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STUDIES ON GENETIC DIVERGENCE FOR FRUIT YIELD AND ITS COMPONENT TRAITS IN OKRA [*ABELMOSCHUS ESCULENTUS* (L.) MOENCH.] GENOTYPES UNDER COASTAL ECO-SYSTEM

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Abstract

An investigation entitled "Studies on genetic divergence for fruit yield and its component traits in okra [*Abelmoschus esculentus* (L.) Moench] genotypes under costal ecosystem" was carried out in the Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University during 2016 – 2017. Fifteen genotypes were evaluated with the objective of selecting superior genotypes namely, Arka Anamika, Varsha Upahar, Thunder, Dhanya, Pusa-7, Basanthi, S-51, Thanvi-66, CO-2, Akshaya, N-U-Lakshmi, Namadhri, PHS, Villupuram Local, and Karur Local for fruit yield traits. The degree of divergence among 15 genotypes was computed using Mahalanobis' D^2 analysis to assess the genetic diversity. For this programme, morphological characters *viz*., days to first flowering, plant height, inter node distance, days to fruit maturity, number of immature seeds per fruit, fruit length, fruit girth, number of branches per plant, number of fruits per plant, fruit weight, and fruit yield per plant were studied. Analysis of variance for 15 genotypes of bhendi revealed that all the genotypes were significantly differed among themselves for all the eleven traits studied. The results revealed that the mean performance for fruit yield per plant was maximum in the genotype namely Basanthi (465 g), followed by Dhanya (438 g) and S-51 (433 g). The genotypes which recorded high mean performance for fruit yield per plant also exhibited significant per se performance for the traits namely inter node distance, number of fruits per plant and average fruit weight. Fifteen diverse genotypes were grouped into five clusters with the highest of five genotypes in the cluster I and II each and two genotype in the cluster III and IV each and only one genotype in the cluster V. Intra and inter cluster D2 values ranged from 15.65 to 16.97 and 21.41 to 80.58, respectively. It showed that inter-cluster distance was higher than the intra-cluster distance indicating wide genetic diversity among the genotypes studied of different groups. The relative contribution of studied characters to the genetic diversity indicated that fruit yield per plant (19.05), followed by number of immature seeds per fruit (20.95), average fruit weight (11.43), fruit length (11.43) and plant height (12.38) contributed highest towards the genetic divergence. Genotypes, which performed high mean having these characters in different cluster could be used in breeding programme to develop high yielding cultivars in okra.

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

Introduction

Okra [*Abelmoschus esculentus* (L) Moench.] is an important vegetable crop widely grown in the tropical and subtropical regions of the world (Tindall, 1983). Cultivated okra has significant variations in the chromosome numbers but most frequent observed chromosome number is 2n = 130 (Joshi and Hardas, 1956) and it belongs to the family Malvaceae. The centre of origin of okra remains unclear, but their centre of genetic diversity includes West Africa, India and Southern Asia (Hamon and Van Sloten, 1998). Okra is an annual and day neutral plant cultivated in all seasons for its delicious tender pods in one and other different parts of the country. Fresh okra fruit contains 35 calories, 89.6 g water, 6.4 g carbohydrate, 1.9 g protein, 0.2 g fat, 1.2 g fiber and minerals per 100 g of edible portion (Gopalan *et al*., 2007). Okra is said to be very useful against genito-urinary disorders, spermatorrhoea and chronic dysentery (Nadkarni, 1927). Okra is an often cross pollinated crop, heterosis is being exploited in form of development of hybrids. Hence, genetic divergence is an important tool while selecting the parents for hybrid breeding.

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Divergence analysis is more authentic and powerful tool for systematic identification of the diverse genotypes for hybridization purposes (Mahalanobis, 1936). To develop high yielding varieties, genetic diversity is an important tool to select genetically diverse parents with high yield and wider adaptability in breeding programme. Progress of any breeding programmes depends to a great extent on the availability of genetic variability for desirable traits in genotypes (Kumar *et al*., 2013, Balai *et al*., 2014). Genetic diversity helps the breeders in deciding the most appropriate breeding method to increase the genetic potentialities as well as to surpass the yield barrier (Langade *et al*., 2013). Use of genetically diverse parents in recombination breeding supposed to give maximum heterosis in F1's and also getting broad spectrum of variability for quantitative traits in segregating generations to select desirable recombinant. Therefore, genetic diversity is prerequisites for any successful breeding programme.

