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Association studies in single and double cross F_3 populations of okra

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ABSTRACT

The experiment was carried out during *kharif* 2007 and 2008 at Agricultural Research Station, Hanumanamatti. The correlation studies was done for four single and three double cross of F_3 and it revealed highly significant positive association of fruit yield per plant with plant height, number of branches per plant, fruit length, fruit weight, number of seeds per fruit and number of fruits per plant. Path analysis revealed high positive direct effect of number of fruits per plant, fruit weight and number of branches per plant on fruit yield per plant. Therefore, emphasis may be laid on these characters for improving fruit yield per plant.

Key words: Correlation, selection, phenotype, okra.

INTRODUCTION

Bhendi (*Abelmoschus esculentus* (L.) Moench) has captured a prominent position among vegetables. Being native of tropical Africa it is commonly known as okra or lady's finger in India. It is choicest fruit vegetable grown extensively in tropical and subtropical parts of the world. Its tender green fruits are used as a vegetable and are generally marketed in fresh state, but sometimes in canned or dehydrated form. India is the largest producer of okra covering an area of 3.58 lakh ha with an annual production of 35.24 lakh tonnes (Anon, 1). Major areas of cultivation in India are Uttar Pradesh, Bihar, Orissa, West Bengal, Andhra Pradesh, Karnataka and Assam (Anon., 1).

Okra is polyploid having chromosome number 2n = 8x = 72 or 144, belongs to the family Malvaceae. This vegetable is basically a self-pollinated crop, though essentially self-pollinated because of its showy corolla, the possibility of cross-pollination by insects cannot be ruled out. Consequently, cross pollination to the extent of 4.0-19.0 per cent with maximum of 42.2 per cent (Kumar, 6) is noticed with the insect assisted pollination. This accounts for considerable variation in fruit yield and its associated traits. Taking into consideration the remunerative market price and its export value, several varieties are available for cultivation. Besides, National Research Institutes and State Agricultural Universities, the private seed companies are also engaged in releasing high yielding, YVMV resistant and fruit borer tolerant varieties and hybrids.

Before starting any crop improvement programme, it is necessary to assess the existing variability in the initial parental material. On the contrary, it is also important to create the variability through different means, after creating the variability the efficiency of selection depends upon the knowledge on the nature and magnitude of genetic variability. Higher mean accompanied by higher genetic variability affords a scope for selection.

Selection based on multiple traits is always better than selection based on yield alone. As we know that yield is a quantitative character controlled by different characters, therefore, adequate knowledge about the magnitude and degree of association of yield with its attributing characters is of great significance to the breeder, through which breeder can clearly understand the strength of correlated traits, when they have to exercise selection for simultaneous improvement of more than one character. However, correlation alone does not provide information on the contribution of related characters, which necessitates the study of cause and effect of relationship of different characters among themselves. Therefore, the path analysis depicts the exact relationship of characters there by providing more information than correlation.

MATERIALS AND METHODS

The present investigation was carried out during *kharif* 2007 & 2008 at Agricultural Research Station, Hanumanamatti, which is located at 14°39' north latitude, 75°33' east longitude and at altitude of 394.36 m above mean sea level (MSL) in the Northern Transitional Agro-climatic Zone (Zone 8). The experimental material for the present study has developed from base population comprising thirteen potential hybrids. These hybrids were evaluated along

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Table 1. Analysis of variance for different quantitative characters in segregating single and double cross F_3 populations of okra.

Source	Degrees of freedom	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
Replication	2	6.98	34.82	0.03	0.18	2.10	0.004	1.50	90.88	0.011	0.30	429.35
Treatment	6	7.73	133.67*	0.24*	6.47*	9.22*	0.15*	15.94*	78.99*	0.16	18.74*	19035.8*
SEm ±	-	1.71	3.91	0.090	0.69	0.83	0.12	1.27	2.89	0.26	0.82	34.56
CD at 5%	-	5.93	13.53	0.31	2.40	2.87	0.43	4.41	10.02	0.90	2.87	119.62
CD at 1%	-	8.47	20.51	0.47	3.60	4.35	0.65	6.69	15.19	1.37	4.34	191.25

X_1 = Days to first flowering
X_2 = Plant height (cm)
X_3 = Number of branches per plant
X_4 = Internodal length (cm)
X_5 = Fruit length (cm)
X_6 = Fruit diameter
X_7 = Fruit weight (g)
X_8 = Number of seeds per fruit
X_9 = 100-seed weight (g)
X_{10} = Fruits per plant
X_{11} = Fruit yield per plant (g)

* = Significant at 5%

with check mainly for productivity and its component traits during *kharif* 2007 following RBD with plot size of four rows of 5 m length with a spacing of 60 cm x 30 cm observations were recorded on five competitive plants for seventeen characters, *viz.,* days to first; flowering, days to 50 per cent flowering, plant height, number of branches per plant, inter nodal length, stem diameter, number of nodes at first flowering, pedicel length, fruit length, fruit diameter, fruit weight, number of ridges on fruit, number of seeds per plant, 100-seed weight, number of fruits per plant fruit yield per plant and fruit yield per plot. The data was subjected to Mahalanobis (1936) D^2 statistics for assessing the genetic diversity among hybrids. Using this information, the most productive hybrids were selected as base and it was crossed to three other hybrids as distinct single cross hybrid to develop three double cross hybrids. Therefore, three double cross hybrids representing the maximum genetic distance between parental single cross hybrids was ensured. Along with these four single cross hybrids, which were involved in developing double cross hybrids were advanced through filial generations by selfing.

