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Performance and Genetic Evaluation of Okra (*Abelmoschus esculentus* (L.) Moench) Genotypes for Agromorphological Traits

Pattan Farooqkhan, R. Ebenezer Babu Rajan, C. Praveen Sampath Kumar, J. Sam Ruban

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ABSTRACT

Okra or Bhendi is a crucial vegetable farmed in India. The state of Tamil Nadu contains a smaller cultivable area and less okra production. As a result, the investigative study was conducted at Sivapuri, Chidambaram, Tamil Nadu to estimate variability metrics such as PCV, GCV, and GA% mean for crop advancement studies. The experiment involved 48 okra genotypes and 12 qualitative variables. In accordance with ANOVA, the mean sum of squares of 48 genotypes was highly significant for all parameters tested. For the twelve studied traits, values of PCV was higher than values of GCV by a little margin, showing the influence of environmental influences on genotypes. High heritability was found in all characters except days to 50% flowering and days to first harvest. High genetic advance % of mean was perceived in all the traits except for days to the 50% flowering, the harvest period and days to first harvest. High heritability combined with high GA was recorded in traits like primary branches per plant, fruit girth, no. of fruits per plant, fruit length, and fruit yield per plant. If genotypes are chosen based on these traits, selection for genetic improvement programs would be highly efficient.

Keywords Heritability, Genetic advance % mean, Okra, PCV, GCV.

INTRODUCTION

Okra, also known as Lady's finger, Gumbo, or Bhendi (*Abelmoschus esculentus* (L.) Moench), is a chief tropical and subtropical vegetable, that is grown extensively throughout the world. It is one of the most widely grown warm-season vegetables belonging to the Malvaceae family. Okra is believed to have originated in tropical regions of Africa, being native to Sudan and Ethiopia, from where it is spread to Asia, America, and other countries (Mohammed *et al.* 2022). It is an allopolyploid crop that is self-pollinated

Pattan Farooqkhan[1], R. Ebenezer Babu Rajan[2]*, C. Praveen Sampath Kumar[3], J. Sam Ruban[4]

[1]PhD Scholar, [2]Associate Professor, [3]Assistant Professor
Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalai Nagar 608002, Tamil Nadu, India

[4]Associate Professor
Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar 608002, Tamil Nadu, India

Email : ebenezer.babu18@gmail.com
* Corresponding author

and has the chromosomal number 2n=2x=130. Due to its versatility of nutritional and medicinal qualities, it is commercially grown and well-liked in India. Okra contains a variety of vitamins and minerals, including ascorbic acid, retinol, riboflavin, calcium, iron, iodine, and phosphorus (Das *et al.* 2019). Dehydrated okra is a processed product for preservation and export (Rani *et al.* 2021). Green unripe pods are processed and eaten as soup, stew, fried, and boiled (Temam *et al.* 2021). Dried okra seeds are roasted, ground, and substituted as coffee, and they also contain a substantial amount of oil (Mohammed *et al.* 2022). One of the key elements in a plant's genetic enhancement programs is characterization. Any breeding program's progress depends on the quantity and complexity of variability present in the crops, as well as how heritable the desirable traits are. Fruit yield is heavily influenced by environmental factors due to its polygenic nature. It will be beneficial to avoid selection that is completely based in terms of yield increase. After eliminating the environmental factors linked to phenotypic variance, the traits with high heritability that are directly or indirectly associated with yield should be chosen (Kavya *et al.* 2019). A sophisticated method for separating the degree of genetic variation from the phenotypic variation is heritability (Harshwardhan *et al.* 2016). For the purpose of choosing appropriate genotypes for yield qualities, the evaluation of genetic variability parameters offers a firm foundation. Strong heritability and significant phenotypic variety in the base population are necessary for the successful selection of elite individuals. Keeping these factors in mind, the current study was conducted to assess the performance of morphological or agronomic traits in different okra genotypes as well as to estimate the components of genetic variability, including PCV, GCV, h^2, and genetic advance.

