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Effects of Varying Doses of Nitrogen and Phosphorus on Vegetative Growth, Flowering and Fruit Quality of Cape Gooseberry (*Physalis peruviana* Linn)

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ABSTRACT

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The experiment was carried out at Main Experiment Station of Horticulture department, Narendra Deva University of Agriculture and Technology, Faizabad (U.P.) during the year 2015-16 to evaluate the effect of varying doses of nitrogen and phosphorus on vegetative growth, flowering and fruit quality of cape gooseberry. The experiment was conducted in Factorial Randomized Block Design with twelve treatments comprising of 4 levels of Nitrogen, i.e., (75, 100, 125, 150 kg/ha), and 3 levels of Phosphorus (60, 80, 100 kg/ha) the doses of Nitrogen and Phosphorus were applied in two splits. The results were recorded on the characters viz., plant height (cm), number of primary and secondary branches / plant, days taken to first flowering, days taken to 50% flowering and quality attributes viz. TSS, Ascorbic acid and acidity. On the basis of experimental finding it is concluded that the application of (N150:P100) kg/ha was suitable doses for better plant vegetative growth and fruit quality of Cape gooseberry.

Introduction

The cape gooseberry (*Physalis peruviana* Linn) is annual minor fruit crop belongs to family Solanaceae. Plant is annual and perennial herb bearing globular fruit, each include in inflated calyx, which become papery on maturity and look like Chinese lantern. It is also commonly called as poha berry in Hawaii, Golden berry in South Africa and Rashbhari, Makoi or Tepari in India (Gupta and Roy, 1980). The name of cape

gooseberry is most probably derived from the name of “Cape of Good Hope” of South Africa, where it was commercially grown (Chattopadhyay, 1996).

The fruit is a smooth berry, resembling a miniature, spherical, looks like yellow tomato. Removed from its bladder like calyx, it is about the size of a marble, about 1-2cm in diameter in size. Like a tomato it contains numerous seeds. It is bright yellow to orange in colour, and it is sweet when ripe, with a

characteristic mildly tart flavour, making it ideal for snacks, pies or jams.

The fruits of the plant that is commercialized are characterized for their nutritional value. They are an excellent source of vitamin A, vitamin C, iron, and some of the vitamin B-complex. The protein and phosphorus levels in the fruits are exceptional high as well as pectin that used in jam production (Fischer, 1995). The name of cape gooseberry in most view, its importance is not less than any other fruit crops.

The edible portion of berry contains 11.5% carbohydrates, 1.8% protein, 0.2% fat, 3.2% fibre, 0.6% mineral matter and 43-49mg ascorbic acid per 100g edible portion of fruit (Khan and Gowder, 1955) The fruit also contains carotene as vitamin A 2380 IU (Anonymous, 1969), pectin 0.9% (Majumder and Bose, 1979) and bioflavonoides (Hayes, 1966). The ripe fruit are eaten as such and use in making excellent quality of jelly, sauces and particularly jam for which it is called as the "Jam fruit of India" (Majumder, 1979). The fruits are also attractive sweet when dipped in chocolate or other glazes or pricked and rolled in sugar.

Based on the available literature, it is evident that very little research work has been carried out so far on the vegetative and floral responses, quality attributes of Cape gooseberry to nitrogen, phosphorus application in many parts of the country especially in the northern regions.

Keeping all these things in view, the present investigation was planned to study the influence of graded levels of Nitrogen and Phosphorus combinations on the vegetative growth and fruit yield of Cape gooseberry and elucidation of partitioning of these nutrients to different parts of the plant in enhancing the fruit quality.

