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CORRELATION AND PATH ANALYSIS IN OKRA [*Abelmoschus esculentus* (L.) Moench]*

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ABSTRACT : Forty five okra genotypes were evaluated in randomized complete block design with two replications. Twenty morphological characters were measured on randomly selected plants for the analysis of correlation and path analysis. Fruit yield per plant showed highly significant and positive correlation with fruit yield per plot and fruit yield per hectare. Fruit yield per plant showed highly significant negative correlation with average fruit weight. Fruit yield per plant showed indirect positive effect *via* plant height at 45 days after sowing (DAS) and internodal length at 90 DAS. Fruit yield per plant showed significant and negative indirect effect via number of fruits per plant and number of leaves per plant at 45 DAS.

Keywords: *Okra, correlation, path analysis.*

Okra is an annual herbaceous plant and belongs to the family Malvaceae under the order Malvales, having a somatic chromosome number 2n=130 and is considered to be an amphidiploid. Okra being an often cross-pollinated crop, out crossing to an extent of 20 per cent by insects is reported (Patil, 9), which renders a considerable amount of variability. Emasculation and pollination processes are easier in okra due to large flower and monoadelphous stamens. Increase in demand and the area under cultivation necessiates improved varieties in this crop.

The study on correlation will help in identifying the traits which have strong association with yield. Path coefficient analysis helps for sorting out the total correlation into direct and indirect effects and useful for choosing most useful traits to be used for yield improvement through selection. So, the knowledge of association of various characters helps the breeder in determining the relative importance of yield components to be considered to improve yield. The correlation values decide only the value and degree of association existing between pairs of characters. It is necessary to partition the genotypic correlation of component characters into direct and indirect effects for the selection to be practised.

MATERIALS AND METHODS

Fourty five okra genotypes were sown in a randomized block design with two replications and a spacing of 60 × 30 cm. FYM was applied at the rate of 25 tonnes per hectare and fertilizers were applied at the rate of 62.5 kg of nitrogen,75 kg phosphate and 62.5 kg of potassium. The remaining dose of 62.5 kg of nitrogen was applied as a split dosage. Data on twenty quantitative traits were recorded. Genotypic and phenotypic correlations were computed using the formula given by Weber and Moorthy (11). Path coefficient analysis was carried out by Wright (12) and illustrated by Dewey and Lu (3).

RESULTS AND DISCUSSION

Correlation coefficient

Data depicted in Table 1 and 2 revealed that Plant height at 45 DAS was positively and significantly correlated with number of fruits per plant (0.213) both at genotypic and phenotypic level. It also showed positive and significant correlation with days to first fruit set (0.217) and number of fruits per plant only at genotypic level. At phenotypic level it also showed positive significant correlation with number of branches per plant at 90 DAS (0.217). Plant height at 90 DAS showed significant and positive correlation with number of leaves per plant at 90 DAS (0.270), fruit yield per plot (0.260), number of fruits per plant (0.231) and number of branches per plant at 90 DAS (0.215) only at phenotypic level. Similar results were also noticed by Nwangburuka *et al.* (8).

Number of leaves per plant at 90 DAS showed significant and positive correlation with number of fruits per plant (0.230) only at phenotypic level. Number of branches per plant at 45 DAS showed significant and positive correlation with days to first fruit set (0.266) only at genotypic level. Number of branches per plant at 90 DAS showed significant positive correlation with

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fruit yield per plant (0.225) only at genotypic level. Reports advocated by Ariyo *et al.* (2) also confirmed present results.

Internodal length at 45 DAS showed significant and positive correlation with internodal length at 90 DAS (0.213) only at genotypic level. Internodal length at 90 DAS showed significant and positive correlation with days to fifty per cent flowering (0.227). Days to first fruit set showed significantly positive correlation with fruit yield per plot (0.211) only at genotypic level.

Number of fruits per plant showed significant and positive correlation with fruit yield per plant (0.272) and fruit diameter (0.215) only at phenotypic level. Average fruit weight showed positive and significant correlation with fruit length (0.217) only at genotypic level. Fruit yield per plot showed significantly positive correlation with number of seeds per fruit (0.216) only at genotypic level. These result are in similar with the finding of Mishra and Singh (7).

