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Research Article

Genetic variability and correlation analysis for yield and yield contributing characters in brinjal (*Solanum melongena* L.)

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Abstract
Thirty brinjal genotypes were evaluated for eighteen quantitative characters in a randomized block design with three replications. Variability studies for 18 quantitative characters revealed that the phenotypic coefficient of variation (PCV) was comparatively greater than the corresponding genotypic coefficient of variation (GCV) for all the characters studied. Maximum PCV (59.49%) and GCV (59.48%) were registered for fruit weight. High estimates of heritability accompanied with high genetic advance as per cent of mean were recorded for most of the traits *viz*., fruit length, diameter, pedicel length, pedicel thickness, relative fruit calyx length, fruit weight, fruits per plant, the number of marketable fruits, marketable fruit yield and fruit yield per plant indicating the prominence of additive gene action, thus pointing towards the effectiveness of simple selection depending on the phenotypic expression of genotypes would be rewarding for genetic improvement of these characters. Significant positive correlation of fruit yield per plant at both genotypic and phenotypic levels with plant height, percentage of medium and long styled flowers, fruit setting percentage, fruit length, fruit diameter, fruit pedicel length, fruit pedicel thickness, fruit weight, marketable fruit yield and significant negative correlation with the number of primary branches, days to 50% flowering, days to first harvest, relative fruit calyx length, fruits per plant, total marketable fruits. Therefore, considering these characters would be beneficial in the selection for fruit yield per plant.

Keywords: Brinjal, Genetic variability, Correlation analysis

INTRODUCTION

Brinjal or eggplant (*Solanum melongena* L. 2n=2x=24) hailing from the family Solanaceae, is a popular and principal vegetable crop widely cultivated in Southern, Central, and Southeast Asia as well as in some African countries (Kalloo, 2002). In India, except for higher altitudes, it is grown extensively in all parts of the country. It is grown year round and is a highly versatile crop adapted to varied agro-climatic regions. The crop exhibits rich genetic diversity and utilization of this variability is essential for the breeding programme. Knowledge of various genetic parameters is necessary to obtain improvement in crops (Kumar *et al.,* 2016). For assessing the genetic variability existing in germplasm, phenotypic and genotypic coefficients of variation are highly beneficial. Environmental influence in the expression of characters and the transfer of traits from parents to their progeny can be estimated using heritability and genetic advance (Falconer, 1989). All these parameters are to be considered for the success of any crop improvement programme. So, the present study was undertaken with the objective to evaluate local cultivars and other genotypes of brinjal for the extent of variability present in them and to observe the association of yield components.

MATERIALS AND METHODS

The experiment was undertaken in a Randomized Block Design with thirty genotypes in three replications at the College of Agriculture, Padannakkad, Kasaragod. The experimental material consisted of two wild relatives of brinjal (*S. insanum* and *S. incanum*) and twenty-eight *S. melongena* accessions including collections from North Kerala (Kannur-5, Kasaragod-4, Malappuram-1), accessions from NBPGR regional station, Thrissur as well as released varieties (Ponny, Haritha and Surya). One month old seedlings after reaching a height of 8-10 cm were planted into the main field at a spacing of 90 x 60 cm and evaluated during 2020-2021 for field validation as a continuation of characterization work done during 2019-2020. The recommendations of Kerala Agricultural University were administered for the timely management of the crop (KAU, 2016). Five plants were randomly selected to record the observations of eighteen characters namely plant height, plant breadth, the number of primary branches, days to 50% flowering, the number of flowers per inflorescence, per cent medium and long styled flowers, fruit setting percentage, days to first harvest, fruit length, relative fruit calyx length, fruit diameter, fruit pedicel length, fruit pedicel thickness, fruits per plant, fruit weight, the number of marketable fruits, marketable fruit yield and fruit yield per plant. The mean data of observations were subjected to analysis using the statistical package R with the help of KAU GRAPES packages (Gopinath *et al*., 2020). Variability parameters, genotypic coefficient of variation (GCV) along with phenotypic coefficient of variation (PCV) were estimated as per Burton and De vane (1953). The heritability estimates were calculated according to Burton and De vane (1953) and Allard (1960), while the genetic advance was determined as per Johnson *et al*. (1955). Correlation coefficients were computed by using the formula of Johnson *et al*. (1955).

