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Estimation of Correlation and Path Coefficient Analysis for Quantitative Characters in Okra *(Abelmoschus esculentus* L. Moench) Genotypes

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The purpose of the present study was to evaluate the genetic variability and parameters such as genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability, genetic advance, as well as perform correlation and path analyses on 20 different okra genotypes, including one check variety. The experiment was conducted during the kharif season of 2022 at the experimental farm of the Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences in Prayagraj, Uttar Pradesh. A randomized block design with three replications was employed for the study. Thirteen characteristics were observed and recorded, which includes: days to first flowering, days to 50% flowering, length of mature fruit (cm), diameter of fruit (cm), average fruit weight (gm), internodal length (cm), number of nodes on the main stem, number of primary branches, plant height (cm),

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number of fruits per plant, number of seeds per fruit, seed index (gm), and fruit yield per plant (gm). Azad Bhindi-1 exhibited the highest mean performance in terms of fruit yield per plant among all the genotypes. The PCV values were consistently higher than the corresponding GCV values for all traits, indicating the influence of environmental factors on trait expression. Fruit yield per plant and number of primary branches displayed the highest GCV and PCV values. The number of primary branches exhibited both high heritability and genetic advance. The correlation analysis revealed a positive and significant association between number of fruits per plant and fruit yield per plant at both the genotypic and phenotypic levels. The traits with the highest positive direct effects on fruit yield per plant were obsereved for average fruit weight and plant height, as determined through genotypic and phenotypic path analysis. These identified traits can serve as effective selection criteria for strategizing an efficient breeding programme to enhance fruit yield in okra.

Keywords: Okra; phenotypic; genotypic; correlation; heritability.

1. INTRODUCTION

Okra, scientifically named (*Abelmoschus esculentus* .L Moench) is a member of the Malvaceae family and is commonly referred to as Lady's finger or bhindi. It has a somatic chromosomal number of 2n=130. Okra is widely cultivated in various regions of the world, including temperate, subtropical and tropical areas [1]. Okra is primarily a self-pollinated crop, but it has been observed that insect-mediated outcrossing occurs to some degree, ranging from 4 to 19 percent [2]. This outcrossing contributes to the emergence of significant genetic diversity in the crop. It is a day-neutral plant, cultivated as an annual crop throughout the year in various regions of the country, primarily for its delectable and tender pods [3]. The origins of okra are subjected to debate, with proponents suggesting its roots in South Asia, Ethiopia and Africa. However, it is believed that okra originated in the Ethiopian region [4, 5].

In world, India is the second largest producer of okra after china. In India, major okra growing states are Gujarat, Maharashtra, Uttar Pradesh, Andhra Pradesh, Karnataka, Tamil Nadu, Punjab *etc.* At national level during 2020-21, okra was grown in 531 ha area with 6466 tonnes of production with average productivity of 12.24 qt/ha. In the state of Utter Pradesh, it was grown in 24.19 ha area with 325.59 tonnes of production with average productivity of 11.30qt/ha. After being cooked, okra fruits are commonly utilized in curries and soups. These fruits are abundant in essential nutrients such as vitamin A and C, riboflavin, as well as minerals like calcium, phosphorus, iodine, iron, and potassium. Verma and Singh, [1]. Fresh okra is highly nutritious, with a composition that includes 86.1 percent water, 0.2 percent fat, 9.7 percent carbohydrates, 2.2 percent protein, 1.0 percent fiber, and 0.8 percent ash [6]. Additionally, it is a rich source of vitamin C (30 mg/100 g), calcium (90 mg/100 g), and iron (1.5 mg/100 g) [7].

The correlation and path coefficient analyses are essential tools for selecting superior genotypes and improving various traits. In the field of plant breeding, correlation analysis plays a vital role by providing insights into the relationships among yield components. This information aids in the identification and selection of superior genotypes from diverse genetic populations.

Path coefficient analysis permits the separation of correlation coefficient into direct and indirect effects. It is basically a standardized partial regression analysis and deals with a closed system of variables that are linearly related. Such information provides a realistic basis for allocation of appropriate weightage to various yield components.