The traits like number of leaves per plant at 45 DAS showed negative (-0.217) and significant correlation with plant height at 45 DAS only at phenotypic level. Number of leaves per plant at 45 DAS showed significant and negative correlation with number of fruits per plant (0.269) and internodal length at 90 DAS (-0.266) only at genotypic level. It also showed negative correlation with number of leaves per plant (-0.202). Number of leaves per plant at 90 DAS showed significant and negative correlation with days to 50 % flowering (-0.235) only at genotypic level confirming to the results of Gondane *et al.* (5).

Number of branches per plant at 45 DAS showed significant negative correlation with number of seeds per fruit (-0.264) only at genotypic level. Number of branches per plant at 90 DAS showed significant and negative correlation with fruit length both at genotypic and phenotypic level (-0227). Similar results were also obtained by Akinyele and Osekita (1). Internodal length at 90 DAS showed significant and negative correlation with fruit diameter (-0.271) and fruit length (-0.212) only at phenotypic level. Days to 50 % flowering significant and negative correlation with fruit diameter (-0.244) only at phenotypic level. Average fruit weight it also had negative significant correlation with fruit length (-0.264) only at phenotypic level. Fruit diameter showed significant and negative correlation with fruit yield per plot (-0.264) only at phenotypic level.

Path analysis

Plant height at 45 DAS had showed positive and significant correlation with fruit yield per plant (rG= 0.715 and rP = 0.353, respectively) both at genotypic and phenotypic level. The high indirect positive effect *via* internodal length at 90 DAS (0.448), fruit yield per plant (0.285) and fruit diameter (0.258) only at genotypic level resulted in significant association with fruit yield per plant. Plant height at 90 DAS showed positive and significant correlation with fruit yield per plant (rG= 0.543). This is mainly because of high indirect positive effect of internodal length at 90 DAS (0.431), number of branches per plant at 90 DAS (0.222) and fruit yield per plant (0.217) only at genotypic level.

Number of leaves per plant at 45 DAS showed high negative and significant correlation with fruit yield per plant (rG=-0.568) only at genotypic level. This is mainly because of high indirect negative effect of number of branches per plant at 45 DAS (-0.314) and fruit yield per plant (-0.227) only at genotypic level. Number of leaves per plant at 90 DAS showed low positive direct effect on fruit yield per plant (0.165) with positive and significant correlation with fruit yield per plant (rG =0.414). This is mainly because of high indirect negative effect of fruit length (-0.306), number of fruits per plant (-0.215) and days to first fruit set (-0.201) only at genotypic level.

Number of branches per plant at 45 DAS was positively correlated with fruit yield per plant (rG=0.681) and it had low positive and direct effect on fruit yield per plant (0.040). The high indirect positive effect through number of leaves per plant at 45 DAS (0.934), fruit yield per plant (0.868), fruit diameter (0.831), number of fruits per plant (0.676), internodal length at 45 DAS (0.599), number of branches per plant at 90 DAS (0.448) and plant height at 90 DAS (0.230) only at genotypic level. It also had high negative indirect effect via days to first fruit set (-0.640), internodal length at 90 DAS (-0.347), fruit length (-0.318) and plant height at 45 DAS (-0.229) only at genotypic level. These results are in agreement by the Gangashetty *et al.* (4). Number of branches per plant at 90 DAS showed significant positive effect on fruit yield per plant (rG=0.225). High positive indirect effect through number of branches per plant at 45 DAS (0.290) only at genotypic level and indirect negative effect through fruit length (-0.233) and number of fruits per plant (-0.205) only at genotypic level.

Table 1: Genotypic correlation coefficient for growth, earliness, yield and seed parameters in okra.

