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Study on genetic analysis for yield and its components and YVMV resistance in okra {*Abelmoschus esculentus* (L.) Moench}

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Abstract
The Genotypes Verma (240.18g) and 6.23 t ha^{-1}) was recorded highest mean performance for fruit yield plant-1 and fruit yield t ha^{-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, YVMV% 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, YVMV% at genotypic and 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 11 out of eighteen genotype. On the other hand cluster II, comprised 4 genotype, cluster III, IV, V cluster comprised 1 genotype. The inter cluster distance was maximum between cluster IV and V (406.41) 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, YVMV%, Plant Height. Days taken to first flowering, Fruiting node, Fruit length (cm), Fruit width (cm), Fruit weight (g) and Yield per plant (g).

Keywords: Genetic variability, correlation and path coefficient analysis, genetic divergence D^2 and Okra

Introduction
Okra [*Abelmoschus esculentus* (L.) Moench] is an important vegetable, mainly grown for its young immature fruits and consumed as a vegetable, raw, cooked, or fried. Also okra fruit has high nutritional value, which contains, carbohydrates, fats, fibres, oil, mineral and vitamins *viz*., B1, A and C (Rashwan, 2011) [29].

India ranks first in the world, it is commercially grown in the West Bengal, Gujarat, Bihar, Andhra Pradesh, Odisha, Uttar Pradesh, Tamil Nadu, Karnataka, Haryana, and Punjab and occupies 532.7 thousand hectare with the production of 6346.4 thousand million tonnes green fruits, where as the productivity is 11.9 MT/ha (Anonymous, 2015).

The low productivity is because of low yielding potential of current varieties and reduction in yield due to frequent attacks of pests and diseases, especially the fruit and shoot borer and yellow vein mosaic virus (Reddy *et al.*, 2012) [30].

Anonymous (2015). Indian Horticulture Database, Ministry of Agriculture, Government Due consideration, therefore may be given to heritability estimates of the characters during selection. However, heritability alone does not give true picture of genetic improvement to be affected by selection. For crop improvement by selection, it is essential to study the extent of heritability along with genetic advance. The possibility of improvement in any crop is measured by variability available in the crop (Mohapatra *et al.*, 2007) [24]. Hence, it is essential to partition overall variability into its heritable and non-heritable components with

the help of genetic parameters like coefficient of variation, heritability, and genetic advance. Information derived from correlation studies will reveal the possibility of simultaneous improvement of various attributes and also helps in increasing the efficiency of selection of complex inherited traits Mishra *et al.,* (2015) [23]. A study of correlation between different quantitative characters provides an idea of association that could be effectively exploited to formulate selection strategies for improving yield components. For any effective selection programme, it would be desirable to consider the relative magnitude of association of various characters with yield. Path analysis splits the correlation coefficient into measures of direct and indirect effects, thus providing understanding of the direct and indirect contribution of each character towards yield AI Patel *et al*., (2019) [32].

Materials and Methods

The present investigation entitled "Study on Genetic Analysis for Yield and Its Components and YVMV Resistance in Okra {*Abelmoschus esculentus* (L.) Moench}" was conducted in randomized block design with 18 genotypes of Okra in three replications. The objectives were to assess the relative performance, estimation of genetic parameters, correlation, path analysis and genetic divergence. The characters studied were *viz*., Growth and yield attributes of Okra. The experiment materials comprised of 18 genotypes of Okra were collected from different sources. The experiment was laid out at Vegetable Research Farm, Department of Horticulture, Naini Agriculture Institute, SHUATS Prayagraj India in randomized block design (RBD) with three replications. The mean data of each character was subjected to statistical analysis for variance and test the significance of each character as per the procedure of Panse and Sukhatme (1967) [26]. The formulae used to calculate PCV and GCV were given by Burton (1952) [7], Heritability (Broad sense) given by Lush (1949) and Burton and Dewane (1953) [20, 6], Genetic advance is given by Lush (1949) and Johnson *et al.* (1955) [20, 17], Genetic advance as percent of mean (GA %) is given by Johonson *et al.* (1955) [17]. Correlation coefficients were computed at genotypic and phenotypic levels between pair of characters adopting following formula given by Al-Jibouri *et al.* (1958) [4]. Genotypic and phenotypic Path coefficient analysis suggested by Wright (1921) [33] and illustrated by Dewey and Lu (1959) [11] was carried out separately to know the direct and indirect effects of the important component traits on fruit yield per plant. The analysis of divergence was carried out by using Mahalanobis D^2 statistics as per Mahalanobis (1936) [21] method and genotypes are grouped into different clusters following Tocher's method as described by Rao (1952).

