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Study on response of varying doses of nitrogen and phosphorus on yield attributes of cape gooseberry (*Physalis peruviana* Linn)

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Abstract
A field experiment on "Effect of varying doses of nitrogen and phosphorus on vegetative growth, fruit yield and quality of cape gooseberry" was conducted at Main Experiment Station of Horticulture department, Narendra Deva University of Agriculture and Technology, Faizabad (U.P.) during the year 2015-16 to study the response of varying doses of nitrogen and phosphorus on vegetative growth, flowering yield and quality attributes of cape gooseberry. The experiment was laid out 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 and potassium (60kg/ha) constant for all the treatments. The maximum berry per plant, weight, volume and yield were recorded in the plants with the application of (N150:P100) kg./ha followed by (N1125:P80) kg./ha and minimum were found with the application of (N75:P60) kg./ha.

Keywords: Yield attributes, cape gooseberry, small fruit, potassium

Introduction
The cape gooseberry (*Physalis peruviana* L.) which belongs to the family Solanaceae, has more than 70 species but only a few have economic value. It is native to Brazil. The cape gooseberry is an annual in temperate regions and a perennial in the tropics. 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. It is an herbaceous, semi-shrub that is upright, perennial in subtropical zones and can grow until reaches 0.9 m. The fruit is 4–5 g in weight, remains protected by a calyx and covered by a brilliant yellow peel (Mayorga, *et al.*, 2001) [6]. The cape gooseberry is known as golden berry in European countries, uchuva in Colombia, uvilla in Ecuador, aguaymanto in Peru and topotopoin Venezuela. Three types of cape gooseberry indigenous to Colombia, Kenya and South Africa are cultivated worldwide. Colombia is the world's largest producer of cape gooseberry followed by South Africa. In North India, the fruit ripens in February, but in South India the main crop extends from January to May. The fruit is rich in vitamins A (3,000 I.U.), C and B complex namely (thiamine, niacin, and vitamin B 12). It also contains higher amount of vitamin C than orange and is good source of dietary fiber. Many medicinal properties have been attributed to cape gooseberry, including anti asthmatic, antiseptic ,and strengthener for the optic nerve, treatment of throat infections and elimination of intestinal parasites, amoebas as well as albumin from kidneys. It has an anti-ulcer activity and is effective in reducing cholesterol level (Mayorga *et al.*, 2001) [6].
The formation of eight to twelve nodes with internodes length averaging 6.4 cm marks the beginning of the reproductive stage. Each node bears one flower (reproductive bud), two petiolate leaves (vegetative buds) and, especially in the lower part of the plant, a lateral shoot. After the appearance of the first flower, two new shoots develop as bifurcated node out growths from the axillary buds at the base of the two leaves developed. These shoots elongate and form a node where another flower forms along with two leaves and two new shoots that elongate to form more reproductive structures.

Materials and Methods
The present investigation entitled Study on response of varying doses of nitrogen and phosphorus on yield attributes of Cape gooseberry *(Physalis peruviana* Linn). was conducted at Main Experiment Station of Horticulture department, Narendra Deva University of Agriculture and Technology, Faizabad (U.P.) during the year 2015-16 to study the response of varying doses of nitrogen and phosphorus on yield attributes of cape gooseberry. The treatment comprised with different doses of Nitrogen@ 150,125, 100 and 75 kg/ha,

Phosphorus@ 100, 80 and 60 kg/ha and constant potassium of 60kg/ha.. The experiment was laid out in Factorial randomized block design with twelve treatments and 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 recomended 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, P_20_5 and K_20 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.

The total number of fruits from five tagged plants in each treatment were counted at each picking and added and recorded as number of fruits per plants. Weight of ten fruits from five tagged plant in each treatment were taken with the help of physical balance and noted as fruit weight of ten fruits .Volume of ten fruits from each treatment was measured by water dispersion method. All the dehusked fruits were dipped one by one in measuring cylinder, filled with water. The increased volume of water due to fruit dipping was recorded as fruit volume of ten fruits in cm^3.

