

Path analysis in okra [*Abelmoschus esculentus* (L.) Moench]

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ABSTRACT

In a path coefficient analysis conducted with 20 parents (17 lines \times 3 testers) and their 51 F_1 's, in two different seasons *i.e.* *Kharif* and summer season. Path coefficient analysis carried out at genotypic level revealed that number of fruit per plant exerted maximum positive direct effect on fruit yield per plant in *Kharif* parents, plant height in *Kharif* F_1 's, number of fruits per plant in summer parent and summer F_1 's exerted maximum positive direct effect on fruit yield per plant.

Key words : Path analysis, Line \times tester, Okra

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Monech] is an important vegetable crop grown for its tender and delicious fruits. It is widely cultivated in tropics, subtropics and warmer parts of temperate region. Now, India has emerged as the second largest producer of vegetables after China. The total area covered under vegetable crops is about 7.8 million hectare and the total production of vegetables has gone up from 58.5 to 125.89 million tonnes, over a period of 17 years from the year 1991-92 to 2007-08 (Anonymous, 2008).

Correlation studies coupled with path coefficient analysis are a powerful tool to study the character association and their final impact on yield, which help the selection procedure accordingly. Path coefficient analysis which determines the cause and effect relationship has been found useful in splitting the correlation into its direct and indirect effects contributing to yield. Path coefficient analysis is a tool to partition the observed correlation coefficient into direct as well as indirect effects of yield components or fruit yield per plant to provide clearer picture of character association for formulating efficient selection strategy. Path analysis differs from simple correlation in that it points out the causes and their relative importance.

MATERIALS AND METHODS

The present investigation was carried out at Institute of Agriculture Sciences, Banaras Hindu University, Varanasi, in a randomized block design with three replications during *Kharif* season, 2007 and summer season, 2008. All the recommended practices were followed during experimentation. The experimental material consisted of 51 F_1 's, involving 17 lines (IC – 128883, VRO – 5, VRO-6, AC-108, IC – 45806, IC – 218877, IC – 218844, Arka Abhay, IC – 43720, IIVR –

342, IC – 140906, IIVR – 198, EC – 305612, IIVR – 435, IIVR – 401, SA – 2 and IC – 140934) and 3 testers (Arka Anamika, Pusa Sawani and Parbhani Kranti). Observations were recorded on fifteen characters *viz.*, plant height (cm), stem diameter (cm), number of branches/plant, number of nodes/plant, internodal length (cm), days to first flowering, days to 50 per cent flowering, number of fruits/plant, single fruit weight (g), fruit length (cm), fruit diameter (cm), fruit yield/plant (g), number of seeds/fruit, number of ridges/fruit and ascorbic acid content (mg/100g). Path coefficients were obtained according to the procedure suggested by Dewey and Lu (1959) using phenotypic and genotypic correlation coefficients.

RESULTS AND DISCUSSION

The phenotypic and genotypic correlation coefficients between yield and other traits have been partitioned into direct and indirect effects by path coefficient analysis. The results are presented in Table 1 for *Kharif* parents, Table 2 for *Kharif* hybrids (F_1 's), Table 3 for summer parents and Table 4 for summer hybrids (F_1 's) are explained at genotypic level in the following paragraphs.

In *Kharif* parents, number of fruits per plant (1.114) had maximum positive direct effect on fruit yield per plant followed by plant height (0.704) and single fruit weight (0.628). Whereas, the highest negative direct effect was found in stem diameter (-0.644). However, high positive indirect effects were found in number of fruits per plant via. ascorbic acid content (0.728) followed by number of seeds per fruit (0.620), fruit length (0.496) and days to first flowering (0.491). While, the highest negative indirect effect was found in plant height (-0.445) via. single fruit weight.

Among *Kharif* hybrids, plant height (1.981) expressed maximum positive direct effect on fruit yield per plant followed by number of fruits per plant (1.651)

Table 1 : Genotypic path of parents for 15 characters in okra during *Kharif* season

