Int.J.Curr.Microbiol.App.Sci (2018) *7*(9): 1543-1552

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 7 Number 09 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.709.185

Studies on Variability, Heritability and Genetic Advance for Yield Attributing Traits in Brinjal (*Solanum melongena* L.) for Two Different Seasons

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Keywords

Brinjal, Genetic variability, Heritability, GCV, Genetic advance as a percent of mean and PCV

Article Info

Accepted:
10 August 2018
Available Online:
10 September 2018

A B S T R A C T

The present experiment was laid down in randomized block design in two different environments (E1 and E2) with the objective to assess the magnitude of genetic variability, heritability and genetic advance among 18 yield attributing traits in brinjal. The analysis of variance revealed that significant genetic differences were present among the brinjal genotypes representing the existence of significant amount of variability widening the greater scope for the improvement of concerned characters through selection. A moderate to wide range of mean values among the genotypes for different characters were observed. Moderate to high genotypic coefficient of variation together with moderate to high heritability and genetic advance as per cent of mean was reported for majority of the characters under study except days to 50 percent flowering, number of primary branches, fruit diameter and days to first fruiting in E2 season which indicated predominant role of additive genetic component in the expression of these traits arising a chance of genetic improvement through phenotypic selection.

Introduction

Brinjal (*Solanum melongena* L.) is one of the most important and popular solanaceous vegetable crops of India. Easy cultivation, year round availability, moderate to high yield and consumption in varieties of ways like as a vegetable, salad, bhaji, bhartha, chatni, pickles *etc*., has made brinjal the king of vegetables in India. The ethno-botanical history of brinjal has been quite fascinating which has indicated that it has been used for vegetable, medicinal and ornamental purposes since ancient time in India. The 21st century begins new vistas regarding the health value of brinjal, which is mainly due to its phenolics, glycoalkaloids, amide and anthocyanine content generally present in the peel of brinjal fruits. It is a rich source of vitamin A, B1, B6 and trace amount of micro nutrient like Cu, Mn, Mg, K (Chen and Li, 1996) and its fruits are mainly used to cure diabetes (Choudhary, 1976), toothache (Chen and Li, 1996), liver complaints and possess antioxidant and anti-cancer activities due to the presence of anthocyanin and polyphenol compound (Sato *et al.*, 2011).

Brinjal can be grown in wide range of agro-climatic zones round the year which provides us a great opportunity to exploit its full potential on condition of its tremendous scope of crop improvement. Planning and implementing of any breeding programme for the improvement of the various quantitative attributes of crop depend upon the extent and magnitude of genetic variability offered in the population. Variation is the secret of success in plant breeding program because it widens the scope of selection. The genetic facts are inferred from observations on phenotypes. Since phenotype is an artifact of the joint effects of genotype and environment, non-genetic part exerts large influence on genetic variability.

The exploitable variability is, therefore required to be judged through various genetic parameters like coefficient of variation at phenotypic and genotypic level, heritability and genetic advance. The estimates of heritability serves as a useful guide for the breeder as it enable them to understand the proportion of variation is due to genotypic effect or additive effect and provide the correct indication of the amount of improvement achieved through selection whereas, high heritability along with high genetic advance as a percent of mean is an indication of more additive gene action (Panse, 1957). Most of the local varieties which are grown by the farmers of India have not been fully utilized in any genetic improvement programs so far, on scientific line. Hence, the present study was under taken with an objective of studying the variability, heritability and genetic advance in different genotypes of brinjal, which can be utilized in future crop improvement programmes.

Materials and Methods

By taking 36 genotypes of brinjal, the present investigation was carried out at Vegetable research centre of G. B. Pant University of agriculture and technology during autumn – winter (E1) and spring – summer (E2) season of 2017-18. The experiment was laid out in Randomized block design in which genotypes were arranged in three replication, each replication containing 36 treatments. The genotypes were studied for 18 yield attributing traits *viz*., days to first flowering, days to 50 percent flowering, days to first fruiting, number of primary branches, plant height (cm), fruit length (cm), fruit diameter (cm), fruit index, average fruit weight (g), number of healthy fruits per plant, number of infested fruits per plant, total number of fruits per plant, percent of shoot and fruit borer incidence, weight of healthy fruits per plant, weight of infested fruits per plant, total yield per plant (kg), fruit yield per hectare (q/hac) and 100 seed weight (g) in both E1 and E2 seasons The analysis of variance was carried out as per methods suggested by Panse and Sukhatme (1967).

