



# **Analysis of Genetic Variability and Correlation Studies on Fruit Yield and Its Component Characters in Okra (*Abelmoschus esculentus* L.)**

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## **ABSTRACT**

A field experiment was carried out with 20 Okra genotypes with one check for analysis of genetic variability and correlation studies on fruit yield and its component characters in Okra (*Abelmoschus esculentus* L.) in a randomized block design with three replications. The material was planted 30 x 45cm, and genotype to genotype 45 cm on July 20, 2023. The experiment was carried out during the *Kharif* season of 2023-2024 at research farm, College of Agriculture Saralgaon, Murbad, Thane. The observations were recorded on thirteen traits viz., days to first flowering, plant height (cm), number of branches per plant, number of internodes, internodal length (cm), fruit length (cm), fruit

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diameter (cm), average fruit weight (cm), number of fruits per plant, number of seeds per fruit, seed index (%), and fruit yield per plant (g). The estimation of analysis of variance revealed mean sum of square due to genotypes were significant for all the characters indicating sufficient genetic variability among the genotypes. The present study revealed that the phenotypic coefficient of variation was higher than the corresponding genotypic coefficient of variation for all the traits which might be due to the interaction of the genotypes with the environment to some degree or other explaining environmental factors influencing the expression of these characters. Moderate phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were recorded in plant height (cm), number of branches per plant, average fruit weight (cm), number of fruits per plant, and fruit yield per plant (g). High estimation genetic advance as a percentage of the mean was recorded for average fruit weight (cm), and number of fruits per plant. Moderate genetic advance as a percentage of the mean was recorded for plant height (cm), number of branches per plant, internodal length (cm) and fruit yield per plant (g). Low genetic advance as a percentage of the mean was recorded for days to first flowering, number of internodes, fruit length (cm), fruit diameter (cm), and number of seeds per fruit.

**Keywords:** Coefficient of variation; heritability; genetic advance; correlation; okra.

## 1. INTRODUCTION

“Okra [*Abelmoschus esculentus* (L.) Monech] is a polyploid, belonging to the family Malvaceae with  $2n = 2x = 72$  or 144 chromosome. It is the only vegetable crop in the Malvaceae family. It is a self-pollinated crop; occurrence of out crossing to an extent of 4 to 19% with the maximum of 42.2% is noticed with the insect assisted pollination. This self-pollinating crop is an example that requires a separation between varieties to maintain purity. It is an important vegetable crop grown in the tropical and sub-tropical parts of the world and commonly known as lady finger” [1,2]. “It has been cultivated for ages, and extensively disseminated from Africa to Asia, Southern Europe and America and currently grown in many countries. It is extensively cultivated for its tender immature fruits, which are largely used as fresh vegetables. Fruit has various medicinal properties too. It is useful in fever, chronic dysentery, and irritable states of genitro” [3]. “It is good for people suffering from renal colic, leucorrhoea, spermatorrhoea, chronic dysentery and general weakness. Nowadays many commercial cultivars including F1 hybrids of okra is available in the market, but all these are not adapted and suited to all the regions of the country. Further, no specific recommendation about the suitability of genotypes for a particular area is available. Farmers face problems in selecting genotypes/cultivars for commercial cultivation in a particular area. Considering the above-mentioned facts, there is a need to compare some of the available genotypes/cultivars to select high yielding, better adaptable genotypes/cultivars for commercial cultivation in Bangladesh. Knowledge of genetic

diversity among okra germplasm will play significant role in breeding program as it helps to develop varieties with desired traits” [4,5]. “It is a prerequisite to develop high yielding okra varieties like in all other crop improvement. This is important for selecting parents in combination breeding and to obtain transgressive segregants. The knowledge of pattern of inheritance of various characters are important consideration while, determining the most approximate breeding procedures applicable to any particular crop. The phenotype is often not true indicator of its genotype. The phenotypic variability is the result of the effect of environment and genotype interaction. Path coefficient analysis is also very useful in formulating breeding strategy to develop elite genotypes through selection in advanced generations. In that perspective, attempts need to be made to determine the magnitude of heritable and non-heritable components and genetic parameters such as genotypic and phenotypic coefficient of variation, heritability and genetic advance as percentage of mean in some of the quantitative characters of Okra” [6,7]. Since the pattern of inheritance of quantitative characters is highly complex, therefore the present investigation was undertaken to determine the genetic divergence, heritability, genetic genetic advance, variability, character association in different okra genotypes and their direct and indirect contribution to fruit yield in okra with the ultimate goal of identifying the most diverse and high yielding genotypes for fruit yield.