1.1 Objectives

The present investigation is contemplated with the following objectives:

1. To assess genetic variability present in okra genotypes.
2. To estimates the correlation coefficient for fruit yield and its contributing traits.
3. To determine direct and indirect effect effects of yield contributing characters on fruityield.

2. MATERIALS AND METHODS

The genetic material used in this study consisted of 20 different genotypes of okra (*Abelmoschus* *esculentus* L. Moench). The experiment was conducted at the Experimental Farm of the Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, located in Prayagraj, Uttar Pradesh. The genotypes were planted using a randomized block design with three replications. The row-to-row distance was maintained at 30 cm, while the plant-to-plant distance was set at 20 cm. Data were recorded on thirteen quantitative traits *viz.,* 1. Days to first flowering 2. Days to 50% flowering 3. Length of mature fruit (cm) 4. Diameter of fruit (cm) 5.Average fruit weight (gm) 6. Internodal length (cm) 7. Number of nodes per plant 8. Number of primary branches 9. Plant height(cm) 10.Number of fruits per plant 11. Number of seeds per fruit 12. Seed index (g) 13. Fruit yield per plant (gm). The experimental material under study were collected from the Indian Institute of Vegetable Research (IIVR) in Varanasi. The study was carried out during the *Kharif* season of 2022.

The Panse and Sukhatme (1967) method were used to analyse the variance in all of the recorded data for the characters under consideration. Additionally, the genetic parameters genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability in the broad sense, genetic advance as percent of mean and correlation analysis were carried out by using the statistical methods. The additional components of variance include phenotypic variance, genotypic variance and environmental variance.

The Software called "R – Language" was used to perform the analyses mentionedabove.

The details of the experimental material were mentioned below in (Table 1).

Table 1. Details of okra genotypes under study

SL.NO	Names of genotypes	SL.NO	Names of genotypes
01	Kashi Lalima	**11**	AZAD BHINDI-2
02	HRB-55	**12**	PUNJAB-8
03	VRO-4	**13**	GO-3
04	SB-6	**14**	HRB-231
05	EMS-8-1	**15**	KASHI PRAGATI
06	IIVR-11	**16**	PUNJAB-7
07	BO-13	**17**	UTTAKAL GAURAV
08	AZAD BHINDI-1	**18**	NO-55
09	ARKA ANAMIKA	**19**	PUNJAB SUHAVANI
10	ARKA ABHAY	**20**	KASHI CHAMAN(check)

Source: Indian Insitute of Vegetable Research, Varanasi, (IIVR)

Table 2. Analysis of variance (ANOVA) among 20 Okra genotypes for 13 quantitative traits

Sl. No.	Source	Mean Sum of Squares (MSS)		
		Replications	Treatments	Error
	Degrees of freedom	**2**	**19**	**38**
1	Days to first flowering	2.62	20.56**	1.37
2	Days to 50% flowering	0.82	26.38**	1.55
3	Length of Mature fruit(cm)	1.94	4.44**	1.56
4	Diameter of fruit (cm)	0.02	0.05**	0.01
5	Inter nodal length (cm)	0.08	0.66**	0.21
6	Number of primary branches	0.02	0.41**	0.01
7	Average fruit weight (gm)	10.64	16.76**	5
8	Number of fruits per plant	1.49	8.53**	0.75
9	Number of nodes on main stem	1.99	10.04**	1.00
10	Plant height(cm)	78.63	482.75**	28.16
11	Number of seeds per fruit	48.64	72.49**	16.49
12	Seed index(gm)	0.001	0.44**	0.18
13	Fruit yield per plant (gm)	1191.84	6364.03**	1192.76

