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EFFECT OF PLANT DENSITY AND NPK DOSE ON YIELD ATTRIBUTES OF CAPE GOOSEBERRY (*PHYSALIS PERUVIANA* L.)

G. Bhrijavasi[1]*, P. Vinaya Kumar Reddy[2], M. Madhavi[3], S. Narasimha Rao[4] and D. Salomi Suneetha[5]

[1]Department of Fruit Science, College of Horticulture, Venkataramannagudem, Dr. Y.S.R. Horticultural University, Venkataramannagudem - 534 101, A.P., India.
[2]Department of Horticulture, College of Horticulture, Venkataramannagudem, Dr. Y.S.R. Horticultural University, Venkataramannagudem - 534 101, A.P., India
[3]Directorate of Research, College of Horticulture, Venkataramannagudem, Dr. Y.S.R. Horticultural University, Venkataramannagudem - 534 101, A.P., India
[4]Department of Plant Pathology, College of Horticulture, Venkataramannagudem, Dr. Y.S.R. Horticultural University, Venkataramannagudem - 534 101, A.P., India.
[5]Department of Bio Chemistry, College of Horticulture, Venkataramannagudem, Dr. Y.S.R. Horticultural University, Venkataramannagudem - 534 101, A.P., India
*Corresponding author E-mail : bhrijavasig@gmail.com

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ABSTRACT

A field experiment was conducted at the Fruit Research Farm, Dr. YSR Horticulture University, Andhra Pradesh, during 2022-23 and 2023-24 to evaluate the response of varying plant densities and NPK doses on the yield attributes of Cape gooseberry. The study followed a Factorial Randomized Block Design with twenty treatment combinations involving four plant densities (60 × 60 cm, 80 × 60 cm, 80 × 80 cm, and 100 × 80 cm) and five NPK levels (0, 100:40:40, 150:80:80, 200:120:120, and 250:160:160 kg/ha). The highest fruit weight (7.34 g), fruit volume (8.73 cm^3), number of fruits per plant (154.97) and yield per plant (1.14 kg) were recorded in 100 × 80 cm spacing with 200:120:120 NPK kg/ha. Wider plant spacing, combined with optimal NPK fertilization, contributed to increased resource availability, enhanced nutrient uptake, and improved fruit development. These results highlight the importance of optimizing plant density and fertilization strategies to maximize Cape gooseberry yield and quality.

Key words : Spacing, NPK, Cape gooseberry, Fruit weight, Volume, Number of fruits, Yield per plant.

Introduction

The cape goose berry (*Physali peruviana* L.) originates from the Andean highlands of South America. It belongs to the family Solanaceae. Legge (1974) reported that the genus physalis includes about 100 species, which form their fruits in an inflated calyx. In northern India, it is not cultivated above 1200 m, but in Southern India it thrives up to 1800 m above the mean sea level. This shrubby herb is a soft-wooded, somewhat vining plant, normally growing to a height of about 1.0 to 1.5 m, with sympodial branch ramification. The calyx (or husk), which is small at the beginning of fruit development, grows to a bladder like organ, which completely encloses the ripening fruit. Fruits measure 1.25 to 2.50 cm in diameter and weight about 4-10 g (Fischer, 1995). There is much interest in Cape gooseberry fruit consumption due to its nutritional values, especially in provitamin A, vitamin C and minerals such as phosphorous and iron, and fiber (Rehm and Espig, 1991) which take it ideal for diets. The high â-carotene content of the fruit has a potentially anticarcinogenic effect. Leaf extract of this species exhibited moderate in vitro anticancer (breast, renal, and melanoma) activity. Despite its high nutritional and economic value, limited research has been conducted on optimizing plant density and NPK fertilization for Cape gooseberry in Indian conditions. This study aims to bridge this gap by evaluating the effects of different plant spacing and fertilizer doses on fruit yield and quality parameters.

