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STUDY OF GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE FOR YIELD AND QUALITY RELATED TRAITS IN BRINJAL (*SOLANUM MELONGENA* L.)

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ABSTRACT

A study was conducted during the Rabi season of 2023–2024 at the Vegetable Research Farm, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.), to evaluate genetic diversity, heritability, and genetic gain across seventeen traits in twenty-seven eggplant genotypes. The analysis of variance revealed significant genetic variation among the genotypes, indicating considerable diversity within the studied material. The findings highlight the potential of selective breeding to enhance key traits. In nearly all traits, the phenotypic coefficient of variation (PCV) was marginally higher than the genetic coefficient of variation (GCV), suggesting that environmental influence on trait expression was limited. Traits such as the number of fruits per cluster, fruit diameter, fruit length, peduncle length, total soluble solids, and dry matter content showed high values for both PCV and GCV. Importantly, traits like fruit diameter, fruit length, peduncle length, dry matter content, and number of fruits per cluster exhibited both high heritability and significant genetic advance, pointing to a predominant role of additive gene action. This implies that these traits are well-suited for improvement through direct phenotypic selection.

Keywords: Variability, heritability, genetic advance, brinjal.

Introduction

Eggplant (*Solanum melongena* L.) is commonly known as "brinjal" in English and "baigan" in Hindi, is a vital vegetable crop in India, belonging to the family Solanaceae. During the 2022–2023 period, vegetable crops were cultivated across approximately 11,309 thousand hectares in India, yielding about 212,548 thousand metric tons of produce. Among these, brinjal was grown on 681 thousand hectares, contributing 12,972 thousand metric tons to the nation's total vegetable production (NHB, 2022–23). The long-standing use of eggplant in India reflects its diverse roles as a food staple, therapeutic agent and ornamental plant. Plant breeding initiatives for eggplant have primarily focused on enhancing yield potential, improving agronomic and resistance traits and developing superior ideotypes. A critical step in these efforts involves assessing the genetic variability and heritability of traits within the available germplasm (Kumar *et al*., 2010). Effective selection for superior genotypes depends on the identification of lineages exhibiting higher mean genotypic values than the base population. The objective of the present study is to evaluate the inherent traits and genetic diversity of key economic characteristics in brinjal, and to determine the scope for genetic improvement using robust selection methodologies.

Material and Methods

The present investigation was carried out during the Rabi (winter) season of 2023–2024 at the Vegetable Research Farm, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Ayodhya (U.P.), India, using twenty-seven brinjal (eggplant) genotypes. The

experiment followed a Randomized Complete Block Design (RCBD) with three replications. Uniform and healthy seedlings, 50 days old, were carefully uprooted from the nursery beds and treated with a 0.1% Bavistin solution for 30 minutes before transplanting. These treated seedlings were then transplanted into the field, and the genotypes were evaluated for various traits under replicated conditions. The seedlings were transplanted into the main field in two-row plots, each measuring three meters. Ten plants per genotype were allowed in each replication, with plant spacing kept at 60 × 50 cm. In order to ensure good crop growth, the cultivation followed the guidelines and tactics that were recommended. Five randomly chosen plants from each plot were taken into consideration for recording observations for seventeen different features. Using the formula developed by (Burton and De Vane, 1953), the genotypic and phenotypic coefficients of variability for each attribute were calculated. According to the guidelines of (Lush 1949 and Hanson *et al.,* 1956), the ratio of genotypic variation to total phenotypic variance was used to calculate the broad-sense heritability (h^2) for each characteristic. Each trait's genetic progress estimates were derived using the formula proposed by (Johnson *et al*., 1955).

Result and Discussion

The variance analysis revealed significant differences between the several varieties, suggesting that the genotypes used in the experiment exhibited a high degree of variability across a range of attributes. They are eligible for further genetic research because of their diversity (Table-1). Lists the relative differences in variability between several attributes (Table 2). Provides comprehensive results for each of the seventeen qualities, including average values, range, phenotypic and genotypic coefficients of variation (PVC and GCV), broad-sense heritability (h^2), and predicted genetic advancement as a percentage of the mean (GAM).