Characters	Plant height (cm)	Stem diameter (cm)	Number of branches/plant	Number of nodes/plant	Inter nodal length (cm)	Days to first flowering	Days to 50 % flowering	Number of fruits/plant	Single fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Number of seeds/fruit	Number of ridges/fruit	Ascorbic acid (mg/100g)	Genotypic correlation coefficient with yield
Plant height (cm)	0.704	-0.440	0.001	-0.024	0.011	-0.098	-0.038	0.192	-0.397	0.030	-0.085	-0.107	-0.004	0.079	-0.533
Stem diameter (cm)	0.481	-0.644	0.001	-0.009	0.009	-0.120	0.010	0.055	-0.315	0.010	-0.061	-0.010	0.014	0.070	-0.471
Number of branches/plant	-0.157	0.094	-0.004	-0.050	-0.013	0.023	-0.001	-0.071	-0.060	0.046	0.124	-0.074	-0.059	0.032	-0.220
Number of nodes/plant	0.083	-0.030	-0.001	-0.203	-0.022	0.040	0.007	0.090	0.171	-0.014	0.018	0.057	-0.072	0.037	-0.253
Inter nodal length (cm)	0.290	-0.208	0.002	0.166	0.027	0.098	0.016	0.235	-0.256	0.009	-0.060	0.216	0.108	0.028	0.192
Days to first flowering	0.302	-0.338	0.000	0.036	0.012	-0.228	-0.039	0.491	-0.194	-0.023	-0.173	-0.105	-0.002	-0.027	0.181
Days to 50 % flowering	0.244	0.056	0.000	0.014	0.004	-0.082	-0.110	0.099	-0.157	-0.019	-0.001	-0.119	-0.058	0.011	-0.072
Number of fruits/plant	0.121	-0.032	0.000	-0.016	0.006	-0.101	-0.010	1.114	0.187	-0.052	-0.133	-0.278	-0.023	-0.097	0.654
Single fruit weight (g)	-0.445	0.323	0.000	-0.055	-0.011	0.070	0.028	0.332	0.628	-0.018	-0.023	-0.012	0.009	-0.094	0.636
Fruit length (cm)	-0.181	0.053	0.002	-0.024	-0.002	-0.044	-0.018	0.496	0.096	-0.116	-0.090	0.027	0.048	-0.076	0.511
Fruit diameter (cm)	-0.260	0.171	-0.002	-0.016	-0.007	0.171	0.000	-0.644	-0.062	0.045	0.231	0.004	0.022	0.037	-0.248
Number of seeds/fruit	0.152	-0.013	-0.001	0.023	0.012	-0.048	-0.026	0.620	0.015	0.006	-0.002	-0.499	0.058	-0.056	0.772
Number of ridges/fruit	-0.015	-0.048	0.001	0.076	0.015	0.002	0.033	-0.131	0.030	-0.029	0.027	-0.152	0.192	-0.039	0.376
Ascorbic acid (mg/100g)	-0.375	0.303	0.001	0.051	0.005	-0.041	0.008	0.728	0.399	-0.059	-0.057	-0.188	0.050	-0.148	-0.194
Residual effect	-0.0624														

Bold lines indicates direct effect.

Table 2 : Genotypic path of hybrids (F₁s) for 15 characters in okra during *Kharif* season

Characters	Plant height (cm)	Stem diameter (cm)	Number of branches/plant	Number of nodes/plant	Inter nodal length (cm)	Days to first flowering	Days to 50 % flowering	Number of fruits/plant	Single fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Number of seeds/fruit	Number of ridges/fruit	Ascorbic acid (mg/100g)	Genotypic correlation coefficient with yield
Plant height (cm)	1.981	1.383	0.021	-4.120	0.636	-0.011	0.003	-0.219	0.243	0.245	-0.226	-0.014	0.005	-0.100	-0.288
Stem diameter (cm)	1.743	1.572	-0.021	-3.682	0.720	-0.010	0.022	-0.286	-0.041	0.130	-0.050	-0.159	-0.034	-0.031	-0.089
Number of branches/plant	0.088	-0.069	0.470	-1.754	1.587	0.001	0.011	0.025	-0.139	0.003	-0.073	-0.027	0.002	-0.050	-0.144
Number of nodes/plant	1.207	0.856	0.122	-6.760	4.445	-0.014	0.008	-0.010	0.157	-0.031	-0.074	-0.045	-0.022	0.007	0.019
Inter nodal length (cm)	-0.235	-0.211	-0.139	5.606	-5.350	-0.004	-0.002	0.076	0.093	0.285	-0.034	0.017	0.037	-0.054	-0.157
Days to first flowering	0.108	0.077	-0.003	-0.456	-0.113	-0.210	0.084	0.767	-0.009	0.066	0.097	-0.033	-0.083	-0.008	-0.024
Days to 50 % flowering	0.026	0.176	0.026	-0.287	0.046	-0.092	0.193	0.526	-0.092	-0.046	-0.056	-0.101	-0.095	-0.016	-0.045
Number of fruits/plant	-0.263	-0.273	0.007	0.040	-0.246	-0.098	0.061	1.651	-0.150	-0.065	-0.110	-0.079	-0.023	0.136	0.392
Single fruit weight (g)	-0.484	0.065	0.066	1.065	0.500	-0.002	0.018	0.249	-0.996	-0.288	0.300	0.189	-0.044	0.097	0.282
Fruit length (cm)	-0.710	-0.298	-0.002	-0.303	2.239	0.020	0.013	0.158	-0.421	-0.683	0.145	0.076	-0.021	0.096	0.276
Fruit diameter (cm)	-0.584	-0.103	-0.045	0.655	0.235	-0.027	-0.014	-0.236	-0.389	-0.129	0.768	0.204	-0.017	-0.011	-0.031
Number of seeds/fruit	0.045	0.396	0.020	-0.484	0.147	-0.011	0.031	0.206	0.299	0.083	-0.248	-0.630	-0.025	0.059	0.360
Number of ridges/fruit	0.035	-0.189	0.003	0.527	-0.717	0.062	-0.068	-0.138	0.156	0.050	-0.048	0.066	0.279	-0.054	0.170
Ascorbic acid (mg/100g)	-0.570	-0.140	-0.068	-0.128	0.841	0.005	-0.009	0.647	-0.280	-0.189	-0.024	-0.107	-0.044	0.346	-0.254

