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Studies on Interrelationship and Path Coefficient Analysis in Okra [*Abelmoschus esculentus* (L.) Moench]

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ABSTRACT

Background: Okra [*Abelmoschus esculentus* (L) Moench] is an important vegetable crop widely grown in tropical and subtropical parts of the world. Okra is high yielding crop under a good cropping system. However, its yield potential has been grossly affected by poor cropping system, use of crude implement, poor soil and insect pest infestation. For improving okra through conventional breeding and selection, it is essential to have adequate knowledge of association that exists between yield and yield related characters for the identification of selection procedure. The knowledge of such mutual relationship between fruit yield and its contributing components can significantly improve the efficiency of a breeding programme through the use of appropriate selection indices.

Methods: A study of correlation and path analysis was undertaken in 18 genotypes of okra for fruit yield and its component traits at Vegetable Research Centre, Banda University of Agriculture and Technology, Banda, (U.P) during summer and rainy season-2019.

Result: It was observed that during summer season fruit yield per plant was positively and significantly correlated with leaf area, number of primary branches per plant and number of fruits per plant and in rainy season plant height, number of nodes and number of fruits per plant showed positive and significant association with fruit yield per plant at genotypic and phenotypic level. During both the season it was observed that estimates of genotypic correlation coefficients were in most cases higher than their corresponding phenotypic correlation coefficients. In the present study during summer season leaf area (0.760) had maximum direct contribution towards fruit yield per plant followed by number of fruits per plant (0.447). However, days to opening first flower exhibited highest negative direct effect (-1.109). During rainy season leaf area (3.274) had maximum direct contribution towards fruit yield followed by days to opening first flower (2.828). However, days to first harvesting (-4.630) exhibited highest negative direct effect. The study suggested that the improvement in yield per plant will be efficient if the selection is based on leaf area, number of fruits per plant, plant height, number of branches per plant and number of nodes per plant.

Key word: Component traits, Correlation coefficient, Fruit yield, Okra, Path coefficient.

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] has occupied a prominent position among vegetable crops. It is one of the important vegetables, which is growing throughout the tropical, sub-tropical part of the world. Okra is known by different local names in different parts of the world. It is called as lady's finger in England, Gumbo in USA and Bhindi in India. It is important vegetable crop grown for its immature green non-fibrous edible pods. Okra has important position among fruit vegetables due to its multiple virtues like high nutritive and medicinal value, ease of cultivation, wider adaptability, year-round cultivation, good portability, good export potential and abundant returns (Reddy, 2010). Fresh fruit of okra contain 35 calories, 89.6 g water, 6.4 g carbohydrate, 1.9 g protein, 0.2 g fat, 1.2 g fibre and minerals per 100 g of edible portion (Gopalan *et al.,* 2007).

For improving okra through conventional breeding and selection, it is essential to have adequate knowledge of association that exists between yield and yield related characters for the identification of selection procedure. Generally, plant breeders commonly select for yield components which indirectly increase yield since direct selection for yield per se may not be the most efficient method for improvement. Indirect selection for other yield related characters, which are closely associated with yield, will be more effective. The knowledge of such mutual relationship between fruit yield and its contributing components can significantly improve the efficiency of a breeding programme through the use of appropriate selection indices. Thus, for selection of superior genotypes and improvement for any character of any character there

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must be adequate knowledge of correlation and path coefficient analysis. In plant breeding, correlation analysis provides information about yield components and thus helps in selection of superior genotypes from diverse genetic populations.

In this study, an attempt was made to study the inter relationship among characters and the direct and indirect effects of some important fruit yield components on fruit yield in varieties by adopting correlation and path coefficient analysis.

MATERIALS AND METHODS

The present study with eighteen genotypes of okra in randomized block design (RBD) was carried at vegetable research farm of the Department of Vegetable Science, College of Horticulture, Banda University of Agriculture and Technology, Banda during summer and rainy season 2019-2020. Each variety was planted in three rows replicated thrice with spacing of 45 cm × 20 cm and 60 cm × 30 cm during summer and rainy season respectively. Observations were recorded from five randomly selected plants from the middle row of each variety in each replication for fifteen plant characters *viz.,* days to 50% germination, days to first flower, days to 50% flowering, days to first harvest, plant height (cm), number of nodes, leaf area (cm^2), number of leaves, number of primary branches per plant, node to first flower appear, number of fruits per plant, fruit length (cm), fruit diameter (cm), pedicle length (cm) and fruit yield per plant (g).

