The Bioscan 11(4):3001-3005,2016(Supplement on Genetics and Plant Breeding) www.thebioscan.com
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES

STUDIES ON VARIABILITY, HERITABILITY AND GENETIC ADVANCE IN BRINJAL (*SOLANUM MELONGENA* L.)

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KEYWORDS
Variability
heritability
genetic advance
quantitative characters

Received on :
13.09.2016

Accepted on :
21.11.2016

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ABSTRACT
Forty brinjal genotypes were evaluated for thirteen quantitative characters and found significant differences among all studied traits. Highly significant differences were observed among all the genotypes and characters under study indicating the presence of sufficient amount of variability in all the characters. PCV estimates were higher than their corresponding GCV for all characters studied. PCV and GCV were high for fruit weight (63.5, 62.5%), fruit length to width ratio (41.7, 40.7%), fruit diameter (39.1, 35.5%), yield per plant (30.7, 30.5%), fruit length (31.7, 29.9%), branches per plant (21.3, 15.8%), fruits per plant (27.5, 24.5%), flower per cluster (29.8, 23.6%) and leaf width (36.5, 34.9%), whereas, plant height, length of peduncle, days to 50% flowering and leaf length showed moderate PCV and GCV. The heritability estimates were high for all the characters. Expected genetic advance was observed to be high for plant height (35.4%), fruits per plant (46.4%), flowers per cluster (58.4%), fruit length (58.4%), fruit diameter (66.6%), fruit weight (127.2%), yield per plant (65.5%), leaf width and fruit length to width ratio (81.9%), whereas moderate for branches per plant, days to 50% flowering and length of peduncle. Therefore, studied characters may be included in assortment criterion for improvement in fruit yield per plant.

INTRODUCTION

Eggplant (*Solanum melongena* L.), as belongs to the family *Solanaceae,* is the native of India and is one of the most popular and widely grown crop of commercial and dietary significance in the world (Thompson and Kelly, 1957). It is popularly known as *brinjal* in India, *aubergine* in France and United Kingdom. It is widely accepted and grown crop of both tropic and sub-tropics of the world. Whatever, it has been the early history of its cultivation the popularity of eggplant has increased rapidly from the middle of 19th century to the present time. Due to its sky-scraping production rate all over world, it is often referred to as a poor man's vegetable (Kumar *et al*., 2014). Hence, it is a good source of income to small and marginal farmers.

In spite of obvious importance in our daily life, little attention has been given to this crop in the past for the yield improvement. Use of traditional varieties and less variability affected by diseases and pest is the important constraint for low yield potentiality. Collection of germplasm and its genetic analysis can help to get a suitable genotype for higher yield or any other desirable character. To meet the demand of ever-increasing population, there is need to enhance the productivity levels of brinjal crop. Simultaneously, demand is increasing for varieties for different culinary purposes.

Moreover, in view of very high local preferences for colour, shape and taste, there are specific genotypes suitable for specific locality since it is not possible to have one common cultivar suitable for different localities and local preferences. Therefore, it is essential to improve the yield potential of available genotypes through suitable breeding programme. It is one of very few self-pollinated crops where exploitation of hybrid vigour has been commercially successful because of high number of seeds obtained from a cross. The success of any crop improvement programme largely depends upon the nature and magnitude of the genetic variability existing in breeding material with, which the plant breeder is working (Prabhu *et al*., 2009; Meena and Bahadur., 2013).

Variability is the basic requirement for any crop improvement programme. The total variability present in germplasm can be divided into heritable and non-heritable components through genetic parameters like phenotypic and genotypic coefficients of variation, heritability and genetic advance, however, heritability is the heritable portion. It is an important index of characters transmission from parents to offspring (Falconer, 1981). The effectiveness of selection directly depends on the amount of heritability and genetic advance as per cent of mean for that character. According to Sharma and Jana (2002), assessment of genetic variation is a prerequisite for initiating efficient breeding programme, as it provides a basis for tailoring desirable genotypes. Knowledge on genetic information obtained through the analysis of genetic variability and relatedness between or within species is pre-requisite towards effective utilization and conservation of plant genetic resources (Chaudhuri *et al*., 1976). Better knowledge on genetic variability or genetic similarity could help to sustain long-term selection gain (Chowdhary *et al*., 2013).