Methods given by Burton and De Vane (1953) were used to determine the genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV). Whereas, heritability (broad sense) and genetic advance as per cent of mean was computed as per Weber and Moorthy (1952**)** and Johnson *et al.*, (1955), respectively.

Results and Discussion

The analysis of variance signifies that the mean sum of square due to treatment was found highly significant for all the yield attributing traits studied in both the E1 and E2 seasons at 1% and 5% level of significance. The significant difference among all the traits indicates the existence of sufficient amount of genetic variability, offering the good opportunity for the improvement of various economic traits in brinjal as presented in Table 1 and 2. The results are in consonance with

Chourasia and Shree (2012), Shekar *et al.,* (2012), Nayak and Nagre (2013), Madavi *et al.,* (2015), Mohammad *et al.,* (2015), Vidya and Kumar (2015), Reshmika *et al.,* (2015), Pujer *et al.,* (2017), Ravali *et al.,* (2017), Tripathy *et al.,* (2017) and Tirkey *et al.,* (2018).

Variability refers to the presence of differences among the individuals of a population which is essential for wider adaptability and resistance to biotic and a biotic factors and hence, an insight into the magnitude of genetic variability present in a population is of paramount important to a plant breeder for starting a judicious breeding programme.

The extent of genetic variation can be judged by both the estimation of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV). The estimates of phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability in broad sense and genetic advance as a percent of mean for eighteen yield attributing traits in E1 and E2 season are presented in Table 3 and 4.

Assessment of variability parameters revealed that there is lot of variation present among the genotypes studied. In general, the value of phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the characters studied in the present study, indicating the considerable influence of environmental factors on the performance of genotypes for different characters. Similar results were also reported in brinjal by Nayak and Nagre (2013), Patel *et al.,* (2015) and Tripathy *et al.,* (2017).

Among 36 genotypes of brinjal, highest GCV and PCV estimate were received for most of the traits *viz.*, fruit index (69.087 and 71.989), weight of infested fruits per plant (48.738 and 51.07), number of healthy fruits per plant (45.12 and 48.46), number of infested fruits per plant (41.68 and 46.61), weight of healthy fruits per plant (41.583 and 42.661), fruit length (37.99 and 39.19), percent of shoot and fruits borer incidence (39.630 and 42.751), total number of fruits per plant (38.28 and 40.03), fruit yield per hectare (33.97 and 37.970), total yield per plant (32.481 and 36.578), fruit diameter (27.55 and 31.46), 100 seed weight (24.935 and 26.193) and average fruit weight (23.34 and 23.50) in E1 season. Whereas in E2 season, high GCV and PCV estimates were observed for fruit index (56.078 ad 56.078), number of healthy fruits per plant(47.961 and 48.75), number of infested fruits per plant (46.961 and 48.036), total number of fruits per plant (44.993 and 46.824), average fruit weight (38.436 and 38.81), fruit length (37.96 and 39.512), percent of shoot and fruit borer incidence (31.614 and 34.912), fruit diameter (30.772 and 35.688), weight of healthy fruits per plant (29.217 and 30.380), weight of infested fruits per plant (29.292 and 29.651), 100 seed weight (25.779 and 26992), fruit yield per hectare (24.35 and 25.61), total yield per plant (24.302 and 25.704) and number of primary branches (22.781 and 26.350). The higher values of PCV and GCV for the above traits signifies there maximum contribution towards genetic variability and thereby suggesting that the parents chosen on the basis of these characters may be utilized in further crossing programme for obtaining good transgressive segregants. The results of the present investigation agreed with the finding of Ansari *et al.,* (2011), Shekar *et al.,* (2012), Balaji *et al.,* (2013), Singh *et al.,* (2013a), Kumar *et al.,* (2013b), Chaudhary and Kumar (2014), Mili *et al.,* (2014), Gavade and Ghadage (2015), Madhavi *et al.,* (2015), Patel *et al.,* (2015), Shende *et al.,* (2014),Vidya and Kumar (2015), Ravali *et al.,* (2017), Sujin *et al.,* (2017).

