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Effect of organic and inorganic fertilizers on growth, yield, and quality of cape goose berry (*Physalis peruviana* L.)

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Abstract
The present experiment was carried out during October 2017 to March 2018 in Departmental Research Field of Department of Horticulture, SHUATS, Allahabad. The experiment was conducted in Randomized Block Design (RBD), with ten treatments, replicated thrice. the treatments were T_0 (Control), T_1 (100% RDN (200:130:180)), T_2 (75% RDN +25% RDN Through FYM (10tonnes)), T_3 (50% RDN + 50% RDN Through FYM (20tonnes)), T_4 (25% RDN+75% RDN Through FYM (30tonnes)), T_5 (100% RDN by FYM + Remaining by inorganic), T_6 (75% RDN + 25% RDN Through Vermi compost (16.66qt)), T_7 (50% RDN + 50% RDN Through Vermi compost (33.3qt)), T_8 (25% RDN + 75% RDN Through Vermi compost (50qt)) and T_9 (100% vermi compost+ Remaining by inorganic)). From the present investigation with different treatment of organic and inorganic fertilizers on vegetative growth, yield, and fruit quality attributes of cape gooseberry, it is found that the Treatment T_5 (100% RDN by FYM + Remaining by inorganic) and T_4 (25%RDN+75%RDN Through FYM) was found to be the best treatment in respect to number of fruits per plant, average fruit weight, Polar and Radial Diameter, yield and Highest B:C ratio. But T_8 (25%RDN+75% through vermicompost) were found to be the best treatment in respect to plant height, TSS, Carotenoid, ascorbic acid, acidity of Cape Goose Berry fruits under Allahabad agro-climatic conditions.

Keywords: cape goose berry, fertilizers, FYM and vermi-compost

Introduction
The cape goose berry (*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) [8]. The cape gooseberry is known as golden berry in European countries, uchuva in Colombia, uvilla in Ecuador, aguaymanto in Peru and topotopo in Venezuela (Puente *et al.* 2011) [12]. Three types of cape gooseberry indigenous to Colombia, Kenya and South Africa are cultivated worldwide. Colombia is the world's largest producer of cape goose berry 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 antiasthmatic, antiseptic 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. (Arun and Asha, 2007; Mayorga *et al.*, 2001) [7, 8]. The fruit contains 78.9-85.5% moisture, 0.3-1.5% protein, 0.150.5% fat, 11-19.6% carbohydrate, 0.4-4.9% fiber, 0.7-1.0% ash and pulp is composed of 1.6 mg/100g carotene, 0.1-0.18mg/100g thiamine, 0.03-0.18 mg/100g riboflavin, 0.8-1.7 mg/100g niacin, 20-43 mg/100g vitaminC, 210-467mg/100g K, 7-19 mg/100g Mg, 8-28 mg/100g Ca, 27-55.3 mg/100g P, 0.3-1.2 mg/100g Fe, 0.28-0.40 mg/100g Zn (Puente *et al.*, 2011; Ramadan and Morsel, 2009) [12].

The chemical fertilizers are mostly used for the cultivation because of quick release of essential elements to the crops, which have some deleterious effect on quality besides adverse effect on soil health, water and environment. Organic manures are the excellent and balanced source of nutrients as they improve the quality of produce, soil health, safety of environment as well as nutrient uptake but release the nutrient slowly (Abusaleha, 1992).

Materials and Methods

The details of the various materials used and methods adopted in laid out the experiment are presented below:

Experimental site

The area of Allahabad district comes under subtropical belt in the South East of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46ºC – 48ºC and seldom falls as low as 4ºC – 5ºC. The relative humidity ranged between 20 – 94 percent. The average rainfall in this area is around 1013.4mm annually. However, occasional precipitation is also not uncommon during winter months**.** The experiment was carried out at the Departmental Research Field of Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad. The experiment was conducted in Randomized Block Design having 10 treatments with three replications. The allocation of treatments of the individual plots using random number in each replication.

Results and Discussion

The present investigation was carried out during October, 2017 to March, 2018 in Departmental Research Field of Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad (U.P.) India. The results of the present investigation, regarding the effect of Bio-fertilizers on growth, Yield and Quality of Brinjal, have been discussed and interpreted in the light of previous research work done in India and abroad.

Growth Parameters

At 25 days after transplanting significantly maximum number of leaves (6) was observed in the treatment T_3 (50%RDN+50%RDN Through FYM (20tonnes) followed by T_2 with (5.83) number of leaves. Minimum number of leaves (3) was observed in control. At 45 days of transplanting maximum number of leaves (15.83) was found in the treatment T_7 (50%RDN+50%RDN Through Vermi compost (33.3qt) followed by T_4 with (15.78) number of leaves. Minimum number of leaves (12.83) was observed in treatment T_5. At 65 days of transplanting significantly maximum number of leaves (44) was noticed in the treatment T_5 (100% RDN by FYM + Remaining by inorganic) followed by T_8 (40.00) number of leaves. The Minimum number of leaves (18.33) was observed in treatment T_0. The maximum number of leaves per plant number were obtained at 100% RDN By FYM + remaining by inorganic. These findings corroborate the result of Naidu *et al.* (2001) [10] in tomato, Naidu *et al.* (2002) [11] in brinjal and Amburani and Manivannan (2003) [1] in brinjal.