@	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1.	1.000	0.115	-0.645**	0.197	-0..910**	**0.457*** *	0.768**	0.728**	0.604**	0.217*	0.171	0.213*	**0.715*** *	-0.025	**0.348*** *	-0.929**	**0.687*** *	0.937**	-0.403**	0.174
2.		**1.000**	-0.388**	0.485**	0.190	0.649**	0.398**	0.701**	0.020	0.245**	-0.198	0.362**	0.543**	0.020	0.191	-0.071	0.640**	0.581**	-0.071	-0.650**
3.			**1.000**	-0.053	0.770**	-0.145	-0.135	-0.266*	-0.018	0.297*	0.396**	-0.269*	-0.568**	-0.150	-0.700	0.721**	-0.202	-0.170	-0.318**	0.069
4.				**1.000**	0.812**	0.112	0.560**	0.019	-0.235*	0.397**	-0.015	0.535**	0.414**	0.141	-0.856**	0.664**	-0.522**	-0.686**	0.023	-0.040
5.					**1.000**	0.172	-0.151	-0.670**	-0.201	0..266*	0.602**	-0.682**	0..681**	-0.980**	-0.889**	-0.997**	0.161	0.930**	-0.264*	0.412**
6.						**1.000**	0.02	-0.153	0.094	0.368**	0.317**	0.510**	0.225*	-0.370**	-0.651**	-0.410**	-0.015	0.149	0.051	-0.451**
7.							**1.000**	0.213*	0.315**	0.089	0.181	0.380**	0.191	0.020	-0.039	-0.484**	0.386**	0.375**	0.547**	0.760**
8.								**1.000**	0.569**	0.302**	0.054	-0.198	0.359**	-0.040	-0.289**	-0.318**	0.676**	0.568**	0.08	0.334**
9.									**1.000**	0.242*	0.233*	-0.512**	-0.061	0.356**	-0.034	-0.152	0.261*	0.326**	-0.599**	0.339**
10.										**1.000**	0.780**	-0.340**	-0.135	0.033	-0.455**	-0.647**	0.211*	0.543**	-0.795 **	-0.537**
11.											**1.000**	-0.244*	-0.006	-0.090	-0.303**	-0.745**	0.045	0.424**	-0.877**	0.042
12.												**1.000**	0.360**	-0.319**	0.076	0.384**	-0.027	0.022	0.276**	-0.664**
13.													**1.000**	-0.500**	0.427**	0.089	0.559**	0.638**	0.154	-0.090
14.														**1.000**	0.217*	-0.519**	0.107	0.330**	-0.296**	-0.005
15.															**1.000**	0.208	-0.102	-0.069	0.188	0.404**
1.6																1.000	-0.835**	-0.127	0.195	-0.769**
1.7																	1.000	0.864**	0.216*	0.501**
1.8																		1.000	-0.282**	0.303**
19.																			1.000	-0.966**
20.																				1.000

*Critical r value 1% = 0.275 5%= 0.209 *Significant at 5% ** Significant at 1 %*

@ Characters

1.	Plant height (45 DAS)	9.	Days to fifty per cent flowering	17.	Fruit yield per plot
2.	Plant height (90DAS)	10.	Days to first fruit set	18.	Fruit yield per hectare
3.	Number of leaves (45 DAS)	11.	Days to first harvest	19.	Number of seeds per fruit
4.	Number of leaves (90 DAS)	12.	Number of fruits per plant	20.	Seed yield per fruit
5.	Number of branches per plant (45DAS)	13.	Fruit yield per plant		
6.	Number of branches per plant (90 DAS)	14.	Average fruit weight		
7.	Internodal length (45DAS)	15.	Fruit length		
8.	Internodal length (90DAS)	16.	Fruit diameter		

Table 2 : Phenotypic correlation coefficient for growth, earliness, yield and seed parameters in okra.

