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Shades of purple: Exploring quantitative variability in Brinjal (*Solanum melongena* L.) Cultivars

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Abstract
A randomized block design experiment was carried out to assess variation within a population of Brinjal (Eggplant) using 60 different genotypes. The ANOVA revealed significant distinctions among the genotypes for all the traits examined, indicating the presence of abundant genetic diversity in the experimental material. Notably, traits such as total soluble sugars, fruits per plant, fruit length, total phenols, and fruit volume exhibited substantial genotypic and phenotypic variability, demonstrating a wide range of variation specifically for these characteristics. Furthermore, traits including total soluble sugars, total phenols, fruits per plant, fruit length, plant height, fruit volume, branches per plant, and fruit yield per plant displayed high heritability and genetic advance. This suggests that selecting individuals based on these traits would likely result in favourable improvements. Consequently, targeting individuals with desirable values for these traits holds the potential for significant enhancements in subsequent generations.

Keywords: Notably, plant height, fruit volume, branches

Introduction
Brinjal, a vegetable crop widely cultivated in India, holds significance in both the Indian subcontinent and beyond. It is known as "brinjal" in the Indian subcontinent, derived from Arabic and Sanskrit origins. Additionally, the name "eggplant" emerged due to the resemblance of certain varieties' white, elongated fruits to chicken eggs. Brinjal varieties can be classified into three main groups based on fruit characteristics: var. esculentum includes large, round or egg-shaped fruits, var. sorpentium comprises cylindrical and elongated types, while var. depressum encompasses dwarf brinjal plants.
Belonging to the Solanaceae family, brinjal is a cross-pollinated crop with a chromosome count of 2n=24. The Solanum genus is extensive, consisting of approximately 200 tuber-bearing species and 1800 non-tuber-bearing species. Brinjal falls into the category of non-tuber-bearing species. Although it is a perennial plant, it is commercially grown as an annual crop. Brinjal shares botanical lineage with other members of the nightshade family such as tomatoes, peppers, and potatoes.
India holds a prominent position as a major producer of brinjal globally. The country's brinjal cultivation spans an area of 0.728 million hectares, resulting in an estimated annual production of 12.66 million tonnes and a productivity of 17.39 million tonnes per hectare (Anon, 2020) [2]. Specifically, in Gujarat, brinjal is cultivated across 71,370 hectares, yielding an annual production of 14.71 metric tonnes and a productivity of 20.15 metric tonnes per hectare (Anon, 2020) [2].
Brinjal exhibits a broad spectrum of variability in terms of fruit size, shape, color, and other characteristics. Furthermore, variations are observed in traits such as vegetative growth, maturity, and the presence or absence of spines on leaves, stems, and fruitcalyx among indigenous brinjal varieties. Despite the availability of numerous brinjal varieties in India, only a limited number show promising characteristics. This indicates that there is ample room for further improvement through breeding programs.
To assess the potential progress resulting from selection, Burton (1952) [6] recommended evaluating genetic variation alongside heritability estimates. These parameters provide valuable insights into the involvement of additive gene action in governing specific traits. Therefore, studying genetic variability, heritability, and genetic advance is crucial for planning effective breeding programs.

Materials and Methods

The present study aimed to assess the genetic variability in brinjal (*Solanum melongena* L.). The investigation was conducted at the Main Vegetable Research Station, Anand Agricultural University, Anand, during the *kharif-rabi* season of the year 2020-21. The experimental material consisted of sixty diverse brinjal accessions, which were arranged in a randomized complete block design with three replications. Each plot contained two rows of a single genotype, and the plants were transplanted with distance of 90 cm x 60 cm. The allocation of genotypes to the plots within each replication was done randomly.

For data analysis, the study utilized the analysis of variance method as recommended by Snedecor and Cochran (1937) [13] and reviewed by Panse and Sukhatme (1978) [11]. The calculation of phenotypic and genotypic coefficients of variation was based on the formula put forward by Burton (1952) [6]. To estimate heritability and genetic advance, the study followed the procedure suggested by Allard (1960) [1].

Results and Discussion

Analysis of Variance

The analysis of variance revealed that the genotypes had a significant impact on all traits examined, confirming a substantial variation in fruit yield per plant, plant height, branches per plant, fruits per plant, fruit length, fruit girth, and fruit weight. These findings align with previous studies conducted by Divya *et al.* (2018) [7], Balas *et al.* (2019) [3], and Jyoti *et al.* (2019) [8], which also reported wide-ranging variations in these traits. Additionally, the present study contributes to the growing body of evidence supporting the presence of significant genetic diversity within the brinjal population.

