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Variability, Heritability and Genetic Advance studies in Brinjal (*Solanum melongena* L.)

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Abstract
A study was conducted using 13 collections and 30 F1 hybrids of brinjal. The analysis of variance revealed highly significant differences among genotypes. Wide range of variability was observed for most of the traits under study. Mean value for days to first fruit picking was 62.01 with a range of 50.70-70.39. Range for number of fruits plant-1 was 10.47 to 27.62 with a mean value of 15.06, for fruit weight and fruit yield ha-1 mean values were 119.95g and 568.38 qha-1while range for these was 82.55-149.90g and 305.25-969.4 qha-1 respectively. Phenotypic variances were slightly higher than corresponding genotypic variances for all the traits studied. Broad sense heritability was high for all the characters studied. Genetic advance as percentage of mean was medium to high for all the parameters studied. High heritability along with high genetic advance as percent of mean were observed for days to first flowering, plant height, plant spread, fruit diameter, no of fruits plant-1, fruit yield, fruit dry matter, Vitamin C and total phenols indicating predominance of additive gene effects and reliability of such traits for effective selection procedure.

Keywords: variability, heritability, genetic advance, genetic gain, Brinjal

Introduction
Brinjal also known as eggplant in United States and auberzine in France and England is one of the few solanaceous species originating from the old world. The crop is extremely variable in India and for this reason, Vavilov (1928) [13] regarded the crop as being of Indian origin. Brinjal fruit contains protein, Vitamin A, Thiamin, Fat, Riboflavin, Carbohydrate, Niacin, fibre and Calories. It is also a rich source of Calcium (6mg/100g) and Iron (0.9mg/100g) (Zenia and Halim, 2008) [14]. Brinjal are highly beneficial for regulation of blood sugar levels and also helps to control the absorption of glucose. White brinjal is said to be good for diabetic patients, (Choudhary, 1976) [5]. Brinjal is recommended for the remedy of liver problems (Shukla and Naik, 1993) [12]. Keeping in view the uses of brinjal and also to meet the food demands of growing population, there is every need to develop more high yielding varieties of brinjal and also to improve the characters of existing varieties. Success of breeder in changing the characters of a population depends upon the degree of correspondence between the genotypic and phenotypic values. This degree when measured in terms of heritability in narrow sense is used as a direct selection parameter to improve the efficiency. The measure of heritability coupled with genetic advance provides useful information regarding the performance of selective population in comparison to base population, such gain also depends upon the extend of genetic variability in the base population, masking effect on environment and its interaction components (Comstock and Robinson, 1952) [6].

Materials and methods
The study was conducted using 43 collections of eggplant germplasms (10 lines, 3 testers and 30 F_1s) for evaluation in Randomized Block Design, with three replications at three different elevations. During *Kharif* 2017 the set of thirty crosses along with their parents were evaluated in RCBD with three replications and a spacing of 60 × 45 cm at three locations. The recommended package of practices was adopted to raise a healthy crop. Five random plants per replication were selected to record observation on each genotype for 17 different yield and quality characters. Observations were recorded on days to first flowering, days to first fruit set, days to first fruit picking, plant height (cm), plant spread (cm), number of branches plant^{-1},fruit length (cm), fruit diameter (cm), number of fruits plant^{-1}, No of pickings plant^{-1}, average fruit weight (g), fruit yield plant^{-1} (kg), fruit yield ha^{-1} (q), dry matter (%), Total Soluble Solids (^{o}Brix), Vitamin C (mg 100^{-1}g) and total Phenols (mg100^{-1}g). Mean data was employed for the estimation of the genotypic (GCV) and phenotypic (PCV) coefficients of variation according to Burton (1952) [2] and Burton and De Vane (1953) [2]; Heritability estimates (broad sense) were obtained following Burton and De Vane (1953) [3] and Johnson *et al.* 1955. Formulae given by Johnson *et al.* 1955 was used for calculating genetic gain.

Table 1: Variability parameters for different traits in parents and crosses of Brinjal (*Solanum melongena* L.)

S. No.	Character	Mean	Range	Phenotypic Variance $\hat{\sigma}_P^2$	Genotypic Variance $\hat{\sigma}_g^2$	Phenotypic coefficient of Variation (PCV %)	Genotypic coefficient of Variation (GCV %)	Heritability	Genetic advance % mean (5%)
1	Days to first flowering	47.79	36.65-54.84	56.02	56.02	15.63	15.60	0.88	32.14
2	Days to first fruit set	55.48	44.65-58.89	41.04	41.04	11.77	11.77	0.851	24.24
3	Days to first fruit picking	59.07	50.70-70.39	62.01	62.01	12.14	12.14	0.790	25.00
4	Plant height (cm)	97.13	62.22-117.22	196.39	196.39	16.30	16.30	0.880	33.58
5	Plant Spread (cm)	67.23	41.80-89.95	150.64	150.64	18.72	18.72	0.930	38.57
6	Number of branches plant^{-1}	7.68	6.52-9.57	1.10	1.10	19.75	19.75	0.970	40.70
7	Fruit Length (cm)	15.35	10.14-19.28	3.53	3.53	13.33	13.33	0.740	27.46
8	Fruit diameter (cm)	3.71	2.28-5.59	1.37	1.37	35.70	35.70	0.870	73.55
9	No of fruits plant^{-1}	15.06	10.47-27.62	36.70	31.64	24.79	23.02	0.860	44.03
10	No of pickings plant^{-1}	4.67	2.13-10.26	1.15	1.13	11.58	11.50	0.971	23.53
11	Fruit weight (g)	119.95	82.55-149.90	252.68	244.63	13.88	13.66	0.968	27.69
12	Fruit yield plant^{-1} (kg)	1.54	0.82-2.62	0.368	0.343	21.96	21.18	0.931	42.07
13	Fruit yield ha^{-1} (q)	568.38	305.25-969.4	51792.71	47933.05	22.29	21.44	0.925	42.49
14	Dry matter (%)	7.60	5.49-9.56	0.863	0.784	19.89	18.96	0.909	37.23
15	Total soluble solids (^{o}Brix)	4.85	4.44-5.22	265.19	261.70	12.60	12.52	0.987	25.63
16	Vitamin C mg 100^{-1} g	3.12	2.66-3.61	11.37	11.34	26.52	26.48	0.987	54.48
17	Total phenols (mg 100^{-1} g)	123.80	104.40-162.73	1.97	1.94	16.35	16.20	0.981	33.06

