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CHARACTER ASSOCIATION AND PATH ANALYSIS STUDIES IN OKRA (*ABELMOSCHUS ESCULENTUS* L. MOENCH)

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ABSTRACT

The present investigation was undertaken to estimate the correlation and path analysis for fruit yield and yield contributing characters in okra (*Abelmoschus esculentus* (L.) Moench). Twenty-one genotypes were sown in a randomized block design with three replications during summer season. The characters studied were, plant height, number of leaves, internodal length, number of nodes at 60 DAS and 90 DAS, days to 50 % flowering, number of fruits per plant, average fruit weight, fruit length and fruit yield per plant. Correlation studies indicated the fruit yield per plant showed a highly significant and positive association with plant height, number of leaves, number of nodes at 60 and 90 DAS, internodal length at 60 DAS, average fruit weight, number of fruits per plant and fruit length. Hence, these traits could be considered as important for improving fruit yield in okra. The path analysis revealed that number of nodes at 60 and 90 DAS, number of leaves and inter nodal length at 90 DAS, average fruit weight, number of fruits per plant and fruit length had a direct and positive effect on fruit yield per plant. Hence, importance must give to these characters because they are directly proportional to fruit yield per plant.

***Keywords* :** Character Association, Path Analysis, Okra (*Abelmoschus esculentus* L. Moench)

Introduction

Okra (*Abelmoschus esculentus*, 2n=2x=130), widely known as lady's finger in England, bhendi in India, and gumbo in the United States, boasts a variety of names across cultures, including guano-gombo in Spanish, guibeiro in Portuguese, Igbo in Nigeria, and qiukui in Taiwan. In India, it goes by regional names such as vendaikai and ramtoriyan. As the most popular vegetable in the Malvaceae family, bhendi thrives as a vital crop during the spring-summer and rainy seasons in tropical and subtropical regions, with year-round cultivation possible in milder winters. India leads global okra production, yielding 6.873 million tonnes from 521 thousand hectares at a productivity rate of 13.19 tons per hectare, followed by Nigeria. In India, Gujarat is the top-producing state, contributing 15.89% of the national total, followed by West Bengal, Bihar, and Madhya Pradesh.

Okra is a nutrient-dense and antioxidant-rich vegetable, low in calories and fat, while being high in fiber and essential vitamins such as C, A, and B. It also provides significant amounts of calcium, potassium, and iodine, which can support goiter treatment. Additionally, its ripe seeds are high in protein and edible oil; when dried, roasted, and ground, they serve as a coffee substitute. This makes okra a vital dietary supplement in developing countries where nutrient deficiencies are common. Beyond its nutritional benefits, the dried fruit skins and stems can be utilized in the production of paper, cardboard, and fiber as well as for mucilage used in industrial and medicinal applications. Moreover, okra possesses pharmacological properties that may help manage diabetes, obesity, and cancer. Overall, okra significantly contributes to food security, nutrition, health, and economic sustainability.

Estimating the correlation coefficient among yield-contributing variables is crucial for guiding selection strategies and maximizing yield in the shortest possible timeframe. Genetic correlation provides insights into the relative importance of specific traits that should be emphasized during yield selection. However, as the number of variables in the analysis increases, the direct and indirect relationships between yield and particular component traits become more intricate. While correlation analysis indicates the direction and strength of associations between pairs of traits, path coefficient analysis further allows for the breakdown of these correlations into direct and indirect effects of various yield components on overall yield.

The present investigation aimed at assessing the association of different traits for yield improvement in okra.

Materials and Methods

The present investigation comprising twenty-one genotypes of okra and they were evaluated in a randomized block design with three replications during summer season at Department of Vegetable Science, College of Horticulture, Mudigere. Each genotype was planted with spacing of 60 cm × 45 cm. All recommended agronomic practices and plant protection measures were followed during the crop growth period to ensure proper growth and good yield. The characters studied were plant height, number of leaves, internodal length, number of nodes at 60 DAS and 90 DAS, days to 50 % flowering, number of fruits per plant, average fruit weight, fruit length and fruit yield per plant. Correlation coefficient were calculated for all quantitative character combinations at phenotypic, genotypic and environmental levels, method suggested by Panse and Sukhatme (1967) and path coefficient were worked out as per the method given by Wright and elaborated by Dewey and Lu (1959).