***1% level of Significance*

3. RESULTS AND DISCUSSION

3.1 Analysis of Variance

(Table 2) presents the mean sum of squares values for the 13 biometrical traits. The results indicate significant differences among the genotypes for all traits. Maximum mean sum of squares values were observed for fruit yield per plant and plant height at 1% significance. This suggests that there is a wide range of variation within the gene pool, providing ample scope for selecting promising lines with high yield and desirable component traits. Among the 20 okra genotypes evaluated, Azad Bhindi-1 (287.0), GO-3 (269.2), and Arka Anamika (237.3) exhibited the highest mean performance for fruit yield per plant from (chart 1)

3.2 Genotypic and Phenotypic Varience

The range for Phenotypic Coefficient of Variation (PCV) varies from (6.328%) in days to first flowering to (25.316 %) in case of fruit yield per plant. The high (>20%) PCV were recorded respectively for fruit yield per plant (25.316) and number of primary branches (22.508). The moderate (10-20%) PCV were recorded respectively for number of fruits per plant (16.126), plant height (15.037), average fruit weight (14.609), number of nodes on main stem (11.472) and internodal length (10.845).The low (<10%) estimates of PCV were observed respectively for number of seeds for fruit (9.647), length of mature fruit (9.397), diameter of fruit (7.562), seed index (7.508), days to 50% flowering (6.745) and days to first flowering (6.328) from (Table 3). A similar declaration has been made by Rana et al*.,* [8] and Kumari et al*.,* [9].

Range for Genotypic Coefficient of Variation (GCV) varies from (22.821%) in fruit yield per plant to (5.776%) in case of seed index. The high (>20%) GCV were recorded respectively for fruit yield per plant (22.821) and number of primary branches per plant (22.165). The moderate (10-20%) GCV were observed for number of fruits per plant (15.403), plant height (14.592), average fruit weight (12.237) and number of nodes on main stem (10.887). The low (<10%) were recorded for internodal length (8.976), number of seeds per fruit (8.479), length of mature fruit (7.563), diameter of fruit (6.817), days to 50% flowering (6.543), days to first flowering (6.114), and seed index (5.776). from (Table 3). A similar identification was made by [10].

3.3 Heritability

The high (>60%) heritability was found for number of primary branches (97%), plant height (94.2%), days to 50% flowering (94.1%), days to first flowering (93.3%), number of fruits per plant (91.2%), number of nodes on main stem (90.1%), diameter of fruit (81.3%), fruit yield per plant (81.3%), number of seeds per fruit (77.3%), average fruit weight (70.2%), internodal length (68.5%), length of mature fruit (64.8%). The magnitude of heritability was found to be moderate (30-60%) for seed index (59.2%). from (Table 3). Such similar observations were reported by Vani et al*.,* [11] and Alam et al*.,* [12].

3.4 Genetic Advance and Genetic Advance as Percent of Mean

The expected genetic advance for different characters ranged from (77.097) in case of fruit yield per plant to (0.21) in case of diameter of fruit. More than (>20%) values were obtained for fruit yield per plant (77.097) and plant height (24.608). The moderate to lowest (<20) values were found in number of seeds per fruit (7.823), days to 50% flowering (5.749), days to first flowering (5.033), average fruit weight (3.416), number of nodes on main stem (3.394), number of fruits per plant (3.168), length of mature fruit (1.623), number of primary branches (0.742), internodal length (0.66), seed index (0.466), and diameter of fruit (0.21) from (Table3). similar findings were observed in [9].

The expected genetic advance as percent of mean for different characters ranged from (44.965%) in case of number of primary branches to (9.153%) as in the case of seed index. The lowest (<50%) values were observed for all the characters fruit yield per plant (42.377), number of fruits per plant (30.307), plant height (29.169), number of nodes on the main stem (21.284), average fruit weight (21.115), number of seeds per fruit (15.353), internodal length (15.306), days to 50% flowering (13.076), days to first flowering (12.67), diameter of the fruit (12.66), length of mature fruit (12.54), and seed index (9.153).The results indicating the characters are predominantly regulated by additive gene action. As a result of accumulation of more additive genes leading to future improvement, simple selection would be effective of these traits based on phenotypic expression.

