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Genetic divergence studies in okra (*Abelmoschus esculentus* (L.) Moench)

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Abstract

The success of crop improvement programme is mainly based on genetic diversity available in the breeding material. Genetic diversity helps in selecting the suitable parents for hybridization. Genetic diversity is a key factor for crop improvement. Therefore, the present investigation was carried out to assess the genetic diversity present in 52 okra genotypes for yield and yield contributing traits. In the present study, 52 okra genotypes were grouped in six clusters on the basis of relative magnitude of D^2 values. Cluster I contain maximum number of genotypes (24) followed by cluster II (17) and cluster III (8). The inter cluster distance was higher than the intra cluster distance indicating wide genetic diversity among the genotypes of different groups. The maximum genetic distance was observed between cluster II and VI followed by cluster I and VI, cluster IV and VI and cluster V and VI. The maximum intra cluster distance was expressed by cluster III followed by cluster I and cluster II. The genotypes which were in cluster I, III and VI exhibited significant performance for yield per plant, number of fruits per plant, fruit weight, fruit length, fruit girth, number of ridges per fruit, number of nodes per plant, plant height, number of branches per plant, internodal length, number of seeds per fruit and 100 seed weight. The relative contribution of studied characters indicated that yield per plant (54.00%) maximum contributed to total variation followed by number of ridges per fruit (15.69%), number of seeds per fruit (10.78%), 100 seed weight (4.52%) and days to 50 percent flowering (4.37%). Based on principal component analysis (PCA), these components explained 89.36% of total genetic variation. These characters are highly genetic variable and genotypes having these characters in different cluster could be used in breeding programme to develop high yielding cultivars in okra.

Keywords: Genetic diversity, okra, D^2 analysis and genetic divergence

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench) also known as Lady's finger, Bhindi etc. is belongs to family *malvaceae*. It is widely distributed and cultivated in the tropics, sub-tropics and warmer portions of the temperate region of the world. It is a vegetable rich in vitamins and mineral salt including calcium which are often lacking in diet further containing 86.1% water, 2.2% protein, 0.2% fat, 9.7% carbohydrate, 1.0% fiber and 0.8% ash. This nutritious fruit plays an important role to meet the demand of vegetables in the country. 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. Divergence analysis is more authentic and powerful tool for systematic identification of the diverse genotypes for hybridization purpose (Mahalanobis, 1936) [5]. The success of breeding programme depends to a large measure on the degree of genetic divergence. Genetic diversity is of paramount importance for heterosis. Hybridization between genetically divergent parents is expected to produce superior hybrids and desirable recombinants and more effective use of plant genetic resources is crucial for the sustainable of the food of the country. Mahalanobis D^2 statistics appears to be a fruitful approach which is based on multivariate analysis and serves to be a good index of genetic diversity.

Materials and Methods

The material for the present experimental investigation contained 52 okra genotypes received from NBPGR New Delhi including 2 checks viz., Parbhani Kranti and Pusa Sawani, were

evaluated to study the genetic diversity. The experiment was conducted at the research farm of Breeder Seed Production Unit, VNMKV, Parbhani during *kharif* 2020. The experiment was laid out in randomized block design with two replications. Rows were spaced at 60 cm, while plants were spaced at 30 cm in the rows. Recommended package of practices were followed to raise a healthy crop. The data on fourteen yield and yield contributing characters were recorded on five competitive plants of each genotype selected randomly in each replication. Data were collected on days to 50 percent flowering, number of days to first harvest, number of fruits per plant, fruit weight (g), fruit length (cm), fruit girth (cm), number of ridges per fruit, number of nodes per plant, plant height (cm), number of branches per plant, internodal length (cm), number of seeds per fruit, 100 seed weight (g) and yield per plant (g). The mean for each character over two replications was computed for each genotype and analyzed statistically. Genetic diversity between groups was estimated by using D^2 statistics given by Mahalanobis (1936)^[5] following the procedure given by Rao (1952)^[8]. The mean values were computed to calculate D^2 values between all possible pairs of genotypes. The grouping of genotypes was done using Tocher's method as described by Rao (1952)^[8].

