The Pharma Innovation Journal 2021; 10(2): 209-213

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2021; 10(2): 209-213

www.thepharmajournal.com
Received: 14-12-2020
Accepted: 23-01-2021

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Genetic studies for parental selection among brinjal (*Solanum melongena* L.) varieties

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Abstract
A field experiment was conducted to evaluate twenty brinjal varieties for suitable parent selection in yield aspects at Horticulture Experiment Station, Department of Horticulture, National Post Graduate Collage, Barhalganj, Gorakhpur (U.P.), India (U.P.) during Sep-2017 to Feb-2018. The experiment was laid out in Randomized Block Design with three replications. The observations were recorded on thirteen quantitative and qualitative traits. The mean data were subjected to the various statistical and biometrical analyses. Analysis of variance indicates that twenty diverse varieties of brinjal differed significantly for the thirteen traits. The highest estimate of phenotypic (PCV) and genotypic (GCV) coefficient of variation were recorded in case of Avg. Fruit Weight (gm) (PCV=35.71) and (GCV=34.80) followed by Avg. Yield/ Plant (kg) (PCV= 28.60) and (GCV=27.53), and Fruit Circumference (cm) (PCV =26.19) and (GCV=24.96) while Days to 50% Flowering exhibited lowest value (11.02 and 7.82). The presences of high heritability with high genetic advance in per cent of mean were observed for Avg. Fruit Weight (gm) (94.95 and 69.85), Avg. Yield/ Plant (kg) (92.62 and 54.58), Fruit Circumference (cm) (90.81 and 49.00), No. of Primary Branches/ Plant (90.08 and 45.77) and No. of Fruits/Plant (89.50 and 45.12) exhibiting additive gene effect and selection for these traits is reliable for further breeding programme. Selection of suitable parents is an important criteria for success of crop improvement programme.

Keywords: Brinjal, GCV, PCV, heritability and genetic advance

Introduction
Eggplant (*Solanum melongena* L.), as belongs to the family *Solanaceae*, having chromosome number 2n=2x=24, is the native of India (Hazra *et al.*, 2011) [7]. It is popularly known as *brinjal* in India, *aubergine* in France and United Kingdom. It is popular among people of all social strata and hence, it is rightly called as vegetable of masses (Patel and Sarnaik, 2003) [21]. It is one of the most popular and widely grown crop of commercial and dietary significance in the world. Eggplant [*Solanum melongena* (L.)] is a major vegetable crop grown in temperate (during warm season) and tropical regions. In India, brinjal occupies an area of 0.71 million hectare with estimated production of 13.59 million tonnes and productivity stands at 19.1 tonnes per hectare (NHB, 2015).

Eggplant is well known for its medicinal properties and has also been recommended as an excellent remedy for liver complaints and diabetic patients (Tiwari *et al.*, 2009) [28]. Eggplant contains the alkaloid solanine in roots and leaves, and there are medicinal uses for eggplant.

Being rich in fiber, potassium, vitamin B-6 and phytonutrients like flavonoids, this vegetable lowers the risk of heart disease (Chauhan *et al.*, 2017) [4]. Consequently, due to the multiple health benefits of eggplant, which include anti-oxidant, anti-diabetic, hypertensive, cardio protective and hepato protective effects, the demand for eggplant has been on a rapid and steady rise in the recent years (Ojiewo *et al.*, 2007) [17].

Due to its sky-scraping production rate all over world, it is often referred to as a poor man's vegetable (Kumar *et al*., 2014) [10]. Hence, it is a good source of income to small and marginal farmers. In spite of obvious importance in our daily life, little attention has been given to this crop in the past for the yield improvement. Use of traditional varieties and less variability affected by diseases and pest is the important constraint for low yield potentiality. Collection of germplasm and its genetic studies can help to get a suitable genotype for higher yield or any other desirable character. To meet the demand of ever increasing population, there is need to enhance the productivity levels of brinjal crop.