Genotypic coefficient of variation (GCV)

The GCV for various traits varied from 43.21% (total soluble sugars) to 4.09% (moisture content). High GCV was observed for total soluble sugars (43.21%) followed by fruits per plant (29.70%), fruit length (28.48%), fruit volume (25.78%), total phenols (21.39 mg/100 g). High GCV estimates were also recorded by Saha *et al.* (2019) [12] and Konyak *et al.* (2020) [9] for total phenol, fruits per plant, fruit length, fruit weight, plant height and branches per plant. Moderate GCV for fruit girth (19.86%), branches per plant (19.23%), fruit yield per plant (19.02%), peduncle length (18.73%), average fruit weight (17.82%) and plant height (17.56%). Similar result for fruit girth and days to 50 per cent flowering were observed by Saha *et al.* (2019) [12] and Konyak *et al.* (2020) [9]. On the other hand low GCV was observed for total soluble solids (7.06%), days to 50 per cent flowering (5.47%) and moisture content (4.09%). Graphical representation of variability parameters (GCV % and PCV %) for quantitative traits and biochemical traits given in figure 1 and figure 3, respectively.

Phenotypic coefficient of variations (PCV)

The lowest PCV was observed for moisture content (5.48%) and the highest was observed for total soluble sugars (43.71%). While, the value was higher for fruits per plant (30.85%), fruit length (29.63%), fruit volume (27.97%), fruit girth (22.51%), total phenols (21.86%), branches per plant (21.51%), fruit yield per plant (21.33%), peduncle length (21.07%) and average fruit weight (20.68%) while, plant height (18.98%) exhibited moderate phenotypic coefficient of variation. Total soluble solids (9.29%), days to 50 per cent flowering (7.10%) and moisture content (5.48%) showed the lowest value for phenotypic coefficient of variation.

High estimate of PCV were recorded total soluble sugars, fruits per plant, fruit length, fruit volume, fruit girth, total phenols, branches per plant, peduncle length and fruit yield per plant. These results are in agreement with Banerjee *et al*. (2018) [4, 5] and Nikitha *et al*. (2020) [10]. Moderate PCV estimate were recorded for fruit weight, plant height. Similar result for days to 50 per cent flowering are in consonance with the findings.

Heritability (%)

Total soluble sugars (97.72%) as well as total phenols (95.75%) showed the highest value for broad sense heritability followed by fruits per plant (92.69%), fruit length (92.37%), plant height (85.61%), fruit volume (84.96%), branches per plant (79.95%), fruit yield per plant (79.50%), peduncle length (79.04%), fruit girth (77.79%) and average fruit weight (74.25%). The traits *viz.*, days to 50 per cent flowering (59.33%), total soluble solids (57.82%) and moisture content (55.58%) had moderate heritability values. High estimate of heritability were also reported by Banerjee *et al.* (2018) [4, 5], Divya and shrma (2018) [7], Balas *et al.* (2019) [3] and Konyak *et al.* (2020) [9]. Heritability of quantitative character mentioned in figure 2.

Genetic advance expressed as percentage of mean

Genetic advance expressed as percentage of mean ranged from 6.28% (moisture content) to 87.99% (total soluble sugars). These values were found higher in magnitude for total soluble sugars (87.99%), fruits per plant (58.91%), fruit length (56.38%), fruit volume (48.95%), total phenols (43.12%), fruit girth (36.08%), branches per plant (35.43%), peduncle length (34.31%), fruit yield per plant (34.06%), plant height (33.48%) and average fruit weight (31.63%). Whereas, total soluble solids (11.07%) exhibited moderate genetic advance expressed as percentage of mean. Similar result were in agreement with Banerjee *et al.* (2018) [4, 5], Saha *et al.* (2019) [12] and Konyak *et al.* (2020) [9]

Traits such as total soluble sugars, total phenols, fruits per plant, fruit length, plant height, fruit volume, branches per plant, fruit yield per plant, peduncle length, fruit girth, and average fruit weight exhibited both high heritability and high genetic advance as a percentage of the mean. This suggests that these traits are predominantly influenced by additive gene action, indicating a greater potential for improvement through effective genotype selection. These findings align with previous studies, indicating that there is ample room for enhancing these specific characteristics in brinjal populations.