MATERIALS AND METHODS

The present experiment was carried out at research farm of

the Department of Vegetable science, CCS Haryana Agricultural University, Hisar during autumn-winter of 2015-16. The material for the present study comprised forty genotypes collected from different geographical regions of the country. The experiment was laid out in randomized block design having 40 genotypes replicated thrice to test the variation in genotypes (Panse and Sukhatme, 1978). The net plot size was 1.5x5.4 m. The seedlings were planted in a fashion accommodating 18 plants in each treatment at spacing of 75cm line to line and 60cm plant to plant. The package of practice and plant protection schedule were given as per recommendations for raising the crop successfully.Ten randomly marked plants were observed for recording various plant characters. Likewise, the randomly picked five fruits were used for recording the fruit characters for each genotype in each replication. The mean of these ten plants and fruits was used for statistical analysis. Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were calculated as per the formula suggested by Comstock and Robinson (1952). Heritability (broad sense) was worked out using the formula given by Burton (1952) and Johnson *et al*. (1955) and Hanson *et al*. (1956).Genetic advance and genetic gain were calculated as per the formula suggested by Lush (1949) and Johnson *et al*. (1955).

RESULTS AND DISCUSSION

A thorough screening of the material studied under present investigation revealed sufficient variability for thirteen characters *viz*., number of branches per plant, plant height, length of peduncle, number of fruits per plant, number of flowers per cluster, fruit length, fruit diameter, days to 50% flowering, leaf length, fruit weight, yield per plant, leaf width and fruit length to width ratio were recorded. Results from the present study in this context indicated that PCV and GCV were high (>20%) for fruit weight, fruit length to width ratio, fruit diameter, yield per plant, fruit length, number of branches per plant, number of fruits per plant, number of flower per cluster and leaf width, whereas, plant height, length of peduncle, days to 50% flowering and leaf length showed moderate PCV and GCV (10-20%).

Number of branches per plant

The grand mean number of primary branches per plant was recorded 6.2. It ranged from four to nine (Table 2). The maximum number of primary branches recorded in genotype HE-103 (9) and minimum in genotype HE-83 (4). The PCV and GCV were 21.3 and 15.8%, respectively. The PCV value was slightly higher than the respective GCV, denoting little influence of environment for the expression of the character. The estimates of heritability were low (55.6%) with low genetic advance (1.5%) and genetic advance as per cent of mean (24.4%), respectively. The results of present investigation confirm the findings of Kumar *et al*. (2004). Singh *et al*. (2002) also showed greater phenotypic coefficient of variation for number branches per plant.

Plant height (cm)

The plant height ranged from 45 to 95 cm with a mean of 68.2 cm. (Table 2). The analysis of variance revealed highly significant differences among the genotypes with respect to plant height. The maximum plant height was recorded in genotype HE-103 (95 cm) and lowest in genotype HE-96 (45 cm). The PCV and GCV were 19.4 and 18.3%, respectively. In the present study, the genotypic and phenotypic coefficients of variation were moderate for plant height. The estimates of heritability were high (88.7%) with an expected genetic advance (35.4%) and genetic advance as per cent of mean (35.4%), respectively. High heritability is effective and less influenced by environment, indicating the relative value of selection based on phenotypic expression of the character. High heritability is effective and less influenced by environment, indicating the relative value of selection based on phenotypic expression of the character. Matin and Kuddus (2001), Naz *et al*. (2013), Patel *et al*. (2015) also reported similar results for plant height. These findings are in close agreement with the findings of Vedivel and Bapu (1990) and Singh *et al*. (2002) who revealed higher phenotypic coefficient of variation than genotypic coefficient of variation for the character and showed high heritability values similar with the present findings.

