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Kalyan Kumar Mohanty
Department of Horticulture, Faculty of Agricultural Sciences (IAS), Siksha 'O' Anusadhan (Deemed to Be University), Bhubaneswar, Odisha, India, India

Hrudananda Mishra
Department of Horticulture, Faculty of Agricultural Sciences (IAS), Siksha 'O' Anusadhan (Deemed to Be University), Bhubaneswar, Odisha, India, India

Satyaprakash Barik
Department of Horticulture, College of Agriculture, OUAT, Bhubaneswar, Odisha, India

Corresponding Author:
Kalyan Kumar Mohanty
Department of Horticulture, Faculty of Agricultural Sciences (IAS), Siksha 'O' Anusadhan (Deemed to Be University), Bhubaneswar, Odisha, India, India

Morphological profiling and assessment of genetic divergence of brinjal (*Solanum melongena* L.) genotypes

Kalyan Kumar Mohanty, Hrudananda Mishra and Satyaprakash Barik

Abstract
A study was conducted on thirty-eight genotypes including local landraces and public as well as private sector genotypes of brinjal collected from different locality of Odisha, India to assess the value and magnitude of genetic divergence among them using Mahalanobis D^2 statistics. The result revealed existence of wide genetic diversity among the 38 evaluated genotypes which were grouped into 13 clusters based on 12 important characters in brinjal. The cluster I was the largest containing 09 genotypes followed by cluster III with 07 genotypes. The diversity among the cluster was measured by inter-cluster distance, highest being observed in between cluster VIII and cluster XIII (D^2 = 1142.59) followed by cluster IX and cluster XIII (D^2 = 941.02) and cluster V and cluster VIII (D^2 = 792.97). Therefore, selection of divergent parents of brinjal based on these cluster distance would be useful in selecting genotypes for hybridization and thereby formulating a comprehensive strategy to develop superior hybrids or better segregates in brinjal. In the present study, superior hybrids or variety (s) can obtained by crossing parents of two divergent groups, cluster VIII (Selection-2 and Selection -8) with cluster XIII (Selection 22).

Keywords: *Solanum melongena* L. clustering pattern, genetic divergence, multivariate analysis

Introduction
Brinjal (*Solanum melongena* L.) (2n= 24), also known as aubergine or eggplant is popularly designated as the poor man's vegetable (Som and Maity, 2002) [17]. The cultivated eggplant is of Indian origin (Vavilov, 1928) [18] and it was introduced to Europe in the 16th century and to America in 1806; from these places, its cultivation spread rapidly worldwide. The fruits are rich source of dietary fibre, calcium, proteins, phosphorus, iron, vitamin A, vitamin B, and vitamin C. It acts as cholesterol-reducing agent due to the high percentage (65%) of polyunsaturated fatty acid, potassium and Magnesium content in the fruit. It is also used as a medicine for controlling high blood cholesterol and liver problems (Daunay and Hazra, 2012) [19]. In African countries, leaves of brinjal are also utilized for culinary purposes (Sunseri *et al*., 2010) [21]. The other medicinal properties of brinjal includes curing of problems such as skin diseases, cough, toothache, piles, and stomach difficulties inflammation and throat problems. (Mak, 2013; Murray, 2004; Sekara *et al*., 2007) [20, 22, 23]. Globally, brinjal is cultivated in an area of 1.86 million hectare, from which 54.1 million tonnes of brinjal are produced with a productivity of 29.1 kg per hectare (Food and Agriculture Organization statistics, 2018). China (56% of world output), India (26% of world output), Egypt, and Turkey are the leading producers of brinjal due to high consumer demand.

However, attempts to enhance its productivity significantly are not fully successful due to their cultivation under diverse and mostly constrained ecologies. Climate change can further limit the productive potential of the crop. Looking at its economic importance in national level, there is always a need for improved varieties/ hybrids for further exploitation commercial level, which could be analyzed by formulating a strategy of genetic improvement in crop breeding programmes. Therefore, breeders always look for genetic divergence among traits to select desirable types. Genetic diversity plays an important role in plant breeding because hybrids between lines of diverse origin generally display a greater heterosis than those between closely related strains (Singh, 1983) which permits to select the genetically divergent parents to obtain the desirable recombination in the segregating generations.

