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STUDIES ON GENETIC DIVERSITY FOR FRUIT YIELD AND COMPONENT TRAITS IN BHENDI [*ABELMOSCHUS ESCULENTUS* (L.) MOENCH]

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Abstract

An investigation entitled "Studies on genetic diversity of fruit yield and its component traits in Bhendi [*Abelmoschus esculentus* (L.) Moench]" was carried out in the Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University during 2013 – 2015. Thirty five genotypes were evaluated with the objective of selecting superior genotypes for fruit yield traits. The degree of divergence among 35 genotypes was computed using Mahalanobis D^2 analysis. These genotypes were used to assess the variability, heritability, genetic advance, and genetic diversity. For this programme, morphological characters *viz*., days to first flowering, number of nodes per plant, number of fruits per plant, fruit length, fruit girth, fruit weight, plant height, and fruit yield were studied. Analysis of variance for 35 genotypes of bhendi revealed that all the genotypes were significantly differed among themselves for all the ten traits studied. The mean fruit yield per plant was the highest (more than 300 g per plant) with the genotypes *viz.,* G12 (Pusa A_4), G20 (Parbhani Kranti), G31 (Punjab Padmini), G9 (Varsha Uphar), G11 (PB 7), G33 (Harbhajan), G26 (PB 266) and G8 (Hissar Unnat). These genotypes also recorded the maximum (more than 20 fruits per plant) number of fruits per plant. High PCV and GCV were observed for the traits fruit yield per plant, plant height and number of fruits per plant. The traits *viz.,* fruit weight, fruit length and girth showed the moderate PCV and GCV. Heritability was high for most of the traits except number of nodes to first fruit and number of branches per plant. Genetic advance as per cent of mean was also high for most of the traits except number of branches per plant. Thirty five genotypes were grouped into ten clusters. Clusters I, III, IV, VI, VII and IX had two genotypes each. The clusters II, V and VIII comprised 12, six and four genotypes, respectively. The cluster X had only one genotype. The intra-cluster distance varied from 0.00 to 29.26. Intra-cluster distance was the minimum between cluster IV and IX and the maximum between cluster VII and X. The traits namely, fruit yield per plant, plant height and fruit length contributed maximum to the genetic diversity and were the major forces of discrimination among the genotypes tested.

Key words : Okra, genetic diversity, mahalanobis' D^2 statistic, cluster.

Introduction

Bhendi [*Abelmoschus esculentus* (L.) Moench] is important member of family malvaceae and commonly known as okra or lady's finger in India. It is one of the most ancient and traditional vegetable crops grown in tropical and subtropical regions of the world. Being native of tropical Africa, it is a prized vegetable of India. The young, immature, non-fibrous, edible and tender delicious fruits of bhendi used as vegetables in salads, soups and sauces, are also good sources of iodine, calcium, iron and vitamin A, B and C. It has been reported that bhendi has an average nutritive value (ANV) of 3.21, which is higher than tomato, egg plant and most of the cucurbits except bitter gourd. The per capita availability of vegetables is only 180 g against minimum requirement of 300 g for adults for a balanced diet. Within this view, we must increase the vegetable production in India to meet the requirements of our growing population (Dwivedi *et al.,* 2003). So it is necessary to increase the production and productivity to meet the self sufficiency of our daily requirements. A further increase in bhendi productivity needs intensive research in genetics and crop breeding. Greater genetic diversity in the germplasm enhances the breeding potential and scope for crop improvement. The

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per se performance of the parents always give a correct indication of their breeding potentialities. Crosses between genetically diverse parents are likely to produce high heterotic effects and also produce a wide spectrum of variability in segregating generations. In the present investigation, Mahalonobis D^2 statistics analysis was adopted to find out the genetic divergence and genetic variability for fruit yield and their component characters among bhendi germplasm.

