Electronic Journal of Plant Breeding, 4(1): 1097-1100 (Mar 2013)
ISSN 0975-928X

Research Note

Variability, heritability and genetic advance studies in Brinjal (S*olanum melongena* L.)

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(Received: 10 Nov 2012; Accepted: 27 Feb 2013)

Abstract
Sixty brinjal germplasm lines were evaluated for fourteen quantitative characters. High PCV and GCV values were seen for plant height, plant spread, number of branches per plant, number of fruits per cluster, average fruit diameter, average fruit weight, shoot and fruit borer incidence on shoot and fruit and fruit yield per plant indicating high variability in the germplasm. In general, values of PCV were higher than the values of GCV indicating influence of environment but differences between PCV and GCV values were minimum, indicating that the traits under study were less influenced by environment and these characters could be improved by following phenotypic selection.. Genetic advance as per cent of mean were high (>20.0) for plant height (25.00), plant spread (115.07), average fruit weight (25.23) and shoot and fruit borer incidence on shoot (21.53).High heritability accompanied with high genetic advance was noticed for plant height, plant spread, average fruit weight and shoot and fruit borer incidence on shoot indicating that simple selection may be effective to fix and improve such traits.

Keywords:
Brinjal , Variability, Heritability, Genetic advance

Brinjal (S*olanum melongena* L, 2n=24) is an important and popular vegetable crop of family Solanaceae, grown throughout the year all over the country. Being primary centre of origin, India has accumulated wide range of variability in this crop. Further, the crop exhibits rich genetic diversity and scope for improvement for various horticultural traits. Heritability is the heritable portion of phenotypic variance. It is a good index of the transmission of characters from parents to offspring (Falconer, 1981).The estimates of heritability help the plant breeder in selection of elite genotypes from diverse genetic populations. Genetic advance under selection measures the role of genetic progress as the deviation between the mean genotypic value of the selected families and the mean genotypic value of the base population due to selection. An improvement in yield and quality of brinjal is normally achieved by selecting the genotypes with desirable character combination existing in nature or by hybridization. With this objective, the present investigation was carried out with brinjal germplasm.

In the present investigation, 60 brinjal germplasm lines were evaluated in randomized block design with two replications. Observations were recorded on five plants per genotype per replication for 14 quantitative characters viz., plant height, plant spread, number of branches per plant, days to 50% flowering, number of flower clusters per plant, number of flowers per cluster, number of fruits per cluster, average fruit length, average fruit diameter, average fruit weight, number of fruits per plant, shoot and fruit borer incidence on shoot and on fruit and fruit yield per plant. The mean of 60 germplasm accessions for 14 quantitative characters were analysed statistically by the method outlined by Ostle (1966)**.** The analysis of variance for different characters was carried out in order to assess the genetic variability among genotypes as given by Cochran and Cox (1950). The level of significance was tested at 5% and 1% using F table values given by Fisher and Yates (1963). Both phenotypic and genotypic co-efficient of variability for all characters were estimated using the formula of Burton and De Vane (1953). The broad sense heritability (h^2) was estimated for all characters as the ratio of genotypic variance to the total or phenotypic variance as suggested by Lush (1949) and Hanson *et al.* (1956). Genetic advance for each character was estimated by using the formula of Johnson *et al.* (1955). Genetic advance as per cent mean was categorized as suggested by Johnson *et al.* (1955).

The mean sum of squares for fourteen characters in 60 genotypes of brinjal is presented in Table 1. Analysis of variance revealed highly significant differences among genotypes for all fourteen quantitative characters. With regard to the mean performance of genotypes (data not presented), the highest plant height was recorded for the genotype IC-99649 (77.20 cm) followed by the genotypes IC-111428 (76.35 cm) and IC-74204(73.95 cm). The line PSR-11773 (265.27 cm^2) showed highest plant spread followed by IC-256208 (244.96 cm^2) and MR/04-02 (243.60 cm^2). The line IC-112851(12.65) recorded highest number of branches per plant followed by IC-345255 (11.95) and IC-111428 (9.30). The germplasm line IC-90930 (33.00) recorded

