DOI : 10.5958/0974-0112.2020.00039.0

Indian J. Hort. 77(2), June 2020: 287-292

Genetic variability and correlation analysis for fruit yield and quality traits in bottle gourd

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ABSTRACT

Twenty-five bottle gourd genotypes were evaluated to know the heritable genetic variation and correlation coefficients among fruit yield, yield attributes and quality parameters. Mean sum of squares due to genotypes were highly significant for all the traits studied. Genotypes Narendra Shivani, MBL 3, Anand Bottle Gourd 1, MBL 2 and IC 085608 were high fruit yielding genotypes. The yield attributes among these genotypes varied from genotype to genotype being governed by different genetic mechanism. In general, the low to moderate estimate of GCV and PCV, ranging from 2.85 to 44.53 and 6.21 to 46.17 was observed in the present material, respectively. Fruit yield q/ha, fruit length, fruits/ vine and vine length showed the moderate estimates of both GCV and PCV, whereas, rest of the characters exhibited the low estimates. Fruit yield q/ha, fruit length, fruits/ vine, vine length, fruit diameter, nodes bearing first female flower, primary branches/ vine and nodes bearing first male flower exhibited high heritability coupled with high genetic advance as percentage of mean thus, direct selection based on phenotypic performance would be effective. Fruit yield q/ha showed significant positive correlation coefficient with fruits/vine, fruit length, harvest index, vine length, primary branches / vine, nodes bearing first female flower, fruit weight, nodes/vine, SPAD value, inter nodal length, fruit diameter, nodes bearing first male flower, inter nodal length and days to first male flower anthesis. Similarly, total soluble solids showed positive and significant correlation with fruit yield, harvest index and dry matter content of the fruits thus, these characters can be improved simultaneously in bottle gourd.

Key words: *Lagenaria siceraria*, interrelationship, diversity, genetic parameters, heritability.

INTRODUCTION

Bottle gourd (*Lagenaria siceraria* (Mol.) Standl.) also known as calabash gourd or white flowered gourd plant and locally known as *Lauki* is a member of the Cucurbitaceae family. It is an easily digestible and cooked vegetable recommended to patients suffering from stomach problems. In addition, white pulp of fruit is emetic, purgative, diuretic, antibilious and it's having a cooling effect. Oil from the seeds is used to relieve headache and also diuretic and nutritive (Rahman *et al*., 8). In India, this crop is successfully cultivated in states of Rajasthan, Punjab, Uttar Pradesh, Bihar, West Bengal, Madhya Pradesh, Maharashtra, Gujarat and Andhra Pradesh. The total area under its cultivation in India was around 149.00 thousand hectares with an annual production of 2458.00 thousand metric tonnes during 2015-16. The crop has a tremendous potential for export and created a huge demand in Gulf markets in recent years. However, its productivity is low which deserve improvement through genetic manipulations with systematic breeding programme.

Selection efficiency largely depends upon the magnitude of variability exists in population. Heritability and genetic advance as percentage of mean determine the extent of ability of a character to transmit in next generation and influence of environment determine their phenotypic expression. The heritability estimates accompanied with genetic advance as percentage of mean through light on nature of inheritance of the characters thus, add in selection. Correlation coefficients among yield and its attributing characters determine the nature of selection criteria to be practice in selection breeding programme. The information on these aspects is very scanty in bottle gourd. The present investigation was planned with this objectives and view.

MATERIALS AND METHODS

Twenty-five bottle gourd genotypes were evaluated in Randomized Complete Block Design with three replications during *kharif* season 2016-17 at Vegetable Research field, Department of Vegetable Science, College of Horticulture, Mandsaur, Madhya Pradesh. The healthy, disease and insect free good quality seeds were treated with mancozeb + carbendazim (2 + 1 g/kg seed) before sowing. The experiment was sown on 7th September in lines at a spacing of 1.5 × 0.9 m^2 and depth of 1.5 - 2.5 cm, which were covered with soil. A dose of fertilizers 60: 50: 50 kg NPK /ha was applied to the crop. The entire quantity of

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phosphorus and potassium and half of nitrogen were mixed thoroughly and incorporated in soil as basal dose before sowing. Two top dressings with nitrogen at 45 DAS and 60 DAS was done. Recommended other cultural practices were adopted for better crop growth. Five competitive plants were selected randomly and tagged from each genotypes and each replications to record observation on vine length (m), primary branches/vine, chlorophyll content in leaves (SPAD value), nodes bearing first male flower, nodes bearing first female flower, nodes/vine, inter nodal length (cm), days to first male flower anthesis, days to first female flower anthesis, days to first fruit picking, fruit length (cm), fruit diameter (cm), fruits/ vine, fruit weight (g), fruit yield (q/ha), harvest index, total soluble solids (ºBrix), dry matter content (%) and flesh thickness (cm). Genetic parameters namely, genotypic and phenotypic coefficients of variation, heritability in broad sense, genetic advance as percentage of mean and correlation coefficients were estimated by adopting standard statistical procedure as described by Singh and Choudhary (13).

