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# Bio-efficacy Studies of Unique in Relation to Growth, Yield and Shelf Life of Super Sonaka Grape Variety Grown in Sangli Region of Maharashtra

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The effect of Unique (bio-stimulant) was studied on yield and quality of Super Sonaka, elongated grape variety by applying different doses through foliar sprays (20, 25 and 30 ml/L) at five key stages of growth (12-13 days after fruit-pruning, 23-25 days after fruit-pruning, at 75-100% flowering, at 100% fruit set (2 mm berry size) and 8-10 days after fruit set). Among the different treatments, the foliar application of 30 ml/L significantly improved several growth and yield parameters including leaf area (163.1 $cm^2$), average bunch weight (580.5 g), 50-berry weight (200.18 g), berry length (28.4 mm), berry diameter (17.2 mm) and yield (20.92 kg/vine) respectively. Biochemical attributes like phenol content (0.54 mg/g), protein (14.9 mg/g), reducing sugar (297.3 mg/g), calcium (48.9 ppm) and phosphorus (0.315%) were also improved with reduction of post-harvest loss (PLW) upto 5.2%. Additionally, the pedicel and skin thickness increased to 0.560 mm and 0.186 mm, respectively. Therefore, the foliar application of 30 ml/L of Unique at these five stages is recommended to optimize both the quality and yield of Super Sonaka grapes.

*Keywords: Bio stimulant; unique; grapes; yield; quality.*

## 1. INTRODUCTION

Grape (*Vitis vinifera* L.) is one of the most widely cultivated fruit crops globally. In India, grape cultivation is a key part of the agricultural sector with table grapes making up 78% of production, raisins (17-20%) and about 2% wine and juice (Somkuwar et al., 2024). Maharashtra state is leading in grape cultivation contributing around 80% of the total production, with an average yield of 25 tons/ha, followed by Karnataka, Tamil Nadu, Mizoram and parts of northern India (Sharma et al., 2023). However, the grape industry faces growing challenges from abiotic stresses such as drought, salinity, excessive rainfall, high temperatures, solar radiation and rising $CO_2$ levels, all exacerbated by global warming. These stresses affected the synthesis and breakdown of primary and secondary metabolites (Bulgari et al., 2019) and combined with soil, water and unfavourable weather conditions they limit the ability to achieve optimal berry size (Upadhyaya et al., 2020). To support both vegetative and reproductive growth stages, plant growth stimulants and crop supplements are often used to mitigate all sorts of stresses (Sharma et al., 2023; Deshmukh et al., 2023). Biostimulants applied to leaves, soil or seeds, enhance plant resistance to abiotic stress by improving root growth, nutrient uptake and immune responses. These include protein hydrolysates, humic substances, seaweed extracts, microbial compounds, phosphites and silicon (Rouphael, 2018; Yilmaz and Sensoy, 2021). Seedless grapes favoured for their high quality and attractive colour, rely heavily on factors like berry size and the sugar-to-acid ratio for consumer acceptance (Sharma et al., 2023). The grape variety Super Sonaka in particular is highly valued in domestic and export markets due to its superior quality traits (Somkuwar et al., 2023). Research on Super Sonaka grapes has shown that bio stimulants enhance berry size, cluster formation, brix levels and shelf life, improving both quality and yield (Nanjappanavar et al., 2017). The benefits of bio stimulants are mitigating stress and improving grapevine yield and quality (Bulgari et al., 2019). Considering this, a research trial was conducted in Sangli, dist. of Maharashtra, to study the effect of Unique (bio stimulant) on berry quality and yield in Super Sonaka grapes grafted onto Dogridge rootstock.

## 2. MATERIALS AND METHODS

### 2.1 Experimental Conditions

The experimental trials were conducted at farmers field at Walwa, Sangli district of Maharashtra during the year 2023-24. The experiment was laid out in RBD with four treatments and five replications and five vines per replication were selected. The vines were pruned twice in a year. First pruning was done during mid-last week of April, 2023 (foundation pruning) while the second pruning (fruit pruning) during mid-last week of October, 2023. Four treatments were imposed by foliar spray during the experiment ie., T1- control (water spray), T2 - foliar spray of Unique@ 20 ml/L, T3- foliar spray of Unique@ 25 ml/L and T4- foliar spray of Unique@ 30 ml/L at five different stages, 1st – after 12 to 13 days of fruit pruning, 2nd after 23 to 25 days of fruit pruning, 3rd on 75 to 100% flowering stage, 4th on 100% setting of fruits stage (2 mm Berry Size) and 5th after 8 to 10 days (100% setting of fruits stage).Water volume was used based on the canopy size (250 to 400 L/acre).