It is one of very few self-pollinated crops where exploitation of hybrid vigour has been commercially successful because of high number of seeds obtained from a cross.

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 base population and provide scope for wide variability (Gavade and Ghadage, 2015) [6]. Phenotypic and genotypic coefficients of variation (PCV and GCV) are useful in detecting the amount of variability present in the available varieties. Genetic variability for yield and yield components is essential in the base population for successful crop improvement. Heritability and genetic advance help in determining the influence of environment in the expression of the characters and the extent to which the improvement is possible after selection (Robinson *et al.*, 1949) [24].

Materials and Methods

Materials for the study comprised of twenty varieties of brinjal (Table 1). The experiment was laid out in a Randomized Block Design with three replications at Department of Horticulture, National Post Graduate Collage, Barhalganj, Gorakhpur (U.P.), India during Sep., 2017 to Feb., 2018. The experiment site had sandy loam soil, low in organic carbon and slightly alkaline having pH=7.4. Eighteen plants were raised separately for each accession in $4m^2$ plot at spacing of 60cm×60cm under three replications. The data were analyzed by the methods of Fisher (1948) [5] and Panse and Sukhatme (1967) [19] using mean values of random plants in each replication from all varieties to determine significance of genotypic effects. Genotypic and phenotypic coefficients of variation were calculated using the formulae of Burton (1952) [3]. Broad sense heritability was calculated as per Lush (1940) and genetic advance estimated by the method of Johnson *et al.*, (1955a) [8]. Categorization of genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV) and genetic advance (GA) were done as per Sivasubramanian and Menon (1973) [27] and heritability categorized as by Johnson *et al.*, (1955) [8].

Table 1: Details of Varieties

S. No.	Name of Variety	Sources
1.	J.B-6	IIVR, Varanasi
2.	Azad B-4	IIVR, Varanasi
3.	Kashi Sandesh	IIVR, Varanasi
4.	DBR-31	IIVR, Varanasi
5.	Green Long	IIVR, Varanasi
6.	Utkal Madhur	IIVR, Varanasi
7.	Azad B-2	IIVR, Varanasi
8.	Bhagyamati	IIVR, Varanasi
9.	Punjab Shree	IIVR, Varanasi
10.	Utkal Anushri	IIVR, Varanasi
11.	Swarnamani	IIVR, Varanasi
12.	Aruna	IIVR, Varanasi
13.	J.B.Round	IIVR, Varanasi
14.	VR-2	IIVR, Varanasi
15.	Pusa Bindu	IIVR, Varanasi
16.	Punjab Barsati	IIVR, Varanasi
17.	Arka Nidhi	IIVR, Varanasi
18.	DBR-8	IIVR, Varanasi
19.	kashi Prakash	IIVR, Varanasi
20.	Arka Shirish	IIVR, Varanasi

Results and Discussion

In the present investigation, significant differences were observed among the all entries for all the characters providing scope of improvement in brinjal for yield traits (Table 2). Similar findings are reported with Manpreet and Sigh (2013) [13]. The suggested existence of wide range variability in the varieties studied. The results pertaining to mean, range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability in broad sense (h2) and expected genetic advance as per cent of mean (GAM) for all the thirteen characters are furnished in table 3.

Mean and ranges are the simple measures of variability. The range of mean values also revealed sufficient variation for all thirteen characters of brinjal. The range of variability was recorded maximum for average fruit weight (64.33- 197.58) followed by plant height (52.45-88.36). These findings are in consonance with Pujer *et al.* (2017) [22] and Arunkumar *et al.* (2013) [2]. The characters showing high range of variation have more scope for improvement. The lowest range of mean was observed for TSS (4.15-5.90˚Brix) indicating availability of low variation for its improvement in the experimental material used. Results from the present study in this context indicated that PCV and GCV were high (>20%) for avg. fruit weight, avg. yield per plant, fruit circumference, number of primary branches per plant, number of flower per cluster, number of fruits per plant and fruit length; whereas, plant height, leaf length, leaf width and dry matter content showed moderate PCV and GCV (10-20%).

