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Estimation of parameters of variability for different quantitative traits in okra, *Abelmoschus esculentus* (L) Moench

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ABSTRACT

The scope of improvement in any crop depends upon the magnitude of genetic variability present in the available germplasm. Greater the variability in the available germplasm better would be the chances of selecting superior genotypes. Therefore thirty five diverse genotypes of okra were evaluated for yield and its contributing traits and analysis of variance showed significant differences among all the genotypes for all the characters under study. Five genotypes namely IC-58235, LC-13-9, VRO-3, LC-12-5 and Arka Anamika gave higher yield and also performed better for other horticultural traits viz days taken to marketable maturity, fruit breadth, average fruit weight, harvest duration, number of marketable pods per plant than the check variety P-8. For all the characters studied phenotypic coefficients of variability were higher in magnitude than genotypic coefficients of variability thus showing that these traits were less influenced by environmental factors. High heritability estimates coupled with high genetic gain were observed for fruit yield per plant and per hectare which indicates that these characters are under additive gene effects and are more reliable for effective selection.

Keywords: Genetic variability; genotypes; traits; germplasm

INTRODUCTION

Okra, *Abelmoschus esculentus* (L) Moench is one of the important vegetable crops grown for its tender green fruits during spring-summer and rainy seasons. It has high nutritive value and export potential. Its immature fruits are generally cooked as vegetable. To improve the yield and other characters information on genetic variability among different quantitative traits is necessary. The improvement in any crop is proportional to the magnitude of its genetic variability present in the population. An evaluation to detect extent of variability available for the yield attributes and their

heritability values is of immense help to the breeders to select the breeding methods for improvement of that trait. Therefore an attempt was made to assess genetic variability in the available okra germplasm by partitioning of overall variability into its heritable and non-heritable components based on genetic parameters like genotypic coefficient of variation, heritability and expected genetic advance for yield and its contributing traits.

MATERIAL and METHODS

The present investigations were carried out with thirty five diverse genotypes of okra collected from different sources (Table 1) at the experimental farm of the Department of Vegetable Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP during Kharif season of 2012. The genotypes were planted in a randomized complete block design (RCBD) with three replication at a spacing of 60 cm between rows and 20 cm between plants accommodating 18 plants per plot (1.8 m x 1.2 m). All the recommended package of practices were followed for raising a healthy crop. The observations were recorded as per NBPGR minimal descriptors from five competitive plants from each replication on thirteen parameters viz node number bearing 1st female flower, days taken to fifty per cent flowering, number of primary branches per plant, average plant height (cm), number of fruiting nodes per plant, inter-nodal distance (cm), days taken to marketable maturity, harvest duration (days), number of marketable fruits per plant, fruit length (cm), fruit breadth (cm), average fruit weight (g), yield per plant (g) and per hectare (q). The analysis of variance for each trait was based on the linear model of Fisher (1954). Phenotypic and genotypic co-efficient of variation (Burton and De-Vane 1953), heritability in broad sense and genetic advance were calculated by using formula given by Hanson et al (1956) and Johnson et al (1955).

RESULTS and DISCUSSION

The analysis of variance revealed highly significant differences among the genotypes for all the traits under study (Table 2) which indicates that the genotypes differed significantly for all the traits. The mean, range, genotypic co-efficient of variability (GCV), phenotypic co-efficient of variability (PCV), heritability (h^2), genetic advance (GA) and genetic gain (GG) for different traits were evaluated and have been presented in Table 3. The range for days to marketable maturity varied from 53.33 to 63.33 days. The number of marketable fruits per plant ranged from 9.17 to 20.22, fruit length from 7.03 to 15.08 cm and fruit breadth from 1.29 to 1.69 cm. Average fruit weight varied from 7.79 to 14.69 g. Variation for number of fruits per plant, average fruit length and average fruit weight was found to be quite high which might be responsible for the wide

Table 1. List of okra genotypes studied along with their sources

Genotype	Source
EC-58235, IC-14080, IC-140906, IC-140927, IC-169359, IC-212267, IC-252256, IC-252272, IC-282237, IC-324402, IC-33995, IC-35995, IC-43733, IC-43742, IC-43750, IC-45802, IC-46018, IC-58235,	NBPGR, New Delhi
VRO-3, VRO-5, VRO-6	IIVR, Varanasi, UP
Arka Anamika	IIHR, Bangalore, Karnataka
LC-3, LC-10 , LC-49, LC-20-1, LC-20-4	Kangra, Himachal Pradesh
LC-12-1, LC-12-5	Bilaspur, Himachal Pradesh
LC-13-1, LC-13-9	Hamirpur, Himachal Pradesh
AE-113	UHF, Nauni, Solan, Himachal Pradesh
Parbhani Kranti	MPKV, Parbhani, Maharastra
P-7, P-8*	PAU, Ludhiana, Punjab

*Check variety

range in yield potential of different genotypes. Similar variation for days to marketable maturity in okra was also reported by Koundinya et al (2013). Dhall et al (2001), Alam and Hossain (2006) and Jindal et al (2010) also reported similar variation for number of marketable fruits per plant, Dhanke et al (2007), Jindal et al (2010) and Koundinya et al (2013) for fruit length in okra, Mehta et al (2006), Yadav et al (2010) and Koundinya et al (2013) for fruit breadth in okra germplasm and Sarkar et al (2004), Mehta et al (2006) and Koundinya et al (2013) reported wide range of variation in fruit weight in okra genotypes. Fruit yield per plant ranged from 108.40 to 291.97 g. A lot of variability for yield indicates a great scope for selection of desirable types. The results collaborated the findings of Jaiprakashan et al (2006), Singh and Singh (2006), Jindal et al (2010), Prakash and Pitchaimuthu (2010) and Koundinya et al (2013).

