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Flowering and fruiting in Cape gooseberry (*Physalis peruviana* L.) as influenced by organic manures and spacing

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ABSTRACT

A field experiment was conducted to study the performance of flowering and fruiting in Cape gooseberry (Physalis peruviana L.*) as influenced by organic manures and spacing at Horticulture Research Farm, Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow, U.P. India during winter season in 2014-2015. The experiment was laid out in a factorial RBD where treatments consisted of two factors:(A) source of organic manures: farmyard manure (F_1, F_2) and vermicompost (V_1, V_2) each applied at full and half dose and (B) plants planted at two spacings: 80×75cm (S_1) and 60×75cm(S_2). The results revealed that manurial treatments had a significant effect and among those applied in the present study, vermicompost had a superior effect on maximizing plant height (45.68cm), number of branches (9.51), number of buds (31.57) number of flowers (30.86), number of fruits (29.94), fruit yield (152.93 kg/ha) fruit length (26.32mm), fruit width (25.78mm), fruit weight (25.10g), fruit volume (24.47ml), specific gravity (1.04g/ml), TSS (13.24^{0}Brix) and acidity (1.13). Since, the second factor i.e. plant spacing (60 cm x 75 cm and 80 cm x 75 cm) and their interaction did not show any significant effect on the performance of flowering and fruiting in cape gooseberry, the closer spacing (60×75cm) along with application of vermicompost may be suggested for good crop yield of cape goose berry for Lucknow condition.*

Keyword: *Cape gooseberry, Physalis peruviana, Farmyard Manure, vermicompost, spacing*

INTRODUCTION

Cape gooseberry (*Physalis peruviana* L.), belonging to family Solanaceae with 2n = 24, bears nutritionally rich fruits is still considered a backyard fruit although it has been spread widely worldwide. Native to Peru and Chile (Legge, 1974) Asia and Europe (Crawford, 2004) it is a quick growing, short duration, herbaceous, annual, at times a short perennial shrub, considered a minor tropical fruit crop of India, which has potential for use as nutraceutical (Ramadan and Morsel, 2007). However, its cultivation is restricted to a limited area in our country due to low production potential, lack of proper awareness regarding package of practices etc. (Girapu and Kumar, 2006). The fruit is a berry with smooth, waxy, orange-yellow skin (Legge, 1974), enclosed in an inflated, bladder-like calyx or husk and can be eaten fresh when ripe or in a variety of processed forms (Klinac, 2012). It has anti-ulcer activity and is effective in reducing cholesterol levels (Branzati and Manaresi, 1980; Sarangi *et al.*, 1989) besides its use in treating diseases such as malaria, asthma, hepatitis, dermatitis and rheumatism.

Successful cultivation of any crop depends primarily on plant spacing and other cultivation practices which ensure proper growth and development of plant resulting in maximum yield and economic use of land. However, there is no report regarding optimum agro-techniques and spacing for the successful cultivation of cape gooseberry, especially under the agro climatic conditions of Central Uttar Pradesh (Dwivedi *et al.*, 2015) although plant spacing or plant population per unit area is reported to have a decisive role with regard to optimum growth of plant and fruit yield (Ayala,1992). Composts act as a long term reserve and slow release sources of major nutrients like N, P and K (Sullivan *et al.*, 2002). Additionally, they increase the microbial activity, anion and cation exchange capacity, organic matter and carbon-content of soil. Organic fertilizers increase the yield and quality of agricultural crops in ways similar to inorganic fertilizers (Arancon *et al.*, 2004a, b; Heeb *et al.*, 2005; a, b; Heeb *et al.*, 2006; Liu *et al.*, 2007 and Tonfack *et al.*, 2009). Nutrient management and spacing run simultaneously in optimising proper agrotechniques for any crop (Girapu and Kumar, 2006), for optimum plant performance. Growing consumer demand for this unique fruit is spurring a need for increased information on standard cultural techniques for Cape gooseberry, more particularly in problem soils. The present work aims to investigate the production potential of Cape gooseberry in saline soils of Central Uttar Pradesh (India) under varying levels of plant spacing and fertility.

MATERIAL AND METHODS

The experiment was conducted at Horticultural Research Farm, Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow during November 2014 to May 2015. The soil type of the experimental plot is reported to be saline having pH 8.2 and low organic carbon (Dwivedi *et al.*, 2012). Full dose of FYM was applied @ 20 tonnes per hectare (Chattopdhyay, 1996). Since the dose of vermicompost has not been standardised for application in capegooseberry, it was applied at same dose as FYM i.e. 20 tonnes per hectare. The experiment was laid out in a factorial randomized block design with two factors: manurial application (F) and plant spacing (S) with following treatments T_1- C_0S_1 - Control and 80cm×75cm spacing, T_2- C_0S_2-Control and 60 cm ×75cm spacing, T_3- F_1S_1 - full dose of FYM + 80 cm ×75 cm spacing, T_4- F_1S_2- full dose of FYM + 60 cm ×75 cm spacing, T_5- F_2S_1 - half dose of FYM +80 cm ×75 cm spacing, T_6- F_2S_2 - half dose of FYM + 60 cm ×75 cm spacing, T_7- V_1S_1 - full dose of vermicompost + 80 cm ×75 cm spacing, T_8- V_1S_2 - full dose of vermicompost + 60 cm ×75 cm spacing, T_9- V_2S_1 - Half dose of vermicompost + 80 cm ×75 cm spacing, T_{10}- V_2S_2 -Half dose of vermicompost + 60 cm ×75 cm spacing. Seedlings were transplanted on 15thOctober, 2015 and organic manures were incorporated in the experimental plots before transplanting. The observations on growth, flowering, fruiting and yield were recorded on four and six plants each in the spacing 80 cm ×75cm and 60 cm ×75cm, respectively, selected randomly in each treatment and the average was computed. The average data was subjected to statistical analysis using Fisher's method (Chandel, 2012) and treatment means were compared at 5% level of significance.