Materials and Methods

The experiment was conducted at Main Experiment Station, Department of Horticulture, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj). Faizabad (U.P) during the period of 2015-2016. The experimental site falls under sub-tropical climatic zone of eastern parts of India, which is situated under Indo-gangetic plains. Faizabaad district comes under eastern region of Uttar Pradesh, The experimental area had a soil sandy loam in texture with good fertility. The experimental was laid out in a factorial randomized block design with three replications. The plot size was 3.6 m × 3.0 m and Spacing 60cm × 60cm. and total number of treatment combination are 12 consisting of 4 levels of nitrogen viz., N₁ (75 kg N/ha), N₂ (100 kg N/ha) N₃ (125 kg N/ha), N₄(150 kg N/ha) and 3 levels of phosphorus P₁ (60 kg/ha), P₂ (80 kg/ha), P₃ (100 kg /ha) with a recommended uniform dose of potassium (60 kg/ha) application to all treatments. A recommended doses of FYM was also applied to all treatments uniformly. The straight fertilizer viz., Urea, Single Super Phosphate and Murate of Potash were used as the source of N, P₂O₅ and K₂O respectively. Half dose of nitrogen and full dose of phosphorous and constant dose of potassium as per requirement of respective treatments were applied before transplanting as basal application while, remaining half doses of nitrogen was top dressed after 30 days of transplanting of the seedlings. Estimation of nutrient status in the soil and plant samples was done in the laboratory by adopting the standard procedures established by several research workers. Available organic carbon in the soil (Walkley and Black, 1947), nitrogen content in the soil and plant samples was estimated by Microkjeldahl's method described by Tandon (1993), phosphorous content in the soil and plant samples was estimated by vando molbdo phosphoric acid

yellow colour method described by Tandon (1993), potassium content in the soil and plant samples was estimated by flame photometric method described by Jackson (1973). The data collected on each character was subjected to statistical analysis by ANOVA technique as described by Panse and Sukhatme (1967). The treatment means were compared by using the least significant difference values calculated at 5% level of significance.

Results and Discussion

Among different essential plant nutrients nitrogen and phosphorus are supposed to be more important with respect to vegetative growth and quality of plant, because these nutrients required in larger quantities for growth and fruit development. Nitrogen is an integral constituent of protein, amino acid, chlorophyll, alkaloids and other biochemical compound in plant. Phosphorus is consider essential constituent of nucleic acid, phospholipids, the co-enzyme, NAD and NADP, ATP and other high energy compound it helps in rapid root development, facilitating carbohydrate translocation and metabolic process in plant. The deficiency of nitrogen and phosphorus affect the vegetative growth, flowering and economic yield of the cape gooseberry (Garg and Singh, 1975). Therefore an adequate supply of nitrogen and phosphorus is necessary for higher yield and quality of fruit. During the course of investigation results obtained on various parameters due to Nitrogen and phosphorus application are described here.

Vegetative growth characters

The height of plant was influence significantly due to application of Nitrogen and phosphorus. The taller plant were observed with application of (N150:P100) kg /ha and the shortest plant were measured in (N75:P60) kg/ha where less nitrogen and phosphorus

fertilizer applied, the probable reason for increased plant height with highest levels of nitrogen and phosphorus application is obvious as more uptake of these nutrient during plant growth and is needed for more protein and protoplasm synthesis for higher rate of meiosis, results in better photosynthesis and plant growth and ultimately increased the plant height. These results are enclosed conformity to the finding of Sharma and Mann (1971) in tomato and Singh *et al.*, (1977) in tomato.

Number of branches per plant was also significantly increased due to nitrogen and phosphorus application. The higher number of branches was recorded with the application of (N150:P100) kg/ha followed by (N150:P80) kg NPK/ha and it was minimum in (N75:P60) kg /ha increased in number of branches per plant due to application attributed to more availability of applied nutrient specially nitrogen, which tends to vigorous growth of plants remitting profused branching Sharma and Mann (1972) also recorded maximum number of branches with application of 150 kg nitrogen/ha in tomato.

