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Variability, Correlation and Path Coefficient Analysis in Okra (*Abelmoschus esculentus* L. Moench.)

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Abstract

Variability, correlation and path analysis were carried out using different quantitative characters for 17 okra genotypes during *kharif* season of 2007. The estimates of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were found to be higher for plant height and number of branches per plant. The characters viz., plant height, number of branches per plant, number of nodes per plant, internodal length, number of fruits per plant, number of seeds per fruit, harvest index and total yield per plant exhibited high heritability coupled with high genetic advance over mean (GAM). Fruit yield for plant was positively and significantly correlated with plant height, number of nodes per plant, number of fruits per plant and harvest index. Path coefficient analysis revealed that number of fruits per plant had highest direct influence towards fruit yield per plant followed by number of seeds per fruit, average fruit weight, harvest index and number of nodes per plant. Hence, these important traits may be viewed in selection program for the further improvement of okra.

Key words : Variability, Correlation, Path coefficient analysis, Okra, Yield.

Okra (*Abelmoschus esculentus* (L.) Moench.) is commonly known as bhendi or lady's finger in India. It is the choicest fruit vegetable grown extensively in tropical and sub-tropical and warm area of the temperate zones of the world. It is widely cultivated in Uttar Pradesh, Assam, Bihar, Orissa, Maharashtra, West Bengal and Karnataka. Fruit yield in okra depends upon many yield components, since it is a polygenic character. The progress in breeding for the economic characters that are mostly environmentally influenced is determined by the magnitude and nature of their genetic variability. Hence, it is essential to partition the overall variability into its heritability and non-heritable components with the help of genetic parameters like phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV), heritability and genetic advance over mean (GAM). The selection for one trait invariably affects a number of associated characters. The estimation of correlation co-efficient is of greater value to determine the extent and nature of relationship. The knowledge of such inter-relationship among the characters is useful to the breeders for efficiency of selection. The path coefficient analysis provides an effective means of finding out direct and indirect causes of association and permits a critical examination of given correlation and measures the relative importance of each factor. The present investigation was conducted to assess the variability, analysis of association of different characters for yield improvement.

Methods

Seventeen genotypes of okra were grown in a randomized block design with three replications at Department of Horticulture, College of Agriculture, Raichur during *kharif* season in 2007. Suitable cultural practices were followed to obtain good phenotypic expression of 13 quantitative characters. In each replication, 50 plants per genotype were planted. The row to row spacing of 60 cm and plant to plant spacing of 30 cm was adopted. The observations were recorded on five randomly selected plants from each genotype for days to 50% flowering, plant height (cm), number of branches per plant, number of nodes per plant, internodal length (cm), number of fruits per plant, average fruit weight (g), average fruit length (cm),

Table 1. Estimation of phenotypic and genotypic variance, phenotypic and genotypic coefficient of variation, heritability, genetic advance, genetic advance over mean (GAM) for 13 quantitative characters in okra.

	Characters	Range	Mean	Variance PV	Variance GV	Coefficient of variation PCV	Coefficient of variation GCV	Heritability (%)	Genetic advance (GA)	GAM (%)
1	Days to 50% flowering	38.57—44.21	41.84	6.85	2.47	6.25	3.76	36.10	1.95	4.66
2	Plant height (cm)	83.44—177.14	133.44	759.64	713.94	20.95	20.02	93.98	53.35	39.98
3	Number of branches/ plant	1.10—2.93	1.77	0.279	0.246	29.84	28.02	88.17	0.96	54.23
4	Number of nodes/plant	21.47—35.27	26.23	18.44	16.61	16.37	15.32	90.10	7.97	30.38
5	Internodal length	3.40—6.53	5.11	1.03	0.79	19.86	17.39	76.69	1.60	31.31
6	Number of fruits/plant	13.34—25.20	20.21	9.80	8.73	15.48	14.61	89.10	5.74	28.40
7	Fruit weight (g)	11.42—14.91	12.77	1.34	0.9	9.06	7.42	67.16	1.60	12.52
8	Fruit length (cm)	13.31—18.33	15.84	2.49	1.81	9.96	8.49	72.69	2.36	14.89
9	Number of ridges/fruit	5.0—7.33	5.14	0.360	0.299	11.67	10.63	83.05	1.02	19.84
10	Fruit thickness	1.66—2.50	2.05	0.058	0.042	11.74	9.99	72.41	0.36	17.56
11	Number of seeds/fruit	42.97—73.50	59.07	77.49	68.74	14.89	14.03	88.70	16.08	27.22
12	Harvest index	0.41—0.68	0.52	0.0065	0.0058	15.50	14.64	89.23	0.148	28.46
13	Total yield/plant	178.14—293.40	239.27	1239.62	1084.11	14.71	13.76	87.45	63.42	26.50