Therefore, current experiment was carried out to assess the nature as well as magnitude of genetic divergence and clustering pattern of thirty-eight genotypes in brinjal; details of which are given below.

Materials and methods

Experimental site and Plant materials

The present investigation was undertaken at Instructional Farm of IAS (Faculty of Agricultural Sciences), S'O'A (deemed to be) University, Bhubaneswar, Odisha during *Rabi* 2018-19. Thirty-eight germplasm accessions including twenty- two local collections, six public sector genotypes and ten private company genotypes were evaluated for plant growth, yield and yield attributing traits. The collected 38 accessions of brinjal along with their sources of collection are given in Table 1.

Raising of seedlings and agronomic practices for brinjal germplasm

Brinjal germplasms were sown in portrays containing coco peat, farmyard manure and vermicompost (2:1:1) media followed by light irrigation and kept inside poly house. Prior to sowing, seeds were soaked for 24 hours for quick and uniform germination. Drenching with fungicides was done at regular interval to protect young seedlings from damping off and other fungal diseases. Two sprays of liquid fertilizer (19:19:19 NPK) or were done at fortnight interval for luxurious growth of seedlings. The seedlings were transplanted in the main field 40 days after sowing at a spacing of 60cm x 45cm. The experiment was laid out in Randomized Complete Block Design with 3 replications.

Observations on plant growth, yield and yield attributing traits of the germplasm

Observations were recorded from five randomly selected highly competitive plants from the middle rows of each genotype in each replication for 12 plant characters. Mean values of five plants were used for statistical analysis.

Statistical analysis

Mahalanobis' (1928) [8] generalized distance, D^2 statistics was used for computing genetic divergence as described by (Rao, 1952) [12]. The original measurements were transformed to standardized uncorrelated variables by pivotal condensation (Rao, 1952) [12]. The divergence between any two varieties was obtained as the sum of squares of the difference in the values of the corresponding transformed values (V_{ij})

$D^2_{jk} = \sum^n{}_{i=1} Y_i j - Y_i k$

Following Tocher's method as described by Rao (1952) [12], the genotypes were grouped into clusters. The criterion of grouping was that any two genotypes belonging to the same cluster should have a smaller D^2 value than those between genotypes belong to different clusters. Inter and intra-cluster distances were determined and represented. The relative contribution of different characters towards total divergence was calculated as per Singh and Choudhury, 1985 [15].

The data obtained for the 12 traits of brinjal were analyzed using OP-STAT software (Sheoran *et al*., 1998) [24] (available at http://14.139.232.166/opstat/default.asp).

Results and discussion

Morphological characterization showed a vast difference among the genotypes with respect to plant vigor and stature, flower and fruit traits, indicating existence of high variability among the population (Table 1). Analysis of variance (ANOVA) was conducted to test the significance of variance among 38 diversified genotypes of brinjal for all the twelve traits (Table 2). Analysis of variance showed significant differences among the genotypes used in the present investigation, for all the twelve characters studied *viz*; plant height, number of branches per plant, days to 50% flowering, days to first fruiting, days to edible maturity, number of fruits per plant, fruit length, fruit girth, fruit weight and fruit yield per plant. This result indicated wide spectrum of variation among the genotypes (Burton *et al.* 2004; Alie *et al.*, 2009; Janaki *et al*. 2015; Patel *et al*., 2015) [3, 1, 6, 11] and thus have considerable scope for their improvement.

Genetic divergence plays an important role in selection of parents by evaluating the general distance among the genotypes. It increases the level of heterosis and creates wide range of variability. The hybrids are mostly preferred because they are results from crossing of divergent parents. The evaluation is done by grouping the genotypes into different clusters. In the present study, thirty-eight genotypes of brinjal when subjected to D^2 analysis, using twelve growth and yield attributing characters revealed that thirteen clusters were formed (Table 3). From the pattern of clustering it could be inferred that sufficient divergence was present to enable the formation of individual clusters. On the basis of Mahalanobis D^2 analysis, 38 genotypes were grouped into 13 clusters (Table 3). Cluster I, the largest group included 09 genotypes (Selection 4, Selection 13, Selection1, Hazzari, Selection 20, Selection 10, Selection 21, Selection 9, Utkal Jyoti), followed by cluster Ill with 07 genotypes (Muktakeshi, Royal Green, Utkal Keshari, New Salini, Selection 15, Brinjal Tirupati, Green Diamond). IX, X, XI, XII, XIII with one genotype each consisting of Brinjal Sandhya, Selection 18, Selection 16, Newstar, Selection 22 genotypes, respectively.