The data pertaining to Table 1 showed that the plant height was significantly influenced by different levels of nitrogen and phosphorus. The interaction between nitrogen and phosphorus were also found significant. Plant height varies significantly with the increasing level of nitrogen ranges from 77.80 cm to 110.16. The maximum plant height 110.16 cm in cape gooseberry was recorded under nitrogen N₄ (150 kg/ha) which was found significantly superior over rest of the treatments followed by N₃ (125 kg/ha) with 99.57 cm height while minimum plant height *i.e.* (77.80 cm) was recorded in N₁.The plant height was significantly increased with the various dose of phosphorus. The maximum plant height 97.18 cm in was recorded under P₃ (100 kg/ha) which was found significantly

superior over rest of the treatments and followed by P₂ (80 kg/ha) with 94.98 cm while minimum plant height *i.e.* 91.08 cm was recorded. The interaction between nitrogen and phosphorus treatments for Plant height was also found significant in cape gooseberry. The tallest plant (112.41 cm) was measured in N₄P₃ (N125:P100) which was found significantly at par with N₄P₂ (N150:P80) and N₄P₁ (N150:P60) with (110.73 cm) and 107.73 cm respectively. The minimum height 74.05 cm was measured in N₁P₁ (N75:P60)

The data pertaining to Table 2 indicated that the number of primary branches per plant was significantly influenced by different levels of nitrogen and phosphorus.

In case of nitrogen, the maximum number of primary branches per plant (13.31) was recorded with application of N₄ (150 kg/ha) followed by N₃ (125 kg/ha) with 9.64 branches. While, the minimum number of branches per plant (4.44) were recorded in N₁.

The number of primary branches was significantly increased with the various dose of phosphorus. The maximum number of primary branches (9.51) was recorded under P₃ (100 kg/ha) which was found significantly at par with P₂ (80 kg/ha) 8.46 branches while minimum number of primary branches *i.e.* 7.48 was recorded in P₁.

The interaction effect of nitrogen and phosphorus were also found significant. The maximum number of branches was recorded in N₄P₃ (N125:P100) (14.27) which was found at par with N₄P₂ (N150:P80) (13.13) and N₄P₁ (N150:P60) (12.54) however minimum number of branches were counted in N₁P₁ (N75:P60) treatment (4.27).

The data pertaining to Table 3 clearly showed that the number of secondary branches per plant was significantly affected by different

level of nitrogen and phosphorus. In case of nitrogen, the maximum number of secondary branches per plant (12.22) was recorded with application of N₄ (150 kg/ha) followed by N₃ (125 kg/ha) with 9.54 branches While, the minimum number of branches per plant (6.47) were recorded in N₁.

The number of secondary branches was significantly increased with the various dose of phosphorus. The maximum number of secondary branches (10.18) was recorded under P₃ (100 kg/ha) which was found significantly superior over rest of the treatments and followed by P₂ (80 kg/ha) with 8.83 branches while minimum number of primary branches *i.e.* 8.35 was recorded in P₁.

The interaction effect of nitrogen and phosphorus were also found significant. The maximum number of branches was recorded in N₄P₃ (N125:P100) with 12.22 branches followed by N₄P₂ (N150:P80) with (11.12) branches, however minimum number of branches were counted in N₁P₁ (N75:P60).

Flowering attributes

The NPK application proved effective to increase number of flowers per plant. Maximum number of flowers per plant was recorded with application of highest dose of (N150:P100) kg/ha followed by (N150:P80) kg NPK/ha and it was minimum in (N75:P60) kg /ha. This might be due to increased photosynthetic efficiency and rate of assimilation due to nitrogen and phosphorus application, which reflects on vigorous growth of plant and ultimately remitting profuse flowering. Prasad *et al.*, (1985) also found similar results in cape gooseberry due to application while phosphorus and potassium non-significant influence. The beneficial effect of phosphorus and fertilizer on flowering in tomato was also reported by Mehla *et al.*, (2000) and Sahoo *et al.*, (2002).

