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Research Article

CORRELATION AND PATH ANALYSIS STUDIES IN OKRA [*Abelmoschus esculentus* L. Moench] UNDER JABALPUR CONDITION

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Abstract- The experimental material for the present investigation was comprised of 20 genotypes of okra. These genotypes were sown in Randomized Complete Block Design with three replications, to estimate the correlation and Path coefficient analysis. Observations were recorded on the basis of five random competitive plants selected from each genotype separately for morphological, phonological, yield and other parameters were evaluated as per standard procedure. Analysis of variance revealed highly significant variance for all the characters. Presence of such variability in the population under study is the ultimate result of variability in the genetic constitution of various individuals. An overall observation of path coefficient analysis of fruit yield per plant revealed that plant height, diameter of fruit, number of branches per plant at 90 DAS, number of seeds per fruit, days taken to 50% flowering, length of internode and number of flowering nodes on main stem played an important role in determining the fruit yield per plant.

Keywords- Okra, Correlation, Path analysis.

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Introduction

Okra *[Abelmoschus esculentus L.* Moench] is one of the most popular vegetable crop grown in tropical and sub-tropical regions of the world. It has high nutritive value and export potential. Okra has captured a prominent position among vegetables [1]. Okra is more remunerative then leafy vegetables. In India, okra is one of the most important vegetable crops grown for its tender green fruits during summer and rainy seasons. Okra is a polyploidy, belongs to the family Malvaceae and a self-pollinated crop. Occurrence of out crossing to an extent of 4 – 19 percent with the maximum of 42.2 per cent is noticed with the insect assisted pollination [2]. Considerable effort is currently being made in a number of okra breeding programmes to improve yield attributes such as seed yield, number of pods per plant, pod length and pod width. These traits are particularly important in the breeding of okra programmes. [3]

To improve yield and other characters, information on genetic variability and inter-relationship among different traits is necessary. Inter-relational knowledge of yield and yield components helps in identification and adoption of suitable breeding methods. Selection of characters which are highly heritable and positively correlated helps in yield improvement. The correlation coefficient helps to indicate the degree of relationship between characters. When more number of variables are considered the association becomes more complex and less obvious. The path analysis study is useful in such situation. This gives clear picture of the direct as well as indirect effects of various traits on yield. The path analysis on major yield contributing components was carried out to have a clear view of individual traits contribution on yield [4].

Correlation and path Analysis are the important tools useful for getting information regarding association of characters. This is very helpful for plant breeder in developing a commercial variety by determining the component characters on which selection can be based for the yield improvement. These studies along with the association analysis will be more useful in the estimation of the nature and extent of direct and indirect effect of yield contributing components using path coefficient analysis.

Material and Methods

The experiment was conducted at Vegetable Research Farm, Department of Horticulture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.). in Kharif season during the year 2011-12. The experimental material for this study comprised of 20 genotypes with four checks HOK-152(C), Arka Anamika, Pusasawani and SOH 152-RC(C) collected from different research institutes. The experiment was laid out in Randomized Complete Block Design (RCBD) with 20 treatments (16genotypes + 4 checks) and three replications. Seeds were sown at a spacing of 60 cm between rows and 30 cm between the plants. All the recommended cultural practices were followed under irrigated conditions. The observations were recorded on five randomly selected plants per replication for each genotype.

Correlation coefficients were calculated in all possible combinations taking all the characters into consideration at genotypic, phenotypic and environmental levels by using the formula as proposed by Miller *et al.* (1958).

$$r = \frac{\Sigma xy - \frac{\Sigma x . \Sigma y}{n}}{\sqrt{\left(\Sigma x^2 - \frac{(\Sigma x)^2}{n}\right)\left(\Sigma y^2 - \frac{(\Sigma y)^2}{n}\right)}}$$

Where,

r = Correlation Coefficient
n = Number of treatments
x and y= Character under study

Genotypic, phenotypic and environmental correlations were computed by

substituting corresponding variance and covariance in the above formula, e. g.

Testing of correlations

The phenotypic correlations are tested for their significance by following formula based on "t" test:

$$Tc = \frac{r}{\sqrt{1-r^2}} . \sqrt{n-2} \sim t\ (n\text{-}2)\ d.f.$$

where,

N=Number of treatments.

R=Phenotypic correlations coefficient.

The calculated value of "t" is compared with table of "t" at (n-2) d.f. if the calculated value is equal to or greater than table value, it is significant at given probability level. If $t_c < t_T$, it is to be non-significant.

