Original Research Article

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Studies on genetic variability, heritability and genetic advance for yield and its attributingtraits in brinjal (*Solanum melongena* L.)

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ABSTRACT

The genotypes of brinjal were assessed for genetic variability, heritability and genetic advance of growth and yield characters. The present investigation was carried out during rabi season of 2021 in randomized block design with three replications. The analysis of variance revealed significant variation for all the traitsamong the genotypes. High genotypic and phenotypic coefficient of variation was observed for the traits such as fruit weight (99.24 % and 99.27 %), number of fruits per plant (57.33 % and 57.58 %), fruit size index (54.80 % and 54.83 %), fruit length (36.54 % and 36.82 %), fruit circumference (32.16 % and 32.46 %) and fruit yield per hectare (27.26 % and 27.42 %) indicating the existence of wider variability among the genotypes for different characters. High heritability in broad sense along with high genetic advance as percent of mean was found in suggesting that these traits can be improved through direct selection due to the existence of additive gene action.

Keywords : Brinjal, genetic variability, phenotypic coefficient of variation, genotypic coefficient of variation, genetic advance

INTRODUCTION

Brinjal (*Solanum melongena* L.) also known as eggplant or aubergine, holds significant importance as asolanaceous vegetable crop particularly in the tropics and sub-tropics regions

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of the world. Brinjal is a staple vegetable, highly cosmopolitan and often referred to as poor man's crop. In India, it's cultivated extensively across the country, except in higher altitudes, and thrives throughout the year due to its adaptability to diverse climatic conditions. Brinjal cultivation in India covers an area of 747,000 hectares,yielding an annual production of 12,982,000 metrictonnes per hectare (Anonymous, 2022) In West Bengal,the cultivated area under brinjal is 161,000 hectares, producing 2,965,600 tonnesper hectareannually[1]. It is cultivated mainly for its tender and immature fruits , which are highly sought after for various culinary preparations . They serve as crucial raw materials for the preparation of pickles and dehydration industries for vast domestic market and export demands. India being the centre of variation for brinjal, exhibits diverse varieties suitable for different agro-climatic conditions. Moreover, the brinjal has been recommended for individuals dealing with various health conditions such as diabetes, asthma, cholera and bronchitisindicating its potential health benefits Devarajuet al. [2].

Brinjal, or eggplant, indeed offers a range of nutritional benefits. Despite being low in calories, it provides a variety of essential macro and micronutrients, making it a valuable addition to a balanced diet. Potassium is presented abundant in the eggplant, ranged from 200 to 600 mg/100 g of fresh fruit. Additionally, eggplant is a rich source of magnesium, calcium and iron which are essential for overall health. The edible part of the fresh and mature fruit has highmoisture content comprising about 92.7 per cent and a large number of chemical compounds including vitamin A (12.4 IU), vitamin C (12.0 mg), and vitamin B_1 (0.04 mg) apart from organic acid and minerals. In traditional medicine like Ayurveda, eggplant is used as an appetizer, cardiotonic agent, and is considered beneficial for conditions associated with Vata and Kapha imbalances Jayalakshmi et al. [3]. It is said to be good for diabetic patients.Interestingly, brinjal exhibits a wide variety of fruits traits, catering to regional preferences ranging from round to long fruit with green, purple, pink, white and even striped multicolours. Considering the potentiality of this crop it is imperative to develop varieties that are suitable for particular agro-ecological circumstances as well as for a particular usage. Crop genetic variability serves as the foundation for selecting and breeding genotypes that are well suited to various environmental conditions. By harnessing the inherent diversity within the crops's genetic pool, breeders can identify and develop varieties that thrive in specific agro-climatic zones. These varieties are better adapted to local conditions, exhibiting traits like tolerance to temperature extremes, resistance to prevalent pests and diseases and optimal responses to varying soil and moisture conditions.

Genetic improvement of any crop mainly depends on the amount of genetic variability present in the population and the germplasm serves as a valuable source of the base population and provide scope for wide variabilityGavade and Ghadage[4].Further, the crop exhibits rich genetic diversity and hence there is a scope for improvement for various horticultural traits in brinjal.

