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Correlation coefficient analysis for yield attributes in okra (*Abelmoschus esculentus*) using line × tester analysis

AAKANSHA GOSWAMI[1], ANUBHUTI SHARMA[2] and B SINGH[3]

Indian Agricultural Research Institute, New Delhi 110 012

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ABSTRACT

The present experiment on okra [*Abelmoschus esculenta* (L.) Moench] was conducted with 20 parents in 17 x 3 line × tester design. The experiment trial was conducted at Horticulture Research Centre, Department of Horticulture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, to study the correlation of that among various agronomic and economic traits for the purpose of genetic improvement and their effect in the population. The highest positive and significant genotypic and phenotypic correlation observed for green fruit yield with number of fruits per plant in parents, F_1s and F_2s generations. Positive and significant correlation in parents F_1s observed for green fruit yield with plant height, length of first fruiting nodes, number of fruits per plant, width of fruits and number of branches per plant whereas in F_2 generation the correlation for green fruit yield was positive significant with days to flowering, plant height, number of fruits per plant and length of fruits etc.

Key words: Okra, Genotypic correlation, Phenotypic correlation, Line × testers.

Okra *(Abelmoschus esculentus* (L.) Moench), is grown for its tender fruits in tropics, subtropics and warmer parts of temperate region, belongs to Malvaceae family. India is the largest producer of okra covering an area of 3.6 lakh ha with an annual production of 34.2 lakh tonnes (Anon. 2004). The states Uttar Pradesh, Asom, Bihar, Odisha, Maharashtra, West Bengal and Karnataka are the major producers of okra. Correlation coefficient analysis measures the mutual relationship among various plant characters and determines the component characters on which selection can be based for improvement in yield. The magnitude and direction of association is measured by correlation coefficients. The estimation of correlation coefficients indicates only the extent and nature of association between yield and its components. As more variables are considered in correlation, their indirect associations become more complicated, less obvious and somewhat perplexing. At this point, produce a given correlation and also measure the relative importance of each casual factor. Therefore, the knowledge of correlated components on yield is of prime importance to select high yielding genotypes (Jagan K. *et al*. 2012, Simon S.Y. *et al.* 2013, Reddy *et al.* 2013, Dhankhar *et al*. 2012). Keeping the export potential of the crop in view, it is imperative to develop the genetically improved population and better utilization of the same in the production of high yield cultivars of okra, hence the present research study was conducted.

[1] Ph D Scholar (e mail: goswami.aakansha14@gmail.com), Department of Bioscience & Biotechnology, Banasthali University, Rajasthan; [2] Assistant Professor (e mail: sharmaanubhuti@yahoo.com), Department of Bioscience & Biotechnology, Banasthali University, Rajasthan; Present address: Senior Scientist, Division of Biochemistry, VPKAS, Almora; [3] Associate Professor (e mail: drbijendrasingh66@gmail.com), Department of Horticulture, SVP University of Agriculture & Technology, Meerut, (UP)

MATERIALS AND METHODS

The materials for the present investigation comprised twenty genotypes (17 Line × 3 Tester) of okra, viz. IC-218872, IC-306053, IC-11527, EC-169367, SC-108, VRO-5, C-7801, BO-2, VRO-3, KS-312, IIHR-4, IC-69302, SKY/TD/RS-113, FB-10, Azad Bhindi – 2, VRO-1668, VRO-238, Parbhani Kranti (PK), Azad bhindi -1 (AB-1), Azad Krishna (AK) were collected from Indian Institute of Vegetable Research, Varanasi (UP). The collected germplasm maintained at Horticulture Research Centre, Department of Horticulture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Modipuram, Meerut, for agronomic practices to keep the crop in good condition. All the homozygous parents were sown during the *kharif* 2011. All the possible 51 F_1 crosses, excluding reciprocals were made among these twenty parents, for building up of the F_2 population of these F_1 crosses. All the 51 F_1s were sown during the next *zaid* 2012. All these F_1s were selfed to procure the F_2 seeds. The parents were maintained by selfing. All the 51 F_1 and 51 F_2 seeds were sown along with twenty parents in the three replications with spacing of 50 cm × 50 cm. Parents were sown in

double rows while F_1s and F_2s in five rows, with ten plants in each row and the length of the rows were of 5 m. The observations were recorded on randomly selected five plants in each parent and F_1 and ten plants in each F_2 populations from each replication. The selected plants were tagged and properly labeled before flowering for recording the observations, viz. days to flowering, plant height (cm), number of branches per plant, length of first fruiting node (cm), length of fruit (cm), width of fruit (cm), number of fruits per plant and yield per plant (g). The data was subjected to Line × Tester analysis and formulate on for calculation of the genotypic and phenotypic coefficient of correlation were worked out as suggested by Robinson *et al.* (1951).

