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Path Coefficient Analysis for Some Characters on Fruit and Seed Yields of Okra

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Abstract

Two field experiments were conducted during 2013 and 2014 summer seasons at Sabahia Horticulture Research Station, Alexandria, Egypt. Plant materials of this study were consisted of five genotypes of okra. The present study was directed to estimate the direct and indirect effects of some characters related to fruit and seed production in some okra varieties and lines, originated from a breeding program at Sabaheia Horticultural Research Station. Concerning fruit yield, the results indicated that the direct effect of number of branches/plant was strongly positive (1.222). So, it may indicate a true relationship, and a direct selection through this trait may be effective in improving yield in okra. Nevertheless, correlation coefficient between total number edible pods/plant and edible pod yield was positive and the direct effect of this trait was negative, it seemed that indirect effect appeared to be the cause of correlation. Regarding seed yield, the genotypic correlation between of number of seed/pod and seed yield (0.983) seemed to be close to the estimated value of its direct effect, so, it may indicate a true relationship and direct selection through this trait may be effective for improving seed yield of okra. However, the correlation coefficient between number of branches/plant and number of mature pods/plant with seed yield was positive (0.790 and 0.718, in order) and the direct effect of these factors were either negative or negligible, it seems that indirect effect appeared to be the cause of correlation. Hence, these traits may be used simultaneously with the other characters.

Keywords: Path coefficient analysis; Okra fruit; Seed yields

Introduction

Okra is a multipurpose use crop with tender and delicious pods. In West Africa; leaves, buds and flowers of okra are, also, consumed. The dried seeds provide oil, protein, vegetable curd and a coffee additives or substitutes. Okra dry seeds are reported to contain 18-20% oil and 20-25% crude protein [1]. Foliage can be used for biomass and the dried stems serve as a source of paper pulp or fuel. Okra, to a certain extent, is used in canned, dehydrated or frozen forms. It has an average nutritive value of 3.21 that is higher than tomato, eggplant and most cucurbits except bitter gourd, so, it may be considered as one of the important vegetable crops in the tropical and subtropical regions of the world; especially in Egypt at the summer season [2].

It is necessary to determine the factors or traits that influence fruit and seed yields of okra, directly and indirectly or both; hence, their response to selection can be predicted. As genetic correlation is the correlation of breeding value and results mainly from pleiotropy and dealing with the assumption simply measures mutual relationships without presumption of causation, so that in path-coefficient analysis, the researcher specifies the plausible causes and measures their relative importance as independent variables [3,4]. Moreover, Agriyo et al. [5] calculated the correlation coefficients of 30 okra-genotypes and found that coefficients varied between seasons; For instance, pod yield/plant was: 1) genotypically correlated with edible pod weight, length and width, mature pod length number of branches/plant, 2) phenotypically correlated with number of branches/plant and edible pod length, and 3) environmentally correlated with edible pod weight and length, and final plant height.

The present study was directed to estimate the direct and indirect effects of some characters related to fruit and seed production in some okra varieties and lines, originated from a breeding program at Sabaheia Horticultural Research Station.

Materials and Methods

Two field experiments were conducted during 2013 and 2014 summer seasons at Sabahia Horticulture Research Station, Alexandria, Egypt. Plant materials of this study were consisted of five genotypes of okra. These genotypes were two varieties and three breeding lines of okra. The varieties were "Sabahia 1" and "Sabahia2", whereas, the lines were originated from a breeding program, started in the summer season of 1995 at the above-mentioned Research Station, Alexandria, Egypt [6].

A randomized complete blocks design was used. Seeds of okra were planted in a single row, 4m long, 0.7 m wide and hills 30 cm apart at the rate of 4 seeds per hill. Each plot contained 5 rows for edible pods yield and 5 rows for seed yield. The plot area was 14 m^2 for each. Sowing date was on the first of May. Three weeks later, seedlings were thinned and the strongest one being remained in each hill. Other cultural practices were carried out as recommended for the conventional okra planting. Harvesting took place during the period from mid of June up to mid of September.