Total fruit yield per plant harvested from five tagged plants in each treatment during all pickings were obtained by adding the weight of fruit of each picking and recorded as fruit yield per plant (g) Fruit yield per hectare was calculated on the basis of fruit yield harvested per plot from overall picking in each treatment and expressed in q/ha.The statistical analysis was done according to method given by Panse and Sukhatme (1985) [11]. The treatment means were compared by using the least significant difference values calculated at 5% level of significance.

Results and discussions

Effects of different nitrogen and phosphorus levels on yield and productivity observed in Cape gooseberry plants in the trial. In this trial experimental plants responded positively to increasing the nitrogen and phosphorus levels as shown in Tables 1 to 5. Number of fruits per plant, Fruit weight of ten fruits(gm), Fruit volume of ten fruits (cm^3), Fruit yield per plant (g), Fruit yield per hectare (q/ha). Nowadays, one of the major challenges of agriculture is to manage water and nutrients in order to maximize production and improve the product quality, while minimizing the adverse environmental effects. Water is becoming a limiting factor in many arid lands in the world and the amount and time of irrigation should be scheduled to maximize the yield and to minimize water application (El-Tohamy *et al.*1999) [3].

Nitrogen is also a limiting factor which markedly affects plant growth and productivity as well, especially under sandy soil conditions. However, monitoring soil and plant nutrient status is an essential safeguard to ensure maximum crop productivity. High dosage of fertilizers could, in analogy to fertile soils, result in favoring vegetative growth over fruit production and this in turn can reduce the total yield of plants. In the present study, the results showed that Cape gooseberry plants responded positively to increasing the nitrogen and phosphorus levels under sandy soil conditions of as shown in Tables 1 to 5. The level of 125 kg ha–1 obtained the highest fruit productivity. Moreover, the differences between treatments in number of fruits, and fruit diameter were also significant, indicating that increasing the nitrogen level under sandy soil conditions is essential for obtaining high growth and yield of Cape gooseberry plants. The vigorous growth of Cape gooseberry plants required high nitrogen application especially under soils with poor fertility such as sandy soil. The maximum fruit yield was obtained with 150 kg N ha–1.and 100 kg P ha–1.

Fruiting and yield attribute:

The nitrogen and phosphorus application provide effective to number of fruits/plant, fruit weight, fruit volume, and fruit yield. The maximum number of fruits per plant was harvested with application of higher doses of (N150:P100) kg/ha followed by (N150:P80) kg/ha and minimum in (N75:P60). This might be due to increased photosynthesis efficiency which reflex on vigorous growth of plants and ultimately remitting profused flowers (Prasad *et al.* 1985) [12]. The nitrogen and phosphorus application significantly influences the fruit yield and yield components (number of fruits/plant, 10 fruit weight and fruit volume). The reason was that number of fruits/plant where increased due to NPK application similar results were also observed by Mehla *et al.* (2000) [8] and Sahoo *et al.* (2002) [13].

The average weight of ten fruit, fruit volume and fruit yield were recorded with higher application of (N150:P100) kg /ha while minimum in (N75:P60) kg/ha. The probable reason for increased in ten fruit weight , fruit volume and fruit yield might be due to fact that increased doses of NPK fertilizer promoted vegetative growth and development and have associated with acceleration of higher rate of photosynthesis and there accumulation in economics part of plant i.e, fruit yield similar results is also reported by in tomato. These finding are enclose in conformity to the findings of Singh *et al.* (1977) [14], Prasad *et al.* (1985) [12] and Angrej Ali (2007) [1] in cape gooseberry.

The perusal data present in Table.1 revealed that number of berry per plant was significantly affected by different levels of nitrogen and phosphorus treatments. The interaction between nitrogen and phosphorus treatment significantly affect the number of berry per plant. The numbers of berry per plant were significantly influenced by different levels of nitrogen treatment. The maximum number of berry per plant 61.93 were recorded with N_4 (150 kg/ha), while minimum number of berry per plant 34.67 were recorded with N_1.

