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Genetic analysis of yield and yield attributing traits of Cape gooseberry genotypes

Vijay Kumar*, R.S. Singh, Mahender Pal, V.B. Patel***, R.B.Verma**** and M.D. Ojha*****

Department of Horticulture (F&FT), Nalanda College of Horticulture (Bihar Agril. University), Noorsarai, Nalanda 803113, Bihar

ABSTRACT

The present investigation was conducted aiming to assess the genetic analysis and observed that the two genotypes, namely NCOH CAP S-9 & NCOH CAP S-13 produced maximum fruit yield per plant (0.51 kg) due to heaviest average fruit weight and number of fruit per plant. Number of branches per plant and fruit weight showed moderate GCV while, number of fruits per plant and yield per plant exhibited high value of GCV i.e. 40.11 and 48.75 have better scope of improvement. Low heritability (0.92 %) accompanied with high genetic advance (29.05) revealed that the trait, number of fruits per plant is governed by additive gene effects and therefore selection based on phenotypic performance may prove useful. The estimates of broad sense heritability values ranging from 0.34 % to 0.97 % indicated more contribution of dominance and epistatic variances for all the traits under study. Estimates of genotypic, phenotypic and environmental correlation coefficients among the eight characters of local populations under study showed significant positive relation with fruits per plant and fruit weight. Plant height was significantly associated with the branches per plant, fruit length, fruit diameter and total soluble solids. Fruit length was significantly associated with the fruit diameter.

Key words: *Physalis peruviana*, variability, heritability, genetic advance.

INTRODUCTION

Cape gooseberry (*Physalis peruviana* L.) is one of the herbaceous minor fruit crops of family Solanaceae having 2n = 4x = 48 chromosome number (Tetraploid) (Trevisani *et.al.*, 10). The origin and diversification of Cape gooseberry is Andean zone, mainly in Colombia, Peru and Equador, from where it was disseminated to different climatic zones of tropical, subtropical and temperate regions (Hawkes, 7). In India, it is mainly grown in few pockets of Uttar Pradesh, Punjab, Rajasthan and Bihar. The major growing districts in Bihar are Nalanda, Gaya, Patna and Buxer. It can be grown successfully as sole crop, intercropping along with perennial fruit orchards and kitchen garden for their cherry size, attractive golden yellow and delicious fruits. Within the *Physalis* genus, there are significant differences between cultivated *P. ixocarpa* and *P. peruviana* in respect of growth, yield and quality parameters (Godina *et. al.*, 5). *Physalis peruviana* fruit contains high level of ascorbic acid (36 mg 100 g^{-1} pulp), rich in vitamin A (1730 IU. 100 g^{-1} of pulp) iron (38 mg 100g^{-1} of pulp) and Phosphorus (1.2 mg 100g^{-1} of pulp) (Fischer, 4). The fruits are eaten fresh and can be commercially used in making excellent jam, ice cream and sweet pickles; sometimes it is canned in heavy sugar syrup.

The genetic potential of the variety can be expressed to maximum through optimum cultural practices and adequate nutrient management as well. The yield is primarily governed by the genetic makeup of the genotype. For the development of effective breeding programme, existence of significant variability, inheritance pattern of yield attributing traits is of prime importance and in this regards information is lacking in cape-gooseberry. Many times direct selection becomes ineffective due to low heritability of the concern trait. The genotypic coefficient of variation helps to measure the range of genetic variability and also provides a measure to compare the genetic variability present for various characters. The heritable portion is thus required to be known with the help of heritability estimation (Burton, 2). Genetic advance, a function of heritability, indicates the potentiality of selection intensity and when considered along with heritability gives a reliable assessment of the resultant effect of selection in breeding population (Johnson *et al.*, 8).Yield *per se* may not be a reliable criterion for selection because of its low heritability and high genotypic and environmental interaction. Understanding of the extent to which the component characters can effectively be utilized in selecting for the ultimate character is expected to increase the efficiency of selection.

