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Study on Heritability, Correlation and Genetic Divergence in Okra (*Abelmoschus esculentus*)

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A B S T R A C T

The Genotypes Annu 50 (240.g) and 10.45 t ha^{-1}) was recorded highest mean performance for fruit yield plant-1 and no. of fruit plant-1). The genotypic coefficient variance value were categorized as low (0-10%), moderate (10-20%) and high (20% and above). In the present study the heritability estimates in broad sense were classified into 3 groups such as high (>75%), moderate (60% - 75%), low (<60%). The genetic advance estimates were found to be high for Plant height, and Yield plant^{-1} (g). The high genetic advance as percent of mean was recorded for Plant height, Number of branches per plant, Fruiting node, Fruit length (cm), Fruit width (cm) and Fruit weight (g). Genotypic and phenotypic coefficient analysis revealed that fruit yield per plant showed positive significant association with Plant height, Length of internodes (cm), Days taken to first picking, Number of nodes to first flowering and Fruit yield (t ha^{-1}). Genotypic and phenotypic that highest direct positive effect on fruit yield per plant (g) was exhibited by Number of branches per plant, Length of internodes (cm) at both genotypic and phenotypic and Days taken to 50% flowering, Number of fruit per plant, Days taken to first picking, Number of nodes to first flowering and Fruiting node at phenotypic and Fruit length (cm), Fruit weight (g), Fruit yield (t ha^{-1}) at both genotypic and phenotypic level. Clustering pattern indicated that cluster I is largest cluster comprising 18 out of twenty-two genotype. On the other hand cluster II, comprised 1 genotype, cluster III, IV, V cluster comprised 1 genotype. The inter cluster distance was maximum between cluster IV and V (435.065) Cluster I, II, III, IV, V was characterized by high mean value for plant height (cm) and low mean values for Fruit width (cm). The highest contribution in manifestation of genetic divergence was exhibited by Number of fruits per plant,. Days taken to first flowering, Fruiting node, Fruit length (cm), Fruit width (cm), Fruit weight (g) and Yield per plant(g)and Yield per plants(t ha^{-1}).

Introduction

Okra is one of the important members of Malvaceae family having higher chromosome number of 2n=130 and polyploidy in nature. The family Malvaceae consists of about 34 Abelmoschus species, including 30 species in the Old World and four in the New World (Joshi *et al.,* 1974). Okra (*Abelmoschus esculentus*) is one of the important tropical vegetables commonly known as Okra in India. It is the most ancient and traditional vegetable crop grown in tropical and sub-tropical low land regions of Asia, Africa, America and warmer parts of Mediterranean regions.

Tender green fruits are cooked in curry and soup, while crop has not adapted in India as leafy vegetable as in for East countries. The cultivated species *A. esculentus* is believed to be originated in the Hindustani centre, i.e., India according to the taxonomic classification of Zeven and Zhukovsky(1975).

According to Vavilov, it was probably domesticated in the Ethopian region but according to Murdock it is in West Africa. Okra is known by many local names in different parts of the world. It is called lady's finger in England, Gumbo in U.S.A. and Bhindi in India. Edible fresh and tender fruits contain 88% moisture and large number of chemical components including Vit. A 88 IU, B 63 IU and C 13 mg/100 gm. Immature okra fruits contain 3100 calorie energy, 1.8g protein, 90 mg calcium and 1.0 mg iron (Aykroyd, 1941).The species *A. tuberculatus*, a wild type is native to India. The Seeds of okra (Pusamakhmali) had the highest oil content 17.3% which is a nutritious ingredient of cattle feed. It has Ayurvedic medicinal properties. Its leaves are used for preparing a medicament to reduce inflammation. It is an excellent source of Iodine for control of goiter (Chadha, 2001). In India It is grown twice in a year for getting regular supply. In the country, a large number of okra varieties are grown, the variation occurs with regards to quantitative and qualitative traits. The plant height, number of primary branches per plant, number of fruits per plant, size of fruit i.e. length as well as weight of fruits are the yield contributing characters while, colour of fruit and fiber content determine the quality of fruit.

