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Evaluation of Cape gooseberry (*Physalis peruviana* L.) genotypes under Jammu Plains

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ABSTRACT

Evaluation of Cape gooseberry cultivars was carried out at Research Farm, Division of Fruit Science, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu. The performance of the ten Cape gooseberry genotypes in terms of vegetative, flowering, fruiting, yield, and biochemical parameters was evaluated. The maximum plant height (114.66 cm) and leaf size (62.02 cm^2) was observed in CITH CGB Sel-10 genotype followed by CITH CGB Sel-9 genotype with 105.33 cm and 61.28 cm^2. The maximum days for flowering, fruiting and harvesting was taken by CITH CGB Sel-10 genotype (62.20, 72.07 and 134.28 days respectively) followed by CITH CGB Sel-9 genotype (61.61, 70.90 and 131.57 days respectively). The CITH CGB Sel-10 genotype showed the highest fruit weight (13.37 g) and fruit yield (1.26 kg $plant^{-1}$) followed by CITH CGB Sel-9 genotype (13.13 g and 1.20 kg $plant^{-1}$). The maximum TSS (12.61^{0}B) was observed in CITH CGB Sel-9 followed by CITH CGB Sel-3 (12.42^{0}B) and CITH CGB Sel-10 (12.31^{0}B). The highest ascorbic acid (31.12 mg 100 g^{-1}), total sugar (10.75 %) were observed in CITH CGB Sel-10 genotype while lowest carotenoids (1.13 mg 100 g^{-1}) and total sugar (5.22%) were found in CITH CGB Sel-5.

***Keywords*:** Ascorbic acid, Cape gooseberry, carotenoids, genotypes, Jammu plains, TSS, Total sugar, yield

INTRODUCTION

Cape gooseberry is a herbaceous, semi-shrubby, erect plant which grows as an annual in temperate regions but as a perennial in tropical & subtropical areas. It is known by different names in different parts of the world like Rasbhari in India, Uchuva in Colombia, Cape gooseberry in South Africa, Goldenberry in English-speaking countries, Topotopo in Venezuela Aguaymanto in Peru and Uvilla in Ecuador. Per 100g of edible portion of berry contains 11.5 per cent carbohydrates, 1.8 per cent protein, 0.2 per cent fat, 3.2 per cent fibre, 0.6 per cent mineral matter and 49 milligrammes ascorbic acid, 13% TSS, 6.0% reducing sugars, 8.6% total sugars and 1.52% total titrable acidity. The fruit or berries are the most important and potential sources of Vitamin A (2380 IU), Vitamin C (49 mg) and produces 55 calories energy per 100 g of fruits. It is successfully grown in several regions including Uttar Pradesh, West Bengal, Madhya Pradesh, Haryana, Punjab, the Nilgiri Hills and other regions of the country but also has good potential to grow under the subtropics and plains of Jammu. It gains special attention because of its availability during lean period, wider adaptation, rapid growth in nature, high productivity, non-perennial land occupation and tasty fruit with a pleasant acetic flavour. Because it is a small fruit crop in India, there is a scarcity of scientific data on its area and productivity, as well as new enhanced production methods under various agroclimatic conditions. Introduction and evaluation is one of the important method for bringing improvement in any fruit crop and for the selection of parents in a viable hybridization programme. Insect-pest occurrence and fruit cracking during fruit growth, development, and maturity are major issues in cape gooseberry (Bisht *et al*., 2018). To give Cape gooseberry a commercial boost, it is critical to find the right genotype. The aim of this study is to evaluate the most elites genotypes for cultivation under the Jammu plains.

MATERIALS AND METHODS

The present investigation was carried out at the Research Farm, Division of Fruit Science, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu during the year 2020-2021. Ten genotypes of Cape

gooseberry were evaluated for various growth, flowering, yield and biochemical parameters. The experiment was carried out in Randomized Block Design with three replications. Ten genotypes of cape gooseberry viz. CITH CGB Sel-1, CITH CGB Sel-2, CITH CGB Sel-3, CITH CGB Sel-4, CITH CGB Sel-5, CITH CGB Sel-6, CITH CGB Sel-7, CITH CGB Sel-8, CITH CGB Sel-9 and CITH CGB Sel-10 which were procured from Central Institute of Temperate Horticulture (CITH) Srinagar as a basis of the plant material. The plants were tagged in each replication of the treatment for data collection. The height of plant was measured at maturity stage using a measuring tape and was recorded in centimeter (cm). The thickness of the stem was also measured at 3 cm above the ground level at maturity stage using vernier caliper and expressed in centimeter (cm). The average shoot number was recorded by counting the number of shoots when the plant was fully grown. The leaf size was calculated by measuring the area of the graph paper covered by the leaf in square centimeter. The days of opening of flower bud in all the treatments was considered as the time of initiation of flowering. The days of start of fruit set in all the treatments was considered as the days for first fruit set. The days when calyx changed its colour from green to papery brown in maximum number of fruits was considered as the days for harvest of each treatment. With the use of an electronic balance, the weight of 10 randomly selected fruits from each replication of all the treatments was weighed. The average weight of fruit was computed and expressed in gram (g). The mean fruit length and breadth were measured using vernier caliper. The fruit volume was measured using water displacement method. The average yield plant^{-1} was calculated as product of average fruit weight and the total number of fruits produced/ plant and expressed in kilogram. The TSS was found using ERMA hand refractometer. The total acidity, reducing sugars, non reducing sugars, total sugars, pectin content, ascorbic acid were measured using A.O.A.C. (1995) method. The total carotenoids was recorded using the method described by (Carvalho *et al*., 2012). Resistance to viral infection and fruit cracking were determined by counting the number of infected fruits in each replication of all the treatment and computed in percent (%).