Residual effect = 0.45083 Bold lines indicates direct effect.

Table 3 : Genotypic path of parents for 15 characters in okra during summer season

Characters	Plant height (cm)	Stem diameter (cm)	Number of branches/plant	Number of nodes/plant	Inter nodal length (cm)	Days to first flowering	Days to 50 % flowering	Number of fruits/plant	Single fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Number of seeds/fruit	Number of ridges/fruit	Ascorbic acid (mg/100g)	Genotypic correlation coefficient with yield
Plant height (cm)	-0.036	0.012	-0.004	0.039	0.021	0.000	0.003	0.265	-0.012	-0.044	-0.006	0.008	-0.003	-0.018	-0.389
Stem diameter (cm)	-0.014	0.030	-0.010	0.032	0.006	0.000	0.008	0.283	-0.151	-0.035	-0.008	0.011	0.001	-0.017	-0.361
Number of branches/plant	-0.003	0.005	-0.057	0.055	-0.018	0.000	0.005	0.062	-0.029	0.017	0.004	0.016	0.001	-0.007	-0.150
Number of nodes/plant	-0.011	0.008	-0.025	0.126	-0.041	0.000	0.010	0.313	0.084	0.004	-0.005	0.007	-0.002	-0.002	-0.045
Inter nodal length (cm)	-0.014	0.004	0.019	-0.098	0.053	0.000	-0.007	-0.199	-0.103	-0.035	0.002	-0.002	0.002	-0.013	-0.275
Days to first flowering	-0.002	-0.006	-0.003	-0.041	0.038	-0.001	-0.014	-0.077	0.031	0.034	0.001	-0.003	-0.001	0.018	0.383
Days to 50 % flowering	0.004	-0.008	0.009	-0.045	0.012	-0.001	-0.028	-0.306	0.087	0.040	0.002	-0.003	0.001	0.009	0.206
Number of fruits/plant	-0.013	0.012	-0.005	0.054	-0.014	0.000	0.012	0.733	0.115	-0.017	-0.011	0.018	-0.006	0.013	0.290
Single fruit weight (g)	0.001	-0.011	0.004	0.025	-0.013	0.000	0.006	0.201	0.421	0.038	-0.004	0.004	-0.003	0.026	0.574
Fruit length (cm)	0.018	-0.012	-0.011	0.005	-0.021	-0.001	-0.012	-0.142	0.180	0.090	0.003	-0.006	0.003	0.018	0.401
Fruit diameter (cm)	0.017	-0.020	-0.020	-0.051	0.007	0.000	-0.004	-0.622	-0.126	0.025	0.012	0.000	0.006	-0.018	-0.401
Number of seeds/fruit	-0.008	0.009	-0.024	0.022	-0.003	0.000	0.002	0.347	0.049	-0.013	0.000	0.037	-0.001	0.005	0.511
Number of ridges/fruit	0.009	0.003	-0.006	-0.026	0.008	0.000	-0.003	-0.372	-0.108	0.023	0.006	-0.003	0.012	-0.014	0.111
Ascorbic acid (mg/100g)	0.014	-0.011	0.009	-0.006	-0.014	-0.001	-0.006	0.212	0.242	0.036	-0.005	0.004	-0.004	0.046	-0.167
Residual effect	-0.0010														

Bold lines indicates direct effect.