Plant height (cm)

The plant height ranged from 52.45 to 88.36 cm with a mean of 67.38 cm. (Table 3). In the present study, the genotypic and phenotypic coefficients of variation were moderate for plant height (13.51 and 15.61). The estimates of heritability were high (74.84%) with an expected genetic advance (16.22%) and genetic advance as per cent of mean (24.07%), respectively. High heritability is effective and less influenced by environment, indicating the relative value of selection based on phenotypic expression of the character. Naz *et al.* (2013) [16] and Patel *et al.* (2015) [20] also reported similar results for plant height. These findings are in close agreement with the findings of Pujer *et al.* (2017) [22] who revealed higher phenotypic coefficient of variation than genotypic coefficient of variation for the character and showed high heritability values similar with the present findings.

Number of primary branches per plant

The grand mean of number of primary branches per plant was recorded 4.34 and ranged from 2.66 to 6.35 (Table 3). The PCV value (24.67) was slightly higher than the respective GCV (23.41), denoting little influence of environment for the expression of the character. The estimates of heritability were high (90.08%) with high genetic advance as per cent of mean (45.77%) while low in genetic advance at 5 per cent (1.99%). The results of present investigation are supported by Manpreet and Sigh (2013) [13]. Mili *et al.* (2014) [14] also showed higher phenotypic coefficient of variation for number of primary branches per plant.

Leaf length (cm)

The variation in length of leaf among the varieties ranged from 12.88 to 21.13cm with grand mean of 17.07cm (Table 3). The difference between GCV (11.46) and PCV (13.79) for leaf length was relatively low, which indicates that the character was comparatively stable and highly heritable. The estimate of heritability was (69.08%) with genetic advance

(3.35%) and genetic advance as per cent of mean (19.63%). This indicates that the character controlled by polygenes might be useful for effective selection. The results obtained in this study are in conformity with the findings of Ullah *et al.* (2014) [29] and Rad *et al.* (2015) [23].

Leaf width (cm)
The grand mean for leaf width was recorded 13.87cm, where it ranged from 9.26 to 19.12cm (Table 3). The PCV and GCV were 16.78 and 14.94%, respectively. Minimum difference between the PCV and GCV indicates that they were less influenced by environment. On the basis of phenotypic expression, selection for this character would be helpful for improvement of this crop. The estimates of heritability were high (79.33%) with low genetic advance (3.80%) and genetic advance as per cent of mean (27.42%). These results are supported by Ullah *et al.* (2014) [29] and Rad *et al.* (2015) [23], who reported slightly higher PCV than GCV for leaf width.

Days to 50% flowering
The grand mean for days to 50% flowering was recorded 74 days. It ranged from 64.13 to 84.37 days (Table 3). The lowest PCV and GCV were 11.02 and 7.82%, respectively recorded with this parameter. The PCV was higher than the respective GCV, denoting environmental factors influencing the expression to some degree or other. The estimates of heritability were moderate (50.37%) with low genetic advance (8.46%) and genetic advance as per cent of mean (11.43%). These results are in conformity with that of Lokesh *et al.* (2013) [11].

Number of flowers per cluster
The range for number of flowers per cluster was recorded 2.73-5.81 and grand mean was 4.04 (Table 3). The PCV and GCV were 21.61 and 20.19%, respectively. The PCV value was slightly higher than the respective GCV, due to moderate influence of environment for the expression of the character. The estimates of heritability were high (87.31%) with low genetic advance (1.57%) and genetic advance as per cent of mean (38.87%). Singh *et al.* (2002) [26] also showed that phenotypic coefficient of variation was greater for number of flowers per cluster. Naik *et al.* (2014) [15] also reported similar results for number of flowers per cluster.

