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Genetic variation and character association in fruit yield components and quality characters in brinjal [*Solanum melongena* L.]

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ABSTRACT

The study was conducted using 70 collections of eggplant germplasm. For growth characters, both phenotypic (PCV) and genotypic (GCV) coefficients of variation corresponded closely, which was reflected by the very high broad sense heritability for most of the characters. Genetic advance as percentage of mean was the highest for mean leaf area followed by leaf area plant^{-1} and leaves plant^{-1}. Heritability was high for fruit yield and other fruit characters excepting fruit weight. All the characters revealed high genetic advance as percentage of mean. Total phenol content registered the highest GCV showing the widest range (7.26 - 26.14 mg 100^{-1} g fresh fruit). Genetic advance was high for total phenol content, moderate for total sugar content, low for crude protein content and very low for moisture content. Most of the characters did not register any significant correlation with fruit yield/plant. Yield plant^{-1} had strong positive association with fruits/plant, leaves/plant and primary branches plant $^{-1}$at both phenotypic and genotypic levels. Significantly negative correlation between fruit yield plant $^{-1}$and sugar and protein content of fruit and significantly positive correlation between fruit yield plant $^{-1}$and total phenol content of fruit indicated that yield improvement might sacrifice fruit quality traits. Different character associations clearly indicated that big and plump-fruited genotypes were superior in quality. Path analysis indicated fruit weight was one of the major contributory factors to yield, fruit girth and leaves plant^{-1} being the others. Fruit number plant^{-1}, fruit weight, fruit girth and leaves plant^{-1} emerged as the most important fruit yield contributing characters of brinjal and these characters may be used as important selection parameters because of their probable conditioning by additive gene action.

Key words: Character association, genetic variation, yield components

Eggplant or brinjal [*Solanum melongena* L.] is the most popular and widely cultivated vegetable crop in the central, southern and Southeast Asia and in some African countries. The crop is extremely variable in India and for this reason, Vavilov (1928) regarded the crop as being of Indian origin. In a strict sense, the question of whether a character is hereditary or influenced by environment has no meaning. The genes cannot cause a character to develop unless they have the proper environment and conversely, no amount of manipulation of the environment will cause a character to develop unless the necessary genes are present. However, it must be recognized that the variability observed in some characters was caused primarily by the differences in the genes carried by the genotypes and that the variability in other characters was due primarily to differences in the environment to which the genotypes have been exposed. So, this study aimed at justifying the real worth of the selection parameters that will be framed through comparative study of genetic variability parameters. Information generated from the studies of character association serve as the most important indicator (plant character) that ought to be considered in the selection programme. Such studies would also help us to know the suitability of multiple characters for indirect selection, because selection for one or more traits results in correlated response in several other traits. The present studies were, therefore, initiated with an objective to determine genetic variability for fruit yield and related attributes along with quality components and their inter-relationships in a collection of 70 genotypes of brinjal, over two seasons.

MATERIALS AND METHODS

The study was conducted using 70 collections of eggplant germplasms (10 elite varieties, 16 stable breeding lines developed at different Agricultural Universities and Research Institutes of India and 44 indigenous cultivars of India and Bangladesh) for evaluation in Randomized Block Design, with three replications in autumn- winter season (September- March) at Central Research Farm of Bidhan Chandra Krishi Viswavidyalaya (23^{0}N latitude, 89^{0}E longitude and 9.75m elevation), West Bengal, India. Each plot consisted of 16 plants spaced by 70 cm in 2 rows, 6m long. Five random plants per replication were selected to record observation on each genotype for 9 different growth and reproductive characters. Four proximate compositions of fresh fruits of marketable maturity (15- 25 days after anthesis depending on the genotype) were estimated from composite fruit samples taken from each selected plant of the replication. The samples were first dried in sun, then oven dried at 70^{0}C for 48 hours and the quality constituents of fruit were estimated following standard methods:(i) total sugars by anthrone method (Dubois *et al.*, 1951), (ii) crude protein through estimation of nitrogen by micro-Kjeldahl method (Sadasivam and Manickam, 1996), (iii) total phenols by Folin-ciocalteau reagent method(Bray and Thrope,1954) and expressed on fresh weight basis. Mean data over two years were employed for the estimation of the genotypic (GCV)

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and phenotypic (PCV) coefficients of variation according to Burton (1952) and Burton and De Vane (1953). Phenotypic and genotypic correlation coefficients for all possible combinations were computed as per Aljibouri *et al.* (1958). Path coefficients were calculated as suggested by Dewey and Lu (1959) to estimate the direct and indirect effects of the characters on fruit yield.