RESULTS AND DISCUSSION

Highly significant mean sum of squares for all the studied characters revealed the presence of sufficient variability in present material thus offer good scope for selection desirable ones. The mean performance of growth attributes was 3.92 m, 19.12, 39.11, 9.44, 12.55, 45.24, and 11.10 cm ranging from 2.33 to 7.03 m, 9.33 to 34, 35.33 to 42.07, 6.93 to 18.20, 8.67 to 27.60, and 9.00 to 14.60 cm vine length, primary branches /vine, SPAD value, nodes bearing first male flower, nodes bearing first female flower, nodes/vine and inter nodal length respectively (Table 1). Similar variation has also been reported by Samadia (9) and Sharma and Sengupta (11). Days to first male flower anthesis, days to first female flower anthesis and days to first fruit picking were on an average, 45.15 days, 50.26 days and 62.88 days ranging from 37.53 to 53.33 days, 42.06 to 58.27 days and 56.66 to 74.00 days, respectively in the present material as also reported by Harika *et al*. (3), Sharma and Sengupta (12), and Muralidharan *et al*. (7).

Average values for fruit length, fruit diameter, fruits/ vine, fruit weight, fruit yield q/ha, and harvest index was 32.33 cm, 9.13 cm, 5.87, 1103.26 g, 6.48 kg, 480.06 q, and 70.88% in present material respectively. It ranged from 10.53 to 74.43 cm, 6.40 to 14.93 cm, 2.87 to 14.20, 697.67 to 1473.00 g, 3.11 to 15.08 kg, 230.35 to 1117.22 q, and 57.93 to 82.20 % for fruit length, fruit diameter, fruits/ vine, fruit weight, fruit yield/vine, fruit yield q/ha, and harvest index as also reported by Harika *et al*. (3) and Muralidharan *et*

Table 1. Genetic parameters for yield attributing traits, fruit yield and quality parameters in bottle gourd.

Trait	Mean	Range	GCV	PCV	h^2	GA % mean
Vine length	3.92	2.33 - 7.03	30.42	33.03	84.8	57.72
Primary branches/ vine	19.12	9.33 - 34.00	29.81	34.10	76.4	53.68
SPAD value	39.11	35.33 - 42.07	2.85	6.21	21.0	2.69
Nodes bearing first male flower	9.44	6.93 - 18.20	23.59	25.63	84.7	44.71
Nodes bearing first female flower	12.55	8.67 - 27.60	27.49	28.89	90.5	53.88
Nodes / vine	45.24	27.00 - 64.67	19.42	23.29	69.5	33.36
Inter nodal length	11.10	9.00 - 14.50	13.11	15.86	68.3	22.31
Days to first male flower anthesis	45.15	37.53 - 53.33	9.79	10.54	86.3	18.74
Days to first female flower anthesis	50.26	42.07 - 58.27	8.17	8.87	85.0	15.52
Days to first fruit picking	62.88	56.66 - 74.00	6.93	8.35	68.8	11.84
Fruit length	32.33	10.53 - 74.43	41.60	42.00	98.1	84.87
Fruit diameter	9.13	6.40 - 14.93	27.20	28.26	92.6	53.94
Fruits/ vine	5.87	2.87 - 14.20	39.44	40.71	93.8	78.71
Fruit weight	1103.26	697.67 - 1473	16.42	17.85	84.6	31.10
Fruit yield	480.06	230.35 - 1117.22	44.53	46.17	93.0	88.47
Harvest index	70.88	57.93 - 82.20	8.11	8.93	82.4	15.16
Total soluble solids	3.04	2.17 - 3.90	12.11	14.53	69.4	20.77
Dry matter content	4.41	3.32 - 5.42	11.61	17.58	43.6	0.28
Flesh thickness	1.03	0.77 - 1.33	14.58	15.86	84.4	27.60

