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

Mahendra B. Hittalamani[1*], S. N. Patil[1], Sateesh Vasudev Pattepur[2], Bhuvaneshwari G.[3], Satyanarayana C.[4], Siddanna Thoke[5] and Basavaraj Padashetti[1]
[1]Department of Fruit Science, College of Horticulture, Bagalkot, Karnataka, India
[2]Department of Fruit Science, KRCCH Arabhavi, Karnataka, India.
[3]Department of Post-Harvest Technology, College of Horticulture, Bagalkot, Karnataka, India
[4]Department of Entomology, College of Horticulture, Bagalkot, Karnataka, India
[5]Department of Fruit Science, Horticulture Research and Extension Centre, Tidagundi (Vijayapura) - 586 119, Karnataka, India
*Corresponding author E-mail: mahendrabh14@gmail.com
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ABSTRACT

Grapes (*Vitis vinifera* L.), a highly promising fruit crop widely cultivated in tropical and subtropical region of the world. Among different management practices, nutrient management is a key determinant of grape yield, quality and shelf life. The present study "Effect of foliar application of different sources of potassium and calcium on growth and yield of grape cv. Thompson Seedless" was conducted during the year of 2023-24 at Horticulture Research and Extension Centre (HREC), Tidagundi (Vijayapura) under the University of Horticultural Sciences, Bagalkot. The experiment was laid out in randomized block design with 12 treatments and 3 replications. The results depicted the T_7 treatment (0.5 % K_2SO_4 and 1 % $CaCl_2$) recorded the highest internodal length (5.50 and 5.90 cm), internodal girth (6.92 and 7.33 mm), leaf area (90.10 and 138.50 cm^2) and chlorophyll content (32.10 and 36.57 SPAD values) at 45 and 90 DAFP respectively. As per the yield and yield attributing parameters are concerned, the T_7 treatment recorded minimum days require for panicle initiation (21.10), days to veraison (84.13) and days taken from pruning to harvest (123.10) and also recorded highest bunch length (23.20 cm), bunch width (9.70 cm), bunch weight (304.89 g), bunch volume (268.20 cm3), berry length (16.88 mm), berry diameter (15.28 mm), 100 berry weight (236.24 g), bunches per vine (58.75), yield (17.91 kg/vine and 38.51 t/ha) and highest benefit cost ratio (3.16:1).
***Keywords* :** Grape, potassium, calcium, growth and yield.

Introduction

Grapes (*Vitis vinifera* L.) from the Vitaceae family are widely cultivated in tropical and subtropical regions. The genus *Vitis* includes two subgenera: *Euvitis* (38 chromosomes) and *Muscadinia* (40 chromosomes), comprising around 60 species. In India grapes are grown on 152,000 hectares, yielding 3.21 million metric tons with an average productivity of 21.13 tons per hectare (Anon., 2022). Maharashtra and Karnataka dominate producing 94 % of the nation's grapes with Nasik district in Maharashtra and Vijayapura in Karnataka leading production (Anon., 2023). Key grape-growing districts in Karnataka include Vijayapura, Belagavi, Bagalkot, Bengaluru, Kolar, Koppal and Gulbarga making it the second-largest producer in India.

Factors influencing grape yield and quality include soil, climate, variety, nutrient management, irrigation and pruning. Among these, nutrient management is critical for growth and yield. Challenges like berry cracking, shattering, uneven colour and pest attacks significantly affect grape production (Swathi *et al.*, 2019).

Potassium plays a key role in plant growth, enhancing sugar accumulation, photosynthesis, enzyme activation and stress resistance. It also improves fruit size, colour, taste and shelf life (Usherwood, 1985). Calcium is vital for cell division, membrane integrity and fruit firmness, contributing to fruit quality and extending storage life. Calcium deficiency can lead to disorders due to its immobility in plants, making foliar applications crucial (White and Broadley, 2003). Calcium also promotes anthocyanin biosynthesis and delays senescence (Xu *et al*., 2014). Applying calcium during berry development enhances its effectiveness, improving fruit firmness and reducing respiration rates (El-Megeed *et al.,* 2007).