Recorded measurements

Fruit yield and its components: Edible pods were picked with all pedicels in the morning every 3 days interval. The following traits were recorded, total number of edible pods/plant and edible pod weight (g). Pod dry matter (%) was measured as the average of three different pickings and expressed as dry weight/fresh weight x 100. Total edible yield (Kg/fed, was calculated based on the plot area) and number of pods/plant were taken for 25 pickings. At the end of harvesting season, plant height (cm) and number of branches/plant were counted at the end of picking.

Seed yield and its components: At the end of harvesting season, plant height (cm) and number of branches/plant were counted. Number of mature pods/plants, Number of seeds/pod, total seed yield (Kg/fed, was calculated based on the plot area), and average weight of 100 seeds were recorded.

Statistical Procedures

1. Simple statistical analysis of a randomized complete blocks design according to Snedecor and Cochran [7] was done to find out the significance of the studied characters and to compare between means by Duncan's multiple range test at 0.05% level of significance.

2. Simple correlation coefficients (r) were calculated for different pairs of the studied characters as shown by Dospekhove [8].

3. Path-coefficient was calculated as described by Dewey and Lu [3]. In the path diagram (Figure 1), the doubled-arrowed lines indicate mutual association as measured by correlation coefficients rij the single arrowed lines represent direct influence as measured by path-coefficient Pix, and "h" represents residual factors.

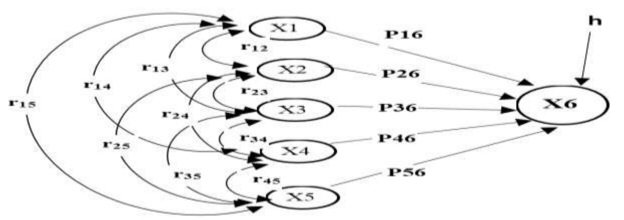

Figure 1: Path diagram with 5 predictor variables "X1" to "X5" and the response variable X6. The variable "h" is the remainder portion or residual. $(1-R^2)^{½}$

$P_{16} + r_{12} P_{26} + r_{13} P_{36} + r_{14} P_{46} + r_{15} P_{56}=r_{16}$ (1)

$r_{21} P_{16} +P_{26} + r_{23} P_{36} + r_{24} P_{46} + r_{25} P_{56}=r_{26}$ (2)

$r_{31} P_{16} +r_{32} P_{26} + P_{36} + r_{34} P_{46} + r_{35} P_{56}=r_{36}$ (3)

$r_{41} P_{16} +r_{42} P_{26} + r_{43} P_{36} + P_{46} + r_{45} P_{56}=r_{46}$ (4)

$r_{51} P_{16} +r_{52} P_{26} + r_{53} P_{36} + r_{54} P_{46} + P_{56}=r_{56}$ (5)

Results and Discussion

Fruits yield and its components of the five okra genotypesare illustrated in Table 1. Sabahia 1 cultivar had the highest significant mean values for plant height (262.6 cm), no. of branches/plant (10.8), and total edible pod yield (5869.2 kg/fed) comparing with the other genotypes. Meanwhile, the highest significant mean values fortotal number of edible pods/plant (83.9) and edible pod weight (5.6 g) were obtained by Line 2 and Line 3, in order. On the other hand, Line 3 gave the lowest percentage of dry matter in edible pods comparing with the other genotypes. With this respect, Abd-Allah and Mansour [6] established new lines of okra to improve and meet the need of new cultivars of okra for fresh consumption. They selected five lines i.e., L3 had early flowers and the pods were tall and thin; L5 had early flowers and the pods were short and thick; L6 had early flowers with tall and thin; L10 had late flowers with; mild-tall and thick, and L12 had late flower with short and thick. All lines gave tall plants with high values for number of pods and total yield/plant.

Seed yield and its components of the five okra genotypesare shown in Table 2. The highest plants were obtained by the cultivars Sabahia 1 (180.8 cm) and Sabahia 2 (179.1 cm), there were no significance differences between them. Meanwhile, the biggest number of branches/plant were obtained by the cultivar Sabahia 1 (7.1) and Line 2 (6.8), there were no significance differences between them. Line 1 gave the highest significant mean values for number of mature pods/ plant (23.5) and weight of 100 seeds (5.18 g). Line 2 had the highest significant mean values for number of seeds/pod (86.3) and seed yield (1981.4 kg/fed).These results are according to Abd-Allah [8,9].

