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RESEARCH ARTICLE

Genetic variability studies in okra [*Abelmoschus esculentus* (L.) Moench]

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SUMMARY

The analysis of variance revealed significant differences among the okra collections for all the traits. The estimates on variability parameters indicated considerable range of variation in the germplasm for all the characters studied. Environmental influence was meagre on expression of characters as evident by narrow gap between genotypic and phenotypic co-efficient of variation. The genotypic and phenotypic co-efficients of variations were high for all the characters except days to 50 per cent of flowering and ridges per fruit. A high range of variation, genotypic co-efficient of variation, heritability and genetic advance on per cent mean for plant height, branches per plant, nodes per plants and fruit yield per plant was recorded. This indicated broad genetic base, less environmental influence and these traits are under control of additive genes, simple and early selection schemes would be effective for improvement of these traits. Despite high heritability, the mean of genetic advance was low for days to 50 per cent flowering indicating low variability for this trait.

Key Words : Genetic variability, Okra, Germplasm

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Okra [*Abelmoschus esculentus* (L.) Moench] an annual, often cross pollinated crop belongs to the family Malvaceae; it is an important vegetable crop of the tropics and subtropics of the world. It has found its place in India since time immemorial. Okra is also referred as gumbo, lady's finger and bhendi.

Before starting any crop improvement programme, it is necessary to assess the existing variability present in the parental materials. The efficiency of selection depends upon the knowledge on the nature and magnitude of genetic variability. The extent of the genetic and non-genetic components of variation formulates proper breeding programme to reach the goal. Higher mean accompanied by higher genetic variability affords a scope for selection.

Robinson *et al.,* (1949) emphasized that heritability of the characters is the main concern to the breeder, since it indicates the possibility and extent to which improvement is possible through selection. It has been suggested that habitability together with genetic advance will bring out the genetic gain expected from selection (Johnson *et al.,* 1955).

MATERIALS AND METHODS

The material for the study comprised of 166 collections of okra genotypes. The details of the genotypes used in the present study are given in Table A. Field evaluation of the genotypes was carried out at vegetables section in Department of Horticulture, UAS, GKVK, Bengaluru, during *Kharif* 2008. The observations for the present study were recorded on 11 characters, *viz.*, Yield and its attributing characters such as days to 50 per cent flowering, Plant height (cm), Primary branches per plant, nodes per plant, inter-node length (cm),

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Table A: List of okra collections used in the present study

