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Short Communication

Correlation and multiple regressions studies in okra (*Abelmoschus esculentus* L.)

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Okra (*Abelmoschus esculentus* L.) belongs to the family Malvaceae of the plant kingdom. It is an annual herbaceous vegetable crop that is grown for its tender fruits often consumed as vegetable. It is considered an important vegetable throughout the tropical and subtropical region of Africa and Asia (Ashati *et. al.,* 1995). Immature okra fruits contain 3100 calorie energy, 1.8 g protein, 90 mg calcium and 1.0 mg iron. Seed of okra (Pusa Makhmali) had the highest oil content 17.3% which is a nutritious ingredient for cattle feed. It is reported to have good alkaline pH which contributes to its relieving effect in gastrointestinal ulcer by neutralizing digestive acid. Mucilage from okra have been reported to be effective as blood volume expander and has the potential to alleviate renal disease, reduce proteinuria and improve renal function. Therefore the aim of this study is to evaluate the character association of some quantitative traits in cultivated variety of okra for possible improvement in quality of yield and yield components. In addition, an understanding of association between the component characters is essential to judge their rational importance. Multiple linear regression estimates the coefficients of the linear equation, involving one or more independent variables, which best predict the value of the dependent variable.

Field experiment was conducted at Horticulture complex, Department of Horticulture, JNKVV, Jabalpur (MP) during 2012-13 to the study of correlation and multiple regressions among thirty genotypes of okra. The soil of the experimental field was medium black, uniform texture with good drainage and medium to high fertility status. Jabalpur is situated on Kymore Plateau and Satpura hills agro-climatic zone of Madhya Pradesh at 23.910 North latitude, 79.50 East longitudes and on an altitude of 411.78 meters above the mean sea level. The climate of region is typically semi-arid and sub-tropical having extreme winter and summer. Thirty genotypes of okra were grown in a randomized block design (RBD) with three replications; every genotype in each replication was grown in a plot of 3.6 m length and 3.0 m width with a spacing of 60 cm between rows and 30 cm between plants. Randomly ten plants from each plots were taken for recording observation on eighteen characters *viz.* plant height, leaves plant^{-1}, branches plant^{-1}, length of internodes (cm), number of nodes to first flowering, numbers of nodes were counted at the time of first flowering, days taken to 50% flowering, fruiting span, number of fruits plant^{-1}, fruit-length(cm), fruit-diameter (cm), number of ridges on fruit, fruit-weight (g) and yield plant^{-1} (kg) were obtained. The data were statistically analyzed to estimate phenotypic and genotypic correlation.

The magnitude of genotypic correlation was higher than the phenotypic correlation for all the traits that indicated inherent association between various characters. The findings were in agreement to Kumar *et al.* (2009) and Senapati *et al.* (2011). Eighteen yield and its attributing characters presented in Table 1. Fruit yield plant^{-1} recorded highly significant and positive with fruit-length (0.408), fruit-weight (0.401), number of fruits plant^{-1} (0.361), number of leaves plant^{-1} at 120 DAS (0.331), fruit-diameter (0.280), plant-height at 60 DAS (0.217) and number of leaves plant^{-1} at 60 DAS (0.209). However, significantly negative association was recorded with days to 50 per cent flowering (-0.236) and nodes to first flowering (-0.228). Association of plant-height at 120 DAS was recorded significant and positive with number of leaves plant^{-1} at 90 DAS (0.703) and also at 60 DAS (0.415), number of branches plant^{-1} (0.385), number of leaves plant^{-1} at 120 DAS (0.376), number of fruits plant^{-1} (0.320) and fruit diameter (0.229). Correlation coefficient of number of leaves plant^{-1} at 120 DAS was exhibited significant and positive with number of fruits plant^{-1} (0.962) and fruit yield plant^{-1} (0.331), while it