MATERIALS AND METHODS

Experimental Layout and design

The experimental trial was performed in an agricultural farm near Sivapuri Village, Chidambaram, Cuddalore district, Tamil Nadu, India from Jan 2022 -May 2022. It was discovered that the soils of Sivapuri village included soil isolates of 29.2, 39.4, 30.5, and 30.2% sand, silt, and clay, respectively. The soils fall under the textural class of clay loam with a pH of 7.6. In this study, forty-eight genotypes were used which is a mixture of indigenous, exotic, and landrace collections as mentioned in Table 1. The genotypes were raised in three replication RBD (Randomized Block Design) with row spacing of 60 cm and 30 cm among the plants. Timely weeding, irrigation, and thinning were performed along with other agronomic practices.

Data collection

The observations of quantitative traits were collected using the International Plant Genetic Resources Institute (IPGRI 1991) list of descriptors list developed for

Table 1. List of genotypes used for study.

1	IC 45732	18	EC 329384	35	Takath TS-102
2	IC 45780	19	Kashi pragati	36	Palam komal
3	IC 45815	20	GFS gold V4	37	Red round
4	IC 45799	21	Harika	38	1 Foot
5	IC 45805	22	Dhanvi 66	39	Bommidi
6	IC 45821	23	Ajeet 121	40	Sunai
7	IC 45818	24	Gold 207	41	Tree
8	IC 44896	25	Ruchi	42	Colorful
9	IC 45791	26	Arka Anamika	43	Dark green
10	IC 45727	27	Super champion	44	IC 45811
11	IC 45802	28	Nol 1307 (Silky)	45	EC329375
12	EC 329362	29	Hari pari	46	EC 329372
13	EC 329364	30	VRO-4	47	EC 329378
14	EC 329366	31	Rani 792	48	Suguna A51
15	EC 329368	32	Lush green		
16	EC 329370	33	Maharani		
17	EC 329382	34	Super lady		

okra. The data were recorded from five random competitive plants of each genotype per replication and the mean of these five plants was used for statistical analysis. Data were collected from phenology traits (Days to 50% flowering, Days to first harvest, and Harvest period), growth and yield-related characters (plant height, no. of primary branches per plant, fruit girth (mm), fruit weight (g), no. of locules per fruit, no. of fruits per plant, fruit length (cm), fruit yield per plant (kg) and peduncle length (cm)).

Biometrical analysis

Panse and Sukhatme (1952) method of ANOVA was utilized to perform an analysis of variance for the data taken. The technique created by Burton and Devane (1953) was used to calculate values of the PCV and GCV and classified as Low (0–10%), Moderate (10–20%), and High (> 20%). Heritability values were calculated and scaled according to the percentage using methods of Robinson (1966) and Hanson *et al.* (1956) respectively. The percentage of heritability was scaled as Low (0-30%), Moderate (30-60%), and High (> 60%). Genetic advance was computed using Johnson *et al*. (1955) method and scaled from Low (0-10%), Medium (10-20%), and High (>20%). The data were worked out using MS Excel, R-Studio, and OPSTAT.

RESULTS AND DISCUSSION

Results of the analysis of variance (ANOVA) for twelve traits of 48 okra genotypes, represented in Table 2, show that the mean sum of squares (MSS) for genotypes is significant at 5% and 1% level of significance for twelve traits, denoting the presence of a substantial amount of natural genetic diversity among the variables being studied. There is no significant difference among the replications showing that environmental error was less frequent. These findings demonstrate that the genotypes exhibit notable variation, providing breeders with the opportunity to choose high-performing accessions for okra improvement programs. Reddy *et al.* (2022) found similar significance for the assessed traits among the genotypes.

The mean of all the genotypes is mentioned in Table 3. The predictable variability parameters i.e., Phenotypic, genotypic coefficient of variation, GA % of the mean, and, heritability are represented in Table 3 and Fig. 1. GCV is the heritable portion of the total variation. The PCV is greater than GCV for all the characteristics used for the study. This strongly shows that the variation is not only due to genotypes, but also due to the relative effect of some environmental factors. The close relation between PCV and GCV values for all traits displayed that they are comparatively stable to environmental variation. Kavya *et al.* (2019) and Mohammed *et al.* (2022) also had parallel results regarding PCV and GCV.