The obtained clustering pattern could be utilized in selection of parents for crossing and deciding the best cross combinations which may generate the highest possible variability for various traits. Mahalanobis D^2 analysis of quantitative traits is a powerful tool for measuring genetic divergence among the material selected even from the same geographic region, reported by Mahalanobis (1936) followed by Rao (1952) [12]. Pattern of distribution of genotypes among various clusters reflected the considerable genetic diversity present in the genotypes under study. The present study also revealed that genotypes from different geographical regions were also grouped in the same cluster indicating no relationship between geographic distribution and genetic divergence. Present results are in line with findings of Golani *et al.*, 2007 [5]. and Tiwari *et al*., 2016 [16]. in brinjal.

In the present investigation the inter cluster and intra cluster distance was estimated among eleven characters (Table 4). It is evident that maximum intra cluster distance was observed in cluster V (D^2 = 171.37), while minimum intra-cluster distance was exhibited by cluster IV (D^2 = 84.27). When the clusters were-compared for divergence, maximum inter-cluster distance was observed between cluster VIII and cluster XIII (D^2 = 1142.59) followed by cluster IX and XIII (D^2 =941.02). The lowest inter-cluster distance was observed between Cluster III and Cluster VII (D^2= 203.13)

Since improvement in yield and other related traits is a basic objective in any breeding programme, cluster means for fruit yield plant"[1] and its major components need to be considered for selection of genotypes. The cluster means of 12 quantitative characters for groups of brinjal genotypes are presented in Table 5. Moderate value with respect to all the characters was observed in Cluster I, III, V, IX consisting of nine, seven, four and one brinjal germplasms each in respective order. Cluster II consisting of four germplasm exhibit lowest value for two characters viz. plant height (53.03 cm) and fruit yield per plant (0.68 kg) among all the clusters. Fruit weight showed lowest value (57.71 kg) in cluster IV having two genotypes among all the clusters. Cluster VI consisting of three germplasms showed highest value for characters like days to first flowering (58.68days), days to 50% flowering (61.57 days) days, days to first fruiting (73.32 days) days and days to edible maturity (86.97 days) among all the clusters. Cluster VII consisting of two genotypes having highest value node at first flowering appeared (8.35) among all the clusters. Cluster VIII comprising two germplasm exhibit highest value for number of fruits per plant (16.20) and lowest value for days to 50% flowering (50.75 days), days to first fruiting (59.32) and fruit girth (12.02 cm) rest of the characters showed moderate value for the cluster. Cluster X is having only one genotype which exhibited highest value for characters like plant height (91.07 cm) and fruit girth (20.99 cm) and lowest value for node at first flowing appeared (3.53), number of branches per plant (4.93) and days to edible maturity (72.27 days) among all the clusters. Cluster XI having one genotype showed highest value for fruit length (14.73 cm) and fruit yield per plant (1.89 kg).Highest value for character like number of branches per plant (8.53) and lowest value for character like days first flowing (47.07 days) had observed in cluster XII with one genotype where other traits show relatively moderate values. Cluster XIII comprise one genotype showing highest value for fruit weight (112.12) and lower value for characters like number of fruits per plant (3.40) and fruit length (7.69 cm) among all the clusters. Results obtained with respect to inter and intra cluster divergences indicated variations in the parameters (Table 4). The genotypes grouped into the same cluster displayed the lowest degree of divergence from one another and in case crosses are made between genotypes belonging to the same cluster, no transgressive segregant is expected from such combinations. Therefore, hybridization program should always be formulated in such a way that the parents belonging to different clusters with maximum genetic distance divergence could be utilized to get desirable transgressive segregants. The maximum intra cluster distance was 171.37 in cluster V followed by cluster VI (159.89), followed by cluster VIII (159.89), while it was zero in case of cluster IX, X, XI, XII and XIII. This result indicates that selection can be made from the cluster V for the superior genotypes. The inter cluster D^2 value varied from 203.13 to 1142.59 and the maximum divergence found between cluster VIII and cluster XIII (1142.59) followed by cluster IX and cluster XIII (941.02) indicated that the genotypes included in these clusters can be used as a parent in hybridization program to get higher heterotic hybrids from the segregating population. Similar results were revealed (Babu and Patil, 2004) [2].