Results and Discussion

The analysis of variance for different characters is presented in table 1. The mean sum of squares due to 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 {*Abelmoschus esculentus* L.) genotypes.

One of the most important considerations in any crop improvement is the detailed study of genetic variability. Variability can be measured by the estimates of genotypic and phenotypic coefficient of variation, heritability and genetic advance. In general, estimates of phenotypic coefficient of variation (PCV) were found to be higher than their corresponding genotypic coefficient of variation (GCV), this was due to environmental component, which was being added to GCV. The estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) for all the16 characters were presented in table 2. Wide range of genotypic coefficient of variation (GCV and PCV) was observed for the characters ranging from Number of leaves per plant (5.25) and Days taken to 50% flowering (7.21) to YVMV% (80.88 and 83.05). High magnitude of GCV and PCV were recorded for YVMV% (80.88 and 83.05), Fruit weight (g) (28.08 & 29.40), Fruit length (cm) (20.22 & 25.78) and Plant height (23.74 and 24.18) at the both GCV and PCV and Fruit width (cm) (22.12) at PCV. The study also indicated invariably, higher values for all the parameters under study for phenotypic coefficient of variation (PCV) as compared to their respective GCV indicating the impact of the environmental factors towards their expression. Similar results were also reported by Singh *et al.* (1998) and Adiger *et al.* (2011) and Indurani and Veeraragavathatham (2005) [31, 1, 13]. In the present investigation in table 2, 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 first flowering (64), Days taken to first flowering (63), Days taken to first picking (62), Fruiting node (83), Fruit length (cm) (61), Fruit width (cm) (78), Fruit weight (g) (91), Number of fruit per plant (88), YVMV% (94) and Yield per plant (g) (91) These results are in close conformity with the findings of (Bendale *et al.*, 2004; Patro and Ravishankar, 2005; Kumar *et al.,* 2012) [5, 27, 19]. In the present investigation in table 2, the genetic advance estimates were found to be high for Plant height (36.89), YVMV % (47.91) and Yield per plant (g) (36.67) and Genetic advance as percent of mean for various characters are presented in table 2 and noticed that high genetic advance as percent of mean was recorded for Plant height (48.02), Number of branches per plant (30.10), Fruiting node (25.88), Fruit length (cm) (32.68), Fruit width (cm) (35.53) and Fruit weight (g) (55.24) Similar results of high heritability and high genetic advance were also reported by Indurani and Veeraragavathatam (2005), Mehta *et al*. (2006) [13, 22].

In the present investigation the genotypic and phenotypic correlation coefficient of different characters with fruit yield per plant and their relationship among themselves are presented in table 3. Genotypic and phenotypic coefficient analysis revealed that fruit yield per plant showed positive significant association with Plant height (0.4618** & 0.4319**), Length of internodes (cm) (0.3840* & 0.3157*), Days taken to first picking (0.4608**), Number of nodes to first flowering (0.4404** & 0.3284*) and Fruit yield (t ha^{-1}) (1.0008* & 0.9970**) The present findings are in conformity with those of Khan *et al*. (2005), Adiger *et al.* (2011), Jagan *et al*. (2013) and Reddy *et al*. (2013) [18, 2, 14]. This indicates the interdependency of the various characters on each other. Jayapandi and Balkrishnan (1992) and Chitra (1999) [16, 10] reported similar results in okra.

