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CORRELATION AND PATH ANALYSIS IN GENOTYPES OF OKRA [*ABELMOSCHUS ESCULENTUS* (L.) MOENCH]

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ABSTRACT
A study of correlation and path analysis was undertaken in 27 genotypes of okra for fruit yield and its component traits. Yield per plant had highly significant positive genotypic and phenotypic correlation with plant height (0.49**, 0.47**), length of pod (0.78**, 0.75**), average weight of edible pod (0.93**, 0.91**) and number of seeds per pod (0.59**, 0.57**). Non-significant correlation was observed for yield component traits like number of pods per plant and weight of 100- seeds with yield per plant. Correlation studies indicated that close relationship between genotypic and phenotypic correlation coefficients and magnitude of genotypic correlation were higher than their corresponding phenotypic correlation for most of the characters. Path coefficient analysis revealed that average weight of edible pod (0.943) had highest positive direct effect followed by number of pods per plant (0.372) and number of leaves per plant (0.125) on yield per plant. The study suggested that plant height, length of pod, average weight of edible pod and number of seeds per pod are important traits which should be used as selection criteria to develop high yielding varieties in okra.

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench.] belongs to the family Malvaceae. It is extensively grown in temperate, subtropical and tropical regions of the world (Kochhar, 1986). India is the leading country in okra production but low yield potential due to low yielding varieties and incidence of various insect pests and diseases (Lyngdoh *et al*., 2013). Unlike other vegetables, it can be grown spring-summer as well as in rainy season. It is one of the most important vegetable grown for its tender green fruit in India. It has high nutritive and medicinal value and export potential. Fresh okra fruit contains 2.1 g protein, 0.2 g fat, 8 g carbohydrate, 36 calories, 1.7 g fiber, 175.2 mg minerals, and 88 mL of water per 100 g of edible portion (Tindall, 1983; Berry *et al*., 1988). Fruit yield of okra is a complex quantitative trait, which is result interaction of various growth and physiological processes during the life cycle (Adeniji and Peter, 2005).

Yield is a polygenic trait, which is governed by numbers of genes. However, direct selection for yield alone is usually not very effective or may often be misleading. Hence, selection based on its contributing characters could be more efficient and reliable (Kumar *et al.,* 2013a; Kumar *et al.,* 2013b). The success of any breeding program mainly depends on genetic variability, heritability, genetic advance, character association and direct and indirect effects on yield and its contributing traits. The study of correlation between plant characters is of great importance to a plant breeder as it provides a measure of the degree of association between yield and other yield attributes. The path coefficient analysis is partitioned the correlation in direct and indirect effects and thus may be useful in choosing the characters that have direct and indirect effects on yield. Hence, study of correlations (genotypic and phenotypic) and path coefficient analysis of yield would be of help in selection of yield component traits in the genetic improvement of quantitative traits, which are positively correlated. Correlation and path coefficient analysis have been studied by several workers to measure the associations between pod yield and other traits. Growth parameters like plant height and number of leaves at different stages varied significantly between the seed weight grades and varieties (Thapa *et al*., 2012). Plant height (Dakahe *et al*., 2007; Adiger *et al*., 2011; Kumar *et al*., 2012; Jagan *et al*., 2013), pod weight (Mehta *et al*., 2006; Chaukhande *et al*., 2011; Simon *et al*., 2013b), pod length (Mehta *et al*., 2006; Dakahe *et al*., 2007; Nasit *et al*., 2009; Adiger *et al*., 2011; Kumar *et al*., 2012) and number of seeds per pod (Simon *et al*., 2013b) were positive and highly significant correlation with yield per plant. Keeping in the view of above facts, the objectives of the present investigation was to study the association of yield and its component traits and the direct and indirect effects of yield component traits on fruit yield in okra genotypes.

MATERIALS AND METHODS

The experimental material comprised of 27 genotypes of okra. The experiment was laid out in randomized block design with three replications at the Horticulture Farm, Rajasthan College

Table 1: Genotypic (G) and phenotypic (P) correlation coefficient among different characters in okra