RESULTS AND DISCUSSION

The genetic parameters *viz*., PCV, GCV, heritability, genetic advance and genetic advance as per cent of mean for the 18 quantitative characters were estimated and given in **Table 1.** The genotypes displayed significant differences for all the traits through analysis of variance study. The characters considered for the present study had PCV a little higher in magnitude than the corresponding GCV. Thus, indicating the reliability of selection based on these traits as possibly the environmental factors have played a lesser role in the expression of these characters. Moderate GCV and PCV values were recorded for the number of primary branches, floral characters *viz*., the number of flowers per inflorescence, per cent medium and long styled flowers as well as fruit characters like fruit diameter, fruit pedicel length, fruit pedicel thickness and fruit setting percentage. But fruit and yield characters *viz*., fruit length, relative fruit calyx length, fruit weight, fruits per plant, the number of marketable fruits, marketable fruit yield and fruit yield per plant recorded high GCV and PCV. It indicates that selection could be practised for improvement of these fruit and yield characters as the population had sufficient variability for these traits and environment has a lesser impact on them. Results for high GCV and PCV were in agreement with the findings of Ravali *et al*. (2017).

The magnitude of variability is shown by GCV and PCV, but the level of variability that is transferred to progeny can only be determined by the parameter's heritability and genetic advance. The broad-sense heritability ranged from 84.68 to 99.96 per cent and almost all the characters showed more than 90 per cent heritability **(Table1)**. High (>20%) genetic gain that is genetic advance expressed as a percentage of mean was recorded for fruit characters such as fruit weight (97.59), fruit length (99.67), marketable fruit yield (99.23) fruit yield per plant (92.53), fruits per plant (88.68), relative fruit calyx length (69.42), fruit pedicel thickness (53.68), fruit pedicel length (50.27), fruit diameter (50.11). Similar results were reported by Lokesh *et al.* (2013).

The high genetic gain was exhibited by plant characters such as plant height (27.95) and the number of primary branches (40.37). Plant breadth (17.21) and days to first harvest (18.23) recorded moderate genetic gain. The flower characters such as days to 50% flowering (22.38), the number of flowers per inflorescence (37.36), per cent medium and long styled flowers (35.60), fruit setting percentage (44.58) showed a high genetic gain. High heritability along with high estimates of genetic gain was estimated for fruit and yield characters *viz*., fruit length, fruit diameter, relative fruit calyx length, fruit pedicel length, fruit pedicel thickness, fruit weight, fruits per plant, the number of marketable fruits, marketable fruit yield, fruit yield per plant. These indicate the prominence of additive gene action, thus pointing towards the effectiveness of simple selection depending on the phenotypic expression of genotypes. These results were in consonance with the findings of Kumar *et al.* (2012) and Jirankali *et al*. (2019). Days to first harvest (99.11; 18.23) and plant breadth (91.72; 17.21) recorded high heritability along with moderate genetic gain.

Quantitative traits typically exhibit intricate interrelationships that have serious implications in evolutionary processes and plant improvement. These interrelationships are the outcome of genetic correlations, which can be induced by pleiotropy (a phenomenon resulting from shared genetic influence) or linkage disequilibrium (a phenomenon resulting from non-random