The genotypic path coefficient among the different fruit yield per plant (g) traits in Okra (*Abelmoschus esculentus* L.) were worked out to assess the association among themselves. Perusal of Table 4 revealed that highest direct positive effect on fruit yield per plant (g) was exhibited by Number of branches per plant (0.0435 & 0.0069), Length of internodes (cm) (0.0357 & 0.0074) at both genotypic and phenotypic and Days taken to 50% flowering (0.0666), Number of fruit per plant (0.0145), YVMV% (0.0193) at genotypic and Days taken to first picking (0.0120), Number of nodes to first flowering (0.0060) and Fruiting node (0.0041) at phenotypic

and Fruit length (cm) (0.0040 & 0.0095), Fruit weight (g) (0.0132 & 0.0005), Fruit yield (t ha^{-1}) (1.0102 & 0.9952) at both genotypic and phenotypic level These findings are in consonance with those of Jaiprakashnarayan and Mulge, (2004) [15]; Mehta *et al*. (2006) [22] and Patro and Sankar (2006) [28] and Mohapatra *et al.* (2007) [24].

Clustering pattern of eighteen genotype of Okra {*Abelmoschus esculentus* L.) were grouped into clusters following Mohalanobis D^2 analysis (Table 5) Clustering pattern indicated that cluster I is largest cluster comprising 11 out of eighteen genotype. On the other hand cluster II, comprised 4 genotype, cluster III, IV, V cluster comprised 1 genotype. The pattern of group constellation proved the existence of significant amount of variability. The distribution of genotypes also indicated that the genotypes originated from different states were grouped into same cluster and genotypes of same states into different clusters.

The inter and intra average distances among five clusters were computed and have been given in the Table 6. The inter cluster distance was maximum between cluster IV and V (406.41) followed by cluster I and Cluster V (309.78), Cluster III and cluster V (294.68), cluster III and IV (222.33), Cluster II and IV (180.55).

A comparison of the mean value of sixteen characters of different clusters has been presented in Table (7). Considerable differences in cluster mean values were evident for all the characters. 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 genotypes with high mean values may be directly used for adaptation or may be used as parents' in future breeding programme.

The percent contribution of sixteen characters towards total genetic divergence is listed in Table 8. The selection and choice of parents mainly depends upon contribution of characters towards divergence. In the present investigation the highest contribution in manifestation of genetic divergence was exhibited by Number of fruits per plant, YVMV%, Plant Height. Days taken to first flowering, Fruiting node, Fruit length (cm), Fruit width (cm), Fruit weight (g) and Yield per plant (g) In other words, selection for these characters may be rewarding.

Table 1: Analysis of variance for 16 quantitative characters in Okra {*Abelmoschus esculentus* L.)

S. No.	Characters	Replication = df 2	Treatment = df 17	Error = df 34
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 firs 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.	YVMV%	7.200	1741.75	30.95
15.	Yield per plant (g)	91.676	1073.33	32.73
16.	Fruit yield (t ha^{-1})	0.186	1.714	0.0615

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

Table 2: Estimation of Genetic variability parameters for growth an yield attributes of Okra

S. No.	Characters	GCV	PCV	Heritability H^2(Broad sense)	GA	GA as Mean (%)
1.	Plant height	23.74	24.18	96	36.89	48.02
2.	Number of leaves per plant	5.25	9.09	33	2.06	6.26
3.	Number of branches per plant	16.30	18.18	80	1.07	30.10
4.	Length of internodes (cm)	10.57	12.74	68	1.44	18.05
5.	Number of nodes to first flowering	9.02	11.20	64	0.75	14.98
6.	Days taken to first flowering	6.33	7.95	63	3.65	10.39
7.	Days taken to 50% flowering	5.50	7.21	58	3.43	8.364
8.	Days taken to first picking	5.95	7.51	62	3.98	9.72
9.	Fruiting node	13.74	15.02	83	1.48	25.88
10.	Fruit length (cm)	20.22	25.78	61	3.58	32.68
11.	Fruit width (cm)	19.53	22.12	78	0.42	35.53
12.	Fruit weight (g)	28.08	29.40	91	5.47	55.24
13.	Number of fruit per plant	18.14	19.32	88	3.73	35.09
14.	YVMV%	80.88	83.05	94	47.91	162.27
15.	Yield per plant (g)	10.50	10.98	91	36.67	20.68
16.	Fruit yield (t ha^{-1})	10.43	11.00	89	1.45	26.13