a) Genotypic correlation r_{xy} (g) = $\frac{Cov._{xy}(g)}{[V_x(g).\ V_y(g)]^{0.5}}$

$Cov._{xy}$ (g) = Genotypic covariance between characters × and y, and this was computed as follows, $Cov._{xy}$ (g) = [($Cov._{xy}$ (p) - $Cov._{xy}$ (e)]/r, V_x(g) V_y (g) = Genotypic variance for the characters x and y respectively, r = number of replication

b) Phenotypic correlation r_{xy} (p) = $\frac{Cov._{xy}(p)}{[V_x(p).\ V_y(p)]^{0.5}}$

Where, $Cov._{xy}$ (p) = Phenotypic covariance between characters × and y and this computed as follows:

$Cov._{xy}$(p) = $Cov._{xy}$(g) + $Cov._{xy}$(e)

V_x(p) and V_y (p) = Phenotypic variance for the characters × and y, respectively; V_{xy}(e) = The error variance for character × and y respectively.

RESULTS AND DISCUSSION

Phenotypic and genotypic correlation coefficients among the characters were worked out in parent (Table 1), F_1s hybrid (Table 2) and F_2 population (Table 3) which are described as follow. In general, the magnitude of coefficients for genotypic correlation coefficient was higher than those of phenotypic correlation coefficients.

Genotypic correlation

In parents - The positive significant correlation was observed for green fruits yield per plant with number of fruits per plant (0.462), green fruits yield per plant also had significant positive association with number of nodes per plant (0.382), positive significant association was observed for number of fruits per plant with number of branches per plant (0.366), and number first fruiting node (0.708), width of fruit with plant height (0.472), number of first fruting node (0.504), length of first fruiting node (0.574) and length of internode (0.354), the length of fruits with plant height (0.597), length of first fruiting node (0.294) and length of internode (0.293), the length of internode with plant height (0.524), the number of node per plant with days to flowering (0.304). While, significant negative association was observed between days to flowering with length of first fruiting nodes (-0.346), length of internode (-0.320), number of fruits per plant (-0.357) and yield per plant (-0.494). The positive correlation was observed for green fruits yield per plant with plant height (0.264), length of first fruiting node (0.044), length of internode (0.251), length of fruits (0.028) and with width of fruits (0.003). Positive correlation observed in number of fruits per plant with plant height (0.217), length of first fruiting node (0.044), length of internode (0.171), length of fruits (0.134) and with width of fruits (0.137). Positive correlation observed in width of fruits with days to flowering (0.050), number of branches per plant (0.141) and with length of fruits (0.238). Positive correlation observed in length of fruits with days to flowering (0.210) and with number of node per plant (0.079), length of internode with number of nodes per plant (0.123) and with length of first fruiting node (0.115), length of first fruiting node with plant height (0.227) and with number of nodes per plant (0.142), number of nodes per plant with plant height (0.309), number of branches per plant with plant height (0.005) and plant height with days to flowering (0.052).

In F_1s hybrids – The positive and significant correlation was observed for green fruits yield per plant with number of fruits per plant (0.385). Green fruits yield per plant also had significant positive association with number of nodes per plant (0.135), green fruits yield per plant with length of first fruiting node (0.535), yield per plant with length of internode (0.288). The positive correlation was observed in green fruits yield per plant with plant height (0.299) and with length of fruit (0.045), number of fruits per plant with number of branches per plant (0.351), number of nodes per plant (0.186), length of first fruiting node (0.181), length of internode (0.344) and with length of fruit (0.105), width of fruit with days to flowering (0.144), number of branches per plant (0.264) and with length of fruit (0.221), length of fruit with plant height (0.064), number of branches per plant (0.238) and with length of first fruiting node (0.052),

Table 1 Genotypic and Phenotypic Correlation coefficients of parents among the characters under study in okra

