Character associationand path coefficient analysis studies for yield and yield related components in okra [*Abelmoschus esculentus* (L.) Moench]

ABSTRACT

The present investigation entitled “Character association and path coefficient analysis studies for yield and yield related components in okra [*Abelmoschus esculentus* (L.) Moench]”was carried out during the summer season of 2020-2021 at Horticulture Research Centre, Department of Horticulture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut.Ninety-five genotypes of okra with twelve traits were evaluated in the present study. The study revealed that the maximum fruit yield per plant had exhibited a highly significant and positive correlation with a number of fruits per plant, number of nodes per plant, number of seeds per fruit, weight of 100 seeds, fruit length, number of primary branches per plant, fruit diameter, and plant height at genotypic and phenotypic levels. Fruit yield per plant was shown to be negatively correlated with internode length.The positive direct effect on fruit yield per plant was exerted by the number of fruits per plant followed by internode length, days to 50 percent flowering, number of seeds per fruit,number of primary branches per plant, number of nodes per plant, fruit diameter, and fruit length at both genotypic and phenotypic levels. Therefore, direct selection of these traits would be beneficial for improvement in okra.

Keywords: Character association, path coefficient analysis, Okra, Direct effect, indirect effects

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench], belongs to the family of Malvaceae and has chromosome number of 2n=130.*Abelmoschus* species number around 34 in the Malvaceae family, including 30 in the Old World and four in the New World (Joshi *et al*., 1974). A wild form of *A. tuberculatus* is endemic to India. According to Zeven and Zhukovsky's (1975) taxonomic classification, It is believed that the cultivated species *A. esculentus* originated in Hindustani center, *i.e.* India. It is widely cultivated in temperate, subtropical, and tropical climates across the world (Kochhar, 1986). It's an often pollinated crop, with an outcrossing rate ranging from 4 to 19 percent and a maximum of 42.2 percent (Kumar, 2006). Okra's tender fruits are commonly used as a vegetable or in culinary preparations as sliced and fried portions (Pradip *et al*. 2010). Its fruits have excellent nutritional, therapeutic, and industrial value, as well as potential for export. Vitamins, calcium, potassium, and other minerals may be found in abundance in okra fruits.

In general, plant breeders choose yield components that indirectly boost yield since direct selection for yield improvement may not be the most efficient strategy. Path coefficient analysis assists in separating out the entire association into direct and indirect impacts, which is important for selecting the most useful features for yield improvement through selection. Plant breeders value the study of correlation between plant features because it gives a measure of the degree of relationship between yield and other yield parameters (Kumar et al., 2013). The correlation between direct and indirect impacts is partitioned in the path coefficient analysis, which may be beneficial in determining which characteristics have direct and indirect effects on yield.

MATERIALS AND METHODS

This experiment "Character association and path coefficient analysis studies for yield and yield related components in okra [*Abelmoschus esculentus* (L.) Moench]"was conducted at the HRC of the SardarVallabhbhai Patel University of Agriculture and Technology, Meerut, during the summer season of 2021. The Horticulture Research Centre, Meerut is located at 29.01^{0}'N latitude and 77.45^{0}'E.It is about 70 K.M away from the national capital, New Delhi, at an altitude of 297 meter higher than mean sea level.In this experiment used 20 parents and 75 hybrids totally 95 genotypes in a randomized block design performe with three replications.The size of each plot was 2.40 m x 1.50 m, with four rows and a total of five plants per row.The distances between rows, plants and adjacent replicates were 0.60, 0.30 and 1 m, respectively.Twenty genotypes were collected from ICAR IIVR, Varanasi, from which seventy-five hybrids were developed using 15 line and 5 tester in line x tester design.Five plants were randomly selected from each replicate and data were recorded for traits such as plant height (cm), days to 50% flowering, days to first flowering, internode length (cm), number of nodes per plant, number of fruits per plant, fruit length (cm), fruit diameter (cm), number of seeds per fruit, weight of 100 seeds per plant (g), and fruit yield per plant (g). Correlation coefficient for all quantitative character combinations at the phenotypic and genotypic levels was determine by approach of Al-Jibouri*et al.,* 1958.Path coefficient analysis was calculated using an approach proposed by Wright in 1921. It was elaborated by Dewey and Lu in 1959.