Table 3: Estimates of genotypic and phenotypic correlation coefficient for 16 growth and yield component with fruit yield per plant

Characters		Plant height	Number of leaves per plant	Number of branches per plant	Length of internodes (cm)	Days taken to first flowering	Days taken to 50% flowering	Days taken to first picking	Number of nodes to firs flowering	Fruiting node	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Number of fruit per plant	YVMV %	Fruit yield (t ha^{-1})	Yield per plant (g)
Plant height	G	1.000	0.1018	-0.2729	0.5335**	-0.0623	-0.4196**	-0.4337**	0.1447	-0.0148	-0.4615**	-0.3769*	0.2641	0.0539	-0.2001	0.4751**	0.4618**
	P	1.000	0.1058	-0.2327	0.3980*	-0.0402	-0.3392*	-0.3482*	0.1248	-0.0127	-0.3346*	-0.3238*	0.2495	0.0571	-0.2053	0.4407**	0.4319**
Number of leaves per plant	G		1.000	0.4611**	-0.1016	0.4141**	0.6772**	0.4852**	-0.0261	0.8903**	-0.2160	-0.3507*	0.5395**	-0.6209**	0.0715	0.089	0.0794
	P		1.000	0.2790	-0.0061	0.14836	0.2814	0.2510	-0.047	0.5158**	-0.0620	-0.0950	0.3894*	-0.3865*	0.0652	0.1346	0.1231
Number of branches per plant	G			1.000	-0.2201	0.4608**	0.5190**	0.3951*	-0.2268	0.5036**	-0.1389	0.0918	-0.1084	-0.2661	-0.2802	-0.0396	-0.0307
	P			1.000	-0.1793	0.3324*	0.4058**	0.3203**	-0.1260	0.4684**	-0.0112	0.0483	-0.0915	-0.1717	-0.2407	-0.0082	-0.0054
Length of internodes (cm)	G				1.000	0.3141*	-0.4334**	-0.4239**	-0.1368	-0.0734	-0.3730*	-0.0779	-0.2103	0.0227	-0.02296	0.3822*	0.3840*
	P				1.000	0.2612	-0.2332	-0.2509	-0.1523	-0.0137	-0.2368	-0.0186	-0.1246	0.0639	-0.0046	0.3180*	0.3157*
Days taken to first flowering	G					1.000	0.0914	-0.0403	-0.4394**	0.1022	-0.1722	-0.1445	-0.3596*	-0.4297**	-0.0704	0.0449	0.0436
	P					1.000	0.3538*	0.2243	-0.2591	0.1390	-0.1114	-0.0871	-0.2771	-0.2486	-0.0768	0.0331	0.0286
Days taken to 50% flowering	G						1.000	0.09819	-0.0208	0.4669**	-0.1720	-0.1240	0.1811	-0.6977**	0.2607	-0.3702*	-0.3683*
	P						1.000	0.9489*	0.0215	0.3927*	-0.0990	-0.0335	0.1521	-0.4528*	0.1893	-0.2451	-0.2526
Days taken to first picking	G							1.000	-0.0580	0.4372**	-0.2713	-0.0397	0.2393	-0.6377**	0.3037**	-0.4640**	-0.4608**
	P							1.000	-0.0108	0.3438*	-0.1219	0.0085	0.2161	-0.4366*	0.2268	-0.3379*	-0.3443*
Number of nodes to firs flowering	G								1.000	-0.3220**	0.1250	-0.7707**	-0.0752	0.1887	-0.2259	0.4264**	0.4404**
	P								1.000	-0.2462	-0.0251	-0.4855*	-0.0148	0.1573	-0.1975	0.3239*	0.3284*
Fruiting node	G									1.000	-0.3709**	0.0996	0.2577	-0.2717	0.0542	-0.0855	--0.0994
	P									1.000	-0.2074	0.0640	0.2305	-0.2219	0.0466	-0.0778	-0.848**
Fruit length (cm)	G										1.000	0.1927	-0.3611*	0.3404*	-0.1571	-0.1436	-0.1358
	P										1.000	0.1565	-0.2618	0.2413	-0.1507	-0.1351	-0.1242
Fruit width (cm)	G											1.000	-0.0953	0.1029	0.4103*	-0.3269*	-0.3239*
	P											1.000	-0.0237	0.323*	0.3234*	-0.2598	-0.2653
Fruit weight (g)	G												1.000	-0.3524*	0.2019	-0.1069	-0.1160
	P												1.000	-0.3516*	0.1993	-0.076	-0.0885
Number of fruit per plant	G													1.000	-0.3836*	0.0845	0.0938
	P													1.000	-0.3550*	0.0648	0.0673
YVMV %	G														1.000	-0.3411*	-0.3477*
	P														1.000	-0.2903	-0.3018*
Fruit yield (t ha^{-1})	G															1.000	1.0008*
	P															1.000	0.9970**

