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Correlation and path coefficient analysis in for quantitative traits in f₂ population in okra [*Abelmoschus esculentus* (L.) Moench]

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Abstract
The experiment was carried out during *kharif*-2016 at Regional Horticultural Research Station, Navsari Agricultural University, Navsari, Gujarat. Correlation and path coefficient analysis of 12 quantitative characters in 148 F_2 plants from cross AOL-09-02 x AOL-10-22 and 160 F_2 plants from cross AOL-09-02 x GAO-5 were studied. In F_2 population of both crosses, fruit yield/plant exhibited positive and highly significant correlation with number of fruits/plant, plant height at final harvest, internodal length, number of branches/plant and fruit length indicating that these characters are the primary yield determinants in okra and selection criteria based on these characters would be beneficial for improvement of fruit yield/plant.
Positive direct effect on fruit yield/plant was recorded for number of fruits/plant, fruit weight, 100 seed weight and fruit girth in F_2 populations of both crosses. While for days to first flowering and number of seeds/fruit in F_2 population of AOL-09-2 x AOL-10-22 and for days to first picking, plant height at final harvest, number of branches/plant at final harvest and fruit length in F_2 population of AOL-09-2 x GAO-5. Direct selection practiced on these characters will result in improvement in yield. In F_2 population of both crosses, internodal length had negative and direct effect on fruit yield/plant. In F_2 population of AOL-09-2 x AOL-10-22, number of branches/plant at final harvest, fruit length, plant height at final harvest and days to first picking had negative and direct effect on fruit yield/plant. In F_2 population of AOL-09-2 x GAO-5, number of seeds/fruit and days to first flowering had negative and direct effect on fruit yield/plant. These important traits may be viewed in selection programme for the further improvement of okra.

Keywords: Correlation and path coefficient analysis

Introduction
Okra [*Abelmoschus esculentus* (L.) Moench], 2n=130 has occupied a prominent position among vegetables; it is one of the choicest fruit vegetable grown extensively in the subtropical to tropical warm area of the world including India, Africa, Turkey and other neighbouring countries. It is widely grown during summer and rainy seasons for its tender green fruits, is one of the most important vegetable crops of India, however its tender green leaves are also eaten in the far east countries. Correlation between yield and yield components are of considerable importance in selection programme. The aim of correlation studies is primarily to know the suitability of various characters for indirect selection because selection on any particular trait may bring about undesirable changes in associated characters.
Correlation coefficient is an indication of simple association between variables. In a biological system, however the relationship may exist in a very complex form. It is therefore, essential to study the relationship among variables in a comprehensive way. Path coefficient analysis is a powerful tool which enables partitioning of the given relationship in its further components.

Materials and Methods
The experimental material comprised of 3 parents AOL-09-02, AOL-10-22 and GAO-5, two hybrids *viz*., AOL-09-2 x AOL-10-22 and AOL-09-2 x GAO-5 and their F_2 generations. The materials were evaluated in non-replicated trial as segregating F_2 generations are involved. Simple correlations were computed using the formula given by Weber and Moorthy, (1952) [20]. Path coefficient analysis was carried out using the simple correlation coefficient to know the direct and indirect effects of the yield components on seed yield as suggested by Wright, (1921) [21] and illustrated by Dewey and Lu, (1959) [3].

Result and Discussion

The correlation coefficients between fruit yield and its component and among the component characters were estimated which are presented in the Table 1 & Table 2.