Materials and Methods

The present investigation was carried out at the horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Science and Technology, Prayagraj. The experimental material comprised of twenty two genotypes including check, which were collected from different source (Table 1). The genotypes were grown in a randomized block design with three replicates during *monsoon* season keep line to line distance of 30 cm. and plant to plant distance of 30 cm during the year 2019-2020. Five competitive plants were selected at randomly tagged from each plot to record observation on various characters *viz*., plant height, number of branches per plants, Fruiting node, fruit length (cm), fruit width (cm), Fruit weight (g), days to 50 per cent flowering, Fruit yield (t ha^{-1})

Coefficient Of Variation (*Burton, 1952*). Genetic Advance (*Lush, 1949*). On the basis of percent of mean were worked out according to the method advocated by Correlation Coefficient Analysis (*Al-Jibour et al,* 1958), respectively.

Results and Discussion

The mean sum of squares due to 22 genotypes showed significant differences for all characters at 1% level and 5% level of significance, indicating the presence of substantial amount of genetic variability among the okra genotypes. The highest fruit

yield per plant (g) was recorded in Annu 50 (240.00) (gm). However, it was found the lowest in Red ruby and okra 107(155.00).

The heritability estimates were found to be high (more than 60%) for Plant height (96), Number of branches per plant (80), Length of internodes (cm) (68), Number of nodes to firs flowering (64), Days taken to first flowering (63), Days taken to first picking (62), Fruiting span (83), Fruit length (cm) (61), Fruit width (cm) (78), Fruit weight (g) (91), Number of fruit per plant (88). The genetic advance estimates were found to be high for Plant height (36.89) and Yield per plant (g) (36.67) and genetic advance as percent of mean was recorded for Plant height (48.02), Number of branches per plant (30.10), Fruiting span (25.88), Fruit length (cm) (32.68), Fruit width (cm) (35.53) and Fruit weight (g)(55.24).Genotypic correlation coefficient analysis revealed that fruit yield per plant showed positive significant association with Plant height (0.214**), Length of internodes (cm) (0.3840*), Days taken to first picking (0.4608**), Number of nodes to first flowering (0.4404**) and Fruit yield (t ha^{-1}) (1.0008*). While as negative significant association was observed with Days taken to 50% flowering (-0.3683*), Days taken to first picking (-0.4608**), Fruit width (cm) (-0.3239*).

Table.1 List of Genotype

SL No.	Genotypes Symbol	Name of Genotypes
1	G_1	**ArkaAnamika**
2	G_2	**Sahiba**
3	G_3	**Red Rubby**
4	G_4	**Super Green**
5	G_5	**Samrat**
6	G_6	**Okra 1182**
7	G_7	**SB-6X747**
8	G_8	**Annu 50**
9	G_9	**Champion**
10	G_{10}	**SB-8XVRO-102**
11	G_{11}	**IC-43735**
12	G_{12}	**Bhindi PG-15**
13	G_{13}	**IC-218872**
14	G_{14}	**SB-6X746**
15	G_{15}	**Okra 326-10-1**
16	G_{16}	**SB-8XOKHYB-4**
17	G_{17}	**Okra 231-10-1**
18	G_{18}	**Okra 304-10-1**
19	G_{19}	**VROSXVRO-101**
20	G_{20}	**VRO 107**
21	G_{21}	**OKRA 107**
22	**G_{22}**	**Okra 232-10-1**

Table.2 Analysis of Variance for various characters in okra genotypes

S. No.	Characters	Replication = df 2	Treatment = df17	Error =df34
1.	Plant height	74.83	1010.92**	**12.44**
2.	Number of leaves per plant	9.06	15.003**	**5.98**
3.	Number of branches per plant	0.1810	1.103**	**0.083**
4.	Length of internodes (cm)	0.646	2.460**	**0.323**
5.	Number of nodes to first flowering	0.353	0.739**	**0.112**
6.	Days taken to first flowering	2.86	17.77**	**2.86**
7.	Days taken to 50% flowering	1.05	17.81**	**3.45**
8.	Days taken to first picking	0.689	21.37**	**3.52**
9.	Fruiting node	2.039	1.98**	**0.121**
10.	Fruit length (cm)	1.95	17.86**	**3.08**
11.	Fruit width (cm)	0.0126	0.180**	**0.0154**
12.	Fruit weight (g)	1.44	23.99**	**0.74**
13.	Number of fruit per plant	0.451	11.69**	**0.500**
14.	Yield per plant (g)	91.676	1073.33**	**32.73**
15.	**Fruit yield (t ha^{-1})**	**0.186**	**1.714****	**0.0615**