RESULTS AND DISCUSSION

Yield is a complex character that is dependent on a number of distinct yield contributing characters, which are referred to as yield components. All changes in the yield components, on the other hand, do not have to be reflected in changes in yield. This is due to the varied degrees of positive and negative associations that exist between yield and its constituents, as well as between components themselves. As a result, after examining their association with fruit output per plant, selection should be based on these component traits.

Correlation coefficient analysis

Tables 1 and 2 show that estimations of genotypic correlation coefficients were in most cases higher than their phenotypic correlation coefficients during both seasons. These present findings are in close harmony with Saryam *et al.* (2017), Singh *et al.* (2016), Balai *et al.* (2014), Senapati *et al.* (2011). More significant genotypic correlation between distinct pairs of traits than phenotypic correlation stated that there is a strong genetic relationship between those characters genetically, but the phenotypic value is diminished by significant environmental interaction.

In the present study during summer season fruit yield per plant was positively and significantly correlated with leaf area (0.362 and 0.332), number of primary branches per plant (0.443 and 0.339) and number of fruits per plant (0.927 and 0.828) whereas, significantly negatively correlated with days to 50% germination (-1.029 and -0.679), days to opening first flower (-0.989 and -0.927), days to 50% flowering (-0.969 and -0.908) and days to first harvesting (-0.979 and -0.900) and during rainy season it was positively and significantly correlated with plant height at (0.672 and 0.468), number of nodes (0.608 and 0.376) and number of fruits per plant (0.600 and 0.297) at genotypic and phenotypic level respectively whereas, significantly negatively correlated with days to opening first flower (-0.918 and -0.574), days to 50% flowering (-0.922 and -0.651), days to first harvesting (-0.943 and -0.703) and pedicle length (-0.538 and -0.435). The present findings are in consonance with the earlier findings of Khalid *et al.* (2018) who also reported positive association of number of fruits per plant and plant height with fruit yield per plant. Positive association of number of branches per plant with yield per plant is also reported by Patero *et al.* (2004). Pachiyappan and Saravannam (2016) reported positive association of number of fruiting nodes with fruit yield per plant and significantly negative association of days to first flowering. Days to 50% flowering is negatively associated with fruit yield per plant is also reported by Reddy *et al.* (2013). Similar result was correlated with Singh *et al.* (2016) that plant height is significantly positively correlated with fruit yield per plant.

Days to 50% germination was positively and significantly correlated with days to opening first flower (0.960 and 0.718), days to 50% flowering (0.870 and 0.636) and days to first harvesting (0.905 and 0.652) during summer season and with pedicle length (0.484 and 0.415) during rainy season at genotypic and phenotypic level respectively.

Plant height was positively and significantly correlated with number of nodes (0.573 and 0.474), number of leaves (0.485 and 0.420), number of primary branches per plant (0.403 and 0.312) and fruit length (0.909 and 0.323) during summer season and with number of nodes (0.945 and 0.640) during rainy season.

Days to opening first flower showed positive and significant association with days to 50% flowering (0.985 and 0.940) and days to first harvesting (0.977 and 0.914) during summer season and with days to 50% flowering (0.937 and 0.919), days to first harvesting (0.941 and 0.890) and node to first flower appear (0.749 and 0.461) during rainy season.

Days to 50% flowering showed positive and significant association with days to first harvesting (0.963 and 0.949) and node to first flower appear (0.597 and 0.408) during summer season. These results are similar with the findings of Sharma *et al.* (2010) that days to 50% flower was recorded highly significant and positive association with days to first harvest.

Days to first harvest during rainy season was significantly and positively associated with node to first flower appear (0.547 and 0.378).

Number of nodes during summer season was significantly and positive associated with number of leaves

Table 1: Estimates of Genotypic (G) and Phenotypic (P) Correlation coefficient among fruit yield and its attributing traits in okra for summer season.