The range of mean values may present a rough estimate about the variation of magnitude of divergence present among different genotypes. But the estimates of genotypic and phenotypic coefficients are of greater use in determining the content of variability present within the material. For all the characters studied phenotypic

Table 2. Analysis of variance for various horticultural traits in okra

Character	(Mean Sum of Squares)			
	Replication	Genotype	Error	Total
df	2	34	68	104
Node # bearing 1st flower	0.197	0.186*	0.099	0.482
Days to 50% flowering	6.886	7.309*	3.180	17.375
# Primary branches/plant	0.034	0.814*	0.036	0.885
Average plant height (cm)	5.250	559.660*	29.340	594.260
# Fruiting nodes	1.025	13.446*	0.764	15.236
Inter-nodal distance (cm)	0.110	3.120*	0.130	3.360
Days to marketable maturity	1.670	15.95*	1.130	18.740
Harvest duration (days)	0.460	44.760*	2.390	47.610
# Marketable fruits/plant	1.880	16.390*	1.100	19.370
Fruit length (cm)	0.180	11.070*	0.450	11.700
Fruit breadth (cm)	0.000	0.016*	0.000	0.017
Average fruit weight (g)	0.204	9.688*	0.403	10.296
# Ridges/fruit	0.009	0.819*	0.029	0.857
Green fruit yield/plant (g)	519.086	5836.611*	287.691	6643.388
Green fruit yield/ha (q)	230.700	2593.997*	127.860	2952.558

*Significant at 5% level of significance

coefficients of variability were higher in magnitude than genotypic coefficients of variability though differences were very less in majority of the cases thus showing that these traits are less influenced by environmental factors. Coefficients of variability varied in magnitude from character to character (either low or moderate) indicating a great diversity in the genotypes under study.

The moderate phenotypic coefficients of variability (PCV) were recorded for number of primary branches per plant (23.59), inter-nodal length (15.38 cm), number of marketable fruits per plant (17.71), fruit length (17.88 cm), average fruit weight (16.49 g), marketable fruit yield per plant (28.79 q) and fruit yield per hectare (28.79). It means that the apparent variation was not only due to genotypes but also due to the influence of environment. For node number bearing first flower (5.70), days taken to 50 per cent flowering (4.17), days to marketable maturity (4.21), average plant height (11.69 cm), number of fruiting nodes (12.39), harvest duration (7.12 days), fruit breadth (5.16 cm) and number of ridges (10.20) phenotypic coefficients of variability were low in magnitude. Thus selection will not be

effective based on these traits. Similar results were also reported for different horticultural traits by Patro and Ravisankar (2004), Mehta et al (2006), Dakahe et al (2007), Singh et al (2008), Magar and Madrap (2009), Akotkar et al (2010), Yadav et al (2010), Jindal et al (2010), Prakash and Pitchaimuthu (2010), Kumar et al (2011), Koundinya et al (2013). Jindal et al (2010) and Koundinya et al (2013) have reported low phenotypic coefficient of variability for different traits in okra.

The moderate genotypic coefficients of variability (GCV) were recorded for number of primary branches per plant (22.11), number of marketable fruits per plant (15.51), fruit length (16.06 cm), average fruit weight (16.83 g), green fruit yield per plant (26.78 g) and fruit yield per hectare (26.78 q). For node number bearing first flower (2.72), days taken to 50 per cent flowering (2.29), days to marketable maturity (3.80), average plant height (10.83 cm), inter-nodal length (14.49 cm), number of fruiting nodes (11.40), harvest duration (6.58 days), fruit breadth (4.74 cm) and number of ridges per fruit (9.68) genotypic coefficients of variability were low in magnitude. Similar results were also reported for different horticultural traits in okra by Mehta et al (2006), Dakahe et al (2007), Singh et al (2008), Magar and Madrap (2009), Akotkar et al (2010) Yadav et al (2010), Jindal et al (2010), Prakash and Pitchaimuthu (2010), Kumar et al (2011) and Koundinya et al (2013). The low genotypic coefficients of variability for average fruit weight was found by Jindal et al (2010) and Koundinya et al (2013) in contrast to moderate GCV for the trait under the present study. This may be due to much genetic variability amongst the experimental material used in the present investigations. Moderate genotypic and phenotypic coefficients of variation were noticed for fruit yield per plant and average fruit weight indicating maximum variability among the genotypes selected for evaluation and thus this trait provides better chance of selection of desirable genotypes.