Genotypes	Plant height (cm)	No. of branches / plant	Total No. of edible pods/ plant	Edible pod weight (g)	Dry matter of edible pod (%)	Total edible pod yield (Kg/fed)
Sabahia 1	262.6 a#	10.8 a	81.6 b	3.9 c	16.45 a	5869.2 a
Sabahia 2	259.1 b	7.5 c	59.8 c	4.0 c	16.46 a	4362.7 e
Line 1	240.3 e	9.7 b	59.9 c	4.4 b	16.51 a	4777.0 d
Line 2	241.9 d	9.2 b	83.9 a	3.6 d	16.05 a	5530.1 b
Line 3	252.3 c	6.7 d	49.1 d	5.6 a	14.69 b	5034.4 c

Table 1: Fruits yield and its components of the five okra genotypes, calculated from the combined data over 2013 and 2014 seasons. #Values with the same alphabetical letters, within a comparable group of means, do not significantly differ from one another, using Duncan's multiple range test at 0.05 level of probability.

Correlation coefficient values among pairs of fruits yield and its components for all okra genotypes are illustrated in Table 3. There were positively correlation between number of branches/plant with both of total edible pod yield and dry matter of edible pod, but it was negatively correlation with edible pod weigh. Total number of edible pods/plant was positively correlated with dry matter of edible pod and highly positively correlated with both of number of branches/plant and total edible pod yield, but highly negatively correlated with edible pod weight. There was highly negatively correlation between edible pod weight and dry matter of edible pod.These results were according with Abd-allah [9-11] and Mansour and Abd- Allah [6].

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Genotypes	Plant height (cm)	No. of branches /plant	No. of mature pods/plant	No. of seeds/pod	Weight of 100 seeds (g)	Seed yield (Kg/fed)
Sabahia 1	180.8 a#	7.1 a	18.9 c	83.1 b	4.89 b	1753.7 b
Sabahia 2	179.1 a	5.6 c	18.4 c	74.6 e	4.87 b	1549.9 c
Line 1	133.5 d	6.5 b	23.5 a	81.1 c	5.18 a	1750.4 b
Line 2	154.1 c	6.8 a	22.2 b	86.3 a	4.52 c	1918.4 a
Line 3	168.4 b	4.8 d	15.5 d	76.1 d	4.62 c	1590.6 c

Table 2: Seed yield and its components of the five okra genotypes, calculated from the combined data over 2013 and 2014 seasons. #Values with the same alphabetical letters, within a comparable group of means, do not significantly differ from one another, using Duncan's multiple range test at 0.05 level of probability.

Character	Plant height	No. of branches/ plant	Total No. of edible pods/ plant	Edible pod weight	Dry matter of edible pod
Total edible pod yield	0.100	0.633*	0.752**	-0.271 -	-0.029
Dry matter of edible pod	0.042	0.688*	0.511*	0.830**	
Edible pod weight	-0.002	-0.641*	-0.833**		
Total No. edible pods/plant	0.017	0.758**			
No. of branches/ plant	-0.050				

Table 3: Correlation coefficient values (r) for pair of the characters of fruits yield and its components of the five okra genotypes. *,** Significant differences at 5% and 1% levels of probability, respectively.

Correlation coefficient values among pairs of seed yield and its components for all okra genotypes are illustrated in Table 4. Seed yield had highly positively correlation with number of branches/plant, number of mature pods/plant, and number of seeds/pod. Meanwhile, number of seeds/pod was positively correlated with number mature pods/plant and highly positively correlated with number of branches/ plant. Moreover, there were highly positive and negative correlation between number of mature pods/plant with number of branches/plant and plant height, in order. In this regard, Abd-Allah [10] suggested that number of branches/plant, and number of pods/plant showed to be the first concern for improving edible and seed yields of okra.

As genetic correlation is the correlation of breeding value and results mainly from pleiotropy [12]. Dealing with the assumption that correlation between yield and its components simply measures mutual relationships without presumption of causation, so that, in path-coefficient analysis, the researcher specifics the plausible causes and measures their relative importance as independent variables [3,4]. This could be shown from Table 5, where edible pod yield was the product of five traits, i.e., plant height, number of branches/plant, number of edible pods/plant, edible pod weight, and pod dry weight, each of which contributed directly and indirectly to yield.