Sr. No.	Name of variety	Source	Sr. No.	Name of variety	Source
1.	IC 43720	NBPGR	43.	1084	Vibha
2.	IC 39137-A	NBPGR	44.	1018	Vibha
3.	IC 43736	NBPGR	45.	1081	Vibha
4.	IC 43750	NBPGR	46.	1114	Vibha
5.	EC 305619	NBPGR	47.	1108	Vibha
6.	IC 265147	NBPGR	48.	1003	Vibha
7.	IC 069286-Sel-87-1	NBPGR	49.	1089	Vibha
8.	SEL 7	Mahyco	50.	2	Vibha
9.	SEL 13	Mahyco	51.	Parbani Kranti	Parbhani
10.	Mahyco 12- F	Mahyco	52.	Arka Abhay	IIHR
11.	SEL 6	Mahyco	53.	1080	Vibha
12.	SEL 10	Mahyco	54.	Pusa Sawani	IARI
13.	Nunhems -M	Nunhems	55.	Arka Anamika	IIHR
14.	SEL 2	Mahyco	56.	IC 43733	IIHR
15.	SEL 11	Mahyco	57.	IC 69242	IIHR
16.	SEL 8	Mahyco	58.	IC 140915	IIHR
17.	SEL 9	Mahyco	59.	IC 33344	IIHR
18.	Punkaj	Mahyco	60.	PUSA A4	IARI
19.	PB 7	ACRP (VC)	61.	IC 282279	IIHR
20.	Mahyco 112-M	Mahyco	62.	IC 282294	IIHR
21.	SEL 1	Mahyco	63.	EC 329406	IIHR
22.	SEL 4	Mahyco	64.	IC 45800	IIHR
23.	Shagun	Mahyco	65.	IC 28226	IIHR
24.	SEL 16	Mahyco	66.	IC 43746	IIHR
25.	SEL 12	Mahyco	67.	IC 43732	IIHR
26.	SEL 3	Mahyco	68.	IC 69257	IIHR
27.	1111	Vibha	69.	IC 43750	IIHR
28.	1080	Vibha	70.	EC 169362	IIHR
29.	1113	Vibha	71.	IC 69290	IIHR
30.	1119	Vibha	72.	IC 282296	IIHR
31.	1007	Vibha	73.	IC 140906	IIHR
32.	1096	Vibha	74.	IC 282292	IIHR
33.	1002	Vibha	75.	IC 282284	IIHR
34.	1085	Vibha	76.	IC 140910	IIHR
35.	1004	Vibha	77.	IC 218894	IIHR
36.	3	Vibha	78.	IC 282286	IIHR
37.	1117	Vibha	79.	IC 45806	IIHR
38.	1012-1	Vibha	80.	IC 282282	IIHR
39.	1097	Vibha	81.	Hissar Unnath	Hissar
40.	1006	Vibha	82.	IC 140877	IIHR
41.	1114-1	Vibha	83.	IC 140927	IIHR
42.	1008	Vibha	84.	IC 282266	IIHR

Table A: Contd.……

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85.	IC 128885	IIHR	127.	111	Hyderabad
86.	EC 329357	IIHR	128.	114	Hyderabad
87.	IC 282232	IIHR	129.	KA 032	Raichur
88.	IC 128893	IIHR	130.	IC159	IIHR
89.	IC 282277	IIHR	131.	Barka	ACRP (VC)
90.	EC 169337	IIHR	132.	DOV 2	ACRP (VC)
91.	IC 282241	IIHR	133.	PB 266	ACRP (VC)
92.	IC 45814	IIHR	134.	102	Hyderabad
93.	IC 282233	IIHR	135.	Punjab Padmini	PAU
94.	IC 85595	IIHR	137.	KA 079	Raichur
95.	IC 128894	IIHR	138.	INDOL 03	ACRP (VC)
96.	IC 45831	IIHR	139.	HRB55 × HRB-9-2	GKVK
97.	IC 43752	IIHR	140.	KA006 × Punjab Padmini	GKVK
98.	EC 329380	IIHR	141.	Mughal Konda Collection	Raichur
99.	IC 69237-SEL 86	IIHR	142.	DVS 125	ACRP (VC)
100.	IC 282293	IIHR	143.	DSN 1	ACRP (VC)
101.	EC 169378	IIHR	144.	KA006	Raichur
102.	IC 282269	IIHR	145.	Punjab Phalgani	PAU
103.	IC 4792	IIHR	146.	KA 016	Raichur
104.	IC 128873	IIHR	147.	Ujwal Seeds	Raichur
105.	EC 329360	IIHR	148.	PB266 × Arka Abhay	GKVK
106.	IC 218873	IIHR	149.	DOV 1	ACRP (VC)
107.	IC 282289	IIHR	150.	29	Hyderabad
108.	IC 140929	IIHR	151.	DSN 28	ACRP (VC)
109.	IC 128889	IIHR	152.	PB266 × 101	GKVK
110.	IC 218877	IIHR	153.	GS 33	ACRP (VC)
111.	IC 140912	IIHR	154.	HRB 9-2	Hissar
112.	IC 282230	IIHR	155.	HRB 55	Hissar
113.	IC 282229	IIHR	156.	Pusa Sawani × HRB-9-2	GKVK
114.	IC 282231	IIHR	157.	Larma1 × Punjab Padmini	GKVK
115.	KA 035	Raichur	158.	KA 026	Raichur
116.	Arya Dhanalaxmi	ACRP (VC)	159.	KA006 × HRB55	GKVK
117.	Karishma -33152	ACRP (VC)	160.	114 × Larma1	GKVK
118.	DSV 1	ACRP (VC)	161.	Kamini	ACRP (VC)
119.	Larma -1	Raichur	162.	KA 013	Raichur
120.	KA 052	Raichur	163.	P-7	ACRP (VC)
121.	KA 075	Raichur	164.	KA006 × 101	GKVK
122.	Punjab Padmini × Arka Abhay	GKVK	165.	Hosalli Local	Koratagere
123.	AOL- 03-1	ACRP (VC)	166.	Holavanahalli Local	Koratagere
124.	KA 010	Raichur			
125.	106	Hyderabad			
126.	Local Collection	Raichur			