The estimates of heritability (in broad sense) were found high for all the characters except moderate for days taken to 50 per cent flowering and low level of heritability was obtained for node number bearing first flower. Similar results of high heritability for number of primary branches per plant, average plant height, number of marketable fruits per plant, fruit length, fruit breadth, average fruit weight, fruit yield per plant and fruit yield per hectare were also reported by Panda and Singh (1997) and Jindal et al (2010). In the light of the results obtained in the present studies it can be inferred that selection can be performed for highly heritable characters.

Genetic gain (expressed as per cent of population mean) was low to high in nature for different characters. It was found high for fruit yield per plant and yield per hectare. Moderate genetic gain was observed for number of primary branches

Table 3. Estimates of phenotypic and genotypic coefficients of variability, heritability, genetic advance and genetic gain for different traits of okra

Character	Range	Mean ± SE(d)	Coefficients o f variability (%)		Heritability (%)	Genetic advance	Genetic gain (%)
			Phenotypic	Genotypic			
Node # bearing 1st flower	5.73-6.80	6.27 ± 0.26	5.70	2.72	22.80	0.17	2.71
Days taken to 50% flowering	47.33-54.67	51.23 ± 1.46	4.17	2.29	30.20	1.33	2.60
# Primary branches per plant	1.47-3.53	2.30 ± 0.16	23.59	22.11	87.80	0.98	42.61
Average plant height (cm)	102.53-153.67	122.81 ± 0.4.42	11.69	10.83	85.80	25.36	20.67
# Fruiting nodes	11.07-22.69	18.04 ± 0.71	12.39	11.40	84.70	3.90	21.62
Inter-nodal length (cm)	4.83-9.27	6.89 ± 0.29	15.38	14.49	88.80	1.94	28.16
Days to marketable maturity (days)	53.33-63.33	58.48 ± 0.87	4.21	3.80	81.40	4.13	51.30
Harvest Duration (days)	50.43-66.07	57.09 ± 1.26	7.12	6.58	85.50	7.16	12.54
# Marketable fruits/plant	9.17-20.22	14.06 ± 0.85	17.71	16.06	82.30	4.22	30.01
Fruit length (cm)	7.03-15.01	11.18 ± 0.55	17.88	16.83	88.60	3.65	32.65
Fruit diameter (cm)	1.29-1.69	1.50 ± 0.03	5.16	4.74	84.40	0.13	8.67
Average fruit weight (g)	7.79-14.61	11.35 ± 0.52	16.49	15.51	88.50	3.41	30.04
# Ridges/fruit	4.67-7.00	5.30 ± 0.11	10.20	9.68	90.00	1.00	18.87
Fruit yield/plant (g)	108.40-291.97	160.58 ± 13.85	28.79	26.78	86.50	82.38	51.30
Fruit yield/hectare (q)	72.27-194.64	107.05 ± 9.23	28.79	26.78	86.50	54.92	51.30

per plant, number of marketable fruits per plant, fruit length and average fruit weight whereas it was recorded low for node number bearing first flower, days taken to 50 per cent flowering, average plant height, days to marketable maturity, number of fruiting nodes, inter-nodal length, harvest duration, fruit breadth and number of ridges per fruit. These findings are in line with the results of Mehta et al (2006), Jindal et al (2010), Kumar et al (2011) and Koundinya et al (2013).

The knowledge of the heritability along with genetic gain aids in drawing valuable conclusions for selection of breeding methods to be employed for further improvement of the traits. Detection of significant genetic variability indicates that genetic variance exists in the genotypes but says nothing about the range of genetic variability within a particular population. A broad sense heritability estimate provides information on relative magnitude of genetic and environmental variation in germplasm pool. High heritability estimates coupled with high genetic gain were observed for fruit yield per plant and per hectare which indicates that these characters are under additive gene effects and these characters are more reliable for effective selection (Panse 1957). Similar results for fruit yield per plant have also been reported by Vashistha et al (1982) and Singh et al (2006). High heritability coupled with moderate genetic gain was observed for number of primary branches per plant, number of marketable fruits per plant, fruit length and average fruit weight that indicates that these characters are under non-additive gene effects and selection for these characters will be less effective. Such traits are more under the influence of environment and do not respond to selection. Similar results for number of marketable fruits per plant were also reported by Koundinya et al (2013). In contrary to the present investigations high heritability coupled with low genetic gain for average fruit length and average fruit weight was reported by Mehta et al (2006) and Jindal et al (2010) respectively which may be attributed to the differences in genotypes used in the study.

Therefore the present investigations conclude that five genotypes namely IC-58235, LC-13-9, VRO-3, LC-12-5 and Arka Anamika resulted in higher yield and also performed better for other horticultural traits viz days taken to marketable maturity, fruit breadth, average fruit weight, harvest duration and number of marketable pods per plant than the check variety P-8. Thus these genotypes can be involved in further breeding programmes and can be tested under multilocations on-farm or adaptive trials before final release in mid-hills of Himachal Pradesh.

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