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Genetic variability, heritability and genetic advance studies for yield components in Okra [*Abelmoschus esculentus* (L.) Moench]

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Abstract
A field examination was carried out with 40 genotypes of okra to study the genetic variability, heritability and genetic advance of fourteen different characters A wide range of variation was observed for all the characters taken under study. The magnitude of phenotypic coefficient of variation was higher than corresponding genotypic coefficient of variation for all the characters studied. The high to moderate genotypic coefficient of variation and phenotypic coefficient of variation was observed for internodal length, number of nodes per plant, green fruit yield per plant, fruit length, number of fruits per plant and plant height, while high heritability (broad sense) values were observed for all the characters taken under study except 10-green fruits weight, number of branches per plant, days to 50 percent flowering, days to last picking, days to first flowering and days to first picking. The high to moderate genetic advance was recorded for green fruit yield per plant, plant height, 10-green fruits weight and internodal length. Green fruit yield per plant and plant height had high heritability and high genetic advance. Fruit width, number of nodes per plant number of fruits per plant, fruit length and number of picking, while it had low heritability coupled with low genetic advance as percent of mean.

Keywords: Okra, variability, heritability and genetic advance

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] of the family Malvaceae, is an important vegetable crop grown in tropical and subtropical region for its tender green fruits. Okra is also known as bhindi, lady's finger and gumbo. Okra is a polyploid and a often cross pollinated crop. Rate of out crossing to an extent of 4 to19 percent with the maximum of 42.2 percent is observed with the insect assisted pollination. It is a robust crop and can grow with considerable success on a wide range of soils and under adjustable environmental conditions. In the country, a large number of okra varieties are grown, the variation occurs with regards to quantitative and qualitative characters. It has high nutritive value and export potential.

This opinion gets its asset from the Sanskrit words 'Tindisha' and 'Gandhmula' found to designate Bhindi. Thus, it is likely that cultigens might have initiated in Asia or it might initially have been present in Africa, and India as a polyphyletic species. The fruits have many medicinal properties too. It is useful in illness, chronic dysentery, and irritable states of genitero. It is good for people suffering from renal colic, leucorrhoea, spermatorrhoea, chronic dysentery and general weakness. Due to high iodine content fruits are considered useful for control of goiter. The stem of the plant is used for cleaning of sugarcane juice and for the extraction of fibers in paper mills.

The genetic variability would be determined with the help of certain genetical parameters such as phenotypic co-efficient of variation (PCV), genotypic co-efficient of variation (GCV), heritability estimates (h^2) and genetic advance (GA). GCV indicates the relative degree of genetic variability existing for different characters in a population of genotypes. The heritability expresses the relative amount of heritable portion of variation. However, the heritability estimates along with genetic gain is more useful in selecting the best population individual. Keeping in view the importance of these, the present research work has been formulated to study the genetic variability, heritability and genetic advance among different quantitative characters of okra.

Materials and Methods

The experimental material was comprising of 40 genotypes and were evaluated in randomized block design with three replications during *Kharif* 2019. The seeds of these genotypes were obtained from Vegetable Research Station, Navsari Agricultural University, Navsari and Vegetable Research Station, Junagadh Agricultural University, Junagadh. Each genotype was sown with a spacing of 60 cm × 30 cm. The recommended agronomical practices and plant protection measures were followed for the successful raising of the crop. The observations were recorded on five randomly selected plants in each genotype from each replication.

The mean of these five plants and fruits was used for statistical analysis. Analysis of variance was carried out as per methodology given by Panse and Sukhatme (1985) [16]. Genotypic and phenotypic coefficients of variation (GCV and PCV) were calculated by the formula given by Burton and De vane (1952) [4], heritability in broad sense (h2) and Genetic advance were calculated as per the formula suggested by Allard (1960) [1].