Table 1. Estimation of various genetic parameters for 18 characters in brinjal

S. No.	Characters	Mean	PCV (%)	GCV (%)	Heritability (%)	Genetic advance	GA as per cent of mean
1	Plant height (cm)	61.46	14.46	14	93.84	17.18	27.95
2	Plant breadth (cm)	71.47	9.11	8.73	91.72	12.30	17.21
3	Number of primary branches	7.80	20.19	19.89	97.07	3.15	40.37
4	Days to 50% flowering	50.40	10.92	10.89	99.44	11.28	22.38
5	Number of flowers per inflorescence	4.25	21.42	19.71	84.68	1.59	37.36
6	Percent medium and long styled flowers	56.07	19.24	18.24	89.80	19.96	35.60
7	Fruit setting percentage	49.89	22.80	22.21	94.93	22.24	44.58
8	Days to first harvest	68.82	8.93	8.89	99.11	12.55	18.23
9	Fruit length (cm)	11.29	51.62	51.60	99.89	11.25	99.67
10	Relative fruit calyx length	42.61	34.26	33.98	98.37	29.58	69.42
11	Fruit diameter (cm)	4.29	25.55	24.93	95.20	2.15	50.11
12	Fruit pedicel length (mm)	37.09	24.43	24.42	99.87	18.64	50.27
13	Fruit pedicel thickness (mm)	2.10	26.08	26.07	99.93	1.13	53.68
14	Fruits per plant	19.64	43.63	43.34	98.66	17.42	88.68
15	Fruit weight (g)	65.89	59.49	59.48	99.96	64.30	97.59
16	Number of marketable fruits	16.72	48.55	48.16	98.40	16.45	98.43
17	Marketable fruit yield (g)	922.71	49.05	48.61	98.22	915.63	99.23
18	Fruit yield per plant (g)	1127.39	45.54	45.23	98.64	1043.14	92.53

allele association) (Lynch and Walsh, 1998). However, genetic correlations on the other hand can make selection more difficult, particularly when traits are paired in an unfavourable way. In the current study, correlation coefficients among 18 different quantitative characters were worked out in all possible combinations at both genotypic and phenotypic levels and are presented in **Table 2**. The genotypic correlation coefficient was larger in this study than the phenotypic correlation coefficient, indicating that the apparent relationship of characters is mostly attributable to genetic causes with comparatively lesser effect from the environment. Similar observations were reported by Sujin *et al.* (2017) and Singh *et al*. (2020).

Fruit yield in brinjal is a highly complicated trait that is influenced by a number of genetic and environmental factors that are intertwined during distinct stages of plant development. Fruit yield per plant showed significant high positive genotypic and phenotypic correlation with nine characters *viz*., plant height, per cent medium and long styled flowers, fruit setting percentage, fruit length, fruit diameter, fruit pedicel length, fruit pedicel thickness, fruit weight and marketable fruit yield. Similar observations for plant height, average fruit weight were observed (Nayak and Nagre, 2013; Rathod *et al.,* 2016), percentage of long styled flowers (Thangamani and Jansirani, 2012) and fruit width and average fruit weight (Kumar *et al*., 2016). A negative significant correlation was observed between fruit yield and the number of primary branches, days to 50% flowering, days to first harvest, relative fruit calyx length and fruits per plant. Similar results of negative correlation were made for the number branches per plant and the number of fruits per plant (Akpan *et al.,* 2016) and days to 50% flowering, days to first harvest (Rathod *et al.,* 2016; Angadi *et al*., 2017). Marketable yield also recorded a similar correlation as that of total yield per plant. Hence, it may be concluded that the traits *viz*., days to 50% flowering, days to first picking can be considered for early fruit bearing of crop and the fruit yield per plant can be improved by simultaneous improvement in plant height, per cent medium and long styled flowers, fruit length, fruit diameter and fruit weight.

The vegetative characters plant height and plant breadth had a significant positive correlation with fruit characters *viz.,* fruit diameter, fruit pedicel length and fruit pedicel thickness but had a significant negative correlation with days to 50% flowering and days to first harvest. The number of primary branches had significant positive genotypic and phenotypic correlation with days to 50% flowering, days to first harvest, fruit pedicel length and fruits per plant. These suggests that improved vegetative growth helps in producing improved fruits but indirectly delays the flowering and fruiting characters (Barik *et al.,* 2021).