Path coefficient analysis

Path coefficient analysis was worked out to show the cause and effect relationship between yield and various yield components, and to partition the total correlation coefficient into direct and indirect effects. This procedure was developed by Wright (1921) and as per concept used by Li (1956) and followed by Dewey and Lu (1959). Path coefficients are the standardized partial regression coefficients and as such measure the direct influence of one variable upon another variable and permits partition of correlation coefficient into components of direct and indirect effects. The sum of the direct and all possible indirect effects via all other traits must be equal to correlation coefficient of dependent traits with independent characters under consideration. Path coefficients were obtained by setting simultaneous equation which expresses basic relationship between correlation and path coefficient analysis:

$$r_{1,y} = P_{1,y} + r_{1,2} P_{2,y} + r_{1,2} P_{1yt} + \ldots\ldots\ldots\ldots\ldots\ldots\ldots + r_{1,10} P_{10,y}$$

$$r_{2,y} = P_{2,y} + r_{2,1} P_{1,y} + r_{2,2} P_{3yt} + \ldots\ldots\ldots\ldots\ldots\ldots\ldots + r_{2,10} P_{10,y}$$

$$r_{10,y} = P_{10,y} + r_{10,y} P_{1,y} + r_{10,2} P_{3yt} + \ldots\ldots\ldots\ldots\ldots\ldots\ldots + r_{10,9} P_{9,y}$$

Where,

1, 2, ... 10 are the component characters and y is dependent upon which direct and indirect effects are studied.

Unexplained variation of the residual effects was obtained from the following equation:

R= Residual effect.

Di= Direct effect of the i^{th} character.

Rij= Correlation coefficient between the i^{th} character and j^{th} dependent character.

Direct and indirect effect of yield per plant was calculated at both genotypic and phenotypic levels.

Results and Discussion

Correlation coefficients were estimated between yield and its components at genotypic, phenotypic and environmental levels to know the correlation among the characters. It provides information about the nature, extent and direction of selection pressure to be applied for practical consideration.

Significant and positive correlation of plant height at 30 DAS was observed with plant height at 60 DAS (0.66), plant height at 90 DAS (0.58), fruiting span (0.56), number of branches per plant at 60 DAS (0.479), length of internode (0.39), yield per plant and number of branches per plant at 30 DAS (0.34), number of leaves per plant (0.31) and number of fruits per plant (0.26). However, significant and negative association was observed with days to first picking (-0.53), days to 50% flowering (-0.44) and number of seeds per fruit (-0.39). Plant height at 60 DAS showed significant and positive association with plant height at 90 DAS (0.89), plant height at 30 DAS (0.66), number of branches per plant at 90 DAS (0.64), number of branches per plant at 60 DAS (0.60), fruiting span (0.57), number of leaves per plant (0.542), days to first picking (0.54), yield per plant (0.47), number of fruits per plant (0.39) and number of branches per plant at 30 DAS (0.36). However, significant and negative correlation was observed with days to 50% flowering (-0.30). A significant and positive correlation was shown by this trait with plant height at 60 DAS (0.89), plant height at 30 DAS (0.58), number of leaves per plant (0.57), number of branches per plant at 90 DAS (0.55), number of branches per plant at 60 DAS (0.52), fruiting span (0.50), yield per plant (0.43), number of fruits per plant (0.40), number of branches per plant at 30 DAS (0.34) and length of internode (0.27). Significant and negative correlation was observed with days to first picking (-0.50) [4,5]. Number of branches per plant at 30 DAS had significant and positive correlation with number of branches per plant at 60 DAS (0.48), number of branches per plant at 90 DAS (0.388), plant height at 60 DAS (0.36), plant height at 30 DAS (0.349), plant height at 90 DAS (0.34) and diameter of fruit (0.24). Significant and negative correlation was exhibited with number of flowering nodes on main stem (-0.41).number of branches per plant at 60 DAS showed Significant and positive correlation with number of branches per plant at 90 DAS (0.89), plant height at 60 DAS (0.60), plant height at 90 DAS (0.52), number of leaves per plant (0.49), number of branches per plant at 30 DAS (0.48), plant height at 30 DAS (0.47), fruiting span (0.33), yield per plant (0.31), number of fruits per plant (0.28) and length of internode (0.25). Significant and negative correlation was recorded with days to 50% flowering (-0.34) and days to first picking (0.28). Number of branches per plant at 90 DAS exhibited significant and positive correlation with number of branches per plant at 60 DAS (0.89), plant height at 60 DAS (0.64), plant height at 30 DAS (0.57), plant height at 90 DAS (0.55), number of leaves per plant, (0.43), fruiting span (0.41), number of branches per plant at 30 DAS (0.38), length of internode (0.31) and yield per plant (0.31) and number of fruits per plant (0.26). However, it showed significant and negative correlation with days to 50% flowering (-0.37) and days taken to first picking (-0.35) [6-8].