Materials and Methods

Thirty five selfed, well-filled, plumpy and sound seeds of bhendi genotypes were obtained from the IIHR, Bangalore namely OKH 666(G1), NOH 303(G2), Akra Anamika (Selection 10) (G3), S 51(G4), Lakshmi(G5), Ankur 40(G6), DOV 1(G7), Hisar Unnat (HRB 55) (G8) Varsha Uphar (HRB 9-2) (G9), Arya 351(G10), PB 7(G11), Pusa A_4(G12), Indol -03-01(G13), Akra Abhay (Selection 4) (G14), DOV 2(G15), MBORH 93(G16), AOL-03-01(G17), OKH 333(G18), Kamini(G19), Parbhani Kranti(G20), Bakra(G21), DSU 1(G22), P 7(G23), MBORH 311(G24), DSN 1(G25), PB 266(G26), Pusa Sawani(G27), Pusa Makhmali(G28), CO 1 (G29), MDU 1(G30), Punjab Padmini (Ludhiana selection – 1) (G31), Gujarat Bhindi 1(G32), Harbhajan (Selection – 6 or Perkins Long Green) (G33), Selection 2(G34), and EMS 8 (P8) (G35). During January 2014, the seeds of all 35 genotypes were sown in ridges separately with a spacing of 45 ´ 30 cm. Experiment was laid in Randomized Block Design, replicated thrice. Twenty plants per genotype were maintained in each replication. Recommended agronomic practices and need based plant protection measures were given. Data on five randomly selected plants from each genotype from each replication were collected for fruit yield and its component traits. The mean of replications was used for D^2 statistical analysis.

Results and Discussion

Mean performance

The analysis of variance revealed that all 35 genotypes significantly differed among themselves for all the ten traits studied (table 1). This indicated the presence of high genetic variability in the reference population. Therefore, further analyses were appropriate. Twelve genotypes *viz.,* G12, G20, G31, G9, G11, G33, G26, G8, G35, G29, G3 and G32 recorded higher fruit yield per plant than the population general mean of 257.12 g. Among these 12 genotypes, G12 recorded the maximum fruit yield coupled with least number of nodes to first fruiting, more number of fruit, high fruit weight,

Table 1 : Analysis of variance of 35 bhendi genotypes.

Source	df	Mean sum of square (MSS)									
		Days to first flowering	Number of nodes to first fruit	Days to first fruit harvest	Number of branches per plant	Number of fruits per plant	Fruit weight	Fruit length	Fruit girth	Plant height	Fruit yield per plant
Replication	2	19.55	6.07	0.54	2.50	16.49	0.86	0.03	0.09	3.68	5321.60
Genotype	34	39.95**	2.72**	39.44**	0.89*	47.92**	13.57**	19.01**	1.38**	1785.68**	15182.27**
Error	68	1.95	1.58	0.66	0.61	1.30	0.09	0.02	0.02	7.30	238.99

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

Table 2 : Genetic variability for ten traits of 35 bhendi genotypes.

Variability parameters / Traits	GCV (%)	PCV (%)	ECV (%)	h^2 (BS) (%)	GA as % of mean
Days to first flowering	8.03	8.62	3.15	87.00	15.39
Number of nodes to first fruit	16.76	38.14	34.26	19.30	15.17
Days to first fruit harvest	6.80	6.97	1.53	95.18	13.67
Number of branches per plant	11.28	30.94	28.81	13.29	8.47
Number of fruits per plant	20.99	21.85	6.07	92.29	41.53
Fruit weight	15.52	15.67	2.18	98.07	31.66
Fruit length	18.59	18.62	1.11	98.00	38.23
Fruit girth	12.05	12.31	2.55	96.00	24.28
Plant height	22.86	23.00	2.54	99.02	46.81
Fruit yield per plant	27.45	28.10	6.01	95.42	55.24

Table 3 : Composition of D^2 clusters for 35 bhendi genotypes.

