Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; SP1: 3195-3198

Ram Ashish Gupta
Department of Vegetable Science, (N.D.U.A & T, Kumarganj, Faizabad U.P.), India

CN Ram
Department of Vegetable Science, (N.D.U.A & T, Kumarganj, Faizabad U.P.), India

Satish Kr. Chakravati
Krishi Vigyan Kendra, Bahraich (N.D.U.A & T, Kumarganj, Faizabad U.P.), India

Chandra Deo
Department of Vegetable Science, (N.D.U.A & T, Kumarganj, Faizabad U.P.), India

MK Vishwakarma
Department of Genetics and Plant Breeding, BHU, Varanasi, India

Renu Arya
Krishi Vigyan Kendra, Bahraich (N.D.U.A & T, Kumarganj, Faizabad U.P.), India

Bijay Pal
Department of Horticulture, IAS, Bundelkhand University, Jhansi, India

Correspondence
C.N. Ram
Department of Vegetable Science, (N.D.U.A & T, Kumarganj, Faizabad U.P.), India

Studies on variability, heritability and genetic advance in brinjal (Solanummelongena L.)

Ram Ashish Gupta, CN Ram, Satish Kr Chakravati, Chandra Deo, MK Vishwakarma, Renu Arya and Bijay Pal

Abstract
Thirty two genotypes of four groups including two checks (*Arka Nidhi*, and *Mukta Keshi*) were evaluated for ten quantitative characters. The analysis of variance for the design of experiment indicated highly significant differences among the genotypes for all the traits. Based on mean performance of genotypes NDB-301 for long purple and NDB-325 for round purple fruit were found as most promising genotypes for total fruit yield per plant. High magnitude of variability was observed in case of unmarketable fruit yield per plant followed by fruit circumference, average fruit yield, marketable fruit yield per plant, primary branches per plant and total fruit yield per plant. Plant height exhibited low value of variability. High heritability coupled with high genetic advance in percent of mean were recorded for fruit circumference, unmarketable fruit yield, average fruit weight, primary branches per plant, number of fruits per plant and marketable fruit yield per plant indicating opportunity for selection response.

Keywords: Variability, heritability and genetic advance

Introduction
Brinjal or eggplant (*Solanummelongena* L.) also known as aubergine or guinea squash which is one of the major vegetable crops in India. It is one of the most important solanaceous vegetable crop having diploid chromosome number 2n=2x=24. It is grown worldwide. It is probably originated in India and showed secondary diversity in South East Asia. It is being grown extensively in India, Bangladesh, Pakistan, China, Japan, Philippines, France, Italy, and U.S.A. In Southern Europe, brinjal is a staple vegetable, and it is a favorite dish in South East of France. Brinjal has got much potential as the raw material in pickle making and dehydration industries. It is highly productive and most preferred vegetable by the poor man. In India, it occupied its place in the main cuisine of both poor and rich people. The consumption of brinjal in several ways like bhaji, bhartha, stuffed brinjal, chatni, pickles, etc. has endorsed brinjal the king of vegetables in India. Now a days brinjal is being exported in the form of consumable products like baingan bhartha, pickles, and chatni, etc. to Middle East countries. Brinjal is usually self-pollinated but categorized as often cross-pollinated or facultative cross-pollinated due to cross-pollination up to 29%. The emergence of Flower after transplanting is 40-45 days. Stigma receptivity is highest during anthesis i.e. flower opening which occurs at about 6-8 a.m. in August-September and usually between 9.30-11.15 a.m. during winter (December-January). Anthers usually dehiscence 15-20 minutes after the anthesis. It has some medicinal properties viz. white brinjal is said to be healthier for diabetic patients (Choudhary, 1976). The brinjal fruit fried in til oil can also cure tooth ache (Chen and Li, 1996). One-hundred-gram edible portion of brinjal fruit contains 92.7% moisture, 24.0% calories, 4.0% carbohydrates, 1.4 g protein, 1.3 g fibers, 0.3 g fats, vitamin A 124.0 (I.U.) and Vitamin C 12.0 mg (Chen and Li, 1996). It also contains 47.0 mg phosphorus, 44.0 mg sulphur, 52.0 mg chlorine, and other minerals (Aykroyd, 1963). It is easily cultivated in almost all parts of India except higher altitudes. It is considered as long duaration crop and highly susceptible to frost. The main crop of brinjal is raised during autumn- winter season however; some production is obtained during spring-summer season also. But during spring- summer season high temperature (above 35ºC) causes drastic reduction in brinjal production due to poor fruit set. The best temperature for fruit set and growth is 15.5-21.1 ºC. Many of the round varieties usually set fruit at the slightly lower temperature and are susceptible to frost and long-fruited varieties set fruits at the higher temperature and show tolerance to frost.