3.5 Correlation Coefficient

For assessing the relationship between different traits, a study of correlation coefficients facilitates the identification of certain traits in plants that could potentially be focused on for genetic yield improvement. In order to increase yield, it is important to look into the existence of these features to understand how they are connected. The correlation coefficient reveals the degree to which two attributes are related to one another as well as if it is possible to simultaneously improve both traits.

3.5.1 Phenotypic correlation coefficient

Phenotypic Correlation coefficient analysis revealed that fruit yield per plant exhibited positive and significant correlation with number of fruits per plant (0.728**), average fruit weight (0.6709**), length of mature fruit (0.651**), number of nodes on the main stem (0.3487**), plant height (0.3131**), and diameter of fruit (0.2092*). However, positive non-significant associations were observed with days to 50% flowering (0.1817), days to first flowering (0.0818), and internodal length (0.0051). On the other hand, there were negative non-significant associations with seed index (-0.0013), number of primary branches (-0.0042), and number of seeds per fruit (-0.1039) from (Table 4). Such similar observations have been made by [13,14].

3.5.2 Genotypic correlation coefficient

Genotypic Correlation coefficient analysis revealed that fruit yield per plant exhibited positive and significant correlation with length of mature fruit (0.7994**), average fruit weight (0.7994**), number of fruits per plant (0.7878**), number of nodes on main stem (0.4113**) and plant height (0.3228**). Fruit yield per plant exhibited positive and non- significant correlation with days to first flowering (0.0998), diameter of fruit (0.1814) and number of primary branches (0.0117). Fruit yield per plant exhibited negative and non- significant correlation with number of seeds per fruit (-0.0877), internodal length (-0.0711) and seed index (-0.0189) from (Table 4). Such similar observations have been made by [15, 16,17,18].

3.6 Path coefficient Analysis

Through path-coefficient analysis, the phenotypic and genotypic correlation coefficients of all the individual parameters assessed with fruit yield have been separated into direct and indirect effects. Fruit yield is directly or indirectly affected by numerous factors at the genotypic and phenotypic levels. The findings indicate the direct as well as indirect effects of numerous variables on plant fruit yield. Path coefficient analyses revealed that direct and indirect impacts at the genotypic level were somewhat greater than direct and indirect effects at the phenotypic level. The analysis serve as an outline for selection and assist in identifying the yield contributing features that impact yield in crop.

3.6.1 Phenotypic path coefficient analysis

The phenotypic path coefficient analysis indicated that several traits had a positive direct effect on fruit yield per plant. The traits with the highest positive direct effects were observed for days to 50% flowering (0.7678), number of fruits per plant (0.4228), plant height (0.2927), number of primary branches (0.2273), average fruit weight (0.2018), internodal length (0.1201) and length of mature fruit (0.007). On the other hand, days to first flowering (-0.619, number of seeds per fruit (-0.2234), diameter of fruit (-0.0784), number of nodes on the main stem (-0.0159), and seed index (-0.0009) exhibited negative direct effects on fruit yield per plant in (Table 5). Similar findings were obsereved by [9,10,19].

3.6.2 Genotypic path coefficient analysis

The genotypic path coefficient analysis revealed positive direct effects on fruit yield per plant for several traits. Plant height had the highest positive direct effect (0.669), followed by average fruit weight (0.5336), number of nodes on the main stem (0.1346), days to first flowering (0.1068), and length of mature fruit (0.0739). On the other hand, the maximum negative direct effect on fruit yield per plant was observed from diameter of fruit (-0.5714), followed by internodal length (-0.5014), number of fruits per plant (-0.4409), number of seeds per fruit (0.4248), seed index (-0.0431), days to 50% flowering (-0.165) and number of primary branches (-0.4409). Similar findings were observed in [14,20,2,21].