## 2. MATERIALS AND METHODS

The experiment was carried out during the *Kharif* season of 2023-2024 at Research Farm,

College of Agriculture Saralgaon, Murbad, Thane. This place is situated at 19°16'53.9"N 73°29'41.3"E. This region has a humid subtropical climate with cool winters and long, hot summers. Summers last from April to June and winters from November to February. Temperatures in the summer vary from average highs of around 48 °C (118 °F) to average lows of around 25 °C (77 °F). Winter temperatures have highs of 19 °C to lows of 10°C. The climate is dry overall, except during the brief southwest monsoon season during July and August. The average annual rainfall is about 120 cm.

The experimental material comprised of 20 Okra genotypes grown in randomized block design with three replications during, *Kharif* 2023. The material was planted 30 x 45cm on July 20, 2023. Data were recorded on five random and competitive plants of each genotype from each replication for various characters viz. days to first flowering, plant height (cm), number of branches per plant, number of internodes, internodal length (cm), fruit length (cm), fruit diameter (cm), average fruit weight (cm), number of fruits per plant, number of seeds per fruit, seed index (%), and fruit yield per plant (g) which were recorded. An analysis of variance was performed on mean values in order to determine the importance for each character, using Panse and Sukhatme's (1967) recommended technique. The formulas provided by Burton (1952) and De Vane (1953) were used to determine GCV and PCV, whereas Johnson et al. (1955)'s method was used to calculate genetic advance, or the projected genetic gain, and heritability in the broad sense ( $h^2$ ). Correlation coefficients were calculated using Singh and Chaudhary's (1985) recommended methodology.

## 2.1 Statistical Analysis

The data on various crop characters were subjected to statistical analysis by using appropriate method of analysis of variance and covariance as described by Panse and Sukhatme (1962) [1]. The range and estimates of mean, phenotypic, genotypic, and environmental variance and covariance, standard error, coefficient of variation and critical difference were obtained for all the thirteen traits. The significance of difference between genotypes for various characters was tested. The significance was tested by referring to the table given by Snedecor [2]. The phenotypic and genotypic

coefficients of variation in percent were computed by the following formulae given by Burton [3]. The PCV and GCV value are ranked as low, medium, and high [4] and are mentioned below. Heritability in percent in a broad sense was estimated by the method given by Hanson et al. [5]. Heritability values are categorized as low, moderate, and high [6]. Improvement in the mean genotypic value of selected plants over the parental population is known as genetic advance. Expected genetic advance (GA) was calculated by the method suggested by Johnson et al. [7]. The Phenotypic, genotypic, and environmental correlation coefficients between characters were computed utilizing respective components of variance and co-variance, by following formula suggested by Al Jibouri et al. [8]. To test the significance of phenotypic and environmental correlation coefficients, the estimated values were compared with the tabulated values of Fisher and Yates (1938) at n-2 d.f. at two levels of probability, viz., 5% and 1%.

## 3. RESULTS AND DISCUSSION

"Analysis of variance indicated that the mean sum of squares due to genotypes were highly significant for all the characters revealing that there was considerable genetic variability amongst the material under study. There is significant variation for replication which shows that error due to a high environment. The results from the analysis of the variance of all characters under the study have been given in Table 1" [9,10,11,12]. The mean performance and range also showed larger variation for all 12 traits studied in the present investigation has been presented in Table 2.

