



Bio-efficacy Studies of Biostimulant (Budmaker) in Relation to Growth, Yield and Shelf-Life of Super Sonaka Grape under Sangli Location, India

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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

Grape (*Vitis vinifera* L.) is a key crop in the Indian agricultural sector, with seedless varieties like Super Sonaka being highly valued for both domestic consumption and export due to their quality and market demand. However, the potential of these grapes is often limited by environmental

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stresses and suboptimal crop management practices. Budmaker, a potent blend of protein hydrolysate, cytokinin and TIBA, boosts bud differentiation, nutrient uptake and productivity. The current study evaluated the bio-efficacy of Budmaker, in improving the growth, yield and shelf life of Super Sonaka grapes under field conditions in Sangli, Maharashtra. Despite the growing importance of biostimulants in grapevine cultivation, there is limited research on their specific impact on grapes. To address this gap, this study applied Budmaker at three different growth stages with varying concentrations (400, 500 and 750 ml/acre) to determine the optimal dosage for enhancing vine performance. The aim of the research was to assess Budmakers effects on key agronomic parameters, such as shoot growth, berry quality and yield, while also examining its role in improving biochemical properties like phenol, protein, reducing sugar and chlorophyll content. Results indicated that Budmaker at 500 ml/acre significantly enhanced leaf area (165.17 cm²), chlorophyll content (16.00 mg/ml) and yield parameters, including bunch weight (550.40 g) and yield per vine (19.85 kg/vine). Additionally, the treatment improved biochemical properties such as phenol content (0.55 mg/g) and reducing sugars (293.60 mg/g), contributing to overall better grape quality and shelf life. However, the effectiveness of Budmaker is a sustainable solution for improving grapevine yield and quality.

Keywords: Sustainable viticulture; PGR; grapes; growth; yield.

1. INTRODUCTION

Grape (*Vitis vinifera* L.) is one of the most widely cultivated fruit crops, valued for their versatility and nutritional content. In India, grape cultivation plays a vital role in the agricultural sector, with table grapes accounting for 78% of production, raisins 17-20%, and wine and juice 2% (Somkuwar et al., 2024). Maharashtra leading in grape cultivation, contributing about 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). Seedless grapes are particularly popular due to their high quality and attractive colour, with berry size and sugar-to-acid ratio playing crucial roles in consumer acceptance (Sharma et al., 2023). However, soil and water problems, along with unfavourable weather conditions, often limit the ability to achieve the desired berry size (Upadhyaya et al., 2020). The Super Sonaka variety is widely accepted in both domestic and export markets due to its high-quality traits (Somkuwar et al., 2023). Environmental factors, including biotic and abiotic stresses and plant nutrition, significantly affect grape yield (Somkuwar et al., 2023). To support the vegetative and reproductive growth stages, various plant growth stimulants and crop supplements are applied (Sharma et al., 2023; Deshmukh et al., 2023). Bio-stimulants, applied to leaves, soil, or seeds, enhance plant resistance to abiotic stress. These substances or microorganisms, including protein hydrolysates, humic substances, seaweed extracts, biopolymers, microbial compounds, phosphites and silicon, improve root growth, nutrient uptake

and plant immune responses (Rouphael, 2018; Yilmaz and Sensoy, 2021; Sharma et al., 2023). Studies on Sonaka grapes have shown that biostimulants enhance berry size, cluster, brix levels and shelf life, improving overall crop quality and yield (Nanjappanavar et al., 2017). Budmaker is a powerful biostimulant formulated with 20% protein hydrolysate, cytokinin, kinetin, 20% TIBA, 10% PGR agents, and 50% essential nutrients. It boosts bud differentiation, enhances nutrient uptake and promotes healthy growth, leading to improved flowering, fruit set and berry quality. Considering the current challenges, a research trial was conducted to study the effect of Budmaker on berry quality at different developmental stages in Super Sonaka grapes grafted on Dogridge rootstock in Sangli, Maharashtra.