The essence of understanding thephenotypic expression of the plant character lies on the genetic makeup of the plant and environment, in which it is grown and the interaction between the genotype and environment. Further, the genetic variance of any quantitative trait comprises both additive variance (heritable) and non-additive variance (non heritable), which include dominance and epistasis (non-allelic interactions). Partitioning the observed phenotypic variability into its genotypic (partly heritable) and environmental (non heritable) components is crucial with suitable parameters, such as phenotypic and genotypic coefficient of variation and heritability in broad sense. Heritability, specifically, offers insights into the

Comment [BAS4]: Remove non heritable words proportion of observed variability in a trait that can be attributed to genetic differences among individuals. Understanding heritability in conjunction with genetic advance enhances accuracy in breeding programs. Genetic advance measures the potential improvement in mean genotypic values of selected families compared to the base population. This information aids breeders in selecting the most promising progenies in earlier generations, streamlining the breeding process. With this background, the present investigation was carried out to assess the variability, heritability and genetic advance for fourteen quantitative traits in brinjal. By systematically analyzing these traits and their genetic underpinnings, the study aims to provide crucial insights that could inform breeding strategies aimed at enhancing specific traits in eggplant varieties

MATERIALS AND METHODS

The present investigation was carried out at the Instructional Horticulture Farm, department of vegetable and spice crops, Faculty of Horticulture, Uttar BangaKrishiViswavidyalaya, pundibari which is situated at 26.40 ^{o}N latitude and 89.38 ^{o}E longitude and at an elevation of 48 meters above mean sea level. Thematerials for this study comprised of genotypes collected from different sources, (Table 1.)were laid out in randomized complete block design comprising of 25 genotypes in three replications during the*rabi* season of 2021-2022. The spacing adopted was 75 cm in between two rows and the plant to plant distance within a row was 60 cm. Four weeks old seedlings were transplanted into the main field from the nursery by adopting ridges and furrow method. A total of five plants under each replication was selected at random and tagged for recording observations on plant height, number of primary branches per plant, leaf length, leaf width, days to first flowering, days to 50 % flowering, fruit length, fruit circumference, fruit weight, number of fruits per plant, fruit weight, fruit size index, fruit yield per plant and fruit yield per hectare.

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The standard packages of practices and plant protection measures were adopted uniformly to ensure good crop growth throughout the experimental period. The mean values over replications for each character were subjected to statistical analysis. The statistical parameters like mean, standard error and coefficient of variation were calculated as per the standard methods of analysis. The phenotypic and genotypic coefficients of variations (PCV, GCV) were estimated by using the formulae suggested by Burton[5]. Heritability in broad sense was estimated by using the formulae suggested by Lush[6] and expected genetic advance was computed by using the formulae suggested by Johnson et al. [7].

RESULTS AND DISCUSSION

Analysis of variance revealed highly significant differences among genotypes for all fourteen Characters (table 2). The results pertaining to mean, range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability in broad sense and expected genetic advance as percent of mean (GAM) for all the characters are furnished in the table 3, figures 1 and 2 respectively..

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Variability is crucial for wider adaptability and resistance to biotic and abiotic factors and hence, an insight into the magnitude of genetic variability present in a population is of great 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 the decisive factor 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 has been used. High magnitude of genotypic as well as phenotypic coefficients of variations were recorded for the traits viz.,fruit weight (99.24 % and 99.27 %), number of fruits per plant

(57.33 % and 57.58 %), fruit size index (54.80 % and 54.83 %), fruit length (36.54 % and 36.82 %), fruit circumference (32.16 % and 32.46 %) and fruit yield per hectare (27.26 % and 27.42 %) indicating the existence of wider genetic variability for these traits in the genotypes under study. Further, the narrow range of difference between PCV and GCV indicated that less influence of environment on the expression of traits and selection on these characters might help to realize improvement in an early generation. Moderate GCV and PCV were recorded for the characters such as plant height (11.19 and 11.47), number of primary branches per plant (17.45 and 17.66) and days to first flowering (11.16 and 11.24) whereas, low GCV and PCV wereobtained in days to 50 % flowering (9.80 and 9.83). Similar results were also reported by Chaudhary and Kumar [8], Vidya and Kumar [9], and Sujin et al. [10].

Heritability estimates gives an idea of gene action involved in the expression of various polygenic traits. Genetic variability, heritability and selection intensity are the primary factors to determine the success
s of genetic advance. Traits such as fruit weight (99.94), fruit size index (99.89), days to 50 % flowering (99.29), number of fruits per plant (99.17), leaf width (98.87), fruit yield per hectare (98.81)exhibiting high heritability indicating the dominant role of additive gene action in the expression of these traits. Absolutely, high heritability estimates for these attributes revealed that the larger portion of the observed variation is due to the genetic factors rather than the influence of environment and fixable in nature. By focusing on these highly heritable traits and implementing targeted breeding strategies, one can anticipate substantial progress and improvements in crop quality and yield over successive generations.