The relative contribution of 12 quantitative traits to genetic divergence among the 38 germplasm of brinjal is presented in Table 6, by rank average of individual character over all 703 paired combinations. Among the yield contributing characters, the maximum contribution towards divergence was made by fruit girth (19.19%) followed by fruit length (17.97%), plant height (9.84%), days to first flowering (8.93%), days to 50% flowing (8.46%), node at which first flowering appeared (8.33%), fruit weight (7.59%), number of fruits per plant (6.21%), number of branches per plant (2.98%), and days to edible maturity (1.73%). Rank average indicated the contribution of traits in the following order days to edible maturity > number of branches per plant> fruit yield per plant > days to first fruiting > number of fruit per plant > Fruit weight>days to 50% flowering >node at which first flowing appeared >days to first flowering >plant height >fruit length >fruit girth.

Among the yield contributing characters, the maximum contribution towards divergence was made by fruit girth, fruit length, plant height, days to first flowering, days to 50% flowing, node at which first flowering appeared, fruit weight and number of fruits per plant, which is in accordance with study conducted by Naik, (2005) [10], Singh *et al*. (2006), Kumar *et al*. (2008) [14], Das *et al*. (2010) [4], and Sadarunnisa *et al*. (2015) [13],

Table 1: Origin, source of collection and characteristics of brinjal germplasm under study

Name of germplasm	Source of Collection	Characteristics						
		Plant Structure	Plant Vigor	Spines	Flower	Fruit Color	Fruit Shape	Fruit Size
Selection 1	Dhenkanal, Odisha	Tall	Erect	No	Cluster	Deep purple	Oval to round	Small
Selection 2	Sukinda, Odisha	Semi-dwarf	Spreading	No	Cluster	Purple fruit with green patches	Long	Medium
Selection 3	Chattia, Odisha	Tall	Erect	No	Solitary	green	Oblong	medium
Selection 4	Remuna, Odisha	Semi-dwarf	Spreading	Yes	Cluster	Purple	Oblong	Big
Selection 5	Salepur, Odisha	Semi-dwarf	Spreading	Yes	Cluster	Green fruit with white strips from blossom end	Long-Slender	Small to medium
Selection 6	Athagarh,Odisha	Semi-dwarf	Spreading	Yes	Solitary	Green	Round	Big
Selection 7	Teispur, Odisha	Semi-dwarf	Spreading	No	Solitary	Green fruits with white dots	Long	Medium
Selection 8	Jajpur, Odisha	Tall	Erect	No	Cluster	Light green	Long (Slender)	Medium
Selection 9	Nimapada, Odisha	Dwarf	Bushy	No	Solitary	Green	Slender	Medium
Selection 10	Gope, Odisha	Dwarf	Spreading	No	Solitary	Green	Long	Medium
Selection 11	Mayurbhanj, Odisha	Dwarf	Spreading	Yes	Solitary	Green	Oval	Small
Selection 12	Karanjia, Odisha	Dwarf	Spreading	Yes	Cluster	Green with white strips	Slender curvy	Small
Selection 13	Chandaka, Odisha	Dwarf	Spreading	Yes	Cluster	Green with white strips	Long to Oval	Medium
Selection 14	Baranga, Odisha	Dwarf	Spreading	Yes	Cluster	Green	Oblong	Big
Selection 15	Aska, Odisha	Tall	Erect	No	Cluster	Purple fruit with few green strips	Round to Oblong	Big
Selection 16	Phulbani, Odisha	Dwarf	Spreading	Yes	Solitary	Green fruit with white strips	Long slightly curved	Medium
Selection 17	Koraput, Odisha	Semi-dwarf	Spreading	Yes	Cluster	Greenish-white fruits	Oval	Small
Selection 18	Anandapur, Odisha	Tall	Erect	No	Cluster	Purplish fruit with green patches	Oblong-roundish	Medium
Selection 19	Gobindapalli,Odisha	Semi-dwarf	Spreading	Yes	Solitary	Light green to creamy white	Oblong	Medium
Selection 20	Kankadahad, Odisha	Tall	Erect	Yes	Solitary	Creamy light glossy green	Oblong to Oval	Medium
Selection 21	Parajang, Odisha	Semi-dwarf	Spreading	No	Cluster	Purple skin with green blotches	Cylindrical	Medium

