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A Genetic Interrelationships among Quantitative Characteristics in Notable Okra Genotypes

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ABSTRACT

Okra is prominent vegetable crop cultivated in various parts of the world. In vegetable breeding there is a continuous need for identification of traits which can aid selection process. Hence, the current experiment was conducted during *Kharif* 2019 for studying the extent of the path and correlation coefficient for resolving indirect and direct effect of several characters on yield of fruit involving thirty genotypes of okra at ANDUA&T, Ayodhya, Uttar Pradesh. During study, the most crucial character i.e., yield of fruit per plant manifested high and positive phenotypic correlation with marketable yield of fruit per plant and fruit circumference while, days taken to fruit harvest, plant height and days to 50 percent flowering showed significant and negative correlation with marketable yield of fruit per plant. The highest extent of phenotypic path coefficient positive direct effect on total fruit yield per plant was applied by marketable yield of fruit per plant subsequently by branches per plant while, direct negative effects on total fruit yield was exerted by total soluble solid subsequently by plant height. Hence, it might be concluded that the choices made on the basis of traits viz., marketable yield of fruit per plant, fruit circumference, branches per plant might be more beneficial during formulating selection indices in okra breeding and advancement programmes.

Key Words: Correlation, fruit yield, genotype, okra, path coefficient, vegetable.

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] having chromosomes as 2n=130 is a crucial crop economically, being cultivated in sub-tropical and tropical, for its immature fruits (Mishra *et al,* 2015; Manu *et al,* 2021). Being a short duration crop, it fits well in multiple cropping systems (Ray *et al,* 2022). The cultivation of okra, which began in Ethiopia along the Nile River and was first grew by the early Egyptians in the 12th century, expanded throughout the North Africa and Middle East (Reddy *et al,* 2012). It is a crop that is frequently cross-pollinated; with outcrossing occurs to a degree of 4 to 19 percent and highest upto 42.2 percent assisted with insect driven pollination (Raval *et al,* 2019). Okra's commercial varieties and hybrids are widely accessible in the seed markets, however the majority of these are not suitable for all of the country's growing regions hence farmers face difficulty in region wise availability of the suitable germplasm (Joshi *et al,* 2020; Joshi *et al,* 2021). Any breeding programme should logically begin with evaluating the current genetic variabilities and genotypes, which generally forms the foundation of any crop development and improvement programme. Therefore, it is crucial to have a complete understanding of the complexion and level of heritability, variability, and associations between the several traits before beginning any breeding project (Kerure *et al,* 2017). An analysis of the correlation between various quantitative characteristics offers a notion of interconnection which might be successfully used for developing picking and selection plans for enhancing yield and related attributes. It would be beneficial to take into account the proportional degree of correlation of different features with yield for any efficient

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selection plan (Raval *et al,* 2017). The values of correlation just indicate the strength and value of link among character pairs. Separating the genotypic association of component qualities into indirect and direct effects is necessary in order to execute effective selection which is performed by the path coefficient analysis (Prajna *et al,* 2015). Therefore, using path and correlation analysis, the current experiment was designed to investigate the link between traits as well as the indirect and direct effects of different yield components on yield of fruit in the cultivars and genotypes under evaluation.

MATERIALS AND METHODS

The current experiment was conducted for studying the interrelationship among characters and the extent of path coefficients analysis among 30 genotypes and cultivars of okra including three checks (Pusa Makhmali, Parbhani Kranti and Pusa Sawani) in the Randomized Complete Block Design (RCBD) with three replicates and every genotype and cultivar with three rows with spacing of 30 cm. The study was carried out in *Kharif* 2019 at Department of Vegetable Science, Main Experimental Station, A.N.D.U.A&T, Ayodhya, Uttar Pradesh, India. As recommended by Gomez and Gomez (1984), the data were determined using ANOVA (One way analysis of variance). The correlation was formulated by the method given by Johnson *et al* (1955), and the path by Dewey and Lu, 1959. The SAS was also used for statistical analysis, with means being compared using the crucial difference (CD) at 0.05. The techniques given by Ranganna (2010) were used to record the fruit's chemical properties and TSS. The characters studied under the present investigation were node to 1^{st} flower appearance, days to 50% Flowering, plant height, crop duration, number of branches per plant, days to first fruit harvest, number of nodes per plant, total soluble solid, fruit length, fruit circumference, average fruit weight, number of fruits per plant and marketable fruit yield per plant.