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High genetic advance as percent of mean was observed for fruit weight, number of fruits per plant, fruit size index, fruit length, fruit circumference, fruit yield per hectare. Results suggested that inheritance of these traits are mainly governed by additive gene action and improvement could be brought about by phenotypic selection. Heritability estimates along with genetic advance as percent of mean allows breeders to make more informed decisions in selecting superior individuals that will lead to greater improvements in the desired traits, there enhancing crop quality and yield. The presence of high heritability in conjunction with substantial genetic advance was observed for all the traits under investigation is indicative of greater preponderance of additive genetic variance and consequently a high genetic gain is expected from selection. Such findings align with previous studies reported by Madhavi et al. [11], Ravali et al. [12] and Tirkey et al. [13] reinforcing the significance of genetic factors in determining these traits expression and potential for improvement through breeding programs.

Table 1. List of genotypes used in the experiment

Sl. No	**Name of the genotypes**	**Source**
1.	Co-2	TNAU, Coimbatore
2.	IR-8	Pundibari, West Bengal
3.	SadaSheetali	Pundibari, West Bengal
4.	PBL-1	Pundibari, West Bengal
5.	Dark Purple Round	Hyderabad, Telangana
6.	Pusa Bindu	IARI, New Delhi
7.	Nababganj Local	Pundibari, West Bengal
8.	PBL-2	Pundibari, West Bengal

9.	PBL-3	Pundibari, West Bengal
10.	Arka Harshitha	IIHR, Banglore
11.	BaramasiJhumka	Pundibari, West Bengal
12.	Purple long	Hyderabad, Telangana
13.	Pusa Ankur	IARI, New Delhi
14.	Arka Nidhi	IIHR, Banglore
15.	Dommeru local	West Godavari, Andhra Pradesh
16.	PBL-4	Pundibari, West Bengal
17.	PBL-5	Pundibari, West Bengal
18.	PBL-6	Pundibari, West Bengal
19.	PBL-7	Pundibari, West Bengal
20.	PBL-8	Pundibari, West Bengal
21.	PBL-9	Pundibari, West Bengal
22.	PBL-10	Pundibari, West Bengal
23.	PBL-11	Pundibari, West Bengal
24.	PBL-12	Pundibari, West Bengal
25.	PBL-13	Pundibari, West Bengal

Table 2. Analysis of variance for growth and yield parameters among brinjal genotypes

Sl.	Source of variation	Replication	Treatments	Error	S.Em±	CD at

No	/characters		(Genotypes)			5 %
	Degrees of freedom	2	24	48		
1.	Plant height (cm)	49.56	329.14	5.42	1.34	3.82
2.	Number of primary branches per plant	0.19	2.76	0.02	0.09	0.24
3.	Leaf length(cm)	3.28	35.61	0.58	0.44	1.26
4.	Leaf width(cm)	0.83	18.81	0.01	0.05	0.44
5.	Days to first flowering	1.57	177.22	0.84	0.53	1.50
6.	Days to 50 % flowering	0.11	165.18	0.40	0.36	1.03
7.	Fruit length(cm)	0.38	76.33	0.38	0.36	1.01
8.	Fruit circumference(cm)	1.91	62.37	0.39	0.36	1.02
9.	Pedicel length(cm)	0.28	3.72	0.07	0.15	0.43
10.	Fruit weight (g)	5.00	3.91	8.00	1.63	4.62
11.	Number of fruits per plant	3.00	533.78	1.48	0.70	2.00
12.	Fruit size index	0.014	11.29	0.004	0.04	0.11
13.	Fruit yield per plant (kg)	0.004	0.77	0.003	0.032	0.091
14.	Fruit yield per hectare (t/ha)	1.26	169.24	0.68	0.47	1.35

Table 3. Mean, range, variability, heritability, genetic advance as percent of mean for different characters in brinjal.

Sl. No	Characters	Mean	Range		Variability (percent)		h^2 (BS) (percent)	GAM
			Min.	Max.	GCV	PCV		

1.	Plant height (cm)	92.84	74.84	128.35	11.19	11.47	95.22	22.49
2.	Number of primary branches per plant	5.48	4.0	7.50	17.45	17.66	97.65	35.53
3.	Leaf length(cm)	14.92	7.67	22.98	22.90	23.46	95.22	46.03
4.	Leaf width(cm)	10.01	5.08	15.98	24.96	25.10	98.87	51.13
5.	Days to first flowering	68.69	57.00	82.60	11.16	11.24	98.59	22.83
6.	Days to 50 % flowering	75.66	64.00	87.80	9.80	9.83	99.29	20.10
7.	Fruit length(cm)	13.76	5.23	20.12	36.54	36.82	98.52	74.72
8.	Fruit circumference(cm)	14.13	6.61	26.64	32.16	32.46	98.16	65.64
9.	Pedicel length(cm)	5.14	2.9	8.24	21.48	22.09	94.58	43.03
10.	Fruit weight (g)	114.95	40.98	623.8	99.24	99.27	99.94	204.37
11.	Number of fruits per plant	23.23	3.77	52.37	57.33	57.58	99.17	117.62
12.	Fruit size index	3.54	0.89.	8.18	54.80	54.83	99.89	112.82
13.	Fruit yield per plant (kg)	1.86	0.94	2.86	27.26	27.42	98.80	55.81
14.	Fruit yield per hectare (t/ha)	27.50	13.94	42.40	27.26	27.42	98.81	55.82