Selection 22	Keonjhar, Odisha	Semi-dwarf	Spreading	Yes	Solitary	Green with white dots	Round	Big
Muktakeshi	Jagannath seeds	Tall	Erect	No	Solitary	Dark purple glossy skin	Oblong to oval	Big
Royal Green	Jagannath seeds	Dwarf	Spreading	Yes	Cluster	Green to Light green	Long slender	Medium
New Star	Jagannath seeds	Semi-dwarf	Spreading	No	Solitary	Light green with purple patches	Oval to round	Medium small
Brinjal Tirupati	Jagannath seeds	Semi-dwarf	Spreading	Yes	Solitary	Dark green	Roundish oval	Medium small
Green Diamond Long Star	Jagannath seeds	Dwarf	Spreading	Yes	Cluster	Light green	Long slender	Medium
Blue Diamond long star	Jagannath seeds	Tall	Erect	Yes	Cluster	Light purple with few green dots	Oval to round	Medium
Hazzari	Jagannath seeds	Dwarf	Spreading	No	Cluster	Purple	Slender curvy	Medium
Green Diamond	Jagannath seeds	Dwarf	Spreading	No	Solitary	Green with white dots	Round	Big
New Salini	Jagannath seeds	Semi-dwarf	Spreading	No	Cluster	Green with white strips	Oblong	Medium small
Brinjal Sandhya	Jagannath seeds	Tall	Erect	No	Solitary	Violet to reddish purple	Cylindrical	Medium long
IC0598430	CHES, Bhubaneswar	Dwarf	Erect	No	Cluster	Green with white strips	Roundish oval	Small
Utkal Anushree	OUAT, BBSR	Tall	Erect	No	Cluster	Green with white strips	Oval	Small
Utkal Tarini	OUAT, BBSR	Tall	Erect	No	Solitary	Purple	Oblong	Small
Utkal Jyoti	OUAT, BBSR	Tall	Erect	No	Solitary	Purple	Oval	Small
Utkal Keshari	OUAT, BBSR	Tall	Erect	Yes	Cluster	Purple	Oblong	Small
Arka Neelachal Shyama	CHES, Bhubaneswar	Dwarf	Spreading	No	Solitary	Greenish purple with white strips	Round	Medium

Table 2: Analysis of variance for 12 quantitative characters studied in brinjal germplasm

Sl. No.	Characters	Mean sum of square		
		Replication (2)	Genotype (37)	Error (74)
1.	Days to First Flowering	3.578	61.866*	1.363
2.	Node at which First Flowering Appeared	0.285	4.191*	0.104
3.	Plant Height (cm)	6.406	417.765*	10.17
4.	Number of Branches per plant	0.671	5.084*	0.343
5.	Days to 50% Flowering	7.718*	65.342*	1.046
6.	Days to First Fruiting	8.562*	66.239*	1.442
7.	Days to Edible Maturity	6.843*	50.765*	1.718
8.	Number of fruits per plant	1.916	35.351*	1.388
9.	Fruit Length (cm)	0.443	12.577*	0.154
10.	Fruit Girth (cm)	1.930*	31.177*	0.417
11.	Fruit Weight (g)	22.843	896.147*	39.946
12.	Fruit yield per plant (kg)	0.001	0.313*	0.012