Cluster No.	Number of genotypes	Genotypes
I	2	G29 (CO 1), G32 (Gujarat Bhindi 1)
II	12	G1 (OKH 666), G2 (NOH 303), G3 (Arka Anamika), G4 (S 51), G5 (Lakshmi), G6 (Ankur 40), G7 (DOV 1), G8 (Hissar Unnat), G9 (Varsha Uphar), G10 (Arya 351), G19 (Kamini), G33 (Harbhajan).
III	2	G11 (PB 7), G20 (Parbhani Kranti).
IV	2	G24 (MBORH 311), G25 (DSN 1).
V	6	G12 (Pusa A_4), G13 (Indol-03-01), G14 (Arka Abhay), G15 (DOV 2), G28 (Pusa Makhmali) ,G34 (Selection 2).
VI	2	G22 (DSU 1), G30 (MDU 1).
VII	2	G23 (P 7), G26 (PB 266).
VIII	4	G24 (MBORH 93), G17 (AOL-03-01), G18 (OKH 333), G21 (Bakra).
IX	2	G27 (Pusa Sawani), G35 (EMS 8).
X	1	G31 (Punjab Padmini)

moderate fruit girth coupled with less number of days to first flowering and first fruit harvest. The genotype *viz.,* G20 which recorded the high fruit yield per plant also registered less number of days to first flowering, days to first fruit harvest, more number of fruits per plant, fruit weight, fruit length and moderate fruit girth. The genotype *viz*., G31 which showed high fruit yield per plant also recorded maximum number of branches, fruit length, more fruit weight, moderate number of fruits and fruit girth. The genotype *viz.,* G9 which recorded the high fruit yield per plant registered maximum number of fruits per plant, fruit length, moderate number of days to first flowering, number of nodes to first fruit, fruit girth and plant height. The genotype *viz*., G11 which registered high fruit yield exhibited the less number of days to first flowering, number of nodes to first fruit, number of days to first fruit harvest coupled with high number of fruits, maximum fruit girth, moderate fruit weight and fruit length. The genotype *viz*., G33 which showed the high fruit yield exhibited the significant mean value for the traits days to first flowering, days to first fruit harvest, number of fruits per plant and fruit length. The genotype *viz*., G26 which showed the significant mean fruit yield per plant also registered favorable mean performance for the traits fruit length and plant height. The genotypes *viz*., G3 and G8 which showed the significant mean fruit yield recorded favorable mean performance for the traits number of nodes to first fruit, fruit weight, fruit length, fruit girth and plant height. Similarly, genotype *viz.,* G35 which recorded significant mean fruit yield expressed the favorable mean performance for the traits days to first flowering, number of nodes to first fruit, days to first fruit harvest, fruit weight and plant height. The genotype *viz.,* G29 expressed the significant mean performance for the traits number of nodes to first fruit, fruit weight, fruit girth and fruit yield per plant. The genotype *viz.,* G32 which recorded the significant mean fruit yield per plant, registered significant mean performance for the traits fruit weight and fruit length. It may be inferred that high yielding genotypes had high mean for fruit weight, number of fruits per plant, fruit length, fruit girth and low mean for number of nodes to first fruit. It may indicate that early maturing but high yielding genotypes could well be achieved in bhendi.

Variability studies

Estimates of variance components obtained for the ten traits in the present study have shown that the phenotypic co-efficient of variation was found to be higher

than the corresponding genotypic co-efficient of variation for all the traits studied (table 2). The highest PCV and GCV (> 20 per cent) were observed for number of fruit per plant, plant height at maturity and fruit yield per plant, which indicated the possibilities of utilization of the variation for further improvement (Vishalkumar *et al*., 2006). The traits number of nodes to first fruit, number of branches per plant, fruit weight, fruit length and fruit girth exhibit moderate PCV and GCV, whereas the traits days to first flowering and days to first fruit harvest exhibited low PCV and GCV with high heritability and moderate genetic advance as per cent of mean indicating the preponderance of non-additive gene action in controlling the expression of these traits. The estimates of heritability and genetic advance as per cent of mean were very high for the remaining traits studied. This indicated the predominance of additive gene effects in these traits and highly heritable suggesting the possibility of improvement through simple selection (Burton, 1952). A character can be improved only if it is highly heritable. The magnitude of heritability indicates the effectiveness with which the selection of genotypes can be made based on phenotypic performance (Johnson *et al*., 1955). Similar observations were also made by Jaiprakashnarayan *et al*. (2006) and Nasit *et al*. (2010).

