Estimates of genetic variability, yield and quality traits of brinjal (*Solanum melongena* L.)

Abstract

The present investigation was carried out involving thirty two genotypes of brinjal with a view to estimate the extent of variability, heritability and genetic advance in per cent of mean. The experiment was conducted in Randomized Block Design with three replications during Kharif, 2020-21. The analysis of variance revealed that mean sum of squares due to genotypes were highly significant for all the traits indicating ample variation among the genotypes for all the traits. High magnitudes of PCV and GCV were observed for some quality traits like non-reducing sugar (34.80% and 34.69%) and ascorbic acid (20.21% and 20.18%). Moderate PCV and GCV were recorded for total fruit yield per plant (16.05% and 15.35%), average fruit weight (16.01% and 15.78%), reducing sugars (14.53% and 14.45%), number of primary branch per plant (13.68% and 13.23%), total phenol content (12.88% and 12.81%) and total sugars (12.14% and 12.07%). While, low PCV and GCV were recorded in fruit circumference (8.34% and 7.71%), total soluble solid (8.04% and 7.79%), days to 50% flowering (7.98% and 7.24%), fruit polar length (7.50% and 4.25%) and number of fruits per plant (6.73% and 6.05%). High estimates of heritability >75% were recorded for all the characters except days to first fruit harvest (59%).The heritability in broad sense ranged from 59 % in case of day to first fruit harvest to 99.90 %for ascorbic acid. High heritability (> 75 %) coupled with high genetic advance in per cent of mean (> 20) were recorded for ascorbic acid (99.90% and 41.50%), non-reducing sugar (99.00% and 71.21%), reducing sugars (99.00% and 29.61%), total phenol content (99.00% and 26.22%), total sugars (99.00% and 24.74 %), average fruit weight (97.00% and 32.03%), number of primary branch per plant (94.00% and 26.37%), total fruit yield per plant (92.00% and 30.26%) and plant height (90.00% and 22.16%)indicating that these traits were less influenced by environment. Thus, there exists ample genetic variability and as consequence scope of improvement in the available germplasm of brinjal.

Key word- Genetic variability, PCV, GCV, heritability, genetic advance.

Introduction-

Brinjal (*Solanum melongena* L.) is one of the most well-known vegetable crops of Solanaceae family often known as egg plant. It is believed to have originated in India, where the large fruited cultivars were domesticated (De Candolle, 1886). However, according to Vavilov (1928), its origins lie in the Indo-Burman region, with the Indian subcontinent and China serving as the primary and secondary centres of variation.

It is commonly grown for its fruits in the tropics and subtropics, particularly in Central, Southern, and Southeast Asia and in several countries of Africa, with the exception of high altitudes (Chowdhury and Tah, 2011). The young and fragile fruits are used in a variety of Indian dishes, including pakoras, bharta, and curries, making them the most widely grown vegetable crop in India. It also goes by the name "poor man's vegetable" due to its high potential for production and widespread consumer availability.

In India, it is grown in 7.36 million hectare area with an average annual production of 127.77 million tonnes (Anonymous, 2019). It is an erect or semi-spreading annual herbaceous plant that is hardy. Egg plants are typically self-pollinated, but cross-pollination has been reported to be as high as 29%, classifying them as frequently cross pollinated or facultative cross-pollinated. The inflorescence is usually solitary, but in some cases it forms a cluster of 2-5 flowers. The inflorescence's solitary or clustering nature is a varietal characteristic. The flower is hermaphrodite and complete. In eggplant, there is a lot of diversity in terms of plant type, stem colour, leaf size, leaf tip, midrib colour, fruit size, fruit shape, fruit colour, fruit yield, fruit quality, cooking quality, and pest and disease tolerance (Ullah *et al.* 2014).

The rate of improvement for any crop or vegetable will mostly depend on the current natural genetic variability for various economic features. Genetic variability in a crop or vegetable determines the best genotypes for creating quick improvements in production and other desirable qualities, as well as to choose the potential parent for hybridization programmes. A prerequisite is the analysis of the genetic architecture of yield and yield components using various genetic factors. Given that India is both the primary and secondary centre of brinjal diversity (Gazenbus, 1962), it is vital to test the genotypes in various environments before using them either directly for commercial purposes or in breeding initiatives.