Table 3: Distribution of thirty-eight genotypes of brinjal in clusters

Cluster No.	Number of Brinjal genotypes	Genotypes
I	9	Selection 4, Selection 13, Selection1, Hazzari, Selection 20, Selection 10, Selection 21, Selection 9, Utkal Jyoti
II	4	Utkal Anushree, Selection 3, Selection 14, Selection 11
III	7	Muktakeshi, Royal Green, Utkal Keshari, New Salini, Selection 15, Brinjal Tirupati, Green Diamond
IV	2	Selection 7, Selection 5
V	4	Blue Diamond Long Star, IC0598430, Selection 6, Arka Neelachal Shyama
VI	3	Selection 12, Green Diamond Long Star, Utkal Tarini
VII	2	Selection 17, Selection 19
VIII	2	Selection 2, Selection 8
IX	1	Brinjal Sandhya
X	1	Selection 18
XI	1	Selection 16
XII	1	Newstar
XIII	1	Selection 22

Table 4: Intra (Diagonal) and Inter cluster average (D^2) corresponding D ($\sqrt{D^2}$) values (in parenthesis) among groups

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
I	143.11 (11.96)	244.02 (15.62)	263.90 (16.25)	203.27 (14.25)	433.95 (20.83)	288.35 (16.98)	416.32 (20.40)	214.99 (14.66)	299.11 (17.29)	324.81 (18.02)	395.36 (19.88)	196.41 (14.01)	648.57 (25.46)
II		135.31 (11.63)	419.64 (20.48)	363.82 (19.07)	540.28 (23.24)	289.55 (17.01)	501.41 (22.39)	293.74 (17.13)	560.52 (23.67)	593.87 (24.36)	740.06 (27.20)	221.64 (14.88)	720.55 (26.84)
III			115.06 (10.72)	356.15 (18.87)	236.24 (15.37)	213.62 (14.61)	203.13 (14.25)	454.5 (21.31)	327.33 (18.09)	346.76 (18.62)	278.06 (16.67)	254.64 (15.95)	367.91 (19.18)
IV				84.27 (9.17)	615.51 (24.81)	370.18 (19.24)	420.11 (20.49)	256.48 (16.01)	467.26 (21.61)	517.77 (22.75)	263.75 (16.24)	215.05 (14.66)	737.60 (27.15)
V					171.37 (13.09)	453.03 (21.28)	374.06 (19.34)	792.97 (28.15)	624.46 (24.98)	330.68 (18.18)	644.79 (25.39)	378.00 (19.44)	203.35 (14.26)
VI						159.89 (12.64)	258.02 (16.06)	392.64 (19.81)	442.28 (21.03)	603.84 (24.57)	417.16 (20.42)	252.02 (15.87)	561.32 (23.69)
VII							139.75 (11.82)	597.21 (24.43)	634.16 (25.18)	689.54 (26.25)	389.51 (19.73)	238.88 (15.45)	507.28 (22.52)
VIII								159.59 (12.63)	286.72 (16.93)	599.48 (24.48)	465.54 (21.57)	328.60 (18.12)	1142.59 (33.80)
IX									0.00 (0.00)	358.84 (18.94)	279.34 (16.71)	529.13 (23.02)	941.02 (30.67)
X										0.00 (0.00)	523.50 (22.88)	579.43 (24.07)	450.94 (21.23)
XI											0.00 (0.00)	489.79 (22.13)	744.61 (27.29)
XII												0.00 (0.00)	543.86 (23.32)
XIII													0.00 (0.00)

