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Assessment of genetic variability, heritability and genetic advance for yield and yield attributing traits in round fruited brinjal (*Solanum melongena* L.)

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Abstract

Brinjal (*Solanum melongena* L.) is an important vegetable crop, with large variability present in Chhattisgarh state, yet its genetic potential for breeding is not fully documented. To investigate this, thirty-two genotypes were evaluated during the Rabi season of 2025–26 in a Randomized Block Design with three replications, recording eighteen traits related to growth, flowering, fruiting and yield. The analysis revealed significant genetic differences across all traits, confirming ample variability. High genetic and phenotypic coefficients of variation, coupled with high heritability and genetic advance, were observed for fruit yield per plant, fruit yield per plot, marketable yield, total yield, number of fruits per plant and average fruit weight, suggesting strong additive gene action and making these traits highly suitable for direct selection. In contrast, traits such as plant height, branching, flowering time, maturity and number of pickings showed low heritability and genetic advance, indicating stronger environmental influence. Overall, fruit yield per plant, number of fruits per plant, average fruit weight and fruit yield per plot emerge as dependable selection indices for yield improvement in round fruited brinjal breeding programs.

Keywords: Brinjal, genetic variability, genotypic and phenotypic coefficients of variation, heritability, genetic advance

Introduction

Brinjal (*Solanum melongena* L., $2n=2x=24$), commonly referred to as eggplant or aubergine, is a significant vegetable crop cultivated widely across tropical and subtropical regions. It belongs to the Solanaceae family, and within this family, it ranks third in economic importance after potato and tomato, contributing significantly to food and nutritional security (Mueller *et al.* 2005) [15]. In India, the crop is grown over an area of approximately 0.68 million hectares, producing nearly 13.1 million tonnes annually, with an average productivity of 17–18 t ha⁻¹ (Horticulture Statistics at a Glance, 2024–25). Modern cultivars are believed to have originated from wild relatives such as *S. incanum* and *S. insanum*, distributed across India, Africa, the Middle East and Southeast Asia (Ranil *et al.* 2017) [21]. India, recognized as the primary center of origin, harbors rich genetic diversity (Vavilov, 1951) [29]. Beyond its culinary role, brinjal provides dietary fiber, minerals and bioactive compounds with antioxidant properties, underscoring its relevance to human health.

The potential for genetic improvement in brinjal depends on the variability present within breeding populations. Phenotypic variance reflects both genetic and environmental factors, the phenotypic coefficient of variation (PCV) alone is insufficient for guiding selection. Burton and DeVane (1953) [7] emphasized the need to separate genotypic (GCV) and environmental components to identify traits under genuine genetic control. Broad-sense heritability indicates the proportion of variability that is heritable, but as (Johnson *et al.* 1955) [9] noted, it must be considered alongside genetic advance to ensure that high heritability reflects true additive gene action rather than reduced environmental influence.

Recent studies confirm that yield in brinjal is a polygenic trait influenced by fruit number, fruit weight, plant architecture and flowering behavior (Begum *et al.* 2022, Kousalya *et al.* 2024 and Tripathy *et al.* 2025) [5, 12, 28]. However, the extent to which these traits are genetically fixable varies, directly affecting the efficiency of selection. In this context, the present study was undertaken to evaluate thirty-two round fruited brinjal genotypes for variability, heritability and

genetic advance in yield and yield attributing traits. The objective was to identify dependable selection indices that can accelerate genetic gain and support the development of resilient, high yielding cultivars suited to diverse agro climatic conditions.

Materials and Methods

The field experiment was undertaken during the *Rabi* season of 2025–26 at the Research cum Instructional Farm, Department of Vegetable Science, Indira Gandhi Krishi Vishwavidyalaya, Raipur. Thirty-two round fruited brinjal genotypes were evaluated using a Randomized Block Design with three replications. Each genotype was grown in a 3 m × 3 m plot at a spacing of 60 cm × 50 cm, following recommended agronomic and plant protection practices. Data was recorded from five randomly selected plants per plot for eighteen quantitative traits, including plant height, number of primary branches, days to first flowering, days to 50% flowering, number of flowers per cluster, number of fruits per cluster, fruit length, fruit girth, fruit stalk length, days to first harvest, days to maturity, total number of pickings, average fruit weight, number of fruits per plant, fruit yield per plant, fruit yield per plot, marketable yield per hectare and total yield per hectare.