Results and Discussion

Estimation of component of genetic parameters of variation for fruit yield and its attributes exhibited a wide range for the characters studied (Table 1) and the result indicated that the values of phenotypic variance and phenotypic coefficient of variations were of higher magnitude than that of genotypic variance and genotypic coefficient of variations for all the characters showing, that the environment had an important role in influencing the expressions of the characters.

The PCV and GCV ration the extent of variation present in the population in the particular character. In the present inspection, PCV was higher than the respective GCV for all the traits studied, divulge that the environment had a significant role to performance in manipulating the expression of these characters which is in accordance with findings of Bendale *et al*. (2003) [2], Dakane *et al*. (2007) [7], Singh *et al*. (2007) [24], Senapati *et al*. (2011) [22] and Sharma and Prasad *et al*. (2015) [23].

The high magnitude of GCV and PCV was observed for internodal length**,** number of nodes per plant and green fruit yield per plant. This is in relation with the earlier reports of Vijay and Manohar (1990) [26], Bindu *et al*. (1997) [3], Dhall *et al*. (2002) [9], Bendale *et al*. (2003) [2], Dakane *et al*. (2007) [7], Singh *et al.* (2007) [24], Das *et al.* (2012) [8], Reddy *et al.* (2012a) [21], Koundinya *et al*. (2013) [12], Pachiyappan and Saravanan (2016) [15] for fruit yield per plant; Chandramouli *et al*. (2016) [5] for internodal length; Das *et al*. (2012) [8] for number of nodes per plant.

The moderate magnitude of GCV and PCV was observed for plant height, number of fruits per plant and fruit length. This is in accordance with the earlier reports of Bindu *et al*. (1997) [3], Dhall *et al*. (2002) [9], Dakane *et al*. (2007) [7], Singh *et al*. (2007) [24], Das *et al*. (2012) [8], Nwangburka *et al*. (2012), Koundinya *et al*. (2013) [12] for plant height; Hazra and Basu (2000) [11] for number of fruits per plant; Das *et al.* (2012) [8] for fruit length and number of fruits per plant; Ramanjinappa *et al.*, (2011) [19], Chandramouli *et al*., (2016) [5] and Yadav *et al.*, (2016) [27] for number of fruits per plant and Goswami *et al.* (2012) [29] for internodal length, number of fruits per plant, fruit length.

However, low magnitudes of GCV and PCV were recorded for days to first flowering, days to last picking, days to 50 percent flowering, days to first picking, 10-green fruits weight, number of branches per plant and fruit width. The most probable reason could be the phenotypic plasticity occurring in these traits is the main source of variation than the genetic variance. Such result also indicated that selection is not effective for these traits because of the narrow genetic base. Lower magnitude of GCV and PCV were also reported by Dakane *et al*. (2007) [7] for days to last picking; Rathava *et al.*, (2019) [20] for days to 50 percent flowering; Dakane *et al*. (2007) [7], Das *et al*. (2012) [8] and Koundinya *et al*. (2013) [12] for days to first flowering and Chandramouli *et al*., (2016) [5], for days to 50% flowering. Low magnitude of GCV and moderate magnitude of PCV were recorded for number of picking.

In the present study, high heritability estimates were observed for green fruit yield per plant, internodal length, plant height, fruit width, number of nodes per plant number of fruits per plant, fruit length and number of picking. High heritability estimates indicated that the characters were least influenced by the environmental effects. This also suggested that the phenotypes were the true representative of their genotypes for these traits and selection based on phenotypic value could be more reliable.