minimum number of days to 50% flowering followed by IC-135955 (33.50) and IC-136006 (36.50). Highest number of flower clusters per plant was produced by IC-104086 (13.35) followed by IC-90930 (13.20) and IC-13601 (12.50). Highest number of flowers per cluster (3.22) were produced by both PSR-11773 and IC-90767 followed by IC-111428 (3.21) and IC-345309 (3.18). Maximum number of fruits per cluster was produced by PSR-11883 (2.82) followed by IC-111428 (2.81) and MR/04-94 (2.40). IC-99649 (10.40 cm) produced longest fruit followed by IC-111431 (9.92 cm) and IC-111074 (9.77 cm). IC-99649 (7.20 cm) produced the fruit with largest average fruit diameter followed by IC-111404 (6.62 cm) and IC-383119 (6.36 cm).Fruit with maximum average fruit weight was produced by MR/04-26 (85.20 g) followed by IC-111086 (59.35 g). Maximum number of fruits per plant was produced by IC-345309 (23.10) followed by IC-13601 (21.90) and PSR-11883 (20.90). While many genotypes viz., IC-104086, IC-111308, IC-089905, IC-345309, IC-383119, IC-111356, IC-245335, IC-135934, MR/04-94, IC-90767, PSR-11883, IC-90930, IC-136056, IC-136245, PSR-11891, IC-90087and IC-74204 recorded 0% incidence on shoot. IC-089905(7.42%) and IC-90930(24.90%) recorded lower incidence of shoot and fruit borer on fruit. Highest fruit yield per plant was produced by MR/04-26 (1.30 kg) followed by PSR-11883(1.08 kg).

The results pertaining to mean, range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability in broad sense (h^2) and expected genetic advance as per cent of mean (GA) for all the fourteen characters are furnished in Table 2. Variability refers to the presence of differences among the individuals of a population. Variability is essential for wide adaptability and resistance to biotic and abiotic factors and hence, an insight into the magnitude of genetic variability present in a population is of paramount importance to a plant breeder for starting a judicious breeding programme. The phenotypic and genotypic variances measure the magnitude of variation arising out of difference in phenotypic and genotypic values. The absolute values of phenotypic and genotypic variances cannot be used for comparing the magnitude of variability for different characters, since the mean and units of measurement of the characters may be different. Hence, the coefficients of variation expressed at phenotypic and genotypic levels have been used. The relative values of these two types of coefficients give an idea about the magnitude of variability present in the germplasm.

In general, the values of PCV were higher than the values of GCV indicating that the apparent variation is not only due to genotypes but also due to influence of environment. Hence selection for improvement of such characters will not be rewarding but the values of GCV and PCV for plant height, plant spread, number of branches per plant, number of fruits per cluster, average fruit diameter, average fruit weight, shoot and fruit borer incidence on shoot and on fruit and fruit yield per plant were high indicating the presence of high variability in the germplasm for selection and even the differences between PCV and GCV values were minimum, indicating that the traits under study were less influenced by environment. Hence, these characters can be relied upon and simple selection can be practised for further improvement. The results are in consonance with Vadivel and Bapu (1990), Ushakumari *et al.* (1991), Chowdhury and Talukdar (1996), Mohanty (1999), Sharma and Kishan Swaroop (2000), Mohanty (2001), Mohanty and Prusti (2002), Baswana *et al.* (2002), Mahaveer Prasad *et al.*(2004), Omkar Singh and Kumar (2005), Mahaveer Prasad *et al.* (2006), Prabhu and Natarajan (2007), Lohakare *et al.* (2008) and Sherly and Shanti (2009).

High heritability (broad sense) estimates (>60.0%) for all the fourteen quantitative characters indicated that though these characters were least influenced by the environmental effects, the selection for the improvement of such characters will be effective. The values of genetic advance as per cent of mean were high(>20.0) for plant height (25.00), plant spread (115.07), average fruit weight (25.23) and shoot and fruit borer incidence on shoot (21.53) indicating that these characters are governed by additive genes and selection will be rewarding for the improvement of such traits. Similar results were reported by Mishra and Mishra (1990), Nainar *et al.* (1991), Singh and Singh (1996), Mahaveer Prasad *et al*. (2004) and Golani *et al.* (2007).

In general, the values of heritability in broad sense for all the characters studied were high (>60.0%), indicating that though the characters were least influenced by the environmental effects, the selection for the improvement of such characters may not effective. Similar results were reported by Nainar *et al.* (1991), Ushakumari *et al.* (1991), Bora and Shadeque (1993). Chowdhury and Talukdar (1996), Singh and Singh (1996), Mohanty (1999), Mahaveer Prasad *et al.* (2004), Omkar Singh and Kumar (2005) and Golani *et al.* (2007). But Heritability coupled with genetic advance as percentage of mean were more useful than h^2 alone in predicting the resultant effect for selecting the best individual as explained by Johnson *et al*. (1955). High heritability accompanied with high genetic advance was noticed for plant height, plant spread, average fruit weight and shoot and fruit borer incidence on shoot indicating that simple selection based on

phenotypic performance of these traits may be effective to improve such traits. Whereas high heritability accompanied with low genetic advance was noticed for number of branches per plant, number of flower clusters per plant, number of flowers per cluster, number of fruits per cluster, average fruit length, average fruit diameter and number of fruits per plant and selection for such traits may not be rewarding.