RESULTS AND DISCUSSION

The experimental results revealed that both the manures at all doses under study improved the vegetative growth as well as fruit physico-chemical parameters of cape gooseberry significantly over the control. Among the manures applied vermicompost improved the plant performances significantly over control and some doses of FYM (Table 1). Plant height (45.68cm), number of branches (9.51), number of buds (31.57), number of flowers (30.86), number of fruits per plant (29.94), fruit yield (751.49 g/plant), average fruit length (26.32mm), fruit width (25.78mm), fruit weight (25.10g), fruit volume (24.47ml), specific gravity (1.04g/ml), TSS (13.24 ^{0}B) and acidity (1.13 %) were recorded maximum under T_7 (100% vermicompost with 80cm×75cm) (Table 2). The reason for improved vegetative performance of cape gooseberry under discussion, upon application of vermicompost, may be associated with 28% higher humic acid content over conventional compost, a neutral to alkaline pH against an acidic pH of compost and the higher degree of decomposition and mineralization due to enhancement of phosphatase activity which results in increased P and K levels in vermicompost by 20 and 38%, respectively, against the conventional compost resulting even in higher N-content (Padmavathiamma *et al.*, 2008). The available nutrient status of soil was thus, greatly enhanced by the application of vermicompost as an organic source. Vermicompost enhanced P concentration and uptake in soil, increasing the solubilisation of P either by microorganisms activation with excretion of organic acids likes citric, glutamic tartaric, succinic, lactic, oxalic, maleic and fumaric (Rao, 1982). This increase in vegetative growth may also be attributed to enhanced availability of nutrients at vital periods of growth and improved water status of plants. The inoculation of organic manure might have increased cell metabolism resulting from enhanced enzyme activity, chlorophyll content and photosynthesis process (Kumar and Singh, 2006). The increased yield is possibly due to the improved vegetative performance of the plant which increases the number of secondary and tertiary branches and subsequently the number of flowers and fruits since Cape gooseberry is an axillary bearer.

Organic manures had significant effect on maximum number of buds, number of flowers and number of fruits in comparison to control. Maximum average number of fruits (29.94 fruits per plant) was obtained with treatment T_7 (Full dose of Vermicompost, at 60cm×75cm spacing) followed by 28.59 fruits per plant under T_8 (Full dose of Vermicompost and spacing 80cm×75cm). The reason for increased number of buds and fruits per plant may be due to solubilisation effect of plant nutrients by addition of N, P, K, Ca and Mg to the crop during the vegetative as well as reproductive phase. These results are in accordance with findings of Patil *et al*. (2004). P and K are also reported to enhance flowering and fruiting in crops (Katyayan, 2001). The highest average number of flowers and fruits and fruit weight was recorded for treatment T_7 which was found to be significantly at par with the treatment T_8. The final maximum yield over control however, has been recorded upon the application of vermicompost with wider spacing however, it was non significant and close to closer spacing (Table 1). This is explainable since a larger number of plants are accommodated per hectare under the closer spacing of 60cm×75cm as compared with that of 80cm×75 cm and because the yield attributing characters *viz*., average number of flowers, fruits and average fruit weight were recorded as being statistically at par with each other for treatments T_7 and T_8. Logically, it will result in higher yield even though it is statistically at par in the yield obtained under wide spacing.

Physico-chemical characteristics of fruits of cape gooseberry (Table 2) also did not vary significantly due to planting at various spacing i.e. close or wide spacing. In all cases (fruit length, width, weight, volume, TSS and acidity except specific gravity) organic manuring had significant effect to improve the fruit quality, however, interaction effect between spacing and organic manuring were non-significant. It was seen that T_7 (Full dose of vermicompost + 80 cm×75 cm spacing) produced fruits with maximum length (26.32 mm) and width (25.78 mm). The average fruit weight and fruit volume were found maximum (25.10 g and 24.47 ml, respectively) also under treatment T_7. The fruit specific gravity depends on fruit dry matter accumulation, fruit weight and fruit volume ratio which has been recorded as non-significant due to spacing, manuring and their interaction. The fruit chemical quality in terms of TSS content was found superior under treatment T_7 (13.24 ^{0}B TSS) followed by T_8. However, T_7 increased the titratable acidity content in fruits might be due to more availability of nitrogen amount. Overall, the superior quality fruits were found under the treatment T_7 due to beneficial effect of vermicompost and wider spacing which allows better vegetative growth influencing higher accumulation of food materials resulting in better quality.

