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Genetic Variability, Heritability and Genetic Advance in Okra

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ABSTRACT

The experiment was conducted to estimate the genetic variability in 20 diverse okra germplasm accessions. The variability parameters like mean, range of variation, genotypic and phenotypic coefficient of variation, heritability in broad sense, genetic advance and genetic advance as percentage of mean were estimated for 18 different characters. The values of phenotypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (GCV) for all the characters indicating the influence of environmental factors. The magnitude of heritability was observed to be high for all the characters under study indicated that the larger portion for total variation would be under genetic control and selection based on phenotypic levels would be useful for the improvement of these traits. High estimates of heritability coupled with high genetic advance expressed as percentage of mean were observed for plant height, number of branches per plant, inter nodal length(cm), days to first flowering, days to 50% flowering, days to first harvest, days to last harvest, fruit length(cm), fruit girth(cm), fruit weight(g), number of fruits per plant, number of seeds per fruit, fruit yield per plant(g), 100 seed weight(g), number of picking, crude fiber content(%), iodine content(g), iron content(g). which may be attributed to the preponderance of additive gene action and possess high selective value and thus, selection pressure could profitably be applied on this character for their improvement. The analysis of variance revealed significant difference for eighteen characters studied suggesting considerable amount of variability exists among the genotypes. Wide range of variability was observed for plant height, number of seeds per fruit, iodine content, and fruit yield per plant indicating the scope for selection of suitable initial breeding material for further improvement. In a true agreement with the GCV and PCV values in the present investigation for most of the characters was noticed, indicating additive genetic variance governing the high heritability (>60%) with high genetic advance as per cent of mean was high (>20%) for plant height, number of branches, days to first flowering, days to 50% flowering, days to first harvest, average fruit weight, number of fruits per plant, number of seeds per fruit, number of pickings, 100 seed weight, crude fibre content, iodine content, iron content and fruit yield per plant. Hence there could be exercised for improvement through selection.

Key words: *Genetic advance, GCV, PCV, Heritability.*

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INTRODUCTION

Bhendi (*Abelmoschus esculentus* (L.) Moench) is one of the important tropical vegetables commonly known as Okra in India. It is the most ancient and traditional vegetable crop grown in tropical and sub-tropical low land regions of Asia, Africa, America and warmer parts of Mediterranean regions. Okra is one of the important members of Malvaceae family having higher chromosome number of 2n=130 and polyploidy in nature. The family Malvaceae consists of about 34 *Abelmoschus* species, including 30 species in the Old World and four in the New World (*Joshi et al.*, 1974). The species *A. tuberculatus*, a wild type is native to India. The cultivated species *A. esculentus*is *believed* to be originated in the Hindustani centre, *i.e.*, India according to the taxonomic classification of Zeven and Zhukovsky[38].

The tender fruit of bhendi has good nutritional value, and 100g edible portion of bhendi fruit contains 2g protein, 1g fibre, 7g carbohydrates, 16 mg ascorbic acid, and 99mg/100g iodine, 35mg/100g iron and has an energy value of 145 kJ/100 g[31]. It serves as a source of vitamins, minerals and calcium (70-90 mg/100 g) in the diet Effing *et al.*[10], Guddadamath *et al.*[13]. It is reported to have alkaline pH which contributes to its relieving effect in gastrointestinal ulcer by neutralizing digestive acid[36]. 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[30]. Being an often cross pollinated crop, okra is heterozygous in constitution. In spite of its adoption for self-pollination, out crossing ranges from 11.80 to 60.00 per cent[23], which renders a considerable amount of genetic diversity. Genetic variability is an important factor for any heritable improvement. A systematic study on the extent of variation in the native germplasm is highly warranted, since knowledge of genetic variability, its nature and degree is useful for selecting a desirable genotype from germplasm.Wide variability that exists in the available germplasm offers ample scope for improvement through selection and further breeding programme.

Heritability is the portion of genotypic variance to phenotypic variance, which indicates the relative success of selection. It is useful in selection of elite genotype from diverse genetic population. Heritability is that portion of variation transmitted from parent to offspring. Higher the heritable variation greater will be the possibility of fixing the characters by selection. Hence, studies on heritability are of more important to be analyzed, whether the observed variation for a trait is heritable or not. Planning and execution of a breeding program for the improvement of quantitative attributes depends, to a great extent, upon the genetic magnitude of genetic variability. The genotypic and phenotypic coefficient variation are helpful in exploring the nature of variability in the breeding population whereas, the estimate of heritability provides index of transmissibility of characters.