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was found significant and negative with fruit weight (-0.213) and nodes to first flowering (-0.236). Number of branches plant^{-1} expressed significant and positive correlation with fruit diameter (0.352), fruiting span (0.278) and nodes to first flowering (0.212). Association of internodal length was recorded significant and positive with fruit weight (0.219). Association of nodes to first flowering was recorded significant and positive with fruiting-span (0.308), fruit-diameter (0.270) and fruit-weight (0.260), while it was found significant and negative with number of fruits plant^{-1} (-0.491) and fruit yield plant^{-1} (-0.228). Days to 50 per cent flowering was recorded highly significant and negative association with fruiting span (-0.792) and fruit yield plant^{-1} (-0.236). Correlation coefficient of fruiting span showed significant and positive with fruit diameter (0.452) and fruit weight (0.357). The correlation coefficient of number of fruits plant^{-1} was found to be significant and positive correlation with fruit yield plant^{-1} (0.361). However, association was recorded to negative and significant with fruit weight (-0.263). Fruit length expressed significant and positive correlation with fruit yield plant^{-1} (0.408), fruit weight (0.305) and fruit diameter (0.224). Fruit diameter expressed a highly significant and positive correlation coefficient with fruit yield plant^{-1} (0.280) and fruit weight (0.276). Fruit weight expressed with highly significant and positively associated with fruit yield plant^{-1} (0.401). These findings were similar to the earlier findings of Chaukhande *et al.* (2011) for plant-height; Choudhary (2006) and Nagre *et al.* (2011) for number of fruits plant^{-1}, fruit length, fruit weight and plant-height; Duzyaman *et al.* (2003) for pod-weight, diameter and early flowering; Patro and Ravishankar (2004) for fruit length and fruit weight; Bhalekar *et al.* (2005), Chaukhande *et al.* (2011) and Senapati *et al.* (2011) for number of fruits plant^{-1}, fruit length; Akinyele and Osekita (2006) for number of fruits plant-^{1}, fruit weight and plant height; Choudhary (2006) for fruit length, fruit weight and fruit diameter. Jaiprakash Narayan and Mulge (2004) recorded negative association for nodes to first flowering. Verma *et al.* (2007) for days to 50 per cent flowering; Shazia Ali *et al.* (2008) for fruit diameter and plant height, Sharma and Prasad (2010) for number of fruits plant^{-1}.

Multiple regression equation involving various traits combinations were prepared to estimate relative contribution of these traits to express the total variation in fruit yield plant^{-1}. The relative contribution to fruit yield was maximum 92.77 % when plant height (X_1), number of leaves plant^{-1} (X_2), days to first flowering (X_3), days to 50 per cent flowering (X_4), number of

Table 1: Estimates of genotypic (G) and phenotypic (P) correlation coefficient among yield and its contributing characters in Okra.

Characters	G/P	Plant height 60 DAS	Plant height 90 DAS	Plant height 120 DAS	Leaves /plant 30 DAS	Leaves /plant 60 DAS	Leaves /plant 90 DAS	Leaves /plant 120 DAS	Branches /plant	Inter nodal length (cm)	Nodes to first flowering	Days to 50% flowering	Fruit span	No. of fruits/ plant	Fruit length (cm)	Fruit diameter (mm)	Fruits weight (g)	Fruits yield/ plant (g)
Plant height 30 DAS	G	-0.011	0.171	0.170	0.101	0.005	0.317	-0.181	0.698	0.268	0.551	-0.581	0.484	-0.265	0.184	0.622	0.301	-0.272
	P	0.031	0.030	0.020	0.199	0.033	0.140	-0.233*	0.373**	0.105	0.255*	-0.156	0.219*	-0.280**	0.013	0.280**	0.306**	-0.150
Plant height 60 DAS	G	1.000	0.783	0.676	-0.052	0.687	0.776	0.657	0.274	0.407	0.282	-0.202	0.438	0.535	-0.251	0.348	-0.022	0.360
	P	1.0	0.542**	0.462**	-0.016	0.935**	0.520**	0.352**	0.244*	0.122	0.150	-0.149	0.317**	0.273**	-0.046	0.190	0.008	0.217*
Plant height 90 DAS	G		1.0	0.954	-0.415	0.783	0.943	0.616	0.520	0.290	0.156	0.034	0.225	0.522	0.216	0.316	0.009	-0.045
	P		1.0	0.913**	-0.028	0.458**	0.736**	0.409**	0.261*	0.227*	0.130	-0.052	0.193	0.330**	0.082	0.220*	-0.040	-0.042
Plant height 120 DAS	G			1.0	-0.448	0.674	0.854	0.489	0.582	0.199	0.085	0.091	0.157	0.421	0.294	0.313	0.120	-0.046
	P			1.0	-0.120	0.415**	0.703**	0.376**	0.385**	0.176	0.060	-0.015	0.165	0.320**	0.155	0.229*	0.017	-0.043
Leaves /plant 30 DAS	G				1.0	-0.001	-0.707	-0.471	0.568	-0.219	0.935	0.228	0.167	-0.597	0.007	0.464	0.076	-0.194
	P				1.0	-0.001	-0.011	-0.117	0.131	-0.056	0.342**	0.091	0.032	-0.200	0.012	0.174	0.018	-0.051
Leaves /plant 60 DAS	G					1.0	0.771	0.632	0.323	0.353	0.338	-0.094	0.406	0.502	-0.257	0.385	-0.054	0.372
	P					1.0	0.475**	0.358**	0.270*	0.118	0.096	-0.129	0.296**	0.294**	-0.059	0.239*	-0.008	0.209*
Leaves /plant 90 DAS	G						1.0	0.559	0.481	0.139	0.109	-0.352	0.482	0.479	-0.053	0.325	0.084	0.122
	P						1.0	0.494**	0.321**	0.106	0.029	-0.229*	0.364**	0.435**	-0.079	0.211*	-0.010	0.039
Leaves/plant 120 DAS	G							1.0	0.049	0.062	-0.488	-0.118	0.171	0.986	-0.231	-0.044	-0.177	0.489
	P							1.0	0.002	0.083	-0.236*	-0.061	0.145	0.962**	-0.152	-0.030	-0.213*	0.331**
Branches /plant	G								1.0	-0.021	0.378	-0.032	0.391	-0.026	-0.017	0.421	0.233	-0.035
	P								1.0	-0.054	0.212*	-0.022	0.278**	-0.057	0.077	0.352**	0.138	-0.010
Inter nodal length (cm)	G									1.0	0.420	0.200	-0.201	-0.023	0.037	0.045	0.364	-0.063
	P									1.0	0.091	0.165	-0.150	0.049	0.042	0.099	0.219*	-0.007
Nodes to 1st flowering	G										1.0	-0.156	0.550	-0.624	0.333	0.723	0.503	-0.586
	P										1.0	-0.110	0.308**	-0.491**	-0.024	0.270*	0.260*	-0.228*
Days to 50% flowering	G											1.0	-0.825	-0.076	0.879	-0.133	-0.300	-0.318
	P											1.0	-0.792**	-0.023	0.189	-0.179	-0.187	-0.236*
Fruit span	G												1.0	0.049	-0.177	0.543	0.477	0.182
	P												1.0	0.044	-0.167	0.452**	0.357**	0.182
No. of fruits/ plant	G													1.0	-0.269	-0.175	-0.253	0.548
	P													1.0	-0.129	-0.103	-0.263*	0.361**
Fruit length (cm)	G														1.0	0.432	0.198	0.123
	P														1.0	0.224*	0.305**	0.408**
Fruit diameter (mm)	G															1.0	0.473	0.172
	P															1.0	0.276**	0.280**
Fruits weight (g)	G																1.0	0.015
	P																1.0	0.401**