* and ** significant at 5% and 1% level of significance respectively

Table.3 Estimates of Path Analysis coefficient for 15 growth and yield component with fruit yield per plant

Traits	Plant height (cm)	Number of branches per plants	No of leaves per plants	Length of internode(cm)	Days taken to first flowering	Days taken to 50% flowering	Days taken to first pickling	No. of nodes at first flowering	First fruiting node	Fruit length(cm)	Fruit width (cm)	Fruit weight (g)	No of fruits per plants	Fruit yield per plants (g)
1. Plant height (cm)	**0.188**	-0.084	0.187	0.013	-0.004	-0.002	-0.048	0.005	0.027	0.267	0.006	-0.085	-0.009	0.461**
Number of branches per plants	0.229	**-0.069**	-0.533	0.012	0.410	-0.001	0.008	0.091	0.053	0.168	-0.058	-0.188	-0.206	-0.083
No of leaves per plants	0.063	0.066	**0.561**	-0.012	-0.020	0.001	-0.021	-0.022	-0.409	-0.335	0.010	-0.121	-0.009	-0.249*
Length of internode(cm)	0.018	-0.006	-0.053	**0.133**	0.070	-0.002	-0.074	-0.003	-0.008	0.129	0.012	0.061	0.013	0.291*
Days taken to first flowering	-0.004	-0.156	-0.061	0.052	**0.182**	0.000	-0.011	0.011	-0.155	0.181	0.003	0.086	-0.057	0.071
Days taken to 50% flowering	-0.075	0.014	0.080	-0.036	-0.001	**0.006**	0.128	-0.004	-0.310	0.049	-0.046	-0.071	-0.112	-0.379**
Days taken to first pickling	-0.067	-0.004	-0.084	-0.072	-0.015	0.006	**0.137**	0.003	-0.229	0.136	-0.038	-0.104	-0.124	-0.456**
No. of nodes at first flowering	-0.023	0.168	0.330	0.012	-0.053	0.001	-0.012	**-0.037**	0.099	0.043	0.007	-0.026	-0.030	0.479**
First fruiting node	-0.009	0.006	0.397	0.002	0.049	0.003	0.054	0.006	**-0.578**	0.152	-0.011	-0.073	-0.026	-0.027
Fruit length(cm)	-0.082	0.019	0.307	-0.028	-0.054	-0.001	-0.031	0.003	0.144	**-0.611**	0.010	0.108	0.066	-0.150
Fruit width (cm)	-0.044	-0.144	-0.198	-0.056	-0.022	0.010	0.189	0.010	-0.221	0.220	**-0.028**	-0.197	-0.203	-0.685**
Fruit weight (g)	0.051	-0.042	0.218	-0.026	-0.050	0.001	0.046	-0.003	-0.135	0.211	-0.018	**-0.312**	-0.068	-0.126
No of fruits per plants	-0.010	0.085	-0.031	0.010	-0.062	-0.004	-0.102	0.007	0.091	-0.240	0.034	0.128	**0.167**	0.072

Table.4 Estimates of genotypic correlation coefficient for 15 growth and yield component with fruit yield per plant