Genotypic and Phenotypic coefficient of variation

For the majority of the traits among the 27 genotypes of brinjal, the highest GCV and PCV estimates were obtained, viz., the number of fruits per cluster (31.11% and 28.30%) and fruit diameter (21.33% and 21.01%). Moderate (10–20%) PCV and GCV estimates were observed for fruit length (16.72% and 16.04%), peduncle length (12.97% and 12.39%), ascorbic acid (11.22% and 10.51%), TSS (11.23% and 10.49%), plant height (10.24% and 9.56%) and dry matter (10.34% and 9.50%). The higher values of PCV and GCV for the aforementioned traits denote their significant genetic variability contribution, which suggests that parental lines selected based on these features may be used in subsequent crossing programmes to produce high-quality transgressive segregants.

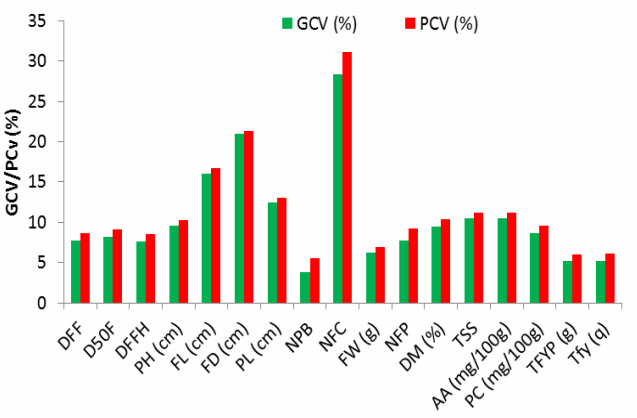

Fig. 1 : Genotypic and Phenotypic coefficient of variation

Heritability and Genetic advance

Among the traits investigated, the highest heritability estimates were documented for several attributes including fruit diameter (96.96%), fruit length (92.08%), peduncle length (91.34%), ascorbic acid (87.85%), total soluble solids (87.33%), plant height (87.22%), dry matter (84.29%), number of fruit per cluster (82.71%), phenol content (81.58%), days to 50% flowering (81.49%), average fruit weight (80.34%), with findings similarly reported by (Tripathi *et al*. 2009, Kumar *et al*.. 2010, Koundinya *et al*. 2017, Banerjee *et al*. 2018, Sakriya *et al*. 2020 and Anbarasi and Haripriya 2021). The substantial heritability values imply that these traits were less influenced by environmental factors. The observed genetic advancement ranged widely across all attributes, spanning from 5.38 to 53.01. The greatest value was observed for number of fruits per cluster (53.01%) followed by fruit diameter (42.61%) and average fruit length (31.71%). Genetic advance as a percentage of the mean (genetic gain) ranged from 0.34% to 89.67%. Notably, the highest values were noted for total fruit yield per plant (89.67%), total fruit yield per hectare (26.96%), and plant height (15.59%). Comparable outcomes were corroborated by (Tripathi *et al*. 2009, Kumar *et al*. 2010, Saha *et al*. 2019 and Anbarasi and Haripriya, 2021) for attributes such as number of fruits per plant, average fruit weight, yield per plant and number of primary branches, while the number of fruits per cluster was only reported by (Anbarasi and Haripriya, 2021). Notably, heritability values for all traits exceeded their genetic advance as a percentage of the mean values, underscoring their relatively minor susceptibility to environmental variations and affirming that the observed phenotypes genuinely

represented the genotypes, thus establishing the credibility of phenotypic-based selection.

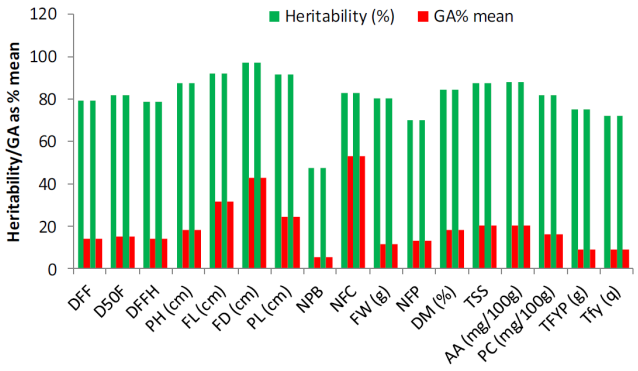

Fig. 2: Heritability and Genetic advance

Conclusion

The current eggplant study showed that the subject material had significant exploitable variability in 17 yield-related characteristics. This suggests a significant chance to improve genetics via hybridization and selection. The study also showed that the expression of yield and its main components was significantly influenced by both additive and non-additive genetic variables. High GCV, significant heritability, and genetic progress relative to the mean were seen for the majority of the examined variables. This suggests that additive genetic factors have a dominant role in determining how these traits manifest and presents a possible path toward genetic improvement via phenotypic selection.