In the present findings, in F_2 population of both crosses, fruit yield/plant exhibited positive and highly significant correlation with number of fruits/plant, plant height at final harvest, internodal length, number of branches/plant and fruit length. Similar results were obtained by Kerure *et al.,* (2017) [7] for number of fruits/plant, number of seeds/fruit and for number of branches/plant; Yadav *et al.,* (2017) [22] for plant height at final harvest; Nirosha *et al.,* (2014) [11] for internodal length and Shivaramegowda *et al,* (2016) [15] for fruit length. In F_2 population of both crosses, number of fruits/plant exhibited positive and highly significant correlation with plant height at final harvest, internodal length and number of branches/plant at final harvest. This was in accordance to the findings of Yadav *et al.,* (2017) [22] for plant height at final harvest; Nirosha *et al.,* (2014) [11] for Internodal length and Shivaramegowda *et al,* (2016) [15] for number of branches/plant at final harvest. While, in F_2 population of AOL-09-2 x GAO-5, number of fruits/plant exhibited positive and highly significant correlation with fruit yield/plant and fruit weight. This was in accordance to the findings of Gogineni *et al.,* (2015) [6] for fruit yield/plant and Kumar and Reddy, (2016) [9] for fruit weight.

In F_2 population of both crosses, plant height at final harvest showed positive and highly significant correlation with number of fruits/plant, fruit yield/plant, internodal length and fruit weight. This was in accordance with the earlier observations made by Aminu *et al.,* (2016) [1] for number of fruits/plant; Kerure *et al.,* (2017) [7] for fruit yield/plant; Patil *et al.,* (2016) [13] for internodal length and Vani, *et al.,* (2012) [19] for fruit weight. While, in F_2 population of AOL-09-2 x GAO-5, plant height at final harvest showed positive and highly significant correlation with number of branches/plant at final harvest. This was in accordance with the earlier observations made by Kumar and Kumar, (2014) [8] for number of branches/plant at final harvest. In F_2 population of both crosses, internodal length showed positive and highly significant correlation with plant height at final harvest, number of fruits/plant and fruit yield/plant. This was in accordance with the earlier observations made by Patil *et al.,* (2016) [13] for plant height at final harvest; Nirosha *et al.,* (2014) [11] for number of fruits/plant and for fruit yield/plant. In F_2 population of both crosses, number of branches/plant at final harvest showed positive and highly significant correlation with fruit yield/plant and number of fruits/plant. Similar results were reported by Kerure *et al.,* (2017) [7] for fruit yield/plant; Umesh, *et al.,* (2014) [18] for number of fruits/plant. In F_2 population of AOL-09-2 x AOL-10-22, number of branches/plant at final harvest showed positive and highly significant correlation with fruit girth and fruit weight. Similar results were reported by Patil *et al.,* (2016) [13] for fruit girth and Nwangburuka *et al,* (2012) [12] for fruit weight. In F_2 population of AOL-09-2 x GAO-5, number of branches/plant at final harvest showed positive and highly significant correlation with plant height at final harvest. Similar results were reported by Aminu *et al.,* (2016) [1] for plant height at final harvest.

In F_2 population of both crosses, fruit length showed positive and highly significant correlation with fruit weight and fruit yield/plant. Similar results were reported by Shivaramegowda *et al,* (2016) [15] for fruit weight; Nirosha *et al.,* (2014) [11] for fruit yield/plant. In F_2 population of both crosses, days to first flowering showed positive and highly significant correlation with days to first picking, which is in accordance with the earlier observations made by Kumar and Kumar, (2014) [8]. It had highly significant and negative correlation with fruit weight, fruit yield/plant, plant height at final harvest and number of fruits/plant. Similar results were obtained by Swamy *et al,* (2014) [17] for fruit weight and for plant height at final harvest; Singh and Goswami, (2014) [16] fruit yield/plant and for number of fruits/plant. In F_2 population of AOL-09-2 x GAO-5, days to first flowering showed highly significant and negative correlation with internodal length. In F_2 population of both crosses, days to first picking showed positive and highly significant correlation with days to first flowering, which is in accordance with the earlier observations made by Kumar and Kumar, (2014) [8]. It had highly significant and negative correlation with fruit yield/plant, plant height at final harvest, number of fruits/plant. Similar results were obtained by Chhatrola and Monpara, (2005) [2] for fruit yield/plant and number of fruits/plant. In F_2 population of AOL-09-2 x AOL-10-22, days to first picking showed highly significant and negative correlation with fruit weight. In F_2 population of AOL-09-2 x GAO-5, days to first picking showed negative and highly significant correlation with internodal length.

