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Research Article

Studies on genetic diversity in brinjal (*Solanum melongena* L.)

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Abstract
Genetic divergence among fifty six brinjal (*Solanum melongena* L.) genotypes was investigated based on twelve agronomic traits. Significant variations were observed among the brinjal genotypes for all the traits studied. D^2 analysis resolved fifty six genotypes into as many as eight clusters. Maximum genotypes were gathered in cluster V (27 genotypes); followed by cluster IV (11 genotypes); cluster VII (07 genotypes), cluster I (04 genotypes). Cluster II, III and IV each had two genotypes. Cluster VIII was a monogenotypic one. The intra-cluster distance was maximum with the cluster I. The genotypes grouped in this cluster may also be different genetically. On other hand, the genotypes grouped in the cluster IX may be similar for the traits of interest due to minimum intra-cluster distance. The inter-cluster distance was maximum between the clusters VI and cluster II. The genotypes gathered in these clusters might be different genetically and utilized in crossing programme to get heterotic hybrids and/ or superior recombinants (segregants).

Key words
Brinjal, Fruit yield, Genetic divergence, D^2.

Introduction

Vegetables are being cultivated over an area of 49 million hectares with its production potential of 487 million tonnes in the world. India is the second largest producer of vegetables in the world, accounting for 10 per cent of the world's production. The area under the brinjal cultivation in India is about 648 thousand hectares with production of 12303 thousand metric tones. The productivity was 18.98 metric tonnes per hectare. Brinjal (*Solanum melongena* L.) (2n = 24), traded as egg plant or Aubergine or Guinea squash is one of the important poor man vegetable crop belonging to the family Solanaceae. It originated from India. According to De Candole (1883), brinjal was known in india in ancient times and probably a native of India. Brinjal is widely cultivated in tropics, sub tropics and warm temperature regions throughout the year. It is having high nutritive value and rich in vitamins and minerals. Brinjal is an often-cross pollinated crop. Hence, possibility of exploitation of heterosis in Brinjal is very bright.

A large indigenous biodiversity exists in eggplant with variation in plant type, stem colour, leaf size, leaf tip, midrip colour, fruit size, fruit shape, fruit colour, fruit quality, cooking quality, and tolerance to pest and diseases (Ullah *et al*., 2014). It is an established fact that genetically diverse parents are likely to yield desirable hybrids and/or segregants in later segregating generations. It was also observed that the more diverse the parents, greater are the chances of obtaining high heterotic F_1s and broad spectrum of variability in the segregating generation (Das *et al.,* 2010). Selection of parents identified on the basis of divergence analysis would be more promising for a hybridization programme (Kumar *et al.,* 2000). Among the several statistical methods developed for measuring the divergence between populations, multivariate analysis (D^2 analysis) developed by Mahalanobis' (1936) has been found to be a potent tool (Rao, 1952). Assessment of Genetic diversity is an important step in crop improvement programme through plant breeding.

Materials and Methods

Fifty six genotypes of brinjal maintained at Department of Genetics and Plant Breeding were utilized for the present inquiry. The experiment was carried out at Plant Breeding Farm, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India, during 2018. The experiment was laid out in a Randomized Block Design (RBD) with three replications, in two rows plots of 4.5 m length. A spacing of 60 × 45 cm was adopted. Observations were recorded on five randomly selected plants per entry per replication on twelve agronomic traits *viz.,* days to 50 per cent

flowering, plant height (cm), number of branches per plant, number of flowers per cluster, number of fruits per cluster, days to first harvest, days to last harvest, number of fruits per plant, fruit length (cm), fruit girth (cm), average fruit weight (g), fruit yield per plant (g). Recommended agronomic practices and need based plant protection measures were judiciously followed. Multivariate analysis (D^2 statistic) as outlined by Mahalanobis' (1936) was adopted. Grouping of genotypes into different clusters was carried out by following Tocher's procedure (Rao, 1952). The relative contribution of different traits towards total genetic divergence was calculated as per Singh and Choudhary (1985). The statistical analyses were performed with Indo stat, licensed at NRRI, Cuttack, India.

