Vegetable Science (2022) 49(2): 176-182

Estimation of correlation and path coefficient for morphological and quantitative traits in okra (*Abelmoschus esculentus* L. Moench)

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Received: May 2022/ Accepted: September 2022

Abstract

An experiment was laid out in Randomized Complete Block Design (RCBD) using 18 diverse okra genotypes for ten quantitative morphological traits in okra. The highest positive and significant correlation coefficient of fruit yield per plant was observed with plant height at 90 DAS, recorded highly significant and positive association with first flowering node (0.541), yield per plant (0.281), and no. of seeds per fruit at 90 DAS (0.274). Fruit diameter expressed a highly significant and positive correlation coefficient with fruit yield per plant (0.490) and no. of fruits per plant (0.264). The correlation coefficient of no. of seeds per fruit was found to be significant and positive correlation with no. of fruits per plant (0.549). The correlation coefficient of no. of fruits per plant was found to be significant and positive correlation with yield per plant (0.858). Path coefficient analysis of different characters contributing towards yield per plant showed that plant height at 45 DAS (1.648) had highest positive direct effect followed by days to first flowering (1.499), length of fruit (0.385), no. of seeds per fruit (0.376), no. of fruits per plant (0.371), diameter of fruit (0.370) whereas, plant height at 90 DAS (-1.218) had the highest negative direct effect on fruit yield per plant followed by days to 50% flowering (-1.049) and first flowering node (-0.165).

Keywords: Okra, correlation, path analysis, genotypic level, yield

Introduction

Okra also known as Lady's finger (*Abelmoschus esculentus* L. Moench, 2n=2x=130) is a fast growing annual herb of which the young seed pods are used as common vegetable. It is an important fruit vegetable crop of tropical and subtropical regions of the world. It is commonly grown throughout the warmer part of temperate Asia, Southern Europe, Northern Africa, and the United States and in all parts of the tropics. It is adapted to the climates with relatively short rainy season, hence its special acceptance in north- east Brazil where it is considered a crop that never fails. In India okra is commercially grown in the states of Gujarat, Maharashtra, Andhra Pradesh, Uttar Pradesh, Madhya Pradesh, West Bengal, Assam, Rajasthan, Tamil Nadu, Karnataka, Haryana and Punjab. It is a polyploidy, self-pollinated crop belongs to the family Malvaceae. Occurrence of out crossing to an extent of 4-19 per cent with the maximum of 42.2 per cent is noticed with the insect assisted pollination. Tender green fruits are cooked in curry and soups, while crop has not adopted in India as leafy vegetable as in for East countries. The genus *Abelmoschus* is small and consists of only six species. Okra is widely cultivated in plains of India on acreage of 509 thousand hectare area with a production of 6095 thousand million tonne (NHB 2017-18). Leading okra producing states in India are Andhra Pradesh, West Bengal, and Madhya Pradesh etc. We know that yield is a result of interaction among different direct as well as indirect effect of different characters and path coefficient analysis gives an idea about the contribution of each independent character on dependent character. It is a powerful tool to study the character association and their final impact on yield, which help the selection procedure accordingly. It determines the cause and

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effect which has been found beneficial in splitting the correlation into its direct and indirect effects contributing yield. Therefore, in the present study, path coefficient analysis of 18 genotypes along with two checks was carried out by taking yield per plant as dependent and all other ten traits as independent variable. In the present study, path coefficient analysis was carried out at phenotypic as well as genotypic level. The association analysis will be more useful in the estimation of inter-relationship among the yield contributing components and in the estimation of the nature and extent of direct and indirect effect of yield contributing components using path coefficient analysis.

Materials and Methods

The experimental material for the present study comprised of eighteen diverse okra genotypes, including Kashi Satdhari and Kashi Kranti which were procured from different national institutes *viz.*, All India Coordinated Research Project on Vegetable Crops, ICAR-IIVR, Varanasi; Indian Agricultural Research Institute, New Delhi; Haryana Agriculture University, Hisar, Haryana; Horticulture Research Station, Sub Campus MAU Prabhani; National Bureau of Plant Genetic Resources, New Delhi; and CSA University of Agriculture and Technology, Kanpur. Experiment was performed in randomize block design with three replications and germplasm evaluated at Vegetable Research Farm, Kalyanpur, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (Uttar Pradesh) during *Kharif* season of 2018-19 which is located at the latitude of 26.49° North and Longitude of 80.31° East, with the height of 133 meters above the mean sea level (MSL). The soil of the plot was sandy loamy with almost neutral soil pH i.e. 6.8 having good fertility with proper drainage facility. The meteorological data (temperature, RH and rainfall) were collected from the Meteorological Observatory, Department of Agronomy, C.S.A. University of Agriculture and Technology, Kanpur. The average annual rainfall of the district is 627.3 mm with most occurrences during middle of June to middle of October. All the agronomic package and practices were adopted to raise the healthy crop. Data were recorded on ten quantitative morphological traits: PH: Plant height (cm) at 45 DAS, PH: Plant height (cm) at 90 DAS, FFN: First flowering node, DFF: Days to first flowering, DF: Days to 50% flowering, LF: Length of fruit (cm), DF: Diameter of fruit (cm.), NSF: No. of seeds per fruit, NFP: No. of fruits per plant, YPP: Yield per plant (g) and their direct and indirect effect on yield per plant. Path coefficients were obtained according to the procedure suggested by Dewey and Lu (1959) using genotypic and phenotypic correlation coefficients.