Fruit yield/plant was considered as the resultant variable, while the remaining characters as the causal variables. The genotypic correlation coefficients were worked out between fruit yield/plant and each of the casual variables and among themselves to study the direct and indirect effects of fruit yield/plant. The data on the direct and indirect effects of these variables on fruit yield/plant are presented in Table 3 & Table 4.

In the present study, F_2 populations of both crosses, path coefficient analysis revealed that number of fruits/plant had highest positive direct effect on fruit yield/plant. This was in accordance to reports by Dhankar *et al.,* (2013a) [4], Positive direct effect on fruit yield/plant was recorded for number of fruits/plant, fruit weight, 100 seed weight and fruit girth. Similar results were reported by Aminu *et al.,* (2016) [1] for number of fruits/plant and for fruit girth; Mishra *et al.* (2018) [10] for fruit weight and Saryam *et al.,* (2015) [14] for 100 seed weight. In F_2 population of AOL-09-2 x AOL-10-22, positive direct effect on fruit yield/plant was recorded for days to first flowering and number of seeds/fruit. Similar results were reported by Gogineni *et al.,* (2015) [6] for days to first flowering and Saryam, *et al.,* (2015) [14] for number of seeds/fruit. F_2 population of AOL-09-2 x GAO-5, positive direct effect on fruit yield/plant was recorded for days to first picking, plant height at final harvest, number of branches/plant at final harvest, fruit length. Similar results were reported by Chhatrola and Monpara, (2005) [2] for days to first picking; Umesh, *et al.,* (2014) [18] for plant height at final harvest and for number of branches/plant at final harvest; Mishra *et al.* (2018) [10] for fruit length. In F_2 population of both crosses, internodal length had negative direct effect on fruit yield/plant. Similar results were reported by Umesh, *et al.,* (2014) [18] for internodal length. In F_2 population of AOL-09-2 x AOL-10-22, number of branches/plant at final harvest, fruit length, plant height at final harvest and days to first picking had negative direct effect on fruit yield/plant. Similar results were reported by Mishra *et al.* (2018) [10] for number of branches/plant; Aminu *et al.,* (2016) [1] for fruit length; Gogineni *et al.,* (2015) [6] for plant height at final harvest and Dhankar *et al.,* (2013b) [5] for days to first picking. In F_2 population of AOL-09-2 x GAO-5,

number of seeds/fruit and days to first flowering had negative direct effect on fruit yield/plant. Similar results were reported by Yadav *et al.*, (2017) [22] for number of seeds/fruit and for days to first flowering.

Table 1: Correlation coefficients among twelve traits in F_2 population of AOL-09-2 x AOL-10-22 in okra

Characters	DFF	DFP	PH	NB	IL	FL	FG	FWt	NF	100SW	NS	FY
DFF	1.00											
DFP	0.99**	1.00										
PH	-0.22**	-0.23**	1.00									
NB	-0.11	-0.11	0.13*	1.00								
IL	-0.05	-0.06	0.44**	-0.06	1.00							
FL	-0.05	-0.04	0.12*	0.05	-0.00	1.00						
FG	-0.07	-0.07	0.09	0.16**	0.02	0.12*	1.00					
FWt	-0.28**	-0.28**	0.21**	0.16**	0.11	0.25**	0.17**	1.00				
NF	-0.20**	-0.20**	0.64**	0.29**	0.36**	0.11	0.05	0.13*	1.00			
100SW	0.02	0.02	-0.04	-0.07	0.05	0.01	-0.04	-0.06	0.03	1.00		
NS	-0.06	-0.06	0.07	0.07	-0.11	-0.002	0.07	0.06	-0.01	-0.11*	1.00	
FY	-0.26**	-0.26**	0.64**	0.31**	0.36**	0.16**	0.09	0.08	0.96**	0.02	0.01	1.00