This study investigates the effect of foliar applications of potassium and calcium on the growth and yield of Thompson Seedless grapes in Northern Karnataka.

Materials and Methods

The present study on "Effect of foliar application of different sources of potassium and calcium on growth and yield of grape cv. Thompson Seedless" was conducted during the year 2023-2024 growing season at the grape vineyard of the Horticultural Research and Extension Centre, Tidagundi located in Vijayapur district. This research center 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. of treatments	:	12
No. of replications	:	3
No. of vines/ 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_2S0_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_2S0_4. $2MgSO_4$ at 0.5 % and Ca $(NO_3)_2$]at 0.5 %
T_{11}: K_2S0_4. $2MgSO_4$ at 0.5 % and $CaCl_2$ at 1 %
T_{12}: Control

Growth parameters

Internodal length of the fruiting shoots (cm)

The distance between the fourth and fifth nodes of the fruiting shoot was measured in centimetres using a 30 cm scale on five randomly selected shoots per vine at 45 and 90 days after forward pruning.

Internodal girth of the fruiting shoots (mm)

The internodal girth between the fourth and fifth nodes of the fruiting shoot was measured in millimetres using digital vernier callipers on five randomly selected shoots per vine at 45 and 90 days after forward pruning.

Leaf area (cm^2)

Leaf area was determined using the linear method, specifically the LBK method.

$$\text{Leaf area (LA)} = L \times B \times K\ (0.81)$$

Where

L = maximum length, B = maximum breadth and

K = Correction factor

Chlorophyll content (SPAD values)

Chlorophyll content of fully matured leaves opposite to the inflorescence was measured using a SPAD-502 meter (Konica-Minolta) at 45 and 90 days after forward pruning to assess chlorophyll levels.

Yield and yield attributing parameters

Bunch length (cm)

The bunch length was measured from the base to the tip and the average length of five bunches was calculated at harvest. The mean bunch length was expressed in centimetres (cm).

Bunch width (cm)

The bunch width was measured from the left to the right end, and the average width of five bunches at harvest was calculated. The mean bunch width was expressed in centimetres (cm).

Berry length (mm) Berry diameter (mm)

Using digital vernier callipers berry length and berry diameter was measured in millimetres (mm) on randomly selected berries from five bunches per replication in each treatment, and the average was calculated from these measurements.

Bunch weight (g)

The weight of five bunches was totaled at harvest to calculate the mean bunch weight, which was expressed in grams.

Bunch volume (cm^3)

The volume of bunches from each replication in each treatment was measured by immersing them in a volumetric beaker filled with water. The displaced water was measured using a graduated cylinder and the bunch volume was expressed in cubic centimetres (cm^3).

Yield (kg/vine)

The yield per vine was calculated by multiplying the mean bunch weight by the average number of bunches per vine and the result was expressed in kilograms (kg).

Yield (t/ha)

The estimated yield per hectare was calculated by multiplying the total number of vines per hectare by the yield per vine (kg/vine) with the result expressed in tonnes.

Results and Discussion

The highest internodal length (5.50 and 5.90 cm) of the fruiting shoot and internodal girth (6.92 and 7.33 mm) of the fruiting shoot and highest leaf area (90.10 and 138.50 cm^2) and leaf chlorophyll (32.10 and 36.57 SPAD values) at 45 and 90 days after forward pruning respectively was recorded in T_7 treatment, whereas the lowest values were recorded in T_{12} -control (Table 1). This variation may be due to the application of potassium sulphate which contains potassium (50 %) enhances internodal length and girth by promoting cell division and cell elongation. Additionally, higher calcium concentration in calcium chloride (36.1 %) improves cell wall stability and supports cell division contributing to these increases. Potassium also plays a crucial role in stomatal regulation and chlorophyll synthesis leading to larger and healthier leaves. Meanwhile, calcium strengthens cell walls and activates essential enzymes i.e., protochlorophyllide reductase and chlorophyll synthase leads to increased chlorophyll content. Similar findings were observed by Altindisli *et al.* (1999), Angadi and Vijayakumar (2000), Park *et al.* (2010), Fekry and Aboel (2020) and Mosa *et al.* (2015).