## 2.2 Growth Parameters

Shoot length was measured from the 1st node at 90 days after fruit-pruning and recorded in cm. Shoot diameter between the fifth and sixth nodes was measured with a Vernier calliper and averaged for five canes per vine and expressed in mm. Leaf area was calculated using the formula: Leaf area (A) = L x B x K (0.810) and expressed in cm².

## 2.3 Bunch and Yield Parameters

The mean number of bunches per vine was calculated from five selected vines after berry set. Similarly, the average number of berries per bunch was determined from five bunches per treatment. The mean bunch weight was recorded by averaging 10 bunches from five randomly selected vines at harvest. Berry weight was calculated from 50 randomly selected berries. Grapes were harvested at proper maturity and the yield was recorded.

## 2.4 Berry Quality Parameters

Ten randomly selected berries per replication were measured for length and diameter using a Vernier caliper (mm). Juice was extracted from selected berries to determine total soluble solids (°Brix) using a hand refractometer. Titratable acidity (%) was measured by titrating the juice with 0.1 N NaOH and chlorophyll content in leaves was estimated using the DMSO method same as previously described by Kakade et al., 2024.

## 2.5 Biochemical Parameter

The Folin-Ciocalteu method (Singleton and Rossi, 1965) was used to estimate phenols and expressed in mg/g. Soluble protein in content in grape berries was measured using Lowry's method (1951) and was expressed in mg/g. Reducing sugars in grapes were determined by DNSA method (Miller, 1972). Calcium (ppm) was measured using the neutral normal ammonium acetate method, while phosphorus content in petiole samples was determined using the Venadomolybdo phosphoric acid method (Jackson, 1973) with absorbance at 470 nm on a spectrophotometer.

## 2.6 Physical Properties of Treated Grapes

Pedicel thickness was measured using vernier calliper and expressed in mm. The skin thickness of ten randomly selected grape berries was measured using a portable digital calliper. To assess physical changes during storage, physiological loss in weight (PLW) was calculated as the percentage of weight lost over time. The weight in each treatment was recorded daily for 5 continuous days to determine PLW (%) and was calculated as:

$$\text{Physiological loss in weight (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

## 2.7 Statistical Analysis

The data recorded was statistically analyzed by standard method of analysis of variance using Randomized Block Design (RBD) as described by Panse and Sukhatme (1985).

## 3. RESULTS AND DISCUSSION

The data recorded on growth parameters of grapes is presented in Table 1. At 90 days after fruit pruning, the treatment T1 showed highest shoot length and shoot diameter (89.50 and 7.60 cm respectively), while lowest shoot length (80.20 cm) was recorded in T4 and shoot diameter in T3 (7.10 cm). The leaf area was higher in T4 (163.10 cm$^2$) which was at par with T3 (160.50 cm$^2$) over the control treatment T1 (156.20 cm$^2$). Increased shoot length and diameter influence grape productivity by affecting photosynthesis and nutrient distribution. However, longer shoots consume more photosynthetic resources, leaving fewer for cane and fruit development (Somkuwar et al., 2024). Optimal shoot growth improves berry size and composition, enhancing grape quality, but excessive vegetative growth can detract from yield by redirecting resources from reproductive parts. Maintaining an ideal leaf area is essential for boosting carbohydrate production, which enhances both yield and quality (Somkuwar et al., 2024a; 2024b; 2024c). Additionally, shoot length and diameter are linked to higher pruning weights and biomass accumulation further contributing to productivity (Somkuwar et al., 2024d).