Co-efficient of variation is useful in the assessment of genetic variability for the particular character. Heritability denotes the proportion of phenotypic variation due to genotypes thus help the breeders to select the elite variety for a character. Genetic advance denotes the improvement in the mean genotypic values of selected families over base population and thus helps the breeder to select the progenies in the earlier generation itself[33]. Keeping in view, different variability parameters like mean, range of variation, genotypic and phenotypic coefficient of variation, heritability in broad sense, genetic advance and genetic advance as percentage of mean were estimated for 18 different characters for 20 diverse okra germplasm accessions.

MATERIAL AND METHODS

The present investigation was conducted to measure the different variability parameters like mean, range of variation, genotypic and phenotypic coefficient of variation, heritability in broad sense, genetic advance and genetic advance as percentage of mean using 20

diverse germplasm accessions in okra. The experiment was laid- out in a Randomized Block Design with two replications at the Vegetable Research farm. The field experiment was carried out at Horticulture Research Scheme (Vegetable) and Department of Horticulture, College of Agriculture, VNMKV, Parbhani, during the *Kharif* season, 2016-17. The observations were recorded for 18 different characters, *viz*., plant height, number of branches per plant, inter nodal length(cm), days to first flowering, days to 50% flowering, days to first harvest, days to last harvest, fruit length(cm), fruit girth(cm), fruit weight(g), number of fruits per plant, number of seeds per fruit, fruit yield per plant(g), 100 seed weight(g), number of picking, crude fiber content(%), iodine content(g), iron content(g). The analysis of variance as suggested by Panse and Sukhatme[25]. The significance was tested against the 'F' value by referring to the statistical and mathematical tables given by Snedecor and Cochran[35]. Phenotypic and genotypic variances were computed as per the formula of Johnson *et al.*[16]. Phenotypic and genotypic coefficients of variations (PCV and GCV) were computed following Burton[6] and expressed in per cent. The estimates of PCV and GCV were categorized as suggested by Siva subramaniam and Madhava Menon[34] Heritability in broad sense (h^2) was estimated based on the formula proposed by Lush[20] and expressed in per cent. The range of heritability was categorized as follows[16] Genetic advance and was range of genetic advance as per cent of mean worked out based on the formula suggested by Johnson *et al.*[16].

RESULTS AND DISCUSSION

1. Variability, Heritability (h^2_b) and Genetic advance

Genetic variability

High phenotypic and genotypic coefficients of variation were recorded for plant height**,** number of branches, fruit weight, crude fibre content, iron content and fruit yield per plant suggesting that variability in these characters is due to genetic constitution. These results confirm the earlier findings of Dhall *et al*.[9], Jaiprakash Narayan *et al*.[15], Singh *et al.*[32], Alam and Hossain[4], Prakash and Pitchaimuthu[27], Adiger *et al*.[1], Oluwa and Kehinde *et al*.[24], Reddy *et al*.[28] Patel *et al.*[26], Singh and Singh and Yonus *et al.*[37] and these characters offer much scope for improvement by selection.

Moderate phenotypic and genotypic coefficient of variation were observed for days to first flowering, days to 50% flowering, days to first harvest, number of fruit per plant, 100 seed weight and iodine content. Similar result was reported by Dhall *et al.*[9], Gandhi *et al.*[11], Alam and Hossain[3], Manivannan *et al*.[21], Oluwa and Kehinde[24] and Das *et al.*[8] in okra.

The phenotypic and genotypic coefficients of variation were low for the characters *viz.*, days to last harvest, Fruit length, Fruit girth and Number of seeds per fruit. These results are in conformity with the earlier findings of Khan *et al.*[18], Manivannan *et al.*[21], Akothar *et al*.[2], Reddy *et al*.[28] in okra. The low estimates of coefficient of variation indicated that the genotypes included in the present study possessed less genetic variability for these characters, while characters having high estimates of coefficient of variation indicated greater genetic variability among the genotypes for these attributes for making effective selection. Estimating variability in a population is an effective tool for the breeder to design the selection procedures more accurately for identifying superior genotypes. Variability helps to choose the potential genotype, since it indicates the extent of recombination for implementing effective selection. The magnitudes of phenotypic and genotypic coefficients of variation have been assessed to know the real worth of the source material. According to Majumdar *et al*.[22], the lowest difference in phenotypic and genotypic coefficients of variation indicates lowest environmental influence, while high difference indicates that environmental variation contributes a major part in the expression of the trait. In the present study, by comparing phenotypic and genotypic coefficient of variation, most of the characters were low

indicating the greater role of genetic factors. This clearly shows that phenotypic values can be used for selection. Sivasubramaniam and Madhava Menon[34] suggested that the values greater than 20 per cent indicate the high phenotypic and genotypic coefficients of variation, the values ranged between 10 to 20 per cent indicate the moderate phenotypic and genotypic coefficients of variation, while the values less than 10 per cent indicate the low phenotypic and genotypic coefficients of variation. Genotypic coefficient of variation would be a useful tool for the assessment of variability, since it depends upon the heritable portion of the total variability[5]. In the present study, the estimated genotypic variance and genotypic coefficient of variation followed a similar trend as that of phenotypic variance and phenotypic coefficient of variation reported by Singh *et al.*[32]. In the present investigation, the accessions IC-43743, PBNOK-2, IC-22237, EC-755647 gave significant higher Fruit yield per plant. Hence could be utilized for improvement in the yield in okra. All the 20 genotypes showed wide range of variation for most of the traits under study (Table 2).