Correlation coefficients were calculated in all possible combinations taking all the characters in to consideration at genotypic, phenotypic and environmental levels by using the formula as proposed by Miller et al. (1958). The calculated value of “t” is compared with table of “t” at (n-2) d.f. Path coefficient are standardized partial regression coefficient and as such these provide the means to direct influence of one character upon another character and also permit portioning of correlation coefficient into direct and indirect effect via other character. The direct indirect contribution of various independent characters on a dependent character yield were calculated through path coefficient analysis as suggested by Wright (1921) and elaborated by Dewey and Lu (1959). The following set of simultaneous equation were formed and used for the estimation of direct and indirect effects. Indirect effect of any independent traits on the dependent one (=yield) via other independent traits are computed by multiplying the direct effects (Pky) of those independent variables with the corresponding correlation coefficient.

Results and Discussion

The phenotypic and genotypic correlation coefficients between yield and other traits have been partitioned into direct and indirect effects by path coefficient analysis. Fruit yield is a complex character which is affected by many independent yield contributing characters, which are regarded as yield components.

Correlation coefficient analysis: Correlation coefficient was worked out at phenotypic, genotypic and environmental levels for all possible combination of ten yield and its attributing characters (Table 1).

Table: 1Estimates of Genotypic and phenotypic correlation coefficients (r) between among yield and its contributing characters

Characters		PH	PH	FFN	DFF	DF	LF	DF	NSF	NFP	YPP
PH	G	1.000	0.958**	0.469**	-0.088	0.018	-0.261	0.038	0.304*	0.244	0.372**
	P	1.000	0.878**	0.457**	-0.084	0.015	-0.186	0.035	0.300*	0.237	0.351**
PH	G		1.000	0.607**	0.044	0.066	-0.266	-0.062	0.298*	0.139	0.297*
	P		1.000	0.541**	0.052	0.064	-0.193	-0.051	0.274*	0.131	0.281*
FFN	G			1.000	0.277*	0.266	-0.268	0.140	0.040	-0.147	-0.085
	P			1.000	0.271*	0.255	-0.177	0.143	0.032	-0.143	-0.092
DFF	G				1.000	0.908**	-0.578**	-0.458**	-0.331*	-0.339*	-0.340*
	P				1.000	0.895**	-0.455**	-0.420**	-0.329*	-0.332*	-0.336*
DF	G					1.000	-0.489**	-0.316*	-0.266	-0.296*	-0.299*
	P					1.000	-0.371**	-0.295*	-0.264	-0.294*	-0.296*
LF	G						1.000	0.551**	-0.101	0.338*	0.260
	P						1.000	0.415**	-0.087	0.235	0.201
DF	G							1.000	0.181	0.286*	0.517**
	P							1.000	0.165	0.264	0.490**
NSF	G								1.000	0.554**	0.523**
	P								1.000	0.549**	0.519**
NFP	G									1.000	0.873**
	P									1.000	0.858**
YPP	G										1.000
	P										1.000

* &** Significant at 5% & 1% respectively

PH: Plant height (cm) at 45 DAS, PH: Plant height (cm) at 90 DAS, FFN: First flowering node, DFF: Days to first flowering, DF: Days to 50% flowering, LF: Length of fruit (cm), DF: Diameter of fruit (cm.), NSF: No. of seeds per fruit, NFP: No. of fruits per plant, YPP: Yield per plant (g)