Results and Discussion

The analysis of variance indicated significant variation among the fifty two okra genotypes for each of the fourteen characters. This suggested that large variability existed among genotypes and the analysis of genetic divergence is reasonable.

Cluster formation

As per Tocher's method the 52 genotypes were grouped into six cluster based on D^2 value such that the genotypes belonging to same cluster had an average smaller D^2 value than those belong to different cluster. Out of 6 cluster formed cluster I comprising maximum number of genotypes (24), followed by cluster II (17) and cluster III contains 8 genotypes. Cluster IV, V and VI were solitary cluster contains only one genotypes each. The formation of solitary cluster may be due to total isolation of preventing gene flow or natural / human selection for rigorous diverse adaptive complexes. These genotypes may be very unique and useful in breeding point of view.

Average intra cluster and inter cluster D^2 values

The maximum inter cluster distance was observed between cluster II and VI (1079.84) followed by cluster I and VI (805.57), cluster IV and VI (760.33), cluster V and VI (750.43), cluster I and V (533.37), cluster II and III (484.52), cluster I and II (365.51), cluster I and III (356.48), cluster III and VI (324.36), cluster III and IV (314.21) and cluster III and V (304.69). The inter cluster distance was found to be least between cluster I and IV (277.23) followed by cluster IV and V (248.58), cluster II and IV (239.35) and cluster II and V (222.92). The maximum intra cluster distance were expressed by cluster III (131.38) followed by cluster I (115.72) and cluster II (115.17). Similar findings reported by Singh *et al.* (2017)^[10], Ranpise *et al.* (2018)^[7] and Kumar *et al.* (2016)^[4].

Cluster means

Cluster mean indicated the variation for the traits among the clusters. The genotypes in cluster IV (46.00) were earliest to flowering followed by cluster II (46.56) and cluster I (47.35). The genotypes in cluster VI (52.50) followed by cluster III (51.94) and cluster V (49.50) were late in flowering. The genotypes in cluster IV (50.50), cluster II (51.32) and cluster I (52.00) required less number of days to first harvest. While

genotypes in cluster III (56.88), cluster VI (56.50) and cluster V (54.00) required maximum number of days to first harvest. The cluster V (8.00) had lowest number of fruits per plant followed by cluster VI (9.50). The highest number of fruits were recorded for cluster I (16.50), cluster IV (15.90), cluster II (11.50) and cluster III (11.30). The cluster mean value of cluster VI (32.00) was highest for fruit weight followed by cluster III (22.76). Cluster IV (12.00) recorded the lowest fruit weight followed by cluster VI (12.70), cluster II (13.57) and cluster I (17.36). The genotypes in cluster VI (9.80) had smallest fruit length followed by cluster V (10.04). While genotypes in cluster I (15.80), cluster III (14.46), cluster IV (12.55) and cluster II (11.92) had largest fruit length. The genotypes in cluster VI (3.90) had maximum fruit girth followed by cluster III (2.09). Whereas genotypes in cluster V (1.35), cluster II (1.63), cluster I (1.72) and cluster IV (1.80) recorded lowest fruit girth. The cluster mean value of cluster IV (10.00) was highest for character number of ridges per fruit followed by cluster VI (9.50), cluster III (8.63) and cluster V (8.50). While genotypes in cluster II (5.35) and cluster I (5.50) had lowest number of ridges per fruit. The cluster mean value for number of nodes per plant was highest in cluster III (17.00) followed by cluster VI (15.70) and cluster I (15.48) and minimum number of nodes per plant recorded for cluster II (13.70), cluster V (13.70) and cluster IV (14.00). The genotypes in cluster VI (158.00) were tallest followed by cluster I (157.48). Whereas genotypes in cluster IV (113.45), cluster II (122.06), cluster V (133.60) and cluster III (136.17) were dwarf. The genotypes in cluster IV (2.00) had maximum number of branches per plant followed by cluster V (1.90) and cluster VI (1.80). While minimum number of branches were recorded for cluster II (1.58), cluster I (1.68) and cluster III (1.76).