High values of GCV and PCV (>20) were found for traits like fruit girth (23.44, 26.39), fruit weight

Table 2. Analysis of variance for 48 genotypes of okra.

Source of variation	Replication	Treatment	Error	SEm	CD (5%)	CV (5%)
Degree of freedom	2	47**	94	-	-	-
Days to 50% flowering	15.19	23.74**	4.67	1.25	3.50	4.94
Plant height (cm)	355.51	480.89**	32.25	3.28	9.21	6.51
Number of primary branches	0.66	1.47**	0.14	0.22	0.61	10.41
Days to first harvest	17.51	20.59**	5.56	1.36	3.82	4.80
Fruit length (cm)	4.20	15.48**	1.29	0.66	1.84	8.00
Fruit girth (mm)	59.64	71.04**	5.81	1.39	3.91	12.13
Fruit weight (g)	28.13	194.52**	8.73	1.71	4.79	14.52
Peduncle length (cm)	0.28	0.48**	0.06	0.14	0.39	10.73
No. of locules / fruit	0.26	2.91**	0.06	0.14	0.40	4.21
No. of fruits/plant	23.84	110.72**	3.41	1.07	2.99	7.13
Harvesting period	24.08	50.13**	6.35	1.45	4.08	4.23
Fruit yield / plant (kg)	0.07	0.14**	0.02	0.07	0.20	23.89

** Significant at 5% and 1% probability levels, SEm - Mean of standard error, CD - Critical difference, CV - Coefficient of variation.

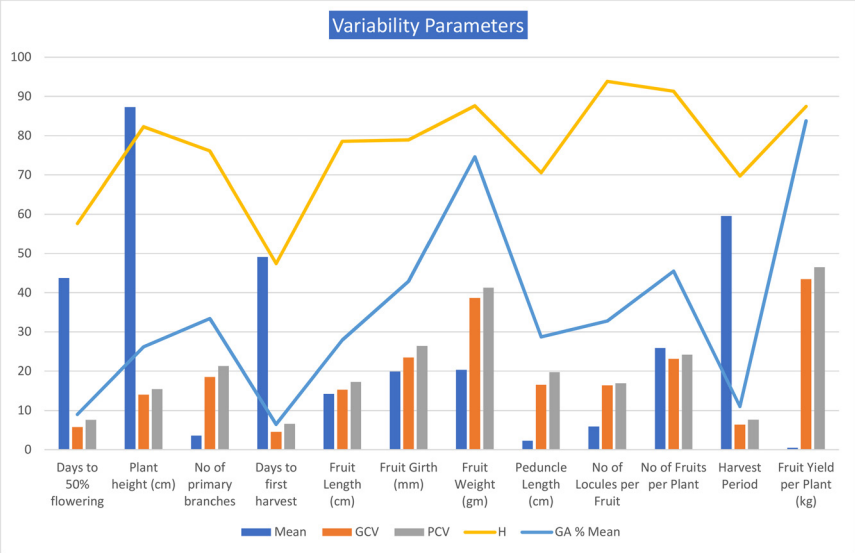

Fig. 1. Estimates of variability parameters for 48 okra genotypes.
GCV- Genotypic coefficient of variation; PCV- Phenotypic coefficient of variation; GA- Genetic advance; GA% mean- Genetic advance % mean.

(38.67, 41.31), no of fruits per plant (23.11, 24.18), and fruit yield per plant (43.47, 46.69). High PCV and GCV indicate that environmental factors have less effect on these characters and selection in them provides a greater opportunity to improve with selective breeding. Moderate values of genotypic and phenotypic coefficient of variation (10-20) were found in traits like plant height (14.01, 15.45), fruit length (15.29, 17.26), peduncle length (16.59, 19.75) and no. of locules per fruit (16.43, 16.96). According to Reddy *et al*. (2012), moderate values indicate the impact of heritable variables as environmental factors are minimal. These results were in accordance with Prakash *et al*. (2022) for plant height and Saryam *et al.* (2012) for fruit length. Low genotypic and phenotypic coefficient of variation (<10), were present

Table 3. Estimates of genetic variability for twelve traits of okra.