Heritability and genetic advance

In the present study, high heritability coupled with high genetic advance as per cent of mean was observed for the characters *viz.*, plant height, Inter nodal length and fruit yield per plant. Similar observation was recorded in okra by Singh *et al.*[32], Manivannan *et al.*[21], Akothar *et al.*[2], Adiger *et al.*[1], Oluwa and Kehinde[24] and Das *et al.*[8], Goswami *et al.*[12], Reddy *et al.*[28], Chandra *et al.*[7], Patel *et al.*[26] and Yonus *et al.*[37] Further, high heritability accompanied with high genetic advance indicated the involvement of additive gene action, therefore selection may be effective.

Whereas, high heritability and moderate genetic advance was observed for the characters *viz.*, days to 50% flowering, days to first harvest, fruit weight, Number of seeds per fruit, iodine content and iron content which implied equal importance of additive and non- additive gene action[14]. The high heritability might be due to unfavorable influence of environment rather than genetic constitution and offers a little scope for selection. Similar results were also reported by Singh *et al.*[32] Akothar *et al.*[2] Shaikh *et al.*[29].

Table 1: Analysis of variance for eighteen characters in okra genotypes

Traits	Replication mean sum of square	Genotype mean sum of square	Error mean sum of square	SEm ±	CD (P=0.05)
df	1	19	38		
Plant height (cm)	18.796	695.227**	9.762	2.21	6.54
Number of branches	0.072	1.961**	0.099	0.22	0.66
Inter nodal length (cm)	0.089	0.617**	0.019	0.10	0.29
Days to first flowering	0.729	36.925**	2.400	1.10	3.24
Days to 50 % flowering	0.100	54.689**	0.303	0.39	1.15
Days to first harvest	0.100	54.763**	0.317	0.40	1.18
Days to last harvest	0.196	29.243**	0.282	0.38	1.11
Fruit length (cm)	1.568	3.093**	0.325	0.40	1.19
Fruit girth (cm)	0.119	0.500**	0.027	0.12	0.35
Fruit weight (g)	1.656	175.777**	6.349	1.78	5.27
Number of fruits per plant	1.056	2.838**	0.169	0.29	0.86
Number of seeds per fruit	9.409	79.150**	1.043	0.72	2.14
100 seed weight (g)	0.072	1.437**	0.041	0.14	0.42
Number of picking	0.004	1.215**	0.017	0.09	0.27
Fruit yield per plant (g)	5.084	14434.627**	9.461	2.18	6.44
Crude fibre content (%)	0.416	10.250**	0.149	0.27	0.80
Iodine content(mg/100g)	0.374	182.283**	7.839	1.98	5.86
Iron content(mg/100g)	0.059	92.625**	0.970	0.70	2.06

Table 2: Estimation of variability, heritability and genetic advance as per cent of mean for eighteen characters in twenty genotypes of okra