The significantly maximum number of branches (2.33) was observed in the treatment T_9 followed by T_5 (2.00). Minimum number of branches (0.83) was observed in treatment control. At 65 Days the maximum number of branches (3.39) was found in the treatment T_5 followed by T_8 (3.05). Minimum number of branches (2.28) was observed in treatment T_6. The maximum number of braches per Plant were obtained at 100% RDN By FYM + remaining by inorganic. These findings corroborate the result of Naidu *et al.* (2001) [10] in tomato, Naidu *et al.* (2002) [11] in brinjal and Amburani and Manivannan (2003) [1] in brinjal.

At 25 days of transplanting significantly the maximum plant height (17.67 cm) was found in Treatment T_2 followed by T_3 (14.83 cm). The minimum plant height (8 cm) was observed in control. At 45 days of transplanting significantly the maximum plant height (41 cm) was noticed in Treatment T_4 followed by T_8 (38.50 cm). The minimum plant height (26.17 cm) was observed in T_9. At 65 Days of transplanting significantly the maximum plant height (110.50 cm) was observed in Treatment T_8 followed by T_7 (106.33 cm). The minimum plant height (59.33 cm) was found in T_0. The increase in vegetative growth and other parameters might be due to the production of more chlorophyll with inoculation of nitrogen fixers. The another reason for increased vegetative growth is owing to the production of plant growth regulators by microorganism in rhizosphere, which might have been absorbed by the roots. The increased vegetative growth has been attributed to the increased biological nitrogen fixation. Better development of root system, synthesis of plant growth hormones likes IAA, GA and Cytokinins (Martinez *et al*. 1993) [7] (Gajbhiye *et al.* 2003) [4] might have caused an increase in plant growth parameters.

At 25 days of transplanting significantly the maximum leaf area (26 cm^2) was observed in Treatment T_4 followed by T_5 (25.00 cm^2). The minimum leaf area (15.67 cm^2) was observed in T_0. At 45 days of transplanting significantly the maximum leaf area (64.67 cm^2) was noticed in Treatment T_5 followed by T_4 (62.67 cm^2). The minimum leaf area (40.33 cm^2) was noticed in Treatment T_6. At 65 days of transplanting significantly the maximum leaf area (297 cm^2) was found in Treatment T_4 followed by Treatment T_5 (243.00 cm^2). The minimum leaf area (60 cm^2) was found in Treatment T_0. The increase in leaf area and other parameters might be due to the production of more chlorophyll with inoculation of nitrogen fixers. The another reason for increased leaf area is owing to the production of plant growth regulators by microorganism in rhizosphere, which might have been absorbed by the roots. The increased vegetative growth has been attributed to the increased biological nitrogen fixation. Better development of root system, synthesis of plant growth hormones likes IAA, GA and Cytokinins (Martinez *et al*. 1993) [7] (Gajbhiye *et al.* 2003) [4] might have caused an increase in plant growth parameters.

Yield Parameters

Under yield parameter number of fruit, polar diameter, redial diameter, average fruit weight and total yield is described below:

The significantly maximum number of fruits/plant (76) was observed in treatment T_5 followed by T_4 with (71) number of fruits. Minimum number of fruits/plant (47) was found in Treatment T_0. It may possibly be due to fact that organic and inorganic fertilizer application accelerated the development of fruits which are positively correlated with the number of fruits in the following spring. Increased number of fruits might have also resulted because of increase in number of flowers per plant. Similar observations were also reported by Tripathi *et al*. (2010) [16] in strawberry.

The significantly maximum average fruit weight (5.60 g) was observed in Treatment T_5 followed by T_9 (5.40 gm). The minimum fruit weight (3.80 gm) was noticed in treatment T_0.

In terms of polar diameter (2.40 cm) was found in Treatment T_5 followed by T_4 (2.30 cm) polar diameter and the minimum polar diameter (1.20 cm) was observed in treatment T_0.

Radial diameter (cm) was significantly affected by organic and inorganic fertilizer. Significantly the highest Radial diameter (2.20 cm) was observed in Treatment T_4 followed by

treatment T_5 (2.10 cm) radial diameter. The minimum radial diameter (1.30 cm) was found in Treatment T_0.