2. MATERIALS AND METHODS

2.1 Experimental Conditions

The experimental trial was carried out at farmer fields in Sangli during 2023-24. The grape variety Super Sonaka was selected for the study. The experiment was laid out in RBD design with four treatments and five replications, each replication comprised five vines. The vines were pruned twice in a year in both the locations. First pruning was done during mid-last week of April 2023 (foundation pruning) while the second pruning during mid-last week of October 2023 (forward pruning). The details of the treatments imposed during experiment are T1: control, T2: foliar application of Budmaker @400 ml/acre, T3: foliar application of Budmaker @500 ml/acre and T4:

foliar application of Budmaker @750 ml/acre. Budmaker was applied at three different stages i.e., at 1st leaf after sub-cane, at 3rd and 4th leaf after sub-cane and at 6th and 7th leaf after sub-cane. Budmaker was applied as foliar spray with water volume based on the canopy size (250 to 400 L/acre).

2.2 Growth Parameters

The length of the shoot was measured from 1st node during 90 days after foundation pruning and expressed in centimetre. Shoot diameter of the matured cane was measured between fifth and sixth node with Vernier calliper for five cane per vine at 90 days after pruning (foundation pruning) from five vines and their mean was expressed in mm. Leaf area was measured by linear method (LBK method) and expressed in cm² (Ghule et al., 2019). The mathematical relationship for calculation was given as follows: Leaf area (A) = L x B x K (0.810). Pruned biomass was collected from each vine immediately after pruning and weight of biomass was recorded using weighing balance and mean was calculated and expressed in kg/vine. The percentage of fruitful canes was computed from number of available canes and number of fruitful canes. Days taken for cane maturity was calculated from the date of foundation pruning to the cane maturity for individual vine and mean was calculated.

2.3 Bunch and Yield Parameters

The total number of bunches were counted from selected five vines after berry set in each treatment and mean number of bunches per vine was calculated (after fruit pruning). The total number of berries were counted from selected five bunches in each treatment and mean number of berries per bunch was calculated. The mean weight of the bunch was recorded by averaging the weight of 10 bunches from five vines selected randomly at harvest. This was expressed in grams. The berries from five vines were collected randomly during harvesting. The mean weight of the berry was derived by averaging the weight of 50 berries and expressed in grams. The grapes were harvested after attaining the maturity (TSS and acidity). The yield was recorded at the time of harvest and expressed in kg.

2.4 Berry Quality Parameters

Ten berries were randomly selected from each replication for the measurements of berry length

(mm) and berry diameter using Vernier Caliper. Randomly selected berries were taken for juice extraction and total soluble solids in the juice were determined using hand refractometer. The TSS was measured in degree brix (°Brix). Total titratable acidity was determined by titrating the berry juice with 0.1 N NaOH. The titratable acidity expressed in (%).

2.5 Biochemical Parameter

Chlorophyll content in leaves was estimated by using Dimethyl sulfoxide (DMSO) method. Phenol was estimated using method of Folin-Ciocalteu (Singleton and Rossi, 1965) and was expressed in mg/g. Fruit soluble protein content at harvest was estimated as per the method suggested by Lowry et al. (1951) and expressed as milligram per gram of fresh weight (mg/g). The percentage of reducing sugars in the grape berries was determined by Dinitro-Salicylic acid (DNSA) method as suggested by Miller (1972). A known volume of alcohol extract was taken and allowed to evaporate the alcohol completely. Clear solution was then taken for estimation of reducing sugar-using DNSA-reagent and results were expressed in percentage. The diacid extract was used for the calcium (ppm) determination. It was determined using neutral normal ammonium acetate method. The digest prepared with diacid mixture was used for the determination of phosphorous content (%) from petiole samples. The phosphorus was estimated by Vanadomolybdo phosphoric acid yellow color method with a Spectrophotometer as given by Jackson (1973). The intensity of the yellow color was measured on a Double Beam Spectrophotometer using wavelength 470 nm.

2.6 Physical Properties of Treated Grapes

The thickness of the pedicel was measured using vernier caliper and expressed in millimeter (mm). The skin of ten randomly selected grape berries peeled off by using razor blade. Skin thickness was then measured by mini portable digital caliper micrometer thickness gauge and was expressed in mm. To study the change in physical properties of treated grapes with advancement in storage time, physiological loss in weight (PLW) was studied as described by Sharma et al., (2023). Shelf-life in terms of physiological loss in weight (%) was calculated as the percentage of mass lost by the bunch from the beginning to the end of the shelf-life period. The mass of each treatment was taken on daily basis for 5 days. The PLW (%) at each interval 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 from field experiment was statistically analyzed by using Randomized Block Design (RBD) as described by Panse and Sukhatme (1985).