RESULTS AND DISCUSSION

CORRELATION COEFFICIENT ANALYSIS

For all of the characteristics investigated in this study, analysis of variance revealed that genotypes differed considerably among themselves. The genotypic and phenotypic correlation coefficients calculated among twelve characteristics (Table-1) demonstrated that the genotypic correlation coefficient was higher than the phenotypic correlation coefficients in general, showing a strong inherent association between various traits. The phenotypic

correlation coefficient was higher in certain situations than the genotypic correlation coefficient, which might be due to the environment's impact on the relationship of characteristics. These results are similar to those found with Pundir*et al.* (2022), Verma and Singh (2020), Yadav*et al.* (2020), Kumar and Patil (2020) and Temam (2020).

The correlation coefficient analysis (Table-1) showed highly significant and positive genotypic and phenotypic correlation of Fruit yield per plant with number of fruit per plant (0.98, 0.97), number of nodes per plant (0.89, 0.88), number of seeds per fruit (0.35, 0.34), weight of 100 seed (0.30, 0.30), fruit length (0.28, 0.27), number of primary branches per plant (0.25, 0.24), fruit diameter (0.23, 0.22) and plant height (0.13, 0.13) indicating the possibility of simultaneous selection for these traits. Correlation estimates suggest that yields can be improved through selection based on these traits. These results are in close harmony with the findings of Bagadiya*et al.* (2022), Sravanthi*et al.* (2021), Verma and Singh (2020),Kumar and Patil (2020), Janarthanan and Sundaram (2020) and Raval*et al.* (2019) for number of fruit per plant. Kumari*et al.* (2019) and Sujata*et al.* (2019) for number of nodes per plant.Raval*et al.* (2019), Prasath*et al.* (2017) and Singh *et al.* (2017) for number of seeds per fruit.Raval*et al.* (2019) andPrasath*et al.* (2017) for weight of 100 seed.Sravanthi*et al.* (2021) and Kumar and Patil (2020) for fruit length.Pundir*et al.* (2022), Verma and Singh (2020), Janarthanan and Sundaram (2020) and Sujata*et al.* (2019) for number of primary branches per plant.Pundir*et al.* (2022) and Temam (2020) for fruit diameter.Verma and Singh (2020), Rynjah*et al.* (2020 for plant height.Fruit yield per plant showed significant negative genotypic and phenotypic correlation with internodes length. Similar result was reported by Bagadiya*et al.* (2022) and Prasath*et al.* (2017).

PATH COEFFICIENT ANALYSIS

Genotypic and phenotypic path coefficient analysis (Table-2) exhibited high positive direct effects on fruit yield per plant were exerted by the number of fruit per plant (1.09, 1.04), internodes length (0.18, 0.12), days to 50 per cent flowering (0.15, 0.12), number of seeds per fruit (0.08, 0.04),number of primary branches per plant (0.02, 0.02), number of nodes per plant (0.02, 0.02) fruit diameter (0.02, 0.01) and fruit length (0.01, 0.01) at both genotypic and phenotypic levels. The number of fruits per plant (1.09, 1.04) had very high positive direct effect on fruit yield per plant but also had a significant positive correlation with fruit yield per plant (0.98, 0.97) and the correlation coefficient is equal to the direct effect. Internode length (0.18, 0.12) showed low positive direct effect on fruit yield per plant, but it is negatively correlated with fruit yield per plant (-0.67, -0.66). Days to 50% flowering (0.15, 0.12) had low positive direct effect on fruit yield per plant, but it was not significantly correlated with fruit yield per plant (0.08, 0.08). The number of seeds per fruit (0.08, 0.04), number of primary branches per plant (0.02, 0.02), number of nodes per plant (0.02, 0.02), fruit diameter (0.02,

0.01), and fruit length (0.01, 0.01) all had negligible positive direct effects on fruit yield per plant but these are significantly positively correlated with fruit yield per plant (0.25, 0.24), (0.35, 0.34), (0.89, 0.88), (0.23, 0.22), (0.28, 0.27), respectively. Similar results were observed by Rajani*et al.* (2022), Al-Juboori (2021), Samiksha*et al.* (2021), Sravanthi*et al.* (2021), Verma and Singh (2020), Kumar and Patil (2020), Sujata*et al.* (2019), Prasath*et al.* (2017) for number of fruit per plant. Pawar*et al.* (2020), Verma and Singh (2020), Prasath*et al.* (2017) for internodes length.Pundir*et al.* (2022), Sravanthi*et al.* (2021), Pawar*et al.* (2020), Rynjah*et al.* (2020) for number of primary branches per plant. Rajani*et al.* (2022), Sravanthi*et al.* (2021), Yadav*et al.* (2020), Kumar and Patil (2020) for days to 50 per cent flowering. Al-Juboori (2021), Samiksha*etal.* (2021), Pawar*et al.* (2020) for fruit diameter.Rajani*et al.* (2022), Samiksha*et al.* (2021), Sravanthi*et al.* (2021), Rynjah*et al.* (2020), Prasath*et al.* (2017) for fruit length. Pundir*et al.* (2022) for number of seeds per fruit and Pawar*et al.* (2020) for number of nodes per plant.