Characters		Days to flowering	Plant height (cm)	Number of branches/ plant	Number of node/ plant	Length of first fruiting node (cm)	Length of internode (cm)	Length of fruits (cm)	Width of fruits (cm)	Number of fruits/ plant	Yield/ plants (g)
Days to flowering	G	1.000	0.052	0.304*	-0.166	-0.346*	-0.320*	0.210	0.050	-0.357**	-0.494**
	P	1.000	0.043	0.277	-0.146	-0.328*	-0.278	0.180	0.038	-0.322**	-0.454**
Plant height (cm)	G		1.000	0.005	0.309	0.227	0.524**	0.597**	0.472**	0.217	0.264
	P		1.000	0.005	0.295	0.215	0.469**	0.543**	0.407**	0.213	0.261
No. branches/plant	G			1.000	0.416*	-0.192	-0.266	-0.102	0.141	0.366**	-0.163
	P			1.000	0.277	-0.100	-0.172	-0.049	0.028	0.270	-0.111
No. of first fruiting node	G				1.000	0.142	0.123	0.079	0.504**	0.708**	0.382**
	P				1.000	0.134	0.146	0.114	0.445**	0.675**	0.367**
Length of Ist fruiting node	G					1.000	0.115	0.294*	0.574**	0.044	0.044
	P					1.000	0.080	0.297*	0.486**	0.049	0.046
Length of internode	G						1.000	0.293*	0.354**	0.171	0.251
	P						1.000	0.192	0.308*	0.144	0.226
Length of fruits	G							1.000	0.238	0.134	0.028
	P							1.000	0.187	0.120	0.027
Width of fruits	G								1.000	0.137	0.003
	P								1.000	0.107	0.002
No. of fruits/plant	G									1.000	0.462**
	P									1.000	0.453**
Yield/plants (g)	G										1.000
	P										1.000

length of internode with number of branches per plant (0.026), number of nodes per plant (0.332) and with length of first fruiting node (0.138), length of first fruiting node with plant height (0.092), number of branches per plant (0.139) and with number of nodes per plant (0.290), number of nodes per plant with plant height (0.031) and with number of branches per plant (0.276), number of branches per plant with days to flowering (0.128), plant height with days to flowering (0.090).

In F_2 population – The positive and significant correlation was observed for green fruits yield per plant with number of fruits per plant (0.356). Green fruits yield plant also had significant positive association with number of nodes per plant (0.122), green fruits yield per plant with length of first fruiting node (0.089), green fruits yield per plant with length of internode (0.441) and width of fruits with length of fruits (0.345). The positive correlation was observed in F_2s population for green fruits yield per plant with days to flowering (0.102), plant height (0.215), number of branches per plant (0.180), length of first fruiting node (0.089) and with width of fruit (0.152), number of fruits per plant with days to flowering (0.058), plant height (0.272), number of branches per plant (0.161), length of first fruiting node (0.174), length of internode (0.261) and with width of fruit (0.070), width of fruits with days to flowering (0.012), plant height (0.125), number of branches per plant (0.203), number of nodes per plant (0.048) and with length of internode (0.013), length of fruits with number of branches per plant (0.174), length of internode with days to flowering (0.216), plant height (0.135) and with length of first fruiting node (0.082), length of first fruiting node with plant height (0.103) and with number of branches per plant with (0.050), number of nodes per plant with plant height (0.191), number of branches per plant with days to flowering (0.103).

Phenotypic correlation

In parents - The positive and significant correlation was observed for green fruits yield per plant with number of fruits per plant (0.453), green fruits yield per plant also has significant positive association with number of nodes per plant (0.367). Positive significant association number of fruits per plant with number of nodes per plant (0.675), width of fruits with plant height (0.407), number of nodes per plant (0.445), length of first fruiting node (0.486) and with length of internode, length of fruits with plant height (0.543) and with length of first fruiting node (0.297), length of internodes with plant height (0.469).

Table 2 Genotypic and phenotypic correlation coefficients in F_1s (hybrids) among the characters under study in Okra.

Characters		Days to flowering	Plant height (cm)	Number of branches/ plant	Number of node/ plant	Length of first fruiting node (cm)	Length of internode (cm)	Length of fruits (cm)	Width of fruits (cm)	Number of fruits/ plant	Yield/ plants (g)
Days to flowering	G	1.000	0.090	0.128	-0.144	-0.173	-0.111	-0.044	0.144	-0.027	-0.067
	P	1.000	0.086	0.065	-0.126	-0.164	-0.111	-0.043	0.133	-0.024	-0.069
Plant height (cm)	G		1.000	-0.157	0.031	0.092	-0.046	0.064	-0.057	-0.041	0.299
	P		1.000	-0.095	0.024	0.091	-0.047	0.056	-0.054	-0.041	0.276
No. branches/plant	G			1.000	0.276	0.139	0.026	0.238	0.264	0.351	-0.072
	P			1.000	0.164	0.088	0.010	0.160	0.145	0.201	-0.044
No. of node	G				1.000	0.290	0.332	-0.003	-0.284	0.186	0.135
	P				1.000	0.267	0.293	-0.007	-0.246	0.166	0.119
Length of Ist fruiting node	G					1.000	0.138	0.052	-0.299	0.181	0.535**
	P					1.000	0.114	0.048	-0.293	0.176	0.495**
Length of internode	G						1.000	-0.123	-0.178	0.344	0.288*
	P						1.000	-0.079	-0.164	0.292	0.222
Length of fruits	G							1.000	0.221	0.105	0.045
	P							1.000	0.204	0.098	0.039
Width of fruits	G								1.000	-0.050	-0.443**
	P								1.000	-0.045	-0.393**
No. of fruits/plants	G									1.000	0.385**
	P									1.000	0.357**
Yield/plants (g)	G										1.000
	P										1.000