@	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1.	**1.000**	0.294**	-0.217*	-0.008	-0.029	0.217*	0.382**	0.361**	0.346**	0.157	0.078	0.209*	0.353**	0.169	0.058	-0.066	0.355**	0.444**	-0.017	-0.011
2.		**1.000**	0.001	0.270*	-0.050	0.215*	0.133	0.095	0.015	0.154	0.054	0.231*	0.143	-0.052	0.095	-0.115	0.260*	0.339**	-0.049	-0.022
3.			**1.000**	0.011	0.005	0.062	-0.072	-0.168	-0.051	0.112	0.171	-0.156	-0.042	-0.103	0.059	0.189	0.016	-0.033	0.018	0.031
4.				**1.000**	-0.017	0.199	0.002	-0.103	0.009	0.185	0.026	0.230*	0.084	-0.068	0.031	0.132	-0.033	0.040	-0.095	-0.072
5.					**1.000**	-0.005	0.002	-0.060	0.167	0.158	0.038	-0.031	0.057	-0.027	-0.071	0.054	0.184	0.141	-0.015	0.010
6.						**1.000**	0.165	0.029	0.050	0.142	0.049	0.184	0.061	-0.051	-0.227*	0.061	0.048	0.094	-0.024	-0.072
7.							**1.000**	0.185	0.161	0.121	0.092	0.177	0.196	0.110	-0.099	-0.061	0.153	0.208	0.028	-0.017
8.								**1.000**	0.227*	0.191	0.069	-0.123	0.117	0.306**	-0.212*	-0.271*	0.414**	0.310**	-0.087	0.060
9.									**1.000**	0.217*	0.093	-0.162	-0.038	0.186	0.049	-0.244*	0.234*	0.311**	-0.158	0.089
10.										**1.000**	0.561**	-0.123	-0.062	0.119	-0.254*	-0.222*	0.094	0.260*	-0.236*	-0.059
11.											**1.000**	-0.081	0.002	-0.045	-0.110	-0.209	0.105	0.289**	-0.202	0.035
12.												**1.000**	0.272*	-0.146	0.016	0.215*	0.054	0.057	0.129	-0.056
13.													1.000	-0.097	0.016	0.153	0.303**	0.413**	0.097	-0.071
14.														1.000	-0.244**	-0.092	0.195	0.140	-0.165	-0.018
15.															**1.000**	0.124	0.031	0.075	-0.004	0.051
16.																**1.000**	-0.264*	-0.200	0.068	-0.065
17.																	**1.000**	0.707**	0.058	0.059
18.																		**1.000**	-0.127	-0.041
19.																			**1.000**	0.028
20.																				**1.000**

Critical r value 1% = 0.275 *5%= 0.209* **Significant at 5%* *** Significant at 1 %*

@ Characters

1. Plant height (45 DAS)
2. Plant height (90DAS)
3. Number of leaves (45 DAS)
4. Number of leaves (90 DAS)
5. Number of branches per plant (45DAS)
6. Number of branches per plant (90 DAS)
7. Internodal length (45DAS)
8. Internodal length (90DAS)
9. Days to fifty per cent flowering
10. Days to first fruit set
11. Days to first harvest
12. Number of fruits per plant
13. Fruit yield per plant
14. Average fruit weight
15. Fruit length
16. Fruit diameter
17. Fruit yield per plot
18. Fruit yield per hectare
19. Number of seeds per fruit
20. Seed yield per fruit

Table 3: Genotypic path coefficient analysis for growth, yield and its component characters.