S. No.	Characters	Range		Mean	Variance		PCV (%)	GCV (%)	h^2 (%)	Genetic Advance	GA as per cent of mean
		Minimum	Maximum		Phenotypic	Genotypic					
1	Plant height (cm)	42.11	123.96	93.26	352.494	342.732	20.132	19.851	97.23	37.605	40.325
2	Number of branches per plant	1.55	5.30	3.53	1.030	0.930	28.735	27.311	90.33	1.889	53.473
3	Inter nodal length (cm)	5.05	7.15	5.86	0.318	0.299	9.630	9.334	93.93	1.092	18.636
4	Days to first flowering	33.00	50.30	38.61	19.662	17.262	11.48	10.760	87.79	8.019	20.771
5	Days to 50 % flowering	38.00	58.50	44.01	27.496	27.193	11.914	11.848	98.90	10.683	24.274
6	Days to first harvest	43.00	61.50	50.28	27.540	27.223	10.437	10.377	98.85	10.686	21.253
7	Days to last harvest	89.10	104.30	92.54	14.762	14.480	4.152	4.112	98.09	7.764	8.390
8	Fruit length (cm)	12.85	17.25	15.72	1.708	1.384	8.313	7.482	81.00	2.181	13.872
9	Fruit girth (cm)	4.38	6.41	5.70	0.263	0.236	9.017	8.535	89.58	0.948	16.642
10	Fruit weight (g)	14.92	47.12	31.93	91.063	84.713	29.887	28.826	93.03	18.287	52.276
11	Number of fruits per plant	6.30	10.15	8.25	1.503	1.334	14.866	14.006	88.77	2.242	27.183
12	Number of seeds per fruit	63.30	84.70	75.45	40.096	39.053	8.393	8.283	97.40	12.705	16.840
13	Fruit yield per plant (g)	58.50	300.92	130.95	7222.044	7212.582	64.896	64.854	99.87	174.835	133.512
14	100 seed weight (g)	2.75	6.40	5.28	0.738	0.698	16.287	15.331	94.50	1.673	31.706
15	Number of picking	6.86	9.60	8.35	0.615	0.599	9.398	9.269	97.27	1.573	18.833
16	Crude fibre content (%)	4.17	13.26	8.30	5.199	5.050	27.464	27.068	97.14	4.563	54.956
17	Iodine content (mg/100g)	56.19	94.86	74.12	95.061	87.221	13.154	12.600	91.75	18.429	24.863
18	Iron Content (mg/100g)	12.79	36.27	24.732	46.797	45.827	27.660	27.371	97.93	13.800	55.798

Table 3: Mean performance of twenty genotypes of okra in terms of growth, yield and its related characters of okra

S. No.	Genotype	Plant height (cm)	No. of branches per plant	Inter nodal length (cm)	Days to first flowering	Days to 50% flowering	Days to first harvest	Days to last harvest	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Number of fruits per plant	Number of seeds per fruit	Fruit yield per plant (g)	100 seed weight (g)	Total number of picking	Crude fiber content (%)	Iodine content (mg/100g)	Iron content (mg/100g)
1	Pusa Sawani	97.76	4.20	5.83	40.30	46.70	53.70	92.80	16.80	6.41	28.96	6.30	79.10	150.88	6.25	7.82	8.85	83.76	24.99