The cluster mean for internodal length was highest for cluster I (8.60) followed by cluster VI (8.17) and lowest internodal length was recorded in cluster III (6.26), cluster V (6.41), cluster II (7.15) and cluster IV (7.23). The cluster mean for number of seeds per fruit was highest in cluster VI (125.60) followed by cluster III (108.60). Genotypes in cluster IV (50.80) had minimum number of seeds per fruit followed by cluster II (58.54), cluster I (59.23) and cluster V (94.30). The genotypes in cluster VI (8.50) had highest 100 seed weight value followed by cluster III (5.69) and cluster IV (5.50). Whereas cluster V (3.50), cluster II (4.52) and cluster I (5.23) recorded lowest cluster mean for 100 seed weight.

The cluster mean for yield per plant was highest in cluster VI (295.81) followed by cluster I (276.12) and cluster III (239.01). While lowest yield per plant was observed in genotypes of cluster V (107.48) followed by cluster II (152.54) and cluster IV (187.80).

The cluster means showed high variance between the clusters for the characters days to 50 percent flowering, number of fruits per plant, fruit weight, number of ridges per fruit, number of nodes per plant, plant height, number of seeds per fruit and yield per plant. Similar findings reported by Ranpise *et al.* (2018)^[7], Balai *et al.* (2015)^[3].

Relative contribution of characters towards divergence

Among the characters studied yield per plant (54.00%) maximum contributed to total variation by 716 times ranked first followed by number of ridges per fruit (15.69%) ranked first by 208 times, number of seeds per fruit (10.78%) ranked first by 143 times, 100 seed weight (4.52%) ranked first by 60 times, days to 50 percent flowering (4.37%) ranked first by 58 times, fruit girth (3.39%) ranked first by 45 times, plant height (2.34%) ranked first by 31 times, internodal length (1.81%) ranked first

by 24 times, fruit weight (0.68%) and fruit length (0.68%) both ranked by 9 times, number of branches per plant (0.53%) ranked first by 7times, number of fruits per plant (0.9%) ranked first by 12 times, number of nodes per plant (0.3%) ranked first by 4 times while, contribution of number of days to first harvest to

genetic diversity was zero percentage. Similar results were observed by Ranpise *et al.* (2018)^[7], Ramgiriy *et al.* (2017)^[6], Bashar *et al.* (2014)^[2], Shaikh *et al.* (2013)^[9] and Akotkar *et al.* (2010)^[1].

Table 1: The mean performance of fourteen characters studied in okra.