Table.1 Analysis of variance for different yield attributing traits in brinjal for E1 season

S. N.	Characters		Mean sum of squares		
			Replication	Genotype	Error
		df	2	35	70
1	Days to first flowering		1.878	69.355**	1.356
2	Days to 50 percent flowering		2.083	91.581**	1.901
3	Days to first fruiting		0.562	91.996**	2.901
4	No. of Primary branches		0.745	13.420**	1.35
5	Plant height (cm)		128.823	513.424**	28.371
6	Fruit length (cm)		1.617	89.982**	1.876
7	Fruit diameter (cm		0.166	7.133**	0.655
8	Fruit index		0.122	14.496**	0.403
9	Average fruit weight (g)		3.865	1021.634**	4.794
10	No. of healthy fruits per plant		15.176	98.013**	4.907
11	No. of infested fruit per plant		0.121	17.040**	1.314
12	Total no. of fruit per plant		14.858	144.376**	4.358
13	Percent of shoot and fruit borer incidence		5.022	535.277**	27.692
14	Weight of healthy fruits per plant (Kg)		0.005	0.452**	0.008
15	Weight of infested fruits per plant (Kg)		0.007	0.119**	0.004
16	Total yield per plant (Kg)		0.068	0.590**	0.048
17	Fruit yield per hectare (q/hac)		3577.333	28410.440**	2366.694
18	100 seed weight (g)		0.003	0.022**	0.001

* Significant at 5% level of probability ** Significant at 1% level of probability

Table.2 Analysis of variance for different yield attributing traits in brinjal for E2 season

S. N.	Characters		Mean sum of squares		
			Replication	Genotype	Error
		df	2	35	70
1	Days to first flowering		13.406	178.868**	10.566
2	Days to 50 percent flowering		63.696	130.111**	18.257
3	Days to first fruiting		100.738	88.827**	36.712
4	No. of Primary branches		3.017	8.909**	0.902
5	Plant height (cm)		7.961	409.453**	7.971
6	Fruit length (cm)		2.184	81.139**	1.919
7	Fruit diameter (cm		0.202	6.328**	0.653
8	Fruit index		0.371	12.990**	0.699
9	Average fruit weight (g)		12.043	2310.978**	15.047
10	No. of healthy fruits per plant		0.658	55.363**	0.637
11	No. of infested fruit per plant		5.792	77.915**	1.184
12	Total no. of fruit per plant		41.296	231.045**	6.224
13	Percent of shoot and fruit borer incidence		16.727	1036.893**	94.395
14	Weight of healthy fruits per plant (Kg)		0.002	0.073**	0.002
15	Weight of infested fruits per plant (Kg)		0.022	0.122**	0.001
16	Total yield per plant (Kg)		0.038	0.266**	0.01
17	Fruit yield per hectare (q/hac)		1883.139	13115.400**	499.49
18	100 seed weight (g)		0.003	0.024**	0.001

* Significant at 5% level of probability ** Significant at 1% level of probability

Table.3 Estimation of coefficient of variation and other genetic parameter in brinjal for E1 season

Sl. No.	Characters	General mean	Range	Coefficient of variation			Heritability (%)	G.A. as % mean
				GCV%	PCV%	ECV%		
1	**Days to first flowering**	44.13	35.26-52.2	10.79	11.11	2.64	94.35	21.589
2	**Days to 50 percent flowering**	50.84	40.096-61.46	10.75	11.09	2.71	94.02	21.481
3	**Days to first fruiting**	56.05	43.233-65.433	9.72	10.19	3.04	91.11	19.118
4	**No. of Primary branches**	10.19	6.75-14.486	19.69	22.75	11.4	74.88	35.091
5	**Plant height (cm)**	136.92	101.546-164.993	9.29	10.07	3.89	85.06	17.559
6	**Fruit length (cm)**	14.26	5.434-34.24	37.99	39.19	9.6	93.99	75.875
7	**Fruit diameter (cm**	5.33	2.933-9.476	27.55	31.46	15.18	76.72	49.715
8	**Fruit index**	3.09	0.952 - 11.67	69.087	71.989	20.53	92.1	136.63
9	**Average fruit weight (g)**	78.89	48.952 - 130.597	23.34	23.5	2.78	98.6	47.735
10	**No. of healthy fruits per plant**	12.35	3.153-28.556	45.12	48.46	17.94	86.35	86.199
11	**No. of infested fruit per plant**	5.49	2.099-11.483	41.68	46.61	20.87	79.96	76.778
12	**Total no. of fruit per plant**	17.85	7.424-39.836	38.28	40.03	11.7	91.46	75.422
13	**Percent of shoot and fruit borer incidence**	32.09	15.505-78.453	39.63	42.751	25.17	85.935	75.68
14	**Weight of healthy fruits per plant (Kg)**	0.91	0.233-1.876	41.583	42.661	22.22	95.009	83.496
15	**Weight of infested fruits per plant Kg)**	0.39	0.141-0.992	48.738	51.07	21.24	90.977	95.763
16	**Total yield per plant (Kg)**	1.31	0.652-2.437	32.481	36.578	16.91	78.854	59.417
17	**Fruit yield per hectare (q/hac)**	288.38	144.960-541.663	33.97	37.97	16.95	80.06	61.123
18	**100 seed weight (g)**	0.34	0.17-0.58	24.935	26.193	9.27	90.629	48.901