green pods per plant, Fruit length (cm), Fruit diameter (cm), ridges per fruit, Average fruit weight (g) and green fruit yield per plant (g). Observations were made on five randomly selected competitive plants per treatment in each replication for above characters and the mean of these five plants was considered for statistical analysis.

On the basis of observations recorded on five randomly selected plants, the mean for each character was computed. The mean values of all the characters were subjected to analysis of variances for RBD following the method suggested by Panse and Sukhatme, 1967. The co-efficient of variability at both phenotypic and genotypic levels was computed for all the characters by applying the formula as suggested by Burton and De Vane (1953). The broad sense heritability (h^2_{bs}) was estimated by following the procedure as given by Weber and Moorthy (1952). Genetic advance was estimated for each character by applying the formula as suggested by Johnson *et al.* (1955).

RESULTS AND DISCUSSION

The results of the present study as well as relevant discussions have been presented under following sub heads:

Mean performance :

The results of the present investigation on genetic variability indicated the presence of adequate variability among the genotypes studied for all the characters. The analysis of variance (Table1) indicated that differences among the genotypes were found to be significant and substantial for all the characters. Several workers like Bendale *et al.* (2008), Vishal kumar *et al.* (2006) have reported similar results in okra.

Days to 50 per cent flowering showed appreciable variation ranging between 35-46 days. This indicated the availability of genotypes showing 11 days earliness in the collection which can be exploited either by using these lines in recombination breeding or through direct selection. Substantial variation was reported by Vijay and Manohar (1990) for this character. The genotypes KA10, IC128873, Sel 13 and Karishma which were relatively early to flowering could be further exploited in crop improvement programme.

Plant height is one of the important yield attributing characters in okra. Plant height along with nodes per plant, inter-node length and branches per plant determine the geometry of okra plant. Fruit formation in okra takes place at the nodes; hence, short inter-node length with tall plants enhances the fruiting nodes; there by increasing the fruit yield per plant. The wide variation for these characters noticed in the present study provides an opportunity for the breeders to tailor the plant type as per the requirement. A good amount of variation for plant height, inter-node length, nodes per plant was reported by Yadav (1985), Vijay and Manohar (1990), Rao (1996), Mohamed *et al.* (1997) and Panda and Singh (1997). The promising genotypes for higher plant height were IC140929, IC282293, IC4792 and Sel 1.

Considerable amount of variation was noticed for fruit characters such as fruits per plant, fruit length, fruit weight, fruit girth and branches per plant. Reddy *et al.* (1985), Vijay and Manohar (1990), Patil (1995) and Rao (1996) have reported the similar results. The genotypes 1006, 1113, Parbani Kranthi, Sel 1 for fruits per plants; IC43750, Sel 6, IC218877, IC69286-Sel-87 for fruit length; EC329406, 1097, KA079, 1096 for average fruit weight; 1097, 1108, 1096, IC265147 for the trait fruit girth and 1097, IC265147, Hosahalli, IC69286-Sel-87 for the character branches per plant manifested higher performance, this emphasizing their utility in okra improvement.