Materials and Methods

The experimental material comprised of 15 genotypes of okra. These genotypes were grown in randomized block design with three replications at the Plant breeding farm, Department of Genetics and Plant Breeding, Annamalai University, Annamalai Nagar. Each genotype was grown in two row of 4.5 m length with spacing of 60 × 45 cm. The recommended agronomic package of practices and plant protection measures were followed to raise a healthy crop. The observations were recorded on five randomly selected plants in each replication for each genotype on 11 characters *viz*., days to first flowering, plant height, inter node distance, days to fruit maturity, number of immature seeds per fruit, fruit length, fruit girth, number of branches per plant, number of fruits per plant, average fruit weight and fruit yield per plant were studied. The data were statistical analyzed as per Mahalanobis' D2 analysis (Mahalanobis, 1936) to measure of genetic divergence among 15 genotypes. The grouping of 15 genotypes into different clusters was done by following K.D. Tocher's methods (Rao, 1952).

Results and Discussion

The analysis of variance revealed that all 15 genotypes significantly differed among themselves for all the eleven traits studied (table 1). The results revealed that the mean performance for fruit yield per plant was maximum in the genotype namely Basanthi(465 g), followed by Dhanya(438 g) and S-51(433 g). The genotypes which recorded high mean performance for fruit yield per plant also exhibited significant *per se* performance for the traits namely inter node distance, number of fruits per plant and average fruit weight (table 2). Wilk's criteria were used to test the aggregate effects of all the characters. It showed that significant differences among the genotypes for all the characters. Genetic divergence among 15 genotypes for 11 characters was made by using Mahalanobis' D^2 analysis as per Rao (1952). Based on Mahalanobis' D^2 analysis, 15genotypes were grouped into five clusters on the basis of observed smaller D^2 values among genotypes within a cluster than those belonging to different cluster following Tocher's methods (table 3). Fifteen diverse genotypes were grouped into five clusters with the highest of five genotypes in the cluster I and II each and two genotype in the cluster III and IV each and only one genotype in the cluster V. It is indicating that Cluster V is more diverse from resting other clusters. The genotypes in these clusters are more genetically diverse and may be used as potential parents for breeding programmes to develop high yielding cultivars. It was also observed that geographical distance between the genotypes had no relation with the genetic divergence as the genotypes from same source had fallen into different clusters as well as the same cluster contained genotypes from different sources. It indicats that clustering pattern of okra genotypes did not follow their geographic distribution. These findings are in agreement to earlier reports of Bindu *et al*. (1994), Bisht *et al.* (1995), Mishra *et al*. (1996), Dhaduk *et al*. (2004), Akotkar *et al*. (2010), Reddy *et al*. (2012), Ab.Mazid *et al*. (2013) in okra.

Average intra and inter cluster D^2 values presented in Table 4, indicating nature of genetic divergence at intra and inter cluster levels, respectively. In general, inter cluster distance was much more than intra cluster distances. This suggesting that within cluster genotypes have same genetic constitution *i.e*., homogeneous are less divergent than those occurred in a different cluster. The information on the degree of genetic divergence would be helpful in selecting parents for hybridization programme.

The D^2 values of intra cluster and inter cluster ranged from 15.65 to 16.97 and 21.41 to 80.58, respectively. Maximum intra cluster distance was observed in cluster II (16.97) followed by cluster I (16.93) while inter cluster distance was maximum in between cluster I and cluster V (80.58) followed by cluster II and cluster V (61.53) and cluster I and cluster III (52.02). Higher intra and inter cluster distance indicating that high degree of genetic divergence within cluster and between clusters, respectively. Therefore, genotypes belonging to these inter clusters may be used in hybridization programme to obtain

Table 1 : ANOVA for yield and yield component characters in okra.