*Corresponding author's Email: vijaykumar0517@gmail.com
**Department of PBG, MBAC, Agwanpur, Saharsa,
***Division of Fruits and Horticultural Technology, IARI, New Delhi
****Department of vegetable & Floriculture, BAC, Bhagalpur, Bihar
*****Department of vegetable & Floriculture, NCOH, Noorsarai, Nalanda

Keeping in view the above facts under consideration, the present investigation was formulated to unravel the inheritance pattern of yield and yield attributing traits of cape gooseberry (*Physalis peruviana* L.) genotypes under sub tropic condition of Bihar (India) and their implications for improvement of the crop.

MATERIALS AND METHODS

The experiment was conducted at experimental field of Nalanda College of Horticulture, Noorsarai, Nalanda, campus of Bihar Agricultural University Sabour, Bhagalpur, Bihar during 2014-15 and 2015-16 to screen out suitable genotypes of Cape gooseberry in respect of yield and quality traits under sub tropic region of Bihar. The experimental site is situated about 10 km away from Nalanda district head quarter and 65 km from Patna city at 25°.27' latitude and 85^0.45' longitude and 57 meters above the mean sea level. The seeds of eighteen genotypes of Cape gooseberry namely, NCOH CAP S 1 (Allahabad), NCOH CAP S 2 (Akangardih), NCOH CAP S 3 (Attasarai), NCOH CAP S 4 (Bhadeja Gaya), NCOH CAP S 5 (Bhagalpur 1), NCOH CAP S 6 (Bhagalpur 2), NCOH CAP S 7 (Biharsharif 1), NCOH CAP S 8 Biharshari 2), NCOH CAP S 9 (Gaya 1), NCOH CAP S 10 (Gaya 2), NCOH CAP S 11 (Gaya 3), NCOH CAP S 12 (Gaya 4), NCOH CAP S 13 (Hilsa), NCOH CAP S 14 (Jafarganj), NCOH CAP S 15 (Patna big 1), NCOH CAP S 16 (Patna small), NCOH CAP S 17 (Patna 1), NCOH CAP S 18 (Sabait) were collected from different district of Bihar and Uttar Pradesh. The seeds were sown in the first fortnight of September on 1.2 × 3 × 0.15 m raised nursery beds keeping 45 cm path cum irrigation channel between each beds. The beds were mulched with paddy straw till germination. Four weeks old seedlings (4-6 leaf stage) were transplanted in the well prepared field of 3m × 2m plot size at 60 × 45 cm spacing in Randomized Block design with three replications in the month of October. Plants were irrigated through watering can just after transplanting to establish the plants in the field. The data were recorded on Plant height (cm), Number of branches per plant, Number of fruits per plant, Fruit diameter (mm.), Fruit length (mm), Fruit weight (g), TSS (°Brix) and fruit yield per plant (kg) at appropriate maturity stage in to 4-5 pickings. The recorded data were subjected for statistical analysis as suggested by (Fisher and Yates, 3). The phenotypic and genotypic coefficients of variations were calculated according to (Burton and Devane, 1). Heritability (h^2) in broad sense was calculated with the help of formula given by (Hanson *et. al.*, 6), Genetic advance was estimated through the method proposed by (Johnson *et. al.*, 8) and character association among yield attributing traits (Panse and Sukhatme, 9).