Length of internode expressed significant and positive correlation withplant height at 30 DAS (0.39), number of leaves per plant (0.37), plant height at 60 DAS (0.36), number of branches per plant at 90 DAS (0.31), plant height at 90 DAS (0.27), number of branches per plant at 60 DAS (0.25). It showed significant and negative correlation with days to 50% flowering (-0.36). Significant and positive association was observed by days to 50% flowering with days to first picking (0.52). However, it showed significant and negative association with fruiting span (-0.54), plant height at 30 DAS (-0.44), number of branches per plant at 90 DAS (-0.37), length of internode (-0.36), number of branches per plant at 60 DAS (-0.34), plant height at 60 DAS (-0.30), number of leaves per plant (-0.29) and yield per plant (-0.24). [9,10]. Days to first picking revealed significant and positive correlation with plant height at 60 DAS (0.54) and days to 50% flowering (0.52). This trait showed significant and negative correlation with fruiting span (-0.80), plant height at 30 DAS (-0.53), plant height at 90 DAS (-0.50), number of branches per plant at 90 DAS (-0.35), number of fruits per plant (-0.29), number of branches per plant at 60 DAS (-0.28) and yield per plant (-0.26). Significant and positive correlation was expressed by fruiting span with plant height at 60 DAS (0.57) plant height at 30 DAS (0.56), plant height at 90 DAS (0.50), number of branches per plant at 90 DAS (0.41), number of branches per plant at 60 DAS (0.33) and yield per plant (0.30). While, it's significant and negative correlation recorded with days to first picking (-0.80), and days to 50% flowering (-0.54) [8,11]. Length of fruit showed significant and positive correlation with diameter of fruit (0.31). Significant and positive correlation was revealed by diameter of fruit with length of fruit (0.31). However, it showed significant and negative correlation with number of seeds per fruit (-0.30) and number of nodes to first flower (-0.27). Weight of fruit showed significant and positive association with number of flowering nodes on main stem (0.29). Number of seeds per fruit expressed significant and positive correlation with number of nodes to first flower (0.27). While, significant and negative association was recorded with plant height at 30 DAS (-0.39) and diameter of fruit (-0.30).Number of fruits per plant showed significant and positive association with number of leaves per plant (0.44), plant height at 90 DAS (0.40), plant height at 60 DAS (0.39), number of branches per plant at 60 DAS (0.28), number of branches per plant at 90 DAS and plant height at 30 DAS (0.26) and number of flowering nodes on main stem (0.25). However, it showed significant and negative correlation with days to first picking (-0.29). Yield per plant exhibited significant and positive association with plant height at 60 DAS (0.47), plant height at 90 DAS (0.43), plant height at 30 DAS (0.34), number of branches per plant at 60 DAS (0.31), and number of branches per plant at 90 DAS (0.31), fruiting span (0.30) number of leaves per plant (0.28). However, it showed significant and negative correlation

Table-1 *Phenotypic and genotypic correlation coefficient of yield and its contributing traits in okra*