plant height (-0.09, -0.05) and weight of 100 seed (-0.02, -0.02) showed direct negative genotypic and phenotypic effects on fruit yield per plant and also showed significant positive correlation with fruit yield (0.13, 0.13), (0.30, 0.30), respectively. Days to first flowering (-0.11, -0.08) showed direct negative effects on fruit yield per plant and also showed non-significant positive correlation with fruit yield (0.08, 0.08). Similar results were observed by Rajani*et al.* (2022), Sravanthi*et al.* (2021), Rynjah*et al.* (2020), Raval*et al.* (2019) for days to first flowering and plant height. Pundir*et al.* (2022), Singh *et al.* (2017) for weight of 100 seed.

Table:1 Estimates of correlation coefficient for genotypic and phenotypic levels among twelve characters in okra [*Abelmoschus esculentus* (L.) Moench]

Characters		**Plant height (cm)**	**Days to 50 % flowering**	**Days to first flowering**	**Number of primary branches per plant**	**Internodes Length (cm)**	**Number of nodes per plant**	**Number of fruits per plant**	**Fruit length (cm)**	**Fruit diameter (cm)**	**Number of seeds per fruit**	**Weight of 100 seed (g)**	**Fruit yield per plant (g)**
Plant height (cm)	**G**	1.00	-0.21**	-0.22**	0.34**	0.57**	-0.03	0.10	0.39**	0.17**	0.31**	0.06	0.13*
	P	1.00	-0.20**	-0.21**	0.33**	0.56**	-0.02	0.10	0.38**	0.16**	0.30**	0.05	0.13*
Days to 50 % flowering	**G**		1.00	0.98**	-0.04	-0.19**	0.12*	0.05	0.15*	0.15*	0.09	-0.13*	0.08
	P		1.00	0.97**	-0.04	-0.18**	0.12	0.04	0.14*	0.14*	0.09	-0.12*	0.08
Days	**G**			1.00	-0.05	-0.19**	0.11	0.04	0.13*	0.15**	0.08	-	0.08

to first flowering												0.11	
	P			1.00	-0.04	-0.18**	0.10	0.03	0.13*	0.14*	0.07	-0.10	0.07
Number of primary branches per plant	**G**				1.00	0.18**	-0.01	0.22**	0.11	0.27**	0.19**	0.28**	0.25**
	P				1.00	0.17**	-0.02	0.21**	0.11	0.26**	0.18**	0.27**	0.24**
Internodes Length (cm)	**G**					1.00	-0.82**	-0.72**	0.01	-0.03	-0.07	-0.16**	-0.67**
	P					1.00	-0.81**	-0.71**	0.02	-0.03	-0.06	-0.16**	-0.66**
Number of nodes per plant	**G**						1.00	0.93**	0.22**	0.18**	0.27**	0.23**	0.89**
	P						1.00	0.92**	0.21**	0.17**	0.26**	0.22**	0.88**
Number of fruits per plant	**G**							1.00	0.26**	0.20**	0.33**	0.32**	0.98**
	P							1.00	0.25**	0.19**	0.32**	0.31**	0.97**
Fruit length (cm)	**G**								1.00	0.30**	0.55**	0.28**	0.28**
	P								1.00	0.29**	0.54**	0.27**	0.27**
Fruit diameter (cm)	**G**									1.00	0.07	0.26**	0.23**
	P									1.00	0.06	0.25**	0.22**
Number of seeds per fruit	**G**										1.00	0.31**	0.35**
	P										1.00	0.30**	0.34**
Weight of 100 seed (g)	**G**											1.00	0.30**
	P											1.00	0.30**
Fruit yield per plant (g)	**G**												1.00
	P												1.00

Table:2 Estimates of direct and indirect effects for twelve characters studied towards fruit yield in okra [*Abelmoschus esculentus* (L.)Moench]