Materials and Methods

The present investigation entitled Study on response of varying plant densities and NPK dose on quality attributes of Cape gooseberry (*Physalis peruviana* L.) was conducted at Vegetable research farm, Dr. YSR Horticulture University, Venkataramannagudem (A.P) during the year 2022-23 and 2023-24 to study the response of varying plant densities and NPK dose on yield attributes of cape gooseberry. The treatment comprised with different plant densities *viz*., 60 × 60, 80 × 60, 80 × 80 and 100 × 80 cm spacing, NPK dose @ 0, 100:40:40, 150:80:80, 200:120:120 and 250:160:160 kg/ha. The experiment was laid out in Factorial randomized block design with twenty treatments and three replications. The plot size was 5 m × 2.2 m. Total number of treatment combinations are 20 consisting of 4 levels of spacing *viz.*, S1(60 × 60 cm), S2(80 × 60 cm), S3(80 × 80 cm) and S4(100 × 80 cm) and five levels of NPK *i.e.*, F0(0 kg/ ha), F1(100:40:40 kg/ha), F2(150:80:80 kg/ha), F3(200:120:120 kg/ha) and F4(250:160:160 kg/ha). The straight fertilizer viz., Urea, Single Super Phosphate and Murate of Potash were used as the source of N, P_2O_5 and K_2O, respectively. Half of the nitrogen and the full doses of phosphorus and potassium were applied as a basal dose before transplanting, while the remaining nitrogen was split and applied at 40 and 75 days after transplanting.

After collecting ten mature fruits from each experimental Cape gooseberry plant, they were weighed individually on a digital weighing balance and the average fruit weight was calculated. Fruit volume was measured using the water displacement method with a measuring cylinder and expressed in cubic centimeters (cc). The total number of fruits from five tagged plants per plot in each treatment was counted at each picking, summed, and recorded as the number of fruits per plant. Yield from the total fruits harvested at different intervals from the sampled plants in each treatment was recorded and expressed in kilograms per plant. Statistical analysis was performed following the method given by Panse and Sukhatme (1985) and treatment means were compared using the least significant difference (LSD) values at a 5% level of significance.

Results and Discussion

The effects of different planting densities and NPK doses on yield attributes were observed in Cape gooseberry plants during the trial. Experimental plants responded positively to decreasing plant density and increasing levels of NPK, as shown in Tables 1 to 3. Key yield attributes such as fruit weight (g), fruit volume (cm^2), number of fruits per plant, and fruit yield per plant (kg) were significantly influenced by these factors. One of the major challenges in agriculture today is optimizing planting density and nutrient management to maximize production and improve product quality while minimizing environmental impact. Plant spacing plays a decisive role in ensuring optimal plant growth and high yield. While closely spaced plants may suffer from overcrowding and reduced reproductive growth due to competition for resources, wider spacing can lead to underutilization of solar energy, nutrients and other resources. Crop growth and yield are influenced by various factors, including climate, soil fertility and growing methods. Fertilizer application is crucial for soil fertility management and plays a significant role in achieving higher yields. In the present study, Cape gooseberry plants responded positively to increasing plant spacing and NPK dose, as illustrated in Tables 1 to 3. The planting density of 100 × 80 cm with NPK 200:120:120 kg/ha resulted in the highest fruit productivity. Moreover, significant differences were observed among treatments in fruit weight, fruit volume, number of fruits per plant and fruit yield per plant, indicating that increasing plant spacing along with an appropriate NPK dose is essential for maximizing Cape gooseberry growth and yield. The highest fruit yield was obtained with 100 × 80 cm spacing and NPK 250:160:160 kg/ha.

Yield attributes

Wider spacing significantly influenced fruit weight, along with fruit volume, number of fruits per plant, and overall yield per hectare. The highest fruit weight (6.92 g) was recorded at the widest spacing (100 × 80 cm), followed by 5.94 g at 80 × 80 cm. The lowest fruit weight (3.01 g) was observed at the closest spacing (60 × 60 cm). This reduction in fruit size under dense planting conditions can be attributed to increased competition for light, nutrients, and water, which limits the plant's ability to carry out photosynthesis efficiently. As a result, carbohydrate production and translocation are restricted, leading to the development of smaller and lighter fruits. These findings align with the research of Dimri and Lal (1988) on tomato and Singh *et al*. (2002) on brinjal, who reported that reduced plant spacing negatively impacts fruit size due to resource competition. Similarly, NPK fertilization significantly influenced fruit weight. The highest average fruit weight (5.57 g) was recorded at 200:120:120 kg NPK/ha, which was statistically on par with 5.28 g at 250:160:160 kg NPK/ha. The probable reason for this increase in fruit weight is that higher NPK levels promoted better vegetative growth, increased leaf production and enhanced photosynthetic activity, leading

Table 1 : Effect of Plant Density and NPK Dose on berry weight and volume of Cape gooseberry.