Fruit yield is the important character. The maximum fruit yield per plant was observed in genotypes namely, KA079 and Parbhani Kranthi. The genotype KA079 needs to be evaluated for its adoption and for stable performance. Fruit yield which ranged from 638.44g per plant to 76.72g (IC85595) per plant. Wide range of variation for this character was reported by Rajni and Manju (1997).

Table 1: Analysis of variance for fruit yield and its attributes in okra.

Sr. No.	Characters	Mean sum of square		
		Replication	Genotypes	Error
1.	Days to 50% flowering	1.99	14.56**	4.45
2.	Plant height (cm)	19757.22	3010.78**	904.57
3.	Primary branches per plant	10.09	1.03**	0.38
4.	Number nodes per plant	943.26	43.31**	19.04
5.	Mean internode length (cm)	29.61	6.87**	2.12
6.	Fruit length (cm)	9.42	4.10**	2.40
7.	Fruit girth (cm)	0.78	1.61**	0.14
8.	Ridges per fruit	0.20	0.29**	0.13
9.	Average fruit weight (g)	22.61	24.74**	8.91
10.	Fruits per plant	24.73	24.39**	7.42
11.	Fruit yield per plant (g)	25475.78	14709.12**	4765.66

*and ** Indicate significance of value at P=0.05 and 0.01, respectively

Genetic variability parameters :

The estimates of variability parameters are presented in Table 2 and Fig. 1. The result on the same are presented character wise. Phenotypic co-efficient of variation (PCV) was higher than genotypic co-efficient of variation (GCV) for all the character under study.there was close correspondence between the estimates of PCV and GCV. This indicated the fact that the environmental influence is very low and hence selection for these characters would be made based on their phenotypic performance. High GCV values for most of the characters reveal the presence of high magnitude of genetic variability in the population studied.

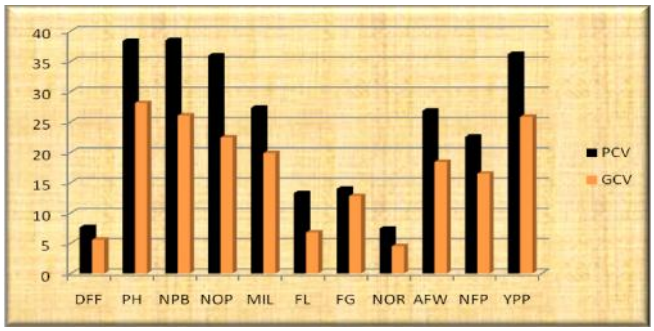

Fig. 1: PCV and GCV for various characters of okra collections per cent mean for collections

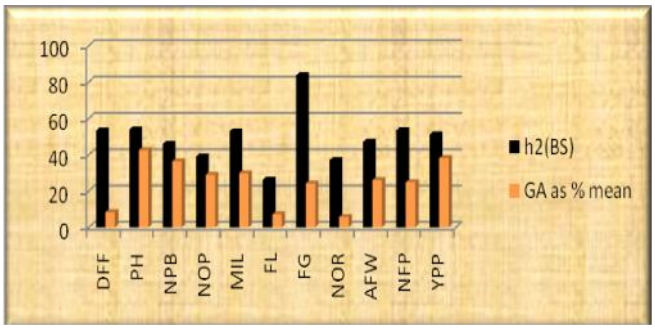

Fig. 2: Heritability and genetic advance as various characters of okra

Greater magnitude of PCV and GCV was observed for plant height, branches per plant, nodes per plant, and fruit yield per plant. Similar findings were reported by Patil *et al.* (1996) for yield per plant, fruits per plant, plant height and branches per plant. High magnitude of PCV and GCV for these characters indicates presence of high degree of variability and better scope for improvement.