Results indicated that genotypic correlation coefficient, in general, were of higher magnitude than the corresponding phenotypic correlation coefficient for all the characters. The results of phenotypic correlation coefficients have been discussed only as the genotypic and environmental correlation were mostly influenced by the environmental conditions, hence phenotypic correlation will give the correct idea about the association between two variables. Plant height at 90 DAS was recorded highly significant and positive association with first flowering node (0.541), yield per plant (0.281), and no. of seeds per fruit at 90 DAS (0.274) whereas, highly significant negative association with length of Fruit (-0.193).These results are in corroborated with the finding of Shazia Ali et al. (2008) for number of inter-nodal length. Association of days to first flowering node was exhibited significant and positive for days to first flowering (0.271) while, it was found significant and negative for length of fruit (-0.177). Association of days to first flowering node was exhibited significant and positive with days to 50% flowering (0.895) while, it was found significant and negative with length of fruit (-0.455), diameter of fruit (-0.420) and yield per plant (-0.336). Days to 50 % flowering was recorded highly significant and negative association with length of fruit (-0.371), yield per plant (-0.296) and diameter of fruit (-0.295). These findings corroborated the earlier finding of Duzyaman et al. (2003) and Verma et al. (2007) for negative association for fruit yield per plant.

Fruit length expressed significant and positive correlation with diameter of fruit (0.415).These findings corroborated the earlier finding of Osekita and Akinyele (2008) for fruit weight. Fruit diameter expressed a highly significant and positive correlation coefficient with fruit yield per plant (0.490) and no. of fruits per plant (0.264). These results are in close harmony with the findings of Bendale et al. (2003), Duzyaman et al. (2003), Pawar (2005) and Choudhary (2006) for fruit yield per plant. The correlation coefficient of no. of seeds per fruit was found to be significant and positive correlation with no. of fruits per plant (0.549). These findings corroborated the earlier finding of Ghosh (2005) for fruit yield per plant. The correlation coefficient of no. of fruits per plant was found to be significant and positive correlation with yield per plant (0.858). These findings corroborated the earlier finding of Niranjan and Mishra (2003), Bendale et al. (2003), Jaiprakash Narayan and Mulge (2004), Sureshbabu et al. (2004), Subrata et al. (2004), Bhalekar et al. (2005), Pawar (2005) and Choudhary (2006) for fruit yield per plant.

Path coefficient analysis: To measure the direct as well as indirect association of one variable (cause) through another on the end product (effects). Path coefficient was calculated at genotypic and phenotypic level for all the yield attributing traits. The observed correlation coefficients of fruit yield with its contributing traits were partitioned into direct and indirect effects. In the present investigation, important characters viz., yield is been used as dependent variable. Since the value of genotypic path is more reliable in predicting the correct idea about the direct and indirect effect of the component traits, only this has been discussed below. The estimates of path coefficient are furnished in the Table 2 & 3.

In general the genotypic direct as well as indirect effects were slightly higher in magnitude as compared to corresponding phenotypic direct and indirect effects.

Table 2: Estimates of phenotypic path coefficient direct and indirect effects of 10 characters on yield per plant in okra

Traits	PH	PH	FFN	DFF	DF	LF	DF	NSF	NFP	YPP
PH	**0.021**	0.290	-0.132	-0.024	-0.003	0.014	0.016	0.003	0.166	0.351**
PH	0.018	**0.331**	-0.157	0.015	-0.012	0.014	-0.023	0.003	0.092	0.281*
FFN	0.009	0.179	**-0.290**	0.076	-0.045	0.013	0.066	0.000	-0.100	-0.092
DFF	-0.002	0.017	-0.079	**0.280**	-0.160	0.034	-0.192	-0.003	-0.232	-0.336*
DF	0.000	0.021	-0.074	0.251	**-0.178**	0.028	-0.135	-0.003	-0.206	-0.296*
LF	-0.004	-0.064	0.051	-0.128	0.066	**-0.075**	0.190	-0.001	0.165	0.201
DF	0.001	-0.017	-0.042	-0.118	0.053	-0.031	**0.457**	0.002	0.185	0.490**
NSF	0.006	0.091	-0.009	-0.092	0.047	0.007	0.076	**0.010**	0.384	0.519**
NFP	0.005	0.044	0.041	-0.093	0.053	-0.018	0.121	0.006	**0.700**	0.858**

R SQUARE = 0.8809; RESIDUAL EFFECT = 0.3451; Bold values shows direct and normal values shows indirect effects
PH: Plant height (cm) at 45 DAS, PH: Plant height (cm) at 90 DAS, FFN: First flowering node, DFF: Days to first flowering, DF: Days to 50% flowering, LF: Length of fruit (cm), DF: Diameter of fruit (cm.), NSF: No. of seeds per fruit, NFP: No. of fruits per plant, YPP: Yield per plant (g)