Plant density	Berry weight (g)						Berry volume (cm^3)					
	NPK dose						NPK dose					
	F_0	F_1	F_2	F_3	F_4	Mean	F_0	F_1	F_2	F_3	F_4	Mean
S_1	2.63	2.84	2.95	3.50	3.14	**3.01**	1.82	2.19	2.48	2.93	3.52	**2.59**
S_2	3.61	4.19	4.60	5.13	4.86	**4.48**	3.21	4.06	4.55	5.15	4.40	**4.27**
S_3	5.41	5.80	5.99	6.32	6.18	**5.94**	5.05	5.63	6.18	7.13	6.25	**6.05**
S_4	6.53	6.81	6.99	7.34	6.94	**6.92**	6.06	6.56	7.55	8.73	8.28	**7.43**
Mean	**4.54**	**4.91**	**5.13**	**5.57**	**5.28**	**5.09**	**4.04**	**4.61**	**5.19**	**5.98**	**5.61**	**5.09**
	S.Em±			C.D at 5%			S.Em±			C.D at 5%		
S	0.088			0.259			0.068			0.200		
F	0.098			0.290			0.076			0.224		
S × F	0.196			0.579			0.151			0.448		

Table 2 : Effect of Plant Density and NPK Dose on number of fruits per plant of Cape gooseberry.

Plant density	NPK dose					
	F_0	F_1	F_2	F_3	F_4	Mean
S_1	83.84	85.44	88.10	89.16	93.40	**87.99**
S_2	90.09	97.24	109.56	109.62	100.74	**101.45**
S_3	102.92	110.73	130.10	145.65	131.81	**124.24**
S_4	129.55	138.28	147.52	154.97	151.01	**144.26**
Mean	**101.60**	**107.92**	**118.82**	**124.85**	**119.24**	**114.49**
	S.Em ±			C.D at 5%		
S	0.237			0.700		
F	0.264			0.783		
S × F	0.529			1.565		

to improved carbohydrate accumulation in the economic part of the plant. These findings are consistent with previous studies in tomato (Singh *et al.*, 2002), where an optimal NPK dosage was found to enhance fruit development by improving nutrient assimilation and photosynthesis.

Fruit volume was significantly influenced by plant spacing, with wider spacing resulting in larger fruit size. The highest fruit volume (7.43 cm³) was recorded at 100 × 80 cm, followed by 6.05 cm³ at 80 × 80 cm, while the lowest volume (2.59 cm³) was observed at the closest spacing (60 × 60 cm). The reduction in fruit volume under closer spacing can be attributed to increased competition for nutrients and reduced light penetration, which limits the plant's ability to conduct photosynthesis effectively. Consequently, lower carbohydrate synthesis and restricted assimilate translocation led to smaller fruit size. These findings are in accordance with the research of Dimri and Lal (1988) and Singh *et al*. (2002) on tomato, which demonstrated that reduced plant spacing negatively affects fruit development due to resource competition.

Similarly, NPK fertilization had a significant effect on fruit volume. The highest fruit volume (5.98 cm³) was recorded at 200:120:120 kg NPK/ha, which was statistically on par with 5.61 cm³ at 250:160:160 kg NPK/ha. The lowest fruit volume (4.04 cm³) was observed in the control treatment (0:0:0 kg NPK/ha). The observed increase in fruit volume with higher NPK doses can be attributed to improved vegetative growth and increased leaf area, which enhances photosynthetic activity and nutrient translocation. A greater leaf surface allows for better light interception, leading to higher carbohydrate synthesis and increased fruit size. These findings align with the studies of Singh *et al*. (2002) on tomato, where higher NPK levels were associated with improved fruit development due to enhanced nutrient assimilation and carbohydrate translocation.

The number of fruits per plant was significantly influenced by plant spacing and NPK fertilization. The highest fruit count (144.26 fruits per plant) was recorded at 100 × 80 cm, followed by 124.24 fruits per plant at 80 × 80 cm, while the lowest fruit count (87.99 fruits per plant) was observed at the closest spacing (60 × 60 cm). The increase in fruit number under wider spacing can be attributed to reduced competition for light, nutrients, and space, which enhanced flowering and fruit set. Conversely, closely spaced plants experienced higher competition, leading to fewer flowers and lower fruit set. A similar trend was observed in tomato (Dimri and Lal, 1988), where closer spacing reduced fruit yield per plant due to resource limitations. The highest number of fruits per plant (124.85) was recorded with 200:120:120 kg NPK/ha, which was statistically on par with 119.24 fruits

Table 3 : Effect of Plant Density and NPK Dose on fruit yield per plant of Cape gooseberry.