Observations recorded and days taken to flowering after transplanting shown delayed flowering due to nitrogen and phosphorus fertilizer. The earliest flowering was noticed without nitrogen and phosphorus application and it was gradually delayed with increased the nitrogen and phosphorus levels and observed maximum with (N150:P100) kg/ha followed by (N150:P80) kg NPK/ha and it was minimum in (N75:P60) kg /ha. The delayed flowering under higher levels of nitrogen and phosphorus fertilizer might be attributed to the pronounced effect of nitrogen, which is more responsible for plant growth by enhancing its vegetative phase. Delayed flowering due to nitrogen application was also reported by Singh and Singh (1992) in tomato.

The data pertaining to Table 4 showed that the days taken to the first flower initiation were significantly influenced by different levels of nitrogen and phosphorus.

The nitrogen treatment significantly influence with the number of days required for opening to first flower in cape goose berry. The minimum 66.62 days were required with N₁ for initiation of first flower followed by 71.76 days in N₂ (125 kg/ha) and N₃ (100 kg/ha) by 75.09. The maximum number of days required for initiation of first flower (81.06 days) was recorded with N₄ (150 kg/ha) which was found significantly superior over rest of the treatments. The interaction between nitrogen and phosphorus treatments for plant height was also found significant in cape gooseberry. The minimum days taken to first flower initiation was recorded in N₁P₂ (64.87 days) (N75:P80) while maximum days taken to first flower initiation was noted is N₄P₃ (85.07 days) (N150:P100)

The data pertaining to Table 5 shows that days taken to 50% flowering was significantly influenced by different levels of nitrogen and phosphorus. The nitrogen treatment

significantly influence with the number of days required for 50% flowering in cape goose berry. The minimum 88.68 days were required with N₁ for initiation of 50% flowering followed by N₂ (125 kg/ha) with 93.80 days. The maximum number of days required for initiation of 50% flowering (103.06 days) was recorded with N₄ (150 kg/ha) which was found significantly superior over rest of the treatments.

The days taken to 50% flowering was significantly increased with various dose of phosphorus.

The minimum days taken to 50% flowering 93.98 days was recorded under P₁ (60 Kg/ha) which was found significantly superior over rest of treatments and followed by P₂ (80 kg/ha) with 95.43 days while maximum days taken to 50% flowering *i.e.* 93.98 was recorded in P₁.

The interaction between nitrogen and phosphorus treatments for plant height was also found significantly in cape gooseberry. The minimum days taken to first flower initiation was recorded in N₁P₁ (87.53 days) (N75:P60) followed by N₁P₂ (88.40 days) (N75:P80) while maximum days taken to first flower initiation was noted is N₄P₃ (105.53 days) (N150:P100).

Quality characters of fruits

Fruit juice was increased significantly due to nitrogen and phosphorus application and the maximum juice percentage was recorded with application of (N150:P100) kg/ha and the lowest were measured in (N75:P60) kg/ ha.

It seems that nitrogen and phosphorus application increased the weight and volume of fruit with more juice percentage. Similar results have also been observed by Prasad *et al.*, (1985)

Table.1 Effect of varying doses of nitrogen and phosphorus on plant height (cm) in cape gooseberry

phosphorus	Nitrogen				
	N ₁	N ₂	N ₃	N ₄	Mean
P ₁	74.05	85.07	97.86	107.35	91.08
P ₂	78.52	91.25	99.43	110.73	94.98
P ₃	80.85	94.03	101.42	112.41	97.18
Mean	77.80	90.11	99.57	110.16	
	N	P			N x P
SEm±	1.62	1.40			2.80
C.D at 5%	4.74	4.10			8.21

Table.2 Effect of varying doses of nitrogen and phosphorus on number of primary branches in cape gooseberry

Phosphorus	Nitrogen				
	N ₁	N ₂	N ₃	N ₄	Mean
P ₁	4.27	5.53	7.60	12.54	7.48
P ₂	4.27	6.87	9.60	13.13	8.46
P ₃	4.80	7.27	11.73	14.27	9.51
Mean	4.44	6.55	9.64	13.31	
	N	P			N x P
SEm±	0.48	0.41			0.83
C.D at 5%	1.41	1.22			2.45