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Table 2. Genotypic (above diagonal) and Phenotypic (below diagonal) correlations of 18 quantitative characters in 30 brinjal genotypes

	PH	PB	NPB	D50%	NF/I	%MLSF	FSP	DFH	FL	RFCL	FD	FPL	FPT	F/P	FW	NMF	MFY	TY/P
PH	1.00	0.452**	0.00	-.310**	0.162*	0.111	0.142	-0.351**	0.524**	-0.320**	0.191*	0.602**	0.302**	-0.253*	0.436**	-0.287**	0.399**	0.457**
PB	0.457**	1.00	0.532**	-0.192*	0.048	-0.187*	-0.129	-0.245*	-0.048	0.131	0.241*	0.376**	0.182*	0.051	-0.079	-0.034	-0.054	0.015
NPB	0.006	0.510**	1.00	0.265*	0.142	-0.073	-0.058	0.248*	-0.258*	0.113	-0.139	0.221*	-0.133	0.182*	-0.412**	0.138	-0.317**	-0.311**
D50%	-0.300**	-0.184*	0.258*	1.00	0.079	-0.256*	-0.251*	0.979**	-0.210*	0.105	-0.306**	-0.148	-0.282**	0.087	-0.550**	0.103	-0.531**	-0.557**
NF/I	0.141	0.047	0.129	0.071	1.00	0.029	0.035	0.004	0.049	-0.103	-0.048	0.294**	-0.013	0.186*	0.013	0.197*	0.165*	0.122
%MLSF	0.102	-0.167*	-0.073	-0.242*	0.019	1.00	0.992**	-0.153	0.159*	-0.110	-0.001	0.041	-0.035	0.079	0.197*	0.080	0.431**	0.413**
FSP	0.134	-0.116	-0.061	-0.242*	0.031	0.952**	1.00	-0.147	0.228*	-0.212*	-0.012	0.094	0.00	0.060	0.218*	0.057	0.454**	0.440**
DFH	-0.340**	-0.237*	0.243*	0.972**	0.002	-0.136	-0.145	1.00	-0.200*	0.095	-0.343**	-0.210*	-0.286**	0.108	-0.572**	0.136	-0.533**	-0.570**
FL	0.509**	-0.045	-0.253*	-0.210*	0.044	0.150	0.222*	-0.199*	1.00	-0.836**	0.031	0.569**	0.406**	-0.399**	0.663**	-0.420**	0.616**	0.664**
RFCL	-0.314**	0.117	0.109	0.103	-0.095	-0.107	-0.210*	0.093	-0.832**	1.00	0.230*	-0.380**	-0.086	0.200*	-0.402**	0.218*	-0.472**	-0.508**
FD	0.185*	0.233*	-0.136	-0.296**	-0.049	-0.007	-0.022	-0.333**	0.030	0.225*	1.00	0.161*	0.676**	-0.551**	0.551**	-0.580**	0.265*	0.329**
FPL	0.583**	0.361**	0.219*	-0.148	0.269*	0.039	0.093	-0.209*	0.568**	-0.377**	0.157	1.00	0.473**	-0.374**	0.474**	-0.390**	0.500**	0.506**
FPT	0.292**	0.174*	-0.131	-0.281**	-0.016	-0.034	0.000	-0.285**	0.406**	-0.085	0.660**	0.473**	1.00	-0.687**	0.657**	-0.676**	0.442**	0.442**
F/P	-0.243*	0.041	0.179*	0.087	0.169*	0.075	0.057	0.107	-0.396**	0.198*	-0.532**	-0.372**	-0.681**	1.00	-0.642**	0.988**	-0.230*	-0.280**
FW	0.422**	-0.076	-0.407**	-0.549**	0.011	0.188*	0.213*	-0.569**	0.663**	-0.399**	0.538**	0.473**	0.657**	-0.637**	1.00	-0.645**	0.779	0.823**
NMF	-0.272*	-0.035	0.138	0.102	0.176*	0.085	0.055	0.134	-0.416**	0.211*	-0.561**	-0.387**	-0.671**	0.977**	-0.640**	1.00	-0.231*	-0.304**
MFY	0.389**	-0.053	-0.308**	-0.524**	0.144	0.411**	0.438**	-0.527**	0.611**	-0.466**	0.256*	0.496**	0.439**	-0.222*	0.772**	-0.213*	1.00	0.982**
TY/P	0.440**	0.012	-0.306**	-0.550**	0.108	0.389**	0.426**	-0.566**	0.659**	-0.500**	0.323**	0.503**	0.440**	-0.267*	0.819**	-0.297**	0.974**	1.00