RESULTS AND DISCUSSION

Growth characters

Both PCV and GCV corresponded closely, which was reflected upon the estimates of broad sense heritability that was very high for all the characters. Genetic advance as percentage of mean was highest for mean area of leaf followed by leaf area plant^{-1} and leaves plant^{-1}.

Fruit characters and yield

Reliability of prediction with respect to phenotypic performance was revealed due to narrow gap between PCV and GCV. Heritability estimates (H) was high for fruit yield and other fruit characters excepting fruit weight. Variation in estimation of genetic variability parameters particularly for fruit number and weight in some earlier studies might have happened due to two probable reasons: use of different set of genotypes and variation in recording the data on fruit weight as fruits produced in a genotype show considerable variation depending on the flowers in the cyme (basal or additional) that set fruits (Nothmann *et al.*, 1979; Rout, 2001) and fruiting load (Passam *et al.*, 2001). All the characters revealed high genetic advance (G.A.) as percentage of mean though it was highest for fruits plant^{-1}.

Quality parameters of fruit

The proximate compositions of fruits estimated in the present investigation *viz.*, moisture, crude protein, total sugar and total phenol contents not only determine fruit quality (Bajaj *et al.*, 1989; Chadha *et al.*, 1990) but also are associated with the tolerance attribute of the genotype against biotic stresses (Darekar *et al.*, 1991; Dutta, 2003). Total phenol content registered the highest GCV showing the widest range of 7.26 –26.14 mg 100^{-1} g fresh fruit (Table 1). Very high broad sense heritability estimates were recorded for these characters. However, genetic advance as % of mean was high for total phenol content, moderate for total sugar content, low for crude protein content and very low for moisture content of fruit revealing varied suitability of these characters for direct 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), and such combination was recorded for mean area of leaf, leaf area plant^{-1}, fruit number plant $^{-1}$and fruit weight which could be improved upon by adopting selection without progeny testing. Combination breeding followed by selection will also be suitable to improve these characters. High heritability coupled with moderate genetic advance for leaves plant $^{-1}$, fruit length, total sugar and phenol contents of fruit and fruit yield plant^{-1} also indicated preponderance of additive gene action for the control of these characters. Revelation of high heritability and low genetic advance was attributable to non-additive gene action for the conditioning of the characters (Panse, 1957; Liang and Walter, 1968), and in this supposition, plant height, primary branches plant $^{-1}$, moisture and crude protein content of fruit may be improved upon by selection with subsequent progeny testing and in combination breeding through deferred selection.

Character association

Most of the characters did not register any significant correlation with fruit yield plant^{-1} indicating that mutual balancing was operative for the expression of the characters. However, yield plant^{-1} had strong positive association with fruits plant^{-1}, leaves plant^{-1} and primary branches plant^{-1} at both phenotypic and genotypic levels. It was apparent that high vegetative growth might have produced increased number of fertile flowers plant^{-1} resulting into increased fruits plant^{-1}. Significantly negative correlation between fruit yield plant $^{-1}$ and sugar and protein content of fruit and significantly positive correlation between fruit yield plant^{-1} and total phenol content of fruit indicated that yield improvement might sacrifice fruit quality traits.

Negative genotypic correlation between fruit number and fruit weight indicated limitation in the capacity for total fruit production because of two divergent growth forces being operative to contribute to total yield. Different character association clearly indicated that big and plumpy-fruited genotypes were superior in quality.

Positive association among sugar, protein and moisture contents and their negative correlations with total phenol contents of fruit needs to be considered carefully at the time of framing a breeding strategy for simultaneous improvement of yield, fruit quality and resistance attributes.

Path cofficient analyses revealed that maximum direct effect on yield was through the fruits plant $^{-1}$ however, its correlation with fruit yieldplant^{-1} though significantly positive but comparatively low in magnitude. This could mainly be due to negative indirect effect through fruit weight.