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

The data presented in Table 1. revealed significant variations for shoot length, shoot diameter, leaf area, pruning biomass, percent fruitful canes and days taken to cane maturity with different concentrations of Budmaker. The control treatment T1 recorded higher shoot length (88.0 cm) which was followed by T2 (86.10 cm) and T4 (83.50 cm) while minimum shoot length was recorded in T3 (79.80 cm). The treatment T1 exhibited higher shoot diameter (7.90 mm) which was followed by T2 (7.80 mm) while the lowest was shoot diameter was recorded in T3 (7.20 mm). The reduced growth and shoot diameter are good character for fruitfulness in grapes. The maximum leaf area was recorded in T3 (165.70 cm²) while it was minimum in T1 (158.40 cm²). During fruit pruning, the pruned biomass was higher in T1 control treatment (0.90 kg) as compared to the lowest in T4 (0.84 kg). The fruitful canes were higher in T3 (90.50%) followed by T4 (87.90% and T2 (86.50%) as compared to the lowest in T1 (84.30%). The canes of grapevines under treatment T3 matured early (87.60 days) followed by T4 (89.40 days) and T2 (90.20 days) as compared to T1 control (92.30 days).

The application of Budmaker had a significant impact on various growth parameters of Super Sonaka grape. While the control treatment (T1) exhibited the greatest shoot length and diameter, Budmaker treatments at different concentrations resulted in improved leaf area and a higher percentage of fruitful canes. Similar trends were noted in Thompson Seedless and Nanasahab Purple Seedless varieties, where Budmaker reduced shoot length but enhanced leaf area. This suggests that achieving balanced vegetative growth can positively affect grape fruitfulness (unpublished data). Increased fruitfulness in Super Sonaka could be attributed to the enhanced nutrient uptake promoted by Budmaker, which plays a critical role in

supporting reproductive growth. Vegetative parameters, such as shoot length and diameter, have an indirect influence on grape yield and quality. As shoot length increases, more photosynthetic products are allocated toward vegetative growth, reducing the resources available for cane development and sink growth (Somkuwar et al., 2024). Moreover, the increase in pruned biomass observed under Budmaker treatment compared to the control is likely due to the bio stimulant's ability to enhance nitrogen uptake by promoting carbon and nitrogen metabolism in plants (Yilmaz and Gazioglu, 2021). This balance between vegetative growth and reproductive development is essential for optimizing grape yield and fruit quality.

3.2 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/vine is presented in Table 2. The differences for number of bunches/vine and number of berries/bunch were non-significant. This was mainly due to the fact that considering the quality yield for export purpose, bunch thinning is also done after berry set. The treatment T3 significantly showed highest average bunch weight (550.40 g), 50 berry weight (195.18 g) and yield/vine (19.85 kg) followed by treatment T4 (530.60, 191.10 g and 19.66 kg respectively) over the control treatment T1 (490.00 g, 176.27 g, 16.20 kg respectively).

Budmaker treatments, especially T3 (500 ml/L), significantly increased average bunch weight, 50-berry weight, and overall yield per vine in Super Sonaka. This result aligns with findings from Thompson Seedless and Nanasahab Purple Seedless, where similar doses of Budmaker enhanced bunch weight and yield (unpublished data). The improvement in berry size and yield across these grape varieties could be attributed to the role of bio-stimulants in enhancing carbon assimilation and nitrogen metabolism, which supports berry growth and weight. The increase in yield was primarily attributed to the larger size and heavier weight of the bunches and berries, likely enhancing the efficiency of carbon assimilation through photosynthesis and protein synthesis due to the application of bio stimulants Deshmukh et al., (2023). The greatest increase in berry and bunch weight was also reported by Secco et al. (2016). Use of bio-stimulant significantly increasing yield over control in Thompson Seedless and Sharad Seedless also reported by Sharma et al., (2023); Deshmukh et

al. (2023) respectively. The increased in bunch and yield parameters under Budmaker applied treatments, it might be due to biostimulator able to modify some molecular processes that allow to improve water and nutrient use efficiency of crops, stimulate plant development and counteract abiotic stresses (van et al., 2017) by enhancing primary and secondary metabolism (Rao et al. 2016).