2	Arka Anamika	97.35	4.45	6.17	39.90	46.20	53.20	92.50	16.20	6.13	30.81	7.85	74.70	76.73	5.85	7.86	8.81	72.14	23.09
3	Arka Abhay	99.75	2.65	5.45	42.10	47.40	54.00	94.50	15.75	6.23	37.96	6.45	72.50	170.22	5.25	8.00	8.83	81.34	18.31
4	IC-43743	108.56	4.60	5.59	37.90	41.20	49.20	91.90	16.25	5.62	42.01	9.40	78.40	300.92	5.35	8.54	5.44	58.63	35.26
5	IC-10533	95.05	4.10	5.05	36.30	41.00	47.90	90.20	17.10	5.73	36.15	8.55	84.40	71.70	5.70	8.46	7.55	94.86	36.27
6	IC-42490	92.89	3.70	5.42	35.30	41.00	48.00	90.00	15.65	5.93	43.59	6.80	64.10	58.50	6.25	8.40	7.88	72.31	25.88
7	IC-45804	118.64	3.60	5.30	37.00	41.70	48.70	90.60	16.45	5.76	36.55	6.60	84.70	67.28	5.65	8.38	8.22	71.41	16.61
8	PBNOK-1	99.94	2.70	6.12	36.70	41.50	48.50	90.50	16.75	5.77	43.36	8.20	75.60	74.85	5.55	8.40	7.37	56.19	22.44
9	IC-18960	123.96	3.85	6.85	33.70	38.50	45.50	91.10	17.25	5.98	47.12	9.35	72.80	80.00	5.20	9.12	4.17	78.57	19.69
10	IC-22237	108.11	4.40	7.15	33.00	38.00	45.00	91.80	16.85	5.84	46.93	9.30	73.30	254.60	5.05	9.36	7.37	81.63	29.75
11	Parbhani Kranthi	90.42	2.90	5.93	40.40	45.80	52.80	91.10	14.28	5.04	20.86	9.60	73.50	187.16	6.40	7.76	9.20	74.42	15.70
12	IC-10265	96.37	4.50	5.97	36.60	41.60	48.60	90.50	15.49	5.26	22.80	8.00	74.40	61.65	3.70	8.43	7.46	85.60	12.79
13	EC-755647	87.00	3.80	6.19	35.10	39.80	43.00	90.65	15.60	5.91	27.62	8.40	77.30	227.90	5.10	9.52	9.92	65.43	33.98
14	EC-755648	110.96	5.30	6.03	50.30	58.50	61.50	104.30	16.19	6.11	29.00	8.70	83.00	99.16	4.75	7.42	11.08	72.01	31.98
15	PBNOK-2	73.97	3.10	5.40	35.35	40.30	44.70	92.70	14.29	6.28	30.63	10.10	79.50	294.37	5.45	9.60	12.20	69.09	21.43
16	PBNOK-3	42.11	3.05	6.23	40.10	45.10	52.10	89.10	13.49	4.38	27.23	7.65	68.50	60.63	2.75	7.60	5.66	66.92	23.91
17	PBNOK-4	71.89	4.00	5.09	36.85	41.75	44.70	90.30	14.57	4.92	19.92	7.35	82.50	199.85	4.80	9.22	5.55	77.90	17.81
18	PBNOK-5	70.44	1.55	5.60	44.70	51.25	58.60	92.90	12.85	5.64	26.90	7.45	63.30	59.05	5.25	6.86	13.26	61.90	30.66
19	PBNOK-6	83.70	1.70	5.41	35.80	40.50	46.60	91.50	15.65	5.50	25.25 14.9200	10.15	67.30	63.42	5.75	8.98	7.56	78.67	26.36
20	PBNOK-7	96.24	2.50	6.39	44.80	52.40	59.30	101.75	17.00	5.49	14.92	8.75	80.00	60.14	5.50	7.28	9.72	79.68	27.76
Grand mean		93.26	3.53	5.86	38.61	44.01	50.28	92.54	15.72	5.70	31.93	8.25	75.45	130.95	5.28	8.35	8.30	74.12	24.73
SEm ±		2.21	0.22	0.10	1.10	0.39	0.40	0.38	0.40	0.12	1.78	0.29	0.72	2.18	0.15	0.09	0.27	1.98	0.70
CD (P=0.05)		6.54	0.66	0.29	3.24	1.15	1.18	1.11	1.19	0.35	5.27	0.86	2.14	6.44	0.42	0.27	0.81	5.86	2.06