Traits		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Fruit yield plant^{-1}
1	G	1.000	-0.548**	0.960**	0.870**	0.905**	-0.331*	-0.505**	-0.504**	-0.550**	0.299*	-0.838**	-0.040	0.596**	0.041	-1.029**
	P	1.000	-0.323*	0.718**	0.636**	0.652**	-0.127	-0.359**	-0.223	-0.425**	0.071	-0.549**	-0.042	0.131	-0.032	-0.679**
2	G		1.000	-0.286*	-0.328*	-0.354**	0.573**	0.070	0.485**	0.403**	0.100	-0.038	0.909**	-0.204	0.316*	0.265
	P		1.000	-0.259	-0.285*	-0.297*	0.474**	-0.004	0.420**	0.312*	0.027	-0.077	0.323*	-0.013	0.258	0.218
3	G			1.000	0.985**	0.977**	0.040	-0.346*	-0.251	-0.368**	-0.008	-0.888**	0.218	0.450**	-0.106	-0.989**
	P			1.000	0.940**	0.914**	0.010	-0.275*	-0.203	-0.298*	0.027	-0.791**	0.132	0.119	-0.099	-0.927**
4	G				1.000	0.984**	0.096	-0.237	-0.208	-0.354**	0.033	-0.861**	0.185	0.319*	-0.251	-0.969**
	P				1.000	0.968**	0.067	-0.213	-0.173	-0.230	0.042	-0.749**	0.055	0.132	-0.200	-0.908**
5	G					1.000	0.082	-0.290*	-0.210	-0.382**	0.068	-0.892**	0.095	0.259	-0.235	-0.979**
	P					1.000	0.042	-0.260	-0.172	-0.214	0.041	-0.757**	0.005	0.088	-0.198	-0.900**
6	G						1.000	0.267	0.810**	0.807**	-0.125	-0.333*	0.406**	-0.150	-0.484**	-0.077
	P						1.000	0.222	0.613**	0.496**	-0.003	-0.256	0.226	-0.029	-0.356**	-0.063
7	G							1.000	0.532**	0.423**	0.101	0.334*	0.120	-0.338*	0.048	0.362**
	P							1.000	0.381**	0.284*	0.052	0.301*	0.156	-0.187	0.019	0.332*
8	G								1.000	0.410**	0.157	-0.059	0.625**	-0.063	-0.264	0.166
	P								1.000	0.297*	0.135	-0.022	0.284*	-0.130	-0.231	0.142
9	G									1.000	-0.407**	0.145	0.061	-0.522**	-0.369**	0.443**
	P									1.000	-0.121	0.161	-0.113	-0.195	-0.217	0.339*
10	G										1.000	-0.238	-0.453**	0.690**	-0.052	-0.093
	P										1.000	-0.035	0.062	0.125	-0.014	-0.045
11	G											1.000	-0.288*	-0.185	0.138	0.927**
	P											1.000	-0.096	-0.100	0.134	0.828**
12	G												1.000	0.142	0.697**	-0.216
	P												1.000	0.066	0.133	-0.067
13	G													1.000	-0.314*	-0.341*
	P													1.000	-0.186	-0.159
14	G														1.000	0.139
	P														1.000	0.111

*and** indicates level of significance at 5% and 1% respectively.

1. Days to 50% germination 2. Plant height (cm) 3. Days to first flower 4. Days to 50% flowering 5. Days to first harvest 6. No. of nodes 7. Leaf area (cm^2) 8. No of leaves per plant 9. No of primary branches 10. Node to first flower appear 11. No of fruits per plant 12. Fruit length (cm) 13. Fruit diameter (cm) 14. Pedicle length (cm).

Table 2: Estimates of genotypic (G) and phenotypic (P) correlation coefficient among fruit yield and its attributing traits in okra for rainy season.