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

Table 4: Direct and indirect effects of genotypic and phenotypic path coefficient for sixteen characters in Okra {*Abelmoschus esculentus* L.) genotypes

S. No.	Characters	Plant height	Number of leaves per plant	Number of branches per plant	Length of internodes (cm)	Days taken to first flowering	Days taken to 50% flowering	Days taken to first picking	Number of nodes to firs flowering	Fruiting node	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Number of fruit per plant	YVMV %	Fruit yield (t ha^{-1})	Yield per plant (g)
Plant height	G	-0.0368	-0.0037	0.0100	-0.0196	0.0023	0.0155	0.0160	-0.0053	0.0005	0.0170	0.01398	-0.0097	-0.0020	0.0074	-0.0175	0.4618
	P	-0.0130	-0.0014	0.0030	-0.0052	0.0005	0.0044	0.0045	-0.0016	0.0002	0.0044	0.00425	-0.0033	-0.0007	0.0027	-0.0057	0.4319
Number of leaves per plant	G	-0.0021	-0.0207	-0.0096	0.0021	-0.0086	-0.0141	-0.101	0.0005	-0.0185	0.0045	0.0073	-0.112	0.0129	-0.0015	-0.0018	0.0794
	P	-0.0014	-0.0133	-0.0037	0.0001	-0.0020	-0.0037	-0.0033	0.006	-0.0068	0.0008	0.0013	-0.0052	0.0051	-0.0009	-0.0018	0.1231
Number of branches per plant	G	-0.0119	0.0200	0.0435	-0.0096	0.0200	0.0226	0.0172	-0.0099	0.0219	-0.0060	0.0040	-0.047	-0.116	-0.0122	-0.0017	-0.0307
	P	-0.0016	0.0019	0.0069	-0.0012	0.0023	0.0028	0.00022	-0.009	0.0032	-0.0001	0.0003	-0.0006	-0.0012	-0.0017	-0.0001	-0.0054
Length of internodes (cm)	G	0.01914	-0.0036	-0.0079	0.0357	0.0112	-0.0155	-0.151	-0.0049	-0.0026	-0.0133	-0.0028	-0.0075	0.0008	-0.0008	0.0137	0.3840
	P	0.0030	0.000	-0.0013	0.0074	0.0019	-0.0017	-0.0019	-0.0011	-0.0001	-0.0018	-0.0001	-0.009	0.005	0.000	-0.0024	0.3157
Days taken to first flowering	G	0.0026	-0.0173	-0.0193	-0.0131	-0.0418	-0.0038	0.0017	0.0184	-0.0043	0.0072	0.0060	0.0150	0.0180	0.0029	-0.0019	0.0436
	P	0.0002	-0.0006	-0.0013	-0.0010	-0.0039	-0.0014	-0.0009	0.0010	-0.0005	0.0004	0.0003	0.0011	0.0010	0.0003	-0.0001	0.0286
Days taken to 50% flowering	G	-0.0280	0.0451	0.0346	-0.0289	0.0061	0.0666	0.0654	-0.0014	0.0311	-0.0115	-0.0083	0.0121	-0.465	0.0174	-0.0247	-0.3683