Table 1: Internodal length, girth of the fruiting shoot, leaf area and leaf chlorophyll content of grape cv. Thompson Seedless as influenced by foliar application of different sources of potassium and calcium

Treatment	Internodal length of fruiting shoot (cm)		Internodal girth of fruiting shoot (mm)		Leaf area (cm^2)		Leaf chlorophyll (SPAD values)	
	45 DAFP	90 DAFP	45 DAFP	90 DAFP	45 DAFP	90 DAFP	45 DAFP	90 DAFP
T_1	4.55	4.92	5.08	5.47	84.23	124.09	27.60	31.67
T_2	4.35	4.60	4.47	4.90	82.20	120.80	26.47	30.10
T_3	4.39	4.83	4.73	5.32	83.07	123.28	27.17	30.97
T_4	4.17	4.37	4.12	4.37	80.40	116.30	25.57	28.73
T_5	4.30	4.53	4.23	4.60	81.27	119.07	26.03	29.43
T_6	5.30	5.70	6.48	7.10	88.33	134.60	31.20	36.00
T_7	5.50	5.90	6.92	7.33	90.10	138.50	32.10	36.57
T_8	4.67	5.00	5.50	5.90	85.63	124.40	28.33	33.63
T_9	4.75	5.13	5.75	6.10	86.87	125.38	29.10	34.13
T_{10}	4.90	5.32	6.07	6.37	86.93	131.63	29.72	34.90
T_{11}	5.10	5.50	6.25	6.73	87.67	132.27	30.50	35.53
T_{12}	4.03	4.13	4.00	4.10	78.37	108.50	23.00	25.17
S.Em ±	0.05	0.06	0.06	0.08	0.51	0.93	0.09	0.08
CD at 5 %	0.15	0.18	0.18	0.24	1.53	2.79	0.27	0.24

DAFP: Days after forward pruning

The shortest time for panicle initiation, days to veraison and days taken from pruning to harvest (21.10, 84.13 and 123.10 respectively) was recorded in T_7 treatment. Whereas, the maximum days for panicle initiation, days to veraison and days taken from pruning to harvest (26.27, 89.97 and 133.80) was recorded in control (Table 2). It is mainly due to the foliar application of potassium sulphate (K_2SO_4) at 0.5 % and calcium chloride ($CaCl_2$) at 1 % can positively influence several growth stages in grapevines. Potassium plays a key role in panicle initiation by activating enzymes that convert carbohydrates and synthesize ribose sugars, enhancing carbohydrate accumulation and providing the energy required for fertile bud development and inflorescence formation. It also accelerates veraison by boosting energy production and nutrient translocation, speeding up the ripening process. Calcium, on the other hand improves cell wall stability, reduces stress and promotes uniform fruit development, supporting a more consistent growth cycle. Together, these nutrients enhance photosynthesis and carbohydrate metabolism, leading to faster fruit maturation and a quicker transition from pruning to harvest. Similar findings were reported by Manivel (1967), Srinivasan (1968), Srinivasan and Muthukrishnan (1970) and Gopalswamy (1969).