Statistical analysis

Analysis of variance (ANOVA) was carried out following (Panse and Sukhatme, 1954) ^[17] to determine the significance of differences among genotypes. Genotypic and phenotypic coefficients of variation (GCV and PCV) were estimated using

the method of (Burton and DeVane, 1953) ^[7], allowing separation of genetic variability from environmental influence. Broad-sense heritability was calculated according to (Allard, 1960) ^[1], while genetic advance was estimated following (Johnson *et al.* 1955) ^[9]. To aid interpretation, traits were categorized into low, moderate and high classes for variability, heritability and genetic advance based on the criteria of (Sivasubramanian and Menon, 1973) ^[24] and (Robinson, 1966) ^[23]. Traits that combined high heritability with high genetic advance were considered to be under additive gene control and therefore suitable for direct selection in breeding programs.

Results and Discussion

Analysis of variance

The analysis of variance revealed that the mean sum of squares attributable to genotypes was highly significant ($P < 0.01$) for sixteen of the eighteen traits and significant at the 5% level for days to first harvesting and days to maturity (Table 1). This confirmed that the thirty-two genotypes differed meaningfully in their growth, flowering, fruit and yield attributes. The relatively small mean sum of squares due to replications compared with genotypes, indicated that the blocking arrangement was effective in minimizing local environmental variation, thereby enhancing the reliability of genotypic mean estimates used in subsequent variability analysis. Similar pronounced genotypic differences for growth, fruit and yield related traits in brinjal have been reported by (Barik *et al.* 2021 and Rathod *et al.* 2024) ^[4, 22].

Table 1: Analysis of variance for fruit yield and yield attributing characters in round fruited brinjal

Character	Replication (df=2)	Genotypes (df=31)	Error (df=62)
Plant height (cm)	113.14	164.62**	48.02
No. of primary branches/plant	4.91	1.81**	0.82
Days to first flowering	66.79	66.86**	11.61
Days to 50% flowering	3.20	56.84**	22.38
Number of flowers per cluster	0.43	0.81**	0.22
Number of fruits per cluster	0.01	0.17**	0.02
Fruit length (cm)	1.30	2.18**	0.52
Fruit girth (cm)	0.67	0.74**	0.21
Fruit stalk length (cm)	0.02	0.59**	0.16
Days to first harvesting	136.57	97.72*	55.91
Days to maturity	11.79	18.40*	10.35
Total number of pickings	0.70	0.73**	0.25
Average fruit weight (g)	1086.52	2819.15**	226.69
Number of fruits per plant	0.66	9.40**	0.58
Fruit yield per plant (kg)	0.04	0.54**	0.02
Fruit yield per plot (kg)	74.65	536.29**	15.98
Marketable fruit yield (q/ha)	7477.00	51375.00**	1597.00
Total fruit yield (q/ha)	9219.00	66198.00**	1974.00

** Significant at 1% level; * Significant at 5% level.

Mean performance of genotypes

A considerable degree of genotypic variation was observed across most of the traits under study (Table 2), underscoring the broad genetic base represented in the experimental material. Yield and yield related parameters displayed particularly wide ranges: fruit yield per plant varied between 0.69 and 2.41 kg, fruit yield per plot ranged from 15.67 to 69.43 kg, marketable fruit yield spanned 140.50 to 671.33 q/ha and total fruit yield extended from 174.11 to 771.36 q/ha. Similarly, the number of fruits per plant showed notable variability, ranging from 5.28 to 14.99. In contrast, phenological traits exhibited comparatively narrow variation, with days to maturity confined to 140–160 days and days to first harvest between 72 and 108 days. Comparable patterns of broad variability in yield traits alongside stable

phenological behavior have also been reported in brinjal germplasm evaluations by (Konyak *et al.* 2020 and Prajapati *et al.* 2021) ^[11, 19].

Genotypic and phenotypic coefficients of variation

The analysis of genotypic and phenotypic coefficients of variation (GCV and PCV) revealed that PCV values were consistently higher than GCV across all traits, indicating environmental influence on trait expression. However, the close correspondence between GCV and PCV for yield traits suggests that genetic factors play a predominant role. Similar observations of PCV surpassing GCV for yield and yield related traits in brinjal have been documented by (Pramila *et al.* 2019, Mohanty *et al.* 2020 and Bisht *et al.* 2022) ^[20, 14, 6].

High variability (>20%) was recorded for fruit yield per plant (GCV 32.28%, PCV 33.81%), fruit yield per plot (38.40%, 40.13%), marketable yield (39.35%, 41.20%), total yield (38.39%, 40.13%) and number of fruits per plant (20.58%, 22.52%). These results suggest strong genetic potential for improvement, in agreement with earlier reports by (Verma *et al.* 2021 and Bandhral *et al.* 2024) [30, 31]. Moderate variability (10–20%) was observed for average fruit weight (15.66%, 17.59%), plant height (10.33%, 15.44%), number of flowers per cluster (15.37%, 22.45%) and number of fruits per cluster (19.12%,

23.03%). Such moderate variation indicates scope for selection with careful evaluation, consistent with findings (Jirankali *et al.* 2019, Rathod *et al.* 2024 and Tiwari *et al.* 2025) [8, 22, 27]. In contrast, low variability (<10%) was found for days to 50% flowering (4.87%, 8.37%), fruit girth (5.59%, 8.25%) and days to maturity (1.08%, 2.37%). These traits appear more influenced by environmental factors, limiting their usefulness for direct selection. Similar low variability has been reported by (Konyak *et al.* 2020, Prajapati *et al.* 2021 and Tabasum *et al.* 2024) [11, 19, 25].