Traits	Plant height (cm)	Number of branches per plants	No of leaves per plants	Length of internode(cm)	Days taken to first flowering	Days taken to 50% flowering	Days taken to first pickling	No. of nodes at first flowering	First fruiting node	Fruit length(cm)	Fruit width (cm)	No of fruits per plants	Fruit yield per plants (g)
1. Plant height	**1.000**	1.214**	0.333**	0.096	-0.021	-0.397**	-0.354**	-0.121	-0.047	-0.437**	-0.232	-0.052	0.461**
No. of branches per plants		**1.000**	-0.949**	0.091	2.255**	-0.202	0.060	-2.441**	-0.092	-0.275*	2.094**	-1.234**	-0.083
No of leaves per plants			**1.000**	-0.093	-0.108	0.142	-0.150	0.588**	0.708**	0.548**	-0.353**	-0.054	-0.249*
Length of internode(cm)				**1.000**	0.387**	-0.267*	-0.540**	0.086	0.014	-0.212	-0.424**	0.075	0.291*
Days taken to first flowering					**1.000**	-0.006	-0.083	-0.289*	0.268*	-0.296*	-0.120	-0.342**	0.071
Days taken to 50% flowering						**1.000**	0.936**	0.117	0.536**	-0.080	1.673**	-0.673**	-0.379**
Days taken to first pickling							**1.000**	-0.089	0.396**	-0.223	1.380**	-0.745**	-0.456**
No. of nodes at first flowering								**1.000**	-0.171	-0.070	-0.262*	-0.178	0.479**
First fruiting node									**1.000**	-0.249*	0.382**	-0.157	-0.027
Fruit length(cm)										**1.000**	-0.360**	0.393**	-0.150
Fruit width (cm)											**1.000**	0.632**	-1.217**
Fruit weight (g)												**1.000**	-0.409**
No of fruits per plants													**1.000**

* and ** significant at 5% and 1% level of significance respectively

Table.5 Clustering pattern of 22 Okra (*Abelmoschus esculentus* L.) genotypes based on D^2 statistics.

Clusters	No. of Genotypes	Name of the Genotypes
Cluster-I	18	**SB-1X1101, IC-42735, OKRA 304-10-1, ArkaAnamika, Super Green, Sahiba, Okra 107, Samrat, 326-10-1, SB-8XVRO-102, Champion, Bhindi PG-15, VRO5XVRO-101, SB-8XOKHYB-4, IC-218872,231-10-1 & SB-6X747**
Cluster-II	1	**232-10-1,**
Cluster-III	1	**SB-6 X 746**
Cluster–IV	1	**Red ruby**
Cluster –V	**1**	**Annu 50**

Table.6 Intra and inter cluster distance (D^2) of Okra (*Abelmoschus esculentus* L.) genotypes

Euclidean² : Cluster Distances : Ward

	1 Cluster	2 Cluster	3 Cluster	4 Cluster	5 Cluster
1 Cluster	48.254	76.944	190.723	89.006	**151.116**
2 Cluster		67.907	187.745	93.042	**172.180**
3 Cluster			0.000	201.137	**435.065**
4 Cluster				37.800	**138.173**
5 Cluster					**0.000**

Cluster Distance

		Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Cluster	1	20.53	31.71	35.79	50.54	63.03
Cluster	2	31.71	0.00	68.50	44.65	77.72
Cluster	3	35.79	68.50	0.00	63.88	69.22
Cluster	4	50.54	44.65	63.88	0.00	145.02
Cluster	5	63.03	77.72	69.22	145.02	0.00

Cluster Means

		Char. 1	Char. 2	Char. 3	Char. 4	Char. 5	Char. 6	Char. 7
Cluster	1	77.54	3.74	31.57	7.72	35.04	39.33	41.00
Cluster	2	96.67	3.67	30.00	9.33	35.00	39.67	40.67
Cluster	3	63.67	3.00	31.67	8.67	36.33	41.00	42.00
Cluster	4	61.67	3.33	33.67	5.67	32.33	46.33	48.33
Cluster	5	119.33	3.33	32.67	8.67	33.00	36.00	36.00
		Char. 8	Char. 9	Char. 10	Char. 11	Char. 12	Char. 13	Char. 14
Cluster	1	4.91	5.57	11.67	1.17	9.52	10.93	175.56
Cluster	2	4.67	6.33	7.67	1.33	15.33	8.67	170.00
Cluster	3	6.00	4.67	10.33	1.33	7.00	6.67	185.00
Cluster	4	5.67	7.33	9.33	1.67	15.33	8.33	155.00
Cluster	5	6.00	5.67	9.33	1.00	10.67	13.00	240.00

Table.7 Cluster mean values for twenty-two growth and yield characters of Okra (*Abelmoschus esculentus* L.)

