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Genetic Diversity and Variability of Eggplant in Bangladesh

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Abstract. The study was conducted at the experimental field of Olericulture Division, Bangladesh Agricultural Research Institute, Gazipur during 2018-19 to assess the extent of genetic diversity among 26 eggplant germplasm. The collected germplasm originating from local and exotic sources were subjected to cluster analysis. The inter-cluster distance in all cases was larger than the intra-cluster distance. Maximum inter-cluster distance (17.73) was observed between germplasm of cluster IV and V followed by cluster II and IV (16.39) and minimum was found between germplasm of cluster II and V (4.41). The highest intra cluster value (3.40) was observed in cluster I. Cluster III was responsible for second highest values viz., number of marketable fruit (23.40), average fruit weight (187.00 g), fruit length (18.60 cm), fruit diameter (6.22 cm), fruit yield (56.84 t/ha), while cluster IV was exhibited highest mean value for average fruit weight (228.33g), fruit diameter (7.40 cm), fruit yield (4.64 kg/plant), fruit yield (60.36 t/ha). Considering the group distance and inter-genotypic crosses between the members of cluster II and IV and cluster IV and V would exhibit high heterosis and is also likely to produce new recombinants with desired traits. But in case of the cluster means values and yield contributing performance cluster III and cluster IV performed well. Therefore, inbreds belong to cluster III, cluster IV and cluster V will be given higher priority for crossing in future eggplant hybridization programme.

Keyword: genetic diversity, eggplant, germplasm, cluster analysis, Bangladesh

1 Introduction

Eggplant is the most important vegetable crop in respect of total acreage (50415 ha) and production (504817 ton) in Bangladesh with an average yield of 10.00 tons per hectare (Anon, 2017), which is very low as compared to that other producing countries. It is available in the country round the year. Improved eggplant varieties have generally higher yield potential than traditional local varieties when grown with sufficient inputs. Although traditional varieties have low yield but locally adapted and suited with better consumption quality.

To carry out any successful breeding programme, it is necessary to select suitable parental lines from available indigenous germplasms. The study of genetic divergence is a popular method in parent selection for researchers involved in breeding programs of several crops, leading to reduce the number of crosses (Guerra *et al.* 1999). The progenies derived from diverse parents are expected to show a broad spectrum of genetic variability and provide better scope to isolate superior recombinants. Therefore, genetically diverse genotypes should be used in a hybridization program to get superior recombinants. The multivariate analysis is the most widely used statistical tools to quantify the genetic divergence. Among the various methods developed to study the genetic divergence in the genotypes/accessions, the Mahalanobis D^2 (Mahalanobis, 1936) is the most reliable and widely used statistical tools to quantify the degree of genetic divergence by assessing the relative contribution of different characters to the total divergence. It is a very useful technique and has been used by several workers in case of self-pollinated or cross pollinated crops (Bashar *et al.,* 2016; Hasan *et al.*, 2015; Huque *et al.*, 2012; Natarajan *et al.*, 1988; Shidhu *et al.,* 1989). Relative contribution of different traits to the total divergence helps to select a particular trait or a combination of traits for intercrossing which avoids wastage to time and labor. Principal component analysis (PCA) is also a powerful technique which allows the visualization of natural grouping of the genotypes and is precise indicator of differences among genotypes (Huque *et al.*, 2012). More stable genotypes are believed to generate superior recombinants through crossing as there is less environmental influence on them. The degree of genetic divergence can be quantified using

Mohalanobis's D^2 statistic of multivariate analysis which is recognized as a powerful tool for assessing the relative contribution of different characters to the total divergence in self-pollinated crops. (Golakia and Makne 1992; Natarajan et al. 1988; Das and Gupta 1984; Shidhu et al. 1989). Therefore, the present study was undertaken to assess the genetic diversity in 13 genotypes of chilli to identify suitable genotypes. The present study was, therefore, undertaken to assess the extent of genetic diversity in 26 eggplant germplasm which will help to select prospective parents to develop transgressive segregate.

2 Materials and Methods

2.1 Experimental Site

The experiment was conducted at the Olericulture Division of Horticulture Research Centre, Bangladesh Agricultural Research Institute (BARI) during 2018-19 with 26 germplasm of eggplant. The seeds of these germplasm were sown on the seedbed on 05 September, 2018.

2.2 Plant Materials

Thirty days old seedlings were transplanted in the main field on 04 October, 2018.