Sr. No	Genotypes	DFP	NDFH	NFPF	FW	FL	FG	NRPF	NNPF	PH	NBPP	IL	NSPF	HSW	YPP
1	Pusa sawani	46.50	51.50	14.50	14.25	11.28	1.65	5.00	15.80	147.80	2.15	6.18	42.00	6.00	212.85
2	IC 1543	46.50	50.50	18.80	18.00	18.40	1.90	5.00	15.80	166.00	2.35	10.70	58.20	5.50	319.65
3	IC 3302	47.50	51.50	17.50	17.30	14.90	1.75	5.00	16.20	168.51	1.70	10.00	50.80	5.00	298.75
4	IC 3340-C	47.50	53.00	10.10	16.95	12.96	1.75	7.00	14.80	108.25	1.30	6.85	66.70	3.00	158.52
5	IC 3759	46.50	51.00	13.10	15.05	14.21	1.90	5.00	16.10	149.20	1.75	7.98	48.20	3.50	193.35
6	IC 3769	47.50	52.50	12.70	17.85	12.98	1.65	5.00	15.10	128.00	1.40	8.49	50.50	4.50	228.30
7	IC 3769A	47.50	52.00	17.10	18.95	16.30	1.65	5.00	15.00	166.00	1.75	9.55	59.30	6.50	315.00
8	IC 4328	46.50	51.50	12.50	12.90	12.50	1.75	5.00	13.60	117.50	1.50	7.45	52.60	7.00	155.00
9	IC 4378	45.50	50.00	12.80	12.70	15.25	1.65	5.00	12.80	137.50	1.20	9.07	50.60	5.50	157.80
10	IC 4507	47.50	52.00	17.50	18.30	15.31	1.60	5.00	18.10	162.00	1.70	9.10	56.00	4.00	316.00
11	IC 6376-B	45.00	50.00	17.50	19.50	17.15	1.75	5.00	15.80	164.30	1.50	8.75	66.60	3.00	335.45
12	IC 6485	42.50	46.50	13.90	19.00	14.94	1.65	5.00	15.00	140.50	1.50	8.38	60.00	6.50	243.37
13	IC 7452	44.50	49.50	12.80	14.85	11.90	1.85	5.00	12.50	130.00	1.30	8.99	57.40	3.50	180.40
14	IC 7472	44.50	49.50	11.00	14.02	12.55	1.60	5.00	13.90	107.50	1.90	6.03	60.40	3.00	131.20
15	IC 7473	45.50	50.00	17.90	15.80	18.90	1.70	5.00	16.85	162.30	1.50	8.50	50.20	5.50	272.20
16	IC 7856-A	45.50	50.00	9.70	12.80	11.87	1.35	5.00	14.00	156.60	1.50	7.08	54.80	3.60	132.65
17	IC 7952	43.50	48.00	9.60	11.55	11.02	1.40	5.00	10.90	112.10	1.50	5.56	47.40	1.75	112.50
18	IC 8991	43.00	48.00	13.00	16.40	14.03	1.55	5.50	14.00	143.00	1.50	9.80	57.40	6.50	200.10
19	IC 8991-A	45.50	51.00	16.00	17.50	14.79	1.70	7.50	14.20	159.90	1.50	8.76	64.30	4.50	287.93
20	IC 9327	45.50	50.50	14.15	14.85	13.03	1.70	5.00	12.85	123.45	1.20	7.09	51.40	3.50	198.40
21	IC 9856	43.00	47.50	15.35	11.65	8.84	1.75	5.00	13.60	113.25	1.30	6.89	59.40	3.00	183.20
22	IC 9856-B	47.50	51.50	12.80	12.50	10.24	1.85	8.50	12.00	107.30	1.70	7.16	74.80	4.50	156.20
23	IC 9856-C	48.50	53.50	15.25	17.75	14.88	1.60	7.00	16.30	130.50	1.70	8.00	62.40	3.00	261.10
24	IC 10252	48.50	53.00	16.00	16.35	16.38	1.60	7.50	13.70	152.50	1.75	8.75	79.95	5.50	257.50
25	IC 10256A	51.50	56.50	16.50	14.05	13.42	1.70	5.00	13.75	145.00	1.70	8.85	69.30	6.50	228.00
26	IC 11533	48.50	53.00	12.20	10.75	12.30	1.30	5.00	13.50	117.50	1.55	8.70	58.50	5.50	133.30
27	Parbhani Kranti	44.50	49.00	15.85	13.85	13.20	1.60	5.00	16.00	159.00	1.50	8.15	48.40	6.00	227.40