Table.3 Effect of varying doses of nitrogen and phosphorus on number of secondary branches in cape goose berry

phosphorus	Nitrogen				
	N ₁	N ₂	N ₃	N ₄	Mean
P ₁	6.00	7.47	9.00	10.93	8.35
P ₂	6.33	8.60	9.20	11.20	8.83
P ₃	7.07	8.67	9.54	12.12	10.18
Mean	6.47	8.24	9.54	12.22	
	N	P			N x P
SEm±	0.16	0.14			0.28
C.D at 5%	0.48	0.41			0.83

Table.4 Effect of nitrogen and phosphorus on days to first flower initiation in cape gooseberry

phosphorus	Nitrogen				
	N ₁	N ₂	N ₃	N ₄	Mean
P ₁	67.73	71.0	73.0	78.53	72.56
P ₂	64.87	71.40	74.13	79.60	72.50
P ₃	66.27	72.87	78.13	85.07	75.58
Mean	66.29	71.75	75.08	81.06	
	N	P			N x P
SEm±	0.28	0.18			0.36
C.D at 5%	0.61	0.52			1.05

Table.5 Effect of nitrogen and phosphorus on days taken to 50% flowering in cape gooseberry

phosphorus	Nitrogen				
	N ₁	N ₂	N ₃	N ₄	Mean
P ₁	87.53	92.80	95.27	100.33	93.98
P ₂	88.40	93.93	96.07	103.33	95.43
P ₃	90.13	94.67	96.87	105.53	96.80
Mean	88.68	93.80	96.07	103.06	
	N	P			N x P
SEm±	0.29	0.25			0.51
C.D at 5%	0.87	0.76			1.50

Table.6 Effect of nitrogen and phosphorus on total soluble solids of cape gooseberry

phosphorus	Nitrogen				
	N ₁	N ₂	N ₃	N ₄	Mean
P ₁	11.20	13.00	13.50	14.70	13.10
P ₂	11.30	13.10	14.00	15.00	13.30
P ₃	12.50	13.40	14.30	15.10	13.80
Mean	11.70	13.20	13.90	14.90	
	N	P			N x P
SEm±	0.58	0.50			1.00
C.D at 5%	1.70	1.47			2.94

Table.7 Effect of nitrogen and phosphorus on ascorbic acid (mg/100 g juice) in cape gooseberry

Phosphorus	Nitrogen				Mean
	N ₁	N ₂	N ₃	N ₄	
P ₁	40.43	43.37	45.72	47.92	44.36
P ₂	41.73	44.29	46.49	48.01	45.13
P ₃	42.85	45.32	46.71	48.23	45.77
Mean	41.67	44.32	46.30	48.05	
	N	P			N x P
SEm±	1.15	0.99			1.99
C.D at 5%	3.38	2.92			5.85

Table.8 Effect of nitrogen and phosphorus on acidity (%) in cape gooseberry

Phosphorus	Nitrogen				Mean
	N ₁	N ₂	N ₃	N ₄	
P ₁	1.12	1.24	1.32	1.78	1.36
P ₂	1.20	1.26	1.34	1.80	1.40
P ₃	1.23	1.29	1.49	1.92	1.48
Mean	1.18	1.26	1.38	1.83	
	N	P			N x P
SEm±	0.06	0.05			0.11
C.D at 5%	0.17	0.15			0.30