Number of fruit per plant
The grand mean of no. of fruits per plant was recorded as 16.09, ranging from 10.67 to 25.31 (Table 3). The PCV and GCV were 24.47 and 23.15%, respectively. The difference between GCV and PCV was relatively low, which indicates that the character was comparatively stable and highly heritable. The estimate of heritability was high (89.5%) with low genetic advance (7.26%) and genetic advance as per cent of mean (45.12%). Sabeena *et al.* (2011) [25] and Patel *et al.* (2015) [20] reported similar results.

Fruit weight (g)
The grand average fruit weight per plant was recorded 114.78g. It ranged from 64.33 to 197.58 g (Table 3). The PCV and GCV were recorded highest as 35.71 and 34.80%, respectively. There was least difference between the phenotypic and genotypic coefficient of variation, indicating little environmental influence in the expression of this character. The estimate of heritability was high (94.95%) with high genetic advance (80.17%) and genetic advance as per cent of mean (69.85%). Similar results with the present findings were exhibited by Ara *et al.* (2009) [1] for average fruit weight per plant.

Fruit length (cm)
The fruit length varied among the varieties ranging from 7.97 to 14.79 cm with an average of 10.28 cm (Table 3). The PCV and GCV were 24.14 and 22.76%, respectively. The difference between GCV and PCV was relatively low, which indicates that the character was comparatively stable and highly heritable. The estimate of heritability was high (88.91%) with low genetic advance (4.55%) and high genetic advance as per cent of mean (44.21%). This indicates that the character governed by many genes might be useful for making effective selection. Similar results were observed by various workers (Panda *et al.*, 2010 and Tirkey *et al.*, 2018) [18].

Fruit circumference (cm)
The average fruit circumference was recorded 14.16cm, ranging from 8.25 to 21.39cm (Table 3). The PCV and GCV were 26.19 and 24.96%, respectively. The smallest difference observed between PCV and GCV values of fruit circumference exhibited lesser influence of environmental factors on the expression of the trait. The estimate of heritability was high (90.81%) with low genetic advance (6.94%) and high genetic advance as per cent of mean (49.00%), which indicates the influence of non-additive gene action and considerable influence of environment in the expression of this trait, which could be exploited through manifestation of dominance and epistatic components through heterosis. Similar results were reported by Ullah *et al.* (2014) [29] for average fruit diameter.

Avg. yield per plant (kg)
The grand mean of average fruit yield per plant was recorded as 1.44 kg. It ranged from 0.88 to 2.67kg (Table 3). The PCV and GCV were 28.60 and 27.53%, respectively. There was very little difference between the phenotypic and genotypic coefficient of variation, indicating little environmental influence in the expression of this character. The estimate of heritability was high (92.62%) with low genetic advance (0.78%) and high genetic advance as per cent of mean (54.58%). Very high heritability estimates for avg. yield per plant indicate possibility of improvement through selection. The results obtained in this study are in conformity with the findings of Kumar and Arumugam (2013) [9]. They also observed high estimates of heritability for fruit yield per plant, indicating possibility of improvement through selection.

Dry matter content
The dry matter content varied among the varieties ranging from 7.55 to 12.23% with an average of 9.45% (Table 3). The PCV and GCV were 14.95 and 12.84%, respectively. The difference between GCV and PCV was relatively low, which indicates little environmental influence in the expression of this character. The estimate of heritability was high (73.71%) with low genetic advance (2.14%) and moderate genetic advance as per cent of mean (22.70%). Similar results were observed by Chauhan *et al.*, (2017) [4].

TSS (°Brix)
The grand mean of TSS was recorded as 5.03°Brix and varied among the varieties ranged from 4.15 to 5.90°Brix (Table 3).

The PCV and GCV were 12.34 and 9.59%, respectively. The difference between GCV and PCV was relatively low, which indicates little environmental influence in the expression of this character. The estimate of heritability was moderate (60.35%) with lowest genetic advance (0.77%) and moderate genetic advance as per cent of mean (15.34%). Similar results were observed by various workers (Panda *et al.*, 2010 and Tirkey *et al.*, 2018) [18].