28	EC 305643	45.50	50.50	9.20	13.20	12.78	1.55	5.00	13.00	96.95	1.80	6.46	45.30	5.00	120.25
29	EC 305635	46.50	52.00	19.50	18.00	19.30	1.70	5.00	16.70	176.00	1.70	8.28	49.10	5.50	337.50
30	EC 305613	48.50	53.50	15.20	15.50	16.85	1.80	7.00	13.50	158.50	1.90	9.40	42.40	4.50	231.00
31	EC 305634	47.50	51.50	13.80	18.75	16.55	1.65	5.00	14.00	162.50	1.70	8.21	53.90	5.50	247.00
32	EC 305652	45.50	49.50	17.50	18.95	16.48	1.75	5.00	15.20	172.25	1.70	9.23	55.20	3.00	310.50
33	EC 305653	47.50	52.50	19.50	18.75	17.15	1.60	5.00	17.35	175.00	1.50	9.07	60.40	6.50	355.40
34	EC 305664	46.00	50.50	15.90	12.00	12.55	1.80	10.00	14.00	113.45	2.00	7.23	50.80	5.50	187.80
35	EC 305672	45.50	50.00	15.85	16.60	13.04	1.55	5.00	15.90	160.15	1.60	6.31	59.30	7.50	251.00
36	EC 305675	45.50	50.00	18.05	16.80	17.10	1.50	5.00	16.00	175.80	1.90	9.00	59.30	6.50	276.50
37	EC 305685	50.50	55.50	9.90	22.00	17.38	2.10	9.00	15.60	128.00	1.60	6.78	101.50	9.00	208.90
38	EC 305687	51.00	55.50	11.50	21.80	15.59	1.90	9.50	17.10	128.90	1.70	6.59	160.00	5.25	238.70
39	EC 305689	49.50	55.50	12.90	20.30	15.10	1.65	9.00	16.90	141.70	1.70	5.90	99.30	6.00	247.50
40	EC 305691	52.50	57.50	11.00	23.05	12.98	1.90	8.50	15.40	133.65	2.10	6.74	104.60	6.00	234.40
41	EC 305609	53.50	58.50	19.50	17.65	17.39	1.85	5.00	16.90	171.05	1.70	9.22	70.60	4.50	299.60
42	EC 305612	49.50	54.50	18.35	17.35	16.00	2.00	5.00	15.00	149.30	1.70	7.21	73.30	7.50	291.25
43	EC 305694	54.50	60.00	10.70	21.50	14.84	2.05	9.00	20.60	140.70	1.50	4.71	98.50	4.50	216.45
44	EC 305714	52.50	57.00	7.50	14.50	11.73	1.70	5.00	16.40	108.50	2.10	5.26	77.80	5.00	110.70
45	EC 305716	53.50	58.50	9.15	10.75	9.83	1.75	5.00	15.60	140.20	1.60	6.04	85.50	3.50	107.90
46	EC 305741	52.50	56.50	9.80	23.10	13.12	2.10	7.50	16.90	136.20	1.90	8.08	117.80	5.50	222.05
47	EC 305745	53.50	58.50	12.90	21.30	16.80	2.10	9.00	18.30	134.20	2.30	4.33	94.50	4.00	249.10
48	EC 305764	52.50	56.50	9.50	32.00	9.80	3.90	9.50	15.70	158.00	1.80	8.16	125.60	8.50	295.80
49	EC 305766	52.50	57.00	13.20	19.00	13.50	2.10	8.00	13.00	125.30	1.70	6.38	73.80	5.00	243.10
50	EC 306709	49.50	54.00	8.00	12.70	10.04	1.35	8.50	13.70	133.60	1.90	6.41	94.30	3.50	107.48
51	EC 305731	48.50	53.00	9.20	16.10	10.54	1.55	5.00	13.60	107.60	1.80	6.83	53.20	7.00	142.17
52	EC 305768	51.50	56.00	11.70	29.00	9.87	2.90	7.50	15.20	146.00	1.30	6.93	92.60	5.25	295.00
	Mean	47.91	52.62	13.75	17.03	14.03	1.78	6.15	15.07	141.32	1.67	7.68	68.38	5.10	225.44
	C.V.	1.69	1.87	5.87	6.58	6.16	8.22	5.08	7.68	4.371	10.05	7.65	6.13	12.33	3.48
	SE+	0.57	0.69	0.57	0.79	0.61	0.10	0.22	0.81	4.37	0.11	0.41	2.96	0.44	5.55
	CD at 5%	1.62	1.98	1.62	2.25	1.73	0.29	0.62	2.32	12.41	0.33	1.18	8.42	1.26	15.77