Divergence analysis

In the present study, the 35 genotypes were grouped into ten different clusters, based on relative magnitude of D^2 values. Cluster II is the largest comprising of 12 genotypes, followed by cluster V with six genotypes and cluster VIII with four genotypes. The clusters namely II, III, IV, VI, VII and IX had two genotypes each and cluster X was monogenotypic cluster (table 3). The clustering pattern in the present study revealed that the genotypes from different sources clustered together showing that there was no association between ecogeographical distribution of genotypes and genetic divergence. Similar findings were also reported by many workers (Hazra *et al*., 2002; Dhaduk *et al*., 2004; Dhankhar *et al*., 2008; Jag Paul Sharma *et al*., 2008). This indicated that selections have been towards the same goal in the different centres of origin of these genotypes and yet, there is sufficient genetic variability that distinctly differentiates them into ten clusters. Hence, the chosen genotypes used in the present study could be considered as a valid material.

The intra-cluster distance varied from 0.00 to 29.96 (table 4). Inter-cluster distance was minimum between cluster IV and IX suggesting closer relationship. Maximum inter-cluster distance existed between cluster VII and X followed by between cluster IV and X,

Table 4 : Intra-cluster and Inter-cluster distances (D^2 values) of bhendi genotypes.

Clusters	I	II	III	IV	V	VI	VII	VIII	IX	X
I	25.67 (5.07)	885.36 (29.96)	499.39 (22.35)	1775.67 (42.14)	1082.62 (32.90)	970.77 (31.16)	2852.52 (53.41)	801.81 (28.32)	1193.34 (35.55)	959.44 (30.98)
II		779.64 (27.92)	1797.60 (42.40)	1081.18 (32.88)	785.43 (28.03)	637.53 (25.25)	1523.58 (39.43)	1232.76 (35.11)	769.61 (27.14)	2697.35 (51.94)
III			79.52 (8.92)	3715.55 (60.96)	2242.07 (47.35)	2122.02 (46.07)	4790.34 (69.21)	1005.30 (31.72)	2700.60 (51.97)	298.63 (17.28)
IV				80.93 (9.00)	798.57 (28.26)	570.65 (23.89)	352.44 (18.77)	2731.91 (52.26)	285.46 (16.90)	5108.76 (71.48)
V					897.42 (29.96)	598.26 (24.46)	1201.82 (34.67)	1611.01 (40.14)	615.82 (24.82)	3276.59 (57.24)
VI						174.86 (13.22)	1005.55 (31.71)	1337.95 (36.58)	516.41 (22.73)	3402.49 (58.33)
VII							222.05 (14.90)	3559.43 (59.66)	643.61 (25.36)	6455.54 (80.35)
VIII								700.22 (26.46)	2051.01 (45.29)	1489.64 (38.60)
IX									529.74 (23.02)	3848.67 (62.04)
X										0.00

Table 5 : Cluster mean performance of bhendi genotypes for various characters.

Traits / Clusters	Days to first flowering	Number of nodes to first fruit	Days to first fruit harvest	Number of branches/ plant	Number of fruits per plant	Fruit weight (g)	Fruit length (cm)	Fruit girth (cm)	Plant height (cm)	Fruit yield per plant (g)
I	44.28	3.27	53.30	2.70	18.78	15.48	16.08	5.83	107.36	291.12
II	45.12	3.69	53.34	2.62	18.91	13.54	13.16	5.56	110.12	254.95
III	38.52	2.93	47.17	2.60	25.00	15.33	17.43	6.38	136.04	383.53
IV	45.38	4.12	54.70	2.27	13.47	14.62	11.27	5.10	69.25	196.88
V	46.22	3.08	54.10	2.37	18.61	13.79	12.71	5.59	100.06	260.73
VI	38.87	3.90	48.10	3.08	14.63	11.65	13.08	5.32	85.89	170.40
VII	42.35	3.92	52.37	3.27	18.30	14.23	9.20	4.88	83.37	261.92
VIII	44.11	4.26	52.95	3.13	20.50	10.66	15.72	5.80	126.08	216.25
IX	47.27	4.12	54.53	2.47	17.35	15.09	12.02	5.33	88.33	262.05
X	43.40	4.27	53.60	3.77	21.80	17.38	18.40	6.17	160.97	378.67