Whereas, high heritability and low genetic advance was observed for the characters *viz*., Days to first flower, days to last harvest, fruit length, fruit girth, 100 seed weight, Number of picking, crude fibre content, iron content and Number of fruit per plant. Similar result were reported by Kumar *et al.*[19] Singh and Singh[32], Singh *et al.*[32], Manivannan *et al.*[21], Oluwa and

Kehinde[24], Chandra *et al*.[7]. On the basis of the present study, it could be concluded that simultaneous selection based on multiple characters *viz.*, plant height, number of branches, inter nodal length, days to first flowering, days to 50% flowering, days to first harvest, fruit length, fruit girth, fruit weight, number of fruits per plant, number of seeds per fruit, 100 seed weight, number of pickings, crude fiber content, iodine content , iron content and fruit yield per plant having high estimates of heritability and genetic advance could be exercised for improvement through simple direct selection.

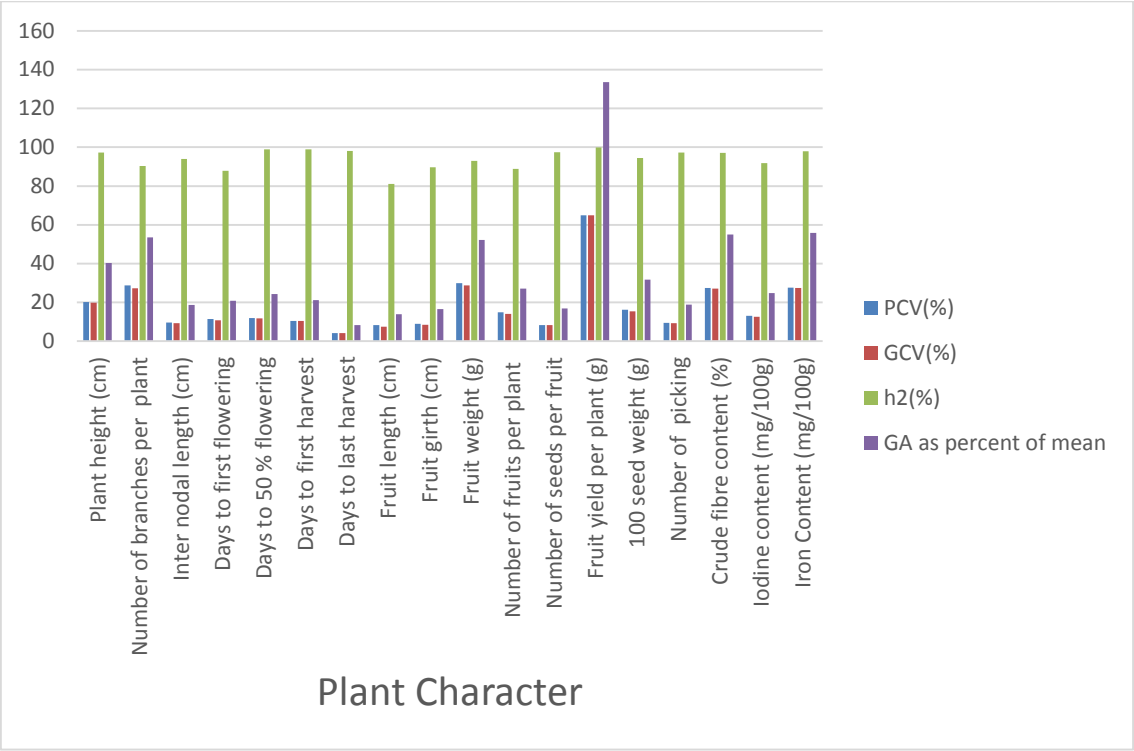

Fig. 1: Estimation of variability, heritability and genetic advance as per cent of mean for eighteen characters in twenty genotypes of okra

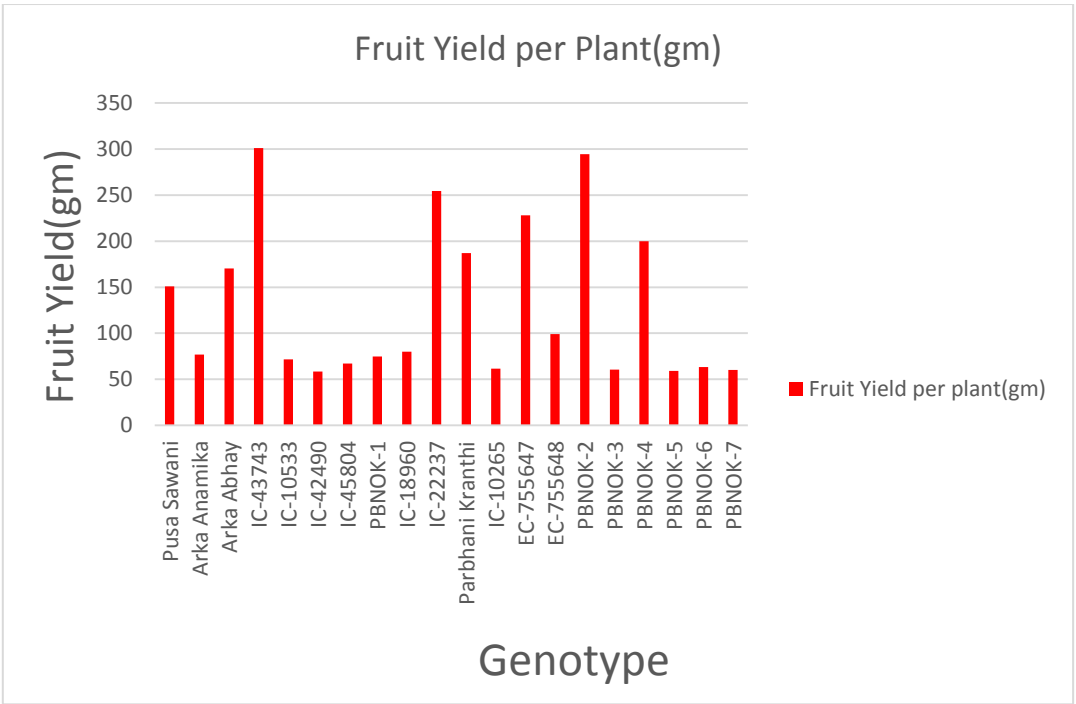

Fig. 2: Estimation of mean fruit yield per plant (g) for eighteen characters in twenty genotypes of okra

CONCLUSIONS

The analysis of variance revealed significant difference for eighteen characters studied and reported that there was sufficient amount of variability exist among the genotypes. Wide range of variability was observed for plant height, number of seeds per fruit, fruit yield per plant, iodine content and indicating the scope for selection of suitable initial breeding material for further improvement.

The GCV and PCV were high for plant height followed by number of branches per plant, fruit weight, fruit yield per plant, crude fibre content and iron content the order of magnitude. The differences between PCV and GCV values were minimum, indicating that the traits were less influenced by environment and these characters could be improved by following phenotypic selection. The heritability estimates high for plant height**,** number of branches, inter nodal length, days to first flowering, days to 50% flowering, days to first harvest, days to last harvest, number of fruits per plant, fruit length, fruit girth, fruit weight, number of seeds per fruit, 100 seed weight, number of pickings, crude fiber content, iodine content and iron content. The genetic advance was high for plant height, number of fruits per plant, Number of seeds per fruit hence fruit yield per plant, hence these traits could be exercised for improvement through selection.