It is most important for producers and consumer; there is need to increase its productivity to meet the consumer's requirement over the year. To develop/improve high yielding varieties knowledge of genetic variability for desirable traits in the available germplasm is the prerequisite. Variability parameters like genotypic and phenotypic coefficient of variation,

heritability and genetic advance, in addition to this degree of association between the various characters and direct effect of yield contributing characters on total yield, is of supreme significance in planning an appropriate breeding strategy aimed at exploiting the inherent variability of the original population. Yield is output of several contributing component characters and environmental factors highly influence it, resultant, estimates of heritability and genetic advance are useful for selection.

Material and Method

The research experiment was carried out in Randomized Complete Block Design with three replications during Kharif season in 2014 to assess the performance of thirty-two genotypes. Each treatment consisted of two rows. Ten plants were maintained in each row and replicated thrice. Transplanting was done at a spacing of 60 cm between row to row and 45 cm plant to plant in plot size of 4.5 x 1.2 m2. Data were recorded on thirteen character viz. plant height (cm), days to 50% flowering, primary branches per plant, fruit circumference (cm), fruit weight (gm), fruits per plant, fruit length (cm), marketable fruit yield per plant (kg), unmarketable fruit yield per plant (kg) and total fruit yield per plant (kg). The analysis of variance (ANOVA) for the design of experiment was carried out according to the procedure outlined by Panse and Sukhatme (1967). The mean squares for error were subtracted from the mean squares due to genotypes, and the difference was divided by the number of replications for obtaining the genotypic variance, which was calculated as suggested by Burton (1952). Environmental variance is the mean squares due to error. The phenotypic variance was calculated by adding genotypic variance and environmental variance, which was suggested by Burton and de Vane (1953). Heritability in the broad sense (h^2_{bs}) was calculated using the formula recommended by Burton and de Vane (1953). Genetic advance (Ga) was estimated by the method suggested by Johnson *et al*. (1955).

Result and Discussion

Genetic variability is the backbone of any crop improvement program and effectiveness of selection depend upon its nature and magnitude in the genetic material at the disposal of plant breeder. In other words, genetic variability is fundamental to selection and a great extent to the breeding methodology as such. The speed of improvement in any crop depends upon the magnitude and kinds of genetic variability present in the population. The genetic variation is heritable and hence important in the selection.

A great deal of genetic variability is available in the germplasm of brinjal in centers of its diversity. Many reports on exploitation of variability in the main crops the of world are available even in the pre-Mendelian period, and this caused improvement in yield. Among the under worked vegetable crops, the brinjal which is grown on a large acreage, it has become necessary to gather basic information on genetic and other statistical parameters which help in the selection and genetic manipulations for improvement in the yield of the crop. With this objective, thirty-two genotypes collected from different places were maintained and evaluated for ten characters. The genetic and statistical parameters were estimated for the genotypic and phenotypic coefficient of variation, heritability in broad sense, genetic advance, correlation coefficient, path coefficient analysis and genetic divergence among the genotypes for various traits along with yield per plant. The results of the present investigation have been discussed in the following heads about reported work relevant to this investigation on brinjal.

Analysis of variance

The analysis of variance (ANOVA) for every character is presented in (Table 1). The mean squares due to genotypes were highly significant for all the characters. In other words, the performances of the genotypes on these aspects were satisfactory; suggesting that, there is a good scope for selection in different traits for brinjal improvement.

Table 1: Analysis of variance (mean squares) for ten quantitative characters in brinjal germplasm

S. No	Characters	Source of variation		
		Replication	Treatments	Error
	Degree of freedom	**2**	**31**	**62**
1.	Days to 50% flowering	1.26	82.81**	5.05
2.	Plant height (cm)	2.27	201.47**	8.22
3.	Number of primary branches per plant	0.40	4.59**	0.26
4.	Fruit length (cm)	0.68	26.22**	1.07
5.	Fruit circumference (cm)	0.72	75.52**	0.60
6.	Number of fruits per plant	0.23	28.40**	1.14
7.	Average fruit weight(g)	1.37	4406.13**	169.27
8.	Marketable fruit yield per plant(kg)	0.00	0.52**	0.05
9.	Unmarketable fruit yield per plant(kg)	0.00	0.00**	0.00
10.	Total fruit yield per Plant(kg)	0.01	0.62**	0.05