The phenotypic coefficient of variation was greater than genotypic coefficient of variation for all the traits (Table 3). It means the observed variation is not only due to the genotypes, but also due to suitable influence of environment. The highest estimates of PCV and GCV indicate that these characters have quantitative inheritance and are considerably more or less influenced by environmental factors. Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) was recorded as moderate for plant height (cm), number of branches per plant, average fruit weight (cm), number of fruits per plant, and fruit yield per plant (g). Similar kind of results were found by

**Table 1. Analysis of variance for twelve characters in Okra**

S. No.	Characters	Source of variation		
		Replications	Treatments	Error
	Degree of freedom	2	19	38
1	Days to first flowering	2.33	10.83**	1.30
2	Plant height (cm)	1.31	178.5**	13.21
3	Number of branches per plant	0.38	0.71**	0.84
4	Number of internodes	0.25	0.52*	0.20
5	Internodal length (cm)	0.10	0.81**	0.07
6	Fruit length (cm)	1.52	4.71**	1.81
7	Fruit diameter (cm)	0.08	0.29**	0.07
8	Average fruit weight (cm)	0.39	5.10**	0.51
9	Number of fruits per plant	1.33	5.99**	0.84
10	Number of seeds per fruit	280.67	10.8*	6.29
11	Seed index (%)	0.07	4.18**	0.7
12	Fruit yield per plant (g)	2170.7	1670.4**	223.2

\* Significant at 5 % probability level, \*\* Significant at 1 % probability level.

**Table 2. Adjusted mean of genotypes and checks, range and least significant differences for ten characters in Okra**

S.N.	Genotypes	Days to first flowering	Plant height (cm)	Number of branches per plant	Number of internodes	Internodal length (cm)	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (cm)	Number of fruits per plant	Number of seeds per fruit	Seed index (%)	Fruit yield per plant (g)
1	IC- 22283	39.67	92.97	6.37	11.39	5.83	18.79	4.13	8.20	8.62	46.37	5.55	215.69
2	IC- 22285	45.33	84.23	5.37	11.39	4.77	17.36	4.13	7.19	7.23	48.12	5.05	165.80
3	IC- 23594	39.67	77.00	6.71	11.77	5.67	18.96	4.50	9.27	11.87	47.02	7.70	275.91
4	IC- 27831	39.33	63.10	5.71	11.01	5.47	14.97	4.10	8.29	11.57	50.72	7.10	230.31
5	IC- 27874	42.00	63.37	5.71	11.39	4.80	16.72	4.53	7.49	8.58	46.41	8.55	210.25
6	IC- 27875	40.00	71.27	5.71	11.01	4.03	17.20	3.83	11.20	8.98	48.08	7.50	209.49
7	IC- 27877	43.67	66.60	4.71	11.01	4.60	19.44	4.10	7.99	9.34	48.99	8.05	206.57
8	IC- 27878	40.00	60.23	6.04	11.01	5.60	16.88	4.60	11.79	8.39	46.23	7.90	203.55
9	IC- 27879	39.33	64.63	5.71	11.01	5.63	18.00	4.40	10.59	11.40	50.13	6.90	221.87
10	IC- 27881	42.00	78.07	5.37	11.01	4.87	16.88	4.33	8.49	8.10	47.01	4.90	197.84
11	IC- 27898	39.67	64.07	5.71	11.39	5.53	18.64	4.20	9.65	11.49	53.18	6.40	232.37
12	IC- 28359	44.33	68.57	4.71	11.01	4.43	18.16	4.50	9.15	9.66	46.09	6.55	217.91
13	IC- 29117	40.00	80.67	5.71	10.62	5.73	18.96	4.40	11.40	11.69	46.12	5.10	253.61
14	EC-112112	40.00	71.60	5.71	11.77	5.43	17.20	4.20	9.57	11.47	48.85	7.50	238.06
15	EC- 112241	40.33	68.80	5.04	11.01	5.63	18.64	4.53	9.64	11.82	47.05	8.45	228.14
16	EC- 169355	39.33	65.40	5.71	10.24	5.67	16.40	4.40	9.32	11.32	47.17	7.50	221.88
17	EC- 169364	44.33	62.97	6.37	11.39	4.90	15.92	4.10	8.13	10.01	52.16	7.60	183.38
18	EC- 169468	40.00	74.83	6.37	11.77	5.40	15.92	4.37	9.89	11.40	48.65	8.45	242.78
19	EC- 169481	40.00	71.53	5.04	11.01	5.20	16.72	4.73	11.00	11.87	48.63	6.50	258.08
20	EC- 169499	43.67	70.10	5.71	10.62	4.33	17.52	4.53	9.59	9.49	50.00	4.51	198.82
<b>Mean</b>		41.13	71.00	5.67	11.14	5.18	17.46	4.33	9.39	10.22	48.35	6.89	220.61
<b>Range</b>	<b>Max</b>	45.33	92.97	6.71	11.77	5.83	19.44	4.73	11.79	11.87	53.18	8.55	275.91
	<b>Min</b>	39.33	60.23	4.71	10.24	4.03	14.97	3.83	7.19	7.23	46.09	4.51	165.80