Results and Discussion

The analysis of variance indicated significant variation among the fifty six genotypes for all the twelve traits. This suggested that large variability existed among the genotypes and further analysis is appropriate (Table 1). On the basis of D^2 analysis, fifty six genotypes were grouped into as many as eight clusters (Table 1).
A maximum of twenty seven genotypes were gathered in cluster V (ICO 374777, ICO 382587, ICO 383119, ICO 394902, ICO 398820, ICO 411485, ICO 422586, ICO 427008, ICO 427029, ICO 545862, ICO 545871, ICO 545916, Whitish blue and riped brinjal, Venyutha brinjal, Namakkal brinjal, Utha brinjal, Udumalai brinjal, Udumalai Samba brinjal, Vellore mullukathari, Dindugal kathiri, Arkakusumakar, CVK Srukkarai Sivappu, Udavai green brinjal, Pusa Upkar, BH-2, Utkalkeshari, PBNB-5) where as cluster IV was endowed with a maximum of eleven genotypes, (ICO 241678, ICO 316294, ICO 329327, ICO 334660, ICO 354727, ICO 354749, ICO 355370, ICO 361838, ICO 373485, Brinjal thorn, IC90087). The cluster VII had seven genotypes (Utkaljyoti, JBH-3, VR-2, DMU-1, KKM-1, IC 89908, IC 90121). The cluster I encompassed of four genotypes (ICO 21264, ICO216794, ICO 334729, IC 89910). Cluster II, III and IV each had two genotypes (ICO 336474, IC 89933), (ICO 344674, IC 89945) and (Punjab Sadabarhar, PBNB-6). Cluster VIII (PBNB-1) included only one genotype.

The estimates of intra-cluster and inter-cluster D^2 and D value are presented in (Table 3). The intra-cluster distance was the maximum with the cluster I (60.30). The genotypes grouped in this clusters may also be different genetically. On other hand, the genotypes grouped in the cluster VIII registered minimum D^2 value. They may be similar for the traits of interest. The inter-cluster distance was the maximum between the clusters VI and cluster II. The genotypes gathered in these clusters might be different genetically. The may be inter-crossed to evolve high yielding heterotic hybrids and/ or superior recombinants (segregants).

Cluster mean indicated the variation for the quantitative traits among the clusters (Table 4). Cluster VI recorded minimum mean value for days to first to flowering (58.80) followed by cluster VII (60.13) and cluster I (60.55). Plant height at maturity was minimum with the cluster VIII (93.75) followed by cluster II (94.30). Cluster VI (7.72), followed by cluster I (6.15). Cluster VII (5.37), evinced maximum number of branches per plant. Cluster VI (4.38), followed by cluster III (4.15) and cluster II (4.14) recorded maximum cluster mean value for number of flowers per cluster. Cluster V (2.78) followed by cluster VII (2.60), and cluster IV (2.41), recorded maximum mean value for number of fruits per cluster. Cluster III (74.46) followed by cluster VII (75.82), and cluster II (76.26), recorded minimum cluster mean value for days to first harvest. Cluster II (151.20) followed by cluster VII (162.64), and cluster I (163.13), recorded minimum cluster mean value for days to last harvest. Cluster II (37.32) followed by cluster III (35.66), and cluster VII (32.86), recorded maximum mean value for number of fruits per plant. Cluster VI (14.26) followed by cluster VIII (12.04), and cluster II (8.17) recorded maximum cluster mean for fruit length. Cluster I and V had same cluster mean (5.98), followed by cluster IV (5.87), and cluster VII (5.86), recorded maximum cluster mean for fruit girth. Cluster VIII (100.55) followed by cluster I (71.07), and cluster II (71.02), recorded maximum cluster mean value for average fruit weight. Cluster III (2570.06) followed by cluster II (2464.29), and cluster I (2048.44), recorded maximum cluster mean value for fruit yield per plant.

The percentage contribution of the various agronomic traits to total genetic diversity is depicted in (Table 5). It revealed that the traits *viz.*, fruit yield per plant (48.02 %), contributed maximum to total genetic divergence followed by average fruit weight (31.54 %). These traits may be given primary importance during selection.

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Table 1. Analysis of variance for 56 brinjal genotypes

Source	df	Mean sum of square (MSS)											
		Days to 50 percent flowering	Plant height at maturity (cm)	Number of branches per plant	Number of flowers per cluster	Number of fruits per cluster	Days to first harvest	Days to last harvest	Number of fruits per plant	Fruit length (cm)	Fruit girth (cm)	Average fruit weight (g)	Fruit yield per plant (g)
Replication	2	4.31	4.56	0.47	0.09	0.04	1.14	2.34	0.21	0.24	0.02	1.29	97.66
Genotype	55	32.85**	112.97**	5.29**	2.11**	1.32**	32.65**	262.95**	160.40**	30.79**	3.24**	1618.60**	2038776.83**
Error	110	6.71	5.36	0.16	0.03	0.02	1.22	1.09	0.42	0.08	0.08	0.65	2148.96