RESULTS AND DISCUSSION

Growth parameters of plant

Data with respect to different growth parameters of Cape gooseberry *viz.,* plant height, stem thickness, shoot number and leaf size is described in Table 1 which clearly indicates the significant variations. The differences in growth parameters might be due to inherent character acquired by strains from prevailing climatic conditions. The highest height of plant (114.66 cm) was found in CITH CGB Sel-10 which was statistically at par with CITH CGB Sel-9 (105.33 cm) while, lowest height of plant (90.33 cm) was recorded in CITH CGB Sel-2. These results are in accordance with the findings of Dwivedi *et al*. (2015); Ali and Singh (2016) and Panayotov (2016) in Cape gooseberry. The highest stem thickness (3.15 cm) was observed in CITH CGB Sel-10 whereas, minimum stem thickness (2.95 cm) was observed in CITH CGB Sel-2. Dwivedi *et al.* (2015) stated that stem diameter varied from 4.5 cm to 5.65 cm at different sowing time and spacing in Cape gooseberry. Singh *et al*. (2014) also reported that in Cape gooseberry maximum stem diameter (1.28 mm) was observed at thirty days after germination. Maximum number of shoot (16.07) was found in CITH CGB Sel-10, which was statistically at par with CITH CGB Sel-5 (15.60) and CITH CGB Sel-9 (16.00) whereas, minimum values of shoot number (13.61) was observed in CITH CGB Sel-2. Diversity in the synthesis of endogenous hormones like auxin and gibberellins as a result of genetic variability and inherent character in different genotypes might be the possible reason for difference in shoot number among various genotypes. Kour and Bakshi (2006) stated that highest number of shoots per plant (13.90) was found in the FRB strain of cape gooseberry. The leaf size ranged from 62.02 cm^2 to 51.40 cm^2 among the genotypes. Similar results were also reported by Kour and Bakshi (2006) that leaf area ranged from 51.40 cm^2 to 56.50 cm^2 among the different strains of cape gooseberry.

Flowering and fruiting behavior

The flowering and fruiting parameters were significantly differed among different genotypes (Table 2). The data mentioned in Table 2 revealed

Table 1: Growth characteristics of selected genotypes of Cape gooseberry under Jammu plains

Treatments	Average plant height (cm)	Average stem thickness (cm)	Average shoot number	Average leaf size (cm^2)
T_1 - CITH CGB Sel-1	92.73	2.98	13.91	53.49
T_2 - CITH CGB Sel-2	90.33	2.95	13.61	51.40
T_3 - CITH CGB Sel-3	104.00	3.10	15.83	61.12
T_4 - CITH CGB Sel-4	95.16	3.00	14.45	59.97
T_5 - CITH CGB Sel-5	99.79	3.07	15.60	60.73
T_6 - CITH CGB Sel-6	97.47	3.03	14.32	55.83
T_7 - CITH CGB Sel-7	94.14	2.99	14.08	55.76
T_8 - CITH CGB Sel-8	91.47	2.96	13.81	51.58
T_9 - CITH CGB Sel-9	105.33	3.09	16.00	61.28
T_{10} - CITH CGB Sel-10	114.66	3.15	16.07	62.02
C.D. (0.05) **(S.E.±m)**	**10.17** **3.42**	**0.12** **0.04**	**1.45** **0.49**	**7.65** **2.58**

Table 2: Flowering and fruiting behavior of selected genotypes of Cape gooseberry under Jammu plains