The F_3 populations of four single crosses and three double crosses along with two checks were evaluated in RBD with three replications during *kharif* 2007. The seeds were treated with Captan @ 0.1 per cent before sowing to prevent damping off disease as a precautionary measure which usually prevalent in *kharif* season. All other recommended practice were followed to raise healthy crop. Fifty plants in each single cross and hundred plants in each double cross F_3 populations were randomly selected. These plants were tagged and observations were recorded on days to first flowering, plant height, number of branches per plant, internodal length, fruit length, fruit weight, number of seeds per fruit, fruit diameter, 100-seed weight, number of fruits per plant and fruit yield per plant. Phenotypic correlation coefficient was calculated following procedure of Singh and Chaudhary (15), and path analysis was carried out according to the method of Dewey and Lu (3).

RESULTS AND DISCUSSION

The phenotype of a plant is the result of interaction of large number of factors; therefore, the yield is the sum total effects of several component characters and is polygenetically controlled. The influence of these characters can be known through correlation studies. Correlation coefficient measures the magnitude and direction of association among the characters. Genetic correlation between different characters of plant often arises because of either linkage or pleiotropy. Grafiaus (4) opined that there may not be any gene for yield as such but operates only through its components. Hence, the study of character association through correlation will help in selecting the yield attributes. The association between two characters can be ascertained by phenotypic correlations which is determined from measurements of two characters in a number of individuals of the F_3 population.

In the present investigation phenotypic correlation were studied for fruit yield per plant and its component traits (Table 2). Phenotypic correlation of fruit yield per plant was positive and significant with plant height, number of branches per plant, fruit length, fruit weight, number of seeds per fruit and number of fruits per plant. The results obtained from study are in confirmation with Singh and Singh *(*17), and Nimbalkar *et al.* (11).

Table 2. Phenotypic correlations coefficients for eleven quantitative characters in single and double cross F_3 populations in okra.

Character	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
X_1	1.000										
X_2	-0.729	1.000									
X_3	-0.793	0.862*	1.000								
X_4	0.477	-0.349	-0.460	1.000							
X_5	-0.723	0.746	0.816	-0.608	1.000						
X_6	0.594	-0.684	-0.803	0.315	-0.782	1.000					
X_7	-0.634	0.864*	0.874*	-0.546	0.855*	-0.664	1.000				
X_8	-0.793	0.899*	0.817	-0.608	0.790	-0.623	0.793	1.000			
X_9	-0.916*	0.778	0.758	-0.616	0.750	-0.542	0.744	0.797	1.000		
X_{10}	-0.819	0.875*	0.943**	-0.550	0.890*	-0.764	0.909*	0.858*	0.821	1.000	
X_{11}	-0.750	0.900*	0.922*	-0.550	0.874*	-0.722	0.964**	0.848*	0.804	0.983**	1.000

*, ** = Significant at 5% and 1% levels

X_1 = Days to first flowering
X_2 = Plant height (cm)
X_3 = Number of branches per plant
X_4 = Internodal length (cm)
X_5 = Fruit length (cm)
X_6 = Fruit diameter (cm)
X_7 = Fruit weight (g)
X_8 = Number of seeds per fruit
X_9 = 100 - seed weight (g)
X_{10} = Number of fruits per plant
X_{11} = Fruit yield per plant (g)

The fruit yield per plant was negative but non significant correlation with internodal length, thus suggesting the possibility of identifying and isolating genotypes with shorter internodes and more number of fruiting points. Mishra and Singh (7), and Jeyapandi and Balakrishnan (5) reported similar results.

The inter correlation among the important component characters of yield revealed that number of fruits per plant was significantly associated with plant height, number of branches per plant, fruit length, fruit weight, number of seeds per fruit and fruit yield per plant. (Mishra *et al.*, 9) and number of branches (Mishra *et al.*, 8). Plant height had significant and positive correlation with number of branches per plant, fruit weight, number of seeds per fruit, number of fruits per plant and fruit yield per plant. The number of branches per plant exhibited positive significant association with plant height, fruit weight, number of fruits per plant and fruit yield per plant, fruit length and fruit weight with number of fruits per plant and fruit yield per plant. It is obvious that taller the plant, more will be the number of branches, higher will be number of fruits, thus resulting in higher yield. Thus, yield may be improved considerably through selecting its components characters like number of fruits per plant, fruit weight, plant height and number of branches per plant. Generally consumers prefer medium-sized fruits, hence care should be taken while selecting for fruit characters.