Table 3: Estimates of genotypic path coefficient direct and indirect effects of 10 characters on yield per plant in okra

Traits	PH	PH	FFN	DFF	DF	LF	DF	NSF	NFP	YPP
PH	**1.648**	-1.166	-0.077	-0.132	-0.019	-0.100	0.014	0.114	0.090	0.372**
PH	1.578	**-1.218**	-0.100	0.067	-0.069	-0.102	-0.023	0.112	0.052	0.297*
FFN	0.772	-0.739	**-0.165**	0.416	-0.279	-0.103	0.052	0.015	-0.055	-0.085
DFF	-0.145	-0.054	-0.046	**1.499**	-0.952	-0.222	-0.170	-0.124	-0.126	-0.340*
DF	0.029	-0.080	-0.044	1.360	**-1.049**	-0.188	-0.117	-0.100	-0.110	-0.299*
LF	-0.431	0.324	0.044	-0.867	0.513	**0.385**	0.204	-0.038	0.125	0.260
DF	0.063	0.075	-0.023	-0.687	0.332	0.212	**0.370**	0.068	0.106	0.517**
NSF	0.500	-0.363	-0.007	-0.496	0.279	-0.039	0.067	**0.376**	0.206	0.523**
NFP	0.402	-0.170	0.024	-0.509	0.311	0.130	0.106	0.209	**0.371**	0.873**

R SQUARE = 0.9006 RESIDUAL EFFECT = 0.3153 Bold values shows direct and normal values shows indirect effects.
PH: Plant height (cm) at 45 DAS, PH: Plant height (cm) at 90 DAS, FFN: First flowering node, DFF: Days to first flowering, DF: Days to 50% flowering, LF: Length of fruit (cm), DF: Diameter of fruit (cm.), NSF: No. of seeds per fruit, NFP: No. of fruits per plant, YPP: Yield per plant (g)

Path coefficient analysis of different characters contributing towards yield per plant showed that plant height at 45 DAS (1.648) had highest positive direct effect followed by days to first flowering (1.499), length of fruit (0.385), no. of seeds per fruit (0.376), no. of fruits per plant (0.371), diameter of fruit (0.370) whereas, plant height at 90 DAS (-1.218) had the highest negative direct effect on fruit yield per plant followed by days to 50% flowering (-1.049), first flowering node (-0.165). The results are in propinquity with Subrata Sarkar Hazara et al. (2004), Sarkar et al. (2004), Magar et al. (2009), Ramanjinappa et al. (2011), Senapati et al. (2011), Sibsankar et al. (2012) and Gangashetti et.al. (2013). Mehta et. al. (2006) and Mihretu yonas et al. (2014) for fruit weight.

Path coefficient analysis of different characters contributing towards plant height at 45 DAS imparted highest positive indirect effect on yield per plant through no. of seeds per fruit (0.114), no. of fruits per plant (0.090) and diameter of fruit(0.014). However, indirect effect was negative via plant height at 90 DAS (-1.166), days to first flowering (-0.132), length of fruit (-0.100), first flowering node (-0.077) and days to 50% flowering (-0.019). First Flowering Node was recorded to have positive indirect effect on fruit yield per plant through plant height at 45 DAS (0.772), days to first flowering (0.416), diameter of fruit (0.052) and no. of seeds per fruit (0.015). However, negative indirect effect was expressed via plant height at 90 DAS (-0.739), days to 50% flowering (-0.279) and length of fruit (-0.103). Days to first flowering expressed a positive indirect effect on fruit yield per plant through length of fruit (0.034) and plant height at 90 DAS (0.017).However, rest of the characters showed negative indirect effect via no. of fruits per plant (-0.232), diameter of fruit (-0.192) and days to 50% flowering (-0.160). Days to 50% flowering revealed that value of positive indirect effect on fruit yield per plant through days to first flowering (1.360) and plant height at 45 DAS (0.029) while, negative indirect effect was exhibited in the character i.e. length of fruit (-0.188) and diameter of fruit (-0.117). Length of fruit revealed positive indirect effect on fruit yield per plant through days to 50% flowering (0.513), plant height at 90 DAS (0.324), diameter of fruit (0.204) and no. of fruits per plant (0.125) however, the remaining characters showed negative indirect effect via. days to first flowering (-0.867) and plant height at 45 DAS (-0.431). Diameter of fruit exhibited significant positive indirect effect on fruit yield per plant through days to 50% flowering (0.332), length of fruit (0.212) and no. of seeds per fruit (0.068) however, negative indirect effect observed through days to first flowering (-0.687), and first flowering node (-0.023). Highest positive indirect effect of number of seed per fruit on fruit yield per plant recorded through plant height at 45 DAS (0.500), days to 50% flowering (0.279) and no. of fruits per plant (0.206) however, negative indirect effect was exhibited via, days to first flowering (-0.496), plant height at 90 DAS (-0.363) and length of fruit (-0.039). Highest positive indirect effect of number of fruits per plant on fruit yield per plant recorded through plant height at 45 DAS (0.402), days to 50% flowering (0.311) and no. of seeds per fruit (0.209) however, negative indirect effect was exhibited via, days to first flowering (-0.509), and plant height (cm.) at 90 DAS (-0.170). The results are in propinquity with Subrata Sarkar Hazara et al. (2004), Sarkar et al. (2004), Magar et al. (2009), Ramanjinappa et al. (2011), Senapati et al. (2011), Sibsankar et al. (2012) and Gangashetti et.al. (2013). Mehta et al (2006) and Mihretu yonas et al. (2014) for fruit weight.