Table 2: Days taken for panicle initiation, days to veraison and days taken from pruning to harvest of grape cv. Thompson Seedless as influenced by foliar application of different sources of potassium and calcium

Treatment	Days taken for panicle initiation	Days to veraison	Days taken from pruning to harvest
T_1	23.60	86.92	130.20
T_2	24.13	87.63	132.60
T_3	23.90	87.20	131.50
T_4	25.13	88.08	133.00
T_5	24.47	88.23	132.90
T_6	21.63	84.70	125.80
T_7	21.10	84.13	123.10
T_8	23.10	86.50	129.60
T_9	22.73	86.03	128.75
T_{10}	22.30	85.30	127.62
T_{11}	21.90	85.07	126.70
T_{12}	26.27	89.97	133.80
S.Em ±	0.08	0.11	1.66
CD at 5 %	0.23	0.33	4.98

The highest bunch length (23.20 cm) and bunch width (9.70 cm) was observed in T_7 (K_2SO_4 at 0.5 % and $CaCl_2$ at 1 %) treatment and lowest bunch length (16.27 cm) and bunch width (7.61 cm) was recorded in control treatment (Table 3). Which is mainly due to the potassium enhances photosynthesis, carbohydrate translocation and sugar accumulation, while calcium improves cell wall structure and fruit development. Together they promote larger and more uniform bunches by supporting better nutrient uptake and reducing physiological disorders. In contrast, the control treatment lacks these benefits resulting in smaller bunch size. These results were in accordance with Huang *et al*. (2018) and Balaji *et al*. (2019).

The combined application of 0.5 % K_2SO_4 and 1 % $CaCl_2$ in treatment T_7 led to the maximum berry length (16.88 mm), berry diameter (15.28 mm) and 100 berry weight (236.24 g). Whereas, the lowest values were recorded in control (Table 3). This enhancement might be attributed due the combination of these nutrients ensures that the plant has a balanced supply of essential elements *i.e.,* 36.1 % Ca, 50 % K and 17 % S which promotes vigorous growth and the improved nutrient availability in petioles and berries likely leads to better retention of healthy leaves and more efficient assimilation of carbohydrates and other vital compounds. The retention of healthy leaves facilitated by this nutrient combination, ensures that the plant can continue to photosynthesize effectively throughout the growing season. These findings align with the earlier research conducted by Bonomelli and Ruiz (2010) and Yang *et al*. (2016).

Table 3: Bunch length, bunch width, berry length, berry diameter and 100 berry weight of grape cv. Thompson Seedless as influenced by foliar application of different sources of potassium and calcium

Treatment	Bunch length (cm)	Bunch width (cm)	Berry length (mm)	Berry diameter (mm)	100 berry weight (g)
T_1	18.40	8.47	14.87	11.65	214.08
T_2	18.03	8.17	14.41	10.88	206.06
T_3	18.23	8.30	14.74	11.35	209.94
T_4	17.63	8.00	14.24	10.35	196.47
T_5	17.97	8.13	14.40	10.63	200.18
T_6	22.06	9.33	16.31	15.12	231.47
T_7	23.20	9.70	16.88	15.28	236.24
T_8	20.47	8.53	15.31	13.45	221.91
T_9	20.63	8.70	15.47	13.81	224.95
T_{10}	21.03	8.80	15.77	14.33	227.67
T_{11}	21.47	8.93	15.91	14.81	229.00
T_{12}	16.27	7.61	13.17	10.11	183.09
S.Em ±	0.38	0.10	0.27	0.20	1.25
CD at 5 %	1.14	0.30	0.81	0.62	3.75

The highest bunch weight (304.89 g) and bunch volume (268.20 cm³) were observed in treatment T_7 (0.5 % K_2SO_4 and 1 % $CaCl_2$) and lowest bunch weight (236.24 g) and bunch volume (169.27 cm³) was recorded in control (Table 4). This might be due to the application of potassium enhances photosynthesis, carbohydrate translocation and sugar accumulation in the fruit. While calcium strengthens cell walls, improving fruit structure and size. This nutrient combination ensures better nutrient uptake, assimilation and sustained photosynthetic activity leading to larger and heavier bunches with improved volume and quality. These results were in consistent with those of the findings of Khayyat *et al.* (2012), Ciccarese *et al.* (2013), Arora *et al.* (2006) and Karimi (2017).