DFP- Days to 50% Flowering, **NFPF-** Number of fruits per plant, **FW** – Weight of fruit (g), **FL** – Fruit length(cm), **FG-** Fruit girth(cm), **NRPF-** Number of ridges per fruit, **NNPF-**Number of nodes per fruit, **PH-**Plant height (cm), **NBPP-**Number of branches per plant, **IL-** Internodal length, **NSPF-** Number of seed per fruit, **HSP-** 100 Seed weight (g), **YPP-** Yield per plant (g)

Table 2: Analysis of Variance (ANOVA) for fourteen characters in Okra

Sr. No.	Characters	Mean Sum of Square		
		Replication (1 d. f.)	Treatment (51 d. f.)	Error (51 d. f.)
1	Days to 50% flowering	0.00	19.66***	0.65
2	Number of days to first harvest	0.77	20.78***	0.97
3	Number of fruits per plant	0.11	22.04***	0.65
4	Fruit weight (g)	0.02	35.35***	1.25
5	Fruit length (cm)	0.05	13.60***	0.74
6	Fruit girth (g)	0.02	0.30***	0.02
7	Number of ridges per fruit	0.00	5.61***	0.09
8	Number of nodes per plant	12.04**	6.34***	1.34
9	Plant height (cm)	70.32	940.87***	38.27
10	Number of branches per plant	0.02	0.13***	0.02
11	Internodal length (cm)	0.23	4.05***	0.34
12	Number of seeds per fruit	0.00	1120.04***	17.59
13	100 seed weight (g)	0.00	4.68***	0.39
14	Yield per plant (g)	12.50	9316.66***	61.74

*** Significant at 0.1 percent level of probability or level of significance

** Significant at 1 percent level of probability or level of significance

Table 3: Composition of fifty two okra genotypes into different clusters for fourteen traits by Tocher's method

Cluster NO.	Number of strains	Genotypes included in the cluster
I	24	IC 3302, IC 3769A, IC 4507, IC 1543, EC 305652, EC 305635, EC 305653, IC 6376-B, IC 7473, EC 305675, IC 8991-A, EC 305609, IC 9856-C, EC 305612, IC 10252, EC 305613, EC 305634, EC 305672, Parbhani Kranti, IC 3769, IC 6485, IC 10256-A, IC 3759, EC 305766.
II	17	EC305643, EC 305731, IC 4328, IC 11533, IC 7472, IC 7952, IC 4378, IC 7856-A, IC 7452, IC 9856, IC 9327, IC 8991, Pusa sawani, IC 3340-C, IC 9856-B, EC 305714, EC305716
III	8	EC 305691, EC 305741, EC 305694, EC 305745, EC 305689, EC 305685, EC 305687, EC 305768.
IV	1	EC 305664
V	1	EC 306709
VI	1	EC 305764

Table 4: Average intra and inter cluster D2 values in fourteen characters of okra

Cluster	I	II	III	IV	V	VI
I	115.72	365.51	356.48	277.23	533.37	805.57
II		115.17	484.52	239.35	222.92	1079.84
III			131.38	314.21	304.69	324.36
IV				0.00	248.58	760.33
V					0.00	750.43
VI						0.00

Table 5: Cluster means for fourteen characters of okra

Characters	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V	Cluster VI
Days to 50% flowering	47.35	46.56	51.94	46.00	49.50	52.50
Number of days to first harvest	52.00	51.32	56.88	50.50	54.00	56.50
Number of fruits per plant	16.50	11.50	11.30	15.90	8.00	9.50
Fruit weight (g)	17.36	13.57	22.76	12.00	12.70	32.00
Fruit length (cm)	15.80	11.92	14.46	12.55	10.04	9.80
Fruit girth (cm)	1.72	1.63	2.09	1.80	1.35	3.90
Number of ridges per fruit	5.50	5.35	8.63	10.00	8.50	9.50
Number of nodes per plant	15.48	13.70	17.00	14.00	13.70	15.70
Plant height (cm)	157.48	122.06	136.17	113.45	133.60	158.00
Number of branches per plant	1.68	1.58	1.76	2.00	1.90	1.80
Internodal length (cm)	8.60	7.15	6.26	7.23	6.41	8.17
Number of seeds per fruit	59.23	58.54	108.60	50.80	94.30	125.60
100 seed weight (g)	5.23	4.52	5.69	5.50	3.50	8.50
Yield per plant (g)	276.12	152.54	239.01	187.80	107.48	295.81

Table 6: Contribution of various characters towards genetic divergence

Sr. No.	Characters	Contribution %	Times ranked 1st
1	Days to 50% flowering	4.37%	58
2	Number of days to first harvest	0.00%	00
3	Number of fruits per plant	0.90%	12
4	Fruit weight (g)	0.68%	09
5	Fruit length (cm)	0.68%	09
6	Fruit girth (cm)	3.39%	45
7	Number of ridges per fruit	15.69%	208
8	Number of nodes per plant	0.30%	04
9	Plant height (cm)	2.34%	31
10	Number of branches per plant	0.53%	07
11	Internodal length (cm)	1.81%	24
12	Number of seeds per fruit	10.78%	143
13	100 seed weight (g)	4.52%	60
14	Yield per plant (g)	54.00%	716