Quantitative characters	Range		Mean	Variance		GCV	PCV	Heritability	GA	GA% mean
	Min	Max		Vg	Vp					
Days to first flowering	39.00	52.33	43.75	6.35	11.02	5.76	7.58	57.6465	3.94	9.01
Plant height (cm)	65.63	112.53	87.27	149.54	181.79	14.01	15.45	82.26	22.84	26.18
Primary branches/plant	2.03	5.07	3.59	0.44	0.58	18.57	21.28	76.09	1.19	33.37
Days to first harvest	44.67	56.33	49.12	5.01	10.56	4.55	6.61	47.41	3.17	6.46
Fruit length (cm)	9.33	20.03	14.22	4.72	6.02	15.29	17.26	78.52	3.97	27.92
Fruit girth (mm)	15.26	38.58	19.89	21.74	27.55	23.44	26.39	78.90	8.53	42.90
Fruit weight (g)	12.67	49.33	20.35	61.93	70.66	38.67	41.31	87.64	15.17	74.58
Peduncle length (cm)	1.59	3.14	2.26	0.14	0.19	16.59	19.75	70.51	0.64	28.70
No. of locules per fruit	4.87	8.45	5.93	0.94	1.01	16.43	16.96	93.84	1.94	32.79
No. of fruits/plant	13.00	39.33	25.88	35.77	39.17	23.11	24.18	91.29	11.77	45.48
Harvest period	51.00	68.33	59.58	14.59	20.94	6.41	7.68	69.69	6.57	11.02
Fruit yield/plant (kg)	0.21	1.27	0.52	0.05	0.05	43.47	46.49	87.44	0.43	83.74

Vg- Genotypic variance; Vp- Phenotypic variance; GCV- Genotypic coefficient of variation; PCV- Phenotypic coefficient of variation; GA- Genetic advance; GA% mean- Genetic advance % mean.

in days to 50% flowering (5.76, 7.58), days to first harvest (4.55, 6.61), and fruiting or harvest period (6.41,7.68). These values showcase that there was a significant influence of environmental factors on these traits and selection for these characters would be ineffective for improvement. Sravanthi *et al.* (2021) documented relevant observations for days to 50% flowering, Kumar *et al*. (2020) for days to first harvest, and Reddy *et al.* (2022) for the harvest period.

Heritability is seen as a reliable indicator of the transference of traits from parents to offspring (Falconer 1981). Genetic advance is referred to as the enhancement of crop genotypic value of some selected types over its total population. The estimates of broad sense heritability and genetic advance over the percentage of the mean (GAM) are presented in Table 3 and Fig. 1. High values of heritability (>60%) were recorded in all the characters excluding days to 50% flowering and days to first harvest which recorded moderate values of heritability. This indicates that environmental effects are the least. Even if environmental influence is minimum, the selection based only on heritability values is ineffective as heritability is assessed based on total genetic variation including both fixable (including additive and AA type epistasis) and non-fixable (dominance and AD, DD epistasis) effects (Singh and Narayan 2017). Selection based on both heritability and genetic advance would be effective for improvement (Johnson *et al.* 1955).

GA percentage of mean ranged from 6.46 to 83.74 for days to first harvest and fruit yield per plant respectively. High heritability accompanied by a high GA % mean (or GAM) was found in primary branches per plant, fruit girth, fruit length, no of fruits per plant, and fruit yield per plant. It will be highly impactful if the genotypes are selected based on these traits. Temam *et al.* (2021) found similar results of strong heritability paired with a high GA% mean. Moderate heritability with low GAM was found in days to 50% flowering and days to first harvest, selection would not be beneficial for improvement in these characters. These are in similarity with Reddy *et al.* (2022).

CONCLUSION

The analysis of 48 genotypes' variability parameters revealed that the MSS (mean sum of squares) due to genotypes according to ANOVA, had highly significant differences for all of the features of study, indicating that genotypes differ from one another. The PCV values are greater than GCV values showing the presence of environmental effects to a little margin. High heritability is observed in all twelve characters except days to 50% flowering and days to first harvest. High heritability accompanied by a high GAM is observed in traits like primary branches per plant, fruit girth, fruit length, no. of fruits per plant, and fruit yield per plant. As a result, the impact of direct selection on these characters might be highly favorable for okra improvement.

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