## 3.1 Bunch and Yield Parameters

The data recorded on number of bunches/ vine, number of berries/bunch, average bunch weight (g), 50-berry weight and yield per vine is presented in Table 2. It was observed that application of Unique did not affect number of bunches/vine and number of berries/ bunch. This was mainly because the fruit bud differentiation was already been completed during the period of 40 to 70 days after the foundation pruning. In addition, considering the quality yield for export purpose, bunch thinning was also done after berry set. However, the treatment T4 recorded highest average bunch weight (580.50 g), 50 berry weight (200.18 g) and yield/vine (20.92 kg) followed by T3 (510.00, 177.10 g and 17.93 kg respectively) over the control treatment T1 (500 g, 168.93 g, 16.53 kg respectively).

Application of Unique significantly improved grapevine physiology, increasing average bunch weight, 50-berry weight and overall yield. Bio stimulants like seaweed extracts and humic acids enhance nutrient uptake and physiological responses, contributing to higher yields (Nardi et al., 2016; Shahrajabian et al., 2021; Irani et al., 2021). The yield boost from larger bunches and berries are likely due to better carbon assimilation and enhanced photosynthesis from bio stimulant use (Deshmukh et al., 2023). The improvements in yield and bunch weight are attributed to bio stimulants enhancing nutrient and water efficiency, plant development and stress tolerance (Van et al., 2017; Rao et al., 2016). Similar findings on increased berry and bunch weight were reported by Secco et al. (2016) and Sharma et al. (2023).

## 3.2 Berry Quality Parameters

The grape berry quality mainly consists of berry length, berry diameter, TSS and acidity. Statistically significant variation was found in berry length and diameter with different concentrations of Unique. The treatment T4 recorded highest berry length (28.40 mm) and berry diameter (17.20 mm) which was at par with treatment T3 for berry length (28.00 mm) and 16.50 mm for berry diameter as compared with untreated control T1 (26.00 and 15.50 mm respectively). Different concentrations of Unique showed non-significant variation in TSS in grape berry. However, the TSS ranged between 17.00°Brix to 18.80°Brix in which treatment T1 showed maximum (18.80°Brix) TSS while least TSS was recorded in T3 (17.00°Brix). The acidity ranged from 0.42 % in T1 to 0.51 % in T4 treatment which was within the acceptable limit in all the treatments. Bio stimulants like protein hydrolysates and humic substances significantly increase berry size, while, treated berries showing greater length and diameter compared to controls (Nardi et al., 2016; Shahrajabian et al., 2021). This was attributed to stimulated cell division and elongation (Warusavitharana et al., 2008; Deshmukh et al., 2023). These findings align with the results of Sharma et al. (2023) who also noted increase in berry size in Thompson Seedless grapevines. However, no significant effects on total soluble solids (TSS) were observed (Frioni et al., 2019; Sharma et al., 2023), though Deshmukh et al. (2023) reported a notable effect on titratable acidity.

## 3.3 Chlorophyll Content in Leaf

The data recorded on leaf petiole nutrient content at 45 and 90 days after fruit pruning is presented in Table 4. At 45 days after the fruit pruning, the chlorophyll a content in leaf was higher in T4 (11.40 ug/ml) which was at par with T2 (11.30 ug/ml) and T3 (10.50 ug/ml) over the untreated control T1 (9.20 ug/ml). The total chlorophyll content in grape leaf were also higher in T4 (14.90 ug/ml) which was at par with T2 (14.70 ug/ml) compared to untreated control T1 (12.15 ug/ml). At 90 days after fruit pruning, the total chlorophyll content in leaf ranged from 15.10 ug/ml (T1) to 17.85 ug/ml (T4) indicating the importance of application of Unique in storing the food material in grapevine. The increase in chlorophyll content in Unique-treated plants was due to improved nutrient absorption and enhanced physiological conditions leading to healthier leaves and better photosynthesis. It boosts sugar transfer, activates key enzymes for chlorophyll synthesis and reduces its degradation. Bhattacharya (2015) and Sharma (2023) confirmed that bio stimulant treatments significantly increase chlorophyll levels in plants.