2.3 Experimental Design and Layout

The experiment was laid out in a RCB design without replication. The unit plot size was 7.0 ×0.7 m and 10 plants were accommodated in a plot with a plant spacing of 70 cm apart in single row maintaining a row to row distance of 70 cm with 30cm drain.

2.4 Land Fertilization and Intercultural Operation

The land was fertilized with organic fertilizer –N-P-K-S-Zn-B @ 3,000-170-50-125-18-4.3-1.70 kg/ha, respectively. One third of the organic fertilizer and half of P and full of S, Zn and B were applied during final land preparation. Rest of organic fertilizer and P and 1/3 of K were applied as basal in pit. One fifth of urea and K were applied after 20 days of transplanting. After that, rest of urea and K were applied in equal four installments at 20 days interval. The intercultural operations (weeding, irrigation, insecticide spray etc.) were done as and when necessary.

2.5 Data Recorded

Data on days to 1st harvest, number of marketable fruit, average fruit weight (g), fruit length (cm), fruit diameter (cm), fruit yield (kg/plant), plant height at last harvest (cm), plant height at 1st harvest (cm), FSB infested fruit (%), Bacterial wilt infestation (%), little leaf infestation (%), fruit yield (t/ha) were recorded from five randomly selected plants per germplasm. Plot means for 10 quantitative characters were used for the statistical analysis.

2.6 Statistical Analysis

Genetic diversity was studied following Mahalanobis's (1936) generalized distance (D^2) extended by Rao (1952). Based on the D^2 values, the germplasm was grouped into clusters following the method suggested by Tocher (Rao, 1952). Genetic diversity was studied following Mahalanobis's (1936) generalized distance (D^2) extended by Rao (1952). Statistical analyses were carried out using Genstat 5 software.

3 Results and Discussion

The analysis of variance showed significant differences between the germplasm for all the characters studied indicated the presence of sufficient variability in the germplasm. Based on the degree of

divergence 26 germplasm were grouped into five clusters (Table 1). The distribution pattern revealed that maximum number of germplasm (7) was included in cluster II, while cluster IV included the minimum (3) germplasm. Hasan *et al.* (2015) got the maximum numbers of genotypes were accommodated in cluster I containing 5 genotypes, followed by cluster II and cluster III containing 4 and 2 genotypes, respectively. Cluster IV and V each contained single genotype. Similar result was found by Indra *et al.* (2000), Sreelathakumary and Rajmony (2004), Farhad *et al.* (2010), Datta and Jana (2011), Datta and Das (2013) and Yatung *et al.* (2014).

Table 1. Distribution of 26 germplasm of eggplant in different clusters

Clusters	Germplasm no./ cluster	Germplasm	Fruit colour	Fruit shape
I	5	SM361	Deep purple	Oblong
		SM371	Blackish purple	Round
		SM378	Deep purple	Elongate
		SM388	Light green with white spot	Oval
		SM393	Light green with white spot	Oval
II	7	SM363	Deep purple	Cylindrical
		SM365	Purple	Elongate
		SM373	Deep purple	Cylindrical
		SM381	Purple	Elongate
		SM382	Deep purple	Cylindrical
		SM383	Deep purple	Cylindrical
		SM387	Light green with white spot	Oval
III	5	SM358	Light purple	Oblong
		SM359	Purple	Elongate
		SM366	Deep purple	Oval
		SM369	Light green	Oval
		SM385	Light green	Oval
IV	3	SM362	Deep purple	Oval
		SM364	Purple	Round
		SM367	Deep purple	Oval
V	6	SM370	Purple	Oval
		SM375	Purple	Elongate
		SM376	Purple	Elongate
		SM377	Purple	Elongate
		SM380	Purple	Oblong
		SM386	Light green	Elongate

The inter cluster distances in all of the cases were larger than the intra cluster distances indicating wider diversity among the germplasm of the distant group (Table 2). The intra cluster distance was maximum in cluster I (3.40) and minimum in cluster V (2.13) indicating the germplasm in cluster I were more heterogeneous and those in cluster V were closely related. The range of the intra cluster distance values indicated homogeneous nature of the germplasm within the clusters. Regarding inter cluster distance, cluster IV showed maximum genetic distance with cluster V (17.73) followed by the genetic distance from cluster II and IV (16.39) and cluster III and cluster V (11.98) suggesting wide diversity between them and the minimum distance was found between the germplasm of cluster II and V (4.41). Moderate inter cluster distance was also found between cluster I with IV (10.54) and cluster II with III (10.03). The difference between the highest inter genotypic distance indicated the existence of variability among the 25 genotypes of bottle gourd. Sukhija *et al.* (1982) while analyzing 46 lines of water melon found that the D^2 values ranged from 3.84 to 308.43 showing high divergence among different lines. Hasan *et al.* (2015) obtained a range 4.87 to 19.989 D^2 values in Chili. The result was supported by scatter diagram (Fig 1).