Table.4 Estimation of coefficient of variation and other genetic parameter in brinjal for E2 season

Sl. No.	Characters	General mean	Range	Coefficient of variation			Heritability (%)	G.A. as % mean
				GCV %	PCV %	ECV %		
1	**Days to first flowering**	58.8	43 - 75.436	12.73	13.887	5.53	84.15	24.073
2	**Days to 50 percent flowering**	117.44	98.2- 129.666	5.181	6.323	4.53	67.13	8.744
3	**Days to first fruiting**	130.38	108.4 - 140.6	3.19	5.641	4.65	32.12	3.732
4	**No. of Primary branches**	7.17	3.873 - 11.546	22.781	26.35	13.24	74.741	40.571
5	**Plant height (cm)**	64.03	46.243 - 92.843	18.066	18.596	4.41	94.379	36.155
6	**Fruit length (cm)**	13.54	5.087-29.74	37.96	39.312	10.23	93.224	75.496
7	**Fruit diameter (cm**	4.47	2.044 - 8.076	30.772	35.688	18.08	74.345	54.657
8	**Fruit index**	3.52	0.808 - 8.620	56.078	60.673	23.74	85.427	106.772
9	**Average fruit weight (g)**	71.97	21.14 - 133.273	38.436	38.81	5.39	98.072	78.411
10	**No. of healthy fruits per plant**	8.91	2.576 - 26.28	47.961	48.75	8.96	96.627	97.067
11	**No. of infested fruit per plant**	10.77	3.576 - 26.778	46.961	48.036	10.11	95.574	94.575
12	**Total no. of fruit per plant**	19.24	7.424 - 53.058	44.993	46.824	12.97	92.332	89.062
13	**Percent of shoot and fruit borer incidence**	57.18	35.547 - 146.489	31.614	34.912	16.99	76.896	55.302
14	**Weight of healthy fruits per plant (Kg)**	0.53	0.188 - 0.852	29.217	30.38	8.32	92.489	57.883
15	**Weight of infested fruits per plant Kg)**	0.68	0.278 - 1.172	29.292	29.651	4.59	97.597	59.612
16	**Total yield per plant (Kg)**	1.2	0.581 - 1.782	24.302	25.704	8.37	89.383	47.329
17	**Fruit yield per hectare (q/hac)**	266.84	129.183 - 396.144	24.35	25.61	7.94	90.38	47.69
18	**100 seed weight (g)**	0.34	0.138 - 0.57	25.779	26.992	7.99	91.218	50.72

With the help of PCV and GCV alone it is not possible to determine the amount of variation which is heritable. The combination of high heritability along with high genetic advance will provide a clear base on the reliability of that particular trait in the selection of variable entries. In the present study broad sense heritability was found high for all the characters except for number of primary branches in both the season while for fruit diameter, days to 50% flowering and days to first fruiting in E2 season. In E1 season, the maximum estimates of heritability were recorded for average fruit weight (98.60) followed by weight of healthy fruits per plant (95.009), days to first flowering (94.35), days to 50% flowering (94.02), fruit length (93.99), fruit index (92.100), total number of fruits per