Chart 1. Mean performance of genotypes with respect to 13 characters

Sl. No.	Genotypes	Days to first flowering	Days to 50% flowering	Length of mature fruit (cm)	Diameter of fruit (cm)	Internodal length (cm)	No. of primary branches	Average fruit weight (gm)	Number of fruits per	Number of nodes on main stem	Plant height (cm)	Number ofseeds per fruit	Seed index (gm)	Fruit yieldper plant (gm)
1	Kashi Lalima	41.0	43.3	12.5	1.7	5.1	1.4	12.9	8.7	14.5	87.2	49.3	4.6	134.9
2	HRB-55	41.7	43.0	12.5	1.7	4.0	1.6	16.3	10.3	16.9	77.5	49.4	4.9	155.3
3	VRO-4	39.0	42.7	13.9	1.5	4.8	1.5	15.1	9.9	16.3	95.6	53.5	4.8	203.7
4	SB-6	37.7	41.3	13.4	1.9	5.3	1.2	16.1	9.6	14.7	112.2	55.5	5.1	208.0
5	EMS-8-1	40.0	43.7	12.0	1.7	4.1	1.5	17.0	8.5	16.1	75.3	53.3	5.3	160.0
6	IIVR-11	41.0	42.0	13.9	1.6	4.2	2.1	13.8	10.5	16.3	82.7	55.3	4.9	146.2
7	BO-13	41.0	43.3	12.4	1.6	3.5	2.3	17.1	12.7	15.5	71.7	47.1	5.6	218.5
8	Azad Bhindi-1	47.7	52.7	13.8	1.8	4.4	1.5	21.4	12.3	20.3	96.4	60.8	5.4	287.0
9	Azad Bhindi-2	48.7	51.3	11.0	1.4	4.0	1.5	12.1	9.3	14.2	75.2	52.9	5.2	126.6
10	Arka Anamika	42.7	44.3	13.4	1.6	4.4	2.3	15.9	11.3	18.6	102.0	46.4	4.9	237.3
11	Arka Abhay	42.7	45.7	14.3	1.8	4.6	1.2	17.1	10.1	16.6	92.7	50.5	5.6	178.7
12	Punjab-8	40.0	42.7	13.7	1.7	4.3	1.4	15.4	11.6	16.5	83.9	49.7	5.3	184.0
13	GO-3	40.3	42.3	14.9	1.5	4.5	1.4	20.1	13.7	13.8	83.8	45.2	4.8	269.2
14	HRB-231	40.0	42.0	10.8	1.5	4.4	1.8	13.8	9.9	14.0	61.3	47.2	5.1	129.2
15	Punjab-7	40.7	43.7	12.4	1.7	3.5	2.5	17.1	9.9	14.7	68.3	46.1	5.1	181.9
16	Uttakal Gauravu	40.7	43.3	12.5	1.9	4.0	1.4	18.2	10.4	13.5	72.9	47.3	5.4	187.9
17	NO-55	41.3	43.7	11.6	1.6	4.1	2.0	14.4	9.5	18.7	92.1	59.0	4.7	132.8
18	Punjab Suhavani	42.0	44.7	12.1	1.7	4.7	1.6	19.0	8.7	14.9	85.2	57.7	5.5	153.7
19	Kashi Pragati	39.3	41.0	15.3	1.7	3.8	1.4	14.0	14.1	17.7	74.4	42.7	4.2	204.5
20	Kashi Chaman (Check)	40.0	42.7	12.6	1.8	4.5	1.4	16.9	8.1	15.0	97.1	50.3	5.6	139.5
	Mean	41.4	44.0	12.9	1.7	4.3	1.7	16.2	10.5	16.0	84.4	51.0	5.1	181.9
Range	Minimum	37.7	41.0	12.5	1.4	3.5	1.2	12.1	8.1	13.5	61.3	42.7	4.2	126.6
	Maximum	48.7	52.7	12.6	1.9	5.3	2.5	21.4	14.1	20.3	112.2	60.8	5.6	287.0
	SEM	0.7	0.7	0.7	0.1	0.3	0.1	1.3	0.5	0.6	3.1	2.3	0.2	19.9
	CD at 5%	1.9	2.1	2.1	0.2	0.8	0.2	3.7	1.4	1.7	8.8	6.7	0.7	57.1
	CD at 1%	2.6	2.8	2.8	0.2	1.0	0.3	5.0	1.9	2.2	11.8	9.0	0.9	76.5
	CV	2.8	2.8	9.7	5.7	10.5	6.8	13.8	8.3	6.3	6.3	8.0	8.3	19.0