In the present investigation the fruit size (length × width) was significantly increased by the use of organic and inorganic fertilizers. The maximum fruit size and volume were recorded in the plants treated with 100%RDN By FYM + Remaining by inorganic, followed by 25% RDN +75%RDN Through FYM. Similar results were obtained by Gajbhiye *et al.* (2003) [4] and Meena *et al.* (2014) [9] in tomato Fruit size, weight, fruit volume are highly correlated with dry matter content, balanced level of hormone and nitrogen fixers which are known for accumulation of dry matter and their translocation as well as synthesis of different growth regulators (Kachot *et al.* 2001) [5].

In terms of Yield q/ha (47.26 q/ha) was found in Treatment T_5 followed by Treatment T_9 with (42.56 q/ha) and the minimum Yield (18.10 q/ha) was found in Treatment T_0. These findings are in line with the Subbiah (1994) [15] in chilli, Wange *et al.* (1998) [17] in strawberry, Kadlag *et al.* (2007) [6] in tomato and Tripathi *et al*. (2010) [16] in strawberry. The increase in yield might be due to increased fruit set per plant, fruit length and fruit width as well as fruit weight influenced by nitrogen fixers.

Quality Parameter

Quality parameter such as TSS, acidity, Ascorbic acid and carotenoid Influence by organic and inorganic fertilizers that describe below:

In terms of Total Soluble Solids (^{0}Brix) (12 ^{0}Brix) was observed in Treatment T_8 followed by T_7 with (11.67 ^{0}Brix). The minimum Total Soluble Solids (7.33 ^{0}Brix) was observed in Treatment T_0. Similar findings were also reported by Singh *et al*. (2009) [14] in ber, Baksh *et al*. (2008) [3] in guava and Rathi and Bist (2004) [13] in pear.

Maximum Carotenoid Content (mg) (1.63 mg/100gm) was found in Treatment T_8 followed by Treatment T_7 with (1.44 mg/100gm). The minimum Carotenoid Value (1.13 mg/100gm) was found in control.

Ascorbic acid (mg/100 g) was recorded (56 mg) in Treatment T_8 followed by treatment T_7 with (44.00 mg). The minimum Ascorbic acid Value (17 mg/100gm) was found in Treatment T_o. The maximum content of ascorbic acid was recorded in fruits produced with 25%RDN+75%RDN through vermi compost. Where as the minimum amount of ascorbic acid was recorded in control treated plants. The respective increase in ascorbic acid content might be due to the increased efficiency of microbial inoculants to fix atmospheric nitrogen, increase in availability of phosphorous and secretion of growth promoting substances which accelerates the physiological processes like carbohydrates synthesis etc. The results obtained also got the support of the findings of Tripathi *et al*. (2010) [16] and Yadav *et al*. (2010) [18].

In terms of Acidity percent minimum Acidity (0.12 %) was observed in Treatment T_6 followed by treatment T_2 (0.14 %). The maximum Acidity % (0.52%) was observed in treatment T_8. The Maximum Titra table acid was recorded with 25% RDN+75% RDN through vermi compost followed by 50% RDN+50% RDN through vermi compost, where as minimum acidity was recorded in 75% RDN + 25% RDN through vermi compost. Although there is no report in the literature to support the results, yet it can be corroborated with the finding of Singh *et al*. (2009) [14] in ber, Baksh *et al*. (2008) [3] in guava and Rathi and Bist (2004) [13] in pear.

Economics

The maximum Gross return was recorded in treatment T_5 with (189040 Rs/ha) followed by T_9 with (170240 Rs/ha, Maximum Net return was recorded in treatment T_5 with (108590 Rs/ha) followed by Treatment T_4 (88290 Rs/ha) net return and maximum Benefit Cost ratio (1:2.34) was found in treatment T_5 followed by Treatment and treatment T_4 (1:2.10). The minimum Gross return (72400 Rs/ha), Net Return (16300 Rs./ha) and Benefit Cost Ratio (1:1.29) was found in treatment T_0. This might be due to the reason that the plant consumed nutrient provided them through inorganic and organic sources. This combination improved the quality as well as fruit yield of plant. Similar results were reported by Selvi *et al.* (2000), Prabhu *et al.* (2002), Srivastava *et al.* (2009), and Bairwa *et al.* (2009).