Crop physiologist, microbiologist and agronomist agree that fruit growth and development are strictly dependent on soil biological fertility factor and earthworms stimulate microbial populations, consequently increasing available nutrients and microbial metabolites release into the soil (Tomati *et al.*, 1988). Vermicompost facilitates plant growth hormones and high levels of soil enzymes, while enhancing microbial populations and tending to hold more nutrients over longer periods without adverse impacts on the environment. It can also be used as a bioremedial measure to reclaim problem soils, especially acid soils, because of the near-neutral to alkaline pH of vermicompost (Padmavathiamma *et al.*, 2008; Aksoy, 2001; Chowdhury, 2004; Maji and Das, 2008). The increase in yield and yield attributing characters may be due to application of organic manure over control and greater presence of essential plant nutrients and balanced C/N ratio for better physiological performance of the plant (Harikrishna *et al.,* 2002 and Sengupta *et al.*, 2002).

The results have further revealed that no significant variation was observed in the performance of plants planted at two spacing under study *viz*., 80cm × 75cm and 60cm × 75cm in respect of vegetative growth, fruit yield per plant and physico-chemical quality of fruits. Further, there is no significant impact of interaction of the two factors. Thus, it is clear that the performance of the crop is independent to the effect of spacing under study and has responded only to the organic manures applied. Among the organic manures, vermicompost had shown the better effect on fruit yield which is important as organic sources of

Table 1: Effect of spacing and organic manure on performance of growth and yield of cape gooseberry

Parameters Treatments	Plant height (cm)	Number of branches per plant	Number of budsper plant	Number of flowers per plant	Number of fruits per plant	Fruit yield per plant (g)
T_1- C_0S_1	27.81	7.22	16.12	15.74	15.44	317.91
T_2- C_0S_2	30.83	6.74	21.29	21.44	21.00	438.90
T_3- F_1S_1	39.08	8.37	25.39	25.69	24.39	519.26
T_4- F_1S_2	40.69	8.53	27.91	26.74	25.61	576.23
T_5- F_2S_1	31.77	7.79	24.42	24.31	24.53	536.96
T_6- F_2S_2	36.88	7.61	24.61	24.68	25.48	576.61
T_7- V_1S_1	45.68	9.51	31.57	30.86	29.94	751.49
T_8- V_1S_2	41.33	9.19	29.49	29.04	28.59	709.32
T_9- V_2S_1	38.19	8.26	28.36	26.46	25.14	594.56
T_{10}-V_2S_2	39.02	7.94	26.55	25.50	25.25	563.08
CD (P=0.05)						
Factor A	3.53	0.51	1.38	2.114	1.59	69.08
Factor B	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Factor A×B	N.S.	N.S.	1.95	2.99	2.25	N.S.

Factor A- Organic manures, Factor B- Spacing

Table 2 : Effect of spacing and organic manure on physico- chemical parameter of cape gooseberry fruits

Parameters Treatments	Fruit length (mm)	Fruit width (mm)	Fruit weight (g)	Fruit volume (ml)	Specific gravity (g/ml)	T.S.S. (^{0}Brix)	Acidity (%)
T_1- C_0S_1	21.40	21.83	20.59	21.46	0.97	11.62	0.97
T_2- C_0S_2	21.70	21.50	20.90	22.17	0.93	8.21	0.95
T_3- F_1S_1	24.95	23.52	21.29	21.93	0.96	12.66	1.03
T_4- F_1S_2	23.32	23.91	22.50	22.33	1.00	12.76	1.04
T_5- F_2S_1	22.87	22.15	21.89	22.68	0.96	11.92	1.04
T_6- F_2S_2	22.67	23.84	22.63	21.61	1.03	11.70	1.02
T_7- V_1S_1	26.32	25.78	25.10	24.47	1.04	13.24	1.13
T_8- V_1S_2	**25.70**	**24.86**	**24.81**	**24.35**	**1.03**	**12.93**	**1.11**
T_9- V_2S_1	23.82	23.96	23.65	23.58	1.00	12.52	1.02
T_{10}-V_2S_2	24.11	23.95	22.30	21.98	1.00	12.45	1.04
C. D. (P=0.05)							
Factor A	1.22	1.74	6.09	1.16	N.S.	2.15	0.04
Factor B	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Factor A×B	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

nutrition is one of the best approach for several crops (Sarath *et al.*, 2016). Therefore, it is concluded that the vermicompost application (full dose) and planting at 80cm × 75cm spacing may be beneficial for cape gooseberry cultivation. The result is as per the principle that within a given crop, the better the individual plants which are able to spread and intercept light, the lower the optimum population per unit area *i.e.* plant density does not need to be higher than that which provides full ground cover (completely shading the ground surface) at maturity (Hargreaves and Merkley, 2004).

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