Table 1: ANOVA table for various characters in brinjal genotypes

S. No.	Traits	Source of variation		
		D.F.		
		Replication	Treatments	Error
		2	26	52
1.	Days to first flowering	0.04	27.59**	2.25
2.	Days to 50% flowering	0.02	40.40**	2.84
3.	Days to first fruit harvest	0.02	63.97**	5.27
4.	Plant height (cm)	2.58	206.59**	9.62
5.	Fruit length (cm)	1.04	18.61**	0.52
6.	Fruit diameter (cm)	0.010	2.824**	0.029
7.	Peduncle length (cm)	0.013	1.165**	0.036
8.	Number of primary branches per plant	0.001	0.240**	0.065
9.	Number of fruits per cluster	0.056	1.274**	0.083
10.	Average fruit weight (g)	6.45	63.83**	4.81
11.	Number of fruits per plant	2.037	3.816**	0.483
12.	Dry matter content (%)	0.030	3.082**	0.180
13.	TSS (^{0}Brix)	0.005	0.867**	0.040
14.	Ascorbic acid (mg/100gm)	0.011	4.635**	0.204
15.	Phenol content (mg/100gm)	0.003	0.145**	0.010
16.	Total fruit yield per plant (g)	382.62	8412.05**	839.06
17.	Fruit yield(q/ha.)	136.80	805.76**	92.31

*, ** significant at 5% and 1% level, respectively

Table 2: Genetic variability, heritability and genetic advance for yield & quality traits in brinjal.

Characters	Mean	Min	Max	var (g)	var (p)	Heritability (%)	Genetic gain%	GA% mean	GCV (%)	PCV (%)
DFF	37.80	32.67	44.00	8.45	10.70	78.97	5.32	14.08	7.69	8.65
D50F	43.01	36.67	51.00	12.52	15.36	81.49	6.58	15.30	8.23	9.11
DFFH	58.37	50.00	66.00	19.57	24.84	78.78	8.09	13.86	7.58	8.54
PH (cm)	84.73	65.67	99.13	65.66	75.28	87.22	15.59	18.40	9.56	10.24
FL (cm)	15.31	8.60	18.50	6.03	6.55	92.08	4.85	31.71	16.04	16.72

FD (cm)	4.59	3.77	6.63	0.93	0.96	96.96	1.96	42.61	21.01	21.33
PL (cm)	4.95	3.97	6.13	0.38	0.41	91.34	1.21	24.40	12.39	12.97
NPB	6.37	5.90	6.87	0.06	0.12	47.33	0.34	5.38	3.79	5.51
NFC	2.23	1.03	3.07	0.40	0.48	82.71	1.18	53.01	28.30	31.11
FW (g)	71.19	61.40	80.30	19.67	24.48	80.34	8.19	11.50	6.23	6.95
NFP	13.66	11.77	15.80	1.11	1.59	69.72	1.81	13.27	7.72	9.24
DM (%)	10.36	9.10	12.87	0.97	1.15	84.29	1.86	17.96	9.50	10.34
TSS	5.00	4.10	6.27	0.28	0.32	87.33	1.01	20.20	10.49	11.23
AA (mg/100g)	11.56	9.90	14.10	1.48	1.68	87.85	2.35	20.30	10.51	11.22
PC (mg/100g)	2.46	2.02	2.88	0.04	0.05	81.58	0.39	16.04	8.62	9.55
TFYP (g)	974.25	866.73	1087.73	2524.33	3363.39	75.05	89.67	9.20	5.16	5.95
TFY (q)	294.88	260.89	330.22	237.82	330.13	72.04	26.96	9.14	5.23	6.16

DFF- days to first flowering, **D50F-** days to 50% flowering, **DFFH-** days to first fruit harvest, **PH-** plant height, **FL-** fruit length, **FD-** fruit diameter, **PL-** peduncle length, **NPB-** number of primary branches, **NFC-** number of fruit per cluster, **FW-** average fruit weight, **NFP-** number of fruit per plant, **DM-** dry matter, **TSS-** total soluble solids, **AA-** ascorbic acid, **PC-** phenol content, **TFYP-** total fruit yield per plant, **TFY-** total fruit yield per hectare.

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