RESULTS AND DISCUSSION

Correlation coefficient analysis

The genotypic and phenotypic correlation coefficient between 13 different traits is presented in Table 1. The amplitude of genotypic correlations was greater than the comparable values of phenotypic correlation coefficients, indicating a strong innate link between distinct pairs of traits. Umrao *et al* (2015) had also reported the same in their studies.

Genotypic correlation coefficient

In the case of genotypic correlation coefficient, the most significant characteristic was the total fruit yield per plant, which showed a strong positive association with the amount of marketable fruit produced per plant, followed by the fruit circumference, while, plant height, days to first fruit harvest and days to 50% flowering possessed significant negative correlation with the marketable fruit yield per plant. Fruit circumference showed a highly substantial and positive association with marketable yield of fruits per plant, while, significant and negative correlation with plant height and average fruit weight. Days to first fruit harvest, days to 50% flowering, and plant height were significantly and negatively connected with the number of fruits per plant, but extremely significantly and positively correlated with total soluble solid, number of branches per plant, and number of nodes per plant. The average fruit weight showed a substantial and negative link with the number of nodes per plant, but a highly significant and positive correlation with plant height, crop duration, and node to first bloom appearance. Likewise, Simon *et al* (2013) and Swamy *et al* (2013) also find out a strong and negative association between the number of nodes per plant and the number of days until 50% flowering. Fruit length showed a substantial and negative link; however, fruit circumference showed a highly significant and positive correlation with marketable fruit yield per plant. Fruit length showed a strong and positive phenotypic association with crop duration, but a substantial and negative link with total soluble solid and the number of branches per plant. Total soluble solid showed a substantial and negative phenotypic association with plant height, but a highly significant and positive correlation with the number of nodes per plant. The phenotypic association between the number of nodes per plant and total soluble solids was found to be highly non-significant, however the correlation between plant height and crop duration was shown to be

Table 1. Estimate of phenotypic and genotypic correlation coefficient between fourteen characters of okra germplasm.

Character		Node to 1st flower appearance	Days to 50% Flowering	Plant height (cm)	Crop duration	Number of branches per plant	Days to first fruit harvest	Number of nodes perplant	Total soluble solid (ºB)	Fruit Length (cm)	Fruit circumference (cm)	Average fruit weight (g)	Number of fruits perplant	Marketable fruit yield per plant (g)	Correlation with total fruit yield per plant (g)
Node to first flower appearance	P G	1.000 1.000	0.098 0.114	0.064 0.011	0.159 0.191	- 0.089 -0.151	0.136 0.140	-0.101 -0.100	0.035 0.036	0.058 0.055	-0.070 -0.042	0.209* 0.252*	0.102 0.114	0.092 0.134	0.085 0.113
Days to 50% Flowering	P G		1.000 1.000	0.252* 0.262*	0.013 0.054	- 0.014 0.002	0.932** 0.983**	-0.057 -0.059	0.137 0.142	-0.119 -0.125	-0.042 -0.037	0.037 0.055	-0.249* -0.277**	-0.158 -0.196	-0.232* -0.249*
Plant height (cm)	P G			1.000 1.000	0.231* 0.269*	0.077 0.065	0.290** 0.294**	-0.528** -0.547**	-0.294** -0.311**	0.105 0.105	-0.194 -0.198	0.519** 0.582**	-0.189 -0.217*	-0.357** -0.379**	-0.377** -0.389*
Crop duration	P G				1.000 1.000	-0.134 -0.175	0.045 0.100	-0.344** -0.385**	-0.159 -0.184	0.234* 0.265*	-0.124 -0.124	0.355** 0.408**	-0.048 -0.033	-0.032 -0.025	-0.014 -0.010
Number of branchesper plant	P G					1.000 1.000	-0.043 -0.033	0.117 0.123	-0.032 -0.039	0.309** - 0.325**	-0.160 -0.189	-0.069 -0.075	0.323** 0.349**	-0.044 -0.035	0.047 0.057
Days to first fruitharvest	P G						1.000 1.000	-0.074 -0.072	0.144 0.159	-0.078 -0.087	-0.141 -0.142	0.055 0.072	-0.263* -0.289**	-0.161 -0.186	-0.237* -0.259*
Number of nodes per plant	P G							1.000 1.000	0.232* 0.234*	-0.047 -0.045	-0.028 -0.032	- 0.582** -0.607**	0.229* 0.236*	0.033 0.029	0.048 0.046
Total soluble solid (ºB)	P G								1.000 1.000	-0.220* -0.225*	-0.043 -0.046	-0.152 -0.162	- 0.354** -0.364**	0.142 0.140	-0.020 -0.020
Fruit Length (cm)	P G									1.000 1.000	-0.205 -0.208*	-0.006 -0.003	0.038 0.038	0.059 0.060	0.090 0.093
Fruit circumference(cm)	P G										1.000 1.000	0.037 0.035	-0.197 -0.207	0.294** 0.306**	0.257* 0.267*
Average fruit weight(g)	P G											1.000 1.000	-0.120 -0.123	-0.241* -0.255*	-0.178 -0.193