Results and discussion

Wide range of variability was observed for most of the traits under study indicating the existence of sufficient variability. The lines and F_1s exhibited wide range of variability for all the 17 traits (Table-1). Days to first flowering exhibited a range of 36.55-54.84 with mean value of 47.79, while mean value for days to first fruit set was 55.48 with a range of 44.65 to 58.89. Mean value for days to first fruit picking was 62.01 with a range of 50.70-70.39. For plant height (cm) mean value was 97.13 with a range of 41.80 to 89.95, for plant spread (cm) a mean of 67.23 with range 41.80 to 89.95 was noted, for number of branches plant^{-1} mean and range were 7.68 and 6.52 to 9.57. Fruit length (cm) recorded a mean value of 15.35 with a range of 10.14 to 19.28. Mean value for fruit diameter (cm) was 3.71 with a range of 2.28 to 5.59 while range for number of fruits plant^{-1} was 10.47 to 27.62 with a mean value of 15.06, for number of picking plant^{-1}, fruit weight (g), fruit yield plant $^{-1}$ (kg), fruit yield ha^{-1}, dry matter (%), total solouble solids (^{o}Brix), Vitamin C (mg 100^{-1}g) and total phenols (mg 100^{-1}g) mean values were 4.67, 119.95, 1.54, 568.38, 7.60, 4.85, 3.12 and 123.80 while range was 2.13-1026, 82.55-149.90, 0.82-2.62, 305.25-969.4, 5.49-9.56, 4.44-5.22, 2.66-3.61 and 104.40-162-73 respectively. This wide range of variability for different characters indicated the scope for selection of suitable initial material for breeding, in the improvement of brinjal. Low phenotypic and genotypic variance was observed for number of branches plant^{-1}, fruit length, fruit diameter, number of pickings plant^{-1} and total phenols. All other traits recorded medium to high phenotypic and genotypic variance. High estimates of GCV for the above mentioned traits indicated considerable amount of genetic variability, thus suggesting the potentiality of the materials for further improvement (Table 1). The GCV values were low in magnitude compared to PCV values for all the characters studied indicating the influence of environment, similar results were revealed by Ambade (2008) [1] and Nayak and Nagree (2013) [8]. It has been suggested that GCV values alone are not sufficient to determine the amount of variation which is heritable. The efficiency of selection for particular character is best reflected by the extent of its heritability. Thus for predicting the expected progress through selection, heritability is a useful parameter according to Panse and Sukhatme (1978) [9] and Burton and De-Vane (1953) [3]. In the present study all the characters studied exhibited high heritability values. High heritability in broad sense indicate that large proportion of phenotypic variance was attributed to genotypic variance and the character difference among the genotypes was genetic, hence the selection based on high heritability values can be relied upon. The estimates of heritability along with genetic gain is more reliable than heritability alone for predicting the resultant effect of selection. Revelation of high heritability and high genetic advance together may be ascribed to the conditioning of the characters by additive effect of the polygenes (Panse, 1957) [10]. The value of genetic advance as percent of mean were medium to high for the characters studied and ranged from 24.24 (days to first fruit set) to 73.55 (fruit diameter). Medium estimates of genetic gain along with high heritability estimates were observed by days to first fruit set (24.24), days to first fruit picking (25), fruit length (27.46), no of pickings plant^{-1} (23.53) and total soluble solids (2.63).Thus mass selection can be employed for improvement of such traits. High heritability along with high genetic advance as percent of mean were observed by days to first flowering (32.14), plant height (33.58), plant spread (40.70), fruit diameter (73.55), no of fruits plant^{-1}(44.03), fruit yield (42.49), fruit dry matter (37.23), Vitamin C (54.48) and total phenols (33.06). Thus showing the preponderance of additive gene effects.These findings are in agreement to those of Maniapan 2010 and Shekhar *et al.* 2014. Thus from the present study it could be inferred that direct selection may be carried out on basis of phenotypic values of days to first flower, days to first fruit set, plant height, plant spread, fruit diameter, number of fruits plant^{-1}, fruit yield, dry matter, Vitamin C and total phenols.

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