Character	Plant height	No of branches /plant	No. of mature pods/plant	No. of seeds/pod	Weight of 100 seeds
Seed yield	-0.472	0.790**	0.718**	0.983**	-0.190
Weight of 100 seeds	-0.342	0.245	0.405	-0.151	
No. of seeds/pod	-0.369	0.851**	0.658*		
No. mature pods/plant	M.764**	0.711**			
No. of branches/plant	-0.206				

Table 4: Correlation coefficient values (r) for pair of the characters of seed yield and its components of the five okra genotypes. *,** Significant differences at 5% and 1% levels of probability, respectively.

The direct effect of number of branches/plant was strongly positive (1.222). So, it may indicate a true relationship, and a direct selection through this trait may be effective in improving yield in okra, as reported by Abd-Allah [10]. As correlation coefficient between total number edible pods/plant and edible pod yieldwere positive (Table 3) and the direct effect of these traits was negative (Table 5), it seemed that indirect effect appeared to be the cause of correlation. The residual effect for pod yield/plot was low value (0.007), which means that the studied traits interfere about 99 % of pod yield and 1% of the attributes are needed to be under investigation. In this respect, Ragheb [13] found that the total number of pods/plant had a strong direct effect on yield followed by plant height, and number of branches seemed to have an indirect effect through number of pods/plant. Abd-Allah [11] reported that number of pods/plant was having a stronger direct effect on yield. Meanwhile, number of pods/plant, number of branches/plant and plant height seemed to have an indirect effect through number of pods/plant.

Direct and indirect effects of yield components on seed yield in okra are tabulated in Table 6. The direct effect of number of seed/pod was positive (0.892. Also, it could be noted that the genotypic correlation between of number of seed/pod and seed yield (0.983) seemed to be close to the estimated value of its direct effect, so, it may indicate a true relationship and direct selection through this trait may be effective for improving seed yield of okra.

Character	Plant height	No. of branches plant	Total No. of edible /plant	Edible pod weight	Dry matter of edible pod	Total effect
Plant height	0.224	-0.061	-0.001	0.002	-0.063	0.100
No. of branches/ plant	-0.011	1.222	-0.052	0.505	-1.031	0.633
Total No. edible pods/ plant	0.004	0.926	-0.069	0.656	-0.765	0.752
Edible pod weight	0.000	-0.783	0.058	-0.788	1.243	-0.271
Dry matter of edible pod	0.009	0.841	-0.035	0.654	-1.498	-0.029

Table 5: Direct effects (Diagonal) and indirect effects of some studied traits on fruit yield of the five okra genotypes. R = 0.007.

Character	Plant height	No. of branches/ plant	No. of mature pods/ plant	No. of seeds/pod	Weight of 100 seeds	Total effect
Plant height	-0.004	0.028	-0.214	-0.329	0.047	-0.472
No. of branches/ plant	0.001	-0.135	0.199	0.759	-0.034	0.790
No. mature pods/plant	0.003	-0.096	0.280	0.587	-0.055	0.718
No. of seeds/pod	0.001	-0.115	0.184	0.892	0.021	0.983
Weight of 100 seeds	0.001	-0.033	0.113	-0.135	-0.137	-0.190

Table 6: Direct effects (Diagonal) and indirect effects of some studied traits on seed yield of the five okra genotypes. R = 0.033

As the correlation coefficient between number of branches/plant and number of mature pods/plant with seed yield was positive (0.790 and 0.718, in order) and the direct effect of these factors were either negative or negligible, it seems that indirect effect appeared to be the cause of correlation. Hence, these traits may be used simultaneously with the other characters. Abd-Allah [10] reported that number of pods/plant was having a stronger direct effect on yield. Meanwhile, number of pods/plant, number of branches/plant and plant height seemed to have an indirect effect through number of pods/plant. It worth mentioning that the residual effect for seed yield/plot was low (0.033). Such result indicated that this character may depend on the most of the studied traits, so, it may not be needed to investigate more attributes affecting pod yield in okra.

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