RESULTS AND DISCUSSION

From the perusal of Table-1, it is evident that all the growth and yield parameters were influenced significantly due to various genotypes of Cape gooseberry. NCOH CAP S-13 genotype attained maximum plant height (131.75 cm) while, the genotype NCOH CAP S-7 produced maximum 23.50 branches per plant. Number of fruits per plant (60.5), Fruit diameter (21.73 mm) and average fruit weight (8.59g) was maximum in NCOH CAP S-9 followed by NCOH CAP S-13 line with 58.3, 22.00 mm, 8.58g respectively. Genotype NCOH CAP S-18 produced longest fruits with 24.23 mm followed by NCOH CAP S-9 with 23.52 mm. as for as quality is concerned, the most important fruit quality trait i.e. total soluble solids did not show significant variation in to various genotypes. Two genotypes i.e. NCOH CAP S-9 and NCOH CAP S-13 yielded maximum of 0.51 kg fruit per plant. These variations may be due to the genetic potential and adaptability of genotypes in the specific climatic conditions. The variation among genotypes for different growth and yield attributing traits of Cape gooseberry could be designated to the genetic attributes of selected genotypes. Similar type of reasons have also been reported by (Singh *et al.*, 11) in Cape gooseberry.

Coefficient of variation measures consistency of the crop. The extent of variability present in the Cape gooseberry genotypes were measured in terms of phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV) and environmental coefficient of variation. The data presented in Table 2 showed wide range of GCV for various characters and varied from 3.68 for total soluble solids to 48.75 for fruit yield per plant. Number of branches per plant and fruit weight showed moderate GCV, while number of fruits per plant and yield per plant exhibiting high value of GCV i.e. 40.11 and 48.75, therefore indicate better scope of improvement. Similarly, high value of PCV for these two traits indicated less influence of environment. Slightly higher value of PCV than the GCV for all the traits indicated that apparent variation was due to the influence of environment.

To determine the amount of heritable variation, estimation of GCV alone is not sufficient. Heritable variation can be found out with greater degree of accuracy when heritability is studied in addition with expected genetic advance which helps the plant breeder to select elite genotypes from diverse genetic population. The estimates of broad sense heritability values ranging from 0.34 % to 0.97

Table 1. Mean values of 18 genotypes for eight characters of Cape gooseberry (*Physalis peruviana* L.) genotypes.

Genotypes	Plant Height (cm)	No. of branches /plant	No. of Fruit/Plant	Weight / Fruit (g)	Fruit diameter (mm)	Fruit Length (mm)	T.S.S. %	Fruit yield/ Plant (kg)
NCOH CAP S-1	99.05	13.50	47.8	7.19	18.26	20.56	13.15	0.34
NCOH CAP S-2	108.34	14.50	57.7	7.92	20.48	22.62	14.28	0.44
NCOH CAP S-3	113.32	17.50	22.8	6.27	19.08	20.12	15.07	0.15
NCOH CAP S-4	121.03	14.17	22.0	8.35	18.15	20.53	14.25	0.18
NCOH CAP S-5	118.53	16.33	15.5	5.30	19.52	20.48	15.05	0.09
NCOH CAP S-6	112.38	17.50	26.7	5.22	19.18	21.02	14.88	0.14
NCOH CAP S-7	107.00	23.50	32.2	6.12	19.38	21.05	13.37	0.20
NCOH CAP S-8	120.92	19.33	28.0	7.92	20.63	22.10	15.30	0.22
NCOH CAP S-9	120.47	20.00	60.5	8.59	21.73	23.52	13.97	0.51
NCOH CAP S-10	110.30	17.83	22.3	6.32	19.38	20.78	14.50	0.14
NCOH CAP S-11	117.83	16.50	28.8	6.45	19.83	21.05	13.50	0.19
NCOH CAP S-12	119.48	19.00	53.7	5.48	19.13	20.70	14.25	0.28
NCOH CAP S-13	131.75	22.83	58.3	8.58	22.00	23.02	14.45	0.51
NCOH CAP S-14	106.45	12.00	27.7	8.38	20.77	21.63	14.60	0.23
NCOH CAP S-15	113.63	14.17	51.7	7.42	21.40	22.26	14.00	0.35
NCOH CAP S-16	116.98	14.17	39.0	6.48	18.90	20.80	14.43	0.25
NCOH CAP S-17	126.68	16.50	41.8	8.37	21.43	21.51	14.95	0.33
NCOH CAP S-18	111.70	21.50	22.0	6.25	22.27	24.23	14.70	0.13
CD at 5%	12.584	3.796	6.273	0.341	1.012	1.317	NS	0.040

Table 2. Estimation of genetic parameters-variability, heritability and genetic advance as percent of mean for 8 characters in Cape gooseberry genotypes.