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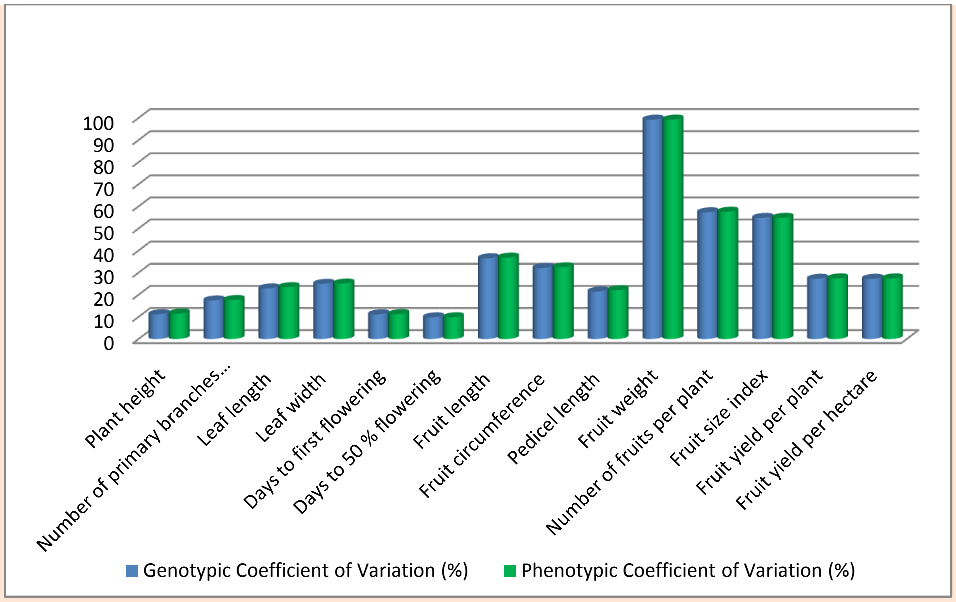

Fig. 1. Genotypic and phenotypic coefficient of variation for fourteen characters in brinjal genotypes

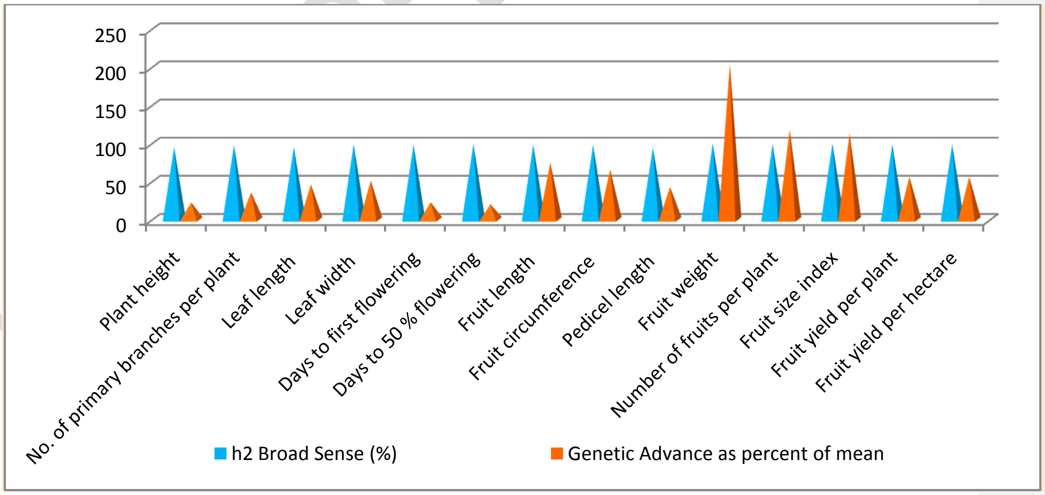

Fig. 2. Heritability and genetic advance as percent of mean for fourteen characters in brinjal genotypes

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CONCLUSION :

From the investigation, it is evident that there was an existence of sufficient variability among the genetic materials studied and the influence of environment was minimal. Hence there is ample of scope for direct selection in future breeding programmes to improve the yield attributes.

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