number of ridges per fruit, fruit thickness (cm), number of seeds per fruit, harvest index and total yield per plant. The coefficient of variation was estimated according to Burton (1) while the heritability in broad sense was calculated following the suggetion of Burton and De Vane (2). The expected genetic advance was calculated by using the formula of Johnson et al. (3). Correlation coefficient and path coefficient analysis were worked out by the method suggested by Panse and Sukhatme (4) and Wright (5) respectively.

Results and Discussion

The results of analysis of variance revealed significant differences among genotypes for all these quantitative characters studied. The mean, range, phenotypic and genotypic coefficient of variation, heritability, genetic advance and genetic advance over mean (GAM) for all the traits are presented in Table 1. In the present investigation least difference was observed between phenotypic coefficient of variation (PCV) and genotypic coefficient variation

Table 2. Simple correlation coefficients of yield with other quantitative characters in okra. **Significant at 1%, *Significant at 5%.

Characters	Days to 50% flowering	Plant height (cm)	No. of branches/ plant	No. of nodes/ plant	Internodal length (cm)	No. of fruits/ plant	Average fruit weight (g)
Days to 50% flowering	1	– 0.102	0.288**	– 0.325**	0.141	– 0.351**	0.086
Plant height (cm)		1	– 0.123	0.616**	0.631**	0.441**	– 0.105
Number of branches/plant			1	– 0.099	0.070	– 0.314**	0.381**
Number of nodes/plant				1	– 0.055	0.558**	– 0.280**
Internodal length					1	– 0.038	0.135
Number of fruits/plant						1	– 0.248*
Average fruit weight (g)							1
Average fruit length (cm)							
Number of ridges/fruit							
Average fruit thickness							
Number of seeds/fruit							
Harvest index							
Total yield/plant							

Table 2. Continued.

Characters	Average fruit length (cm)	No. of ridges/ fruit	Average fruit thick-ness	No. of seeds/ fruit	Harvest index	Total yield/ plant
Days to 50% flowering	– 0.029	0.161	0.105	– 0.117	– 0.206*	– 0.482**
Plant height (cm)	0.098	0.060	– 0.019	0.207*	0.304**	0.254**
Number of branches/plant	0.380**	0.515**	0.353**	– 0.082	– 0.153	– 0.259**
Number of nodes/plant	0.114	– 0.268**	0.147	0.324**	0.530**	0.613**
Internodal length	–0.054	0.329**	– 0.048	– 0.028	– 0.140	– 0.271**
Number of fruits / plant	0.007	– 0.306**	– 0.283**	– 0.249*	0.651**	0.680**
Average fruit weight (g)	0.414**	0.452**	0.196*	– 0.301**	– 0.112	– 0.102
Average fruit length (cm)	1	0.358**	0.063	– 0.028	0.282**	– 0.010
Number of ridges / fruit		1	0.509**	0.045	– 0.285**	– 0.406**
Average fruit thickness			1	0.0665	– 0.199*	– 0.101
Number of seeds / fruit				1	– 0.197*	0.124
Harvest index					1	0.548**
Total yield / plant						1

(GCV) for plant height, number of branches per plant, number of nodes per plant, internodal length, number of fruits per plant, fruit weight, fruit length, number of ridges per fruit, fruit thickness, number of seeds

Table 3. Path coefficient analysis showing direct and indirect effects of 12 quantitative characters in okra. X_1—Days to 50% flowering, X_2—Plant height (cm), X_3—Number of branches per plant, X_4—Number of nodes per plant, X_5—Internodal length, X_6—Number of fruits per plant, X_7—Average fruit weight, X_8—Average fruit length, X_9—Number of ridges per fruit, X_{10}—Average fruit thickness, X_{11}—Number of seeds per fruit, X_{12}—Harvest index, X_{13}—Total yield per plant.