The maximum number of bunches per vine (58.75) was recorded in T_7 treatment (0.5 % K_2SO_4 and 1 % $CaCl_2$) and minimum bunches per vine (47.50) was recorded in control (Table 4). The higher bunches per vine is due to the role of potassium in enhancing bud differentiation and fruit set, while calcium improves overall plant health and flowering efficiency. This nutrient combination ensures better energy production and reproductive success leading to more fruitful buds and consequently a higher number of bunches which is also in accordance with Arora *et al.* (2006), Karimi (2017), Suresh and Rajkumar (2018).

Table 4: Bunch weight, bunch volume, number of bunches/vine and yield (kg/vine and t/ha) of grape cv. Thompson Seedless as influenced by foliar application of different sources of potassium and calcium

Treatment	Bunch weight (g)	Bunch volume (cm^3)	Number of bunches/vines	Yield (kg/vine)	Yield (t/ha)	B: C ratio
T_1	278.30	231.31	53.26	14.82	31.86	2.42:1
T_2	266.23	207.60	49.54	13.19	28.36	2.04:1
T_3	272.92	220.10	51.80	14.13	30.39	2.29:1
T_4	255.41	175.60	48.26	12.33	26.50	1.82:1
T_5	260.23	187.68	48.82	12.70	27.31	1.87:1
T_6	299.00	261.87	56.80	16.98	36.51	2.94:1
T_7	304.89	268.20	58.75	17.91	38.51	3.16:1
T_8	288.48	236.70	54.78	15.80	33.97	2.61:1
T_9	290.00	245.60	55.24	16.02	34.44	2.62:1
T_{10}	294.60	250.83	55.90	16.46	35.10	2.81:1
T_{11}	297.40	255.20	56.12	16.69	35.92	2.86:1
T_{12}	236.24	169.27	47.50	11.22	24.13	1.55:1
S.Em ±	1.38	1.28	0.76	0.21	0.44	-
CD at 5 %	4.16	3.84	2.28	0.62	1.33	-

The maximum yield (17.91 kg/vine and 38.51 t/ha) was obtained in the T_7 treatment where 0.5 % K_2SO_4 and 1 % $CaCl_2$ were applied and lowest yield (11.22 kg/vine and 24.13 t/ha) was recorded in control (Table 4). The increased grapevine yield with potassium sulphate application can be attributed due to its role in enhancing chlorophyll production, which is vital for efficient photosynthesis. By boosting chlorophyll levels potassium improves the plant's ability to capture and utilize light energy leading to increased production of carbohydrates and essential compounds for fruit development. Similarly, foliar application of calcium chloride ($CaCl_2$) contributes to higher grape yields by providing a readily available source of calcium which strengthens cell walls and improves fruit firmness, thus reducing issues like blossom end rot. Calcium also helps grapevines better withstand environmental stresses such as drought and disease and also supports various metabolic processes. Similar results were observed in studies by Prakash *et al*. (2014), Thirupathi and Ghosh (2015) and Balaji *et al*. (2019).

The consistent size, colour and boldness of the berries along with the appealing appearance of the grape bunches, enhances their market value. As a result, this achieves the highest benefit-cost ratio (Table 4) was recorded in T_7 treatment (3.16:1) followed by T_6 (2.94:1) and lowest benefit-cost ratio was recorded in control (1.55:1) which was due to the Similar results were noticed by Amarcholi *et al.* (2016), Shekhar (2019) and Chidananda (2020).

Conclusion

Based on the results of the study, it could be concluded that the different combination of foliar application of potassium and calcium showed a significant influence on plant growth and yield of the grape cv. Thompson Seedless. Moreover, the vines treated with 0.5 % K_2SO_4 and 1 % $CaCl_2$ showed significantly higher influence on growth and yield parameters also in terms of benefit: cost ratio of grape cv. Thompson Seedless.

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