Table 1: Genetic parameters of variability for different characters

Characters	Grand mean	Range	PCV	GCV	H (%)	G.A. %	G.A. as % mean
Plant height (cm)	71.94	47.83-98.47	16.53	14.30	74.9	18.34	25.49
Primary branches plant^{-1}	13.56	6.50-17.33	18.53	16.12	75.7	3.92	28.91
Leaves plant^{-1}	250.19	53.50-405.77	33.79	31.54	87.1	151.76	60.66
Mean area of leaf (cm^2)	127.83	52.47-333.70	50.44	47.90	90.2	119.78	93.70
Leaf area plant^{-1} (m^2)	3.11	0.69-7.27	51.48	47.68	85.8	2.83	91.00
Fruit length (cm)	10.57	5.57-20.43	30.33	28.17	86.2	5.70	53.93
Fruit girth (cm)	5.55	2.20-9.07	27.56	26.52	92.6	2.92	52.61
Fruit weight (g)	116.95	27.27-472.40	62.35	51.70	68.7	103.26	88.29
Fruit number plant^{-1}	29.21	1.90-101.90	78.55	72.70	85.7	40.49	138.62
Moisture (%)	91.80	88.43-94.00	1.46	1.34	84.0	2.32	2.53
Crude protein (%)	1.58	1.17-1.87	10.26	10.09	96.6	0.32	20.25
Total sugar (%)	3.16	1.42-3.95	21.45	21.43	99.8	1.39	43.99
Phenol (mg 100^{-1} g)	11.42	7.26-26.14	33.33	32.54	95.3	0.07	61.40
Fruit yield plant^{-1} (kg)	2.58	0.17-5.20	50.45	43.73	75.2	2.01	77.91

Table 2: Prominent phenotypic (P) and genotypic (G) correlations between characters

Pair of characters	Correlation coefficients	
Primary branchesplant $^{-1}$and leaves plant^{-1}	P : 0.45*	G : 0.53
Primary branches plant^{-1} and fruits plant^{-1}	P : 0.31*	G : 0.29
Primary branchesplant^{-1} and fruit yieldplant^{-1}	P : 0.32*	G : 0.37
Leaves plant^{-1} and fruitsplant^{-1}	P : 0.37*	G :0.44
Leaves plant^{-1} and fruit yieldplant^{-1}	P : 0.36*	G : 0.43
Fruits plant^{-1} and fruit yieldplant^{-1}	P : 0.64*	G : 0.71
Fruits plant^{-1} and crude protein content	P : -0.68*	G : -0.75
Fruits plant^{-1} and total sugar content	P : -0.69*	G : -0.74
Fruits plant^{-1} and total phenol content	P : 0.71*	G : 0.78
Fruit yieldplant^{-1} and crude protein content	P : -0.32*	G : -0.35
Fruit yieldplant^{-1} and total sugar content	P : -0.31*	G : -0.36
Fruit yieldplant^{-1} and total sugar content	P : 0.31*	G : 0.34

*Note: * Significant at 5% level of probability*

Table 3: The characters showing direct effect on fruit yield

Characters	Direct effect on fruit yield plant^{-1}
Plant height	0.019
Primary branchesplant^{-1}	0.014
Leavesplant^{-1}	0.141
Mean area of leaf	-0.155
Leaf area plant^{-1}	0.029
Fruit length	0.013
Fruit girth	0.224
Fruit weight	0.402
Fruitsplant^{-1}	0.949
Moisture content	0.169
Crude protein content	-0.237
Total sugar content	-0.069
Total phenol content	-0.282

Path analysis indicated fruit weight as one of the major contributory factors to yield (Table 3) however, correlation coefficient gave a misleading impression that fruit weight had little to do with fruit yield. Fruit girth and leaves plant^{-1} also emerged as important fruit yield components. High and negative direct effect of phenol content on fruit yield might have registered due to negative indirect effect through fruit number plant^{-1}. From this study, fruit number plant^{-1}, fruit weight, fruit girth and leaves plant $^{-1}$ emerged as the most important fruit yield contributing characters of eggplant and these characters may be used as important selection parameters because of their probable conditioning by additive gene action.

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