3.3 Berry Quality Parameters

The grape quality mainly consists of berry length, berry diameter, TSS and acidity. The data recorded on grape berry quality is presented in Table 3. The treatment T3 recorded highest berry length (29.60 mm) followed by T4 (28.40 mm) as compared to the lowest in T1 (27.10 mm). Berry diameter varied significantly among the different treatments with highest in T3 (15.80 mm) followed by T4 (15.60 mm) as compared to lowest in T1 (14.80 mm). With the application of Budmaker, there was no effect on TSS of grape berries. However, the TSS ranged from 17.50^oB in T3 to 18.50^oB in T1. The acidity ranged from 0.41 % in T2 to 0.52 % in T3. The acidity in grape berries was within the acceptable limit in all the treatments (Table 3). Budmaker also positively affected berry quality in Super Sonaka, particularly in terms of berry length and diameter. The maximum values were recorded in T3 and T4 treatments. Similarly, in Thompson Seedless and Nanasahab Purple Seedless, Budmaker increased berry size (unpublished data). This improvement can be linked to enhanced cell division and nutrient uptake, which biostimulants such as Budmaker promote, ultimately leading to better fruit quality. The increase in berry size could be attributed to the stimulation of cell

division and elongation, likely triggered by the application of bio stimulants (Warusavitharana et al., 2008; Deshmukh et al. 2023). Berry length and berry diameter together contribute for shape of berry. The results of the present study also confirm finding of Sharma et al. (2023) who reported bio stimulant contribute in increasing berry length and diameter significantly over control. At harvest no significant effect on total soluble solids were also reported by Frioni et al. 2019; Sharma et al.2023). Similar result also reported by Deshmukh et al., (2023) who reported non-significant effect of bio stimulant on TSS and significant in titratable acidity.

3.4 Chlorophyll Content in Leaf

The data recorded on chlorophyll content in leaf at 90 days after foundation pruning and fruit foundation and pruning of grapes is presented in Table 4. After 90 days from foundation pruning, higher chlorophyll a content in leaf was recorded in T3 (13.00 ug/ml) followed by T4 (12.40 ug/ml) and T2 (11.20 ug/ml) as compared to control T1 (10.30 ug/ml). However, chlorophyll b content in leaf was higher in T2 (3.90 ug/ml) followed by T4 (3.80 ug/ml) as compared to lowest in T1 (2.20 ug/ml). Higher total chlorophyll content was recorded in T4 (16.20 ug/ml) followed by T3 (15.70 ug/ml) as compared to the lowest in T1 (12.50 ug/ml). This clearly indicated the importance of Budmaker in storing the food material in grapevine as compared to the control.

After 90 days of fruit pruning, maximum total chlorophyll content was recorded in T2 (16.30 ug/ml) followed by T1 (16.10 ug/ml) while the lowest total chlorophyll content was recorded in T4 (15.80 ug/ml).

Table 1. Effect of budmaker on growth parameters of super sonaka grapes

Treatments	90 Days Foundation pruning			October pruning		
	Shoot length (cm)	Shoot diameter (mm)	Leaf area (cm ²)	Pruned biomass (kg/vine)	Fruitful canes (%)	Days taken to cane maturity
T ₁ - Control	88.00	7.90	158.40	0.90	84.30	92.30
T ₂ - Budmaker @ 400 L/acre	86.10	7.80	160.80	0.87	86.50	90.20
T ₃ - Budmaker @ 500 L/acre	79.80	7.20	165.70	0.85	90.50	87.60
T ₄ - Budmaker @ 750 L/acre	83.50	7.60	162.20	0.84	87.90	89.40
CD at 5%	2.00	0.16	3.80	0.02	2.06	2.14
Sig	**	**	**	**	**	**