The phosphorus influenced the number of berry per plant significantly increased with the various dose of phosphorus. The maximum number of berry per plant 49.08 in cape gooseberry was recorded under P_3 (100 Kg/ha) which was found significantly superior over rest of treatments and followed by P_2 (80Kg/ha) with 46.76. While, minimum numbers of berry per plant i.e. 44.13 were recorded in P_1.

The interaction between nitrogen and phosphorus treatments for number of berries per plant was found significantly in cape gooseberry. The maximum number of berry per plant 62.87 was recorded in N_4P_3 (N150:P100) which was found significantly at par with N_4P_2 (N150:P80) and N_4P_1 (N150:P60) with 62.53 and 60.40 berries respectively. The minimum number of berries 33.27 was recorded in N_1P_1 (N75:P60).

The perusal data Table 2 revealed that the weight of 10 fruits per plant were significantly affected by different levels of nitrogen and phosphorus treatments. The interaction between

nitrogen and phosphorus treatment significantly affect the weight of 10 berry per plant.

The weight of 10 fruits per plant was significantly influenced by different levels of nitrogen treatment. The maximum weight of 10 fruits per plant 94.41 were recorded with N_4 (150 kg/ha), followed by 86.12 g in N_4 (125 kg/ha), while minimum weight of 10 fruits per plant 69.61g were recorded with N_1.

The phosphorus influenced the weight of 10 berry per plant significantly increased with the various dose of phosphorus. The maximum weight of 10 berry per plant 84.03g in cape gooseberry was recorded under P_3 (100 Kg/ha) which was found significantly superior over rest of the treatments and followed by P_2 (80Kg/ha) with 81.98g. While, minimum weight of 10 fruits i.e. 79.11g were recorded in P_1.

The interaction between nitrogen and phosphorus treatments for weight of 10 berry per plant was found significantly in cape gooseberry. The maximum weight of 10 berry per plant 95.83g was measured in N_4P_3 (N150:P100) which was found significantly at par with 92.77 N_4P_1 (N150:P60) and 94.63 N_4P_2 (N150:P80). The minimum weight of 10 berry was measured in N_1P_1 (N75:P60).

The data pertaining to Table.3 revealed that volume of 10 fruit per plant was significantly affected by different levels of nitrogen and phosphorus treatments. The interaction between nitrogen and phosphorus treatment significantly affect the volume of 10 fruits per plant.

The volume of 10 fruits per plant was significantly influenced by different levels of nitrogen treatment. The maximum volume of 10 fruits per plant 90.43 cc were recorded with N_4 (150 kg/ha), while minimum volume of 10 fruits per plant 71.12 cc were recorded with N_1.

The volume of 10 berry per plant was significantly increased with the various dose of phosphorus. The maximum volume of 10 berry per plant 81.53 cc in capegooseberry was recorded under P_3 (100 Kg/ha) which was found significantly superior with P_2 (80Kg/ha) with 80.99 cc. While, minimum volume of 10 berry per plant i.e. 78.59 cc was recorded in P_1.

The interaction between nitrogen and phosphorus treatments for volume of 10 berry per plant was found significantly in cape gooseberry. The maximum volume of 10 berry per plant 90.87 cc was measured in N_4P_3 (N150:P100) which was found significantly at par with 90.55 cc N_4P_1 (N150:P60) and 89.88 cc N_4P_2 (N150:P80). The minimum weight of 10 berry 68.03 cc was measured in N_1P_1 (N75:P60).

Table 1: Effect of nitrogen and phosphorus on number of berry per plant in cape gooseberry.

phosphorus	Nitrogen				
	N_1	**N_2**	**N_3**	**N_4**	**Mean**
P_1	33.27	36.73	46.13	60.40	44.13
P_2	34.27	40.87	49.40	62.53	46.76
P_3	36.47	44.27	52.73	62.87	49.08
Mean	34.67	40.63	49.42	61.93	
	N	P			N x P
SEm±	0.56	0.49			0.98
C.D at 5%	1.86	1.44			2.89

Table 2: Effect of nitrogen and phosphorus on weight of 10 berry per plant of cape gooseberry.