	X_1	X_2	X_3	X_4	X_5	X_6	X_7
X_1	**– 0.1500**	0.0131	0.0026	– 0.0534	– 0.0217	– 0.2224	0.0302
X_2	0.0154	**– 0.1276**	– 0.0011	0.1013	– 0.0969	0.2789	– 0.0370
X_3	– 0.0433	0.0157	**0.0091**	– 0.0164	– 0.0108	– 0.1988	0.1333
X_4	0.0488	– 0.0783	– 0.0009	**0.1643**	0.0086	0.3531	– 0.0980
X_5	–0.0212	– 0.0802	0.0060	– 0.0092	**– 0.1535**	– 0.0246	0.0475
X_6	0.0528	– 0.0561	– 0.0029	0.0918	0.0060	**0.6319**	– 0.0870
X_7	–0.0130	0.0134	0.0035	– 0.0460	– 0.0209	– 0.1571	**0.3498**
X_8	0.0045	– 0.0126	0.0035	0.0188	0.0084	0.0048	0.1450
X_9	– 0.0242	– 0.0077	0.0047	– 0.0441	– 0.0506	– 0.3201	0.1581
X_{10}	– 0.0158	0.0025	0.0032	0.0243	0.0075	– 0.1793	0.0688
X_{11}	0.0176	– 0.0263	– 0.0008	0.0533	0.0043	– 0.1580	– 0.1053
X_{12}	0.0310	– 0.0387	– 0.0014	0.0871	0.0215	0.4115	– 0.0395

Table 3. Continued.

	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}
X_1	0.0070	– 0.0007	0.0024	– 0.0441	– 0.0456	– 0.4525
X_2	– 0.0232	– 0.0003	– 0.0004	0.0777	0.0673	0.2546
X_3	– 0.0891	– 0.0022	0.0081	– 0.0311	– 0.0338	– 0.2592
X_4	– 0.0268	0.0011	0.0034	0.1216	0.1171	0.6139
X_5	0.0128	– 0.0014	– 0.0011	– 0.0105	– 0.0310	– 0.2717
X_6	– 0.0018	0.0022	– 0.0065	– 0.0938	0.1439	0.6805
X_7	– 0.0972	– 0.0019	0.0045	– 0.1129	– 0.0249	– 0.1027
X_8	**– 0.2343**	– 0.0015	0.0015	– 0.0107	0.0623	– 0.0104
X_9	– 0.0840	**– 0.0043**	0.0117	0.0170	– 0.0637	– 0.4070
X_{10}	– 0.0148	– 0.0022	**0.0230**	0.0250	– 0.0441	– 0.1019
X_{11}	0.0067	– 0.0002	0.0015	**0.3751**	– 0.0437	0.1243
X_1	– 0.0661	0.0012	– 0.0046	– 0.0742	**0.2210**	0.5488

per fruit , harvest index and total yield per plant. Thus, indicating phenotypic variability to be reliable measure of genotypic variability. Higher values of PCV and GCV have been obtained for plant height and number of branches per plant. The results obtained are in conformity with the findings of Vishal Kumar et al. (6). Moderate levels of PCV and GCV were obtained for number of nodes per plant, internodal length, number of fruits per plant, number of ridges per fruit, fruit thickness, number of seeds per fruit, harvest index and total yield per plant. However, low values were obtained for days to 50% flowering, fruit weight and fruit length which indicates narrow range of variation for these characters and provides very least scope for selection. Similar findings were reported by Rajani and Manju (7) and Gandhi et al. (8).

The heritability estimates indicate the relative amount of heritable variation. Hence, heritability in broad sense were also calculated. Heritability estimates have been found to be satisfactory tools for selection based on phenotypic performance. In the present investigation, high heritability estimates were obtained for all the characters, except for days to 50% flowering which exhibited moderate heritability (36.10%). The high estimates of heritability for these characters suggested that selection based on phenotypic performance would be more effective. Similar findings were reported by Mahto (9) and Vishal Kumar et al. (6). However, heritability values alone may not provide clear predictability of the breeding value. Heritability in conjugation with genetic advance over mean (GAM) is more effective and reliable in predicting the resultant effect of selection. In the present study, high heritability along with high GAM were observed for plant height, number of branches per plant, number of nodes per plant, internodal length, number of fruits per plant, number of seeds per fruit, harvest index and total yield per plant. These results are in consonance with the earlier results of Patil et al. (10). Other characters like days to 50% flowering, fruit weight, fruit length, number of ridges per fruit and fruit thickness exhibited low to moderate genetic advance over mean.