Significant at 5 % and 1% probability level, respectively

Mean performance

In order to evaluate the listed genotypes, the mean of thirty-two genotypes including a check for ten characters has been presented in (Table 2). A very wide range of variations in mean performance of genotypes was observed for all the characters under study. The comparison of mean performance of thirty-two genotypes for ten traits using critical differences revealed the existence of a very high level of variability in the used genotypes. The genotype NDB-320 (2.46 kg) significantly out yielded in respect of all genotypes as well as check in case of long purple and long green groups and also showed high mean performance for fruits per plant. This genotype also showed high mean performance for some other characters. The genotype NDB-329 (2.45 kg) produced higher yield per plant than the best check MuktaKeshi (2.39 kg) in the case of round purple round green group.

Table 2: Mean performance of thirty two genotypes for ten characters in brinjal

S. No	Characters / Genotypes	Days to 50% flowering	Plant height (cm)	No of primary branches per plant	Fruit length (cm)	Fruit circumference (cm)	No of fruits per plant	Average fruit weight (g)	Marketable fruit yield per plant (kg)	Unmarketable fruit yield per plant (kg)	Total fruit yield per plant (kg)
1.	NDB-301	51.67	65.33	4.67	14.83	10.20	14.67	135.80	2.15	0.15	2.31
2.	NDB-302	52.00	91.00	7.00	22.50	18.47	16.33	130.80	1.89	0.25	2.14
3.	NDB-303	51.67	68.17	6.67	19.73	15.67	17.00	123.67	1.83	0.26	2.09
4.	NDB-304	51.00	58.20	4.33	17.50	18.47	10.93	127.17	1.24	0.13	1.38
5.	NDB-305	54.33	63.67	4.72	14.23	17.50	15.83	127.00	1.52	0.15	2.00
6.	NDB-306	45.67	76.20	3.47	13.71	13.10	10.71	119.83	1.09	0.15	1.28
7.	NDB-307	46.00	85.40	6.83	18.53	11.48	9.43	132.47	1.10	0.14	1.24
8.	NDB-308	42.67	72.08	4.27	25.72	14.60	12.21	145.77	1.61	0.13	1.77
9.	NDB-309	61.67	70.38	4.28	18.63	12.43	14.50	126.90	1.66	0.19	1.84
10.	NDB-310	41.67	72.73	3.63	17.42	10.97	12.10	119.97	1.30	0.14	1.45
11.	NDB-311	45.33	72.00	4.50	18.17	12.57	12.50	141.83	1.57	0.19	1.77
12.	NDB-312	39.67	69.80	5.03	16.10	9.50	12.00	97.07	1.04	0.11	1.15
13.	ArkaNidhi©	44.67	75.53	6.20	20.83	12.53	17.38	98.77	1.54	0.17	1.71
14.	NDB-313	52.00	85.13	6.72	18.32	17.42	16.53	131.63	1.90	0.26	2.16
15.	NDB-314	51.33	73.93	5.70	13.50	11.68	16.40	121.77	1.81	0.19	2.00
16.	NDB-315	42.00	65.97	5.17	18.33	14.27	21.57	86.47	1.69	0.18	1.86
17.	NDB-316	49.00	82.60	4.17	15.57	9.73	16.53	120.70	1.87	0.12	1.99
18.	NDB-317	46.33	90.27	7.40	18.67	13.80	15.70	105.80	1.51	0.15	1.66
19.	NDB-318	53.00	82.53	4.60	15.03	14.93	10.53	105.47	1.00	0.10	1.10
20.	NDB-319	42.33	73.33	3.27	18.03	13.53	12.50	118.37	1.29	0.18	1.47
21.	NDB-320	43.00	75.17	3.97	18.23	13.10	21.20	120.97	2.24	0.22	2.46
22.	NDB-321	49.33	85.00	6.50	16.50	23.17	11.70	201.23	1.95	0.24	2.17
23.	NDB-322	48.00	77.00	4.10	18.57	23.10	12.15	171.10	1.84	0.24	2.08
24.	NDB-323	50.67	77.30	4.10	12.70	21.20	12.07	179.26	1.84	0.31	2.15
25.	NDB-324	51.33	76.80	4.47	13.90	22.73	10.73	200.97	1.97	0.17	2.15
26.	NDB-325	50.00	80.57	6.90	21.67	23.80	15.93	203.80	2.96	0.31	3.25
27.	NDB-326	53.00	88.00	4.27	17.87	22.07	11.63	191.03	2.03	0.20	2.23
28.	NDB-327	48.67	78.80	3.90	17.67	22.47	11.33	210.70	2.15	0.21	2.38
29.	NDB-328	58.00	70.03	5.30	14.00	25.23	10.70	205.77	2.04	0.16	2.20
30.	NDB-329	38.00	71.67	4.73	13.83	23.33	11.87	206.33	2.18	0.27	2.45
31.	NDB330	51.33	89.03	7.50	13.77	19.50	10.67	185.67	1.80	0.17	1.97
32.	MuktaKeshi©	52.00	83.19	5.33	15.43	24.27	12.80	186.67	2.02	0.22	2.39
Mean		48.66	76.46	5.11	17.17	16.77	13.69	146.27	1.73	0.18	1.94
C.V.		4.62	3.74	10.04	6.03	4.65	7.80	8.89	13.08	11.59	11.98
S.E.		1.29	1.65	0.29	0.59	0.45	0.61	7.51	0.13	0.01	0.13
CD 5 %		3.67	4.67	0.83	1.69	1.27	1.74	21.23	0.37	0.03	0.38
Range lowest		38.00	58.20	3.26	12.70	9.50	9.42	86.46	1.00	0.10	1.10
Range Highest		61.66	91.00	7.50	25.71	25.23	21.56	210.70	2.95	0.30	3.24