Table 6 : Percentage contribution of each character towards genetic divergence of bhendi genotypes.

S. no.	Characters	Contribution (%)
1.	Days to first flowering	0.10
2.	Number of nodes to first fruit	0.10
3.	Days to first fruit harvest	2.52
4.	Number of branches per plant	0.10
5.	Number of fruits per plant	0.50
6.	Fruit weight	3.87
7.	Fruit length	25.88
8.	Fruit girth	5.04
9.	Plant height	28.40
10.	Fruit yield per plant	33.78

between cluster III and VII, between cluster IX and X and between cluster III and IV. There existed sufficient inter-cluster distances between all the ten clusters (table 5). This clearly indicated that the genotypes included in these clusters are having broad spectrum of genetic diversity. The superior genotypes from the ten different clusters may be used as parents in hybridization programme to get superior hybrid combination as well as desirable segregants (Hazra *et al*., 2002; Bendale *et al*., 2003; Kiran Patro *et al*., 2005; Singh and Singh, 2008; Jag Paul Sharma *et al*., 2008).

Perusal of data on cluster mean for various characters revealed wide differences in mean value under study (table 5). The cluster III had two genotypes namely, G11 (PB7), G20 (Parbhani Kranti) with early flowering, minimum number of nodes to first fruit, early days to first fruit harvest, maximum number of fruits per plant, maximum fruit girth and fruit yield per plant while they have intermediate plant height. The cluster X had only one genotype G 31 (Punjab Padmini) with maximum number of branches per plant, fruit weight, fruit length, more number of fruits, high fruit girth and fruit yield per plant. The clusters VI, IV and VIII have recorded the lowest cluster mean fruit yield per plant.

Based on the *per se* performance of different fruit yield component traits, different clusters of D^2 analysis (diversity) and cluster mean, seven genotypes were selected. They are *viz*., G9 (Varsha Uphar), G12 (Pusa A_4), G20 (Parbani Kranti), G26 (PB 266), G31 (Punjab Padmini), G32 (Gujarat Bhindi 1) and G35 (EMS 8) from the clusters II, V, III, VII, X, I and IX respectively for further evaluation. These seven genotypes may be utilized as the parents for the hybridization programme to evolve high yielding hybrids. The genotypes *viz.,* G9, G12 and G20 which recorded maximum fruit yield per plant from different clusters also exhibited significant and favourable *per se* performance for the traits, days to first flowering, days to first fruit harvest, number of fruits per plant, fruit weight and fruit length. The genotype *viz.,* G26 had significant *per se* performance with fruit weight, plant height and fruit yield per plant from the cluster VII. Similarly, the genotypes *viz*., G31 and G32 were also showed significant *per se* performance for the traits fruit weight, fruit length and fruit yield per plant from the cluster X and I, respectively. The genotype *viz*., G35 registered maximum fruit yield per plant in the cluster IX coupled with significant mean value for the traits days to first flowering, days to first fruit harvest, fruit weight and plant height.

Character's contribution

The relative contribution of individual character towards genetic diversity revealed that fruit yield per plant,

plant height, fruit length, fruit girth and fruit weight were the major forces of discrimination among the genotypes tested (table 6). Similar findings were earlier reported by Kiran Patro *et al*. (2005) and Jag Paul Sharma *et al*. (2008).

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