Characters		Plant height at (cm)		No. of branches per plant at			No. of leaves per plant	No. of nodes to first flower	Flowering nodes on main stem	Length of internode (cm)	Days to 50% flowering (days)	Days to first picking (days)	Fruiting span (days)	Length of fruit (cm)	Diameter of fruit (cm)	Weight of fruit (g)	No. of seeds per fruit	No. of fruit per plant	Yield per plant (g)
		60 DAS	90 DAS	30 DAS	60 DAS	90 DAS													
Plant height at 30 DAS (cm)	P	0.66**	0.58**	0.34**	0.47**	0.57**	0.31*	-0.10	0.11	0.39**	-0.44**	-0.53**	0.56**	-0.03	0.11	-0.12	-0.39**	0.26*	0.34**
	G	0.68	0.60**	0.70**	0.88**	0.97**	0.60**	-0.21	0.11	0.58**	-0.53**	-0.70**	0.73**	-0.08	0.150	-0.26*	-0.43**	0.47**	0.36**
Plant height at 60 DAS (cm)	P		0.89**	0.36**	0.60**	0.64**	0.54**	0.04	-0.15	0.36**	-0.30**	-0.54**	0.57**	0.02	0.10	0.02	-0.03	0.39**	0.47**
	G		0.93**	0.74**	1.02	1.02	0.93**	0.05	-0.201	0.53**	-0.37**	-0.71**	0.72**	0.03	0.10	-0.06	-0.03	0.64**	0.48**
Plant height at 90 DAS (cm)	P			0.34**	0.52**	0.55**	0.57**	0.118	-0.118	0.27*	-0.23	-0.50**	0.50**	0.015	0.04	0.66**	0.024	0.4**	0.43**
	G			0.70**	0.88**	0.92**	0.87**	0.24	-0.156	0.39**	-0.31	-0.67	0.68	-0.011	0.09	0.13	0.02	0.77**	0.45**
No. of branches per plant at 30 DAS	P				0.48**	0.38**	0.20	-0.02	-0.41**	0.15	-0.16	-0.05	0.209	0.13	0.24	-0.16	0.021	-0.01	0.10
	G				0.94**	0.82**	0.92**	0.54**	-0.60**	0.23	-0.42**	0.47	0.33	0.179	0.61	-0.37**	0.07	0.50**	0.24
No. of branches per plant at 60 DAS	P					0.89**	0.49**	-0.09	-0.10	0.25*	-0.34**	-0.28*	0.33**	0.01	0.22	-0.056	-0.05	0.28*	0.31*
	G					0.96**	0.87**	0.21	-0.35**	0.98**	-0.63**	-0.59	0.63	0.22	0.46	-0.18	-0.18	0.43**	0.53**
No. of branches per plant at 90 DAS	P						0.43**	-0.06	-0.07	0.31*	-0.37**	-0.35**	0.41**	-0.03	0.10	-0.09	-0.18	0.26*	0.31*
	G						0.64**	0.29*	-0.23	0.91**	-0.65**	-0.67	0.69	0.218	0.36	-0.14	-0.34**	0.41**	0.51**
No. of leaves per plant	P							0.23	-0.15	0.37**	-0.29*	-0.16	0.20	0.05	-0.02	0.09	0.02	0.44**	0.28*
	G							0.50**	-0.22	0.71**	-0.46**	-0.62	0.63	-0.02	0.14	0.24	0.04	0.57**	0.58**
No. of nodes to first flower	P								-0.35**	0.13	-0.09	-0.08	0.017	0.04	-0.27*	-0.20	0.27*	0.07	-0.18
	G								-0.72**	-0.05	0.02	0.05	0.02	0.31*	-0.21	-0.33	0.55**	0.01	-0.44**
Flowering nodes on main stem	P									0.06	-0.14	-0.014	-0.08	-0.09	-0.02	0.29*	-0.22	0.25*	0.013
	G									0.13	-0.16	0.005	0.09	-0.08	-0.08	0.43**	-0.26*	0.40**	0.03
Length of internode (cm)	P										-0.36**	-0.17	0.19	-0.17	-0.04	0.08	-0.16	0.18	0.09
	G										-0.59**	-0.40	0.4	-0.18	0.07	0.05	-0.25*	0.09	0.109
Days to 50% flowering (days)	P											0.52**	-0.54**	-0.04	0.13	0.04	0.07	0.02	-0.24*
	G											0.83	-0.85	-0.02	-0.06	0.14	0.10	-0.07	-0.29*
Days to first picking (days)	P												-0.80**	0.122	0.116	0.112	0.02	-0.29*	-0.26*
	G												-0.93	-0.08	0.21	0.03	-0.02	-0.37**	-0.33**
Fruiting span (days)	P													-0.04	-0.03	-0.06	-0.05	0.23	0.30*
	G													0.06	-0.23	-0.05	-0.03	0.44**	0.39**
Length of fruit (cm)	P														0.31*	-0.07	-0.03	-0.02	-0.04
	G														0.73**	-0.39**	-0.12	0.22	-0.05
Diameter of fruit (cm)	P															-0.09	-0.30*	0.02	0.02
	G															-0.14	-0.13	-0.08	0.06
Weight of fruit (g)	P																0.02	0.11	0.19
	G																-0.15	0.29*	0.26*
No. of seeds per fruit	P																	-0.1	-0.02
	G																	0.04	-0.04
No. of fruit per plant	P																		-0.09
	G																		-0.162

Table-2 *Genotypic path coefficients showing direct and indirect effects of different characters on fruit yield per plant*