*Significant at 5% probability level, ** Significant at 1% probability level fruits plant^{-1} (X5), fruit length (x_6) and fruit diameter (X_7) were taken together to construct regression equation. When six characters *viz.,* number of leaves plant^{-1} coupled with days to first flowering, days to 50 per cent flowering, number of fruits plant^{-1}, fruit length and fruit diameter are involve in combination and recorded 92.69 % variability in fruit yield per plant. Among five character combinations, i.e. number of leaves plant^{-1} coupled with days to first flowering, days to 50 per cent flowering, number of fruits plant^{-1} and fruit diameter which expressed 91.57% variability, four character combinations such as plant height, number of leaves plant^{-1}, days to first flowering and number of fruits plant^{-1} (80.94%), while three character combinations *viz.,* number of leaves plant^{-1} coupled with days to first flowering, days to 50 per cent flowering and number of fruits plant^{-1} which expressed (90.08%) of variability in fruit yield plant^{-1}. However, the traits i.e. days to 50 per cent flowering (47.64 %) followed by fruit diameter (37.89 %) were important when considered alone to express variation in yield. The combination of these two characters *viz.,* number of leaves plant^{-1} and number of fruits plant^{-1} among two characters combination group had the most efficient prediction power (63.73%). Addition of days to first flowering to this combination resulted in relative contribution of 86.05 per cent which were maximum among three characters combination group. It is clear that number of leaves plant^{-1} and number of fruits plant^{-1} were the most patent characters in explaining the variation in fruit yield. Fruit weight had erratic behaviour and could not contribute to yield when considered alone or in combination with other characters. These characters have negative correlation with fruit yield plant^{-1}. Days to 50 per cent flowering and fruit diameter was the most prominent characters in expressing variability in fruit yield. This can be supported by visualizing the multiple regression equation which indicated that whenever days to 50 per cent flowering and fruit diameter were included in the equation, it resulted in increased value of coefficient of determination. These findings are in agreement with the findings of Asati *et al.* (1995) reported that 1000 seed weight, number of leaves plant^{-1} and plant height were important parameters. These parameters contributed 96% to the seed yield in onion. Duzyaman (2006) revealed that number of days to flowering (r=- 0.89), first flowering node (r=-0.84), proportion of generative nodes translated into fruits (r=0.80)] explained 85% of the variation. Adeniji and Aremu (2007) reported that the stepwise multiple regression analysis identified two characters (height at maturity and number of pods plant^{-1}) to have accounted for 31% of variation.

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