The characters *viz.*, plant height, fruit weight, number of fruits per plant, number of seeds per fruit and iodine content recorded high genetic variability. The high heritability in conjunction with high genetic advance as per cent mean indicated the predominance of additive gene action. Therefore, a plant breeder may use to obtain superior hybrids and good recombinants.

Genetic advance as per cent of mean was high (>20%) for plant height, number of branches, days to first flowering, days to 50% flowering, Days to first harvest, average fruit weight, number of fruits per plant, fruit yield per plant, number of pickings, 100 seed weight, crude fibre content, iodine content and iron content aforesaid traits recorded high estimates. This indicated that all the above said traits were under the influence of additive gene action and simple selection process based on phenotypic performance of these traits would be effective.

REFERENCE

1. Adiger, S. G., Shanthkumar, P. I., Gangashetty and Salimath, P. M., Association studies in okra (*Abelmoschus esculentus* (L.) Moench). *Electron. J. Pl. Breed.* **2(4):** 568-573 (2011).
2. Akothar, P. K., De, D. K. and Pal, A. K., Genetic variability and diversity in okra (*Abelmoschus esculentus* (L.). Moench). *Electron. J. Pl. Breed*. **1(4):** 393-398 (2010).
3. Alam, A. K. M. A. and Hossain, M. M., Variability of different yield contributing parameters and yield of some okra (*Abelmoschus esculentus* (L.) Moench) accessions. *J. Agric. Rural Dev*. **4(1&2):** 119-127 (2006).
4. Alam, A. K. M. A. and Hossain, M. M., Variability of different growth contributing parameters of some okra (*Abelmoschus esculentus* (L.) Moench) accessions and their inter correlation effects on yield. *J. Agric. Rural. Dev*. **6(1&2):** 25-35 (2008).
5. Allard, R. W., Principles of plant breeding. John Whiley Sons. New York, p. 485. (*Abelmoschus esculentus* (L.) Moench*). Journal of Genetics and Breeding* **59(1):** 1-6 (1960).
6. Burton, G. W., Quantitative inheritance in grasses. Proc. *Sixth Int*. *Grassl. Congr*. **1:** 277-283 (1953).
7. Chandra, S., Bhardwaj, M. L., Kumar, R., Kumar, D., Kumar, S., Gautam, N., Dogra, B. and Sharma, S., *Int. J. Farm Sci*. **4(3):** 33-41 (2014).
8. Das, S., Chattopadhyay, A., Chattopadhyay, S. B., Dutta, S. and Hazra, P., Genetic parameters and path analysis of yield and its components in okra at different sowing dates in the Gangetic plains of eastern India. *Afr. J. Biotechnol*. **11(95):** 16132-16141 (2012).