Table 2: Mean, range and estimate of genetic variability parameters for fruit yield and its component characters in round fruited brinjal

Character	Mean	Range		GCV (%)	PCV (%)	h ² (%)	GA (% of mean)
		Min.	Max.				
Plant height (cm)	60.36	43.10	85.72	10.33	15.44	44.73	14.23
No. of primary branches/plant	10.45	8.00	13.40	5.51	10.26	28.84	6.10
Days to first flowering	51.85	40.00	64.00	8.28	10.57	61.34	13.35
Days to 50% flowering	69.52	58.00	85.00	4.87	8.37	33.91	5.85
Number of flowers per cluster	2.89	1.13	4.86	15.37	22.45	46.90	21.69
Number of fruits per cluster	1.14	1.00	2.80	19.12	23.03	68.92	32.70
Fruit length (cm)	9.47	7.72	12.20	7.84	10.94	51.32	11.57
Fruit girth (cm)	7.54	6.00	8.86	5.59	8.25	45.89	7.80
Fruit stalk length (cm)	4.70	3.56	5.88	8.00	11.69	46.82	11.28
Days to first harvesting	92.95	72.00	108.00	4.02	8.99	19.96	3.70
Days to maturity	152.11	140.00	160.00	1.08	2.37	20.59	1.01
Total number of pickings	6.80	5.00	8.00	5.89	9.38	39.47	7.62
Average fruit weight (g)	187.72	101.00	298.00	15.66	17.59	79.22	28.71
Number of fruits per plant	8.33	5.28	14.99	20.58	22.52	83.53	38.74
Fruit yield per plant (kg)	1.29	0.69	2.41	32.28	33.81	91.16	63.49
Fruit yield per plot (kg)	34.30	15.67	69.43	38.40	40.13	91.56	75.69
Marketable fruit yield (q/ha)	327.32	140.50	671.33	39.35	41.20	91.22	77.43
Total fruit yield (q/ha)	381.08	174.11	771.36	38.39	40.13	91.56	75.68

h² = Broad sense heritability; GA = Genetic advance expressed as per cent of mean.

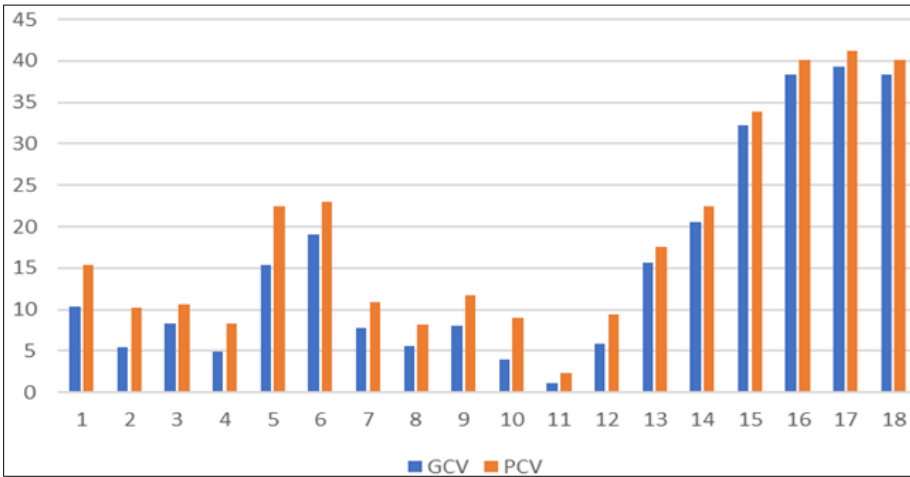


Fig 1: Genotypic and phenotypic coefficient of variation for fruit yield and yield attributing component characters in round fruited brinjal