al. (7). Total soluble solids (TSS), dry matter content and flesh thickness was on average 3.04°brix, 4.41% and 1.03 cm, which varied from 2.17 to 3.90°Brix, 3.32 to 5.42% and 0.77 cm to 1.33 cm, respectively in conformity to the findings of Muralidharan *et al*. (7). Mean performance of fruit yield, growth and quality parameters revealed that Narendra Shivani, MBL 3, Anand Bottle Gourd 1, MBL 2 and IC 085608 were high fruit yield q/ha yielders. High fruit yield in Narendra Shivani was attributed by primary branches/ plant, fruit length and fruits/vine. It also possesses high total soluble solids (Table 2). MBL 3 possess maximum vine length, nodes bearing first female flower, nodes/vine, fruit length and fruit weight. Anand Bottle Gourd1exhibited higher estimates of nodes bearing first male flower, inter nodal length, fruit length, fruits/vine, fruit weight, fruit yield/vine, harvest index, total soluble solids and dry matter content. The results showed that yield attributes are determined by genetic mechanism of the genotypes and varied from genotype to genotype in bottle gourd.

The direction of phenotypic coefficient of variation (PCV) was similar to genotypic coefficient of variation (GCV) but the magnitude of PCV was higher than GCV for all the characters (Table 1). It may be due addition of environmental variation in phenotypic expression of the characters as also observed by Kumar *et al*. (5), Samadia (10), Yadav and Kumar (16) and Deepthi *et al*. (2). The magnitude of GCV and PCV varied from 2.85 to 44.53 and 6.21 to 46.17, respectively. In general, the low to moderate estimate of GCV and PCV observed in the present material. Fruit yield/vine, yield q/ha, fruit length, fruits/vine and vine length showed the moderate estimates of both GCV and PCV, whereas, rest of the characters exhibited the low estimates of both genetic parameters.

High heritability estimates indicate the potential of traits to inherit in next generation thus, found useful selection breeding programme. Heritability in broad sense ranging from 21.00 to 98.1 was observed high for almost all the characters except SPAD value bearing the lowest value (Table 1). Kumar *et al.* (5), Sharma and Sengupta (12), Muralidharan *et al.* (7) and Deepthi *et al.* (2) have also noted more or less similar observation in bottle gourd. High heritability coupled with genetic advance as percentage of mean is more useful selection breeding as it through light

Table 2. Five promising genotypes for fruit yield traits and quality parameters in bottle gourd.

Trait	Five superior genotypes
Vine length	MBL3, MBL2, Thar Samridhi, Kashi Ganga and Arka Bahar
Primary branches/ vine	Narendra Shivani, IC085620, IC085608, Kashi Ganga and IC-085616
SPAD value	MBL2, IC085614, Arka Bahar, IC-085620 and Pusa Samridhi
Nodes bearing first male flower	IC085614, MBL2, IC085612, IC085610 and Anand Bottle Gourd 1
Nodes bearing first female flower	MBL2, IC085618, MBL4, IC085611and MBL3
Nodes / vine	Thar Samridhi, MBL-2, MBL-3, MBL-4, Kashi Ganga
Inter nodal length	IC085618, Pusa Naveen, Thar Samridhi, Anand Bottle Gourd 1 and IC-085617
Days to first male flower anthesis	MBL2, Kashi Ganga, IC085618, IC085614 and Pusa Santusthi
Days to first female flower anthesis	MBL2, IC085618, MBL1, IC085614 and IC085617
Days to first fruit picking	MBL4, IC085612, IC085608, Thar Samridhi and Pusa Samridhi
Fruit length	Narendra Shivani, MBL 3, MBL2, Anand Bottle, Gourd 1 and Kashi Ganga
Fruit diameter	MBL1, Thar Samridhi, IC085615, Pusa Samridhi ad IC085620
Fruits/ vine	Narendra Shivani, MBL3, Anand Bottle Gourd 1, IC085608 and MBL2
Fruit weight	IC085615, MBL3, Anand Bottle Gourd 1, IC085611 and MBL2
Fruit yield q/ha	Narendra Shivani, MBL3, Anand Bottle gourd 1, MBL2and IC085608
Harvest index	Narendra Shivani, Anand Bottle gourd 1, Narendra Rashmi, IC085614 and IC-085613
Total soluble solids	ArkaBahar, Anand Bottle gourd 1, Pusa Samridhi, Narendra Shivani, MBL4 and Thar Samridhi
Dry matter content	Arka Bahar, Anand Bottle Gourd 1, Pusa Santusthi, Pusa Samridhi and Narendra Shivani
Flesh thickness	IC085620, Pusa Samridhi, Thar Samridhi, IC085615 and Pusa Santusthi