Character		Plant height (cm)	Number of branches /plant	Number of leaves/ plant	Number of pods/ plant	Length of pod (cm)	Average wt of edible pod (g)	Number of seeds/ pod	Weight of 100-seed (g)	Days to anthesis of I^st flower	Days to first harvest	Yield per plant (g)
Plant height (cm)	G	1.00	-0.15	0.47*	0.22	0.38	0.43	0.22	-0.10	0.18	0.24	0.49**
	P	1.00	-0.15	0.47*	0.18	0.37	0.43	0.21	-0.10	0.17	0.21	0.47**
Number of branches/plant	G		1.00	-0.16	0.06	-0.28	-0.32	0.12	-0.04	0.42	0.42	-0.29
	P		1.00	-0.17	0.08	-0.27	-0.31	0.11	-0.04	0.39	0.38	-0.26
Number of leaves/plant	G			1.00	-0.06	0.26	0.33	-0.00	-0.24	-0.22	-0.19	0.29
	P			1.00	-0.06	0.26	0.33	-0.00	-0.23	-0.20	-0.17	0.27
Number of pods/plant	G				1.00	-0.06	-0.01	0.31	-0.24	0.45	0.53**	0.36
	P				1.00	-0.06	-0.00	0.27	-0.22	0.33	0.38	0.41
Length of pod (cm)	G					1.00	0.86**	0.40	-0.20	-0.14	-0.19	0.78**
	P					1.00	0.85**	0.38	-0.20	-0.14	-0.19	0.75**
Average wt of edible pod (g)	G						1.00	0.53**	-0.13	-0.26	-0.31	0.93**
	P						1.00	0.53**	-0.13	-0.23	-0.28	0.91**
Number of seeds/pod	G							1.00	-0.07	0.17	0.09	0.59**
	P							1.00	-0.07	0.16	0.08	0.57**
Weight of 100-seed (g)	G								1.00	0.11	0.10	-0.22
	P								1.00	0.10	0.10	-0.22
Days to anthesis of I^st flower	G									1.00	0.99**	-0.07
	P									1.00	0.96**	-0.07
Days to first harvest	G										1.00	-0.08
	P										1.00	-0.09
Yield per plant (g)	G											1.00
	P											1.00

*and** indicate significant values at p = 0.05 and p = 0.01, respectively

Table 2: Path coefficient showing direct (diagonal) and indirect effects of different characters on yield per plant

Character	Plant height (cm)	No. of branches/ plant	No. of leaves/ plant	No. of pods/ plant	Length of pod (cm)	Av. wt of edible pod (g)	No. of seeds/ pod	Wt. of 100- seed (g)	Days to anthesis of I^st flower	Days to I^st harvest	Correlation with yield/ plant
Plant height (cm)	-0.1199	0.0003	0.0593	0.0827	-0.0047	0.4089	-0.0057	0.0013	0.0014	-0.0022	0.4907**
Number of branches/plant	0.0182	-0.0019	-0.0203	0.0240	0.0035	-0.3061	-0.0031	0.0006	0.0032	-0.0039	-0.2866
Number of leaves/plant	-0.0568	0.0003	0.1252	-0.0212	-0.0032	0.3154	0.0001	0.0031	-0.0017	0.001	0.2857
Number of pods/plant	-0.0266	-0.0001	-0.0071	0.3727	0.0007	-0.0069	-0.0082	0.0032	0.0035	-0.005	0.3585
Length of pod (cm)	-0.0455	0.0005	0.0326	-0.0224	-0.0123	0.8133	-0.0105	0.0026	-0.0011	0.0018	0.7823**
Average wt of edible pod (g)	-0.0520	0.0006	0.0418	-0.0027	-0.0106	0.9435	-0.0141	0.0018	-0.0020	0.0028	0.9291**
Number of seeds/pod	-0.0259	-0.0002	-0.0004	0.1158	-0.0049	0.5019	-0.0265	0.0009	0.0013	-0.0008	0.5946**
Weight of 100- seed (g)	0.0118	0.0001	-0.0297	-0.0911	0.0024	-0.1272	0.0018	-0.0130	0.0008	-0.0010	0.2186
Days to anthesis of I^st flower	-0.0214	-0.0008	-0.0274	0.1687	0.0017	-0.2430	-0.0046	-0.0014	0.0077	-0.0092	0.0717
Days to first harvest	-0.0284	-0.0008	-0.0237	0.1993	0.0024	-0.2890	-0.0023	-0.0014	0.0076	-0.0093	0.0846