Traits		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Fruit yield plant^{-1}
1	G	1.000	-0.336*	-0.080	-0.053	0.068	-0.023	0.116	-0.549**	-0.809**	-0.149	0.311*	0.413**	-0.647**	0.484**	-0.220
	P	1.000	-0.313*	-0.050	-0.026	0.083	-0.013	0.104	-0.425**	-0.520**	-0.074	0.086	0.088	-0.337*	0.415**	-0.153
2	G		1.000	-0.145	-0.269*	-0.289*	0.945**	0.375**	0.272*	0.560**	-0.006	0.232	0.433**	0.264	-0.671**	0.672**
	P		1.000	-0.057	-0.149	-0.174	0.640**	0.302*	0.223	0.321*	0.056	0.208	0.031	0.141	-0.520**	0.468**
3	G			1.000	0.937**	0.941**	-0.145	-0.003	0.327*	0.344*	0.749**	-0.704**	-0.926**	-0.825**	-0.013	-0.918**
	P			1.000	0.919**	0.890**	-0.038	-0.001	0.194	0.234	0.461**	-0.311*	-0.274*	-0.159	0.040	-0.574**
4	G				1.000	0.963**	-0.319*	-0.015	0.230	0.208	0.597**	-0.609**	-1.062**	-0.593**	0.225	-0.922**
	P				1.000	0.949**	-0.180	0.000	0.117	0.227	0.408**	-0.321*	-0.265	-0.127	0.204	-0.651**
5	G					1.000	-0.373**	-0.041	0.032	0.007	0.547**	-0.595**	-0.800**	-0.577**	0.201	-0.943**
	P					1.000	-0.169	-0.013	-0.048	0.076	0.378**	-0.329*	-0.158	-0.124	0.208	-0.703**
6	G						1.000	0.445**	0.323*	0.318*	0.111	-0.051	0.570**	-0.259	-0.519**	0.608**
	P						1.000	0.323*	0.202	0.106	0.008	0.198	0.192	-0.109	-0.401**	0.376**
7	G							1.000	0.124	0.154	0.155	-0.010	-0.428**	-0.404**	-0.253	0.171
	P							1.000	0.107	0.122	0.129	-0.020	-0.089	-0.161	-0.227	0.134
8	G								1.000	1.043**	0.341*	0.010	-0.641**	-0.152	-0.131	0.037
	P								1.000	0.576**	0.181	-0.057	-0.229	-0.016	-0.133	0.007
9	G									1.000	0.341*	-0.140	-1.600**	0.095	-0.526**	0.180
	P									1.000	0.268	-0.020	-0.083	0.119	-0.285*	0.101
10	G										1.000	-0.587**	-1.209**	-0.606**	-0.255	-0.334*
	P										1.000	-0.232	-0.292*	-0.343*	-0.194	-0.218
11	G											1.000	1.322**	0.021	0.362**	0.600**
	P											1.000	0.153	0.113	0.126	0.297*
12	G												1.000	-0.527**	0.340*	0.705**
	P												1.000	0.205	0.109	0.125
13	G													1.000	-0.026	0.471**
	P													1.000	0.104	0.108
14	G														1.000	-0.538**
	P														1.000	-0.435**

**and* indicates level of significance at 5% and 1% respectively.

1. Days to 50% germination 2. Plant height (cm) 3. Days to first flower 4. Days to 50% flowering 5. Days to first harvest 6. No. of nodes 7. Leaf area (cm^2) 8. No of leaves per plant 9. No of primary branches 10. Node to first flower appear 11. No of fruits per plant 12. Fruit length (cm) 13. Fruit diameter (cm) 14. Pedicle length (cm).

Table 3: Genotypic path coefficients showing direct and indirect effects of different characters on fruit yield per plant (g) in okra for summer season.