Table 3. Genetic parameters for 13 quantitative traits of 20 okra genotypes

Sl.No.	Characters	GCV	PCV	h^2 (BroadSense)	GeneticAdvance	Gen.Adv as % of Mean
1	Days to firstflowering	6.114	6.328	93.3	5.033	12.167
2	Days to 50%flowering	6.543	6.745	94.1	5.749	13.076
3	Length of Mature fruit(cm)	7.563	9.397	64.8	1.623	12.54
4	Diameter of fruit(cm)	6.817	7.562	81.3	0.21	12.66
5	Internodallength (cm)	8.976	10.845	68.5	0.66	15.306
6	Number of primary branches	22.165	22.508	97	0.742	44.965
7	Average fruitweight (gm)	12.237	14.609	70.2	3.416	21.115
8	Number of fruitsper plant	15.403	16.126	91.2	3.168	30.307
9	Number of nodeson main stem	10.887	11.472	90.1	3.394	21.284
10	Plant height(cm)	14.592	15.037	94.2	24.608	29.169
11	Number of seedsper fruit	8.479	9.647	77.3	7.823	15.353
12	Seed index(gm)	5.776	7.508	59.2	0.466	9.153
13	Fruit yield perplant (gm)	22.821	25.316	81.3	77.097	42.377

Table 4. Estimation of correlation coefficient for phenotypic (PC) and genotypic (GC) levels among different characters in okra genotypes

Traits		DFF	DTFPF	LMF	DOF	INL	NOPB	AFW	NFPP	NNMS	PH	NSPF	SI	FYPP
DFF	**PC**	1.00	0.9523**	-0.2187	-0.1862	-0.179	0.0389	0.0908	0.0296	0.3002**	-0.027	0.3442**	0.2727*	0.0818
	GC	1.00	0.9816**	-0.2805*	-0.2068*	-0.2212*	0.0448	0.0684	0.0407	0.3388**	-0.0217	0.3642**	0.4449**	0.0998
DTFPF	**PC**		1.000	-0.1968	-0.0444	-0.077	-0.0713	0.2232*	-0.0314	0.318**	0.083	0.4617**	0.3664**	0.1817
	GC		1.000	-0.2331*	-0.0838	-0.0721	-0.0718	0.2384*	-0.0478	0.3403**	0.0886	0.5145**	0.5446**	0.2111*
LMF	**PC**			1.000	0.2036*	0.1753	-0.3015**	0.2952**	0.644**	0.3119**	0.3735**	-0.209*	-0.3192**	0.651**
	GC			1.000	0.228*	0.286*	-0.4071**	0.3127**	0.8787**	0.4464**	0.4641**	-0.3652**	-0.6808**	0.7994**
DOF	**PC**				1.000	0.1078	-0.3138**	0.4894**	-0.0657	0.067	0.2722*	0.1174	0.3618**	0.2092*
	GC				1.000	0.1163	-0.3313**	0.5664**	-0.1296	0.0828	0.284*	0.1628	0.5656**	0.1814
INL	**PC**					1.000	-0.5733**	-0.025	-0.3495**	-0.0922	0.6962**	0.3457**	-0.0681	0.0051
	GC					1.000	-0.669**	-0.018	-0.4514**	-0.1654	0.7827**	0.5306**	-0.0066	-0.0711
NOPB	**PC**						1.000	-0.0779	0.1079	0.1507	-0.3167**	-0.1389	-0.0202	-0.0042
	GC						1.000	-0.087	0.1165	0.1557	-0.3289**	-0.1706	-0.0779	0.0117
AFW	**PC**							1.000	0.2619*	0.1235	0.1719	0.142	0.4637**	0.6709**
	GC							1.000	0.3321**	0.1678	0.2038*	0.1945	0.8573**	0.7944**
NFPP	**PC**								1.000	0.2999*	-0.1322	-0.414**	-0.2943*	0.728**
	GC								1.000	0.3236**	-0.1488	-0.4743**	-0.367**	0.7878**
NNMS	**PC**									1.000	0.3803**	0.3681**	-0.1804	0.3487**
	GC									1.000	0.3776**	0.4505**	-0.2462*	0.4113**
PH	**PC**										1.000	0.4653**	0.0092	0.3131**
	GC										1.000	0.5382**	0.0122	0.3228**
NSPF	**PC**											1.000	0.2506*	-0.1039
	GC											1.000	0.4113**	-0.0877
SI	**PC**												1.000	-0.0013
	GC												1.000	-0.0189
FYPP	**PC**													1.000
	GC													1.000