Table 1: Analysis of variance (mean sum of squares) for fourteen characters 60 genotypes of brinjal

Sr. No.	Characters	Source of Variance		
		Replications	Genotypes	Error
Degree of freedom		2	59	118
1	Days to 50 per cent flowering	11.84	21.83**	4.06
2	Fruit length (cm)	1.10	37.034**	0.99
3	Fruit girth (cm)	1.03	25.07**	2.18
4	Average fruit weight (g)	110.15	714.28**	74.10
5	Fruits per plant	12.19	364.80**	9.34
6	Peduncle length (cm)	0.67	4.01**	0.33
7	Plant height (cm)	12.13	702.28**	37.25
8	Branches per plant	0.501**	1.17**	0.09
9	Fruit yield per plant (kg)	0.02	0.89**	0.07
10	Fruit volume (cc)	90.76	2860.88**	159.37
11	Moisture content (%)	0.75	37.91**	7.98
12	Total phenol (mg/100g)	73.55*	1090.59**	15.89
13	Total soluble sugars (%)	0.64**	5.06**	0.04
14	Total soluble solids (˚Brix)	0.36	0.73**	0.14

**significant at 1% level of significant

Table 2: The estimates of components of variance, genotypic and phenotypic coefficient of variations and other genetic parameters for fourteen traits in 60 genotypes of brinjal

Sr. No.	Characters	Components of variance			GCV (%)	PCV (%)	h^2_b (%)	GA	GA (%)
		σ^2g	σ^2p	σ^2e					
1	Days to 50 per cent flowering	5.92	9.98	4.06	5.47	7.10	59.33	3.86	8.68
2	Fruit length	12.01	13.00	0.99	28.48	29.63	92.37	6.86	56.38
3	Fruit girth	7.63	9.81	2.18	19.86	22.51	77.79	5.01	36.08
4	Average fruit weight	213.42	287.43	74.01	17.82	20.68	74.25	25.93	31.63
5	Fruits per plant	118.47	127.82	9.34	29.70	30.85	92.69	21.58	58.91
6	Peduncle length	1.22	1.55	0.33	18.73	21.07	79.04	2.02	34.31
7	Plant height	221.67	258.92	37.25	17.56	18.98	85.61	28.37	33.48
8	Branches per plant	0.36	0.45	0.09	19.23	21.51	79.95	1.10	35.43
9	Fruit yield per plant	0.271	0.341	0.07	19.02	21.33	79.50	0.957	34.06
10	Fruit volume	900.49	1059.87	159.37	25.78	27.97	84.96	56.98	48.95
11	Moisture content	9.97	17.95	7.98	4.09	5.48	55.58	4.85	6.28
12	Total phenols	358.22	374.11	15.88	21.39	21.86	95.75	38.15	43.12
13	Total soluble sugars	1.67	1.71	0.04	43.21	43.71	97.72	2.63	87.99
14	Total soluble solids	0.194	0.337	0.14	7.06	9.29	57.82	0.691	11.07