* Significant at 5 per cent level ** Significant at 1 per cent level

Table 2. Composition of clusters

Clusters	Number of genotypes	Name of genotype
I	4	ICO 216264, ICO216794, ICO 334729, IC 89910
II	2	ICO 336474, IC 89933
III	2	ICO 344674, IC 89945
IV	11	ICO 241678, ICO 316294, ICO 329327, ICO 334660, ICO 354727, ICO 354749, ICO 355370, ICO 361838, ICO 373485, Brinjal thorn, IC90087
V	27	ICO 374777, ICO 382587, ICO 383119, ICO 394902, ICO 398820, ICO 411485, ICO 422586, ICO 427008, ICO 427029, ICO 545862, ICO 545871, ICO 545916, Whitish Blue and Ripped Brinjal, Venyutha Brinjal, Namakkal Brinjal, Utha Brinjal, Udumalai Brinjal, Udumalaisamba Brinjal, Vellore Mullukathari, Dindugalkathiri, Arkakusumakar, CVK Sirukkarai Sivappu, Udavai Green Brinjal, Pusa upkar, BH-2, Utkalkeshari, PBNB-5
VI	2	Punjab sadabarhar, PBNB-6
VII	7	Utkaljyoti, JBH-3, VR-2, DMU-1, KKM-1, IC 89908, IC 90121
VIII	1	PBNB-6

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Table 3. Intra-cluster and Inter-cluster distances (D^2 values) of brinjal genotypes

Clusters	I	II	III	IV	V	VI	VII	VIII
I	(3635.75) (60.30)	(2105.26) (45.88)	(2466.28) (49.66)	(4010.40) (63.33)	(3960.68) (62.93)	(4802.20) (69.30)	(2894.04) (53.80)	(4067.85) (63.78)
II		(15.12) (3.90)	(7194.40) (26.73)	(3938.49) (62.76)	(3512.13) (59.27)	(5063.39) (71.16)	(2191.00) (46.81)	(4238.40) (65.10)
III			(18.21) (4.27)	(4418.54) (66.47)	(4355.74) (65.91)	(6524.77) (80.78)	(2880.25) (53.67)	(4958.47) (70.42)
IV				(3361.11) (57.98)	(3045.26) (55.18)	(2823.05) (53.13)	(2973.68) (52.45)	(7485.16) (86.95)
V					(2909.80) (53.94)	(2443.09) (49.43)	(2751.33) (52.45)	(7559.77) (86.95)
VI						(436.60) (20.90)	(3027.50) (55.02)	(8390.36) (91.60)
VII							(2573.37) (50.73)	(5586.68) (74.74)
VIII								(0.00) (0.00)

Table 4. Cluster mean performance of brinjal genotypes for various characters

Traits / Clusters	Days to 50 per cent flowering	Plant height at maturity (cm)	Number of branches per plant	Number of flowers per cluster	Number of fruits per cluster	Days to first harvest	Days to last harvest	Number of fruits per plant	Fruit length (cm)	Fruit girth (cm)	Average fruit weight (g)	Fruit yield per plant (g)
I	60.55	96.40	6.15	4.63	2.05	76.81	163.86	28.35	7.73	5.98	71.07	2048.44
II	62.70	94.30	4.52	4.14	2.17	76.26	151.20	37.32	8.17	5.64	71.02	2464.29
III	63.95	111.74	3.92	4.15	2.15	74.46	163.67	35.66	2.70	2.62	52.20	2570.06
IV	61.55	99.42	4.93	3.59	2.41	77.41	166.76	30.45	6.98	5.87	50.06	1370.87
V	61.43	99.67	4.94	4.12	2.78	77.75	165.23	29.97	8.14	5.98	51.38	1643.35
VI	58.80	104.09	7.72	4.38	2.40	79.71	173.16	28.98	14.26	4.98	30.38	1016.28
VII	60.13	97.95	5.38	4.12	2.60	75.82	162.64	32.86	8.24	5.86	50.02	1723.06
VIII	62.63	93.75	3.22	3.26	2.24	80.92	166.50	18.03	12.04	3.88	100.55	1813.70

Table 5. Percentage contribution of each character towards genetic divergence of brinjal genotypes

S. No.	Characters	Times ranked	Contribution (%)
1.	Days to 50 per cent flowering	0	2.16
2.	Plant height at maturity (cm)	0	3.25
3.	Number of branches per plant	0	2.02
3.	Number of flowers per cluster	2	1.32
4.	Number of fruits per cluster	5	1.05
5.	Days to first harvest	0	1.02
6.	Days to last harvest	46	2.97
7.	Number of fruits per plant	71	3.62
8.	Fruit length (cm)	72	2.52
10.	Fruit girth (cm)	8	0.51
11.	Average fruit weight (g)	532	31.54
12.	Fruit yield per plant (g)	804	48.02