It may be concluded from the present results that the estimation of correlation and path coefficient for morphological and quantitative related traits in Okra. The correlation coefficient of no. of seeds per fruit was found to be significant and positive correlation with no. of fruits per plant (0.549) was found to be significant and positive correlation with yield per plant (0.858). Fruit diameter expressed a highly significant and positive correlation coefficient with fruit yield per plant (0.490) and no. of fruits per plant (0.264). Path coefficient analysis of different characters contributing towards yield showed that plant height at 45 DAS had highest positive direct effect (1.648) followed by days to first flowering (1.499), length of fruit (0.385), no. of seeds per fruit (0.376), no. of fruits per plant (0.371) and diameter of fruit (0.370). Path coefficient analysis revealed that most important character contributing towards fruit yield and hence purposeful and balance selection based on these characters would be rewarding improvement in okra. Direct selection of days to 50% flowering and fruiting span should be avoided instead of direct selection.

सारांश

रैंडमाइज्ड कंप्लीट ब्लॉक डिजाइन (आर.सी.बी.डी.) में 18 विविध भिंडी जनन द्रव्य का उपयोग करते हुए एक प्रयोग किया गया था, जिसमें दो चेक यानी काशी सातधारी और काशी क्रांति शामिल थे, खरीफ मौसम, 2018–19 के दौरान

भिंडी में प्रति पौधे उपज पर दस मात्रात्मक रूपात्मक लक्षणों पर अवलोकन दर्ज किए गये। प्रति पौधे फल उपज का उच्चतम सकारात्मक और महत्वपूर्ण सहसंबंध गुणांक बुवाई के 90 दिन बाद पौधे की ऊँचाई के साथ देखा गया, पहली फूल गांठ (0.541), प्रति पौधे उपज (0.281), और संख्या के साथ अत्यधिक महत्वपूर्ण और सकारात्मक जुड़ाव दर्ज किया गया। बुवाई के 90 दिन बाद (0.274) पर प्रति फल बीजों की संख्या। फलों के व्यास ने प्रति पौधे फल उपज (0.490) और नहीं के साथ एक अत्यधिक महत्वपूर्ण और सकारात्मक सहसंबंध गुणांक व्यक्त किया, प्रति पौधे फल (0.264), संख्या का सहसंबंध गुणांक, प्रति फल बीजों की संख्या महत्वपूर्ण और संख्या के साथ सकारात्मक सहसंबंध पाया गया। प्रति पौधे फल (0.549), संख्या का सहसंबंध गुणांक, प्रति पौधे फलों की संख्या महत्वपूर्ण और प्रति पौधे उपज (0.858) के साथ सकारात्मक सहसंबंध पाया गया। प्रति पौधा उपज में योगदान देने वाले विभिन्न लक्षणों के पथ गुणांक विश्लेषण से पता चला है कि बुवाई के 45 दिन बाद (1.648) पर पौधे की ऊँचाई का उच्चतम सकारात्मक प्रत्यक्ष प्रभाव था, जिसके बाद पहले फूल आने के दिन (1.499), फल की लंबाई (0.385), संख्या प्रति फल बीजों की संख्या (0.376), संख्या प्रति पौध फलों की संख्या (0.371), फल का व्यास (0.370) जबकि, बुवाई के 90 दिन बाद (–1.218) पौधे की ऊँचाई प्रति पौधे फल उपज पर उच्चतम नकारात्मक प्रत्यक्ष प्रभाव था, इसके बाद दिनों में 50 प्रतिशत फूल (–1.049), पहली फूल गांठ (–0.165)।

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