In any crop improvement program, knowledge on the association of characters is important since it contributes directly to the success of selection. The simple correlation coefficient between yield and yield components are presented in Table 2. Fruit yield per plant exhibited high significant and positive correlation with plant height (0.254), number of nodes per plant (0.613), number of fruits per plant (0.680) and harvest index (0.548). Thus it can be concluded that selection based on these characters will bring about improvement in yield. Similar findings were also reported by Chacko et al. (11) and Vishal Kumar et al. (12). However, the negatively significant association of fruit yield per plant was observed with days to 50% flowering (– 0.482), number branches per plant (–0.259), inter nodal length (–0.271) and number of ridges per fruit (–0.406) indicating the helpful relationship between the attributes. The other characters like average fruit weight, average fruit length and average fruit thickness were negative and non-significantly correlated with this character.

Path coefficient analysis is an important method for estimating the association between traits with cause and effect i.e., the direct and indirect basis of association. The results indicating the direct and indirect effects of traits on fruit yield per plant are presented in Table 3. Number of fruits per plant had the highest positive and direct effect (0.6319) on fruit yield per plant followed by number of seeds per fruit (0.3751), average fruit weight (0.3498), harvest index (0.2210) and number of nodes per plant (0.1643). Whereas, average fruit length had negative and direct effect (–0.2343) on fruit yield per plant followed by internodal length (–0.1535), days to 50% flowering (–0.1500) and plant height (–0.1276). In the present investigation, number of fruits per plant, number of nodes per plant and harvest index exhibited positive correlation and also high direct effect on yield there by indicating true relationship. Thus, it can be concluded that number of fruits per plant, harvest index and number of nodes per plant can be selected to achieve improvement in fruit yield.

From the studies, it can be concluded that plant height, number of branches per plant, number of nodes per plant, number of fruits per plant and harvest index are considered to be important characters for yield improvement in okra.

References

1. Burton G. W. 1952. Quantitative inheritance in grasses. *Proc. 16th Int. Grassland Congr.* 1 : 273—283.
2. Burton G. W. and E. M. De Vane. 1953. Estimation of

heritability in tall fescue (*Festica arundinaceae*) from replicated clonal material. *Agron J.* 45 : 478—481.
3. Johnson H. W., H. F. Robinson and R. E. Comstock. 1955. Estimates of genetic and environmental variability in soybean. *Agron. J.* 47 : 314—318.
4. Panse V. G. and P. V. Sukhatme. 1967. *Statistical methods for agricultural workers.* Ind. Coun. Agric. Res. New Delhi, India.
5. Wright S. 1921. Correlation and causation. *J. Agric. Res.* 20 : 557—587.
6. Vishal Kumar, M. G. Patil, T. B. Allolli, M. K. Naik and R. S. Patil. 2006. Variability studies in okra (*Abelmoschus esculentus* (L.) Moench). *J. Asian Hort.* 2 : 208—210.
7. Rajani B. and P. Manju. 1997. Variability studies in okra (*Abelmoschus esculentus* (L.) Moench.). *South Ind. Hort*. 45 : 61—62.
8. Gandhi H. T., M. D. Yadav and P. A. Navale. 2001. Studies on variability in okra (*Abelmoschus esculentus* (L.) Moench). *J. Maha. Agric. Univ.* 26 : 146—148.
9. Mahto J. L. 1996. Correlation and path coefficient analysis in bhendi *J. Mah. Agric. Univ*. 21 : 337—340.
10. Patil Y. B., B. B. Madalageri, B. D. Biradar and R. M. Hosmani. 1996. Variability studies in okra (*Abelmoschus esculentus* (L.) Moench.). *Karna. J. Agric. Sci.* 9 : 289—293.
11. Chacko R. S., K. V. S. Babu, S. Rajan and S. Krishnan. 1997. Genetic variability in *Abelmoschus caillei* (L.). *J. Trop. Agric*. 37 : 1—4.
12. Vishal Kumar, M. G. Patil, T. B. Allolli, M. K. Naik and R. S. Patil. 2006. Correlation and path analysis studies in okra (*Abelmoschus esculentus* (L.) Moench). *J. Asian Hort*. 2 : 298—300.