Traits	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Fruit yield/ plant (g)
Days to 50% germination	**0.349**	-0.037	-1.065	-0.179	0.376	0.067	-0.384	0.317	-0.065	0.016	-0.374	-0.005	-0.029	-0.023	-1.029**
Plant height (cm)	-0.191	**0.068**	0.317	0.067	-0.147	-0.115	0.053	-0.306	0.048	0.005	-0.017	0.120	0.010	-0.172	0.265
Days to opening first flower	0.335	-0.019	**-1.109**	-0.203	0.406	-0.008	-0.263	0.158	-0.043	0.000	-0.396	0.029	-0.022	0.057	-0.989**
Days to 50% flowering	0.304	-0.022	-1.093	**-0.206**	0.409	-0.019	-0.180	0.131	-0.042	0.002	-0.385	0.024	-0.015	0.136	-0.969**
Days to first harvest	0.316	-0.024	-1.084	-0.202	**0.415**	-0.016	-0.221	0.132	-0.045	0.004	-0.399	0.013	-0.012	0.128	-0.979**
No of nodes	-0.116	0.039	-0.044	-0.020	0.034	**-0.201**	0.203	-0.511	0.095	-0.007	-0.149	0.054	0.007	0.263	-0.077
Leaf area (cm^2)	-0.176	0.005	0.384	0.049	-0.121	-0.054	**0.760**	-0.335	0.050	0.005	0.149	0.016	0.016	-0.026	0.362**
No of leaves per plant	-0.176	0.033	0.279	0.043	-0.087	-0.163	0.404	**-0.630**	0.048	0.008	-0.027	0.082	0.003	0.144	0.166
No of primary branches	-0.192	0.027	0.408	0.073	-0.159	-0.162	0.322	-0.258	**0.118**	-0.021	0.065	0.008	0.025	0.201	0.443**
Node to first flower appear	0.104	0.007	0.009	-0.007	0.028	0.025	0.077	-0.099	-0.048	**0.052**	-0.107	-0.060	-0.033	0.028	-0.093
No of fruits per plant	-0.292	-0.003	0.984	0.177	-0.371	0.067	0.254	0.037	0.017	-0.012	**0.447**	-0.038	0.009	-0.075	0.927**
Fruit length (cm)	-0.014	0.062	-0.241	-0.038	0.040	-0.082	0.091	-0.394	0.007	-0.023	-0.129	**0.132**	-0.007	-0.379	-0.216
Fruit diameter (cm)	0.208	-0.014	-0.499	-0.066	0.108	0.030	-0.257	0.040	-0.062	0.036	-0.083	0.019	**-0.048**	0.171	-0.341*
Pedicle length (cm)	0.014	0.021	0.117	0.052	-0.098	0.097	0.036	0.167	-0.044	-0.003	0.062	0.092	0.015	**-0.544**	0.139

R square= 1.0122; Residual effect= -0.0122; Bold values shows direct and normal values shows indirect effect.

Table 4: Genotypic path coefficients showing direct and indirect effects of different characters on fruit yield per plant (g) in okra for rainy season.

Traits	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Fruit yield/ plant (g)
Days to 50% germination	**0.6275**	0.4933	-0.2269	-0.0366	-0.316	-0.002	0.3782	0.5685	-0.409	0.1294	-0.0474	-0.0959	0.0547	0.4131	-0.220
Plant height (cm)	-0.2109	**-1.4673**	-0.41	-0.1875	1.3386	0.0819	1.2289	-0.2817	0.2835	0.0048	-0.0354	-0.1005	-0.0223	-0.5728	0.672**
Days to opening first flower	-0.0503	0.2128	**2.8275**	0.6526	-4.3592	-0.0126	-0.0102	-0.3389	0.1742	-0.6521	0.1073	0.215	0.0697	-0.0109	-0.918**
Days to 50% flowering	-0.033	0.3949	2.6491	**0.6966**	-4.4602	-0.0277	-0.0499	-0.2382	0.1052	-0.5198	0.0928	0.2465	0.0502	0.1923	-0.922**
Days to first harvest	0.0428	0.4242	2.662	0.671	**-4.6302**	-0.0323	-0.1354	-0.033	0.0037	-0.4764	0.0906	0.1857	0.0488	0.172	-0.943**
No of nodes	-0.0147	-1.3862	-0.4101	-0.2224	1.7251	**0.0867**	1.4565	-0.3345	0.1608	-0.0966	0.0078	-0.1323	0.0219	-0.4428	0.608**
Leaf area (cm^2)	0.0725	-0.5508	-0.0088	-0.0106	0.1915	0.0386	**3.2736**	-0.1285	0.0778	-0.1353	0.0016	0.0995	0.0341	-0.216	0.171
No of leaves per plant	-0.3443	-0.3989	0.9249	0.1602	-0.1476	0.028	0.4059	**-1.036**	0.5277	-0.2974	-0.0015	0.1488	0.0129	-0.1121	0.037
No of primary branches	-0.5073	-0.8223	0.9738	0.1448	-0.0338	0.0276	0.5034	-1.0806	**0.5059**	-0.2975	0.0213	0.3714	-0.008	-0.4488	0.180
Node to first flower appear	-0.0932	0.0081	2.1165	0.4156	-2.5318	0.0096	0.5084	-0.3537	0.1727	**-0.8712**	0.0895	0.2807	0.0512	-0.2174	-0.334*
No of fruits per plant	0.1951	-0.3403	-1.9898	-0.4239	2.753	-0.0044	-0.0336	-0.0105	-0.0706	0.5116	**-0.1524**	-0.3068	-0.0018	0.3089	0.600**
Fruit length (cm)	0.2593	-0.6352	-2.619	-0.7399	3.7051	0.0494	-1.4027	0.6643	-0.8094	1.0536	-0.2015	**-0.2321**	0.0445	0.2903	0.705**
Fruit diameter (cm)	-0.4058	-0.3869	-2.3315	-0.4132	2.6732	-0.0225	-1.3217	0.1579	0.0479	0.5278	-0.0032	0.1223	**-0.0845**	-0.0219	0.471**
Pedicle length (cm)	0.3035	0.9843	-0.0362	0.1569	-0.9324	-0.0449	-0.8279	0.136	-0.2659	0.2218	-0.0551	-0.0789	0.0022	**0.8539**	-0.538**