Characters	Plant height (cm)			Number of branches per plant			Number of leaves per plant	Number of nodes to first flower	Number of flowering nodes on main stem	Length of internode (cm)	Days to 50% flowering (days)	Days to first picking (days)	Fruiting span (days)	Length of fruit (cm)	Diameter of fruit (cm)	Weight of fruit (g)	Number of seeds per fruit	Number of fruits per plant	Yield per plant (g)
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS													
Plant height at 30 DAS (cm)	**-0.099**	-0.068	-0.060	-0.070	-0.088	-0.097	-0.06	0.0216	-0.0113	-0.058	0.0533	0.0705	-0.073	0.0080	-0.015	0.0267	0.0432	-0.04	0.363
Plant height at 60 DAS (cm)	-0.900	**-1.316**	-1.233	-0.975	-1.347	-1.352	-1.41	-0.071	0.2651	-0.700	0.4876	0.9387	-0.956	-0.048	-0.135	0.0887	0.0448	-0.85	0.484
Plant height at 90 DAS (cm)	2.281	3.527	**3.764**	2.664	3.330	3.479	4.11	0.936	-0.5902	1.4829	-1.197	-2.517	2.584	-0.042	0.0032	0.5187	0.0106	2.903	0.456
Number of branches per plant at 30 DAS	-0.490	-0.577	-0.494	**-0.697**	-0.856	-0.738	-0.64	-0.367	0.4246	-0.1622	0.2958	0.3308	-0.234	-0.125	-0.431	0.2648	-0.055	-0.35	0.241
Number of branches per plant at 60 DAS	-1.672	-1.935	-1.673	-2.319	**-1.890**	-1.91	-2.20	-0.410	0.6778	-1.8716	1.2053	1.1238	-1.202	-0.419	-8765	0.3513	0.3459	-0.81	0.530
Number of branches per plant at 90 DAS	0.987	1.045	0.940	1.076	1.028	**1.017**	1.184	0.304	-0.2431	1.1302	-0.663	-0.688	0.7117	0.2222	0.3686	-0.143	0.3479	0.417	0.513
number of leaves per plant	-0.150	-0.268	-0.272	-0.229	-0.289	-0.289	**-0.24**	-0.126	0.0558	-0.1787	0.1166	0.1556	-0.159	0.0060	-0.035	-0.060	-0.010	-0.14	0.587
Number of nodes to first flower	0.079	-0.020	-0.091	-0.199	-0.080	-0.110	-0.18	**-0.368**	0.2674	0.0214	-0.007	-0.018	-0.007	-0.116	0.0808	0.1222	-0.205	-0.05	-0.44
Number of flowering nodes on main stem	0.024	-0.044	-0.034	-0.133	-0.078	-0.052	-0.04	-0.159	**0.2197**	0.0292	-0.035	0.0012	0.0206	-0.019	-0.019	0.0952	-0.058	0.089	0.033
Length of internodes (cm)	0.167	0.151	0.1123	0.066	0.282	0.316	0.204	-0.016	0.0379	**0.2851**	-0.169	-0.116	0.1143	-0.051	0.0223	0.0153	-0.730	0.026	0.109
Days to 50% flowering (days)	-0.188	-0.130	-0.112	-0.149	-0.224	-0.229	-0.16	0.007	-0.0576	-0.2102	**0.3526**	0.2948	-0.301	-0.008	-0.022	0.0527	0.0353	-0.02	-0.29
Days to first picking (days)	0.432	0.437	0.410	0.290	0.364	0.415	0.383	-0.030	-0.0035	0.2504	-0.512	**-0.613**	0.7092	0.0498	-0.134	-0.020	0.0001	0.229	-0.33
Fruiting span (days)	0.131	0.134	0.126	0.061	0.117	0.129	0.118	0.003	0.0173	0.0740	-0.157	-0.213	**0.1846**	0.0113	-0.043	-0.010	-0.006	-0.08	0.398
Length of fruit (cm)	0.084	-0.036	0.011	-0.176	-0.217	-0.214	0.023	-0.309	0.0868	0.1773	0.0232	0.0796	-0.060	**-0.981**	-0.722	03870	0.1194	-0.21	-0.05
Diameter of fruit (cm)	0.308	0.211	0.001	1.271	0.952	0.744	0.289	-0.450	-0.1779	0.1611	-0.128	0.4513	-0.482	1.5138	**2.0553**	-0.289	-0.654	-0.17	0.063
Weight of fruit (g)	0.185	0.046	-0.095	0.263	0.128	0.097	-0.16	0.230	-0.3004	-0.0371	-0.103	-0.023	0.0399	0.2734	0.0977	**-0.693**	0.1086	-0.20	0.267
Number of seeds per fruit	0.304	-0.24	0.0020	0.056	-0.129	-0.241	0.030	0.393	-0.1875	-0.1805	0.0705	-0.001	-0.002	-0.085	-0.224	-0.110	**0.7051**	0.034	-0.04
Number of fruits per plant	-0.517	-0.710	0.844	-0.556	-0.471	-0.449	-0.62	-0.016	-0.4473	-0.1021	0.0805	0.4107	-0.487	-0.245	0.0955	-0.327	-0.052	**-1.09**	-0.16