**Table 3. Estimate of coefficient of variation, h<sup>2</sup> (broad sense), and genetic advance in percent of mean in Okra**

S. No.	Characters	Range		Mean	Coefficient of variation		Heritability in broad sense (%)	Genetic advance in percent of mean
		Max	Min		PCV	GCV		
1	Days to first flowering	45.33	39.33	41.13	5.72	3.31	81.43	7.12
2	Plant height (cm)	92.97	60.23	71	12	9.58	90.5	19.96
3	Number of branches per plant	6.71	4.71	5.67	12.02	10.12	87.42	19.29
4	Number of internodes	11.77	10.24	11.14	5.94	2.61	51.53	4.44
5	Internodal length (cm)	5.83	4.03	5.18	10.03	8.03	92.51	16.58
6	Fruit length (cm)	19.44	14.97	17.46	9.09	5.45	61.71	-0.36
7	Fruit diameter (cm)	4.73	3.83	4.33	5.21	2.83	80.76	6.18
8	Average fruit weight (cm)	11.79	7.19	9.39	12.33	10.16	89.84	20.43
9	Number of fruits per plant	11.87	7.23	10.22	17.59	14.41	84.24	28.48
10	Number of seeds per fruit	53.18	46.09	48.35	5.28	2.19	53.49	3.9
11	Seed index (%)	8.55	4.51	6.89	5.72	3.31	96.36	30.19
12	Fruit yield per plant (g)	275.91	165.8	220.61	12	11.18	81.43	18.85

**Table 4 (a). Estimates of Phenotypic correlation between different characters in Okra**

S.N.	Characters	Days to first flowering	Plant height (cm)	Number of branches per plant	Number of internodes	Internodal length (cm)	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (cm)	Number of fruits per plant	Number of seeds per fruit	Seed index (%)	Fruit yield per plant (g)
1	Days to first flowering	<b>1.0000</b>	0.1084	-0.1612	0.2315	-0.6261	0.1112	-0.0075	-0.2828	-0.4938	0.2436	-0.1548	-0.5653
2	Plant height (cm)		<b>1.0000</b>	0.2535	0.1959	0.2322	0.2909*	-0.1167	-0.1183	-0.0648	-0.2956	-0.4405	0.1831
3	Number of branches per plant			<b>1.0000</b>	0.4839**	0.2957*	-0.1488	0.0097	0.2339	0.119	0.2246	0.2322	0.2656
4	Number of internodes				<b>1.0000</b>	0.0659	-0.0546	0.0523	0.0683	-0.0847	0.2566	0.3198*	0.0811
5	Internodal length (cm)					<b>1.0000</b>	0.1360	0.2988*	0.0659	0.5944**	-0.1452	0.1364	0.5577**
6	Fruit length (cm)						<b>1.0000</b>	0.182	0.1564	0.2489	-0.0259	-0.0825	0.3114
7	Fruit diameter (cm)							<b>1.0000</b>	0.3421**	0.3039	-0.2254	0.203	0.3733*
8	Average fruit weight (cm)								<b>1.0000</b>	0.2831*	-0.0378	0.0665	0.3529**
9	Number of fruits per plant									<b>1.0000</b>	0.5403	0.2364	0.7703**
10	Number of seeds per fruit										<b>1.0000</b>	-0.0457	-0.1861
11	Seed index (%)											<b>1.0000</b>	0.2186
12	Fruit yield per plant (g)												<b>1.0000</b>

\*, \*\* Significant at 5 % and 1 % probability levels, respectively.