9. Dhall, R. K., Arora, S. K. and Rani, M., Correlation and path analysis in advanced generations of okra (*Abelmoschus esculentus* (L.) Moench). *Indian Journal of Horticulture* **57(4):** 342-346 (2000).
10. Effing, G. S., Ogban, P. I., Ibia, T. O. and Adam, A. A., Evaluation of Nitrogen supplying Potentials of Fluted Pumpkin (*Telfairia occidentalis*, Hook, F.) And Okra (*Abelmoschus esculentus*) (L) Monech. *Academic Journal of Plant Science*. **2(3):** 209-214 (2009).
11. Gandhi, H. T., Yadav, M. D. and Navale, P., A Studies on variability in okra (*Abelmoschus esculentus* (L.) Moench). *Journal of Maharashtra Agricultural University* **26(2):** 146-148 (2001).
12. Goswami, A., Singh, B., Kumar, A. and Bhadana, G., Genetic variability in okra (*Abelmoschus esculentus* (L). Monech.). *Prog. Agric.* **12(2):** 407-411 (2012).
13. Guddadamath, S., Mohankumar, H. D., Salimath, P. M. and Sujatha, K., Genetic analysis of biparental mating and selfing in segregating populations of okra. *Indian J. Hort*. **68(3):** 340-344 (2011).
14. Jain, A. K., Tiware, A. S., Kushwah, V. S. and Hirve, C. D., Genetics of quantitative traits in Indian mustard. *Indian J. Agric. Sci*. **48:** 117–119 (1988).
15. Jaiprakash narayan, R. P., Mulge, R., Kotikal, Y. K., Patil, M. P., Madalageri, M. B. and Patil, B. R., Studies on genetic variability for growth and earliness characters in okra (*Abelmoschus esculentus* (L.) Moench). *Crop Research* **32(3):** 411-413 (2006).
16. Johnson, H. W., Robinson, H. F. and Comstock, R. E., Genotypic and genotypic correlations in soybean and their implications in selection. *Agron. J.* **47:** 314 -318 (1955).
17. Joshi, A. B., Gadwal, V. R. and Hardas, M. W., Okra. In N.W. Simmonds (ed.) *Evolution of crop plants, p* 194-195. Longmans, London (1974).
18. Khan, S. H., Ahmed, N. and Jubeen, N., Variability and correlation studies in okra. *Journal of research, SKUAST-J*, **14(2):** pp 179-183 (2005).
19. Kumar, P. S., Rodney S. M. and Karuppaiah, P., Studies on certain genetic parameters in bhendi (*Abelmoschus esculentus* (L.) Moench). *Crop Research* **32(1):** 66-68 (2006).
20. Lush, J. L., Intro-site correlation and regression of off spring on corn as a method of estimating heritability of characters. Proc. *Amer. Soc. Animal Prodn*. **33:** 293-301 (1940).
21. Manivannan, M. I., Rajangam, J. and Geetharani, P., Variation studies in okra. Asian. *J. Hort*. **2(2):** 188-191 (2007).
22. Manjumdar, P. K., Prakash, R. and Herque, H. D. F., Genotypic and phenotypic variability in quantitative characters in groundnut. *Indian J.Genet.* **29:** 291-296 (1969).
23. Martin, F. W., A second edible okra species and its hybrid with common okra. *Ann. Bot*. **50:** 277-283 (1979).
24. Oluwa, O. O. and Kehinde, O. B., Genetic variability studies in West African okra (*Abelmoschus caillei*). *Agric. Biol. J. N. Am*. **2(10):** 1326-1335 (2011).
25. Panse, V. G. and Sukhatme, P. V., Statistical methods for agricultural workers. *ICAR, New Delhi. p*. 134-192 (1985).
26. Patel, R., Sengupta, S. K. and Verma, A. K., Studies on genetic parameter in okra (*Abelmoschus esculentus* (L.) Monech). *Trends in Biosciences*. **7(14):** 1808 1811 (2014).
27. Prakash, K. and Pitchmuthu, M., Nature and magnitude of genetic variability and diversity in okra (*Abelmoschus esculentus* (L.) Monech). *Electronic Journal of Plant Breeding* **1(6):** 1426-1430 (2010).
28. Reddy, M. T., Babu, K. H., Ganesh, M., Reddy, K. C., Reddy, B. P. and Narshimulu, G., Genetic variability analysis for the selection of elite genotypes based on pod yield and quality from the germplasm of okra (*Abelmoschus esculentus* (L.) Moench. *Agric. Techol.* **8(2):** 639-655) *J* (2012).
29. Shaikh, M. S., Akhil, M. A., Mohrir, M. N. and Jadhav, R. S., Genetic divergence

in okra (*Abelmoschus esculentus* L.). *Electronic Journal of Plant Breeding*. **4(3):** 1258-1260 (2013).

30. Siesmonsma, J. S. and Kouame, C., Vegetables. Plant resources of tropical Africa 2 (Grubben GJH & Denton OA Eds.) PROTA Foundation, Wageningen, *Agric. Biol. J. N. Am*. **4(5):** 532-538 (2004).
31. Simon, S. Y., Gashua, I. B. and Musa, I., Genetic variability and trait correlation studies in okra (*Abelmoschus esculentus* (L.). Moench). *Agric. Biol. J.N. Am*. **4(5):** 532-538 (2013).
32. Singh, B., Pal, A. K. and Singh, S., Genetic variability, correlation and path analysis in okra (*Abelmoschus esculentus* (L.) Moench). *Indian J. Hort*. **63(3):** 281-285 (2006).
33. Singh, Narayan, Biometrical techniques in plant breeding. *Kalyani publishers. Ludhiana india. pp* 195 (1993).
34. Sivasubramanian, S. and Madhava Menon, P., Genotypic and phenotypic variability in rice. *Madras Agric. J*. **60(9-13):** 1093-1096 (1973).
35. Snedecor, G. W. and Cochran, C. W. G., Statistical methods. *The Iowa State University Press, IOWA, U.S.A.* (1967).
36. Wamanda, D. T., Inheritance studies in collected local Okra (Abelmoschus esculentus (L.) Moench) cultivars. Combining ability analysis and heterosis on diallel cross of Okra. *African J. Agric. Res*. **5(16):** 2108 – 2155 (2007).
37. Yonus, M., Garedew, W. and Debela, A., Variability and association of quantitative characters among okra (*Abelmoschus esculentus* (L.) Moench) collection in south western Ethiopia. *J. Biol. Sci*. **14(5):** 336-342 (2014).
38. Zeven, A. C. and Zhukovsky, P. M., Dictionary of cultivated plants and their centres of diversity. Centre for Agricultural Publishing and Documentation, *Wageningen, the Netherlands, p*. 219 (1975).