Residual effect : 0.475

Table-3 *Phenotypic path coefficients showing direct and indirect effects of different characters on fruit yield per plant*

characters	Plant height at 30 DAS	Plant height at 60 DAS	Plant height at 90 DAS	No. of branches per plant at 30 DAS	No. of branches per plant at 60 DAS	No. of branches at 90 DAS	No. of leaves per plant	No. of nodes to first flower	Flowering nodes on main stem	Length of internodes	Days to 50% flowering (days)	Days to first picking (days)	Fruiting span (days)	Length of fruit (cm)	Diameter of fruit (cm)	Weight of fruit (g)	No. of seeds per fruit	No. of fruits per plant	Yield per plant (g)
Plant height at 30 DAS (cm)	**0.1235**	0.0820	0.072	0.0426	0.059	0.0708	0.0389	-0.0125	0.0141	0.0483	-0.055	-0.0660	0.0693	-0.004	0.0144	-0.0158	-0.048	0.032	0.3485
Plant height at 60 DAS (cm)	0.2212	**0.3332**	0.299	0.1207	0.200	0.2135	0.1800	0.0014	-0.0509	0.1224	-0.100	-0.1819	0.1920	0.007	0.0346	0.0067	-0.010	0.131	0.4735
Plant height at 90 DAS (cm)	0.0892	0.1376	**0.153**	0.0525	0.080	0.0854	0.0877	0.0181	-0.0182	0.0427	-0.035	-0.0766	0.0767	0.002	00006	0.0106	0.0037	0.067	0.4309
No. of branches per plant at 30 DAS	-0.0440	-0.0462	-0.043	**-0.1277**	-0.061	-0.0496	-0.0269	0.0035	0.0524	-0.0200	0.021	0.0067	-0.026	-0.017	-0.0307	0.0205	-0.002	0.002	0.1064
No. of branches per plant at 60 DAS	0.0651	0.0815	0.071	0.0652	**0.135**	0.1214	0.0673	-0.0132	-0.0139	0.0350	-0.047	-0.0383	0.0455	0.002	0.0300	-0.0077	-0.007	0.038	0.3152
No. of branches per plant at 90 DAS	-0.041	-0.046	-0.040	-0.0280	-0.064	**-0.0721**	-0.0312	0.0045	0.0055	-0.0230	0.026	0.0259	-0.030	0.003	-0.0076	0.0069	0.0131	-0.019	0.3127
No. of leaves per plant	0.080	0.137	0.146	0.0156	0.126	0.1103	**0.2548**	0.0589	-0.0383	0.0961	-0.055	-0.0428	0.515	0.013	-0.0054	0.0247	0.0075	0.111	0.2822
No. of nodes to first flower	0.012	-0.005	-0.015	0.0035	0.012	0.0079	-0.0294	**-0.127**	0.0451	-0.0170	0.0013	0.0105	0.0023	-0.005	0.0035	0.0259	-0.035	-0.009	-0.186
Flowering nodes on main stem	0.014	-0.019	-0.014	-0.0513	-0.0128	-0.0096	-0.0188	-0.0444	**0.1252**	0.0009	-0.017	-0.0018	-0.010	-0.011	-0.0032	0.0374	-0.027	0.032	0.0139
Length of internodes (cm)	-0.043	-0.041	-0.031	-0.0175	-0.0289	-0.0358	-0.0422	-0.0150	-0.0008	**-0.1120**	0.040	0.0200	-0.022	0.019	0.0024	-0.0100	0.0108	-0.020	0.0989
Days to 50% flowering (days)	-0.018	-0.012	-0.009	-0.0071	-0.0147	-0.0156	-0.0091	-0.0004	-0.0059	-0.0152	**0.042**	0.0220	-0.023	-0.001	0.0006	0.0017	0.0032	0.009	-0.240
Days to first picking (days)	0.031	0.032	0.029	0.0031	0.0165	0.0211	0.0098	0.0048	0.0008	0.0105	-0.030	**-0.0587**	0.047	-0.007	-0.0068	-0.0066	-0.014	0.017	-0.260
Fruiting span (days)	0.036	0.037	0.032	0.0136	0.0217	0.0270	0.0131	-0.0012	-0.0054	0.0130	-0.035	-0.0520	**0.064**	-0.003	-0.0025	-0.045	-0.003	0.014	0.303
Length of fruit (cm)	0.001	-0.001	-0.007	-0.0059	-0.0008	0.0002	-0.0023	-0.0020	0.0042	0.0077	0.001	0.0054	0.002	**-0.04**	-0.0140	0.0033	0.0014	0.001	-0.041
Diameter of fruit (cm)	0.003	0.003	0.001	0.0072	0.0066	0.0032	-0.0006	-0.0083	-0.0008	-0.006	0.004	0.0035	-0.001	0.0095	**0.0299**	-0.0028	-0.009	0.000	0.028
Weight of fruit (g)	-0.020	0.0033	0.011	-0.0262	-0.0092	-0.0157	0.0158	-0.0333	0.0487	-0.014	0.006	0.0184	-0.011	-0.012	-0.0152	**0.1633**	0.0037	0.019	0.194
No. of seeds per fruit	-0.024	-0.0019	0.0015	0.0013	-0.0034	-0.0113	0.0018	0.0173	-0.0138	-0.010	0.0047	0.0015	-0.003	-0.002	-0.0192	0.0014	**0.062**	-0.001	-0.023
No. of fruits per plant	-0.137	-0.2054	-0.230	0.0087	-0.1483	-0.1384	-0.2275	-0.0373	-0.1341	-0.094	-0.105	0.1544	-0.119	0.012	-0.0147	-0.0609	0.0103	**-0.51**	-0.097