R square = 0.7984; Residual effect = 0.4490; Bold values shows direct and normal values shows indirect effects.

(0.810 and 0.613), number of primary branches per plant (0.807 and 0.496) and during rainy season with leaf area (0.445 and 0.323).

During summer season number of leaves with number of primary branches per plant (0.410 and 0.297) and fruit length (0.625 and 0.284) and during rainy season with number of primary branches per plant (1.043 and 0.576).

Path coefficient analysis

The estimates of direct and indirect effects of the fifteen fruit yield related characters on fruit yield per plant are presented in Table 3 and 4 for summer and rainy season respectively.

In the present study during summer season leaf area (0.760) had maximum direct contribution towards fruit yield per plant followed by number of fruits per plant (0.447), days to first harvesting (0.415) and days to 50% germination (0.349). However, days to opening first flower exhibited highest negative direct effect (-1.109) and during rainy season leaf area (3.274) had maximum direct contribution towards fruit yield followed by days to opening first flower (2.828) and pedicle length (0.854). However, days to first harvesting (-4.630) exhibited highest negative direct effect followed by plant height (-1.467), number of leaves (-1.036), node to first flower appear (-0.871) and fruit length (-0.232). These are the important traits which may be viewed in selection programme for the further improvement of okra.

During summer season the genotypic direct effect of leaf area, days to 50% germination and number of primary branches whereas, during rainy season leaf area, number of primary branches per plant contributed directly and positively to fruit yield per plant possess significant correlations suggesting that the association between these traits is perfect and direct selection through these traits will be effective.

During rainy season genotypic path coefficient analysis revealed that days to opening first flower had high positive direct effect on fruit yield per plant, though their association was significantly negative. Under these circumstances, a restricted simultaneous selection model is to be followed *i.e.* restrictions are to be imposed to nullify the undesirable indirect effects *via* days to 50% flowering to make use of the direct effect. Similar findings were reported by Dhall *et al.* (2000), that number of fruits per plant and plant height had direct effect on fruit yield per plant. Ramanjinappa *et al.* (2011) for number of fruits per plant and number of nodes. Senapati *et al.* (2011) for number of fruits per plant and fruit length. Singh *et al.* (2016) for number of fruits per plant and number of nodes. Patro *et al.* (2004) for days to 50% germination. Number of branches per plant, number of nodes and plant height. Saryam *et al.* (2017) for number of branches per plant. Mehta *et al.* (2006) for fruit length. Khalid *et al.* (2018) for days to 50 % flowering.

Highly positive indirect effect on fruit yield per plant during summer season exerted by number of leaves (0.404) via days to 50% germination. Whereas, during rainy season highly positive indirect effect on fruit yield per plant exerted by fruit length (3.7051), number of fruits per plant (2.753) and fruit diameter (2.6732), *via* days to first harvesting.

The residual factor determines how best the casual factors account for the variability of the dependent factor, the fruit yield per plant in this case. In spite of the large number of characters used in the path coefficient analysis, the value of the residual factor was found to be negative during summer season which may be due to rounding off errors.