Table 4 : Genotypic path of hybrids (F₁s) for 15 characters in okra during summer season

Characters	Plant height (cm)	Stem diameter (cm)	Number of branches/plant	Number of nodes/plant	Inter nodal length (cm)	Days to first flowering	Days to 50 % flowering	Number of fruits/plant	Single fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Number of seeds/fruit	Number of ridges/fruit	Ascorbic acid (mg/100g)	Genotypic correlation coefficient with yield
Plant height (cm)	-0.137	-0.041	-0.001	0.224	-0.028	0.001	-0.008	0.363	0.008	-0.009	0.000	-0.004	-0.001	-0.001	-0.031
Stem diameter (cm)	-0.088	-0.064	-0.003	0.180	-0.058	-0.001	0.000	0.494	0.033	0.001	0.000	0.003	-0.002	0.009	0.254
Number of branches/plant	-0.004	-0.005	-0.041	0.139	-0.090	0.001	-0.007	0.192	-0.022	0.001	0.000	0.001	-0.001	0.000	-0.004
Number of nodes/plant	-0.105	-0.039	-0.019	0.295	-0.128	0.002	-0.016	0.348	0.052	-0.003	0.000	-0.001	-0.001	0.003	0.094
Inter nodal length (cm)	0.022	0.021	0.021	-0.216	0.174	-0.002	0.008	-0.212	-0.136	-0.010	0.000	-0.008	0.002	-0.010	-0.291
Days to first flowering	0.013	-0.004	0.008	-0.085	0.046	-0.007	0.028	0.103	-0.067	-0.010	0.000	0.001	0.000	-0.007	-0.196
Days to 50 % flowering	0.026	-0.001	0.007	-0.112	0.034	-0.005	0.042	-0.049	-0.016	-0.003	0.000	0.002	0.000	0.003	0.082
Number of fruits/plant	-0.060	-0.038	-0.010	0.124	-0.045	-0.001	-0.002	0.825	0.035	-0.002	0.000	0.004	-0.001	0.003	0.097
Single fruit weight (g)	-0.002	-0.004	0.002	0.027	-0.042	0.001	-0.001	0.052	0.559	0.011	0.000	-0.004	-0.001	0.006	0.182
Fruit length (cm)	0.032	-0.002	-0.002	-0.022	-0.043	0.002	-0.003	-0.049	0.153	0.040	0.000	0.003	-0.001	0.004	0.127
Fruit diameter (cm)	-0.022	-0.009	0.006	0.059	-0.027	0.001	-0.008	-0.110	0.094	0.010	0.001	-0.014	-0.001	0.000	0.006
Number of seeds/fruit	0.015	-0.006	-0.01	-0.006	-0.036	0.000	0.002	0.085	-0.058	0.003	0.000	0.036	-0.002	0.006	0.195
Number of ridges/fruit	0.011	0.015	0.003	-0.032	0.032	0.000	-0.001	-0.070	-0.079	-0.006	0.000	-0.006	0.009	-0.007	0.177
Ascorbic acid (mg/100g)	0.004	-0.016	0.000	0.028	-0.051	0.001	0.003	0.080	0.102	0.005	0.000	0.006	-0.002	0.034	-0.176

Residual effect = 0.0048 Bold lines indicates direct effect.

and stem diameter (1.572) (Table 2). However, the highest negative direct effect was found in number of nodes per plant (-6.760). The highest positive indirect effect was found in number of nodes per plant (5.606) via. internodal length followed by internodal length (4.445) via. Number of nodes per plant and also for internodal length (2.239) via. fruit length. The highest negative indirect effect was found in number of nodes per plant (-4.120) via. plant height. These characters have also been identified as major direct contributors towards fruit yield per plant in okra by earlier workers (Kamal *et al.*, 2003; Patro *et al.*, 2004; Bali *et al.*, 2005; Patro and Sankar, 2006 and Singh *et al.*, 2007).

In summer parents, the highest positive direct effect on fruit yield per plant was found in number of fruits per plant (0.733) followed by single fruit weight (0.421) and number of nodes per plant (0.126) (Table 3). However, the highest negative direct effect was observed in number of branches per plant (-0.057). The high positive indirect effects were expressed in number of fruits per plant via. number of seeds per fruit (0.347), number of nodes per plant (0.313) and stem diameter (0.283) while, highest negative indirect effect was observed in number of fruits per plant via. fruit diameter (-0.622).

Among summer F_1 's, the highest positive direct effect on yield was expressed in number of fruits per plant (0.825) followed by single fruit weight (0.559) and number of nodes per plant (0.295) (Table 4). Whereas, the highest negative direct effect was found in plant height (-0.137). The traits like, number of fruits per plant showed high positive indirect effect via. stem diameter (0.494) and plant height (0.363) followed by number of nodes per plant via. plant height (0.224). While, number of nodes per plant (-0.216) expressed high negative indirect effect via. internodal length. Such results have also been reported

by Akinyele and Osekita (2006) and Singh *et al.* (2007) in okra.

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