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EFFECT OF FOLIAR APPLICATION OF DIFFERENT SOURCES OF POTASSIUM AND CALCIUM ON QUALITY OF GRAPE CV. THOMPSON SEEDLESS

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ABSTRACT

Grapes (*Vitis vinifera* L.) a member of the vitaceae family is a highly promising fruit crop grown extensively in tropical and subtropical regions worldwide. The quality of grapes is influenced by various factors such as soil, climate, variety, rootstock, irrigation, maintenance and pruning. Among these, effective nutrient management plays a crucial role in determining grape fruit quality and shelf life. The present study "Effect of foliar application of different sources of potassium and calcium on quality of grape cv. Thompson Seedless" was conducted during 2023-24 at Horticulture Research and Extension Centre (HREC), Vijayapura, Tidagundi. The experiment was designed using a randomized block design with 3 replications and 12 treatments. The results depicted the T_7 treatment (0.5 % K_2SO_4 and 1 % $CaCl_2$) recorded the highest TSS (21.80 ^{o}Brix), TSS to acid ratio (55.90), juice content (75.77 %) fruit firmness (4.92 N), ascorbic acid content (4.92 mg/100g). However, it also recorded lowest titratable acidity (0.39 %) and minimum percentage of physiological loss in weight (6.10, 11.30 and 16.20) at 2nd, 4th and 6th day after storage respectively.
Keywords**:** Grape, foliar application, potassium, calcium and quality.

Introduction

Grape (*Vitis vinifera* L.) a fruit crop of temperate regions, which is well-adapted to tropical and sub-tropical agro-climatic conditions. The genus Vitis is divided into two sub genera: Euvitis (38 chromosomes) and Muscadinia (40 chromosomes) with approximately 60 species. In India grapes are grown across 152,000 hectares, producing 3.21 million metric tons with an average yield of 21.13 tons per hectare (Anon., 2022). Maharashtra and Karnataka accounts for 94% of India's grape production with Nasik in Maharashtra and Vijayapura in Karnataka being the leading districts. In Karnataka other key grape-growing areas includes Belagavi, Bagalkot, Bengaluru, Kolar, Koppal and Gulbarga making it the second-largest grape producer in the country.

Grape quality is influenced by several factors including soil, climate, variety, nutrient management, irrigation and pruning. Of these, nutrient management plays a crucial role in production of quality fruits. Additionally, challenges such as berry cracking, shattering, uneven colour development and pest infestations can severely impact grape production and fruit quality (Swathi *et al.*, 2019).

Potassium is recognized as a vital nutrient in crop production playing a major role in enhancing various quality aspects of crops. It is regarded as one of the most important elements for plants because of its significant impact on the quality characteristics of fruits and vegetables (Usherwood, 1985). Potassium influences critical factors such as fruit size, appearance, colour, soluble solids, acidity, vitamin content, flavour and even shelf life. While potassium is not a part of the plant's structural or functional molecules, it is essential for many biochemical and physiological processes that support plant growth, yield and overall quality.

Calcium serves as a secondary messenger in numerous signalling pathways during abiotic and biotic stress conditions. It also regulates flesh firmness, ethylene production, fruit ripening and stimulates colour development in grapes. High calcium levels help delay grape senescence (Dodd *et al.,* 2010). This study investigates the effect of foliar applications of potassium and calcium on quality of Thompson Seedless grapes in Northern Karnataka.

Materials and Methods

The present study "Effect of foliar application of different sources of potassium and calcium quality of grape cv. Thompson Seedless" was conducted during 2023-2024 in the grape vineyard of Horticultural Research and Extension Centre, Tidagundi located in Vijayapur district. This research centre is situated in the Northern dry zone of Karnataka at a latitude of 16°49′ North and a longitude of 75°43′ East. The soil in this area is medium black in colour and shallow with a pH range of 7.5 to 8.5. The region experiences an average annual temperature of 26.5°C and receives an average rainfall of 590 mm.

No.oftreatments	:12
No. of replications	:3
No.ofvines/treatment	: 5
Spacing	:3.1 × 1.5 m
Design	: Randomized Block Design (RBD)

Treatment details

T_1: K_2SO_4 at 0.5 %
T_2: KNO_3 at 1 %
T_3: K_2SO_4. $2MgSO_4$ at 0.5 %
T_4: $Ca(NO_3)_2$ at 0.5 %
T_5: $CaCl_2$ at 1 %
T_6: K_2SO_4 at 0.5 % and $Ca(NO_3)_2$ at 0.5 %
T_7: K_2SO_4 at 0.5 % and $CaCl_2$ at 1 %
T_8: KNO_3 at 1 % and $Ca(NO_3)_2$ at 0.5 %
T_9: KNO_3 at 1 % and $CaCl_2$ at 1 %
T_{10}: K_2SO_4. $2MgSO_4$ at 0.5 % and $Ca(NO_3)_2$]at 0.5 %
T_{11}: K_2SO_4. $2MgSO_4$ at 0.5 % and $CaCl_2$ at 1 %
T_{12}: Control

TSS (^{0}Brix): Total soluble solid of grapes was measured by feeding the juice of randomly selected berries in each replication into digital refractometer (ERMA 0-32 %) and the average was worked out and expressed in °Brix.