The estimation of correlation coefficient revealed only the relationship between yield and yield components but did not show the direct and indirect effects of different yield components on yield *per se*. The path analysis suggested by Dewey and Lu (3) provides an effective measure of direct and indirect effect on of association and depicts the relative importance of each factor involved in contributing to the final product, *i.e.* yield. Hence, an attempt has been made to know the cause and effect relationship between yield *per se* and its components in four single cross and three double crosses F_3 populations through path coefficient analysis and the results are discussed as follows (Table 3).

The present investigation revealed that plant height, number of branches per plant, fruit weight and number of fruit per plant showed positive direct effect while, days to first flowering, internodes length, fruit length, fruit diameter, number of seeds per fruit and 100 seed weight exerted negative direct effect on fruit yield per plant. These findings are in line with the results obtained by Reddy *et al.* (13) and Shukla and Gautam (16). Hence, considerable improvement may be brought about by selecting genotypes with more number of fruits per plant and higher fruit weight.

Plant height had a positive direct effect on fruit yield per plant. Its indirect effect *via* characters like internoded length, fruit diameter, fruit weight and 100-seed weight was positive. Hence, plant height appears

Table 3. Path coefficient analysis for fruit yield and its component characters in single and double cross, F_3 populations in okra.

Character	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	Correlation with yield
X_1	-0.014	-0.078	0.116	-0.008	0.068	-0.004	-0.250	0.038	0.007	-0.625	-0.750
X_2	-0.010	0.108	-0.126	0.006	-0.070	0.004	0.341	-0.043	-0.006	0.696	0.900*
X_3	-0.011	0.092	0.146	0.008	-0.087	0.005	0.211	-0.089	-0.056	0.703	0.922
X_4	0.007	-0.037	0.067	-0.018	0.057	-0.002	-0.215	0.029	0.005	-0.442	-0.550
X_5	-0.010	0.080	-0.119	0.011	-0.094	0.005	0.337	-0.038	-0.006	0.708	0.874*
X_6	0.008	-0.074	0.117	-0.006	0.073	-0.006	-0.262	0.030	0.004	-0.607	-0.722
X_7	-0.009	0.093	-0.127	0.010	-0.080	0.004	0.394	-0.038	-0.006	0.723	0.964**
X_8	-0.011	0.097	-0.119	0.011	-0.074	0.004	0.313	-0.048	-0.006	0.682	0.848*
X_9	-0.013	0.084	-0.111	0.011	-0.070	0.003	0.293	-0.038	-0.008	0.653	0.804
X_{10}	-0.011	0.094	-0.138	0.010	-0.084	0.005	0.359	-0.041	-0.006	0.795	0.983**

Residual = 0.0006, *, ** = Significant at 5 and 1% levels

X_1 = Days to first flowering
X_2 = Plant height (cm)
X_3 = Number of branches per plant
X_4 = Internodal length (cm)
X_5 = Fruit length (cm)
X_6 = Fruit diameter (cm)
X_7 = Fruit weight (g)
X_8 = Number of seeds per fruit
X_9 = 100-seed weight (g)
X_{10} = Number of fruits per plant

to be most reliable index to get more number of fruits per plant, fruit weight and more number of branches per plant. Similar results were reported by Vijay and Manohar (18).

Number of branches per plant also exerted positive direct effect on fruit yield per plant. Its indirect effect through plant height, internodes length, fruit diameter, fruit weight and number of fruit per plant were positive. Internodes length exerted negative direct effect on fruit yield per plant. Selection for shorter internodes length resulted in increased number of nodes on stem resulting in early fruiting and higher number of fruits per plant ultimately leading to increased yield.

Fruit length also had negative direct effect on fruit yield per plant, in spite its positive significant correlation with yield, because of its indirect effect *via* fruit weight and number of fruits per plant. Similar findings were reported by Vijay and Manohar (18), and Ariyo (2). This demonstrates the defect of selection only on the basis of inter character correlation as such may not produce the desired results. Fruit diameter exhibited negative direct effect on fruit yield per plant and its indirect effects via most of the characters were also low. Similar findings were reported by Shukla and Gautam (16). Fruit weight and number of fruits per plant had high positive direct effect on fruit yield per plant. These results are in agreement with (Mishra and Singh, 7; Reddy *et al.*, 13; Ariyo, 2; Mohanty, 10).

Low residual effect indicated that the selection of traits for path coefficient analysis is appropriate and no characters were neglected. In the present investigation, number of fruits per plant, fruit weight, plant height, number of branches per plant, days to first flowering and inter nodal length were important components characters. They must and should be given weight age, when a plant breeder practice selection.

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