## 3.4 Biochemical Parameters in Grape Berries

The data recorded on different biochemical parameters (phenol, protein, reducing sugar and calcium) and phosphorus content in petiole at full bloom and at veraison stage of berry development is presented in Table 5. Among the different biochemicals, phenol content was relatively higher in T3 (0.57 mg/g) while it was lowest in T2 (0.47 mg/g). The maximum protein content was recorded in T4 (14.90 mg/g) which was at par with T3 (14.60 mg/g) while minimum protein was observed in T1(13.40 mg/g). Reducing sugar varied significantly among the different treatments. The treatment T4 recorded highest reducing sugar (297.30 mg/g) which was at par with T3 (291.30 mg/g) whereas T2 recorded lowest reducing sugar (267.30 mg/g). The maximum calcium content in grape berries was recorded in T4 (48.90 ppm) followed by T3 (45.70 ppm), T2 (37.60 ppm) while minimum in T1 control (37.00 ppm). Phosphorus content in petiole at full bloom and at veraison stage of berry development varied significantly among the different treatments with highest phosphorus content in petiole in T4 at full bloom (0.560%) and at veraison (0.315 %) stage followed by T3 (0.530 and 0.300 % respectively) whereas T1 showed lowest concentration in full bloom (0.500 %) and at veraison (0.260 %). There was positive correlation between phosphorus (%) and fruitful canes percent (0.960). Phenolic compounds are vital plant metabolites involved in essential physiological processes, crucial for plant health and development (Martínez-Lorente et al., 2024). Bio stimulants, particularly seaweed extracts, significantly increase phenolic content in fruits, leaves and roots, enhancing fruit quality, sugar levels and antioxidant properties (Irani et al., 2021). These bio stimulants also optimize nitrogen metabolism, boosting protein synthesis and sugar accumulation, especially under stress conditions (Shahrajabian et al., 2021). Additionally, bio stimulants improved nutrient uptake, particularly phosphorus and calcium, essential for healthy growth and higher yields (El-Boray et al., 2007; Martínez-Lorente et al., 2024).

**Table 1. Effect of Unique on growth parameters of Super Sonaka grapes**

| Treatments | Shoot length (cm) | Shoot diameter (mm) | Leaf area (cm$^2$) |
|---|---|---|---|
| $T_1$- Control | 89.50 | 7.60 | 156.20 |
| $T_2$- Unique @ 20 ml | 87.40 | 7.20 | 158.40 |
| $T_3$- Unique @ 25 ml | 84.30 | 7.10 | 160.50 |
| $T_4$- Unique @ 30 ml | 80.20 | 7.30 | 163.10 |
| **S Em ±** | **0.66** | **0.05** | **1.22** |
| **CD at 5%** | **2.02** | **0.16** | **3.77** |
| **Sig** | ** | ** | * |

**Table 2. Effect of Unique on bunch and yield parameters of Super Sonaka grapes**

| Treatments | No of bunches/ vine | No of berries/bunch | Average bunch weight (g) | 50 berry weight (g) | Yield/vine (kg) |
|---|---|---|---|---|---|
| $T_1$- Control | 33.00 | 148.00 | 500.00 | 168.93 | 16.53 |
| $T_2$- Unique @ 20 ml | 34.00 | 148.00 | 500.30 | 169.03 | 17.05 |
| $T_3$- Unique @ 25 ml | 35.00 | 144.00 | 510.00 | 177.10 | 17.93 |
| $T_4$- Unique @ 30 ml | 36.00 | 145.00 | 580.50 | 200.18 | 20.92 |
| **S Em ±** | **0.89** | **1.39** | **3.62** | **0.91** | **0.26** |
| **CD at 5%** | **2.73** | **4.29** | **11.16** | **2.82** | **0.79** |
| **Sig** | **NS** | **NS** | ** | ** | ** |

**Table 3. Effect of Unique on berry quality parameters of Super Sonaka grapes**

| Treatments | Berry length (mm) | Berry diameter (mm) | TSS (°Brix) | Acidity (%) |
|---|---|---|---|---|
| $T_1$- Control | 26.00 | 15.50 | 18.80 | 0.42 |
| $T_2$- Unique @ 20 ml | 27.50 | 16.20 | 18.40 | 0.45 |
| $T_3$- Unique @ 25 ml | 28.00 | 16.50 | 17.00 | 0.47 |
| $T_4$- Unique @ 30 ml | 28.40 | 17.20 | 17.90 | 0.51 |
| **S Em ±** | **0.22** | **0.13** | **0.99** | **0.004** |
| **CD at 5%** | **0.67** | **0.39** | **3.05** | **0.013** |
| **Sig** | ** | ** | **NS** | ** |