***, ** significant at 5% and 1% level, respectively**

Table 2. Direct and indirect effects of thirteen characters on total fruit yield (g) at phenotypic and genotypic level in okra.

Character		Node to 1st flower appearance	Days to 50% Flowering	Plant height (cm)	Crop duration	Number of branches per plant	Days to first fruit harvest	Number of nodes perplant	Total soluble solid (ºB)	Fruit Length (cm)	Fruit circumfe rence (cm)	Average fruit weight (g)	Number of fruits per plant	Marketable fruit yield per plant (g)	Correlation with total fruit yield per plant (g)
Node to first flower appearance	P	0.055	-0.001	-0.017	-0.0021	-0.017	-0.006	-0.006	-0.010	0.003	0.005	0.028	-0.025	0.077	0.085
	G	0.035	0.129	-0.003	0.0002	-0.022	-0.168	-0.015	-0.013	0.001	0.012	0.063	-0.044	0.113	0.113
Days to 50% Flowering	P	0.005	-0.015	-0.066	-0.0002	-0.003	-0.042	-0.003	-0.038	-0.007	0.003	0.005	0.061	-0.133	-0.232*
	G	0.004	0.132	-0.071	0.0001	0.000	-0.183	-0.009	-0.051	-0.003	0.011	0.014	0.108	-0.201	-0.249*
Plant height (cm)	P	0.004	-0.004	-0.260	-0.0031	0.014	-0.013	-0.029	0.081	0.006	0.013	0.068	0.046	-0.299	-0.377**
	G	0.000	0.296	-0.271	0.0003	0.009	-0.354	-0.083	0.111	0.002	0.059	0.145	0.084	-0.389	-0.389**
Crop duration	P	0.009	0.000	-0.060	-0.0135	-0.025	-0.002	-0.019	0.044	0.014	0.008	0.047	0.012	-0.027	-0.014
	G	0.077	0.062	-0.073	0.0012	-0.025	-0.120	-0.058	0.066	0.006	0.037	0.102	0.013	-0.026	-0.010
Number of branchesper plant	P	-0.005	0.000	-0.020	0.0018	0.185	0.002	0.006	0.009	-0.018	0.011	-0.009	-0.079	-0.037	0.047
	G	-0.005	0.003	-0.018	-0.0002	0.145	0.040	0.019	0.014	-0.007	0.056	-0.019	-0.136	-0.036	0.057
Days to first fruitharvest	P	0.008	-0.014	-0.076	-0.0006	-0.008	-0.045	-0.004	-0.040	-0.005	0.009	0.007	0.064	-0.135	-0.237*
	G	0.005	0.113	-0.080	0.0001	-0.005	-0.204	-0.011	-0.057	-0.002	0.042	0.018	0.112	-0.191	-0.259*
Number of nodes per plant	P	-0.006	0.001	0.138	0.0047	0.022	0.003	0.055	-0.064	-0.003	0.002	-0.077	-0.056	0.028	0.048
	G	-0.003	-0.066	0.149	-0.0005	0.018	0.087	0.152	-0.084	-0.001	0.010	-0.151	-0.092	0.030	0.046
Total soluble solid (ºB)	P	0.002	-0.002	0.077	0.0021	-0.006	-0.006	0.013	-0.274	-0.013	0.003	-0.020	0.087	0.119	-0.020
	G	0.001	0.160	0.084	-0.0002	-0.006	-0.192	0.035	-0.357	-0.005	0.014	-0.040	0.141	0.144	-0.020
Fruit Length (cm)	P	0.003	0.002	-0.027	-0.0032	-0.057	0.004	-0.003	0.060	0.058	0.014	-0.001	-0.009	0.050	0.090
	G	0.002	-0.141	-0.029	0.0003	-0.047	0.105	-0.007	0.080	0.021	0.062	-0.001	-0.015	0.061	0.093
Fruit circumferen ce(cm)	P	-0.004	0.001	0.051	0.0017	-0.030	0.006	-0.002	0.012	-0.012	-0.067	0.005	0.048	0.246	0.257*
	G	-0.001	-0.042	0.054	-0.0002	-0.027	0.171	-0.005	0.017	-0.004	-0.297	0.009	0.080	0.314	0.267*
Average fruit weight (g)	P	0.012	-0.001	-0.135	-0.0048	-0.013	-0.002	-0.032	0.042	0.000	-0.002	0.132	0.029	-0.202	-0.178
	G	0.009	0.062	-0.158	0.0005	-0.011	-0.086	-0.092	0.058	0.000	-0.010	0.249	0.048	-0.262	-0.193
Number of fruits per plant	P	0.006	0.004	0.049	0.0007	0.060	0.012	0.013	0.097	0.002	0.013	-0.016	-0.245	0.159	0.155
	G	0.004	-0.314	0.059	0.0000	0.051	0.348	0.036	0.130	0.001	0.061	-0.031	-0.388	0.211	0.168
Marketable	P	0.005	0.002	0.093	0.0004	-0.008	0.007	0.002	-0.039	0.003	-0.020	-0.032	-0.047	0.838	0.806**