Table 2. Mean intra (bold) and inter cluster distances (D2) for the 26 eggplant germplasm obtained on the basis of the 12 morphological characters

Clusters	I	II	III	IV	V
I	**3.40**	6.70	4.84	10.54	8.65
II		**2.57**	10.03	16.39	4.41
III			**2.20**	7.20	11.98
IV				**2.90**	17.73
V					**2.13**

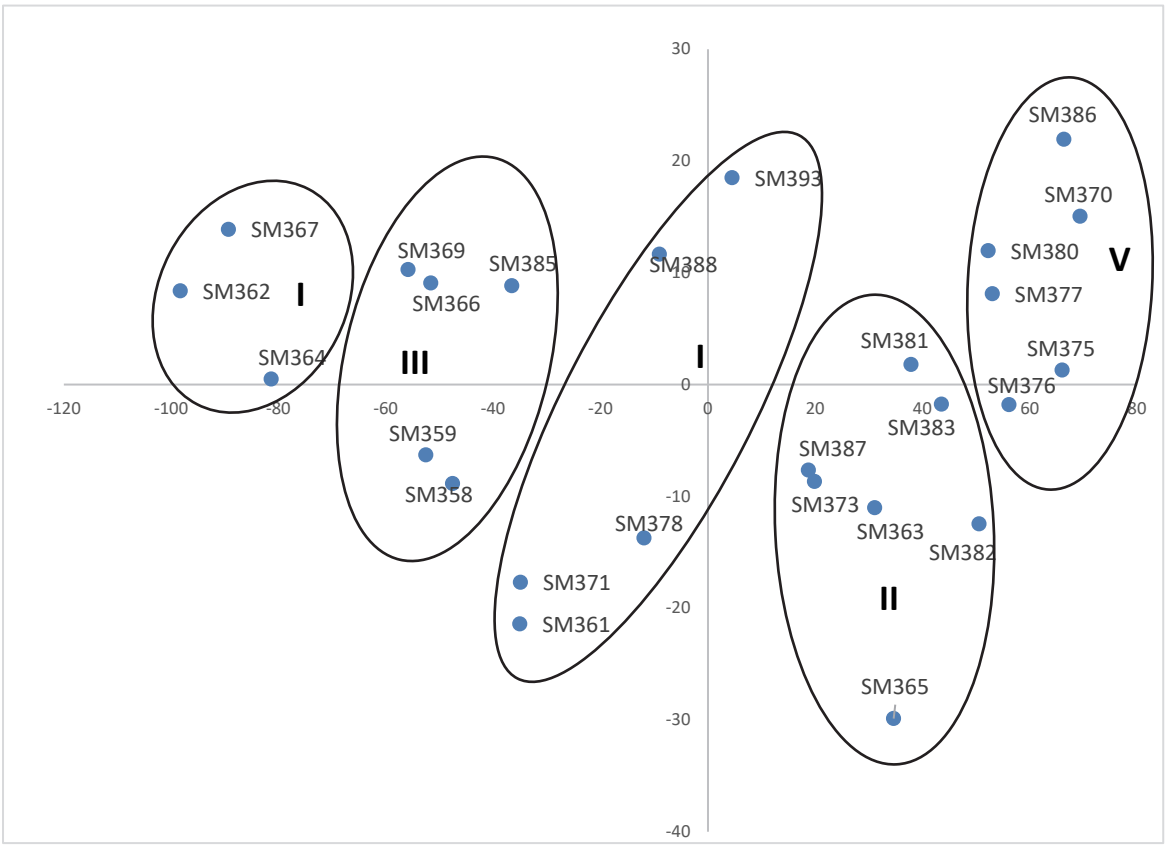

Figure 1. Distribution of 26 eggplant germplasm in a two-dimensional scatter diagram based on PCA scores superimposed with clusters.