	P	0.0088	-0.0073	-0.0105	0.0060	-0.0092	-0.0259	-0.0246	-0.0006	-0.0102	0.0026	0.0009	-0.0039	0.0117	-0.0049	0.00063	-0.2526
Days taken to first picking	G	0.0265	-0.0297	-0.0242	0.0259	0.0025	-0.0600	-0.0612	0.0035	-0.267	0.0166	0.0024	-0.0146	0.0390	-0.0186	0.0284	-0.4608
	P	-0.0042	0.003	0.0038	-0.0030	0.0027	0.0114	0.0120	-0.0001	0.0041	-0.0015	0.0001	0.0026	-0.0052	0.0027	-0.0041	-0.3443
Number of nodes to firs flowering	G	-0.0048	0.0009	0.0075	0.0045	0.0145	0.0007	0.0019	-0.0329	0.106	-0.0041	0.0254	0.0025	-0.0062	0.0074	-0.0140	0.4404
	P	0.0008	-0.0003	-0.0008	-0.0009	-0.0016	0.0001	-0.0001	0.0060	-0.0015	-0.0002	-0.0029	-0.0001	0.0009	-0.0012	0.000	0.3284
Fruiting node	G	0.0003	-0.0171	-0.0097	0.0014	-0.0020	-0.0090	-0.0084	0.0062	-0.0192	0.0071	-0.0019	-0.0050	0.0052	-0.0010	0.0016	-0.0994
	P	-0.001	0.0021	0.0019	-0.0001	0.0006	0.0016	0.0014	-0.0010	0.0041	-0.0009	0.0003	0.0010	-0.0009	0.0002	-0.0003	-0.0848
Fruit length (cm)	G	-0.0018	-0.0009	-0.0006	-0.0015	-0.0007	-0.0007	-0.0011	0.0005	-0.0015	0.0040	0.0008	-0.0014	0.0014	-0.0006	-0.0006	-0.1358
	P	-0.0032	-0.0006	-0.0001	-0.0023	-0.0011	-0.0009	-0.0012	-0.0002	-0.0020	0.0095	0.0015	-0.0025	0.0023	-0.0014	-0.0013	-0.1242
Fruit width (cm)	G	0.0183	0.0171	-0.0045	0.0038	0.0070	0.0060	0.0019	0.0375	-0.0048	-0.0094	-0.0487	0.0046	-0.0050	-0.0200	0.0159	-0.3239
	P	0.0028	0.0008	-0.0004	0.0002	0.0007	0.0003	-0.0001	0.0041	-0.0005	-0.0013	-0.0085	0.0002	-0.0003	-0.0028	0.0022	-0.253
Fruit weight (g)	G	0.0035	0.0071	-0.0014	-0.0028	-0.0047	0.0024	0.0032	-0.0010	0.0034	-0.0048	-0.0013	0.0132	-0.0046	0.0027	-0.0014	-0.1160
	P	-0.0001	-0.0002	0.000	0.0001	0.0001	-0.0001	-0.0001	0.000	-0.0001	0.0001	0.0000	-0.0005	0.0002	-0.0001	0.000	-0.0885
Number of fruit per plant	G	0.0008	-0.0090	-0.0039	0.0003	-0.0062	-0.101	-0.0092	0.0027	-0.0039	0.0049	0.0015	-0.0051	0.0145	-0.0056	0.0012	0.0938
	P	-0.0008	0.0056	0.0025	-0.0009	0.0036	0.0066	0.0063	-0.0023	0.0032	-0.0035	-0.0005	0.0051	-0.0145	0.0052	-0.0009	0.0673
YVMV	G	-0.0039	0.0014	-0.0054	-0.004	-0.0014	0.0050	0.0059	-0.0044	0.0010	-	0.0079	0.0039	-	0.0193	0.0066	-