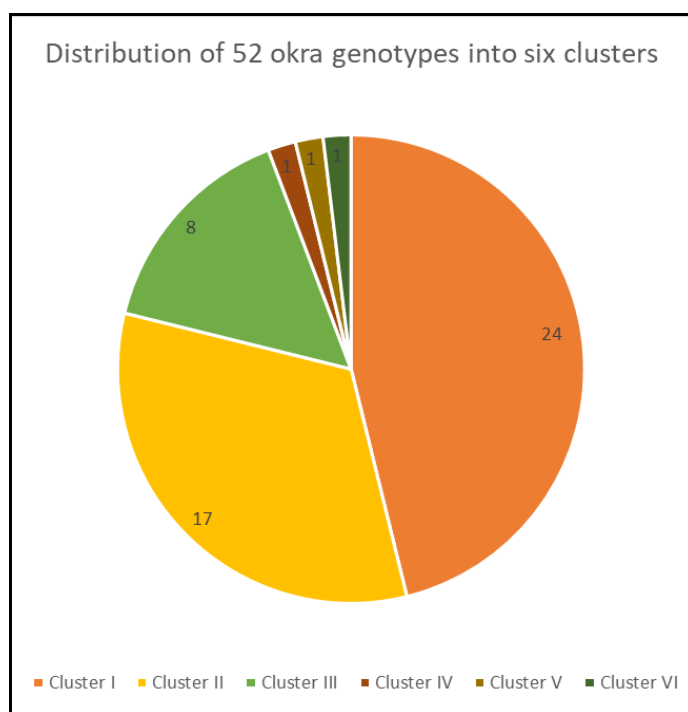


Fig 1: Composition of fifty-two okra genotypes into different clusters for fourteen traits by Tocher’s method

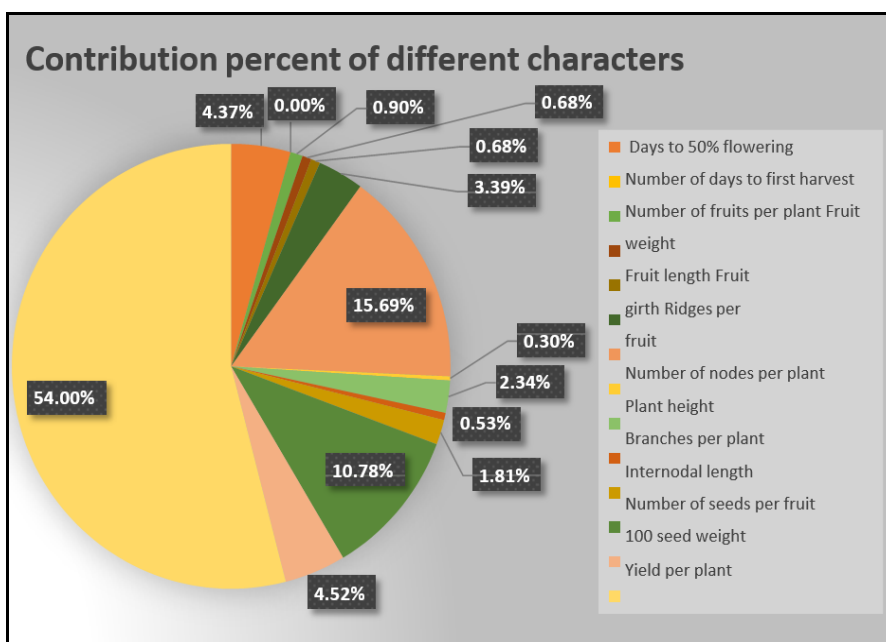


Fig 2: Percent contribution of different characters to genetic diversity in okra.