***1% level of significance;*5% level of significance*

DFF: Days to first flowering, DTFPF: Days to 50% flowering, LMF: Length of mature Fruit(cm), DOF: Diameter of fruit(cm), INL: Internodal length (CM), NOPB: Number of primary branches, AFW: Average fruit weight(gm), NFPP: Number of fruits per plant, NNMS: Number of nodes on main stem, PH: Plant height, NSPF: Number of seeds per fruits, SI: Seed index,FYPP: Yield per plant (gm)

Table 5. Direct and indirect effect of twelve characters with fruit yield per plant at phenotypic (PC) and genotypic (GC) levels in okra genotypes

Traits		DFF	DTFPF	LMF	DOF	INL	NOPB	AFW	NFPP	NNMS	PH	NSPF	SI	FYPP
DFF	**PC**	**-0.6191**	-0.5896	0.1354	0.1153	0.1108	-0.0241	-0.0562	-0.0183	-0.1859	0.0168	-0.2131	-0.1689	0.0818
	GC	**0.1068**	0.1048	-0.03	-0.0221	-0.0236	0.0048	0.0073	0.0043	0.0362	-0.0023	0.0389	0.0475	0.0998
DTFPF	**PC**	0.7312	**0.7678**	-0.1511	-0.0341	-0.0591	-0.0547	0.1714	-0.0241	0.2442	0.0637	0.3545	0.2813	0.1817
	GC	-0.1619	**-0.165**	0.0384	0.0138	0.0119	0.0118	-0.0393	0.0079	-0.0561	-0.0146	-0.0849	-0.0898	0.2111*
LMF	**PC**	-0.0015	-0.0014	**0.007**	0.0014	0.0012	-0.0021	0.0021	0.0045	0.0022	0.0026	-0.0015	-0.0022	0.651**
	GC	-0.0207	-0.0172	**0.0739**	0.0168	0.0211	-0.0301	0.0231	0.0649	0.033	0.0343	-0.027	-0.0503	0.7994**
DOF	**PC**	0.0146	0.0035	-0.016	**-0.0784**	-0.0085	0.0246	-0.0384	0.0052	-0.0053	-0.0213	-0.0092	-0.0284	0.2092*
	GC	0.1182	0.0479	-0.1303	**-0.5714**	-0.0665	0.1893	-0.3236	0.0741	-0.0473	-0.1623	-0.093	-0.3232	0.1814
INL	**PC**	-0.0215	-0.0092	0.0211	0.013	**0.1201**	-0.0688	-0.003	-0.042	-0.0111	0.0836	0.0415	-0.0082	0.0051
	GC	0.1109	0.0362	-0.1434	-0.0583	**-0.5014**	0.3355	0.009	0.2264	0.083	-0.3925	-0.2661	0.0033	-0.0711
NOPB	**PC**	0.0088	-0.0162	-0.0685	-0.0713	-0.1303	**0.2273**	-0.0177	0.0245	0.0343	-0.072	-0.0316	-0.0046	-0.0042
	GC	-0.0053	0.0086	0.0485	0.0395	0.0797	**-0.1192**	0.0104	-0.0139	-0.0186	0.0392	0.0203	0.0093	0.0117
AFW	**PC**	0.0183	0.045	0.0596	0.0988	-0.005	-0.0157	**0.2018**	0.0528	0.0249	0.0347	0.0287	0.0936	0.6709**
	GC	0.0365	0.1272	0.1669	0.3022	-0.0096	-0.0464	**0.5336**	0.1772	0.0895	0.1088	0.1038	0.4575	0.7944**
NFPP	**PC**	0.0125	-0.0133	0.2723	-0.0278	-0.1478	0.0456	0.1107	**0.4228**	0.1268	-0.0559	-0.175	-0.1244	0.728**
	GC	-0.018	0.0211	-0.3874	0.0571	0.199	-0.0514	-0.1464	**-0.4409**	-0.1427	0.0656	0.2091	0.1618	0.7878**
NNMS	**PC**	-0.0048	-0.0051	-0.005	-0.0011	0.0015	-0.0024	-0.002	-0.0048	**-0.0159**	-0.0061	-0.0059	0.0029	0.3487**
	GC	0.0456	0.0458	0.0601	0.0111	-0.0223	0.021	0.0226	0.0436	**0.1346**	0.0508	0.0606	-0.0331	0.4113**
PH	**PC**	-0.0079	0.0243	0.1093	0.0797	0.2038	-0.0927	0.0503	-0.0387	0.1113	**0.2927**	0.1362	0.0027	0.3131**
	GC	-0.0145	0.0592	0.3105	0.19	0.5236	-0.2201	0.1363	-0.0996	0.2526	**0.669**	0.36	0.0082	0.3228**
NSPF	**PC**	-0.0769	-0.1031	0.0467	-0.0262	-0.0772	0.031	-0.0317	0.0925	-0.0822	-0.104	**-0.2234**	-0.056	-0.1039
	GC	-0.1547	-0.2185	0.1551	-0.0691	-0.2254	0.0725	-0.0826	0.2015	-0.1914	-0.2286	**-0.4248**	-0.1747	-0.0877
SI	**PC**	-0.0002	-0.0003	0.0003	-0.0003	0.0001	0.00001	-0.0004	0.0003	0.0002	0.00001	-0.0002	**-0.0009**	-0.0013
	GC	-0.0192	-0.0235	0.0293	-0.0244	0.0003	0.0034	-0.0369	0.0158	0.0106	-0.0005	-0.0177	**-0.0431**	-0.0189