**Table 4(b). Estimates of Genotypic correlation between different characters in Okra**

S.N.	Characters	Days to first flowering	Plant height (cm)	Number of branches per plant	Number of internodes	Internodal length (cm)	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (cm)	Number of fruits per plant	Number of seeds per fruit	Seed index (%)	Fruit yield per plant (g)
1	Days to first flowering	<b>1.0000</b>	0.0165	-0.2012	0.0647	-0.7321	-0.0030	-0.1228	-0.4390	-0.6001	0.2050	-0.2718	-0.7702
2	Plant height (cm)		<b>1.0000</b>	0.1617	0.1028	0.1336	0.3650**	-0.2548	-0.3186	-0.2123	-0.5070	-0.57668	0.0781
3	Number of branches per plant			<b>1.0000</b>	0.6111**	0.3237**	-0.3526	-0.1382	0.1113	0.0455	0.1353	0.1177	0.1771
4	Number of internodes				<b>1.0000</b>	-0.0404	-0.4069	-0.0291	-0.0056	-0.3210	0.2254*	0.4268**	0.0157
5	Internodal length (cm)					<b>1.0000</b>	0.1195	0.3004	0.0633	0.6272	-0.2089	0.1565	0.5449**
6	Fruit length (cm)						<b>1.0000</b>	0.0764	0.0680	0.1858	-0.2433	-0.2091	0.2291
7	Fruit diameter (cm)							<b>1.0000</b>	0.3226**	0.2516*	-0.5632	0.0992	0.3101
8	Average fruit weight (cm)								<b>1.0000</b>	0.3029*	-0.0639	0.0507	0.4335**
9	Number of fruits per plant									<b>1.0000</b>	0.3584**	0.2141	0.9004**
10	Number of seeds per fruit										<b>1.0000</b>	-0.0239	-0.1094
11	Seed index (%)											<b>1.0000</b>	0.2156
12	Fruit yield per plant (g)												<b>1.0000</b>

\*, \*\* Significant at 5 % and 1 % probability levels, respectively

[13,14,15,16]. "High heritability estimates were observed by in days to first flowering, plant height (cm), number of branches per plant, internodal length (cm), fruit diameter (cm), average fruit weight (cm), number of fruits per plant, seed index (%), and fruit yield per plant (g). Moderate heritability was found in number of internodes, fruit length (cm), and number of seeds per fruit. Very high heritability coupled with high genetic advance observed in traits viz., for seed index (%) thus these characters show additive gene action in their expression. High estimation genetic advance as a percentage of the mean was recorded for average fruit weight (cm), and number of fruits per plant. Moderate genetic advance as a percentage of the mean was recorded for plant height (cm), number of branches per plant, internodal length (cm) and fruit yield per plant (g). Low genetic advance as a percentage of the mean was recorded for days to first flowering, number of internodes, fruit length (cm), fruit diameter (cm), and number of seeds per fruit". Similar kind of results were found by [17,18,19,16,20].

In the present findings, the magnitudes of the phenotypic correlation coefficient Table 4 (a) were greater than the corresponding genotypic correlation coefficient Table 4 (b). Similar findings by [21,22,23,24,25]. A significant phenotypic and genotypic correlation with the fruit yield per plant exhibited highly significant and positive at phenotypic level followed by internodal length (cm), average fruit weight (cm), and number of fruits per plant.

#### 4. CONCLUSION

Our investigation revealed that genotypes possessed considerable genetic variability for different characters under study which makes them suitable for utilization in different breeding programmes. The mean sum of squares attributed to genotypes were significant for all features, according to the calculation of analysis of variance, suggesting that there was enough genetic diversity among the genotypes. The results of this study showed that for every trait, the phenotypic coefficient of variation was greater than the corresponding genotypic coefficient of variation. This finding may be the result of some interaction between the genotypes and the environment, which could explain environmental factors that affect how these characters express themselves. PCV and GCV

are highly observed for was recorded as moderate for plant height (cm), number of branches per plant, average fruit weight (cm), number of fruits per plant, and fruit yield per plant (g). which suggests greater phenotypic and genotypic variability among the genotypes and responsiveness of the attributes for making further improvement by selection. High heritability estimates were observed by in days to first flowering, plant height (cm), number of branches per plant, internodal length (cm), fruit diameter (cm), average fruit weight (cm), number of fruits per plant, seed index (%), and fruit yield per plant (g). High estimation genetic advance as a percentage of the mean was recorded for average fruit weight (cm), and number of fruits per plant. Thus, this character revealed the most important association of fruit yield per plant in Okra.

#### DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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