Moderately high GCV and PCV for mean inter-node length, fruit length, fruit girth, average fruit weight and fruits per plant, indicates the existence of comparatively high variability which could be exploited for improvement through the selection in advanced generations. These findings are in agreement with results obtained by Patil *et al.* (1996), Vijay and Manohar (1990), Rajani and Manju (1997).

The characters like days to 50 per cent flowering and ridges per fruit registered low GCV and PCV values indicating narrow genetic base for these traits. This is in conformity with the findings of Panda and Singh (1997) and Vijay and Manohar (1990). Improvement in these characters can be brought about by hybridization to widen genetic base and then followed by pedigree selection in advanced generations.

In the present investigation, in general, considerable range of variation for various characters was observed as reported by various author indicating adequacy of germplasm collection in the present study.

Existence of mere variability in population may not serve the whole objective of breeding programme. To exercise an effective selection, it is important to know about the extent of variation that is heritable. Therefore, it is essential to partition the overall variability into its heritable and non-heritable components for predicting the genetic advance, which will enhance the precision of selection.

In the present study, the collections of genotypes consist of established lines or varieties and hence they are all homozygous in nature. Thus, for the prediction of response to selection, it is appropriate to use broad sense heritability

Table 2: Estimates of genetic variability parameters for various characters in okra genotypes

Characters	Mean	Range Min - Max	PCV	GCV	$h^2_{(BS)}$	GA as % mean
Days to 50% flowering	40.34	35.00-46.50	7.64	5.57	53.19	8.37
Plant height (cm)	115.31	38.83- 244.88	38.37	28.14	53.79	42.52
Primary branches per plant	2.19	1.00-4.56	38.5	26.07	45.86	36.37
Number nodes per plant	15.52	6.23-29.20	35.97	22.44	38.93	28.85
Mean internode length (cm)	7.75	3.04- 15.15	27.34	19.86	52.76	29.72
Fruit length (cm)	13.59	9.28-19.48	13.26	6.79	26.19	7.16
Fruit girth (cm)	0.671	5.06-13.25	13.97	12.78	83.72	24.09
Ridges per fruit	6.23	5.26-7.35	7.41	4.51	37.01	5.65
Average fruit weight (g)	15.27	9.59- 38.43	26.86	18.42	47.02	26.02
Fruits per plant	17.68	8.00-31.00	22.56	16.48	53.36	24.79
Fruit yield per plant (g)	272.52	76.72-638.44	36.21	25.87	51.06	38.09

because the entire genotypic value is transmitted to the progeny when any selection is advanced through selfing.

The results of present study also revealed high heritability for fruit girth and genetic advance over per cent of mean for all the characters except days to 50 per cent flowering, fruit length and ridges per fruit. Similar observations were made by Patil *et al.* (1996) and Ariyo *et al.* (1990) for plant height, days to 50 per cent flowering, fruit diameter and yield per plant; Vijay and Manohar (1990) for branches, internodal length and ridges on fruits; Bindu *et al.* (1994) for fruit length, fruit weight and fruits per plants. However, moderate heritability and low genetic advance over per cent of mean was reported for days to 50 per cent flowering by Rajani and Manju (1997). A very high estimate of heritability and genetic advance over the mean for the traits indicate the presence of additive genetic effects and hence selection for these characters in early generation will be most effective.

Presence of moderate heritability and low genetic advance over mean for days to 50 per cent flowering emphasizes the role of non- additive gene effect and hence, selection for this might not be effective.

Based on the present study, it is concluded that, the genotypic and phenotypic co-efficients of variations were high for plant height, branches per plant, nodes per plant and fruit yield per plant. A high range of variation, genotypic co-efficient of variation, heritability and genetic advance on per cent mean for plant height, branches per plant, nodes per plant and average fruit weight was recorded. This indicated broad genetic base, less environmental influence and these traits are under the control of additive genes, simple and early selection schemes would be effective for improvement of these traits.

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