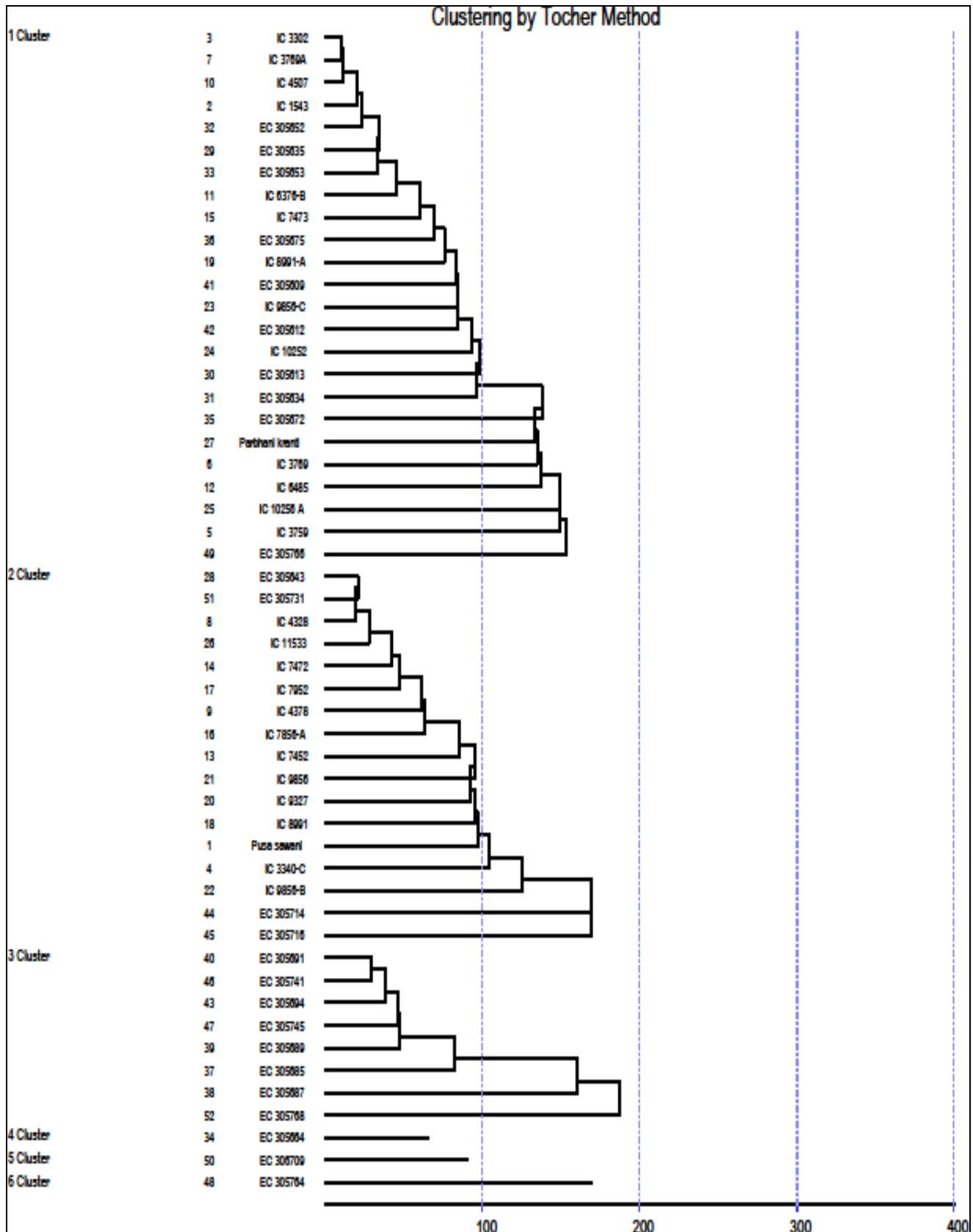


Fig 3: Clustering of genotypes by Tocher,s method for fourteen traits in okra

Conclusion

Divergence study revealed that, highest cluster mean for yield per plant was observed in cluster VI, cluster I and cluster III. Hence, the crosses between the genotypes of these clusters can be tried for improvement of yield. Genetic diversity is largely contributed by yield per plant followed by number of ridges per fruit, number of seeds per fruit, 100 seed weight, days to 50

percent flowering, fruit girth, plant height and internodal length. Thus, these characters may be given high emphasis while selecting genotypes for hybridization programme to generate large variability and it will provide immense scope for improvement of yield through selection. Highly divergent parents can be crossed for creating variability and isolating better segregants in advanced generation.

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