	Plant Height (cm)	No .of branches/ Plant	No. of fruits/ Plant	Fruit Weight (g)	Fruit diameter	Fruit Length (mm)	TSS %	Fruit Yield/ Plant (kg)
Var Genotypic	37.18	8.62	215.35	1.39	1.92	1.75	0.28	0.02
GCV	5.29	17.00	40.11	16.73	6.27	6.44	3.68	48.75
Var Phenotypic	109.39	15.12	233.18	1.43	2.64	2.11	0.53	0.02
PCV	9.07	22.52	41.74	16.99	7.36	7.08	5.07	49.62
Var Environmental	72.21	6.50	17.83	0.04	0.72	0.37	0.25	0.00
ECV	7.37	14.77	11.54	2.91	3.86	2.96	3.49	9.23
h^2 (Broad Sense)	0.34	0.57	0.92	0.97	0.73	0.83	0.53	0.97
Genetic Advance 5%	7.32	4.57	29.05	2.39	2.43	2.47	0.79	0.26
General Mean	115.33	17.27	36.58	7.03	22.08	20.53	14.37	0.26

% indicated more contribution of dominance and epistatic variances for all the traits under study. Low heritability value (0.92 %) accompanied with high genetic advance (29.05) revealed that the trait number of fruits per plant is governed by additive gene effects and therefore, selection based on phenotypic performance may prove useful. This low heritability was due to high environmental effects. Improvement in yield is the main target of any crop breeding programme and in the present investigation, fruit yield per plant showed slightly higher heritability along with low genetic advance.

This heritability was due to dominant gene effects and selection for the trait will be ineffective. Selection will also be ineffective for rest of all the traits having low heritability values accompanied with low genetic advance.

Improvement of economic characters, like yield is affected through selection of superior genotypes as judged from phenotypic appearances. A given phenotype is a manifestation of given genotype, environment and interaction of the both. The complexes the phenotype, the greater the interaction. Fruit yield, an extremely complex entity, is a result of many growth and development processes in plant and each step is liable to environmental fluctuation. Reports suggested that there may not be genes for yield but rather for various components, the multiplicative interaction of which results in artefact of yield. Since, selection for increased yield is usually concern with changing two or more characters; simultaneously an understanding of the nature and magnitude of their relationship in populations would be of immense value in assigning rational weights to the different component characters during selection.

Estimates of genotypic, phenotypic and environmental correlation coefficients among the eight characters of local populations under study are presented in Table 3 and found significant positive relation with fruit per plant and fruit weight. Plant height was significantly associated with the branches per plant, fruit length, fruit diameter and total soluble solids. Fruit length was significantly associated with the fruit diameter. Branches per plant, fruit diameter and fruit length was positively associated for environmental correlation. All the traits under study for genotypic correlation were positively correlated though with non-significant value except for total soluble solids with negative association.

The present investigation was conducted aiming to assess the genetics of yield and yield attributing traits of Cape gooseberry (*Physalis peruviana* L.) genotypes under sub tropic condition of Bihar (India) and observed that two genotypes i.e., NCOH CAP

Table 3. Genotypic (G), Phenotypic (P) and Environmental (E) correlation matrix for eight yield attributing traits of Cape gooseberry genotypes