Titratable acidity (%): The estimation of titratable acidity in fresh juice followed the procedure outlined by Ranganna (1979). Ten millilitres of fresh juice were taken and diluted to a volume of 100 ml with distilled water in a volumetric flask. From the resulting diluted juice, another 10 ml was transferred into a conical flask and two to three drops of phenolphthalein was added as an indicator. The solution was titrated with 0.1 N NaOH until a light pink colour change was observed as the endpoint. The titratable acidity was then expressed as a percentage.

$$\text{Acidity }\% = \frac{\text{Titrable value} \times \text{Normality of NaOH} \times \text{volume made up} \times \text{Equivalent weight of acid}}{\text{Volume of sample for estimation} \times \text{weight or volume of sample taken}}$$

Juice (%): The juice content was determined by weighing 100 berries and extracting their juice. This content was then calculated as the ratio of the juice volume to the weight of the berry pulp.

Berry firmness (N): Berry firmness was measured using a TAXT plus texture analyzer (Make: Stable Micro System, Model: Texture Export Version 1.22). The force required to cut through the sample was recorded and the peak force value from the graph was taken as the texture value, expressed in Newtons (N).

Type of probe used	:	Piercing probe
Test option used	:	Return to start
Test Speed	:	5.0 mm/s
Post-test speed	:	10.00 mm/s
Distance	:	10 mm
Load cell	:	5 kg

Ascorbic acid (mg/100g): The concentration of ascorbic acid or vitamin C in the grape was evaluated by analysing five fruits per replication in each treatment using the dye solution (dichlorophenolindophenol) binding technique. The results were quantified and expressed as milligrams per 100 grams of sample (mg/100g of sample) (Anon., 1980).

$$\text{Ascorbic acid} = \frac{0.5\,\text{mg} \times V_2 \times 100\,\text{m}}{1 \times 5\,\text{ml} \times \text{weight of sample}}$$

Physiological loss in weight (PLW) (%) : The bunches from each treatment were kept separately at room temperature and in cold storage conditions to calculate the PLW, which was subsequently taken in 2nd, 4thand 6th day interval. The PLW was computed using the following formula and expressed as a percentage.

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

Results and Discussion

The highest total soluble solids (TSS) content was recorded in the treatment T_7 (21.80 °Brix) which was followed by treatment T_6 (20.90 °Brix), the lowest acidity (0.39 %) was observed in T_7 treatment which was followed by treatment T_6 (0.40 %) and the highest TSS to acid ratio (55.90) was recorded in the treatment T_7 which was followed by the treatment T_6 (55.25). However, the control treatment (T_{12}) showed the lowest TSS to acid ratio (29.19) (Table 1). The rise in total soluble solids (TSS) in grapes can be attributed due to the beneficial influence of potassium sulphate on sugar accumulation also enhances the transport of sugars within the plant, improving water relations in the berries and promoting better sugar distribution (Nireshkumar *et al.* 2020). The decreased titratable acidity is mainly because potassium sulphate regulates the ionic balance in grape cells, affecting the synthesis and degradation of organic acids like malic and tartaric acids (Huang *et al.* 2018). Calcium chloride supports this by stabilizing cell membranes and cell walls which helps to manage metabolic processes related to acid breakdown. The rise in TSS to acid ratio is because TSS primarily consists of sugars which enhance sweetness while acidity is due to organic acids such as malic and tartaric acids. Potassium sulphate (K_2SO_4) boosts sugar accumulation and raising TSS, while calcium chloride ($CaCl_2$) stabilizes cell membranes and reduces acid synthesis leads to lowering acidity.Similar results have been reported by El-Baz et al. (2003) in Thompson Seedless, Sharma and Sindhu (2005) in grapes and Kumar *et al.* (2011) in banana.

Table 1: Total soluble solids, titratable acidity and TSS to acid ratio of grape cv. Thompson Seedless as influenced by foliar application of different sources of potassium and calcium

Treatment	Total soluble solids (°Brix)	Titratable acidity (%)	TSS to acid ratio
T_1	20.13	0.48	41.94
T_2	19.63	0.51	38.49
T_3	19.80	0.50	39.60
T_4	18.90	0.55	34.36
T_5	19.01	0.53	35.87
T_6	20.90	0.40	52.25
T_7	21.80	0.39	55.90
T_8	20.32	0.47	43.23
T_9	20.54	0.45	45.64
T_{10}	20.61	0.43	47.93
T_{11}	20.72	0.42	49.33
T_{12}	18.10	0.62	29.19
S.Em ±	**0.25**	**0.01**	**0.62**
CD at 5 %	**0.75**	**0.03**	**1.86**