Residue effect: 0.05, * and ** indicate significant values at p = 0.05 and p = 0.01, respectively of Agriculture, Udaipur. Each genotype was sown in two row of 4.5m length with crop geometry 60 x 45 cm. All the recommended agronomic package of practices was followed to raising a healthy crop. The observations were recorded on five randomly selected plants in each replication for each genotype on 11 characters *viz.,* plant height (cm), number of branches per plant, number of leaves per plant, number of pods per plant, length of pod (cm) average weight of edible pod (g), number of seeds per pod, weight of 100-seed (g), days to anthesis of first flower, days to first harvest and yield per plant (g). The data were subjected to statistical analyzed to calculate genotypic and phenotypic correlation coefficient as per Singh and Chaudhary (1985). The genotypic correlation was subjected to calculate path coefficient analysis as per method suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Yield is a complex quantitative trait and it depends on a number of other associated traits. Therefore, yield can be improved by direct as well as indirect selection. To identify yield component characters, correlation is an important biometrical tool. Further, estimates of correlation at genotypic as well as at phenotypic levels is more informative. The results (Table 1) showed highly significant and positive correlation of yield per plant with plant height (0.49**, 0.47**), length of pod (0.78**, 0.75**), average weight of edible pod (0.93**, 0.91**) and number of seeds per pod (0.59**, 0.57**) at both genotypic and phenotypic level respectively. It suggested that yield per plant could be improved through selection based on these associated traits. Similarly length of pod with average weight of edible pod (0.86**, 0.85**), number of seeds per pod with average weight of edible pod (0.53**, 0.53**), plant height with number of leaves per plant (0.47**, 0.47**) and days to anthesis first flower with days to first harvest showed highly significant and positive association at genotypic and phenotypic level respectively. It indicated that inter-relationship of these characters on each other and could be simultaneously improved through selection of these associated traits to increase yield of okra. These results are in agreement with those of Mehta *et al.* (2006); Dakahe *et al.* (2007); Chaukhande *et al.* (2011); Kumar *et al.* (2012); Reddy *et al.* (2013) and Simon *et al.* (2013a).

Number of seeds per pod with weight of 100-seed and length of pod, and average weight of edible pod with number of pods per plant had non-significant genotypic and phenotypic correlation. This indicates these yield component traits are independent to each another and they could be selected separately and genetically improved for seed yield. Akinyele and Osekita (2006) also reported that non-significant genotypic correlation between weight of hundred seeds and number of seeds per pod. The correlation results indicated that there was a close agreement between phenotypic and genotypic correlation coefficients in most of the characters, thus indicating that environmental influences does not play an important role in the expression of quantitative traits. However, the estimates of genotypic correlation were higher than their corresponding phenotypic correlation for most of the characters. It is indicating that masking effect of environment on the expression of the genotype leading to reduce phenotypic expression. Simon *et al.* (2013b) also reported that genotypic correlation showed more significant relationship between the characters.

Correlation does not provide any idea about cause and effects of relationship. On the other hand, path analysis is the partitioning of correlation in direct and indirect effects. Path coefficient analysis (Table 2) revealed that average weight of edible pod had highest positive direct effect (0.943) on fruit yield per plant followed by number of pods per plant (0.372) and number of leaves per plant (0.125). This suggested that these characters were main determinant, an increase in these traits might be increase seed yield per plant. The magnitude of residual effect at genotypic level was recorded to be very low (0.05).

Akinyele and Osekita (2006) also reported that high positive direct effects of number of pods per plant on seed yield in okra. Adiger *et al.* (2011) reported that fruit weight had highest direct effect towards fruit yield followed by number of fruits per plant. Chaukhande *et al.* (2011) also observed that number of fruits per plant exhibited maximum direct effect followed by average weight of fruit on yield per plant. Kumar *et al.* (2012) also reported that fruit length and number of seeds per fruit had high positive direct effect on fruit yield. Reddy *et al.* (2013) reported that fruit weight and number of fruits per plant had positive high direct effect on pod yield per plant.

Correlation and path analysis results (Table 2) revealed that number of seeds per pod was positive and highly significant correlation with yield per plant (0.59**) as well as low negative direct effect with yield (-0.02). It indicating that selection for number of seeds per pod would increase seed yield. Singh and Chaudhary (1985) also reported that if the correlation is positive but the direct effect is negative or negligible, the indirect effects might be the causal factor of correlation. Simon *et al.* (2013b) also reported that positive and highest significant correlation with yield but low negative direct effect on yield. Plant height recorded high and positive indirect effect via average weight of edible pod and also recorded positive and highly significant correlation with yield per plant. Hence, these traits explained true relationship via plant height on yield and direct selection for these traits would be effective to increase yield per plant. However, plant height, number of branches per plant, length of pod, number of seeds per pod, weight of 100- seed and days to first harvest showed negative direct effect. Adeniji and Aremu (2007) also reported that 100 seed weight had negative direct effect on yield per plant. The significant positive association of yield with plant height, length of pod and number of seeds per pod was mainly due to the indirect effect through average weight of edible pod. It can be concluded that plant height, number of leaves per plant, length of pod, average weight of edible pod, number of seeds per pod has significant association and direct effect on seed yield. Therefore, genetic improvement of these characters through selection would be helpful in improving yield of okra.

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