S. no.	Characters	df	MSS	F value
1.	Days to first flowering	14	7.39**	27.64
2.	Plant height	14	770.11**	150.97
3.	Inter node distance	14	3.25**	24.81
4.	Days to fruit maturity	14	1.50**	6.45
5.	Number of immature seeds per fruit	14	145.23**	29.84
6.	Fruit length	14	5.72**	102.62
7.	Fruit girth	14	1.45**	46.55
8.	Number of branches per plant	14	0.37**	7.68
9.	Number of fruits per plant	14	32.76**	23.75
10.	Average fruit weight	14	22.37**	53.45
11.	Fruit yield per plant	14	4341.49**	20.80

**- significant at 1 per cent level

*- significant at 5 per cent level

transgressive segregants with broad spectrum of genetic variability for yield and other component traits to isolate high yielding genotypes in okra. These results are in accordance with the finding of Vahab *et al*. (1994), Bisht *et al*. (1995), Mishra *et al*. (1996), Dhaduk *et al*. (2004), Akotkar *et al*. (2010), Reddy *et al*. (2012), Ab. Mazid *et al*. (2013). Since high yield and earliness is a prime objective in any breeding programme, cluster those having high means for fruit yield per plant, earliness and its components traits need to be considered for selection of genotypes for breeding programme. The cluster means for 11 characters (table 5) indicated that considerable variability present in characters among the five clusters. The data showed that maximum cluster mean variation was observed for fruit yield per plant (320.26 g in cluster V to 473.80 g in cluster II), average weight (17.50 g in cluster III to 23.37 g in cluster IV), number of immature seeds per fruit (43.06 in cluster IV to 58.55 in cluster II) and plant height (82.93 cm in cluster V to 125.24 cm in cluster I).

It was observed that genotypes under cluster II has highest desirable cluster mean for five characters

Table 2 : Mean Performance of fifteen genotypes.

Genotypes	Days to first flowering	Plant height (cm)	Inter node distance (cm)	Days to fruit maturity	Number of immature seeds / fruit	Fruit length (cm)	Fruit girth (cm)	Number of branches per plant	Number of fruits / plant	Average fruit weight (g)	Fruit yield per plant (g)
Arka Anamika	39.00	103.33	7.21	6.40	64.40	13.47	5.33	2.67	19.33	20.80	402.01
Varsha upahar	40.00	82.93	7.11	5.53	51.76	13.07	4.53	2.63	18.00	17.81	320.26
Thunder	38.00	101.66	5.89	5.53	51.50	10.04	4.60	2.97	21.67	17.41	377.03
Dhanya	38.60	144.17	7.16	5.00	42.47	12.17	5.13	3.03	26.67	16.45	438.56
Pusa-7	36.20	96.67	4.55	5.40	57.78	14.63	6.23	2.90	17.33	24.46	423.93
Basanthi	38.60	122.50	7.05	5.57	49.95	13.00	5.86	2.80	21.00	22.18	465.71
S-51	38.40	122.50	5.91	5.40	50.62	13.03	5.57	2.90	25.00	17.33	433.28
Thanvi-66	36.70	112.60	6.52	5.67	56.06	15.06	5.30	2.73	18.33	20.09	359.04
C0-2	41.63	130.33	6.66	6.90	48.42	11.86	4.73	3.33	20.33	23.08	381.00
Akshaya	35.40	104.63	5.69	5.07	54.03	12.60	6.20	2.43	16.66	16.80	349.53
N-U-Lakshmi	37.33	96.80	4.52	6.40	61.64	14.48	5.27	2.57	16.00	18.75	393.76
Namadhri	37.00	95.93	5.81	7.10	54.90	10.48	5.90	3.60	20.33	20.53	406.04
PHS	38.20	118.06	3.96	4.60	37.71	13.19	4.50	3.1	23.00	23.67	426.63
Villupuram Local	38.50	124.43	5.23	6.23	44.98	13.14	6.40	2.77	22.00	22.66	416.39
KarurLocal	36.60	115.17	6.34	5.57	54.23	12.28	4.26	2.17	15.00	17.60	383.20

Table 3 : Grouping of 15 genotypes of okra in different clusters.