Length of peduncle (cm)

Length of peduncle was range from 3.7 to 7.5 cm with a grand mean of 5.3 (Table 2). The maximum and minimum length of peduncle was recorded in genotype IC 545972 (7.5) and HE-87 (3.7), respectively. The PCV and GCV were 19.1 and

Table 1: Estimation of genetic parameters in thirteen characters of 40 genotype of brinjal

Sr. No.	Character	Mean square			CV%	CD%
	df	Replication	Genotype	Error		
		2	39	78		
1	Number of branches per plant	0.9	3.7**	0.8	14.7	1.4
2	Plant height (cm)	48.9	510.3**	19.7	15.1	16.5
3	Length of peduncle (cm)	1.3	2.4**	0.3	11.1	0.9
4	Number of fruits per plant	0.3	10.7**	0.7	11.7	1.4
5	Number of flowers per cluster	0.8	2.2**	0.4	18.3	0.9
6	Fruit length (cm)	0.7	32.7**	1.2	10.3	1.8
7	Fruit diameter (cm)	10.4	954.8**	62	16.2	12.8
8	Days to 50% flowering	0.2	9.9**	189	2.9	3.1
9	Leaf length (cm)	1.2	5.3**	1.8	9.6	2.2
10	Fruit weight (g)	33.5	3535.4**	28.4	9.7	8.7
11	Yield per plant (g)	66.5	38996.9**	148.3	3.2	19.8
12	Leaf width (cm)	0.2	26.2**	0.8	10.4	1.4
13	Fruit length to width ratio (cm)	0.1	3.3**	0.05	8.9	0.4

*, **P≤ 0.05 and 0.01, respectively

Table 2: Components of genetic variance and estimates of genetic parameters in thirteen characters of 40 genotype of brinjal

Sr. No.	Characters	Range	Mean ± SEm	PCV (%)	GCV(%)	Heritability h^2bs(%)	Genetic Advance(%)	Genetic Advance (as % of mean)
1	Number of branches per plant	9-Apr	6.2 ± 0.5	21.3	15.8	55.6	1.5	24.4
2	Plant height (cm)	45-95	68.2 ± 5.8	19.4	18.3	88.7	24.2	35.4
3	Length of peduncle (cm)	3.7-7.5	5.3 ± 0.3	19.1	15.6	66.2	1.4	26.1
4	Number of fruits per plant	12-Apr	7.3 ± 0.5	27.5	24.9	81.9	3.4	46.4
5	Number of flowers per cluster	6-Feb	3.3 ± 0.3	29.8	23.6	62.5	1.3	38.4
6	Fruit length (cm)	4.2-18.9	10.8 ± 0.6	31.7	29.9	89.4	6.3	58.4
7	Fruit diameter (cm)	26.3-114.1	48.5 ± 4.5	39.1	35.5	82.7	32.3	66.6
8	Days to 50% flowering	49.3-56	56. ± 1.1	17.2	12.5	52.5	2.4	18.6
9	Leaf length (cm)	11.1-16.5	14.1 ± 0.8	12.3	7.7	38.9	1.4	9.9
10	Fruit weight (g)	84-192.7	54.7 ± 3.1	63.3	62.5	97.6	65.6	127.2
11	Yield per plant (g)	118.7-606.7	372.9 ± 7.0	30.7	30.5	98.9	233.1	65.5
12	Leaf width (cm)	2.7-14.3	8.3 ± 0.5	36.5	34.9	91.9	5.7	96
13	Fruit length to width ratio (cm)	0.7-4.6	2.6 ± 0.1	41.7	40.7	95.4	2.1	81.9

15.6%, respectively. Studies on coefficient of variation indicate that the estimates PCV were slightly higher than GCV, indicating that the environment influenced the characters less. Therefore, selection as the basis of phenotype alone can be effective for the improvement of this trait. The estimate of heritability was high (66.2%) with low genetic advance (1.4%) and genetic advance as per cent of mean (26.1%), respectively. The present study is similar with the findings of Islam and Khan (1991) and Sawadogo *et al*. (2016).