Coefficient of variation

The estimate of the genotypic coefficient of variation is of prime importance to the breeder because genetic variance alone does not allow a decision as to which characters were showing the highest degree of variability. Therefore, the accurate relative comparison can be made with the help of phenotypic and genotypic coefficient of variation. In general, the phenotypic coefficient of variability was higher than the genotypic coefficients of variability for all the characters under study which indicates that environment played very crucial role in the expression of the traits.

The highest phenotypic and genotypic coefficient of variation (PCV and GCV) was observed for unmarketable fruit yield per plant, fruit circumference and average fruit weight (Table 3). Islam and Uddin (2009); Thangavel *et al*. (2011); Kumar *et al*. (2012) and Kumar *et al*. (2013) also reported similar results in their studies. Moderate PCV and GCV were estimated for fruit per plant yield per plant, and primary branches per plant. The phenotypic and genotypic coefficient of variations was lower for plant height. It may be because the environment influenced the observed variance. Such influences were also evident for a genotypic coefficient of variation. The genotypic coefficient of variation ranged from 10.46 (days to 50% flowering) to 22.01 (fruits per plant). A similar result was also reported by Ansari (2011).

Heritability and genetic advance

Heritability in the broad sense of a character is important to the breeder since it indicating the possibility of further selection for improvement of a crop. It also shows during selection, a direction of selection pressure to be applied for a trait because it assesses the relationship between parents and their progeny, hence widely used in determining the degree to which a character may be inherited from parents to offspring. However, high heritability alone is not enough to make an active selection in the advanced generation unless companies by the substantial amount of genetic advance (Burton, 1952). High estimates of heritability along with high genetic advance provide good scope for further improvement in advanced generations.

The result of heritability and genetic advance in percent of mean of present investigation has been shown in (Table-3). The heritability estimates for different characters ranged from 75.28 to 97.62%. High heritability was recorded for all the

characters. High heritability along with the high genetic advance in percent of the mean has been registered for fruit circumference, the Polar length of fruit, fruit weight, primary branches per plant, plant height, total fruit yield per plant and marketable fruit yield per plant, indicating that environment less influenced these traits. Thus require low selection intensity for improvement. Similar results were also reported by Dubi *et al*. (1983); Nagi *et al*. (2000); Naik *et al*. (2009) and Muniappan *et al*. (2010). Sharma *et al*. (2000) observed high heritability coupled with high genetic advance for the length of fruit, fruits per plant, fruit weight and yield per plant. Nagi *et al*. (2000) found high genetic advance coupled with high heritability for fruits per plant, fruit weight and yield per plants, Shekhar et. al (2012) reported highest genetic advance as percent of mean for almost all the characters except for days to first flowering, days to first picking.