Similar results of high heritability was reported by Bindu *et al.* (1997) [3], Hazra and Basu (2000) [11], Dhall *et al.* (2000) [30], Verma *et al.* (2004) [25], Dakane *et al.* (2007) [7], Singh *et al.* (2007) [24], Prashant Kumar *et al.* (2011) [18], Das *et al.* (2012) [8], Nwangburuka *et al*. (2012) [14], Reddy *et al.* (2012a) [21], Duggi *et al.* (2013) [10], Koundinya *et al.* (2013) [12], Yonas *et al.* (2014) [28], Phani *et al*. (2015) [17] and Yadav *et al*. (2016) [27] for plant height; Bindu *et al.* (1997) [3], Hazra and Basu (2000) [11], Nwangburuka *et al.* (2012) [14], Singh *et al.*, (2007) [24], Das *et al.* (2012) [8], Reddy *et al.* (2012a) [21], Duggi *et al.* (2013) [10], Pachiyappan and Saravannan (2016) [15] and Yadav *et al*. (2016) [27] for fruit weight; Hazra and Basu (2000) [11], Dhall *et al.* (2000) [30], Naidu *et al.* (2007) [13], Singh *et al.* (2007) [24], Prashant Kumar *et al.* (2011) [18], Das *et al.* (2012) [8], Reddy *et al.* (2012a) [21], Duggi *et al.* (2013) [10], Koundinya *et al.* (2013) [12], Phani *et al*. (2015) [17] and Chandramouli *et al.* (2016) [5] for number of fruits per plant; Hazra and Basu (2000) [11], Dakane *et al.* (2007) [7], Naidu *et al.* (2007) [13], Singh *et al.* (2007) [24], Prashant Kumar *et al.* (2011) [18], Senapati *et al.* (2011) [22], Das *et al.* (2012) [8], Reddy *et al.* (2012a) [21], Duggi *et al.* (2013) [10], Koundinya *et al.* (2013) [12], Chandramouli *et al*. (2016) [5] and Pachiyappan and Saravannan (2016) [15] for fruit yield per plant; Singh *et al.* (2007) [24] and Phani *et al*. (2015) [17] for number of pickings; Bindu *et al.* (1997) [3], Singh *et al.* (2007) [24], Prashant Kumar *et al.* (2011) [18] and Phani *et al.* (2015) [17] for number of nodes per plant; Bindu *et al.* (1997) [3], Hazra and Basu (2000) [11], Dhall *et al.* (2000) [30], Singh *et al.* (2007) [24], Nwangburuka *et al.* (2012) [14], Reddy *et al.* (2012a) [21] and Duggi *et al.* (2013) [10] for fruit length; Singh *et al.* (2007) [24], Das *et al.* (2012) [8] and Chandramouli *et al*. (2016) [5] for fruit width, Reddy *et al.* (2012a) [21], Koundinya *et al.* (2013) [12], Yonas *et al.* (2014) [28], Phani *et al*. (2015) [17] and Chandramouli *et al*. (2016) [5] for internodal length.

The estimates of heritability were moderate for 10- green fruits weight, number of branches per plant, days to 50 percent flowering, days to last picking, days to first flowering and days to first picking. Similar results of moderate heritability was reported by Rathava *et al.* (2019) [20] for fruit weight.

Estimates of genetic advance in general help to predict the extent of improvement that can be achieved in one cycle of selection for improving the different characters. Genetic advance as percentage of mean was calculated to predict the genetic gain. The expected genetic advance value was high for characters green fruit yield per plant, plant height and 10-green fruits weight while, moderate for number of nodes per plant and internodal length. weight. Similar results were also observed by Dhall *et al.* (2002) [9], Verma *et al.* (2004) [25], Dakane *et al.* (2007) [7], Naidu *et al.* (2007) [13], Prashant Kumar *et al.* (2011) [18], Reddy *et al.* (2012a) [21] and Koundinya *et al.* (2013) [12] for the plant height; Dhall *et al.* (2002) [9], Dakane *et al.* (2007) [7], Naidu *et al.* (2007) [13], Prashant Kumar *et al.* (2011) [18], Reddy *et al.* (2012a) [21] and Koundinya *et al.* (2013) [12] for fruit yield per plant. In the present study, low genetic advance was observed for fruit width, number of branches per plant, days to first flowering, number of picking, days to 50 percent flowering, days to first picking, fruit length, days to last picking and number of fruits per plant. Low genetic advance was also observed by Vijay and Manohar (1990) [26] and Koundinya *et al.* (2013) [12] for fruit length; Koundinya *et al.* (2013) [12] for days to first flowering.