Results and Discussion

Correlation coefficient analysis

For a breeding programme information on the genetic association between yield and its component is a pre-requisite. From this point of view the relationship between yield of okra and 12 other important traits were endeavoured to find out through correlation and path coefficient analysis. Knowledge of the association among plant characteristics is useful while selecting traits for yield improvement. It was evident from the Table 1 and 2. that estimates of genotypic correlation coefficients were in most cases higher than their corresponding phenotypic correlation coefficients. These findings are in close harmony with Saryam *et al.* (2017), Singh *et al.* (2016), Balai *et al.* (2014); Senapati *et al.* (2011). The narrow difference between genotypic and phenotypic correlation coefficients depicted a low environmental effect on the expression of these characters with fruit yield per plant and due to the strong genetic makeup of the evaluated material. A strong positive association of traits with yield may be due to linkage and pleiotropy. Singh *et al.* (2006) had also reported higher estimates of genotypic correlations than the corresponding phenotypic correlations between yield and its attributing traits.

In the present study fruit yield per plant showed a highly significant and positive association with plant height, number of leaves, number of nodes at 60 and 90 DAS, internodal length at 60 DAS, average fruit weight, number of fruits per plant and fruit length at both phenotypic and genotypic level. While, significantly positive correlation with internodal length at 90 DAS at genotypic level suggesting that this character could be considered important for direct selection for improving fruit yield in okra crop improvement. Similar results were obtained by Koundinya *et al.* (2013), Thulasiram *et al.* (2017), Pithiya *et al.* (2017), Dwivedi *et al.* (2017), Raval *et al.* (2019), Rathava *et al.* (2019), Tudu *et al.* (2021), Chaudhary *et al.* (2020), Samiksha *et al.* (2021) and Sravanthi *et al.* (2021).

The trait exhibits a highly significant and negative correlation with days to 50% flowering. The similar findings were recorded by Duggi *et al.* (2013), Koundinya *et al.* (2013) and Dwivedi *et al.* (2017) and Samim *et al.* (2018).

Path coefficient analysis

Path coefficient analysis is important tool for selection of characters those have direct and positive effect on fruit yield per plant for improvement of fruit yield. This helps in giving the weightage to a particular character during the selection. The estimates of direct and indirect effects of 12 fruit yield related characters on fruit yield per plant are presented in Table 3 and 4.

Path analysis revealed that number of nodes at 60 and 90 DAS, number of leaves and inter nodal length at 90 DAS, average fruit weight, number of fruits per plant and fruit length had a direct and positive effect on fruit yield per plant. While number of leaves at 60 DAS and days to 50 % flowering showed direct positive effect at phenotypic level. Thus, the higher magnitude of the positive association of these traits explains the higher value of association between these traits and fruit yield per plant. Therefore, direct selection for these traits would reward for improvement of yield. These findings are agreement with the results of Kelemoge *et al.* (2019), Kumari *et al.* (2019), Raval *et al.* (2019), Rathod *et al.* (2019), Alam *et al.* (2020), Verma and Singh (2020), Samiksha *et al.* (2021), Sravanthi *et al.* (2021) and Rajani *et al.* (2022).

The traits plant height at 60 and 90 DAS, internodal length at 60 DAS shown negative direct effect on fruit yield per plant. While, the number of leaves at 60 DAS and days to 50 % flowering showed negative direct effect on fruit yield per plant at genotypic level. These are agreement with findings of Mehta *et al.* (2006), Sharma and Prasad (2015), Yadav *et al.* (2017), Singh *et al.* (2018) and Rathava *et al.* (2019).

Conclusion

It may be concluded from the study that fruit yield per plant showed a highly significant and positive association with plant height, number of leaves, number of nodes at 60 and 90 DAS, internodal length at 60 DAS, average fruit weight, number of fruits per plant and fruit length. Path coefficient analysis further suggested that number of nodes at 60 and 90 DAS, number of leaves and inter nodal length at 90 DAS, average fruit weight, number of fruits per plant and fruit length had a direct and positive effect on fruit yield per plant.

Table 1 : Genotypic correlation coefficient among growth and yield parameters in okra genotypes.

Genotypic correlation matrix													
	1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**	**11.**	**12.**	**13.**
1.	1	0.7933**	0.7566**	0.7354**	0.7149**	0.7240**	0.8830**	0.8599**	-0.6077**	0.8615 **	0.7935 **	0.7643 **	0.831 **
2.		1	0.8938**	0.9013**	0.6842**	0.7710**	0.7275**	0.857**	-0.4228 NS	0.8376 **	0.6405 **	0.5559 **	0.7415 **
3.			1	0.9642**	0.5743**	0.6156**	0.7760**	0.9002**	-0.6659**	0.8355 **	0.7772 **	0.6644 **	0.8372 **
4.				1	0.6057**	0.6448**	0.7338**	0.9193**	-0.5468*	0.8640 **	0.7884 **	0.6852 **	0.8589 **
5.					1	0.863**	0.4863*	0.6099**	-0.2363 NS	0.6949 **	0.4507 *	0.5265 *	0.5606 **
6.						1	0.4848*	0.6401**	-0.122 NS	0.6757 **	0.4373 *	0.4056 NS	0.5486 *
7.							1	0.9029**	-0.6436**	0.8526 **	0.9098 **	0.7842 **	0.9048 **
8.								1	-0.5174*	0.9464 **	0.9182 **	0.8177 **	0.9671 **
9.									1	-0.5099 *	-0.6225 **	-0.6674 **	-0.5831 **
10.										1	0.8697 **	0.8273 **	0.949 **
11.											1	0.9181 **	0.9768 **
12.												1	0.9215 **
13													1