Table 2. Effect of budmaker on bunch and yield parameters of supar 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	139.00	490.00	176.27	16.20
T ₂ - Budmaker @ 400 L/acre	33.00	146.00	520.20	178.23	17.20
T ₃ - Budmaker @ 500 L/acre	36.00	141.00	550.40	195.18	19.85
T ₄ - Budmaker @ 750 L/acre	37.00	139.00	530.60	191.10	19.66
CD at 5%	3.68	6.22	5.78	2.51	0.40
Sig	NS	NS	**	**	**

Table 3. Effect of budmaker on berry quality parameters of super sonaka grapes

Treatments	Berry length (mm)	Berry diameter (mm)	TSS (°Brix)	Acidity (%)
T ₁ - Control	27.10	14.80	18.50	0.44
T ₂ - Budmaker @ 400 L/acre	27.90	15.10	18.30	0.41
T ₃ - Budmaker @ 500 L/acre	29.60	15.80	17.50	0.52
T ₄ - Budmaker @ 750 L/acre	28.40	15.60	17.80	0.48
SEm±	0.21	0.12	0.99	0.004
CD at 5%	0.66	0.38	3.05	0.012
Sig	**	**	NS	**

Budmaker significantly increased chlorophyll content in Super Sonaka, especially in treatments T₃ and T₄, which recorded the highest levels of chlorophyll a and total chlorophyll. Similar trends were observed in Thompson Seedless and Nanasaheb Purple Seedless, where Budmaker treatments resulted in higher chlorophyll content, enhancing photosynthesis and nutrient absorption (unpublished data). The increase in chlorophyll content is crucial for maintaining plant vigor, which supports sustained fruit production. The increase in chlorophyll content in Budmaker treatments might be due to increase in photosynthesis, nutrient uptake, iron and magnesium which are essential elements for chlorophyll biosynthesis. The rise in chlorophyll content resulted from a decrease in its degradation and an enhancement in chloroplast biogenesis. One of the roles of bio stimulant treatment is an increase in chlorophyll content in the treated plant has been recorded by Battacharyya, et al. (2015) and Sharma et al. (2023).

3.5 Biochemical Parameters in Grape Berries

The data recorded on different biochemicals (phenol, protein, reducing sugar and calcium) is

presented in Table 5. Statistically significant variations were recorded for biochemical contents and phosphorous at full bloom and at veraison stage using different concentrations of Budmaker. Phenol was relatively higher in T₃ (0.55 mg/g) while it was lowest in T₁ (0.48 mg/g). The treatment T₃ recorded highest protein (15.60 mg/g) and reducing sugar (293.60 mg/g), whereas T₁ showed lowest protein (14.10 mg/g) while T₂ recorded lowest concentration of reducing sugar (272.20). The maximum calcium content in grape berries was recorded in T₃ (36.50 ppm) followed by T₄ (36.20 ppm), while minimum calcium content was recorded in T₁ (26.20 ppm). The maximum phosphorous content in leaf petiole at full bloom was recorded in T₃ (0.580 %) and T₄ (0.325 %) at veraison stage, whereas minimum phosphorous at full bloom and at veraison was found in T₁ (0.520 and 0.240 %). Phosphorus (%) content in leaf petiole was found positively correlated with fruitful canes percent (0.924) of grapevine.

The application of Budmaker enhanced various biochemical contents in Super Sonaka, with T₃ recording the highest levels of phenol, protein, and reducing sugar. This aligns with findings in Thompson Seedless and Nanasaheb Purple Seedless, where Budmaker treatments significantly improved biochemical parameters,

Table 4. Effect of budmaker on chlorophyll content in leaf of super sonaka grapes

Treatments	90 Days Foundation Pruning			90 Days 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	10.30	2.20	12.50	13.00	3.10	16.10
T ₂ - Budmaker @ 400 L/acre	11.20	3.90	15.10	13.80	2.50	16.30
T ₃ - Budmaker @ 500 L/acre	13.00	2.70	15.70	12.60	3.40	16.00
T ₄ - Budmaker @ 750 L/acre	12.40	3.80	16.20	12.90	2.90	15.80
SE _(m) ±	0.08	0.02	0.09	0.10	0.02	0.09
CD @ 5%	0.26	0.05	0.27	0.30	0.06	0.28
Sig	**	**	**	**	**	*