Differences in cluster means existed for all the characters. Cluster I recorded the highest mean for plant height at 1st harvest (62.20 cm), plant height at last harvest (92.60 cm) and lowest mean for bacterial wilt infestation (4.00 %). Cluster II was constituted of seven germplasm and exhibited highest mean value for number of marketable fruit (27.86), fruit length (24.14 cm) and lowest mean values for days to 1st harvest (101.00 days), while second highest mean value for plant height at 1st harvest (61.43 cm), plant height at last harvest (87.71 cm). Cluster III had five germplasm and was responsible for moderate type of quality (second highest values) viz., number of marketable fruit (23.40), average fruit weight (187.00 g), fruit length (18.60 cm), fruit diameter (6.22 cm), fruit yield (4.37 kg/plant), fruit yield (56.84 t/ha), while second lowest vales for days to 1st harvest (101.33 days), FSB infested fruit (11.40 %), bacterial wilt infestation (6.00 %), little leaf (4.00 %). Cluster IV was constituted of three germplasm and exhibited highest mean value for average fruit weight (228.33g), fruit diameter (7.40 cm), fruit yield (4.64 kg/plant), fruit yield (60.36 t/ha), while cluster V was constituted of six germplasm and exhibited lowest mean value for FSB infested fruit (10.67 %), little leaf (1.67 %). Jagadev *et al.* (1991) reported that the characters contributing maximum to the divergence should be given greater emphasis

for deciding the type of cluster for the purpose of further selection and the choice of parents for hybridization.

Table 3. Cluster means for twelve characters in 26 eggplant germplasm

Characters	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V
Days to 1st harvest	102.60	101.00	101.33	104.00	101.66
Number of marketable fruit	22.00	27.86	23.40	20.33	17.00
Average fruit weight (g)	156.8	106.29	187.00	228.33	84.50
Fruit length (cm)	14.40	24.14	18.60	12.33	17.50
Fruit diameter (cm)	5.56	3.96	6.22	7.40	4.52
Fruit yield (kg/plant)	3.47	2.95	4.37	4.64	1.44
Plant height at 1st harvest (cm)	62.20	61.43	60.00	58.67	61.00
Plant height at last harvest (cm)	92.60	87.71	84.80	84.33	83.33
FSB infested fruit (%)	13.00	11.57	11.40	12.67	10.67
Bacterial wilt infestation (%)	4.00	8.57	6.00	10.00	15.00
Little leaf (%)	12.00	11.43	4.00	10.00	1.67
Fruit yield (t/ha)	45.07	38.33	56.84	60.36	18.78

Based on principal component axes I and II, a two -dimensional scattered plotting diagram (Z_1 and Z_2) reflecting the position of germplasm are presented in Fig. 1. It was revealed that from the diagram there were mainly five clusters. Most distantly located germplasm was within cluster IV [SM362, SM364, SM367] and cluster V [SM370, SM375, SM376, SM377, SM380, SM386] as well as cluster II [SM363, SM365, SM373, SM381, SM382, SM383, SM387] and cluster IV [SM362, SM364, SM367]. Distribution pattern of germplasm in the scattered diagram also revealed that considerable variability exists in the germplasm studied.

Contributions of the characters towards divergence are presented in Table 4. The canonical analysis revealed that, values in both vectors (Vector I and II) for fruit length (0.108 and 0.424) and bacterial wilt infestation (0.166 and 0.285) were positive. Such results indicated that this character contributed maximum towards divergence of the germplasm. It is interesting to note that the greater divergence among the materials in the present study due to fruit length and bacterial wilt infestation will offer a good scope for improvement of yield through rational selection of parents for producing heterotic eggplant hybrids. The major contribution of these characters to divergence was well confirmed by their cluster mean; where the ranges varied indicating the major role of these characters as differentiate at inter cluster level. The cluster means for fruit length were 12.33 for Cluster IV and 24.14 for Cluster II and for bacterial wilt infestation were 4.00 for Cluster I and 15.00 for Cluster V showed significant difference.