While, significant negative association was observed between days to flowering with length of first fruiting node (-0.328), length of internode (-0.278), number of fruits per plant (-0.322) and green fruits yield per plant (-0.454). The positive correlation was observed for green fruits yield per plant with plant height (0.261), length of first fruiting node (0.046), length of internode (0.226), length of fruit (0.027) and with width of fruit (0.002). Positive correlation observed in number of fruits per plant with plant height (0.213), number of branches per plant (0.270), length of first fruiting node (0.049), length of internode (0.144), length of fruits (0.120) and with width of fruit (0.107). Positive correlation was observed in width of fruit with days to flowering (0.038), number of branches per plant (0.028) and with length of fruits (0.187). Positive correlation was observed in length of fruits with days to flowering (0.180), number of nodes per plant (0.114) and with length of internodes (0.192), length of internode with number of nodes per plant (0.146) and with length of first fruiting node (0.080), length of first fruiting node with plant height (0.215) and with number of nodes per plant (0.134), number of nodes per plant with plant height (0.295) and with number of branches per plant (0.277), number of branches per plant with days to flowering (0.277) and plant height (0.005), plant height with days to flowering (0.043).

In F_1s hybrids – The positive and significant correlation was observed for green fruits yield per plant with number of fruits per plant (0.357), green fruits per yield plant also has significant positive association with number of node per plant (0.119), green fruits yield per plant with length of first fruiting node (0.495). The positive correlation was observed for green fruit yield per plant with plant height (0.276), length of internode (0.222) and with length of fruits (0.039), number of fruits per plant with number of branches per plant (0.201), number of nodes per plant (0.166), length of first fruiting node (0.176), length of internode (0.292) and with length of fruits (0.098), width of fruits with days to flowering (0.133), number of branches per plant (0.145) and with length of fruit (0.204), length of fruit with plant height (0.056), number of branches per plant (0.160) and with length of first fruiting node (0.048), length of internode with number of branches

Table 3 Genotypic and phenotypic correlation coefficients in F_2s population among the characters under study in okra

Characters		Days to flowering	Plant height (cm)	Number of branches/ plant	Number of node/ plant	Length of first fruiting node (cm)	Length of internode (cm)	Length of fruits (cm)	Width of fruits (cm)	Number of fruits/ plant	Yield/ plants (g)
Days to flowering	G	1.000	-0.247	0.103	-0.305	-0.006	0.216	0.000	0.012	0.058	0.102
	P	1.000	-0.230	0.077	-0.279	-0.003	0.191	-0.004	0.016	0.050	0.095
Plant height (cm)	G			-0.029	0.191	0.103	0.135	-0.072	0.125	0.272	0.215
	P			-0.017	0.184	0.099	0.122	-0.070	0.124	0.257	0.211
No. branches/plant	G			1.000	-0.117	0.050	-0.142	0.174	0.203	0.161	0.180
	P			1.000	-0.094	0.056	-0.090	0.125	0.145	0.133	0.132
No. of node	G				1.000	-0.073	-0.173	-0.137	0.048	-0.044	0.122
	P				1.000	-0.073	-0.144	-0.130	0.046	-0.046	0.117
Length of Ist fruiting node	G					1.000	0.082	-0.127	-0.050	0.174	0.089
	P					1.000	0.076	-0.123	-0.052	0.171	0.084
Length of internode	G						1.000	-0.192	0.013	0.261	0.441**
	P						1.000	-0.157	-0.001	0.233	0.386**
Length of fruits	G							1.000	0.345**	-0.118	-0.267
	P							1.000	0.335**	-0.116	-0.261
Width of fruits	G								1.000	0.070	0.152
	P								1.000	0.064	0.151
No. of fruits/plant	G									1.000	0.356**
	P									1.000	0.339**
Yield/plants (g)	G										1.000
	P										1.000

per plant (0.010), number of nodes per plant (0.293) and with length of first fruiting node (0.114), length of first fruiting node with plant height (0.091), number of branches per plant (0.088) and with number of nodes per plant (0.267), number of nodes per plant with plant height (0.024) and with number of branches per plant (0.164), number of branches per plant with days to flowering (0.065), plant height with days to flowering (0.086).