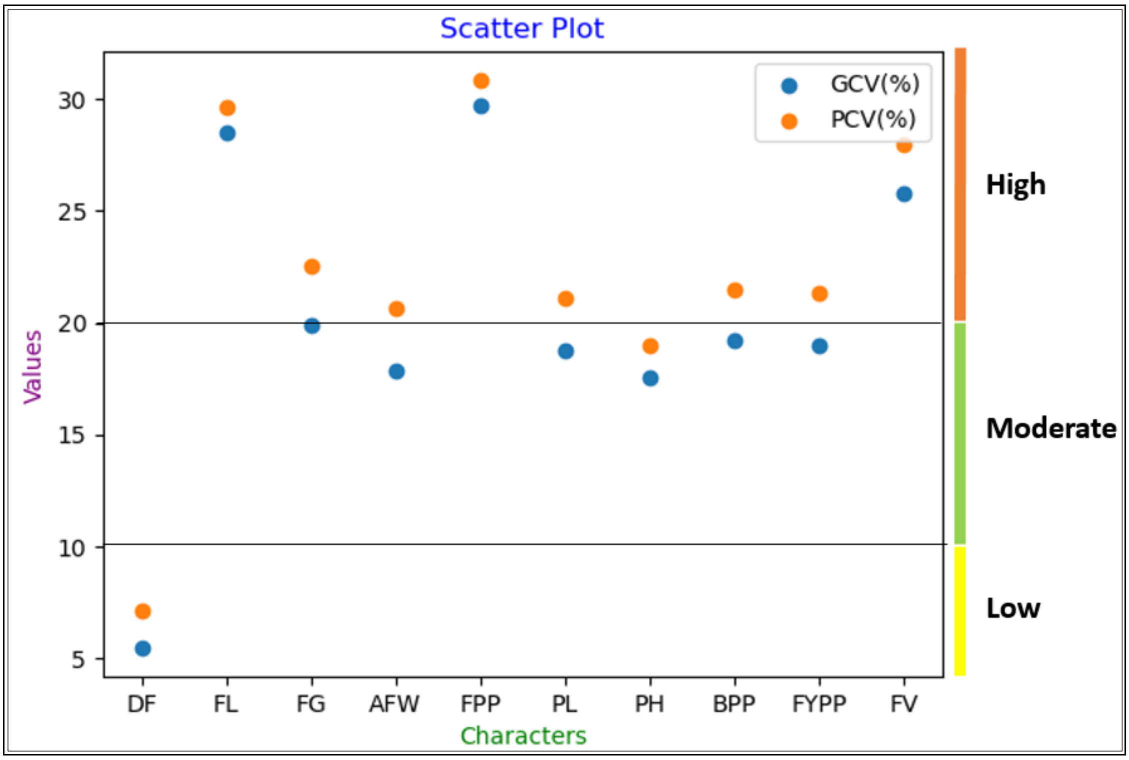

Fig 1: Scatter plot of genotypic and phenotypic coefficient of variation for quantitative traits in brinjal