Under different environmental conditions, phenotypic variability changes, whereas genetic variability remains constant and is more useful to a plant breeder for selection or hybridization. As yield is a complex characteristic controlled by several yield contributing components and influenced heavily by environmental factors, estimates of heritability and genetic advance are useful for selection.

The degree to which a specific environment influences the expression of genotypes is measured by heritability. It assists in determining which parts of variability are heritable and which are not. As a result, a biometrical approach is required to divide the total calculated variability into heritable and non-heritable parts using various genetical parameters such as genetic heritability, coefficient of variation and genetic advance.

MATERIALS AND METHODS-

The current study was carried out in the experimental farm of the Department of Vegetable Science, A.N.D. University of Agriculture and Technology Narendra Nagar (Kumarganj), Ayodhya, India, during the "*rabi*" season of 2020–2021. The experimental material consists of thirty-two different genotypes including local collections of the brinjal plant *Solanum melongena* L. There were two rows in each treatment. Each row had six plants, three replication With a net plot size of 1.2 x 3.0 m2 , transplanting was done at a spacing of 60 cm between rows and 50 cm between plants.

Five random plants were selected from each plot for recording the observations for days to 50% flowering days, number of primary branches per plant, plant height (cm), fruits polar length (cm), fruit circumference (cm), average fruit weight (g),number of fruits per plant, total soluble solids (ºBrix), reducing sugars (%), non-reducing sugars (%), total sugar (%), total phenol content (mg/100g), ascorbic acid content (mg/100g), total fruit yield per plant (kg). Simple RBD was used for the variance analysis, and Fisher's method (1925) was used to divide the overall variation into its component sources. The genotype variance was assessed for significance using the F-test, and the difference between the means of the various treatments was tested for significance using the crucial difference (CD) values. Heritability and coefficient of variation were calculated using the Adesoye *et al*. technique (2013).

Heritability in broad sense:

Heritability in broad sense ($H^2{}_{bs}$)was calculated using the formula suggested by Burton and de Vane (1953).

$$H^2{}_{bs}= \frac{\sigma^2 g}{\sigma^2 g+\sigma^2 e} \text{ or } \frac{\sigma^2 g}{\sigma^2 p}$$

$$h^2{}_{bs}\,(\%)=\frac{\sigma^2 g}{\sigma^2 p}\,x100$$

Where,

h^2=Heritability

Genetic advance in per cent of mean:

Genetic advance (Ga) was estimated by the method suggested by Johnson *et al.* (1955).

The independent variable (causes), directly as well as indirectly through other characters. The variation in total yield per plant unexplained by the 11 causes was presumed to be contributed by residual factor (x) which is uncorrelated with other factors. Path-coefficients were estimated by solving the following simultaneous equations indicating the basic relationship between correlation and path-coefficient. The equations used are as follows:

$$r_{iy} = P_{iy} + \sum_{j-1}^{14} r_{iy} P_{jy} \mathrm{for}_{ij} = 1.\ r_{iy} = P_{iy} + \sum_{j-1}^{14} r_{iy} P_{jy} \mathrm{for}_{ij} = 1,2...14.$$

The above equation can be written in the form of matrix.

[A] 14x1= [B]14x1[C]14x1

Where,

A is column vector of correlations r_{iy}

B is the correlation matrix of r_{ij}, and

C is the column vector of direct effects, P_{iy}

Residual factor was calculated as follows:

$$P_{xy} = \sqrt{1 - R^2}$$

Where,

$$R^2 = \sum_{j} P_{iy}\ r_{iy}$$

The r_{ij}'s i.e., $r_{1.2}$ to $r_{13\text{-}14}$ denote correlations between all possible combination of independents characters P_{1y} to P_{14y} denote direct effect of various characters on character y.

r_{iy}= Correlation coefficient between 1^{th} and y character.

p_{iy}= Direct effect of i^{th} character on Y.

Results and discussion-

On the basis of mean square among fifteen characters showed highly significant. In other words, the genotypes performance on these features was statistically distinct, showing that there is lots of scope for brinjal improvement selection in multiple traits. The analysis of variance found that the thirteen features of twenty different brinjal types differed significantly, according to Verma *et al*. 2021.