Table 4. Latent vectors for twelve quantitative characters of 26 germplasm of eggplant

Characteristics	Vector (Z_1)	Vector (Z_2)
Days to 1st harvest	-0.221	0.054
Number of marketable fruit	-0.184	-0.248
Average fruit weight (g)	-0.468	0.129
Fruit length (cm)	0.108	0.424
Fruit diameter (cm)	-0.337	0.255
Fruit yield (kg/plant)	-0.491	-0.029
Plant height at 1st harvest (cm)	0.027	-0.353
Plant height at last harvest (cm)	-0.145	-0.465
FSB infested fruit (%)	-0.109	0.332
Bacterial wilt infestation (%)	0.166	0.285
Little leaf (%)	-0.165	-0.371
Fruit yield (t/ha)	-0.491	-0.029

4 Conclusion

Considering the group distance and inter-genotypic crosses between the members of cluster II and IV and cluster IV and V would exhibit high heterosis and was also likely to produce new recombinants with desired traits. But in case of the cluster means values and yield contributing performance cluster III and cluster IV performed well. Therefore, inbreds belong to cluster III, cluster IV and cluster V will be given higher priority for crossing in future eggplant hybridization programme.

Conflicts of Interest. The authors declare no conflicts of interest regarding the publication of this paper.

References

1. Anonymous. 2017. Year Book of Agricultural Statistics of Bangladesh 2016. Bangladesh Bureau of Statistics, Ministry of Planning, Government of Peoples Republic of Bangladesh, Dhaka, Bangladesh. pp 249-290.
2. Bashar A., Hossain M.K., Hasan R., Islam S., Huque AKMM., and Alam N., 2016, Breeding potential of common eggplant (*Solanum melongena* L.) using divergence analysis, Bangladesh Journal of Botany, 45(1): 109-115
3. Das P.K., and Gupta T.D., 1984, Multivariate analysis in blackgram, Indian Journal of Genetics, 44(2): 243-247.
4. Datta S., and Das L., 2013, Characterization and genetic variability analysis in *Capsicum annuum* L. germplasm, SAARC Journal of Agriculture, 11(1): 91-103
5. Datta S., and Jana J.C., 2011, Studies on genetic divergence in chilli (*Capsicum* spp.) under sub Himalayan tracts of West Bengal, Journal of Crop and Weed, 7(1):44-48
6. Farhad M.I., Hasanuzzaman M., Biswas B.K., Arifuzzaman M., and Islam M.M., 2010, Genetic divergence in chilli (*Capsicum annuum* L.), Bangladesh Research Publications Journal, 3(3): 1998-2003
7. Golakia P.R., and Makne V.G., 1992, D^2 analysis in Varginia runner ground nut genotypes, Indian Journal of Genetics, 55(3): 253-253.
8. Guerra E.P., Destro D., Miranda L.A., and Montalván R., 1999, Parent selection for intercrossing in food type soybean through multivariate genetic divergence, Acta Scientiarum Agronomy, 21(3): 429-437
9. Hasan R., Huque A.K.M.M., Hossain M.K., and Alam N., 2015, Assessment of genetic divergence in Chilli (*Capsicum annuum* L.) genotypes, Plant Gene and Trait, 2015, Vol. 6, No. 3 doi: 10.5376/pgt.2015.06.0003
10. Indra P., Peter K.V., and Unnithan V.K.G., 2000, Divergence in chilli, Spice India, 13 (4):15-20
11. Jagadev, P N, K.M. Shamal and L. Lenka. 1991. Genetic divergence in rape mustard. Indian J. Genet. Pl. Breed. 51:465-466.
12. Mahalanobis P.C., 1936, On the generalized distance in statistics, Proceedings of the National Institute of Sciences of India, 2: 49-55
13. Natarajan C., Thiyagarajan K., and Rathanaswary R., 1988, Association and genetic diversity studies in greengram, The Madras Agricultural Journal,75(8): 238-245.
14. Rao, C.R. 1952. Advanced statistical methods in biometrical research. John Wiley and Sons. New York, pp 1-120.
15. Shidhu J.S., Ahmed S., Sing M.P., and Sing P.K., 1989, Multivariate analysis in blackgram (*Vigna mungo* L.), Legume Research, 12(1): 35-37.
16. Sreelathakumary I., and Rajmony L., 2004, Genetic divergence in chilli (*Capsicum annuum* L.), Indian Journal of Horticulture, 61(2): 137-139
17. Yatung T., Dubey R.K., Singh V., and Upadhyay G., 2014, Genetic diversity of chilli (*Capsicum annuum* L.) genotypes of India based on morpho-chemical traits, Australian Journal of Crop Science, 8(1):97-102.