Table 1: Effect of organic and inorganic fertilizers on plant height (cm), number of leaves/plant, leaf area (cm^2) and number of branches/plant of cape goose berry

Treatment Symbol	Treatments Combination	Plant height (cm)			Number of leaves/plant			Leaf area (cm^2)			Number of Branches/Plant	
		25 Days	45 Days	65 Days	25 Days	45 Days	65 Days	25 Days	45 Days	65 Days	45 Days	65 Days
T_0	Control	8.00	28.00	59.33	3.00	15.67	18.33	15.67	42.00	60.00	0.83	2.61
T_1	100%RDN (200:130:180)	12.33	31.00	98.60	4.67	15.33	22.83	16.67	40.67	92.00	1.50	2.94
T_2	75%RDN+25%RDN Through FYM	17.67	32.00	87.33	5.83	13.17	22.00	18.00	49.00	123.00	1.50	2.50
T_3	50%RDN+50%RDN Through FYM	14.83	37.83	104.83	6.00	13.67	27.00	20.67	50.33	96.00	1.67	2.61
T_4	25%RDN+75%RDN Through FYM	12.50	41.00	100.67	4.33	15.78	30.50	26.00	62.67	297.00	1.83	2.83
T_5	100% RDN by FYM + Remaining by inorganic	12.00	31.00	73.17	5.17	12.83	44.00	25.00	64.67	243.00	2.00	3.39
T_6	75%RDN+25%RDN Through Vermi compost	12.03	30.67	101.00	5.67	14.50	26.00	18.00	40.33	140.00	1.50	2.28
T_7	50%RDN+50%RDN Through Vermi compost.	9.67	36.17	106.33	4.83	15.83	32.67	19.00	44.67	154.00	1.67	2.78
T_8	25%RDN+75%RDN Through Vermi compost	11.17	38.50	110.50	4.67	15.17	40.00	20.33	46.67	188.00	2.00	3.05
T_9	100% vermi compost+ Remaining by inorganic	10.50	26.17	99.83	4.83	13.50	38.83	22.00	42.33	115.00	2.33	3.00
F-test		S	S	S	S	NS	S	S	S	S	NS	S
S.Ed.		2.34	3.90	12.57	0.64	2.67	4.83	2.49	4.05	11.48	0.30	0.31
C.D. at 5%		4.92	8.20	26.41	1.34	5.60	10.14	5.24	8.51	24.11	0.62	0.64

Table 2: Effect of organic and inorganic fertilizers on no. of fruits/plant, avg. fruit weight (g), polar and radical diameter (cm), yield q/ha, carotenoid (mg), ascorbic acid (mg/100 g), acidity (%) and benefit cost ratio of cape goose berry

Treatment Symbol	Treatments Combinations	No. of fruits/plant	Average of fruit weight (g)	Polar diameter (cm)	Radial diameter (cm)	Yield (q/ha)	TSS (ºBrix)	Carotenoid (mg)	Ascorbic Acid (mg/100 g)	Acidity (%)	Benefit Cost Ratio
T_0	Control	47.00	3.80	1.20	1.30	18.10	7.33	1.13	17.00	0.17	1.29
T_1	100%RDN (200:130:180)	56.00	4.10	1.80	1.80	26.36	8.67	1.25	25.00	0.36	1.40
T_2	75%RDN+25%RDN Through FYM	52.00	4.20	2.00	1.80	26.28	8.67	1.20	27.00	0.14	1.37
T_3	50%RDN+50%RDN Through FYM	68.00	5.10	2.10	1.60	39.54	10.67	1.40	25.00	0.38	2.02
T_4	25%RDN+75%RDN Through FYM	71.00	4.80	2.30	2.20	41.96	10.33	1.36	39.00	0.18	2.10
T_5	100% RDN by FYM + Remaining by inorganic	76.00	5.60	2.40	2.10	47.26	11.00	1.42	27.00	0.25	2.34
T_6	75%RDN+25%RDN Through Vermi compost	48.00	5.00	1.60	1.60	29.47	11.33	1.34	36.00	0.12	1.43
T_7	50%RDN+50%RDN Through Vermicompost	62.00	4.90	2.00	1.50	33.53	11.67	1.44	44.00	0.45	1.50
T_8	25%RDN+75%RDN Through Vermi compost	60.00	5.10	2.20	1.60	37.18	12.00	1.63	56.00	0.52	1.56
T_9	100% vermi compost+ Remaining by inorganic	63.00	5.40	2.30	2.00	42.56	11.33	1.23	42.00	0.19	1.65
F-test		S	S	S	S	S	S	S	S	S	
S.Ed.		3.89	0.31	0.16	0.12	0.06	0.44	0.03	1.57	0.01	
C.D. at 5%		8.16	0.64	0.33	0.26	0.13	0.92	0.07	3.30	0.02	

Conclusion

From the present investigation with different treatment of organic and inorganic fertilizers on vegetative growth, yield, and fruit quality attributes of cape gooseberry, it is found that the Treatment T_5 (100% RDN by FYM + Remaining by inorganic) and T_4 (25%RDN+75%RDN Through FYM) was found to be the best treatment in respect to number of fruits per plant, average fruit weight, Polar and Radial Diameter, yield and Highest B:C ratio. But T_8 (25%RDN+75% through vermicompost) were found to be the best treatment in respect to plant height, TSS, Carotenoid, ascorbic acid, acidity of Cape Goose Berry fruits under Allahabad agro-climatic conditions.

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