Table 5. Effect of budmaker 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	0.48	14.10	287.40	26.20	0.520	0.240
T ₂ - Budmaker @ 400 L/acre	0.52	15.00	272.20	34.40	0.550	0.280
T ₃ - Budmaker @ 500 L/acre	0.55	15.60	293.60	36.50	0.580	0.310
T ₄ - Budmaker @ 750 L/acre	0.50	14.80	289.30	36.20	0.540	0.325
SE _m ±	0.005	0.11	2.19	0.29	0.005	0.003
CD at 5%	0.014	0.35	6.73	0.89	0.015	0.009
Sig	**	**	**	**	**	**

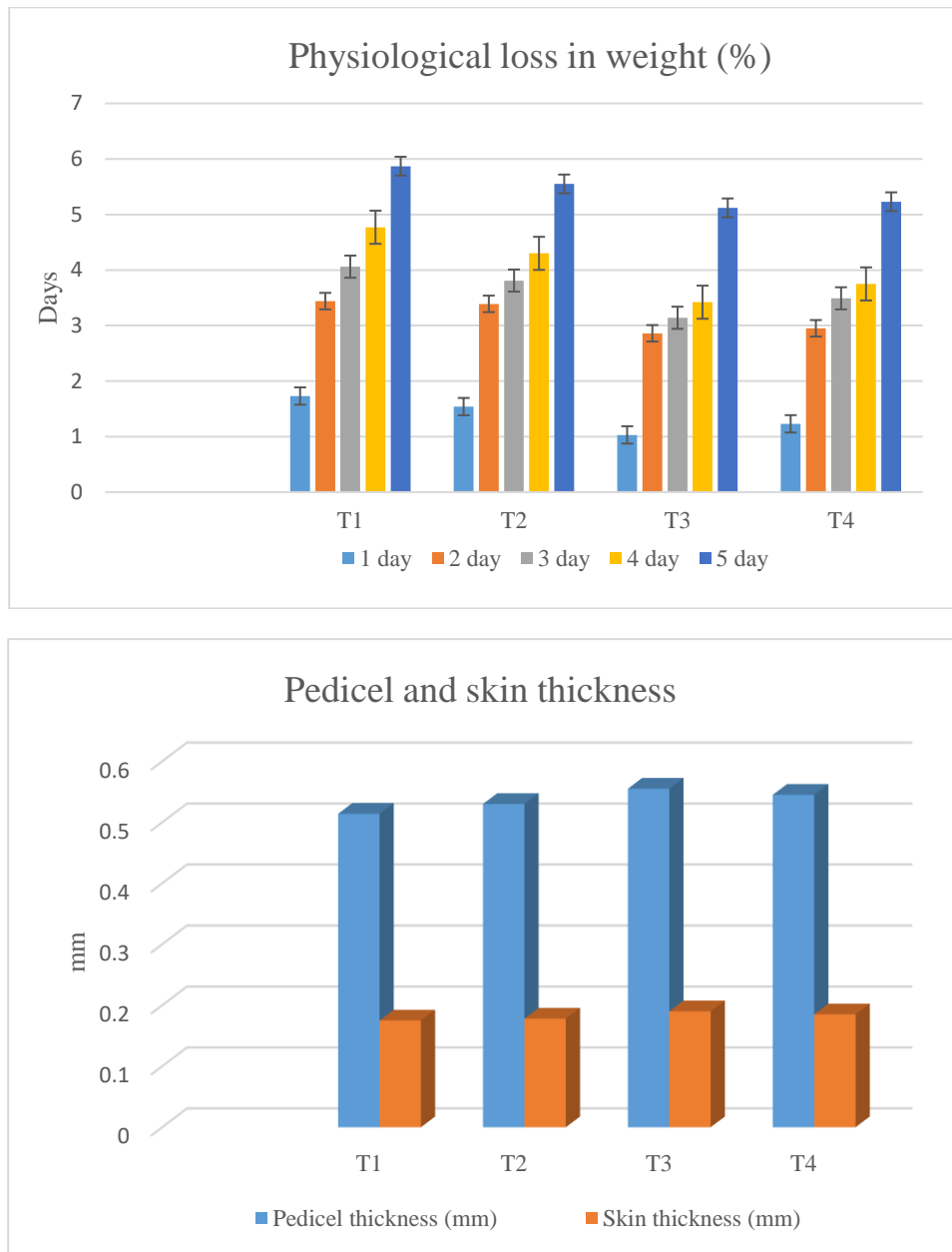


Fig. 1. Effect of Budmaker on pedicel thickness (mm) and skin thickness (mm) of Super Sonaka grapes