Number of fruit per plant

The grand mean of fruit per plant was recorded as 7.3, ranging from four to twelve (Table 2). The maximum number of fruits per plant was recorded in genotype HE-103 (12) and the minimum in genotype HE-83 (4). The PCV and GCV were 27.5 and 24.9%, respectively. The difference between GCV and PCV was relatively low, which indicates that the character was comparatively stable and highly heritable. The estimate of heritability was high (81.9%) with low genetic advance (3.4%) and genetic advance as per cent of mean (46.4%). Sherly *et al*. (2006), Sabeena *et al*. (2011) and Patel *et al*. (2015) reported similar results.

Number of flowers per cluster

The mean for number of flowers per cluster was recorded 3.3 and ranged from two to six (Table 2). The maximum number of flowers per cluster was recorded in genotype HE-103 (6) and the minimum in genotype HE-111(2). The PCV and GCV were 29.8 and 23.6%, respectively. The PCV value was slightly higher than the respective GCV, denoting moderate influence of environment for the expression of the character. The estimates of heritability were low (62.5%) with low genetic advance (1.3%) and genetic advance as per cent of mean (38.4%). Singh *et al*. (2002) also showed that phenotypic coefficient of variation was greater for number of flowers per cluster. Kumar *et al*. (2004) and Naik *et al*. (2014) also reported similar results for number of flowers per cluster.

Fruit length (cm)

The fruit length varied among the genotypes ranging from 4.2 to 18.9 cm with an average of 10.8 cm (Table 2). The maximum fruit length was recorded in genotype HE-101 (18.9 cm) and minimum in genotype HE-97 (4.2 cm). The PCV and GCV were 31.7 and 29.9%, respectively. The difference between GCV and PCV was relatively low, which indicates that the character was comparatively stable and highly heritable. The estimate of heritability was high (89.4%) with high genetic advance (6.3%) and genetic advance as per cent of mean (58.4%). This indicates that the character controlled by polygenes might be useful to the plant breeder for making effective selection. Similar results were observed by various workers (Panda *et al.*, 2010; Ullah *et al.*, 2014; and Rad *et al.*, 2015).

Fruit diameter (cm)

The average fruit diameter was recorded 48.5cm, ranging from 26.3 to 114.1cm (Table 2). The maximum fruit diameter was recorded in genotype HE-105 (114.9cm) and minimum in genotype HE-96 (26.35 cm). The PCV and GCV were 39.1 and 35.5%, respectively. The smallest difference observed between PCV and GCV values of fruit diameter suggested lesser influence of environmental factors on the expression of the trait. The estimate of heritability was high (82.7%) with moderate genetic advance (32.3%) and genetic advance as per cent of mean (66.6%), which indicates the influence of non-additive gene action and considerable influence of environment in the expression of this trait, which could be exploited through manifestation of dominance and epistatic components through heterosis. Similar results were reported by Singh *et al*. (2002), Patel *et al*. (2004), Babu and Patil (2005) and Ullah *et al*. (2014) for average fruit diameter.

Days to 50% flowering

The grand mean number of days to 50% flowering was recorded 56 days. It ranged from 49.3 to 56 days (Table 2). The maximum number of days to 50% flowering was in genotype HE-103 (56) and minimum in genotype HE-96 (49.3). The PCV and GCV were 17.2 and 12.5%, respectively. The PCV was slightly higher than the respective GCV, denoting environmental factors influencing the expression to some degree or other. The estimates of heritability were high (52.5%) with low genetic advance (2.4%) and genetic advance as per cent of mean (18.6%). These results are in consonance with that of Mohanty and Prusti (2002) and Lokesh *et al*. (2013).