@	**1**	2	3	4	5	6	7	**8**	**9**	10	11	12	13	14	rG
1.	**0.293**	0.007	-0.41	0.008	-0.17	0.156	-0.146	0.448	-0.110	-0.086	0.285	0.124	0.258	0.029	0.715 **
2.	0.034	**0.057**	-0.246	0.020	0.163	0.222	-0.076	0.431	-0.124	-0.146	0.217	0.068	0.020	0.001	0.543 **
3.	-0.189	-0.022	**0.635**	-0.002	-0.314	-0.049	0.026	-0.164	-0.150	0.108	-0.227	-0.250	-0.200	-0.031	-0.568 **
4.	0.058	0.028	-0.034	**0.042**	0.195	0.038	-0.107	0.012	-0.201	-0.215	0.165	-0.306	-0.184	-0.013	0.414 **
5.	-0.229	0.230	0.934	0.202	**0.040**	0.448	0.599	-0.347	-0.640	0.676	0.868	-0.318	0.831	-0.134	0.681 **
6.	0.134	0.037	-0.092	0.005	0.290	**0.341**	-0.190	-0.094	-0.186	-0.205	0.090	-0.233	0.114	-0.025	0.225 *
7.	0.225	0.023	-0.086	0.024	-0.128	0.342	**-0.190**	0.131	-0.045	-0.153	0.076	-0.014	0.134	0.046	0.191
8.	0.213	0.040	-0.169	0.001	-0.286	-0.052	-0.040	**0.615**	-0.153	0.080	0.143	-0.103	0.366	0.021	0.359 **
9.	0.064	0.014	0.189	0.017	0.051	0.126	-0.017	0.186	**-0.506**	0.137	-0.054	-0.163	0.180	-0.012	-0.135
10.	0.063	0.021	-0.171	0.022	-0.068	0.174	-0.072	-0.122	0.172	**-0.402**	0.413	0.027	-0.107	0.022	1.036 **
11.	0.210	0.031	-0.361	0.017	0.189	0.077	-0.036	0.221	0.068	-0.417	**0.399**	0.153	-0.025	0.032	1.000 **
12.	0.102	0.011	-0.444	-0.036	-0.036	-0.222	0.007	-0.178	0.230	-0.030	0.170	**0.358**	-0.058	0.023	0.427 **
13.	-0.272	-0.004	0.458	0.028	-0.121	-0.140	0.092	-0.811	0.328	-0.155	0.035	0.074	**-0.277**	-0.069	0.089
14.	0.101	0.000	-0.236	-0.006	-0.065	-0.103	-0.104	0.155	0.070	-0.107	0.153	0.100	0.229	**0.084**	0.559 **

Table 4: Phenotypic path coefficient analysis for growth, yield and its component characters in okra.

@	1	2	3	4	5	6	7	8	9	10	11	12	13	14	rP
1.	**0.143**	0.043	-0.039	0.000	-0.007	-0.005	-0.013	0.107	-0.008	0.011	0.073	0.004	0.015	0.029	0.353 **
2.	0.042	**0.146**	0.000	-0.005	-0.012	-0.005	-0.005	0.028	-0.007	0.012	0.030	0.006	0.026	0.002	-0.143
3.	-0.031	0.000	**0.179**	0.000	0.001	-0.001	0.003	-0.050	-0.005	-0.008	-0.009	0.004	-0.043	-0.022	-0.042
4.	-0.001	0.039	0.002	**-0.017**	-0.004	-0.004	0.000	-0.031	-0.009	0.012	0.018	0.002	-0.030	-0.010	0.084
5.	-0.004	0.007	0.001	0.000	**0.232**	0.000	0.000	-0.018	-0.008	-0.002	0.012	-0.004	-0.012	-0.006	0.057
6.	0.031	0.031	0.011	-0.003	-0.001	**-0.021**	-0.006	0.009	-0.007	0.010	0.013	-0.014	-0.014	0.010	0.061
7.	0.055	0.019	-0.013	0.000	0.001	-0.004	**-0.035**	0.055	-0.006	0.010	0.041	-0.006	0.014	0.023	0.196
8.	0.052	0.014	-0.030	0.002	-0.014	-0.001	-0.007	**0.297**	-0.009	-0.007	0.024	-0.013	0.062	0.043	0.117
9.	0.023	0.023	0.020	-0.003	0.037	-0.003	-0.004	0.057	**-0.048**	-0.007	-0.013	-0.016	0.051	-0.022	-0.062
10.	0.030	0.034	-0.028	-0.004	-0.007	-0.004	-0.006	-0.037	0.006	**0.054**	0.057	0.001	-0.049	0.008	0.272 **
11.	0.051	0.021	-0.008	-0.001	0.013	-0.001	-0.007	0.035	0.003	0.015	**0.208**	0.001	-0.035	0.009	1.000 **
12.	0.008	0.014	0.010	-0.001	-0.016	0.005	0.003	-0.063	0.012	0.001	0.003	**0.061**	-0.028	0.021	0.016
13.	-0.009	-0.017	0.034	-0.002	0.013	-0.001	0.002	-0.080	0.011	0.012	0.032	0.008	**-0.229**	-0.035	0.153
14.	0.250	0.002	-0.024	0.001	-0.008	-0.001	-0.005	0.078	0.006	0.003	0.012	0.008	0.048	**0.166**	0.303 **