Table 1: Analysis of variance showing mean squares of 14 characters in 40 genotypes of okra

Source	D.F.	Days to first flowering	Days to 50 percent flowering	Days to first picking	Plant height (cm)	Number of fruits per plant	Fruit length (cm)	Fruit width (cm)
Replications	2	7.15	17.50	25.08	378.05	4.45	3.18	0.01
Genotypes	39	5.03**	11.61**	15.62**	1265.46**	14.07**	5.83**	0.04**
Error	78	2.67	5.63	8.31	126.08	1.78	1.03	0.005

Source	D.F.	10-green fruits weight	Days to last picking	Number of picking	Number of nodes per plant	Internodal length (cm)	Number of branches per plant	Green fruit yield per plant (gm)
Replications	2	297.20	37.63	3.75	2.22	2.20	0.85	453.87
Genotypes	39	237.55**	26.21**	2.98**	22.43**	17.08**	0.87**	4448.17**
Error	78	95.83	13.63	1.07	2.57	0.71	0.42	152.35

*, ** significant at 5% and 1% levels, respectively

Table 2: Mean performance and range including variability parameters for 14 characters in okra

Sr. No.	Characters	Range	Coefficient of range (%)	Mean	Genotypic coefficients of variance (GCV %)	Phenotypic coefficients of variance (PCV %)	Heritability in broad sense H^2_{bs} (%)	Genetic advance (GA)	Genetic advance as % of mean (GAM%)
1.	Days to first flowering	40.73-46.40	6.50	42.94	2.07	3.02	47.01	1.25	2.92
2.	Days to 50 percent flowering	48.33-57.33	8.51	51.77	2.72	3.80	51.54	2.09	4.03
3.	Days to first picking	46.27-57.27	10.62	51.73	3.02	4.41	46.79	2.20	4.25
4.	Plant height (cm)	108.65-210.19	31.84	134.26	14.51	15.30	90.04	38.09	28.37
5.	Number of fruits per plant	11.07-23.20	35.39	14.97	13.52	14.47	87.37	3.90	26.04
6.	Fruit length (cm)	9.46-17.25	29.16	12.00	10.53	11.61	82.30	2.36	19.68
7.	Fruit width (cm)	1.32-1.75	14.00	1.53	7.57	8.00	89.67	0.23	14.77
8.	10-green fruits weight (g)	103.80-157.73	20.62	121.04	5.68	7.35	59.66	10.94	9.03
9.	Days to last picking	75.93-92.00	9.62	81.47	2.51	3.63	47.99	2.92	3.58
10.	Number of picking	8.00-13.87	26.84	9.46	8.43	10.54	64.03	1.31	13.90
11.	Number of nodes per plant	8.13-17.53	36.63	12.40	20.74	22.04	88.52	4.99	40.19
12.	Internodal length (cm)	4.63-14.99	52.80	8.05	29.02	29.64	95.85	4.71	58.52
13.	Number of branches per plant	5.20-7.60	18.75	5.90	6.58	9.13	52.00	0.58	9.78
14.	Green fruit yield per plant (g)	133.81-366.44	46.50	184.22	20.54	20.90	96.57	76.60	41.58

Conclusion

The study revealed that the phenotypic coefficient of variation estimates were higher than their corresponding genotypic coefficient of variation for all characters studied due to the environmental condition. The high heritability values were observed for all the fourteen characters except 10- green fruits weight, number of branches per plant, days to 50 percent flowering, days to last picking, days to first flowering and days to first picking. The high heritability values indicated that heritability may be due to higher contribution of genotypic component in these traits. The genetic advance expressed as percentage of mean was found high for green fruit yield per plant, internodal length, plant height, fruit width, number of nodes per plant number of fruits per plant, fruit length and number of picking. It can be resolved from variability parameters that additive gene action was operating for number of fruits per plant, plant height, fruit length, internodal length, number of branches per plant, and green fruit yield per plant.

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