Table 5: Mean of 12 characters in different clusters of brinjal germplasm

SI. No.	Clusters Characters	I (9)	II (4)	III (7)	IV (2)	V (4)	VI (3)	VII (2)	VIII (2)	IX (1)	X (1)	XI (1)	XII (1)	XIII (1)
1.	Days to First Flowering	47.99	49.41	55.83	48.90	52.80	58.68	55.97	47.15	52.07	48.40	55.60	47.07	55.80
2.	Node at which First Flower Appeared	5.73	5.10	6.95	6.03	6.51	6.46	8.35	5.90	6.77	3.53	7.27	7.80	5.47
3.	Plant Height (cm)	73.45	53.03	72.29	84.93	78.32	59.60	78.13	57.17	56.40	91.07	82.47	74.13	85.80
4.	Number of Branches per plant	6.66	8.16	7.72	5.97	7.45	8.27	8.07	8.43	7.00	4.93	6.00	8.53	6.20
5.	Days to 50% Flowering	51.49	53.62	59.51	51.96	57.10	61.57	61.47	50.75	54.07	52.68	58.93	50.47	59.80
6.	Days to First Fruiting	62.55	63.20	69.57	61.57	66.78	73.32	68.38	59.32	62.73	62.00	67.27	61.73	71.87
7.	Days to Edible Maturity	79.34	80.03	85.01	78.90	83.96	86.97	84.51	75.52	79.90	77.27	83.27	78.47	85.27
8.	Number of fruits per plant	11.33	10.57	10.31	14.93	7.28	9.27	10.43	16.20	8.33	7.07	11.20	10.67	3.40
9.	Fruit Length (cm)	12.59	9.87	12.00	11.60	10.07	11.06	10.06	13.98	16.92	13.55	14.73	9.92	7.69
10.	Fruit Girth (cm)	14.15	12.26	16.71	12.60	20.67	12.53	14.46	12.02	14.63	20.99	13.80	12.07	20.29
11.	Fruit Weight g)	71.18	67.41	90.83	57.71	101.89	65.91	71.93	60.36	99.64	101.85	82.27	85.56	112.12
12.	Fruit yield per plant (kg)	0.86	0.68	0.94	1.75	0.74	0.70	0.75	1.00	0.89	0.84	1.89	0.91	1.39

Figures in the parenthesis indicate number of cultivars in a cluster.

Table 6: Relative contribution to different characters to genetic divergence in brinjal germplasm

SI. No.	Characters	Rank Total	Rank Average	Average D^2	Contribution % of Total D^2
1.	Days to First Flowering	4152	7.57 (4)	30.29	8.93 (IV)
2.	Node at which First Flowering Appeared	4184	7.63 (5)	28.28	8.33 (VI)
3.	Plant Height (cm)	4008	7.31 (3)	33.39	9.84 (III)
4.	Number of Branches per plant	5545	10.11 (11)	10.10	2.98 (XI)
5.	Days to 50% Flowering	4310	7.86 (6)	28.71	8.46 (V)
6.	Days to First Fruiting	5384	9.82 (9)	11.62	3.42 (X)
7.	Days to Edible Maturity	6177	11.26 (12)	5.87	1.73 (XII)
8.	Number of fruits per plant	4672	8.52 (8)	21.09	6.21 (VIII)
9.	Fruit Length (cm)	3296	6.01 (2)	60.97	17.97 (II)
10.	Fruit Girth (cm)	3192	5.82 (1)	65.12	19.19 (I)
11.	Fruit Weight (g)	4426	8.07 (7)	25.75	7.59 (VII)
12.	Fruit Yield per plant (kg)	5488	10.01 (10)	18.15	5.35 (IX)

Conclusion

In the present study, a significant amount of genetic variability was observed in the thirty-eight for plant growth, earliness yield attributing traits of brinjal germplasm. Thirteen clusters were observed in the germplasm, the selection of parents from different clusters for the crossings will through good segregants in breeding for the traits under interest. Genotypes from Cluster VIII, Cluster X, Cluster XI and Cluster XIII possessing desirable traits like plant height, fruit girth, number of fruits per plant, yield per plant and having desirable inter cluster distance, can be further evaluated and utilized for crop improvement programme in brinjal.