Marked influence on quality characters of fruits viz. total soluble solids, acidity, ascorbic acid, and total sugar contents were found due to variation in nitrogen and phosphorus levels. All these quality characters were increased with increasing levels of nitrogen and phosphorus fertilizers and recorded maximum with application of (N150:P100) kg/ha and the lowest were measured in (N75:P60) kg/ha. The increase in total soluble solids and sugars in fruits due to nitrogen and phosphorus application might be due to fact that these nutrients are related to carbohydrate synthesis. When the nutrients supply became insufficient, the limited synthesized carbohydrate synthesis. When the nutrient supply became insufficient, the limited synthesized carbohydrate meets the requirements of only vegetative parts. Contrary to this, when adequate supply of nutrients is available, the synthesized

carbohydrate translocate to the fruits, which ultimately increased the total soluble solids and sugars. The plants grown with luxuriant supply nitrogen and phosphorus, prolonged their bio-chemical process and exhibited high acidity and ascorbic acid content in fruit juice. Similar findings have been reported by Singh *et al.*, (1977) and Prasad *et al.*, (1985)

The persual data present in Table 6 revealed that total soluble solids were significantly affected by different levels of nitrogen and phosphorus treatments. The interaction between nitrogen and phosphorus treatment significantly affect the total soluble solids. The total soluble solids were significantly influenced by different levels of nitrogen treatment. The maximum TSS (14.92) were recorded with N₄ (150 kg/ha), while minimum number of berry per plant 11.69 were recorded with N₁.

The different phosphorus doses do influenced TSS content non-significantly in cape gooseberry. The maximum TSS 13.83 brix in cape gooseberry was recorded under P₃ (100 Kg/ha) while, minimum TSS i.e. 13.10 brix were recorded in P₁.

The interaction between nitrogen and phosphorus treatments for TSS was found significantly in cape gooseberry. The TSS 15.70⁰ brix was measured in N₄P₃ (N150:P100) which was found significantly at par with 15.00⁰ brix N₄P₂ (N150:P80), 14.70⁰ brix N₄P₁ (N150:P60), 13.40⁰ brix N₃P₃ (N100:P80), 14.00⁰ brix N₃P₂ (N125:P80), 13.50⁰ brix N₃P₁ (N125:P60), and 13.40⁰ brix N₂P₃ (N125:P80). The minimum TSS 11.20⁰ brix was measured in N₁P₁ (N75:P60).

The data pertaining to Table 7 revealed that different nitrogen levels and phosphorus increased ascorbic acid content significantly.

The ascorbic acid was significantly influenced by different levels of nitrogen treatment. The maximum ascorbic acid content 48.05 mg/100 g juice was recorded with N₄ (150 kg N/ha). While, minimum ascorbic acid i.e. 41.67 mg/100 g juice was recorded with N₁. The maximum content of vitamin C 45.77 was found in P₃ while, minimum ascorbic acid content (44.36 mg/100g juice) was recorded in P₁. It was found non-significant.

The interaction between nitrogen and Phosphorus for ascorbic acid content was also found significant. The maximum vitamin C was recorded in N₄P₃ (48.23 mg) which was found significantly at par with N₄P₂ (48.01 mg), 47.92mg N₄P₁ (N150:P60), 46.71 mg N₃P₃ (N100:P80), 46.49 mg N₃P₂ (N125:P80), 45.72 mg N₃P₁ (N125:P60), and 45.32 mg N₂P₃ (N125:P80), 44.29 mg N₂P₂ (N125:P60), 43.37 mg N₂P₁ (N125:P60). N₁P₃ (N75:P100), Lowest vitamin C was found in N₁P₁ (40.43mg).

The data pertaining to Table 8 shows that different nitrogen levels and phosphorus increased acidity significantly.

The acidity was significantly influenced by different levels of nitrogen treatment. The maximum acidity 1.83% was recorded with N₄ (150 kg N/ha) followed by N₃ (125 kg N/ha) 1.38%. While, minimum ascorbic acid i.e. 1.18% was recorded with N₁.

The interaction between nitrogen and Phosphorus for acidity was also found significant. The maximum acidity was recorded in N₄P₃ (1.92%) which was found significantly at par with N₄P₂ (1.80%) and N₄P₁ (1.78%). Lowest acidity was found in N₁P₁ (1.12%).

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