Residual effect : 0.729

with days to first picking (-0.26) and days to 50% flowering (-0.24). [4,10,12]

Correlation coefficients are the 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 portioning of the given relationship in its further components. In other words, it take into account not only the relationship of component characters with the dependent characters, but simultaneously takes care of its relationship with other components also. Thus, it helps in understanding the causal system in a better may because it enables partitioning of the total correlation coefficients into direct and indirect effects of various characters.

In the present investigation path coefficient analysis used for characters under study using genotypic and phenotypic coefficient and taking yield per plant as dependable variables, in order to see the causal factor and so as to identify the components which are responsible for producing fruit yield per plant. These results are in close harmony with [12-16]. The characters plant height, diameter of fruit, number of branches per plant at 90 DAS, number of seeds per fruit, days taken to 50% flowering, length of internode and number of flowering nodes on main stem had correlation coefficient value at par with yield per plant and direct selection for these traits would result in higher breeding efficiency for improving fruit yield. Thus, these traits might be reckoned as the most important component traits for fruit yield per plant. Characters like number of branches per plant at 60 DAS exhibited negative direct effect on fruit yield per plant followed by plant height at 60 DAS, number of fruit per plant, length of fruit, number of branches per plant at 30 DAS, weight of fruit, days taken to first picking, number of nodes to first flower, number of leaves per plant and plant height at 30 DAS but were positively associated to it. Similar results have been reported by [10,17]. This indicated that indirect effect was cause of correlation and the indirect causal factors are to be considered simultaneously for selection.

The indirect effect of number of leaves per plant was observed with fruit yield per plant in high magnitude followed by number of branches per plant at 60 DAS, number of branches per plant at 90 DAS, plant height at 60 DAS and plant height at 90 DAS [17].

An overall observation of path coefficient analysis of fruit yield per plant with plant height, diameter of fruit, number of branches per plant at 90 DAS, number of seeds per fruit, days taken to 50% flowering, length of internode and number of flowering nodes on main stem played an important role in determining the fruit yield per plant.

Conclusions

The phenotypic correlation coefficients were higher in magnitude than their corresponding genotypic one, indicating there by strong inherent association between different traits under studied.

Fruit yield per plant was found significantly and positively correlated with plant height at 60 DAS, plant height at 90 DAS, plant height at 30 DAS, number of branches per plant at 60 DAS, number of branches per plant at 90 DAS, fruiting span and number of leaves per plant. However, it showed significant and negative correlation with days to first picking and days to 50% flowering.

Path coefficient analysis of different characters revealed that plant height at 90 DAS had the highest positive direct effect on fruit yield per plant followed by diameter of fruit, number of branches per plant at 90 DAS, number of seeds per fruit, days to 50% flowering, length of internode, number of flowering nodes on main stem and fruiting span. Therefore, selection pressure on these characters may be given due importance for genetic improvement.