**Table 4. Effect of Unique on chlorophyll content in leaf of Super Sonaka grapes**

| Treatments | 45 days after fruit pruning | | | 90 days after fruit pruning | | |
|---|---|---|---|---|---|---|
| | Chlorophyll a (ug/ml) | Chlorophyll b (ug/ml) | Total Chlorophyll (ug/ml) | Chlorophyll a (ug/ml) | Chlorophyll b (ug/ml) | Total Chlorophyll (ug/ml) |
| $T_1$- Control | 9.20 | 2.95 | 12.15 | 12.30 | 2.80 | 15.10 |
| $T_2$- Unique @ 20 ml | 11.30 | 3.40 | 14.70 | 12.60 | 2.95 | 15.55 |
| $T_3$- Unique @ 25 ml | 10.50 | 2.60 | 13.10 | 13.10 | 3.60 | 16.70 |
| $T_4$- Unique @ 30 ml | 11.40 | 3.50 | 14.90 | 13.95 | 3.90 | 17.85 |
| **S Em ±** | **0.34** | **0.36** | **0.34** | **0.09** | **0.02** | **0.09** |
| **CD @ 5%** | **1.08** | **1.12** | **1.04** | **0.29** | **0.06** | **0.27** |
| **Sig** | ** | **NS** | ** | ** | ** | ** |

**Table 5. Effect of Unique on biochemical parameters of Super Sonaka grapes**

| Treatments | Phenol mg/g | Protein mg/g | Reducing sugar mg/g | Calcium (ppm) | Phosphorus (%) full bloom | Phosphorus (%) at veraison |
|---|---|---|---|---|---|---|
| $T_1$- Control | 0.49 | 13.40 | 284.20 | 37.00 | 0.500 | 0.260 |
| $T_2$- Unique @ 20 ml | 0.47 | 14.00 | 267.30 | 37.60 | 0.530 | 0.295 |
| $T_3$- Unique @ 25 ml | 0.57 | 14.60 | 291.30 | 45.70 | 0.530 | 0.300 |
| $T_4$- Unique @ 30 ml | 0.54 | 14.90 | 297.30 | 48.90 | 0.560 | 0.315 |
| **S Em ±** | **0.005** | **0.11** | **2.21** | **0.46** | **0.004** | **0.003** |
| **CD at 5%** | **0.014** | **0.35** | **6.82** | **1.41** | **0.014** | **0.008** |
| **Sig** | ** | ** | ** | ** | ** | ** |

### 3.5 Shelf Life

The data on shelf life in terms of PLW (%) during storage at room temperature is presented in Fig. 1. In all the treatments, the PLW (%) increased with the advancement in storage duration. The minimum PLW was recorded in treatment T4 from 1st day (1.32 %), 2nd day (2.02 %), 3rd day (3.02 %), 4th day (4.00 %) and 5th day (5.20 %). The physiological loss in weight in grape berries of control treatment increased rapidly from 1st day (1.81 %), 2nd day (2.81 %), 3rd day (3.87 %), 4th day (4.74 %) and 5th day (6.12 %). Pedicel thickness was relatively higher in T4 (0.560 mm) while it was lowest in T1 (0.510 mm) treatment (Fig. 2). The treatment T4 also recorded maximum skin thickness (0.186 mm) while it was minimum in T2 (0.170 mm). The study highlights the effectiveness of Unique in improving grape berry quality. Thicker pedicels and skins enhance storage life as also reported by Deshmukh et al. (2023). Bio stimulants trigger lipid peroxidation and defense enzymes, preserving berry firmness, reducing fruit drop, minimizing weight loss and preventing decay during storage (Liu et al., 2016; Zaharah et al., 2012; Deshmukh et al., 2023; Sharma et al., 2023).

