powdery mildew. However, the most surprising aspect of this trial was the duration of this epidemiological effect. Given the presumed physiological effects of multiple silicon applications, a longer-lasting activity might be expected. Contrary to this expectation, silicon did not show clear activity. Even at the later rating, all treatments displayed similar disease patterns, though by then the responses were simply trends (Table 2).

Table 1. Factorial analysis of sulfur, silicon, a surfactant, and their impact on grapevine powdery mildew leaf severity (%) 48 days after their last application

	Microthiol Disperss Sulfur[xy]		
Silicon	No sulfur	Sulfur	Mean[b]
None	34.6	18.4	26.5 a
Sil-Matrix	27.6	15.5	21.6 a
Sil-Matrix + Silwet	15.9	8.7	12.3 b
Mean	26.0 a	14.2 b	

[x] Each value is derived from the arithmetic mean of five replicates.

[y] Powdery mildew severity (% of leaf covered by powdery mildew) was calculated from 25 leaves per treated plant. Means followed by the same letter are not significantly different based on a post-hoc Fisher's protected LSD test ($P = 0.05$). LSD = 6.4 for the main effect of sulfur. LSD = 7.8 for the main effect of silicon. No significant interactions were observed ($P = 0.4965$).

Table 2. Factorial analysis of sulfur, silicon, a surfactant, and their impact on grapevine powdery mildew leaf severity (%) 60 days after their last application

	Microthiol Disperss Sulfur[xy]		
Silicon	No sulfur	Sulfur	Mean[b]
None	37.5	24.9	31.2
Sil-Matrix	27.5	24.4	25.9
Sil-Matrix + Silwet	22.0	16.3	19.2
Mean	29.0	22.0	

[x] Each value is derived from the arithmetic mean of five replicates.

[y] Powdery mildew severity (% of leaf covered by powdery mildew) was calculated from 25 leaves per treated plant. The ANOVA for this test was not significant ($P = 0.12$).

Impact. This study evaluated the effectiveness of a foliar-applied silicon product, Sil-Matrix, in controlling powdery mildew on grapevines under southeastern U.S. conditions. Conducted on mature 'Chardonnay' vines at the University of Georgia's Blairsville Research and Education Center, the trial compared various treatments including silicon (Sil-Matrix), sulfur (Microthiol Disperss), and a surfactant (Silwet L-77). Despite heavy rainfall delaying disease development, powdery mildew severity was successfully assessed. Results showed that sulfur and the surfactant treatments significantly reduced disease severity, whereas silicon did not show a clear benefit. The findings highlight the challenges of managing powdery mildew in southeastern vineyards and underscores the limited or variable effectiveness of silicon-based treatments under high rainfall conditions. Although sulfur and the surfactant were effective, the anticipated long-term benefits of silicon were unfortunately not observed, suggesting its role may be more supportive than primary in disease management strategies. These insights are important for promoting accurate and sustainable fungicide use and for developing integrated disease control strategies in regions facing fungicide resistance and regulatory challenges.

References

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