Leaf length (cm)

The leaf length varied among the genotypes ranging from 11.1 to 16.5 cm with an average of 14.1 cm (Table 2). The maximum fruit length was recorded in genotype HE-102 (16.5 cm) and minimum in genotype BRL (11.1 cm). The PCV and GCV were 12.3 and 7.7%, respectively. The difference between GCV and PCV was relatively low, which indicates that the character was comparatively stable and highly heritable. The estimate of heritability was high (38.9%) with genetic advance (1.4%) and genetic advance as per cent of mean (9.9%). This indicates that the character controlled by polygenes might be useful to

the plant breeder for making effective selection. The results obtained in this study are in conformity with the findings of Kushwah and Bandhyopandhya (2005), Sherly *et al*. (2006), Panda *et al*. (2010) Ullah *et al*. (2014) and Rad *et al*. (2015).

Fruit weight (g)

The grand average fruit weight per plant was recorded 54.7 g. It ranged from 84 to 192.7 g (Table 2). The maximum fruit yield per plant was recorded in genotype HALB (192.7 g) and minimum in genotype HE-84 (84 g). The PCV and GCV were 63.3 and 62.5%, respectively. There was little difference between the phenotypic and genotypic coefficient of variation, indicating little environmental influence in the expression of this character. The estimate of heritability was high (97.6%) with high genetic advance (65.6%) and genetic advance as per cent of mean (127.2%). Similar results with the present findings were exhibited by Vedivel and Bapu (1990), Patel *et al*. (2004), and Ara *et al*. (2009) for average fruit weight per plant.

Yield per plant (kg)

The average fruit yield per plant was recorded 372.9 kg. It ranged from 118.7 to 606.7 kg (Table 2). The maximum fruit yield per plant was recorded in genotype HE-103 (606.67 kg) and minimum in genotype HE-111 (118.67 kg). The PCV and GCV were 30.7 and 30.5%, respectively. There was very little difference between the phenotypic and genotypic coefficient of variation, indicating little environmental influence in the expression of this character. The estimate of heritability was high (98.9%) with high genetic advance (233.1%) and genetic advance as per cent of mean (65.5%). Very high heritability estimates for fruit yield per plant indicate possibility of improvement through selection. The results obtained in this study are in conformity with the findings of Vedivel and Bapu (1990), Patel *et al*. (2004) and Singh and Kumar (2005). They also observed high estimates of heritability for fruit yield per plant, indicating possibility of improvement through selection.

Leaf width (cm)

The grand mean for leaf width was recorded 8.3, where it ranged from 2.7 to 14.3 (Table 2). The maximum leaf width was recorded in genotype HE-111(14.3) and minimum in genotype HE-105 (2.7). The PCV and GCV were 36.5 and 34.9%, respectively. Narrow difference between the values of PCV and GCV indicates that they were less influenced by environment and could be convinced by looking for low value of ECV. Selection based on the phenotypic expression of this character would be helpful for improvement of this crop. The estimates of heritability were high (91.9%) with moderate genetic advance (5.7%) and genetic advance as per cent of mean (96%). These results are in consonance with that explained by Islam and Khan (1991), Kushwah and Bandhyopandhya (2005), Sherly *et al*. (2006), Ullah *et al*. (2014) and Rad *et al*. (2015), who reported slightly higher PCV than GCV for leaf width.

Fruit length to width ratio (cm)

The grand average fruit weight per plant was recorded 2.6. It ranged from 0.7 to 4.6 (Table 2). The maximum ratio was recorded in genotype HE-99 (4.6) and minimum ratio in genotype IC 545972 (0.7). The PCV and GCV were 41.7 and 40.7%, respectively. There was little difference between the phenotypic and genotypic coefficient of variation, indicating little environmental influence in the expression of this character. The estimate of heritability was high (95.4%) with high genetic advance (2.1%) and genetic advance as per cent of mean (81.9%). Similar results for high heritability were obtained by Ara *et al*. (2009), Ullah *et al*. (2014) and Rad *et al*. (2015).

ACKNOWLEDGEMENT

The authors are grateful to the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar for providing necessary facilities to carried out the experiment.

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