S. no.	Cluster	Number of genotypes	Genotypes
1	I	5	Basanthi, Villupuram local, S-51, Dhanya,Thanvi-66,
2	II	5	Arka Anamika, N-U-Lakshmi, Akshaya, Namadhri, Pusa-7
3	III	2	Thunder, Karur local,
4	IV	2	C0-2,PHS
5	V	1	Varsha Upahar

Table 4 : Average intra (diagonal and bold) and inter (above diagonal) cluster distance (D^2 values) in 15 genotypes of okra.

Cluster	I	II	III	IV	V
I	**286.72(16.93)**	617.86 (24.85)	2201.25(52.02)	2705.73(52.01)	6493.93(80.58)
II		**287.92(16.97)**	458.40(21.41)	1579.25(39.74)	3785.81(61.53)
III			**268.51(16.39)**	949.64(30.82)	2445.51(49.45)
IV				**244.77(15.65)**	1257.51(35.46)
V					**0.01(0.1)**

Table 5 : Cluster mean of 15 genotypes for 11 characters in okra.

Character	Clusters with their number of genotypes				
	I	II	III	IV	V
	5	5	2	2	1
Days to first flowering	48.81	58.55	52.86	43.01	51.76
Plant height	125.24	99.47	108.42	124.2	82.93
Inter node distance	6.37	5.55	6.11	5.31	7.11
Days to fruit maturity	5.57	6.07	5.54	5.75	5.53
Number of immature seeds per fruit	48.81	58.55	52.86	43.06	51.75
Fruit length	13.28	13.12	11.16	12.52	13.07
Fruit girth	5.65	5.78	4.43	4.61	4.53
Number of branches per plant	2.84	2.83	2.56	3.23	2.63
Number of fruits per plant	22.60	17.93	18.33	21.66	18.00
Average fruit weight	19.74	20.26	17.50	23.37	17.81
Fruit yield per plant	422.59	473.80	380.11	403.61	320.26

Table 6 : Relative contribution of 11 different characters to divergence in 15 genotypes of okra.

Characters	Contribution (%)	Rank
Days to first flowering	7.61	8
Plant height	12.38	13
Inter node distance	6.67	7
Days to fruit maturity	0.01	0
Number of immature seeds per fruit	20.95	22
Fruit length	11.43	12
Fruit girth	4.76	5
Number of branches per plant	3.80	4
Number of fruits per plant	1.91	2
Average fruit weight	11.43	12
Fruit yield per plant	19.05	20

followed by cluster I for three characters, two characters in cluster IV and one character in cluster V. Cluster IV recorded highest mean for days to first flowering (58.55), days to fruit maturity (6.07), number of immature seeds per fruit (58.55), fruit girth (5.78 cm), and fruit yield per plant (473.80 g). Cluster III recorded highest desirable cluster mean for plant height (48.81 cm), fruit length (13.38 cm), and number of fruits per plant (22.60). Cluster IV and cluster V have lowest desirable cluster mean for number of branches per plant (3.23), average fruit weight (23.37) and inter node distance (7.11).

The results on relative contribution of different character presented in table 6 showed that number of fruits per plant (1.91) followed by number of branches per plant (3.80), fruit girth (4.76), days to fruit maturity (6.67) and days to first flowering (7.61) contributed maximum towards the genetic divergence. It suggested that these characters are highly genetic variable and these characters should be considered while selecting parents for hybridization programmes under studied genotypes. John *et al*. (1992), Abdul *et al*. (1994), Kumari and Chaudhury (2006), Akotkar *et al*. (2010) and Ab. Mazid *et al*. (2013) also observed contribution of plant height, fruit length and weight of fruits towards the genetic divergence. In the present study, it is concluded that genotypes for hybridization programme should be selected between cluster I and cluster II followed by cluster IV and cluster II and cluster V and cluster II and cluster III and cluster II. These clusters contain wide genetic diversity among the genotypes for different traits under studied. Therefore, selection of these divergent genotypes and use in crossing programme would give greater chances of obtaining high heterosis and high genetic variability for quantitative and other desirable traits in

segregating generations to develop high yielding cultivars in okra.

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