Characters		Plant height (cm)	Days to 50 % flowering	Days to first flowering	No. of primary branches per plant	Internodes Length (cm)	No. of nodes per plant	No. of fruits per plant	Fruit length (cm)	Fruit diameter (cm)	No. of seeds per fruit	Weight of 100 seed (g)	R with Fruit yield per plant (g)
Plant height (cm)	**G**	**-0.09**	-0.02	0.02	0.01	0.10	-0.05	0.11	0.04	0.02	0.01	-0.02	0.13**
	P	**-0.05**	-0.02	0.02	0.01	0.07	-0.04	0.10	0.03	0.01	0.02	-0.02	0.13**
Days to 50 % flowering	**G**	0.02	**0.15**	-0.11	-0.08	-0.03	0.02	0.05	0.02	0.01	0.00	0.03	0.08
	P	0.01	**0.12**	-0.08	-0.08	-0.02	0.01	0.05	0.02	0.01	0.01	0.03	0.08
Days to first flowering	**G**	0.02	0.14	**-0.11**	-0.04	-0.03	0.02	0.05	0.01	0.01	0.00	0.01	0.08
	P	0.01	0.11	**-0.08**	-0.07	-0.02	0.02	0.04	0.02	0.02	0.00	0.02	0.07
Number of primary branches per plant	**G**	-0.03	-0.06	0.05	**0.02**	0.03	-0.02	0.24	0.02	0.04	0.02	-0.06	0.25**
	P	-0.02	-0.05	0.03	**0.02**	0.02	-0.04	0.22	0.01	0.04	0.02	-0.01	0.24**
Internodes Length (cm)	**G**	-0.05	-0.03	0.02	0.03	**0.18**	-0.03	-0.78	0.02	-0.05	-0.01	0.03	-0.67**
	P	-0.03	-0.02	0.03	0.01	**0.12**	-0.03	-0.76	0.02	-0.02	-0.01	0.03	-0.66**
Number of nodes per plant	**G**	0.02	0.02	-0.08	-0.02	-0.14	**0.02**	1.01	0.03	0.03	0.02	-0.02	0.89**
	P	0.01	0.01	-0.06	-0.01	-0.10	**0.02**	0.95	0.02	0.03	0.02	-0.01	0.88**
Number of fruits per	**G**	-0.08	0.07	-0.05	0.04	-0.13	0.02	**1.09**	0.03	0.03	0.03	-0.07	0.98**
	P	-0.0	0.02	-0.03	0.02	-0.09	0.02	**1.04**	0.03	0.03	0.03	-0.0	0.97**

plant		5										5	
Fruit length (cm)	**G**	-0.04	0.02	-0.02	0.02	0.03	0.03	0.28	**0.01**	0.01	0.00	-0.06	0.28**
	P	-0.02	0.01	-0.01	0.01	0.02	0.02	0.26	**0.01**	0.01	0.00	-0.04	0.27**
Fruit diameter (cm)	**G**	-0.02	0.02	-0.02	0.05	-0.06	0.04	0.22	0.02	**0.02**	0.01	-0.05	0.23**
	P	-0.01	0.01	-0.02	0.05	-0.03	0.04	0.2	0.01	**0.01**	0.00	-0.04	0.22**
No. of seeds per fruit	**G**	-0.07	0.01	-0.09	0.03	-0.01	0.05	0.37	0.01	0.01	**0.08**	-0.04	0.35**
	P	-0.05	0.01	-0.06	0.03	-0.01	0.04	0.35	0.00	0.01	**0.04**	-0.02	0.34**
Weight of 100 seed (g)	**G**	-0.05	-0.02	0.02	0.01	-0.03	0.02	0.34	0.00	0.01	0.02	**-0.02**	0.30**
	P	-0.03	-0.02	0.01	0.01	-0.02	0.02	0.32	0.00	0.01	0.02	**-0.02**	0.30**

Genotypic Residual effect = 0.0291, Phenotypic Residual effect = 0.0365

CONCLUSION

The correlation coefficient studies revealed that fruit yield per plant significant positive correlation with number of fruit per plant, number of nodes per plant, number of seeds per fruit, weight of 100 seed, fruit length, number of primary branches per plant, fruit diameter and plant height. The path coefficient analysis revealed that the positive significant positive effect on fruit yield per plant was observed by number of fruits per plant followed by internode length, number of primary branches per plant, days to 50 per cent flowering, number of seeds per fruit, number of nodes per plant, fruit diameter and fruit length at both genotypic and phenotypic levels, indicating that these traits will be considered as main component of selection in a breeding programme for fruit yield per plant.

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