In F_2 population – The positive and significant correlation was observed for green fruits yield per plant with number of fruits per plant (0.339), green fruits per yield plant also has significant positive association with number of nodes per plant (0.117), green fruit yield per plant with length of internode (0.386) and width of fruits with length of fruits (0.335). While, significant negative association was observed between days to flowering with length of first fruiting node (-0.328), length of internode (-0.278), number of fruits per plant (-0.322) and green fruits yield per plant (-0.454). The positive correlation was observed for green fruits yield per plant with days to flowering (0.095), plant height (0.211), number of branches per plant (0.132), number of nodes per plant (0.117) length of first fruiting node (0.084) and with width of fruit (0.151), number of fruits per plant with days to flowering (0.050), plant height (0.257), number of branches per plant (0.133), length of first fruiting node (0.171), length of internode (0.233) and with width of fruit (0.064), width of fruit with days to flowering (0.016), plant height (0.124), number of branches per plant (0.145) and with number of nodes per plant (0.046), length of fruit with number of branches per plant (0.125), length of internode with days to flowering (0.191), plant height (0.122) and with length of first fruiting node (0.076), length of first fruiting node with plant height (0.099) and with number of branches per plant with (0.056), number of nodes per plant with plant height (0.184), number of branches per plant with days to flowering (0.077).

The knowledge of correlation coefficient between yield and its components may be valuable indicating the components. Where, selection process could profitably be exercised in order to obtain an increase in the yield ability (Grafius 1964, Fisher 1918 and Wright 1921). Understanding of the genotypic correlation coefficient among

characters is also of theoretical interest because of genotypic correlation may derived from genetic linkage, pleiotrophic development induced relationship between components that are only inbreeding the consequence of gene action. In general genotypic correlation coefficient were higher than phenotypic correlations suggesting inherent relationship in different genotypes and to which okra crop is no exception as has been revealed from the present investigation. Similar findings were also reported by Yadav *et al.* (2003), Jagan *et al*. (2012), Simon *et al.* (2013), Reddy *et al.* (2013), Celestin *et al.* (2012).

The green fruit yield per plant had high and positive genotypic correlation with number of nodes per plant in parent, F_1s hybrid and in F_2s population suggested that these characters are the major contributing towards yield in segregating and non-segregating generation. High significant and positive correlation, green fruits yield per plant with length of first fruiting node in F_1s hybrid and F_2 population. In parents positive significant association in number of fruits per plant with number of branches per plant and with number of nodes per plant, width of fruit with plant height, with number of nodes per plant, with length of first fruiting node and with length of internode, length of fruit with plant height, with length of first fruiting node and with length of internode, length of internode with plant height, number of node per plant with number of branches per plant, number of branches per plant with days to flowering. In F_1s hybrid, yield per plants with length of internode and in F_2s population green fruit yield per plant with length of internode and width of fruit with length of fruit. While, significant negative association was observed between days to flowering with length of first fruiting node, with length of internode, with number of fruits per plant and with yield per plant in parents only suggested that the high yielding plant were correlated with these characters in respective generations. Similar findings had also reflected by the result of Reddy *et al.* (2013).

The positive and significant phenotypic correlation was observed for green fruits yield per plant with number of fruits per plant in parents, F_1 hybrid and F_2 population. Green fruit yield per plant also has significant positive association with number of nodes per plant in parent, F_1s hybrid and F_2s population. Green fruits yield per plant with length of first fruiting node in F_1s hybrid. In parents positive significant association in number of fruits per plant with number of nodes per plant, width of fruits with plant height, number of nodes per plant, length of first fruiting node and with length of internode, length of fruit with plant height and with length of first fruiting node, length of internode with plant height. In F_2s population green fruits yield per plant correlated with length of internode and width of fruit with length of fruit. While, significant negative association was observed between days to flowering with length of first fruiting node, length of internode, number of fruit per plant and with green fruits yield per plant. The direction of genotypic and phenotypic correlation was identical in most the cases in F_1 and F_2 population.

CONCLUSION

The green fruit yield per plant had high and positive genotypic correlation with number of nodes per plant in parent, F_1s hybrid and in F_2s population suggested that these characters are the major contributing towards yield in segregating and non-segregating generation. High significant and positive correlation, green fruit yield per plant with length of first fruiting node in F_1s hybrid and F_2 population.

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