%											0.0030			0.0074			0.3477
	P	0.0022	-0.0007	0.0026	0.0001	0.0008	-0.0021	-0.0025	0.0022	-0.0005	0.0017	-0.0035	-0.0022	0.0039	-0.0110	0.0032	-0.3018
Fruit yield (t ha^{-1})	G	0.4799	0.0899	-0.0400	0.3861	0.0454	-0.3739	-0.4688	0.4308	-0.0863	-0.1450	-0.3302	-0.1080	0.0854	-0.3446	1.0102	1.008
	P	0.4386	0.1339	-0.0081	0.3165	0.0329	-0.2439	-0.3363	0.3223	-0.0774	-0.1345	-0.2586	-0.0793	0.0645	-0.2889	0.9952	0.997

Table 5: Clustering pattern of 18 Okra {*Abelmoschus esculentus* L.) genotypes based on D^2 statistics

Clusters	No. of genotypes	Name of the Genotypes
Cluster-I	11	Samrat, Nidhi, Bhindi PG-52, Joyti, Arka Anamika, Research variety, Palam Komal,Annu 50-OP, Champion, Indam 9821, rohini Bhindi Sel,
Cluster-II	4	Sahiba, Supergreen, Pandhari, Bhindi S-51
Cluster-III	1	Joya
Cluster–IV	1	Red ruby
Cluster –V	1	Verma

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

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Cluster 1	87.50	167.99	149.64	130.45	309.78
Cluster 2		86.47	160.26	180.55	173.41
Cluster 3			0.00	222.33	294.68
Cluster 4				0.00	406.41
Cluster 5					0.00

Table 7: Cluster mean values for seventeen 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	67.41	99.15	63.40	61.77	119.61
2.	Number of leaves per plant	32.64	32.93	32.22	36.94	33.61
3.	Number of branches per plant	3.66	3.27	3.34	4.50	3.19
4.	Length of internodes (cm)	7.86	8.62	8.33	5.73	8.70
5.	Number of nodes to firs flowering	35.54	35.18	36.50	32.30	32.70
6.	Days taken to first flowering	39.53	39.40	41.17	45.50	35.87
7.	Days taken to 50% flowering	40.67	40.85	42.17	48.50	35.87
8.	Days taken to first picking	4.94	4.77	5.82	5.63	6.24
9.	Fruiting node	5.60	5.95	4.98	7.40	5.45
10.	Fruit length (cm)	11.95	9.39	10.17	9.13	9.23
11.	Fruit width (cm)	1.30	1.15	0.87	0.96	0.82
12.	Fruit weight (g)	9.13	11.43	6.63	15.13	10.53
13.	Number of fruit per plant	11.21	9.99	6.77	8.47	13.12
14.	YVMV%	28.81	29.16	45.82	39.57	12.47
15.	Yield per plant (g)	174.94	171.81	185.16	155.15	240.18
16.	Fruit yield (t ha^{-1})	7.01	6.91	7.40	6.23	9.63

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

S. No.	Characters	Contributions (%)	Time ranked 1st
1.	Plant height	13.07	20
2.	Number of leaves per plant	0.00	
3.	Number of branches per plant	0.65	1
4.	Length of internodes (cm)	1.31	
5.	Number of nodes to firs flowering	0.00	
6.	Days taken to first flowering	5.88	9
7.	Days taken to 50% flowering	0.00	
8.	Days taken to first picking	0.00	
9.	Fruiting node	1.31	2
10.	Fruit length (cm)	3.92	6
11.	Fruit width (cm)	3.92	6
12.	Fruit weight (g)	9.15	14
13.	Number of fruit per plant	30.07	46
14.	YVMV%	22.88	35
15.	Yield per plant (g)	7.84	12
16.	Fruit yield (t ha^{-1})	0.00	

Conclusion

From the present study it is concluded that Okra genotypes under investigation showed significant genetic variability. Based on mean performance for fruit yield per plant (240.18) and fruit yield ((9.63t/ha^{-1}), genotypes Verma were considered suitable genotypes in Prayagraj climatic condition.

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