*Phenotypic path correlation (**1 level of significance, *5 level of significance, Residual effect= 0.1722). Genotypic path correlation **1% level of significance, *5% level of significance, Residual effect = SQRT (1- 1.2853)*

DFF: Days to first flowering, DTFPF: Days to 50% flowering, LMF: Length of mature Fruit(cm), DOF: Diameter of fruit(cm), INL: Internodal length (CM), NOPB: Number of primary branches, AFW: Averagefruit weight(gm), NFPP: Number of fruits per plant, NNMS: Number of nodes on main stem, PH: Plant height, NSPF: Number of seeds per fruits, SI: Seed index, FYPP: Yield per plant (gm)

4. CONCLUSION

It is concluded from the present study that significant variation was observed in okra germplasm. On the basis of mean performance maximum fruit yield was recorded by Azad bhindi-1 followed by GO-3 and BO-13 over the Check (Kashi chaman). These genotypes could be used further breeding programmes or recommended to farmers for profitable okra cultivation. Genetic analysis revealed that estimates of phenotypic coefficients of variance (PCV) were higher than genotypic coefficients of variance (GCV) which indicated the consequence of environmental impact on the phenotypic expressions of the characters. The maximum values were obtained for fruit yield per plant and number of primary branches. High heritability together with high genetic gain was obtained for number of primary branches. Hence, selection of these characters for improvement could be more effective and efficient. Fruit yield had a strong, positive and significant association with the number of fruits per plant, average fruit weight, length of mature fruit, number of nodes on main stem and plant height. Therefore, improvement of okra can be practiced with direct selection of these characters. Plant height and average fruit weight had a positive direct effect on fruit yield at both levels, showing their suitability for direct selection.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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