Treatments	Days for initiation of flowering (days)	Days for initial fruit set (days)	Days for fruit harvest (days)
T1- CITH CGB Sel-1	31.69	38.48	86.50
T2- CITH CGB Sel-2	45.80	51.55	101.42
T3 - CITH CGB Sel-3	56.36	64.17	123.11
T4- CITH CGB Sel-4	54.49	61.81	113.72
T5 - CITH CGB Sel-5	55.70	63.56	117.73
T6- CITH CGB Sel-6	58.34	66.96	127.79
T7- CITH CGB Sel-7	57.20	65.53	125.55
T8 - CITH CGB Sel-8	59.02	68.17	129.10
T9- CITH CGB Sel-9	61.61	70.90	131.57
T10 - CITH CGB Sel-10	62.20	72.07	134.28
C.D. (0.05) **(S.E.±m)**	**6.87** **2.31**	**9.43** **3.18**	**14.61** **4.92**

that maximum time to initiate flowering (62.20 days) was taken by CITH CGB Sel-10 which was statistically at par with CITH CGB Sel-3 (55.70 days), CITH CGB Sel-5 (56.36 days), CITH CGB Sel-7 (57.20 days) and CITH CGB Sel-9 (61.61 days) while minimum time to initiate flowering (31.69 days) was taken by CITH CGB Sel-1. The variation in the time of flowering might be based on the differences in various physiological phenomenon in different genotypes. Maximum time of fruit set (72.07 days) was also observed CITH CGB Sel-10 whereas, minimum time of fruit set (38.48 days) was observed in CITH CGB Sel-1. Dwivedi *et al*. (2014) reported that first flower opening and fruit set were observed at 24.50 and 32.00 DAT respectively in cape gooseberry**.** The

Table 3: Physical characteristics of fruits of selected genotypes of Cape gooseberry under Jammu plains

Treatments	Average weight of fruit(g)	Average length of fruit (cm)	Average breadth of fruit(cm)	Average volume of fruit (cc)	Average yield per plant (kg)
T_1- CITH CGB Sel-1	11.55	2.08	2.41	11.72	1.02
T_2- CITH CGB Sel-2	11.10	2.00	2.31	11.50	0.88
T_3 - CITH CGB Sel-3	12.87	2.97	3.20	12.17	1.18
T_4 - CITH CGB Sel-4	12.44	2.45	2.80	12.20	1.15
T_5- CITH CGB Sel-5	12.74	2.51	3.11	12.54	1.17
T_6- CITH CGB Sel-6	12.15	2.21	2.50	13.50	1.11
T_7- CITH CGB Sel-7	12.13	2.14	2.48	12.10	1.08
T_8 - CITH CGB Sel-8	11.45	2.11	2.45	11.15	0.98
T_9 - CITH CGB Sel-9	13.13	2.72	3.44	13.72	1.20
T_{10} - CITH CGB Sel-10	13.37	3.04	3.47	14.71	1.26
C.D. (0.05) **(S.E.±m)**	**1.29** **0.44**	**0.41** **0.14**	**0.42** **0.14**	**1.64** **0.55**	**0.17** **0.06**

Table 4: Biochemical parameters of fruits of (selected) genotypes of cape gooseberry under Jammu plains

Treatments	T.S.S (°Brix)	Acidity (Per cent)	Carotenoids (mg/ 100g)	Pectin (Per cent)	Ascorbic acid (mg/ 100g)	Reducing sugar (Per cent)	Non reducing sugar (Per cent)	Total sugar (Per cent)
T_1 - CITH CGB Sel-1	10.40	0.89	1.40	0.53	24.28	5.47	5.26	10.73
T_2- CITH CGB Sel-2	9.63	0.95	1.20	0.99	22.41	3.08	2.93	6.00
T_3 - CITH CGB Sel-3	12.42	0.46	1.45	1.01	22.70	3.26	3.13	6.40
T_4 - CITH CGB Sel-4	11.50	0.61	1.55	0.98	23.17	3.55	3.46	7.02
T_5- CITH CGB Sel-5	11.92	0.52	1.13	1.02	24.22	2.68	2.55	5.22
T_6- CITH CGB Sel-6	10.73	0.78	1.60	0.97	26.10	4.03	3.84	7.87
T_7- CITH CGB Sel-7	10.52	0.88	1.42	0.95	29.66	4.85	3.68	8.50
T_8 - CITH CGB Sel-8	9.48	1.10	1.49	0.67	29.79	4.50	4.31	8.80
T_9 - CITH CGB Sel-9	12.61	0.41	1.28	0.61	30.57	5.24	4.95	10.22
T_{10} - CITH CGB Sel-10	12.31	0.50	1.39	0.57	31.12	5.48	5.27	10.75
C.D. (0.05) **S.E. (±m)**	**1.18** **0.40**	**0.09** **0.03**	**0.18** **0.06**	**0.10** **0.03**	**3.24** **1.09**	**0.41** **0.14**	**0.35** **0.12**	**1.06** **0.36**

time of harvesting ranged from 134.28 days to 86.50 days among the various genotypes. These results are in agreement with Kaur and Bakshi, (2006); Panayotov and Popova, (2014), Singh *et al*. (2014) and Gond *et al*. (2018) in cape gooseberry.