**Significance at 1% level *Significance at 5% level

1.Plant height at 60 DAS (cm)
2. Plant height at 90 DAS (cm)
3. Number of leaves at 60 DAS
4. Number of leaves at 90 DAS
5. Inter nodal length at 60 DAS (cm)
6. Inter nodal length at 90 DAS (cm)
7. Number of nodes at 60 DAS
8. Number of nodes at 90 DAS
9. Days to 50 per cent flowering
10. Number of fruits per plant
11. Average fruit weight (g)
12. Fruit length (cm)
13. Fruit yield per plant (g)

Table 2 : Phenotypic correlation coefficient among growth and yield parameters in okra genotypes

Phenotypic correlation matrix													
	1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**	**11.**	**12.**	**13.**
1.	1	0.7907**	0.7394**	0.7208**	0.6807**	0.7176**	0.864**	0.8481**	-0.4832**	0.8581**	0.7913**	0.7625**	0.8303**
2.		1	0.8769**	0.8822**	0.6577**	0.7657**	0.7039**	0.8451**	-0.3377**	0.8351**	0.6389**	0.5551**	0.7410**
3.			1	0.9305**	0.5275**	0.6036**	0.7512**	0.8807**	-0.5138**	0.8214**	0.7637**	0.6537**	0.8325**
4.				1	0.566**	0.6326**	0.7059**	0.8958**	-0.3994**	0.8452**	0.7733**	0.6733**	0.8533**
5.					1	0.8179**	0.4139**	0.57**	-0.1664 NS	0.6612**	0.4301**	0.5019**	0.5516**
6.						1	0.4687**	0.6351**	-0.1016 NS	0.6711**	0.4351**	0.4032**	0.5476**
7.							1	0.8765**	-0.5019**	0.834**	0.8868**	0.7659**	0.8977**
8.								1	-0.4171**	0.9354**	0.9053**	0.81**	0.9631**
9.									1	-0.4065**	-0.4853**	-0.5281**	-0.5320**
10.										1	0.8673**	0.8259**	0.9484**
11.											1	0.9165**	0.9765**
12.												1	0.8657**
13													1

**Significance at 1% level *Significance at 5% level

1. Plant height at 60 DAS (cm)
2. Plant height at 90 DAS (cm)
3. Number of leaves at 60 DAS
4. Number of leaves at 90 DAS
5. Inter nodal length at 60 DAS (cm)
6. Inter nodal length at 90 DAS (cm)
7. Number of nodes at 60 DAS
8. Number of nodes at 90 DAS
9. Days to 50 per cent flowering
10. Number of fruits per plant
11. Average fruit weight (g)
12. Fruit length (cm)
13. Fruit yield per plant (g)

Table 3 : Phenotypic path coefficient analysis among growth and yield parameters in okra genotypes.

Phenotypic path matrix												
	1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**	**11.**	**12.**
1.	**-0.0563**	-0.0446	-0.0423	-0.0412	-0.0396	-0.0407	-0.0494	-0.0482	0.0313	-0.0485	-0.0447	-0.0425
2.	-0.1044	**-0.1318**	-0.1170	-0.1179	-0.0889	-0.1013	-0.0948	-0.1124	0.0510	-0.1102	-0.0843	-0.0718
3.	0.0292	0.0345	**0.0389**	0.0371	0.0217	0.0238	0.0299	0.0348	-0.0235	0.0323	0.0301	0.0245
4.	0.0342	0.0419	0.0446	**0.0468**	0.0277	0.0300	0.0339	0.0427	-0.0228	0.0402	0.0367	0.0305
5.	-0.0062	-0.0059	-0.0049	-0.0052	**-0.0088**	-0.0074	-0.004	-0.0052	0.0018	-0.0060	-0.0039	-0.0043
6.	0.0181	0.0193	0.0153	0.0161	0.0213	**0.0251**	0.0120	0.0160	-0.0028	0.0169	0.0110	0.0101
7.	0.0086	0.0070	0.0075	0.0071	0.0045	0.0047	**0.0098**	0.0087	-0.0057	0.0083	0.0088	0.0075
8.	0.1854	0.1847	0.1935	0.1973	0.1291	0.1383	0.1936	**0.2166**	-0.103	0.2041	0.1979	0.1679
9.	-0.0013	-0.0009	-0.0014	-0.0011	-0.0005	-0.0003	-0.0014	-0.0011	**0.0023**	-0.0011	-0.0013	-0.0014
10.	0.3338	0.3247	0.3223	0.3328	0.2651	0.2615	0.3283	0.3657	-0.1811	**0.3880**	0.3371	0.3000
11.	0.3645	0.2943	0.3552	0.3602	0.2040	0.2007	0.4147	0.4202	-0.2601	0.3995	**0.4598**	0.4125
12.	0.0247	0.0178	0.0206	0.0213	0.0160	0.0132	0.0251	0.0254	-0.0194	0.0253	0.0294	**0.0327**
13.	0.8303**	0.7410**	0.8325**	0.8533**	0.5516**	0.5476**	0.8977**	0.9631**	-0.532**	0.9488**	0.9765**	0.8657**
Partial R^2	-0.0468	-0.0976	0.0324	0.0400	-0.0048	0.0137	0.0088	0.2086	-0.0012	0.3681	0.4490	0.0283