Phenotypic residual effect = 0.264,*, ** significant at 5% and 1% level, respectively

Genotypic residual effect = 0.157,*, ** significant at 5% and 1% level, respectively significant and negative. Days till first fruit harvest showed a non-significant and negative phenotypic association with the number of branches per plant, but a highly significant and positive link with days to 50% flowering and plant height. Plant height showed a highly significant and positive phenotypic association with crop duration, however, the number of branches and fruits per plant and the marketable yield per plant showed a non-significant and negative link. While Goswami *et al.* (2012), Patel *et al.* (2014), and Chandramouli *et al.* (2016) likewise revealed non-significant and negative connection, plant height showed a substantial and positive genotypic link with days to 50% flowering.

Phenotypic correlation coefficient

Regarding the phenotypic correlation coefficient, the data indicated that the most noteworthy attribute, the total fruit production per plant, exhibited a significant negative correlation with plant height, days to 50% flowering, and days to first fruit harvest, but a strong positive phenotypic correlation with fruit circumference and marketable yield of fruit per plant. The phenotypic association between fruit circumference and marketable fruit production per plant was found to be highly significant and positive, however there was a substantial and negative link between fruit weight and plant height. There was a substantial and negative correlation found between the number of fruits per plant, total soluble solid, days to first fruit harvest, and days to 50% flowering, and the number of branches and nodes per plant. The average fruit weight showed a substantial and negative phenotypic association with the number of nodes per plant, but a highly significant and positive correlation with plant height, crop duration, and node to first bloom appearance. Fruit length showed a strong and positive phenotypic association with crop duration, but a substantial and negative link with total soluble solid and the number of branches per plant. Total soluble solid showed a substantial and negative phenotypic association with plant height, but a highly significant and positive correlation with the number of nodes per plant. Marketable fruit production per plant was positively correlated with the number of nodes on the plant, although there was a substantial negative association with plant height and crop duration. Days till first fruit harvest showed a non-significant and negative phenotypic association with marketable fruit output per plant, number of nodes per plant, and fruit circumference, but a highly significant and positive correlation with days to 50% flowering and plant height. Plant height showed a highly significant and positive phenotypic association with crop duration, whereas fruit circumference, number of nodes per plant, and marketable fruit output per plant showed non-significant and negative correlations. In contrast to the non-significant and negative association with fruit circumference, plant height showed a highly significant and favourable phenotypic correlation with days to 50% flowering.