To conclude, the genotypes IC-99649, IC-90930, IC-345309, IC-089905 and MR/04-26 were found to be elite for tallness, earliness, prolificacy, less incidence of shoot and fruit borer and yield respectively in brinjal. High estimates of PCV and GCV and high estimates of heritability coupled with high estimates of genetic advance for plant height, plant spread, average fruit weight and shoot and fruit borer incidence on shoot indicated that the variability available for these traits in the germplasm was high and selection for these traits may be effective. The promising accessions identified in this study could be used for prebreeding and other brinjal crop improvement programmes.

Acknowledgements: The authors are thankful to the Director, National Bureau of Plant Genetic Resources (NBPGR), New Delhi, and Head, Germplasm Exchange Unit, NBPGR, New Delhi and to the Officer-in-Charge, NBPGR Regional Station, Hyderabad for providing the brinjal germplasm for the present study.

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Table 1.Mean squares of the fourteen characters studied in brinjal

Source of variation	Replication	Treatments	Error	S.E.	C.V (%)	C.D. 5%
Degrees of Freedom	1	59	59			
Plant height (cm)	12.29	310.89**	5.55	1.67	4.64	4.72
Plant spread (cm^2)	52.06	6251.22**	3.49	1.32	1.32	3.74
Number of branches per plant	0.2	6.45**	0.06	0.17	4.5	0.49
Days to 50% flowering	4.8	76.44**	3.54	1.33	4.14	3.77
Number of flower clusters per plant	0.08	4.42**	0.03	0.13	1.91	0.36
Number of flowers per cluster	0.03	0.30**	0.02	0.1	5.89	0.3
Number of fruits per cluster	0.03	0.29**	0.01	0.06	4.82	0.17
Fruit length (cm)	0.06	2.84**	0.01	0.09	1.73	0.26
Fruit diameter (cm)	0.01	1.61**	0.02	0.1	3.24	0.28
Fruit weight (g)	2.01	300.52**	0.18	0.3	1.1	0.85
Number of fruits per plant	0.2	15.76**	0.3	0.39	3.49	1.1
Shoot and fruit borer incidence on shoot (%)	30	400.62**	77.46	6.22	51.27	17.61
Shoot and fruit borer incidence on fruit %)	0.83	85.21**	1.9	0.97	7.74	2.76
Yield per plant (kg)	0	0.10**	0	0.02	3.71	0.04

Table 2. Estimates of variability, heritability and genetic advance as percent of mean for fourteen characters in 60 germplasm accessions of brinjal

Character	Mean±S.E	Range Min.	Max.	PCV (%)	GCV (%)	h^2(%)	GAM (%)
Plant height (cm)	50.82±1.67	27.75	77.20	24.75	24.31	96.49	49.20
Plant spread(cm^2)	140.93±1.32	25.02	265.27	39.68	39.66	99.89	81.65
Number of branches per plant	5.44±0.17	2.9 0	12.65	33.18	32.87	98.16	67.09
Days to 50% flowering	45.47±1.33	33.00	60.00	13.91	13.28	91.13	26.11
Number of flower clusters per plant	9.39±0.13	6.75	13.35	15.90	15.79	98.55	32.28
Number of flowers per cluster	2.53±0.11	1.67	3.22	15.88	14.75	86.26	28.22
Number of fruits per cluster	1.78±0.06	1.04	2.82	21.72	21.18	95.07	42.53
Fruit length (cm)	7.67±0.09	4.58	10.40	15.58	15.49	98.77	31.70
Fruit diameter (cm)	4.36±0.10	3.15	7.20	20.68	20.43	97.55	41.56
Fruit weight (g)	38.38±0.30	17.90	85.20	31.94	31.92	99.88	65.72
Number of fruits per plant	15.75±0.39	10.60	23.10	18.00	17.65	96.23	35.68
Shoot and fruit borer incidence on shoot (%)	17.17±6.22	0.00	50.00	90.06	74.05	67.60	125.41
Shoot and fruit borer incidence on fruit (%)	17.81±0.97	7.42	38.05	37.06	36.24	95.64	73.00
Yield per plant (kg)	0.61±0.02	0.24	1.3	37.26	37.07	99.01	75.98