DFF - Days to first flowering
DFP - Days to first picking
PH - Plant height at final harvest (cm)
NB - Number of branches/plant at final harvest
IL - Internodal length (cm)
FL - Fruit length (cm)
FG - Fruit girth (cm)
FWt - Fruit weight (g)
NF- Number of fruits/plant
100SW -100 seed weight (g)
NS - No. of seeds/ fruit
FY - Fruit yield/ plant (g)
**- Significant at 1.0 per cent level of probability and *- Significant at 5.0 per cent level of probability

Table 2: Correlation coefficients among twelve traits in F_2 population of AOL-09-2 x GAO-5 in okra

Characters	DFF	DFP	PH	NB	IL	FL	FG	FWt	NF	100SW	NS	FY
DFF	1.00											
DFP	0.99**	1.00										
PH	-0.17**	-0.17**	1.00									
NB	-0.10	-0.11	0.28**	1.00								
IL	-0.15**	-0.16**	0.22**	0.15*	1.00							
FL	-0.02	-0.02	0.14*	0.04	0.08	1.00						
FG	-0.03	-0.03	-0.16**	0.04	-0.16**	-0.04	1.00					
FWt	-0.15**	-0.15*	0.15**	0.05	0.10	0.52**	-0.04	1.00				
NF	-0.25**	-0.25**	0.72**	0.47**	0.33**	0.11	-0.11	0.15**	1.00			
100SW	0.00	0.00	-0.03	-0.02	0.05	0.13*	-0.04	0.08	-0.01	1.00		
NS	0.15*	0.15*	-0.05	-0.20**	0.10	0.10	0.11	-0.08	0.01	0.11	1.00	
FY	-0.27**	-0.27**	0.71**	0.46**	0.32**	0.24**	-0.11	0.40**	0.96**	0.03	-0.02	1.00

DFF - Days to first flowering
DFP - Days to first picking
PH - Plant height at final harvest (cm)
NB - Number of branches/plant at final harvest
IL - Internodal length (cm)
FL - Fruit length (cm)
FG - Fruit girth (cm)
FWt - Fruit weight (g)
NF- Number of fruits/plant
100SW -100 seed weight (g)
NS - No. of seeds/ fruit
FY - Fruit yield/ plant (g)
**- Significant at 1.0 per cent level of probability and *- Significant at 5.0 per cent level of probability

Table 3: Direct and indirect effects of different characters on fruit yield/plant in F_2 population of AOL-09-2 x AOL-10-22 in okra

Characters	DFF	DFP	PH	NB	IL	FL	FG	FWt	NF	100SW	NS	CCFY
DFF	0.09	-0.09	0.0028	0.0002	0.0001	0.0002	-0.0001	-0.07	-0.18	0.0001	-0.0003	-0.26**
DFP	0.08	-0.09	0.0029	0.0002	0.0001	0.0002	-0.0001	-0.07	-0.19	0.0002	-0.0003	-0.26**
PH	-0.02	0.02	-0.01	-0.0002	-0.0005	-0.0005	0.0002	0.06	0.60	-0.0003	0.0003	0.64**
NB	-0.01	0.0097	-0.0016	-0.001	0.0001	-0.0002	0.0003	0.04	0.27	-0.0006	0.0003	0.31**
IL	-0.0047	0.0050	-0.0056	0.0001	-0.001	0.00	0.00	0.03	0.34	0.0004	-0.0006	0.36**
FL	-0.0044	0.0039	-0.0016	-0.0001	0.00	-0.004	0.0002	0.07	0.10	0.0001	0.00	0.16**
FG	-0.0059	0.0063	-0.0011	-0.0003	0.00	-0.0005	0.002	0.04	0.05	-0.0004	0.0004	0.09
FWt	-0.02	0.03	-0.0027	-0.0003	-0.0001	-0.0010	0.0003	0.26	0.13	-0.0005	0.0003	0.08
NF	-0.02	0.02	-0.0082	-0.0005	-0.0004	-0.0005	0.0001	0.04	0.93	0.0002	0.00	0.96**
100SW	0.0014	-0.0019	0.0005	0.0001	-0.0001	0.00	-0.0001	-0.01	0.03	0.01	-0.0006	0.02
NS	-0.0050	0.0053	-0.0009	-0.0001	0.0001	0.00	0.0001	0.02	-0.0072	-0.0010	0.01	0.01