phosphorus	Nitrogen				
	N_1	**N_2**	**N_3**	**N_4**	**Mean**
P_1	66.36	73.95	83.38	92.77	79.11
P_2	70.73	76.76	85.81	94.63	81.98
P_3	71.76	79.33	89.18	95.83	84.02
Mean	69.61	76.68	86.12	94.41	
	N	P			N x P
SEm±	0.63	0.55			1.10
C.D at 5%	1.86	1.61			3.22

Table 3: Effect of nitrogen and phosphorus on volume of 10 berry per plant of cape gooseberry.

phosphorus	Nitrogen				
	N_1	**N_2**	**N_3**	**N_4**	**Mean**
P_1	68.03	75.65	80.82	89.88	78.59
P_2	72.18	75.50	85.74	90.55	80.99
P_3	73.16	76.76	85.35	90.87	81.53
Mean	71.12	75.97	83.97	90.44	
	N	P			N x P
SEm±	0.88	0.76			1.52
C.D at 5%	2.57	2.23			4.46

The data presented in Table 4 releaved that the fruit yield per plant (g) was significantly influenced by different nitrogen levels and phosphorus.

In case of nitrogen, the fruit yield per plant was significantly influenced by different levels of nitrogen treatment. The maximum fruit yield per plant 550.69 g was recorded with N_4 (150 kg N/ha) followed by N_3 (125 kg N/ha) with 371.41 g while, minimum weight of flower 235.86 g per plant was recorded N_1.

The maximum fruit yield per plant (386.73 g) was recorded with phosphorus which was found significantly superior over rest of the treatments. While, minimum weight of flower per plant (331.51 g) was recorded with P_1.

The interaction between nitrogen and spacing treatment for fruit yield per plant was also found significant. The maximum weight of fruit yield per plant was recorded in N_4P_3 (605.21 g) (N150:P80) followed by N_4P_2 (561.53g) (N150:P60) . Lowest fruit yield per plant was found in N_1P_1 (218.27g) (N75:P60).

The data presented in Table 5 revealed that different nitrogen levels and phosphorus increased of yield of fruit per ha significantly. The yield of fruit q/ha was significantly influenced by different levels of nitrogen treatment. The maximum fruit yield 154.48 q/ha was recorded with N_4(150 kg N/ha) followed by N_3 (125 kg N/ha) 112.69 q/ha .While, minimum fruit yield *i.e*. 65.51 q/ha was recorded with N_1.

Among different doses of phosphorus the maximum yield of fruit 114.57 q/ha was found in P_3 which was found at par with P_2 (80 kg N/ha) 101.70 q/ha while, minimum yield of fruit per ha (93.21q/ha) was recorded in P_1 .

The interaction between nitrogen and Phosphorus treatment yield of fruit q/ ha was also found significant. The maximum yield of fruit was recorded in N_4P_3 (168.11 q/ha) which was found at par with N_4P_2 (155.98 q/ha), N_4P_1 (139.36q/ha), N_3P_3 (134.82 q/ha). Lowest yield of fruit q/ ha was found in N_1P_1 (60.62 q/ha).

Table 4: Effect of nitrogen and phosphorus on fruit yield per plant (g) in cape gooseberry.

Phosphorus	Nitrogen				
	N_1	N_2	N_3	N_4	Mean
P_1	218.27	271.41	351.05	485.33	331.51
P_2	234.12	288.23	380.69	561.53	366.14
P_3	255.13	304.03	382.49	605.21	386.73
Mean	235.86	287.89	371.41	550.69	
	N	P			N x P
SEm±	8.62	7.47			14.94
C.D.(P=0.05) (P=0.05)	25.30	21.91			43.83

Table 5: Effect of nitrogen and phosphorus on fruit yield per hectare (qt/ha) in cape gooseberry.

phosphorus	Nitrogen				
	N_1	N_2	N_3	N_4	Mean
P_1	60.62	75.39	97.50	139.36	93.21
P_2	65.03	80.06	105.74	155.98	101.70
P_3	70.88	84.45	134.82	168.11	114.57
Mean	65.51	79.96	112.69	154.48	
	N	P			N x P
SEm±	6.40	5.54			11.08
C.D at 5%	18.77	16.25			32.51

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