Characters like number of branches per plant at 60 DAS exhibited negative direct effect on fruit yield per plant followed by plant height at 60 DAS, number of fruit per plant, length of fruit, number of branches per plant at 30 DAS, weight of fruit, days taken to first picking, number of nodes to first flower, number of leaves per plant and plant height at 30 DAS but were positively correlated to it except length of fruit, number of fruit per plant, days to first picking and number of nodes to first flower. This indicated that the indirect effect was the cause of correlation and the indirect causal factors are to be considered simultaneously for selection.

Fruit yield per plant was found significantly and positively correlated with plant height at 60 DAS, 90 DAS and 30 DAS, number of branches per plant at 60 DAS and 90 DAS, fruiting span and number of leaves per plant. However, significant and negative correlation showed with days to first picking and days to 50% flowering.

High heritability coupled with high genetic advance were recorded for trait plant height at 30 DAS, plant height at 60 DAS and number of seeds per fruit suggested that the prepondance of additive genes.

An overall observation of path coefficient analysis of fruit yield per plant with its components revealed that the characters plant height, diameter of fruit, number of branches per plant at 90 DAS, number of seeds per fruit, days to 50% flowering, length of internode and number of flowering nodes on main stem) played an important role in determining the fruit yield per plant in okra.

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Abbreviations: RCBD: Randomized Complete Block Design

Conflict of Interest: None declared

References

[1] Kumar S., Sharma J.P. and Singh A.K. (2006) *Production technology of okra. Division of Vegetable Science and Floriculture, SKUAST-J, Jammu. Tech. Bull*., No. 04. pp. 1-8.

[2] Kumar N. (2006) *Breeding of Horticultural crops. New India Publicashing Agency, New Delhi*, p 173-177.

[3] Ariyo O.J. (1992a) *Indian J. Agric. Sci.,* 62,83-84.

[4] Chaukhande Pooja, Chaukhande P.B. and Dod V.N. (2011) Correlation and path analysis studies in okra [*Abelmoschus esculentus* L. Moench*]. Abstract of National Symposium on Vegetable Biodiversity,* April 4-5, 2011, Organised by ISVS Vranasi, JNKVV Jabalpur, IIVR Varanasi. pp.30.

[5] Ramanjinappa V., Patil M.G., Hugar P.N.A., Arunkumar K.H. (2011) *Environment and Ecology [Environ. Ecol.].,* 29(2A), pp. 778-782.

[6] Patro T.S. and Ravisankar C. (2004) *Tropical Agricultural Research,* 16, 99-113.

[7] Bhalekar S.G., Nimbalkar C.A. and Desair U.T. (2005) *J. Maharashtra Agric. Univ*., 30 (1), 109-112.

[8] Choudhary A.K. (2006) Genetic behavior of yield and its components in hybrid okra [*Abelmoschus esculentus* L. Monch]. *M.Sc. (Ag.) Thesis,* J.N.K.V.V., Jabalpur.

[9] Gondane S.U., Batia G.L. and Partap P.S. (1995) *Haryana J. Hort. Sci.,* 24 (2), 151-156.

[10] Verma B.K., Naidu A.K. and Bajpai H.K. (2007) *Correlation and path coefficient analysis in okra [Abelmoschus esculentus L. Moench]. Abstract of International Conference on sustainable Agriculture for food. Bio- energy and Livelihood Security,* Feb.14-16, 2007, vol.II:463.

[11] Ghosh J.S. (2005) *Genetic variability and correlation studies in okra. [Abelmoschus esculentus L. Monch]. M.Sc. (Ag.) Thesis, J.N.K.V.V., Jabalpur.*

[12] Magar R. G. and Madrap I. A. (2009) *CAB Abstracts International Journal of Plant Sciences (Muzaffarnagar),* 4(2), 498-501.

[13] Choudhary D.N. and Sharma R.K. (1999) *Haryana J. Hort. Sci.,* 28(3&4), 221-222.

[14] Narayan R.P. and Muldge R. (2004) *Indian. J. Hort.,* 61(3), 232-235.

[15] Sureshbabu K.V., Gopalkrishnan T.R. and Saly K. Mathew (2004) *Abstracts of first Indian* Horticulture *congress, New Delhi*. Pp 85-86.

[16] Pawar S.K. (2005) Genetic analysis of yield and its components in okra [*Abelmoschus esculentus* L. Monch]. *M.Sc. (Ag.) Thesis*, J.N.K.V.V., Jabalpur.

[17] Saifullah M. and Rabbani M.G. (2010) *CAB Abstracts International Journal of Sustainable Agricultural Technology*; 6(4), 10-15.