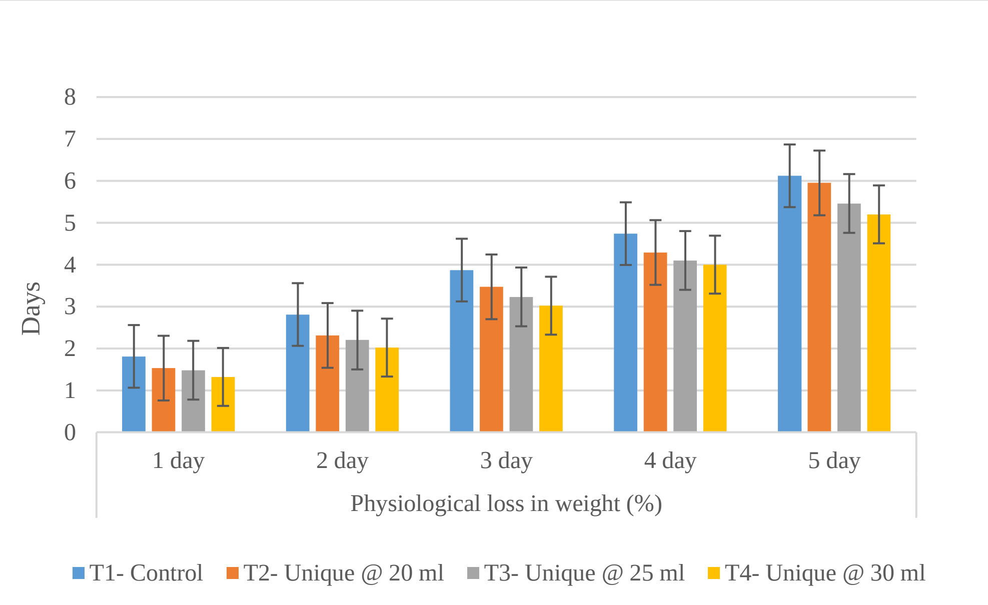


**Fig. 1. Effect of Unique on physiological loss in weight (%) of Super Sonaka grapes**

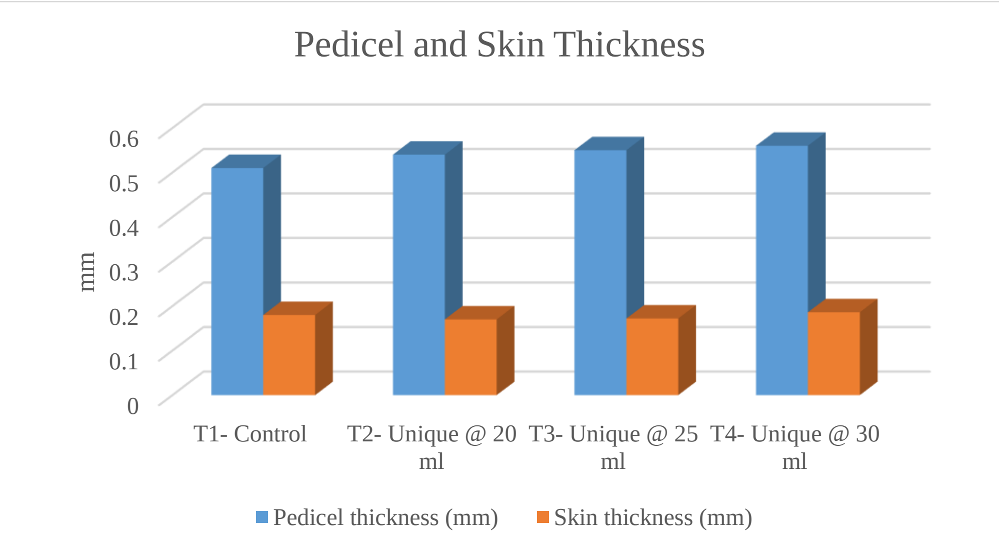


**Fig. 2. Effect of Unique on pedicel thickness (mm) and skin thickness (mm) of Super Sonaka grapes**

## 4. CONCLUSION

The application of 30 ml/L of Unique (bio-stimulant) at five different growth stages significantly enhanced both yield and quality of Super Sonaka grapes. This treatment resulted in increased fruitful canes, larger leaf area, higher average bunch and berry weights and improved overall yield. Additionally, biochemical attributes such as phenol, protein, reducing sugars, calcium and phosphorus content showed marked improvement, reflecting better nutrient uptake and metabolic activity. Post-harvest parameters including reduced physiological loss in weight (PLW) and thicker pedicel and skin indicated an extended shelf life and better storage quality. Thus, foliar application of 30 ml/L Unique at these growth stages can be used to maximize both the productivity and post-harvest quality of Super Sonaka grapes.

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that No generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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