Table 2: Analysis of variance for 13 characters in Brinjal (mean squares)

S. No.	Characters	Source of variation		
		Replications	Treatments	Error
	d.f.	2	19	38
1.	Plant Height (cm) at maturity	9.71	276.27**	27.84
2.	No. of Primary Branches/ Plant	0.05	3.22**	0.11
3.	Leaf Length (cm)	0.83	13.19**	1.71
4.	Leaf Width (cm)	0.73	14.01**	1.12
5.	Days to 50% Flowering	10.36	133.47**	32.99
6.	No. of Flowers/Clusters	0.02	2.09**	0.10
7.	No. of Fruits/Plant	0.46	43.27**	1.63
8.	Avg. Fruit Weight (gm)	55.13	4869.95**	84.82
9.	Fruit Length (cm)	0.13	17.11**	0.68
10.	Fruit Circumference (cm)	0.92	38.72**	1.26
11.	Avg. Yield/ Plant (kg)	0.01	0.48**	0.01
12.	Dry Matter Content %	0.20	4.93**	0.52
13	TSS (°Brix)	0.04	0.85**	0.15

** Significant at 5% levels

Table 3: Estimates of range, grand mean, phenotypic, genotypic, coefficients of variation, heritability in broad (h^2_{bs}) sense and genetic advance in per cent of mean ($\overline{GA}$) for thirteen characters in brinjal genotypes

	Characters	Mean Value Range		Grand mean	P.C.V. (%)	G.C.V. (%)	Heritability Broad Sense (%) (h^2_{bs})	Genetic Advancement 5%	Genetic Advance in per cent of mean
		Lowest	Highest						
1.	Plant Height (cm) at maturity	52.45	88.36	67.38	15.61	13.51	74.84	16.22	24.07
2.	No. of Primary Branches/ Plant	2.66	6.35	4.34	24.67	23.41	90.08	1.99	45.77
3.	Leaf Length (cm)	12.88	21.13	17.07	13.79	11.46	69.08	3.35	19.63
4.	Leaf Width (cm)	9.26	19.12	13.87	16.78	14.94	79.33	3.80	27.42
5.	Days to 50% Flowering	64.13	84.37	74.00	11.02	7.82	50.37	8.46	11.43
6.	No. of Flowers/Clusters	2.73	5.81	4.04	21.61	20.19	87.31	1.57	38.87
7.	No. of Fruits/Plant	10.67	25.31	16.09	24.47	23.15	89.50	7.26	45.12
8.	Avg. Fruit Weight (gm)	64.33	197.58	114.78	35.71	34.80	94.95	80.17	69.85
9.	Fruit Length (cm)	7.97	14.79	10.28	24.14	22.76	88.91	4.55	44.21
10.	Fruit Circumference (cm)	8.25	21.39	14.16	26.19	24.96	90.81	6.94	49.00
11.	Avg. Yield/ Plant (kg)	0.88	2.67	1.44	28.60	27.53	92.62	0.78	54.58
12.	Dry Matter Content %	7.55	12.23	9.45	14.95	12.84	73.71	2.14	22.70
13.	TSS (°Brix)	4.15	5.90	5.03	12.34	9.59	60.35	0.77	15.34

Conclusion

The genetic architecture of fruit yield is based on the overall net effect produced by various yield traits interaction with each other. Based on the studies on genetic variability, it is concluded that, the characters avg. fruit weight (gm) followed by avg. yield per plant (kg), fruit circumference (cm), no. of primary branches per plant, no. of fruits per plant and fruit length (cm) recorded high amount of genetic variability along with heritability and genetic advance. This reveals that there is a large scope for improving these characters by simple phenotypic selection. Days to 50% flowering, which was found to be under the influence of non - additive gene action, suggested that heterosis breeding is more reliable to improve this trait. Therefore, direct selection based on these combinations of traits help in harnessing for selecting good varieties as a parent with high yield per plant in improvement programmes.

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