Table 3: Range, grand mean, phenotypic (PCV), genotypic (GCV), environmental (ECV) coefficient of variation, heritability in broad sense, genetic advance in per cent of mean (Ga) for ten characters in brinjal germplasm

S. No.	Characters	Range		Grand mean	PCV (%)	GCV (%)	ECV (%)	Heritability broad sense (%) (h^2_{bs})	Genetic advance in per cent of mean (Ga)
		Lowest	Highest						
1.	Days to 50% flowering	38.00	61.66	48.66	11.43	10.46	4.62	83.68	19.71
2.	Plant height (cm)	58.20	91.00	76.46	11.14	10.49	3.74	88.68	20.36
3.	Number of primary branches per plant	3.26	7.50	5.11	25.55	23.49	10.04	84.56	44.50
4.	Fruit length (cm)	12.70	25.71	17.17	17.91	16.86	6.07	88.65	32.70
5.	Fruit circumference (cm)	9.50	25.23	16.77	30.14	29.78	4.65	97.62	60.62
6.	Number of fruits per plant	9.42	21.56	13.69	23.36	22.01	7.80	88.82	42.74
7.	Average fruit weight(g)	86.46	210.70	146.27	27.18	25.69	8.89	89.30	50.01
8.	Marketable fruit yield per plant(kg)	1.00	2.95	1.73	26.32	22.83	13.08	75.28	40.81
9.	Unmarketable fruit yield per plant(kg)	0.10	0.30	0.18	30.42	28.13	11.59	85.48	53.58
10.	Total fruit yield per Plant(kg)	1.10	3.24	1.94	25.37	22.35	11.98	77.67	40.59

Acknowledgment
The work onbrinjal reported in this paper has been supported by research and teaching faculties of the Department of Vegetable Science, N.D.U.A.T., Kumarganj, Faizabad.

References

1. Ansari SF, Mehta N, Ansari S, Gavel JP. Variability studies in Brinjal (*Solanummelongena* L.) in Chhattisgarh plains. Electronic J Plant Breeding. 2011; 2(2):275-281.
2. Aykroyd WR. The nutritive value of Indian foods and planning of satisfactory diet. I.C.M.R., 1963, 42.
3. Burton GW. Quantitative inheritance in grasses. *Proc. 6th Int. Grassland. Cong.* J. 1952; 1:227-283.
4. Burton GW, de Vane EH. Estimated heritability in tall replicated clonal material. Agron. J. 1953; 45:474-478.
5. Chen NC, Li HM. Cultivation and Seed Production of Eggplant. *AVRDC, Annual Publication*, 1996; 203(64):246-261.
6. Choudhary B. *Vegetable, 4thedn.National Book Trust, New Delhi*, 1976, 50-58.
7. Dudi BS, Dixit J, Pratap PS. Components of variability, heritability and genetic advance studies in tomato. Haryana Agri. Univ. J Res. 1983; 13(1):135-139.
8. Islam MS, Uddin MS. Genetic variation and trait relationship in the exotic and local eggplant germplam. Bangladesh J Agric. Res. 2009; 34(1):91-96.
9. Johnson HW, Robinson HF, Comstock RE. Genotypic and phenotypic correlation in soybean and their implications in selection. Agron. J. 1955; 47:477-483.
10. Kumar SR, Arumugam T, Premalakshmi V. Evaluation and variability studies in local types of brinjal for yield and quality (*Solanummelongena* L.). Electronic J. Plant Breed. 2012; 3(4):977-982.
11. Kumar SR, Arumugam T, Anandakumar CR, Premalakshmi V. Genetic variability for quantitative and qualitative characters in brinjal (*Solanummelongena L.*). African J Agri. Res. 2013; 8(39):4956-4959.
12. Muniappan S, Saravan K, Ramya B. Study on genetic divergence and variability for certain economic characters in eggplant (*Solanummelongena*L.). Electronic J Pl.Breed. 2010; 1(4):462-465.
13. Naik K, Sreenivasulu GB, Prashanth SJ, Jayaprakashnarayan RP, Madalageri MB, Mulge R. Studies on genetic variability and its importance in brinjal (*Solanummelongena* L.). Asian J Hort. 2009; 4(2):380-382.
14. Negi AC, Baswana KS, Singh A, Sanwal SK, Batra BR. Studies on genetic variability and heritability in brinjal (S*olanummelongena*L.) under high temperature conditions. Haryana J Hort. Sci. 2000; 29(3&4):205-206.
15. Panse VG, Sukhatme PV. *Statistical Methods for Agricultural Workers, ICAR Publication*, New Delhi, 1967.
16. Sharma TVRS, Kishan S, Swaroop K. Genetic variability and character association in brinjal (*Solanummelongena*L.). Indian. J Hort. 2000; 57(1):59-65.
17. Shekar KC, Ashok P, Sasikala K. Studies on heritability and multivariate analyses in brinjal (*Solanummelongena* L.). Veg. Crops Res. Bulletin 2012; 76:79-88.