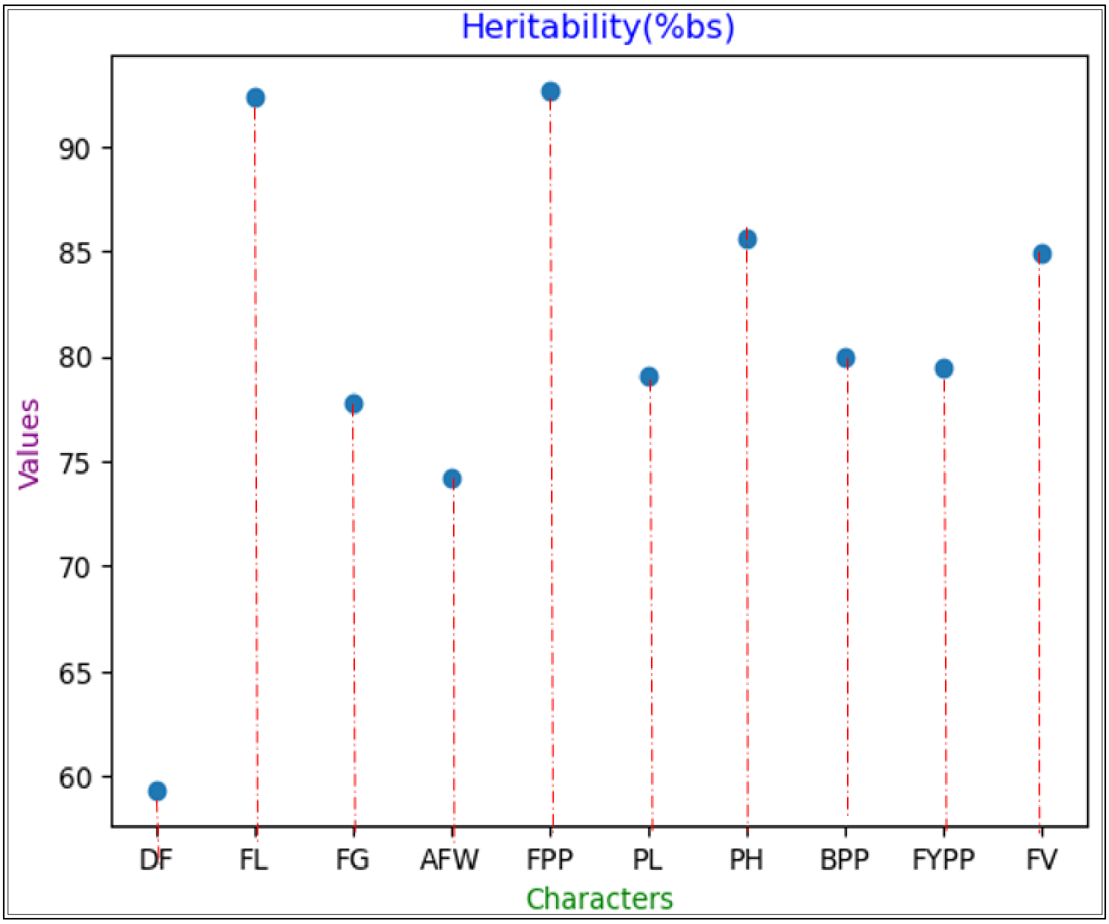

Fig 2: Scatter plot of broad sense heritability for quantitative traits in brinjal

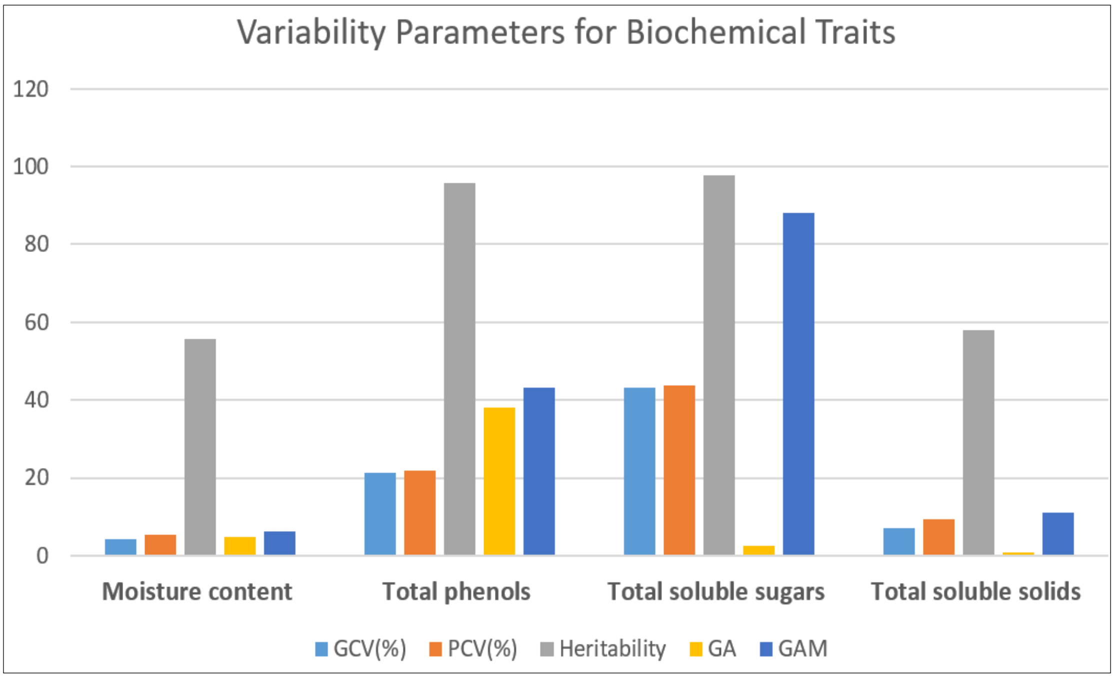

Fig 3: Bar chart showing the variability parameters for biochemical traits in brinjal

Conclusion

The current investigation demonstrated considerable genetic variation among the different genotypes of brinjal, encompassing a range of traits. Traits such as total soluble sugars, fruits per plant, fruit length, total phenols, and fruit volume exhibited noteworthy diversity at both the genetic and observable levels, indicating significant variation within the population. By prioritizing genotypes with desirable traits based on these considerations, substantial improvements can be attained in subsequent generations, leading to the development of superior brinjal varieties with enhanced agronomic characteristics and quality attributes. Ultimately, this study adds to our understanding of the genetic diversity and the potential for enhancing brinjal crops, providing valuable insights to guide future breeding endeavors in this vital vegetable crop.

Author Contributions

Gal Chetan, M. M. Pandya and N. A. Patel conducted the trial. Gal Chetan and M. M. Pandya collected the data. Rutvik J. Joshi, Bhavya Desai and M. M. Pandya wrote the manuscript of paper.

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Conflict of Interest

The authors declare no conflict of interest.

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