CONCLUSION

In conclusion, the correlation coefficient analysis of fifteen traits revealed strong association among growth, earliness and yield parameter of okra under study. Fruit yield per plant had significant and positive genotypic and phenotypic correlation with leaf area, number of primary branches per plant and number of fruits per plant whereas, significantly negatively correlated with days to 50% germination, days to opening first flower, days to 50% flowering and days to first harvesting during summer season and during rainy season it was positively and significantly correlated with plant height, number of nodes and number of fruits per plant at genotypic and phenotypic level whereas, significantly negatively correlated with days to opening first flower, days to 50% flowering, days to first harvesting and pedicle length. Path coefficient analysis revealed that during summer season leaf area, number of fruits per plant, fruit length, number of primary branches per plant and during rainy season leaf area (3.274) had maximum direct contribution towards fruit yield followed by days to opening first flower (2.828). However, days to first harvesting (-4.630) exhibited highest negative direct effect and are the main determiners of fruit yield per plant. The improvement in yield per plant will be efficient if the selection is based on leaf area, number of fruits per plant, plant height, number of branches per plant and number of nodes per plant.

Conflict of interest: None.

REFERENCES

Balai, T.C., Maurya, I.B., Verma, S. and Kumar, N. (2014). Correlation and path analysis in genotypes of okra [*Abelmoschus esculentus* (L.) Moench]. The Bioscan. 9(2): 799-802.

Dhall, R.K., Arora, S.K. and Rani, M. (2000). Correlation and path analysis in advanced generations of okra [*Abelmoschus esculentus* (L.) Moench]. Indian Journal of horticulture. 57(4): 342-346.

Gopalan, C., Rama, S.B.V. and Balasubramanian. S. (2007). Nutritive Value of Indian Foods, published by National Institute of Nutrition (NIN), ICMR.

Khalid, S., Sani, MD, N.H., Narif, S.O., Parvin, S., Rony, MD.M.H., Islam, M.S. and MD., H.S. (2018). Genetic variability, Heritability, character association and morphological diversity in okra [*Abelmoschus esculentus* (L.) Moench]. International Journal of Plant and Soil Science. 25(6): 1-11.

Mehta, D.R., Dhaduk, L.K. and Patel, K.D. (2006). Genetic variability correlation and path analysis studies in okra [*Abelmoschus esculentus* (L.) Moench]. Agric. Sci. Digest. 26(1): 15-18.

Pachiyappan, R. and Saravannan, K. (2016). Studies on genetic variability and correlation for fruit yield and fruit quantity characters of okra. The Asian Journal of Horticulture. 11(1): 101-104.

Patro, T.S.K.K.K. and Ravisankar, C. (2004). Genetic Variability and Multivariate Analysis in okra [*Abelmoschus esculentus* (L.) Moench]. Tropical Agriculture Research. 16: 99-113.

Ramanjanappa, V., Patil, M.G., Narayanaswamy, P., Ashok, H. and Arunkumar, K.H. (2011). Variability, correlation and path coefficient analyses in okra [*Abelmoschus esculentus* (L.) Moench]. Environment and Ecology. 29(AS): 778-782.

Reddy, M.T., Haribabu, K., Mutyala, G., Reddy, K.C., Begum, H., Reddy, R.S.K. and Babu. J.D. (2013). Correlation and path coefficient analysis of quantitative characters in okra [*Abelmoschus esculentus* (L.) Moench]. Songklana Karin J. Sci. technology. 35(3): 243-250.

Reddy, M.T. (2010). Genetic diversity, heterosis, combining ability and stability in okra [*Abelmoschus esculentus* (L.) Moench]. Ph. D. Thesis, Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad. p. 313.

Saryam, D.K., Mittra, S.K., Mehta, A.K. and Prajapati, S. (2017). Variation in genetic diversity in okra [*Abelmoschus esculentus* (L.) Moench]. Journal of functional and environmental Botany. 7(1): 57-64.

Senapati, N., Mishra, H.N., Beura, S.K., Darla, S.K., Prasad, G. and Patnaik. A. (2011). Genetic analysis in okra hybrids. Environment and Ecology. 29(3A): 1240-1244.

Sharma, R.K. and Prasad, K. (2010). Characterisation of promising okra genotypes of the basis of Principal component Analysis. Journal of Applied Horticulture. 12(1): 71-74.

Singh, D., Dudi, B.S., Meena, O.P and Dhankhar, S.K. (2016). Determination of genetic relationships among different agro-morphological traits in okra genotypes. International Journal of Agricultural and Statistical Sciences. 12(1): 245-253.