RESEARCH ARTICLE

ASSESSMENT OF DIRECT AND INDIRECT RELATIONSHIPS AMONG FRUIT YIELD AND YIELD COMPONENTS IN OKRA (*ABELMOSCHUS ESCULENTUS* L. MOENCH)

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Abstract: Path analysis was studied using 31 diverse okra genotypes along with two checks *i.e,* Pusa Sawani and Pusa A-4. The experiment was laid out in Randomized Complete Block Design (RCBD) and observations were recorded on thirteen quantitative morphological traits on yield per plant in okra during Rainy season, 2017-2018. Among the characters studied, days to 50% flowering, number of fruits per plant and average fruit weight has direct positive effect on fruit yield per plant at both phenotypic as well as genotypic level. At phenotypic level, number of fruits per plant (0.792) exhibited maximum positive direct effect on fruit yield per plant followed by average weight of fruit (0.375), days to 50% flowering (0.275) and number of nodes (0.173). Whereas, at genotypic level number of fruits per plant (0.678) followed by number of primary branches (0.259), days to 50% flowering (0.102) and plant height (0.013) exhibited maximum positive direct effect on fruit yield per plant. However, the negative direct effect was found for percent disease incidence of YVMV at both phenotypic and genotypic levels. Some characters like Plant height, number of nodes and number of fruits per plant showed positive indirect effect on fruit yield per plant via days to first flowering at phenotypic level, whereas, at genotypic level plant height, number of primary branches, number of nodes and fruit length showed positive indirect effect on fruit yield via number of fruits per plant.

Keywords: Okra, Path analysis, Phenotypic level, Genotypic level, Yield

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is one of the most economically versatile vegetable crop of Malvaceae family, grown throughout tropical and sub-tropical parts of India and world. It is a multipurpose and multifarious crop valued for its tender and delicious pods (Chinatu and Okocha, 2006). It is mostly grown in tropical and sub tropical part of India as a warm season vegetable crop, require warm nights (>20ºC) for proper growth and development (Seth *et al.,* 2017). It is known by various local names in different parts of the world like *Lady's Finger* in England, *Gumbo* in U.S.A and *Bhindi* in northern India. In India, the states like West Bengal, Gujarat, Bihar, Orissa, Jharkhand, Madhya Pradesh, Uttar Pradesh, Chhattisgarh, Andhra Pradesh, Haryana, Assam and Tamil Nadu are the major okra producing state (Anonymous, 2017). Indian continent having good variability among okra genotypes due to geographically separation, genetic barriers to crossability and involvement of different parents in varietal development. Presence of natural variations to the larger extent for various traits in okra are quite enough to reflect the scope of improvement in economic traits through conventional breeding techniques. One of the major problems in okra cultivation in India is lack of location specific high yielding and disease resistant varieties. At present time, there is a need to develop new varieties with location specific and disease resistance with improve quality. 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 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 31 genotypes along with two checks was carried out by taking yield per plant as dependent and all other thirteen traits as independent variable. In the present study, path coefficient analysis was carried out at phenotypic as well as genotypic level.

MATERIALS AND METHODS

The present investigation was carried out using 31 diverse okra genotypes along with two checks Pusa Sawani and Pusa A-4 procured from different national institutes *viz*., All India Coordinated Research Project on Vegetable Crops, ICAR-IIVR, Varanasi, India, Indian Institute of Horticulture Research (IIHR), Bengaluru and Indian Agricultural Research Institute, New Delhi. 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

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(Uttar Pradesh) during rainy season of 2017-2018 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 thirteen quantitative morphological (DFF= Days to first flowering, D50%F= days to 50% flowering, FFN= First flowering node, PH= Plant Height (cm), NPB= Number of Primary Branches, NN= Number of nodes, IL= Inter-nodal Length (cm), FL= Fruit Length (cm), FD= Fruit Diameter (cm), NOFPP= Number of Fruits per Plant, AFW= Average Fruit Weight (g), NOSPP= Number of Seeds per Pod, PDI= Percent disease incidence) 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.