DFF - Days to first flowering
DFP - Days to first picking
PH - Plant height at final harvest (cm)
NB - Number of branches/plant at final harvest
IL - Internodal length (cm)
FL - Fruit length (cm)
FG - Fruit girth (cm)
FWt - Fruit weight (g)
NF- Number of fruits/plant
100SW -100 seed weight (g)
NS - No. of seeds/ fruit
CCFY - Correlation Coefficient with fruit yield/plant (g)
Residual effect= 0.0099
**- Significant at 1.0 per cent level of probability and *- Significant at 5.0 per cent level of probability

Table 4: Direct and indirect effects of different characters on fruit yield/plant in F_2 population of AOL-09-2 x GAO-5 in okra

Characters	DFF	DFP	PH	NB	IL	FL	FG	FWt	NF	100SW	NS	CCFY
DFF	-0.07	0.07	-0.0014	-0.0013	0.0029	-0.0001	0.00	-0.04	-0.23	0.00	-0.0007	-0.27**
DFP	-0.07	0.07	-0.0014	-0.0013	0.0029	-0.0001	0.00	-0.04	-0.23	0.00	-0.0007	-0.27**
PH	0.01	-0.01	0.01	0.0035	-0.0043	0.0011	-0.0002	0.04	0.66	-0.0004	0.0002	0.71**
NB	0.01	-0.0076	0.0024	0.01	-0.0028	0.0003	0.0001	0.01	0.43	-0.0002	0.0009	0.46**
IL	0.01	-0.01	0.0020	0.0018	-0.02	0.0006	-0.0003	0.03	0.31	0.0006	-0.0005	0.32**
FL	0.0011	-0.0011	0.0012	0.0005	-0.0015	0.01	-0.0001	0.13	0.10	0.0016	-0.0004	0.24**
FG	0.0021	-0.0020	-0.0013	0.0005	0.0031	-0.0003	0.0015	-0.01	-0.1	-0.0005	-0.0005	-0.11
FWt	0.01	-0.01	0.0013	0.0006	-0.0020	0.0040	-0.0001	0.25	0.14	0.0010	0.0004	0.40**
NF	0.02	-0.02	0.01	0.01	-0.01	0.0009	-0.0002	0.04	0.92	-0.0001	0.00	0.96**
100SW	0.00	0.0001	-0.0003	-0.0002	-0.0009	0.0010	-0.0001	0.02	-0.0048	0.01	-0.0005	0.03
NS	-0.01	0.01	-0.0004	-0.0025	-0.0019	0.0007	0.0002	-0.02	0.01	0.0013	-0.0046	-0.02

DFF - Days to first flowering
DFP - Days to first picking
PH - Plant height at final harvest (cm)
NB - Number of branches/plant at final harvest
IL - Internodal length (cm)
FL - Fruit length (cm)
FG - Fruit girth (cm)
FWt - Fruit weight (g)
NF- Number of fruits/plant
100SW -100 seed weight (g)
NS - No. of seeds/ fruit
CCFY - Correlation Coefficient with fruit yield/plant (g)
Residual effect= 0.0089

**- Significant at 1.0 per cent level of probability and *- Significant at 5.0 per cent level of probability

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