on nature of gene action operative in inheritance of a particular character. In this, genetic advance as percentage of mean varied from 0.28 to 88.47 in different characters. It was noted high for yield q/ha, fruit yield/vine, fruit length, fruits/ vine, vine length, fruit diameter, nodes bearing first female flower, primary branches/ vine and nodes bearing first male flower. All these characters also exhibited high heritability coupled with high genetic advance as percentage of mean indicating the presence of additive gene action in the phenotypic expression of these traits thus, offer good scope for the selection desirable genotypes based on phenotypic performance of these characters as also reported by Kumar *et al.* (5), Sharma and Sengupta (12) and Muralidharan *et al.* (7) and Deepthi *et al.* (2).

The moderate estimates of genetic advance as percentage of mean was found in case number of nodes per vine, fruit weight and flesh thickness. Rest of the characters like inter nodal length, total soluble solids, days to first male flower anthesis, days to first female flower anthesis, harvest index, days to first fruit picking, and dry matter content having high heritability showed the low estimate of genetic advance as percentage of mean reflecting the existence of non-additive gene action in the phenotypic expression of these characters thus direct selection based on these characters cannot be more fruitful in bottle gourd. Kumar *et al*. (5) and Muralidharan *et al*. (7) have also observed high heritability and low genetic advance for these traits in bottle gourd. The SPAD value showed low heritability coupled with low genetic as percentage of mean indicating that this character is mostly under control of environmental factors in their phenotypic expression hence found not suitable for selection in bottle gourd.

Correlation coefficients arise due to linkages, pleotropisum and developmental physiological interactions are frequent feature in selection breeding programmes. It indicates the extent to which two or more characters can be improved simultaneously. Hence, correlation coefficients at phenotypic (P) and genotypic (G) levels were estimated among fruit yield and its attributing characters on one hand and quality traits on the other (Tables 3 & 4). The direction of phenotypic and genotypic correlations was mostly same but magnitude of genotypic correlation coefficients was higher than phenotypic correlations. It may be due to masking influence of environmental factor in phenotypic expression of the characters in bottle gourd.

Fruit yield q/ha recorded significant positive correlation coefficient with fruits/vine, fruit length, harvest index, vine length, primary branches / vine, nodes bearing first female flower, fruit weight, nodes/ vine, SPAD value, inter nodal length, fruit diameter, nodes bearing first male flower, inter nodal length and days to first male flower anthesis (Table 3). Fruit length showed significantly positive association with fruits/ vine and harvest index. Fruit diameter had significant positive association with fruit weight. Fruits/vine had positive and significant correlation with harvest index, nodes bearing first female flower, primary branches/ vine and nodes/vine. Primary branches/vine showed positive and significant association with nodes/ vine and SPAD value. These results are in confirmatory with findings of Suchitra and Haribabu (14), Kumar *et al*. (5), Yadav and Kumar (16), Bawkar *et al*. (1), Janaranjani and Kanthaswami (4), and Mandal *et al*. (6) in bottle gourd.

Correlation coefficients among quality parameters and fruit yield q/ha (Table 4) indicates that total soluble solids showed positive and significant correlation with fruit yield, harvest index and dry matter content of the fruits. Correlation coefficient between dry matter content and total soluble solids was also positive and significant as also reported by Vaidya *et al*. (15). On the other hand, flesh thickness had recorded significantly negative association with fruit yield and harvest index.

It can be concluded from present study that Narendra Shivani, MBL 3, Anand Bottle Gourd 1, MBL 2 and IC 085608 were high fruit yielding genotypes. The yield attributes among these genotypes varied from genotype to genotype being governed by different genetic mechanism. In general, the low to moderate estimate of GCV and PCV, ranging from 2.85 to 44.53 and 6.21 to 46.17, respectively was observed in the present material. Fruit yield q/ha, fruit length, fruits/ vine and vine length showed the moderate estimates of both GCV and PCV whereas, rest of the characters exhibited the low estimates. Fruit yield q/ha, fruit length, fruits/ vine, vine length, fruit diameter, nodes bearing first female flower, primary branches/ vine and nodes bearing first male

Table 4. Phenotypic (P) and genotypic (G) correlation coefficients among fruit yield and quality parameters in bottle gourd.