Plant density	NPK dose					
	F_0	F_1	F_2	F_3	F_4	Mean
S_1	0.22	0.24	0.26	0.31	0.29	**0.26**
S_2	0.32	0.41	0.50	0.56	0.49	**0.45**
S_3	0.56	0.64	0.78	0.92	0.81	**0.74**
S_4	0.85	0.94	1.03	1.14	1.05	**1.00**
Mean	**0.46**	**0.53**	**0.61**	**0.70**	**0.63**	**0.61**
	S.Em±			C.D at 5%		
S	0.010			0.030		
F	0.011			0.034		
S × F	0.023			0.068		

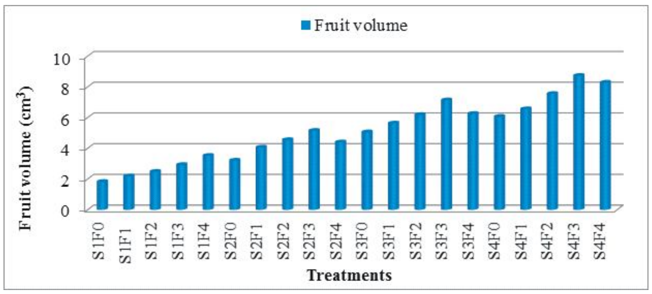

Fig. 1 : Effect of spacing and fertilizer dose on fruit volume (cm^3) in Cape gooseberry (*Physalis peruviana* L.). Spacing (S) - S_1: 60 × 60 cm, S_2: 80 × 60 cm, S_3: 80 × 80 cm, S_4: 100 × 80 cm; Fertilizer (F) -F_0: Control, F_1: 100:40:40 kg ha^{-1}, F_2: 150:80:80 kg ha^{-1}, F_3: 200:120:120 kg ha^{-1}, F_4: 250:160:160 kg ha^{-1}.

per plant at 250:160:160 kg NPK/ha, followed by 101.60 fruits per plant at 150:80:80 kg NPK/ha. The lowest fruit count was recorded in the control treatment (0:0:0 kg NPK/ha). The increase in fruit number with higher NPK levels can be attributed to enhanced nutrient availability, which promoted better vegetative growth, increased flower formation, and improved fruit set. These findings are consistent with the research of Ignatov (1974) on tomato, which demonstrated that higher nutrient application significantly improves reproductive growth and fruit development.

Fruit yield per plant was significantly influenced by plant spacing and NPK fertilization. The highest yield (1.00 kg per plant) was recorded at 100 × 80 cm spacing, followed by 0.74 kg per plant at 80 × 80 cm spacing. The increased yield in wider spacing can be attributed to a combination of factors, including reduced competition for light, water and nutrients, which allowed for a greater number of fruits per plant and enhanced their average weight. These factors are critical for maximizing overall yield. Similar findings have been reported in previous research by Kori (2004) and Sonavane *et al*. (2012), which highlighted the positive effect of wider spacing on fruit development and productivity. NPK fertilization also played a crucial role in enhancing fruit yield per plant. The highest fruit yield (0.70 kg per plant) was recorded with 200:120:120 kg NPK/ha, which was statistically on par with 0.63 kg per plant at 250:160:160 kg NPK/ha. The lowest fruit yield (0.46 kg per plant) was recorded in the control treatment (0:0:0 kg NPK/ha). The increase in fruit yield with higher NPK levels can be attributed to improved nutrient availability, leading to enhanced vegetative growth, better flower formation, and increased fruit set. This positive relationship between NPK fertilization and fruit yield was also reported in tomato (Singh *et al*., 1977), where optimal nutrient application significantly enhanced yield attributes.

Conclusion

The findings of this study demonstrate that, under the agro-climatic conditions of Venkataramannagudem, the combination of wider spacing (100 × 80 cm) and the optimum NPK level (200:120:120 kg/ha) resulted in significant improvements in key yield attributes, including fruit weight, fruit volume, number of fruits per plant, and overall fruit yield per plant. These results highlight the importance of optimizing plant spacing and nutrient management to enhance the productivity and quality of Cape gooseberry. Further studies are needed to evaluate long-term soil health effects and post-harvest fruit quality under varying plant densities and NPK doses.

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