For all of the characters studied, the phenotypic coefficients of variation were higher than the genotypic coefficients of variation, indicating that the environment had a significant impact on the expression of the traits. It is possible that the observed variance was influenced by the surroundings.Genotypic coefficient of variations (Table-2) ranged from 4.25 (fruit polar length) to 34.69 (non-reducing sugar). Similar result was also reported by Ansari (2011). The highest phenotypic and genotypic coefficient of variation was observed for non-reducing sugar (34.80% and 34.69%) followed by ascorbic acid (20.21% and 20.18%), average fruit weight (16.01% and 15.78%), total fruit yield per plant (16.05% and 15.35%), reducing sugars (14.53% and 14.45%), number of primary branches per plant(13.68% and 13.23%), total phenol content (12.88% and 12.81%), total sugars(12.14% and 12.07%), plant height (11.97% and 11.35%). While low GCV and PCV were recorded in case of days to first fruit harvest (5.57% and 4.2%),number fruits per plant (6.73% and 6.05%), fruit polar length (7.50% and 4.25%), days to 50 % flowering (7.98% and 7.24%), T.S.S (8.04% and 7.79%), fruit circumference (8.34% and 7.71%). Rajpoot *et al.* 2015 and Verma *et al.* 2021 also reported similar results in their studies.

For a breeder, heritability in the broad sense of a character is significant because it suggests the feasibility and extent of improvement through selection. Because it assesses the link between parents and their progeny, it also shows the direction of selection pressure to be applied for a trait during selection. High heritability alone, however, is insufficient for efficient selection in advanced generations unless it is accompanied by a significant degree of genetic development (Burton, 1952). High heritability estimates combined with high genetic progress allow plenty of room for advancement in future generations.

The result on heritability and genetic advance in per cent of mean of present investigation have been presented in Table -2. The heritability estimates for different characters ranged from 32.00 to 99.90%. High heritability (> 75%) was recorded for all the characters except fruit polar length (32%) and days to first fruit harvest (59.00%). Dixit et al. (1982) also reported high heritability for all traits except plant height and yield per plant. Ravali *et al.* (2017), Verma *et al.* (2021) also reported high heritability for all traits.

Highest value of genetic advance in per cent of mean was shown by non-reducing sugar (71.21%) while, days to fruit polar length exhibited lowest value (4.96%) for this parameter. The characters showing very high estimate of genetic advance were non-reducing sugar (71.21%), ascorbic acid (41.50%), average fruit weight (32.03%), total fruit yield per plant (30.26%), reducing sugars (29.61%), number of primary branches per plant (26.37%), total phenol (26.22%), total sugars (24.74%), plant height (22.16%), T.S.S (15.55%), fruit circumference (14.69%), days to 50 % flowering (13.53%), number of fruits per plant (11.19%). Low genetic advance in per cent of mean were recorded for days to first fruit harvest (6.72%), fruit polar length (4.96%). Tirkey *et al.* (2018), Balsubramniyam *et al.* (2021) also reported that the similarly result.

High heritability (> 75 %) coupled with high genetic advance in per cent of mean (> 20) were recorded for ascorbic acid (99.90% and 41.50%), non-reducing sugar (99.00% and 71.21%), reducing sugars (99.00% and 29.61%), total phenol content (99.00% and 26.22%), total sugars (99.00% and 24.74 %), average fruit weight (97.00% and 32.03%), number of primary branch per plant (94.00% and 26.37%), T.S.S (94.00% and 15.55%), total fruit yield per plant (92.00% and 30.26%), plant height (90.00% and 22.16%), fruit circumference (86.00% and 14.69%), days to 50 % flowering (82.00% and 13.53%) and number of fruits per plant (81.00% and 11.19%) indicating that these traits were less influenced by environment. Thus, require low selection intensity for improvement. Similar results were also reported by Muniappan *et al.* (2010).

Days to first fruit harvest and days to fruit polar length exhibited moderate heritability (50 %) along with low genetic advance as per cent of mean (< 10 %) indicate that it is largely influenced by environment and thus, require high selection intensity for improving these trait. Tirkey et al. (2018) observed moderates heritability coupled with low genetic advance for days to first fruit harvest (59.00% and 6.72%) and days to fruit polar length (32.00% and 4.96%).