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. In this experiment, days to 50% flowering, number of fruits per plant and average fruit weight has positive effect on fruit yield per plant at both phenotypic and genotypic levels (Table 1 & 2). This indicates that direct selection for number of fruit per plant and average weight in desired direction would be very effective for yield improvement. Similar results was obtained by the investigation of Soni *et al.* (2018), in which path coefficient analysis revealed that number of fruits per plant had highest positive direct effect on fruit yield. Path coefficient analysis by Aminu *et al.* (2016) further revealed that number of pods/plants exhibited positive and direct influence on the pod yield and these all results also corroborates with the findings of Jonah and Kwaga (2019) and Sood *et al.* (2016). Whereas, the highest negative direct effect was found in percent disease incidence at both phenotypic and genotypic levels (-0.162, -0.446), respectively. Days to first flowering showed direct negative effect at phenotypic as well as genotypic levels (-0.235, -0.121), respectively. Similar findings reported by Singh *et al.* (2017). At phenotypic level, characters *viz*., plant height, number of primary branches, number of nodes and fruit diameter has indirect positive effect on fruit yield via number of fruits per plant whereas, days to first flowering, days to 50% flowering, first flowering nodes, intermodal length, number of seeds and percent disease incidence expressed negative indirect effect. At genotypic level some characters *viz*., days to first flowering, days to 50% flowering and first flowering nodes exerted positive indirect effect on fruit yield via number of nodes per plant. Similar trend for path analysis were reported by Neeraj *et al.* (2017) and Raval *et al.* (2019) as well as in the same way Aminu *et al.* (2016) reported days to 50% flowering were positive and highly significantly associated with pod yield in okra.

The results of the present investigation indicated that number of fruits per plant (0.678) followed by number of primary branches (0.259), days to 50% flowering (0.102) and plant height (0.013) exhibited maximum positive direct effect on fruit yield per plant at genotypic level. Moreover, plant height, number of nodes and fruit length showed positive indirect genotypic effect on fruit yield via number of fruits per plant. Overall, number of fruits per plant, number of primary branches, days to 50% flowering, plant height is the most important characters contributing towards fruit yield.

Table 1. Estimates of phenotypic direct and indirect effects of 13 characters on yield per plant in okra during Rainy season, 2017-2018.

Traits	DFF	DF50%	FFN	PH	NPB	NN	IL	FL	FD	NF/P	AFW	NOSPP	PDI (%)	Y/P
DFF	**-0.235**	0.258	0.001	0.026	-0.001	-0.024	-0.006	0.000	0.000	-0.126	-0.051	-0.003	-0.032	-0.195
DF50%	-0.221	**0.275**	0.001	0.022	0.000	-0.035	-0.004	0.000	0.000	-0.167	-0.049	-0.004	-0.048	-0.229
FFN	-0.067	0.093	**0.003**	-0.003	0.000	-0.012	-0.009	-0.001	0.000	-0.134	-0.091	0.000	-0.042	-0.261
PH	0.064	-0.064	0.000	**-0.095**	-0.004	0.093	0.022	0.000	0.002	0.310	0.036	0.008	0.042	0.416*
NPB	-0.022	0.003	0.000	-0.046	**-0.007**	0.109	0.008	0.001	0.000	0.410	-0.012	-0.002	0.050	0.490**
NN	0.033	-0.056	0.000	-0.051	-0.005	**0.173**	-0.002	0.000	-0.001	0.646	-0.079	-0.003	0.078	0.734
IL	0.031	-0.020	-0.001	-0.044	-0.001	-0.007	**0.047**	0.000	-0.002	-0.015	0.070	0.010	0.000	0.067
FL	0.009	-0.031	-0.001	-0.020	-0.003	0.000	0.010	**0.002**	0.002	0.149	0.123	0.005	0.054	0.298
FD	0.003	-0.004	0.000	-0.008	0.000	-0.010	-0.004	0.000	**0.020**	0.023	-0.009	0.002	0.010	0.025