Trait		Total soluble solids	Dry matter content	Flesh thickness
Fruit yield	P	0.40**	0.30**	-0.38**
	G	0.52**	0.51**	-0.42**
Total soluble solids	P		0.72**	-0.08
	G		0.69	-0.04
Dry matter content	P			-0.01
	G			-0.02

Table 3. Estimates of genotypic correlation coefficient between different plant characters in bottle gourd

Trait		Primary branches/ vine	SPAD value	Node to first male flower	Node to first female flower	Nodes per vine	Inter nodal length (cm)	Days to first male flower anthesis	Days to first female flower anthesis	Days to first fruit picking	Fruit length (cm)	Fruit dia. (cm)	Fruits per vine	Fruit wt. (g)	Yield (q/ha)	Harvest index
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1+	P	0.64**	0.14	0.12	0.09	0.76**	0.28*	-0.17	-0.17	-0.03	0.49**	-0.24*	0.54**	0.23*	0.60**	-0.08
	G	0.79**	0.41**	0.14	0.12	0.75**	0.35**	-0.19	-0.23*	-0.07	0.53**	-0.30*	0.53**	0.31**	0.62**	-0.02
2	P		0.23*	-0.08	-0.02	0.52**	0.06	-0.02	-0.09	-0.22	0.45**	-0.24*	0.42**	0.34**	0.54**	0.06
	G		0.68**	-0.06	-0.04	0.68**	0.04	-0.07	-0.15	-0.34**	0.53**	-0.29*	0.49**	0.49**	0.65**	0.15
3	P			-0.04	0.03	0.03	0.17	0.17	0.04	-0.17	0.11	-0.05	0.14	0.13	0.14	0.09
	G			-0.17	0.13	0.26*	0.25*	0.30**	0.17	-0.19	0.25	-0.15	0.32**	0.45**	0.45	0.33**
4	P				0.79**	0.05	0.29*	0.38**	0.31**	0.38**	0.24*	0.10	0.41**	-0.06	0.31**	0.08
	G				0.89**	0.06	0.32**	0.43**	0.40**	0.52**	0.27	0.10	0.44**	-0.05	0.33	0.07
5	P					-0.14	0.42**	0.46**	0.53**	0.49**	0.43**	-0.12	0.55**	-0.04	0.43**	0.27*
	G					-0.15	0.54**	0.51**	0.59**	0.60**	0.46**	-0.12	0.59**	-0.05	0.46**	0.28*
6	P						-0.15	-0.16	-0.23*	-0.15	0.14	0.05	0.32**	0.12	0.36**	0.26*
	G						-0.27*	-0.24*	-0.34**	-0.30**	0.17	0.04	0.26	0.24*	0.34**	-0.24
7	P							0.03	0.10	0.23*	0.31**	-0.12	0.29*	0.17	0.29*	0.23*
	G							0.03	0.16	0.24*	0.38**	-0.22	0.33**	0.18	0.35**	0.31**
8	P								0.74**	0.25*	0.05	0.04	0.33**	0.08	0.27*	0.29*
	G								0.86**	0.36**	0.05	0.04	0.35**	0.15	0.31**	0.36**
9	P									0.41**	0.12	-0.16	0.32**	-0.002	0.22	0.24*
	G									0.52**	0.14	-0.16	0.34**	-0.013	0.22	0.29*
10	P										0.22	-0.12	0.22	0.06	0.14	0.04
	G										0.25*	-0.15	0.24*	0.04	0.15	0.08
11	P											-0.67**	0.79**	0.16	0.79**	0.43**
	G											-0.70**	0.82**	0.17	0.82**	0.46**
12	P												-0.43**	0.25*	0.32**	-0.14
	G												-0.47**	0.27*	-0.35**	-0.15
13	P													0.08	0.93**	0.57**
	G													0.12	0.94**	0.66**
14	P														0.41**	0.29*
	G														0.45**	0.30**
15	P															0.62**
	G															0.67**

1+ - Vine length, ** Level of significant 1 %, *Level of significant 5%,

flower exhibited high heritability coupled with high genetic advance as percentage of mean thus direct selection based on phenotypic performance would be effective. Fruit yield q/ha showed significant positive correlation coefficient with fruits/vine, fruit length, harvest index, vine length, primary branches / vine, nodes bearing first female flower, fruit weight, nodes/ vine, SPAD value, inter nodal length, fruit diameter, nodes bearing first male flower, inter nodal length and days to first male flower anthesis. Similarly, total soluble solids showed positive and significant correlation with fruit yield, harvest index and dry matter content of the fruits thus, these characters can be improved simultaneously in bottle gourd.

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Received : January, 2019; Revised : May, 2020;
Accepted : June, 2020