The combined application of T_7treatment (0.5 % K_2SO_4 and 1% $CaCl_2$) led to the maximum juice content (75.77 %), berry firmness (4.92 N) and ascorbic acid content (4.92 mg/100g). Whereas, the lowest values were recorded in control treatment (Table 2). The increase in juice content was due to their impact on several physiological processes where potassium increases photosynthesis, leading to more carbohydrates and better nutrient transport to the fruit. While calcium strengthens cell walls, reducing breakdown and helping the fruit to retain more juice. Together, these nutrients optimize nutrient flow, water balance and cell wall integrity resulting in higher juice volume.These results were in accordance with Dutta (2011) in guava, Thirupathi and Ghosh (2015) in pomegranate, Karimi (2017) in Sultana grapes. The potassium boost plant metabolism and helps the plant to take up more calcium which directly improves firmness. Calcium especially from $CaCl_2$ strengthens cell walls by forming calcium pectates making the fruit more solid and less likely to break down. Our study aligns with Gill *et al.* (2012) in pear and Kumar *et al.* (2017) in Flame Seedless grapes. The increase in ascorbic acid is primarily due to potassium role in photosynthesis and carbohydrate metabolism which boosts its production. Sulphate helps by supporting enzyme function and amino acid production further promoting ascorbic acid synthesis and reducing oxidative stress. Calcium also contributes by strengthening cell walls, reducing oxidative damage and improving nutrient uptake, which enhances fruit quality. These findings are in consistent with previous research conducted by Prasad *et al.* (2015) in pomegranate and Kumar *et al.* (2017) in guava.

Table 2: Juice, berry firmness and ascorbic acid content in grape cv. Thompson Seedless as influenced by foliar application of different sources of potassium and calcium

Treatment	Juice (%)	Berry firmness (N)	Ascorbic acid (mg/100g fresh weight)
T_1	73.13	3.75	3.85
T_2	72.33	3.50	3.54
T_3	72.87	3.62	3.67
T_4	71.80	3.36	3.20
T_5	72.00	3.44	3.32
T_6	74.97	4.71	4.73
T_7	75.77	4.92	4.92
T_8	73.50	3.82	3.98
T_9	73.90	3.91	4.15
T_{10}	74.13	4.20	4.33
T_{11}	74.53	4.52	4.56
T_{12}	69.43	3.10	3.01
S.Em ±	**0.20**	**0.04**	**0.05**
CD at 5 %	**0.61**	**0.14**	**0.17**

The minimum PLW was observed in treatment T_7 (6.10 %, 11.30 % and 16.20 %) at 2nd, 4th and 6th days after storage respectively. While, control treatment (T_{12}) exhibited the highest PLW (Table 3). The application of 0.5 % potassium sulphate (K_2SO_4) and 1 % calcium chloride ($CaCl_2$) significantly decrease the physiological loss in weight (PLW) of grapes by improving several aspects of fruit preservation. Potassium helps in maintaining fruit firmness by supporting cell turgor and regulating water retention, which also contributes to a reduction in respiration rates and transpiration. This leads to lower water loss and a slowdown in the fruit's ripening process. Calcium strengthens cell wall which helps to prevent tissue disintegration and protein breakdown, thereby delaying senescence. As a result, these treatments effectively prolong the shelf life of grapes, preserving their firmness and quality for an extended period. Similar findings were also reported by Kumar and Kumar (2007) in banana, Kumar *et al.* (2011) in banana, Srivastava *et al.* (2013) and Thakur and Chawla (2019) in apple.

Table 3: Physiological loss in weight (PLW) of grapes cv. Thompson Seedless as influenced by foliar application of different sources of potassium and calcium

Treatment	Physiological loss in weight (PLW) (%)			
	2nd day	4th day	6th day	Mean
T_1	8.10	13.80	18.50	13.47
T_2	8.70	14.70	19.30	14.23
T_3	8.40	14.20	18.80	13.80
T_4	9.30	15.50	20.20	15.00
T_5	9.00	15.10	19.80	14.63
T_6	6.40	11.70	16.50	11.53
T_7	6.10	11.30	16.20	11.20
T_8	7.90	13.40	18.10	13.13
T_9	7.50	13.10	17.70	12.77
T_{10}	7.20	12.50	17.30	12.33
T_{11}	6.80	12.10	16.90	11.93
T_{12}	10.10	18.40	24.40	17.63
S.Em±	**0.10**	**0.15**	**0.28**	**--**
CD at5%	**0.30**	**0.45**	**0.84**	**--**

Conclusion

Based on the results of the study, it could be concluded that the foliar application of different combination of potassium and calcium showed a significant influence on quality of grape cv. Thompson Seedless. Moreover, the vines treated with 0.5 % K_2SO_4 and 1 % $CaCl_2$ showed significantly better-quality parameters of grape cv. Thompson Seedless.

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