S. No.	Characters	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
1.	Plant height	119.333	91.714	61.667	74.800	**55.333**
2.	Number of leaves per plant	3.333	3.905	3.333	3.667	**3.333**
3.	Number of branches per plant	32.667	32.048	33.667	30.800	**32.556**
4.	Length of internodes (cm)	8.667	8.000	5.667	7.800	**7.667**
5.	Number of nodes to first flowering	33.000	36.524	32.333	34.633	**33.333**
6.	Days taken to first flowering	36.000	39.333	46.333	39.733	**38.667**
7.	Days taken to 50% flowering	36.000	41.048	48.333	41.433	**39.667**
8.	Days taken to first picking	6.000	4.762	5.667	5.067	**5.000**
9.	Fruiting node	5.667	5.952	7.333	5.300	**5.556**
10.	Fruit length (cm)	9.333	10.000	9.333	11.333	**14.889**
11.	Fruit width (cm)	1.000	1.190	1.667	1.200	**1.111**
12.	Fruit weight (g)	10.667	10.952	15.333	9.167	**8.444**
13.	Number of fruit per plant	13.000	9.905	8.333	10.400	**12.889**
14.	**Fruit yield plants (g)**	**240.000**	**176.667**	**155.000**	**177.500**	**167.778**

Table.8 Percent contribution of each character toward genetic divergence of Okra (*Abelmoschus esculentus* L.)

Source	Times ranked 1st	Contribution %
1 Plant height (cm)	24	10.39%
2Numberofbranchesperplants		.%
3 No of leaves per plants	1	.43%
4 Length of internode(cm)	1	.43%
5 Days taken to first flowering	6	2.6%
6Daystakento50%flowering	32	13.85%
7 Days taken to first pickling	2	.87%
8No.ofnodesatfirstflowering		.%
9 First fruiting node	28	12.12%
10 Fruit length(cm)	7	3.03%
11 Fruit width (cm)	5	2.16%
12 Fruit weight (g)	56	24.24%
13 No of fruits per plants	25	10.82%
14 Fruit yield per plants (g)	44	19.05%

Phenotypic correlation coefficient analysis revealed that fruit yield per plant (g) showed positive and significant association with Plant height (0.4319**), Length of internodes (cm) (0.3157*) and Number of nodes to first flowering (0.3284*) and Fruit yield (t ha^{-1}) (0.9970**). While as negative significant association was observed with Days taken to first picking (-0.3443*), Fruiting span (-0.848**)Genotypic path coefficient revealed that highest direct positive effect on fruit yield per plant (g) was exhibited by Number of branches per plant (0.0435), Length of internodes (cm) (0.0357), Days taken to 50% flowering (0.0666), Fruit length (cm) (0.0040), Fruit weight (g) (0.0132), Number of fruit per plant (0.0145)Phenotypic path coefficient revealed that highest direct positive effect on fruit yield per plant (g) was exhibited by Number of branches per plant (0.0069), Length of internodes (cm) (0.0074), Days taken to first picking (0.0120), Number of nodes to first flowering (0.0060), Fruiting span (0.0041), Fruit length (cm) (0.0095), Fruit weight (g) (0.0005).Clustering pattern indicated that cluster I is largest cluster comprising 18 out of twenty-two. On the other hand cluster II, cluster III, IV, V cluster comprised 1. The inter cluster distance was maximum between cluster IV and V (138.173) followed by cluster I and Cluster V (151.116), Cluster III and cluster V (435.065), cluster III and IV (201.137), Cluster II and IV(93.042). The Okra genotypes under investigation showed significant genetic variability. Based on mean performance for fruit yield per plant (300.00) and, genotypes Annu 50 were considered suitable genotypes in Prayagraj climatic condition..

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