**Significance at 1% level *Significance at 5% level

1. Plant height at 60 DAS (cm)
2. Plant height at 90 DAS (cm)
3. Number of leaves at 60 DAS
4. Number of leaves at 90 DAS
5. Inter nodal length at 60 DAS (cm)
6. Inter nodal length at 90 DAS (cm)
7. Number of nodes at 60 DAS
8. Number of nodes at 90 DAS
9. Days to 50 per cent flowering
10. Number of fruits per plant
11. Average fruit weight (g)
12. Fruit length (cm)
13. Fruit yield per plant (g)

Table 4 : Genotypic path coefficient analysis among growth and yield parameters in okra genotypes.

Genotypic path matrix												
	1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**	**11.**	**12.**
1.	**-0.1740**	-0.1380	-0.1317	-0.1280	-0.1244	-0.1260	-0.1537	-0.1496	0.1057	-0.1499	-0.1381	-0.1401
2.	-0.1210	**-0.1525**	-0.1363	-0.1375	-0.1043	-0.1176	-0.1109	-0.1307	0.0645	-0.1277	-0.0977	-0.0885
3.	-0.0690	-0.0815	**-0.0911**	-0.0879	-0.0523	-0.0561	-0.0707	-0.0820	0.0607	-0.0761	-0.0708	-0.0611
4.	0.0265	0.0325	0.0347	**0.0360**	0.0218	0.0232	0.0264	0.0331	-0.0197	0.0311	0.0284	0.0250
5.	-0.0172	-0.0165	-0.0138	-0.0146	**-0.0241**	-0.0208	-0.0117	-0.0147	0.0057	-0.0168	-0.0109	-0.0123
6.	0.0707	0.0753	0.0601	0.0629	0.0842	**0.0976**	0.0473	0.0625	-0.0119	0.0660	0.0427	0.0414
7.	0.0253	0.0209	0.0223	0.0210	0.0139	0.0139	**0.0287**	0.0259	-0.0185	0.0245	0.0261	0.0237
8.	0.4347	0.4333	0.4551	0.4648	0.3083	0.3236	0.4565	**0.5056**	-0.2616	0.4785	0.4642	0.4207
9.	0.0559	0.0389	0.0613	0.0503	0.0218	0.0112	0.0592	0.0476	**-0.0920**	0.0469	0.0573	0.0645
10.	0.3023	0.2939	0.2931	0.3031	0.2438	0.2371	0.2991	0.3320	-0.1789	**0.3509**	0.3051	0.2892
11.	0.2481	0.2003	0.2430	0.2465	0.1409	0.1367	0.2845	0.2871	-0.1946	0.2719	**0.3127**	0.2982
12.	0.0487	0.0351	0.0406	0.0420	0.0309	0.0257	0.0501	0.0504	-0.0424	0.0499	0.0577	**0.0605**
13	0.8310**	0.7415**	0.8372**	0.8589**	0.5606**	0.5486**	0.9048**	0.9671**	-0.5831**	0.9490**	0.9768**	0.9215**
Partial R^2	-0.1446	-0.1131	-0.0763	0.0309	-0.0135	0.0536	0.0259	0.4889	0.0537	0.3330	0.3054	0.0558

**Significance at 1% level *Significance at 5% level

1. Plant height at 60 DAS (cm)
2. Plant height at 90 DAS (cm)
3. Number of leaves at 60 DAS
4. Number of leaves at 90 DAS
5. Inter nodal length at 60 DAS (cm)
6. Inter nodal length at 90 DAS (cm)
7. Number of nodes at 60 DAS
8. Number of nodes at 90 DAS
9. Days to 50 per cent flowering
10. Number of fruits per plant
11. Average fruit weight (g)
12. Fruit length (cm)
13. Fruit yield per plant (g)

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