NF/P	0.037	-0.058	0.000	-0.037	-0.004	0.141	-0.001	0.000	0.001	**0.792**	-0.078	-0.001	0.093	0.885**
AFW	0.032	-0.036	-0.001	-0.009	0.000	-0.037	0.009	0.001	-0.001	-0.164	**0.375**	0.003	0.025	0.198
NOSPP	0.029	-0.040	0.000	-0.031	0.001	-0.022	0.018	0.000	0.002	-0.044	0.043	**0.025**	0.032	0.013
PDI (%)	-0.046	0.082	0.001	0.025	0.002	-0.084	0.000	-0.001	-0.001	-0.454	-0.057	-0.005	**-0.162**	-0.701**

R SQUARE = 0.9585 RESIDUAL EFFECT = 0.2037

Bold values shows direct and normal values shows indirect effects

Where, DFF= Days to first flowering, D50%F= days to 50% flowering, FFN= First flowering node, PH= Plant Height (cm), NPB= Number of Primary Branches, NN= Number of nodes, IL= Inter-nodal Length (cm), FL= Fruit Length (cm), FD= Fruit Diameter (cm), NF/P= Number of Fruits per Plant, AFW= Average Fruit Weight (g), NOSPP= Number of Seeds per Pod, PDI= Percent disease incidence, Y/P= Yield per plant.

Table 2. Estimates of genotypic direct and indirect effects of 13 characters on yield per plant in okra during Rainy season, 2017-2018.

Traits	DFF	DF50%	FFN	PH	NPB	NN	IL	FL	FD	NF/P	AFW	NOSPP	PDI (%)	Y/P
DFF	**-0.121**	0.097	-0.050	-0.004	0.045	0.011	-0.016	0.036	-0.001	-0.075	-0.035	0.006	-0.104	-0.209
DF50%	-0.115	**0.102**	-0.055	-0.004	0.002	0.050	-0.010	0.054	0.008	-0.180	-0.029	0.007	-0.154	-0.324
FFN	-0.042	0.039	**-0.143**	-0.001	-0.016	0.040	-0.024	0.120	0.025	-0.212	-0.030	0.000	-0.145	-0.388*
PH	0.036	-0.029	0.006	**0.013**	0.117	-0.089	0.051	-0.097	0.040	0.212	0.028	-0.015	0.123	0.395*
NPB	-0.021	0.001	0.009	0.006	**0.259**	-0.111	0.016	-0.154	0.030	0.344	0.024	0.004	0.165	0.570**
NN	0.007	-0.028	0.031	0.006	0.158	**-0.182**	-0.008	-0.068	-0.007	0.560	0.001	0.008	0.324	0.802**
IN	0.020	-0.010	0.034	0.007	0.042	0.014	**0.098**	-0.082	-0.040	-0.001	0.025	-0.018	-0.009	0.079
FL	0.018	-0.023	0.071	0.005	0.165	-0.052	0.033	**-0.241**	0.038	0.298	0.022	-0.011	0.185	0.509**
FD	-0.006	-0.063	0.266	-0.039	-0.564	-0.100	0.290	0.666	**-0.014**	-0.028	-0.041	0.077	-0.773	-0.329
NF/P	0.013	-0.027	0.045	0.004	0.132	-0.151	0.000	-0.106	0.001	**0.678**	-0.007	0.004	0.342	0.929**
AFW	0.058	-0.041	0.060	0.005	0.085	-0.002	0.034	-0.074	0.008	-0.061	**0.073**	-0.016	0.119	0.246
NOSPP	0.017	-0.018	0.000	0.005	-0.025	0.037	0.042	-0.062	0.025	-0.061	0.027	**-0.041**	0.095	0.041
PDI (%)	-0.028	0.035	-0.046	-0.004	-0.096	0.133	0.002	0.100	-0.024	-0.521	-0.019	0.009	**-0.446**	-0.905**

Bold values shows direct and normal values shows indirect effects

R SQUARE = 0.9932 RESIDUAL EFFECT = 0.0825

Where, DFF= Days to first flowering, D50%F= days to 50% flowering, FFN= First flowering node, PH= Plant Height (cm), NPB= Number of Primary Branches, NN= Number of nodes, IL= Inter-nodal Length (cm), FL= Fruit Length (cm), FD= Fruit Diameter (cm), NF/P= Number of Fruits per Plant, AFW= Average Fruit Weight (g), NOSPP= Number of Seeds per Pod, PDI= Percent disease incidence, Y/P= Yield per plant.

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