Character		Plant Height (cm)	Branches/ Plant	Fruits/ Plant	Average Fruit Weight (g)	Fruit Length (mm)	Fruit diameter	TSS % of Fruits	Fruit Yield/ Plant (kg)
Plant Height (cm)	G	1.0000	0.3764	0.2201	0.3736	0.5984	0.2497	0.5224	0.3380
	P		0.3159*	0.1269	0.2223	0.2804*	0.2804*	0.3119*	0.1817
	E		0.2819*	0.0161	0.0556	-0.1079	0.3673**	0.1625	-0.0785
Branches/ Plant	G	0.3764	1.0000	0.0625	-0.1783	0.1946	0.2516	0.0616	0.0702
	P	0.3159*		0.0705	-0.1421	0.0867	0.2717*	0.0003	0.0673
	E	0.2819*		0.1389	-0.0849	-0.1712	0.3199*	-0.0742	0.1253
Fruits/ Plant	G	0.2201	0.0625	1.0000	0.4527	0.0867	-0.0165	-0.4825	0.9475
	P	0.1269	0.0705		0.4270**	0.0676	-0.0283	-0.2883*	0.9268***
	E	0.0161	0.1389		-0.0355	-0.0700	-0.1024	0.2538	0.6261***
Average Fruit Weight (g)	G	0.3736	-0.1783	0.4527	1.0000	0.5777	0.4930	-0.0499	0.6881
	P	0.2223	-0.1421	0.4270**		0.5093***	0.4112**	-0.0483	0.6683***
	E	0.0556	-0.0849	-0.0355		-0.1108	-0.0277	-0.1075	0.0683
Fruit Length (mm)	G	0.5984	0.1946	0.0867	0.5777	1.0000	0.9224	0.3878	0.2611
	P	0.2804*	0.0867	0.0676	0.5093**		0.6726***	0.1781	0.2280
	E	-0.1079	-0.1712	-0.0700	-0.1108		-0.1889	-0.2708*	-0.0659
Fruit Width	G	0.2497	0.2516	-0.0165	0.4930	0.9224	1.0000	0.2923	0.1586
	P	0.2804*	0.2717*	-0.0283	0.4112**	0.6726***		0.1937	0.1104
	E	0.3673**	0.3199*	-0.1024	-0.0277	-0.1889		0.0362	-0.2292
TSS % of Fruits	G	0.5224	0.0616	-0.4825	-0.0499	0.3878	0.2923	1.0000	-0.3656
	P	0.3119*	0.0003	-0.2883*	-0.0483	0.1781	0.1937		-0.2614
	E	0.1625	-0.0742	0.2538	-0.1075	-0.2708*	0.0362		-0.0050
Fruit Yield/ Plant (kg)	G	0.3380	0.0702	0.9475	0.6881	0.2611	0.1586	-0.3656	1.0000
	P	0.1817	0.0673	0.9268***	0.6683***	0.2280	0.1104	-0.2614	
	E	-0.0785	0.1253	0.6261***	0.0683	-0.0659	-0.2292	-0.0050	

S-9 & NCOH CAP S-13 produced maximum fruit yield per plant (0.51 kg) due to heaviest average fruit weight and number of fruits per plant. Wide range of genotypic coefficient of variation was observed for the traits under study ranging from 3.68 for total soluble solids to 48.75 for fruit yield per plant. Number of branches per plant and fruit weight showed moderate GCV, while number of fruits per plant and yield per plant exhibited high value of GCV 40.11 and 48.75 indicating better scope of improvement. The estimates of broad sense heritability values ranging from 0.34 - 0.97 per cent indicated more contribution of dominance and epistatic variances for all the traits under study. Low heritability (0.92 per cent) accompanied with high genetic advance (29.05) revealed that the trait number of fruit per plant is governed by additive gene effects and therefore, selection based on phenotypic performance may prove useful. Estimates of genotypic, phenotypic and environmental correlation coefficients among the eight characters of local populations under study showed significant positive relation with fruit per plant and fruit weight. Plant height was significantly associated with the branches per plant, fruit length, fruit diameter and total soluble solids. Fruit length was significantly associated with the fruit diameter.

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