including phenolic compounds and protein content (unpublished data). These improvements are likely due to the enhanced nitrogen metabolism and increased photosynthetic activity stimulated by Budmaker, which boosts the synthesis of these critical compounds. Phenolic compounds constitute one of the most important groups of plant metabolites, as they participate in a multitude of physiological processes (Martínez-Lorente et al. 2024). The application of bio stimulant has been found to increase phenolic compounds in different plant parts such as fruits,

leaves and roots of multiple crops (Martínez-Lorente et al. 2024). The application of bio stimulants provides a balance during maturity, preserves the sugar content of fruits and increases the anthocyanin and polyphenol contents (Salvi et al., 2015). Phosphorus is essential for plant energy transfer through the formation of ATP and other nucleotide triphosphates. It supports the synthesis of key molecules like sucrose, phospholipids, cellulose, and nucleic acids (DNA and RNA), which are crucial for cell structure and function, including

protoplasm, the nucleus and cell walls. Its mobility within plants allows efficient translocation, ensuring it reaches all parts to sustain vital cellular processes (El-Boray et al. 2007). Nutrient absorption and assimilation from the soil are crucial for healthy plant growth, as they are required for the production of essential metabolites and enzymes, as well as serving as cofactors in various physiological processes. Many researchers reported that different bio stimulants can significantly improve the uptake of phosphorus (P) and calcium (Ca) in different fruit crops (Martínez-Lorente et al. 2024).

3.6 Shelf Life

The data on shelf-life of Super Sonaka grapes 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 physiological loss in weight (%) was recorded in treatment T3 from 1st day (1.03 %), 2nd day (2.86 %), 3rd day (3.14 %), 4th day (3.42 %) and 5th day (5.12 %). The physiological loss in weight (%) in berries of control treatment increased rapidly from 1st day (1.73 %), 2nd day (3.44 %), 3rd day (4.06 %), 4th day (4.77 %) and 5th day (5.87 %). The data recorded on pedicel thickness and skin thickness of fresh berries presented in Fig. 1. Pedicel thickness and skin thickness was relatively higher in T3 (0.555 and 0.190 mm respectively) while it was lowest in T1 (0.514 and 0.175 mm respectively).

Use of Budmaker reduced physiological loss in weight (PLW) during storage, with the lowest values recorded in T3. Similar results were observed in Thompson Seedless and Nanasahab Purple, where Budmaker helped preserve the quality of stored berries by minimizing weight loss and improving pedicel and skin thickness (unpublished data). These enhancements in storage life can be attributed to the role of bio stimulants in reinforcing berry firmness and preventing decay. Similarly, Deshmukh et al. (2023) also reported maximum skin thickness in bio stimulant treated vines lead to increase in storage life of grapes compared to untreated ones. The application of bio stimulants may activate various lipid peroxidation processes and defense-related enzymes, which contribute to preserving the firmness of grape berries. This also helps reduce fruit drop, minimize physiological weight loss, and prevent berry decay during storage (Liu et al., 2016; Zaharah

et al., 2012; Deshmukh et al., 2023; Sharma et al., 2023).

4. CONCLUSION

The result of the present study demonstrated the effectiveness of Budmaker in boosting the growth, yield and shelf life of Super Sonaka grape variety grown under tropical condition. Application of Budmaker @ 500 ml/acre after the emergence of the 1st, 3rd -4th, and 6th -7th leaves after sub cane key growth stages improved bud differentiation, cane maturity, berry size and overall yield. The findings confirm significantly enhanced fruitfulness, berry quality and yield to improve grapevine performance.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare 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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