** Significance at 1% level * Significance at 5% level

PH = Plant height , PB = Plant breadth , NPB = Number of primary branches, D50% = Days to 50 per cent flowering, NF/I = Number of flowers per inflorescence, %MLSF = Percent medium and long styled flowers, FSP= Fruit setting percentage, DFH= Days to first harvest, FL= Fruit length , RFCL = Relative fruit calyx length, FD= Fruit diameter , FPL = Fruit pedicel length , FPT = Fruit pedicel thickness , F/P= Fruits per plant, FW = Fruit weight , NMF= Number of marketable fruits, MFY= Marketable fruit yield, TY/P=Total yield/plant

Among the floral traits, days to 50% flowering had a significant positive genotypic and phenotypic correlation with days to first harvest, flowers per inflorescence, fruits per plant as well as total marketable fruits. A similar observation was made by Yadav *et al*. (2018) and Singh *et al*. (2020) for days to first harvest. Flowers per inflorescence had a significant positive genotypic and phenotypic correlation with fruit pedicel length, fruits per plant as well as total marketable fruits. Per cent medium and long styled flowers had significant positive genotypic and phenotypic correlation with fruit setting percentage as well as fruit weight. Long and medium-styled flowers set fruits in normal field conditions, with long-styled flowers having a more effective fruit set (Kowalska, 2006; Sekara and Bieniasz, 2008).

Fruit length and diameter had significant positive genotypic and phenotypic correlation with fruit pedicel thickness and fruit weight while it showed significant negative genotypic and phenotypic correlation with fruits per plant and total marketable fruits (Arti *et al*., 2019; Kustagi *et al*., 2019). Fruits per plant had significant positive genotypic and phenotypic correlation with total marketable fruits whereas significant negative genotypic and phenotypic correlation with fruit weight as also reported by Koundinya *et al.* (2017) and Tripathy *et al*. (2017).

The fruit characters including fruit length, fruit diameter, fruit setting percentage, fruit pedicel length, fruit pedicel thickness had a significant correlation with fruit weight. All of these traits showed a high positive significant correlation with total fruit yield and total marketable yield as well. Character association occurs as a result of the correlated response, a process caused by pleiotropy and linkage (Lynch and Walsh, 1998). When two characters have a mutual correlation and also have a correlation with yield, the association of characters is primarily due to pleiotropy. And that when certain of these mutually linked traits show no correlation with yield, the association is most likely due to linkage rather than pleiotropy. In the present study, the significant association of fruit characters with average fruit weight and with yield gives an indication of pleiotropy (Lakshmi *et al*., 2014). There was a significant negative correlation of the number of fruits per plant with fruit weight as well as fruit yield. It's possible that this correlation is due to linkage. As a result, it appears that the two features have a mutual trade-off when it comes to yield improvement.

Fruit and yield characters *viz.,* fruit length, relative fruit calyx length, fruit weight, fruits per plant, the number of marketable fruits, marketable fruit yield and fruit yield per plant had high GCV and PCV suggesting sufficient 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 the environment. High heritability together with high estimates of genetic gain for characters *viz*., fruit length, fruit diameter, relative fruit calyx length, fruit pedicel length, fruit pedicel thickness, fruit weight, fruits per plant, the number of marketable fruits, marketable fruit yield, fruit yield per plant reveals the importance of additive gene action over these characters. Hence, there is a scope for selection for improvement of these traits. Fruit yield per plant showed significant high positive genotypic and phenotypic correlation with plant height, per cent medium and long styled flowers, fruit setting percentage, fruit length, fruit diameter, fruit pedicel length, fruit pedicel thickness, fruit weight and marketable fruit yield. Therefore, simple selection for these characters based on phenotypic performance would be rewarding to warrant selection for better eggplant genotypes. These traits can, therefore, be given special attention in selections aimed at yield improvement of eggplants.

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