Physical parameters of fruit

The data mentioned in Table 3 revealed that maximum value of fruit weight (13.37 g) was observed in CITH CGB Sel-10 whereas, minimum fruit weight (11.10 g) was observed in CITH CGB Sel-2. Kour and Bakshi, (2006) observed that

weight of fruit ranged from 9.80 grammes to 12.20 grammes in various strains of Cape gooseberry. Similarly maximum fruit length (3.04 cm) was observed in CITH CGB Sel-10 which was statistically at par with CITH CGB Sel-9 (2.72 cm) and CITH CGB Sel-3 (2.97 cm) while minimum fruit length (2.00 cm) was observed in CITH CGB Sel-2. The diameter of fruit ranged from 3.47 cm to 2.31 cm. Genotype CITH CGB Sel-10 recorded maximum fruit volume (14.71 cc) which was statistically at par with CITH CGB Sel-6 (13.50 cc) and CITH CGB Sel-9 (13.72 cc) whereas, minimum fruit volume (11.15 cc) was observed in CITH CGB Sel-8. Highest yield per plant (1.26 kg) was observed in CITH CGB Sel-10 whereas, lowest yield per plant (0.88 kg) was observed in CITH CGB Sel-2 (T_2). Sharma *et al.* (2019) reported that the yield per plant varies between 1.20 kg/plant to 3.64 kg/plant in various genotypes of cape gooseberry.

Biochemical parameters

Mean performance of different Cape gooseberry genotypes for the chemical parameters clearly showed the significant difference (Table 4). TSS ranged from 12.61^0 Brix in (CITH CGB Sel-9) to 9.48^0 Brix in (CITH CGB Sel-8). The variation in TSS among various genotypes could be attributed due to their genetic constitution as well as it depends on the nature of the variety which governs the chemical composition of the fruits. Silva, (2013) stated that average TSS (6.52^0 Brix) was observed in *Physalis pubescens*. The maximum titratable acidity (1.10 %) was observed in CITH CGB Sel-8 whereas, the minimum titratable acidity (0.41 %) was observed in CITH CGB Sel-9. The variation in acidity among various genotypes could be attributed to environmental condition during the peak growth of the fruits as well as the genotype differences. Ersoy and Bagci (2011) recorded that mean titratable acidity value ranged from 0.78 % to1.83 % in golden berries. Maximum reducing sugar (5.48 %) was observed in CITH CGB Sel-10 while minimum value of reducing sugar (2.68 %) was observed in CITH CGB Sel-5. Rodrigues *et al.* (2014) recorded 6.4 % reducing sugar in *Physalis peruviana* L. Highest magnitude of non reducing sugar (5.27 %) was reported in CITH CGB Sel-10 which showed non significant difference with CITH CGB Sel-10 (4.95 %) while, minimum value of non reducing sugar (2.55 %) was recorded in CITH CGB Sel-5. The total sugar ranged from 10.75% to 5.22%. Kumar *et al.* (2021) reported that total sugar ranged from 2.05 % to 10.86 %. Maximum carotenoids content (1.60 mg/ 100 g) was observed in CITH CGB Sel-6 whereas, minimum carotenoids content (1.13 mg/ 100 g) was observed in CITH CGB Sel-5. Patidar *et al.* (2018) reported that in different fertilizers treatments carotenoid content ranges from 1.13 to 1.63 mg/ 100 g. Ascorbic acid varied from 31.12 mg to 22.41 mg/ 100 g. Sharma *et al.* (2017) reported that ascorbic acid value varied from 22.69 mg/100 g to 32.24 mg/100 g among different genotypes. Maximum value of pectin content (1.02 %) was observed in CITH CGB Sel-5 which was statistically at par with CITH CGB Sel-2 (0.99 %) and CITH CGB Sel-3 (1.01 %) while minimum value of pectin content (0.53 %) was observed in CITH CGB Sel-1. Such variations might be due to varietal differences and environmental conditions during ripening. Mazova *et al.* (2020) reported that *Physalis peruviana* L. contains 1.03 % pectin.

CONCLUSION

In this study the growth, yield and biochemical parameters were assessed in different genotypes of Cape gooseberry. Significant variations were observed among the various parameters. Based on the overall study of all the parameters i.e earliness physical and chemical characters of fruits in various genotypes, CITH Sel-10, CITH Sel-9 and CITH Sel-3 were found to be superior with respect to plant height, stem thickness, shoot number, leaf size, fruit weight, length of fruit, breadth of fruit, volume of fruit, yield, TSS, reducing sugar, non reducing sugar, total sugar, carotenoids and pectin content.

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