References

1. Alie FA, Singh T, Tariq, Sharma PK. Genetic diversity analysis in Indian mustard [*Brassica juncea* (L.) Czern and Coss]. Progressive Agriculture 2009;9:50-53.
2. Babu BR, Patil RV. Genetic divergence in brinjal. Vegetable Science 2004;3:125-128.
3. Burton WA, Ripley VL, Potts DA, Salisbury PA. Assessment of genetic diversity in selected breeding lines and cultivars of canola quality *Brassica juncea* and their implication for canola breeding. Euphytica 2004;136:181-192.
4. Das S, Mandal AB, Hazra P. Genetic diversity in brinjal genotypes under eastern Indian conditions. Indian Journal of Horticulture 2010;67:166-169.
5. Golani IJ, Mehta DR, Naliyadhara MV, Pandya HM, Purohit VC. A Study on Genetic Diversity and Genetic Variability in Brinjal. Agricultural Science Digest 2007;27:22-25.
6. Janaki M, Naidu LN, Ramana CV, Rao MP. Genetic divergence among chilli (*Capsicum annuum* L.) genotypes based on quantitative and qualitative traits. International Journal of Science and Nature 2016;7(1):181-189.
7. Kumar G, Meena BL, Kar R, Tiwari SK, Gangopadhyay KK, Bisht IS *et al*. Morphological Diversity in Brinjal (*Solanum melongena* L.) Germplasm Accessions. Plant Genetic Resources: Characterization and Utilization 2008;6(3):232-236.
8. Mahalanobis PC. On the need for standardization in measurements on the living, Biometrika 1928;20:1-31.
9. Mahalanobis PC. On the generalized distance in statistics. National Institute of Science in India 1936.
10. Naik KCK. Genetic variability and divergence studies in brinjal (*Solanum melongena* L.). MSc thesis. University of Agricultural Science, Dharwad, India 2005
11. Patel DK, Patel BR, Patel JR, Kuchhadiya GV. Genetic variability and character association studies for green fruit yield and quality component traits in chilli (*Capsicum annuum* var. longum (dc.) sendt.). Electronic Journal of Plant Breeding 2015;6(2):472-478.
12. Rao CR. In Advance Statistical methods in biometric research. Ed. 1, John WUey and Sous Inc., New York, 1952, 390-395.
13. Sadarunnisa S, Reddy RVK, Begum H, Reddy TD, Reddy PN. Genetic Divergence in Brinjal (*Solanum melongena* L.). Electronic Journal of Plant Breeding 2015;6(1):331-336.
14. Singh AK, Ahmed N, Narayan S. Genetic divergence studies in brinjal under temperate conditions. Indian Journal of Horticultural Science 2006;63:407-409.
15. Singh RK, Choudhury BD. In: Biometrical methods in quantitative genetic analysis. Kalyaci Publishers, New Delhi 1985.
16. Tiwari SK, Bisht IS, Kumar G, Karihaloo JL. Diversity in Brinjal (*Solanum melongena* L.) Landraces for Morphological Traits of Evolutionary Significance, Vegetable Science 2016;43(1):106-111.
17. Som MG, Maity JK. In: Bose, T.K., Kabir, J., Maity, T.K., Parthasarthy, V.A. (Eds.), Brinjal – Vegetable Crops, 3rd revised edition, Som MG and Prokash N Publishers, Kolkatta 2002;1:265-344.
18. Vavilov NI. Geographical centers of our cultivated plants. Prov. V. Intern. Cong. Genet 1928, 342-369.
19. Daunay MC, Hazra P. In: Peter, K.V., Hazra, P. (Eds.), ‘’Eggplant,’’ in Handbook of Vegetables. Studium Press), Houston, TX, 2012, 257-322.
20. Mak G. Health Benefits of Aubergine 2013 Retrieved from. www.healthbenefitstimes. com. on 22nd October, 2015.
21. Sunseri F, Polignano GB, Alba V, Lotti C, Bisignano V, Mennella G. Genetic diversity and characterization of African eggplant germplasm collection. African Journal of Plant Science 2010;4:231-241.
22. Murray MT. The Healing Power of Herbs: The Enlightened Person’s Guide to the Wonders of Medicinal Plants, second ed. United States of America, Random House Incorporated 2004.
23. Sekara A, Cebula S, Kunicki E. Cultivated eggplants – origin, breeding objectives and genetic resources, A Review. Folia Horticulture Ann 2007;19(1):97-114.
24. Sheoran OP, Tonk DS, Kaushik LS, Hasija RC, Pannu RS. Statistical software package for agricultural research workers. In: Hooda, D.S., Hasija, R.C. (Eds.), Recent Advances in Information Theory, Statistics & Computer Applications. Department of Mathematics and Statistics, CCS-HAU, Hisar 1998, 139-143.
25. Singh P. Studies on genetic variability and diversity of rice. Madras Agricultural Journal 1983;70:436-440.
26. Sharma P, Badhan R. "Employment of agro waste to develop biofertilizer and its effect on Solanum melongena var. depressum cv. Pragati (Chu Chu)". International Journal of Agriculture and Plant Science.2020:2(3):15-21.