Path Coefficient Analysis

The path analysis (Table 2), offers a way to distinguish between the direct and indirect effects of different traits on fruit yield at the phenotypic and genotypic levels. Regarding the direct effects of phenotypic path coefficient, it was determined that marketable fruit production per plant and number of branches per plant exhibited the largest positive direct path coefficient effects on total fruit yield per plant. The remainder of the features, such as fruit weight, fruit length, number of nodes per plant, and node to first flower appearance, had relatively little positive direct effects. Likewise, Dhall *et al* (2000) found a strong positive direct relationship between the total fruit production per plant and the marketable fruit yield per plant. The total soluble solid had a significant negative direct influence on the total fruit yield per plant, followed by the height of the plant and the number of fruits per plant. The other features, such as fruit circumference, plant height, and days till first fruit harvest, had relatively little negative direct effects. Days to 50% flowering had a negative direct impact on the overall fruit output, as documented by Adiger *et al* (2011). On the other hand, it was found that the fruit circumference and flesh number of fruits per plant, total soluble salt, node to first flower appearance, and number of nodes per plant displayed indirect positive effects via marketable fruit yield per plant on total fruit yield per plant in the case of the indirect effects of phenotypic path coefficient. Plant height, on the other hand, had a strong negative and significant indirect effect on the total fruit production per plant through the marketable fruit yield per plant. The marketable fruit yield per plant had an indirect negative impact on the total fruit yield per plant, as did the average fruit weight, the number of branches per plant, the days to 50% flowering, the days to the first fruit harvest, and the length of the crop. The average fruit weight revealed negative indirect impacts on the total fruit produce per plant through plant height.

Marketable yield of fruit per plant and average fruit weight exhibited the largest positive direct path coefficient impacts on total fruit yield per plant in the case of the direct genotypic path coefficient effect. However, the remaining characteristics i.e., number of nodes per plant, number of branches per plant, and days to 50% flowering had very little positive direct effects. The number of fruits per plant and total soluble solid had the greatest negative direct influence on the total fruit production per plant. The remainder of the features, such as fruit circumference, plant height, and days to first fruit harvest, had relatively little negative direct consequences. In contrast, fruit circumference, followed by the number of fruits on each plant, total soluble solid, the node to the first flower appearance, fruit length, and the number of nodes on each plant revealed indirect positive effects through marketable fruit yield per plant on the total fruit yield per plant in the case of the indirect path coefficient effects. Plant height, on the other hand, had a strong negative and significant indirect effect on the total fruit production per plant through the marketable fruit yield per plant. The study found that the average fruit weight, number of branches per plant, days to 50% flowering, days to first fruit harvest, and crop length had indirect negative effects on the total fruit production per plant.

CONCLUSION

It was revealed that while days to first fruit harvest, plant height, and days to 50% flowering all showed significant negative correlations with marketable fruit yield per plant, total fruit yield per plant showed a highly significant and positive correlation with both fruit circumference and marketable yield of fruit per plant. The marketable fruit yield per plant and average fruit weight had the greatest degree of positive direct path coefficient effects on the total fruit yield per plant. The number of fruits per plant and total soluble solid had the largest negative direct effect on the total fruit production per plant. Plant height, on the other hand, had a strong negative and significant indirect effect on the total fruit yield per plant through the marketable yield of fruit per plant. Therefore, it can be concluded that the characteristics that can be taken into account during breeding and selection for strong selection process include fruit yield per plant, number of fruits per plant, fruit circumference, and plant height.

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