plant (91.46), days to first fruiting (91.11),weight of infested fruits per plant (90.977), 100 seed weight (90.629), number of healthy fruits per plant (86.35), percent of shoot and fruit borer incidence (85.935), plant height (85.06), fruit yield per hectare (80.06), number of infested fruits per plant (79.96), total yield per plant (78.854) and fruit diameter (76.72). Whereas, in E2 season the maximum estimate of heritability was recorded for average fruit weight (98.072) followed by weight of infested fruits per plant (97.597), number of healthy fruits per plant (96.627), number of infested fruits per plant (95.574), plant height (94.379), fruit length (93.224), weight of healthy fruits per plant (92.489), total number of fruits per plant (92.332), 100 seed weight (91.218), fruit yield per hectare (90.38), total fruit yield per plant (89.383), fruit index (85.427), days to first flowering (84.15) and percent of shoot and fruit borer incidence (76.896). The high heritability estimates for these traits indicate that these characters are least influenced by the environment.

The genetic advance in a trait is an artifact of the heritability and selection differential expressed in terms of phenotypic standard deviation of the trait concerned and for comparison it is better to express the characters in terms of genetic advance as a percentage of mean. In the present study higher estimates of genetic advance as percentage of mean (> 20%) was observed for most of the characters under study in E1 season starting from fruit index (136.63) followed by weight of infested fruits per plant (95.763), number of healthy fruits per plant (86.199), weight of healthy fruits per plant (83.496), number of infested fruits per plant (76.778), fruit length (75.875), percent of shoot and fruit borer incidence (75.680), total number of fruits per plant (75.422), fruits yield per hectare (61.123), total fruits per plant (59.417), fruit diameter (49.715) 100 seed weight (48.901), average fruit weight (47.735), number of primary branches (35.091) days to first flowering (21.589), and days to 50 % flowering (21.481). While for E2 season, fruit index (106.772) followed by number of healthy fruits per plant (97.067), number of infested fruits per plant (94.575), total number of fruits per plant (89.062), average fruit weight (78.411), fruit length (75.496), weight of infested fruits per plant (59.612), weight of healthy fruits per plant (57.883), percent of shoot and fruit borer incidence (55.302), fruit diameter (54.657), 100 seed weight (50.720), fruit yield per hectare (47.69), total yield per plant (47.329), number of primary branches (40.571), plant height (436.155) and days to first flowering (24.073) recorded the maximum estimates of genetic advance as percent of mean. High estimates of genetic advance as percentage of mean indicated that the preponderance of additive genetic effects in expression of these characters. Therefore, selection for these characters in segregating generations based on phenotypic performance would likely be more effective.

All the characters studied showed high to high, moderate to high or high to moderate values of heritability along with high genetic advance as a percent of mean except for days to 50 percent of flowering, number of primary branches, fruit diameter and days to first fruiting in E2 season showing low to low or moderate to low values of heritability along with low genetic advance. High heritability along with high genetic advance among the resulted traits indicate the predominant role of additive genetic component in expression of the traits hence, phenotypic selection will be rewarding for the further improvement of such traits. For different characters, similar results were also observed by various researchers like Chattopadhyay *et al.*, (2011), Indiresh and Santhosha (2011), Thangavel *et al.*, (2011), Dhaka and Soni (2012), Kumar *et*

al., (2013a), Chaudhary and Kumar (2014), Mili *et al.,* (2014), Gavade and Ghadage (2015), Patel *et al.,* (2015), Tripathy *et al.,* (2017) and Tirkey *et al.,* (2018).

The present investigation on brinjal revealed the presence of substantial amount of exploitable variability in the material studied with respect to 18 yield attributing traits projecting, thereby, immense scope for genetic improvement through selection and hybridization. The study further elucidated that both non-additive and additive genetic component played the vital role in governing the expression of yield and its major components. Moderate to high GCV together with moderate to high heritability and genetic advance as per cent of mean was reported for majority of the characters under study which indicated predominant role of additive genetic component in the expression of these traits arising a chance of genetic improvement through phenotypic selection.

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How to cite this article:

Priyanka Verma, M.L. Kushwaha and Ankit Panchbhaiya. 2018. Studies on Variability, Heritability and Genetic Advance for Yield Attributing Traits in Brinjal (*Solanum melongena* L.) for Two Different Seasons. *Int.J.Curr.Microbiol.App.Sci*. 7(09): 1543-1552.
doi: https://doi.org/10.20546/ijcmas.2018.709.185