Heritability (broad sense) and genetic advance as percentage of mean

Broad sense heritability estimates for the eighteen traits are summarized in Table 2 and illustrated in Figure 2. Heritability estimates showed clear differences among the traits. High heritability (>70%) was found for fruit yield per plant (91.16%), fruit yield per plot (91.56%), marketable yield (91.22%), total yield (91.56%), number of fruits per plant (83.53%) and average fruit weight (79.22%) suggesting that these are strongly governed by genetic factors and with relatively limited environmental influence (Katta and Jana, 2024) [10]. Moderate heritability (50–70%) was observed for number of fruits per cluster (68.92%), days to first flowering (61.34%) and fruit length (51.32%). Such

results suggest a balanced contribution of genetic and environmental components in determining these traits, in line with the observations of (Prajapati *et al.* 2021 and Pandey *et al.* 2025) [19, 16], while low heritability (<50%) appeared in plant height (44.73%), days to maturity (20.59%) and days to first harvest (19.96%) These results indicate that the expression of these traits is strongly influenced by environmental factors, Similar patterns have been reported by (Magar *et al.* 2019 and Tripathy *et al.* 2025) [13, 28] for days to maturity and total number of pickings. Genetic advance as a percentage of mean (GA%) also varied. High GA (>50%) was recorded for fruit yield per plot (75.69%), marketable yield (77.43%), total yield (75.68%) and fruit yield

per plant (63.49%) These results highlight the predominance of additive gene action, indicating that these traits are largely governed by fixable genetic components, with the findings of (Tiwari *et al.* 2025 and Pandey *et al.* 2025) [27, 16]. Moderate GA (25–50%) was noted for number of fruits per plant (38.74%), number of fruits per cluster (32.70%) and average fruit weight (28.71%). This suggests that while selection would be effective for these traits, the expected genetic gain may be comparatively slower than for yield traits, consistent with the observations of Patil *et al.* (2021) [18]. While low GA (<25%) was seen in plant height (14.23%), days to first flowering (13.35%) and days to maturity (1.01%) These values reflect limited scope for improvement of these traits through direct phenotypic selection, consistent with the observations of (Tirkey *et al.* 2018 and Magar

et al. 2019) [26, 13].

Traits that combined high heritability with high genetic advance such as fruit yield per plant, fruit yield per plot, marketable yield and total yield emerged as dependable selection indices, since they are largely governed by additive gene action and can be effectively improved through direct selection. Traits with moderate heritability and genetic advance including number of fruits per plant, number of fruits per cluster and average fruit weight also hold promise, though their improvement may require careful evaluation. In contrast, traits with low heritability and genetic advance such as plant height, days to first flowering and days to maturity are more strongly influenced by environmental factors. For these, direct selection is less effective.

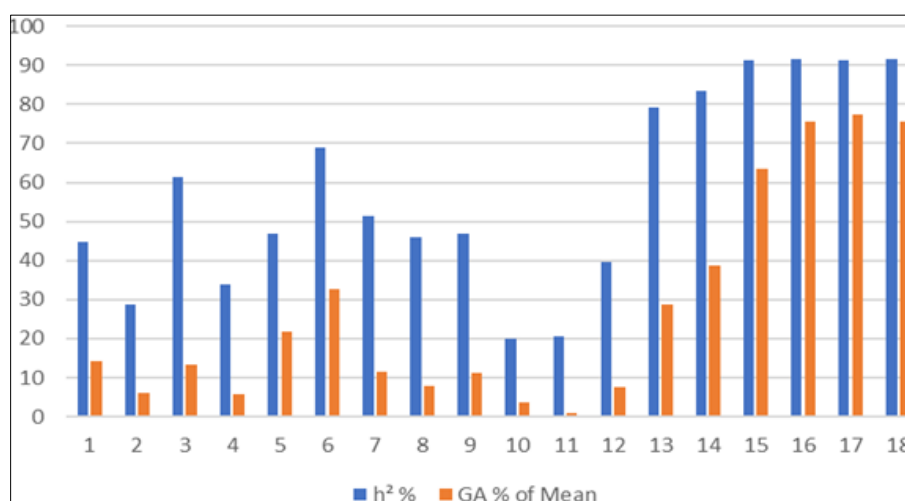


Fig 2: Broad sense heritability and genetic advance (per cent of mean) for fruit yield and yield attributing characters in round fruited brinjal

Conclusion

This study highlights the presence of substantial genetic variability among thirty-two round fruited brinjal genotypes. The consistent observation that PCV values exceeded GCV underscores the role of environmental factors in shaping trait expression. Importantly, key yield traits including fruit yield per plant, fruit yield per plot, marketable yield, total yield, number of fruits per plant and average fruit weight combined high GCV and PCV with high heritability and genetic advance, confirming additive gene action and their suitability for direct selection. In contrast, traits with low variability, heritability and genetic advance were found to be strongly influenced by the environment. Overall, number of fruits per plant, average fruit weight and yield components emerge as dependable selection indices for developing high yielding round fruited brinjal cultivars.

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Author Contributions

Sidrama Telagi: Conceptualization, experimentation, data collection, data analysis, manuscript preparation and editing.; **Dhananjay Sharma:** Supervision, review, technical guidance and final approval of the manuscript.

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Conflicts of Interest

The authors have no conflicts of interest to declare regarding this manuscript.

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