Diagonal indicates direct effect

*Residual (G)= 0.0213 (P) = 0.5736 * Significant at 5%*

** Significant at 1 % rP Phenotypic correlation with fruit yield per plant*

@ Characters

1. Plant height (45 DAS), 2. Plant height (90 DAS), 3. Number of leaves per plant (45 DAS), 4. Number of leaves per plant (90 DAS) 5. Number of branches per plant (45 DAS), 6. Number of branches per plant (90 DAS), 7. Internodal length (45 DAS) 8. Internodal length (90 DAS) 9. Days to first fruit set, 10. Number of fruits per plant, 11. Fruit yield per plant, 12. Fruit length 13. Fruit diameter, 14. Fruit yield per plot.

Internodal length at 45 DAS showed negligible negative direct effect on fruit yield per plant (rG= -0.190). But it had significant positive indirect effect through number of branches per plant at 90 DAS (0.342) and plant height at 45 DAS (0.225) only at genotypic level. Internodal length at 90 DAS showed positive and significant correlation with fruit yield per plant only at genotypic level (rG=0.359). High indirect and positive effect via fruit diameter (0.366) and plant height at 45 DAS (0.213) only at genotypic level. But it also had negative indirect effect via number of branches per plant at 45 DAS (-0.286) only at genotypic level. Days to first fruit set showed significant and negative direct effect on fruit yield per plant (-0.506). Although it had a low negative correlation with fruit yield per plant (rG=-0.135). Similar type of results were also reported by (Manna and Paul 6) and Shukla (10).

Number of fruits per plant showed positive and significant correlation with fruit yield per plant (rG=1.036) both genotypic and phenotypic level. The positive association of the trait was mainly because of its high indirect and positive effect through fruit yield per plant (0.413) only at genotypic level. However, it had low positive effect on fruit yield per plant (0.057) only at phenotypic level. Fruit yield per plant resulted in significant and positive correlation with fruit yield per plant (rG=1.000) both at genotypic and phenotypic level. It also showed indirect positive effect via internodal length at 90 DAS (0.221) and plant height at 45 DAS (0.210). It also showed significant and negative indirect effect via number of fruits per plant (-0.417) and number of leaves per plant at 45 DAS (-0.361) only at genotypic level resulted in increased genotypic and phenotypic correlation with fruit yield per plant. Results given by Gangashetty *et al.* (4) and Manna and Paul (6) are in confirmation of present findings.

Fruit length showed significant and positive correlation and direct effect on fruit yield per plant (rG=0.427). It also showed significant positive effect via days to first fruit set (0.230). But it also had negative and significant indirect effect through number of leaves per plant at 45 DAS (-0.444) and number of branches per plant at 90 DAS (-0.222) only at genotypic level. Fruit diameter had showed low significant and negative direct effect on fruit yield per plant (-0.277). It also had positive and significant indirect effect via number of leaves per plant at 45 DAS (0.458) and days to first fruit set (0.328) only at genotypic level. It had negative and significant indirect effect via internodal length at 90 DAS (-0.811) and plant height at 45 DAS (-0.272) only at genotypic level.

Fruit yield per plot was positively and significantly correlated with fruit yield per plant (rG= 0.559 and rP= 0.303) and it had positive but low direct effect on fruit yield per plant both at genotypic and phenotypic level. Positive correlation of the trait is mainly because of its positive indirect effect through fruit diameter (0.229). But it also had low indirect negative effect via number of leaves per plant at 45 DAS (-0.236) only at genotypic level.

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