Table-1 Analysis of variance for yield and quality characters-

S.N.	**Traits**	**Mean squares**		
		Replicate	**Genotypes**	**Error**
		2	**31**	**62**
1	Day to 50% flowering	19.494	63.734**	11.262
2	Day to first fruit harvest	40.84	47.434**	19.669
3	Number of primary branches per plant	1.751	0.579**	0.059
4	Plant height (cm)	112.814	303.475**	19.487
5	Fruit Polar length (cm)	1.645	3.084	2.094
6	Fruit circumference (cm)	8.769	10.387**	1.504
7	Average fruit weight (g)	11.404	2474.040**	70.949
8	Number of fruit per plant	0.762	2.223**	0.429
9	T.S.S (ºBrix)	0.105	0.594**	0.036
10	Reducing Sugars (%)	0.005	0.100**	0.001
11	Non-reducing sugar (%)	0.001	0.152**	0.001
12	Total sugars (%)	0.005	0.139**	0.001
13	Total phenol content (mg/100 g)	0.007	0.279**	0.003
14	Ascorbic acid (mg/100 g)	0.185	18.523**	0.057
15	Total fruit yield per plant (kg)	0.014	0.482**	0.041

*- Significant at 5% probability level, **- Significant at 1% probability level.

Table-2 Heritability and genetic advance as percent of mean

S. No.	Characters/ traits	range		Grand mean	Phenotypic coefficients of variance (PCV %)	Genotypic coefficients of variance (GCV %)	ECV %	Heritability broad sence (%) (h^2bs)	Genetic Advance (Ga)	Gen. Adv as % of Mean ($\overline{Ga}$)
		Min	Max							
1	Day to 50% flowering	**51.31**	**67.53**	**57.79**	**7.98**	**7.24**	**5.81**	**82.00**	**7.82**	**13.53**
2	Day to first fruit harvest	**62.23**	**84.45**	**71.36**	**5.57**	**4.26**	**6.22**	**59.00**	**4.80**	**6.72**
3	Number of primary branches per plant	**56.19**	**88.09**	**73.52**	**13.68**	**13.23**	**6.00**	**94.00**	**19.39**	**26.37**
4	Plant height	**2.99**	**4.58**	**3.67**	**11.97**	**11.35**	**6.59**	**90.00**	**0.81**	**22.16**
5	Fruit Polar length	**9.78**	**14.82**	**13.53**	**7.50**	**4.25**	**10.70**	**32.00**	**0.67**	**4.96**
6	Fruit circumference	**17.99**	**27.07**	**22.32**	**8.34**	**7.71**	**5.49**	**86.00**	**3.28**	**14.69**
7	Average fruit weight	**87.78**	**225.99**	**179.41**	**16.01**	**15.78**	**4.70**	**97.00**	**57.46**	**32.03**
8	Number of fruit per plant	**10.58**	**14.00**	**12.78**	**6.73**	**6.05**	**5.13**	**81.00**	**1.43**	**11.19**
9	T.S.S	**4.62**	**6.34**	**5.53**	**8.04**	**7.79**	**3.45**	**94.00**	**0.86**	**15.55**
10	Reducing sugars	**0.96**	**1.56**	**1.25**	**14.53**	**14.45**	**2.63**	**99.00**	**0.37**	**29.61**
11	Non-reducing sugar	**0.24**	**1.18**	**0.65**	**34.80**	**34.69**	**4.98**	**99.00**	**0.46**	**71.21**
12	Total sugars	**1.46**	**2.21**	**1.77**	**12.14**	**12.07**	**2.12**	**99.00**	**0.44**	**24.74**
13	Total phenol content	**1.70**	**2.83**	**2.37**	**12.88**	**12.81**	**2.41**	**99.00**	**0.62**	**26.22**
14	Ascorbic acid	**8.42**	**16.42**	**12.30**	**20.21**	**20.18**	**1.94**	**99.90**	**5.10**	**41.50**
15	Total fruit yield per plant	**1.56**	**3.15**	**2.50**	**16.05**	**15.35**	**8.10**	**92.00**	**0.76**	**30.26**

Conclusion-

For all of the characters studied, the phenotypic coefficients of variation were higher than the genotypic coefficients of variation, indicating that the environment had a significant impact on the expression of the traits. Also there is high degree of variation seen among the genotypes suggests that there is ample opportunity for selection in brinjal. High heritability coupled with genetic advance in present of mean where recorded show rest of the traits. Which suggest selection for this will be effective.

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