HortFlora Research Spectrum, 1(2): 139-144 (2012) Online Copy ISSN : 2250-2823

GENETIC VARIABILITY, HERITABILITY, GENETIC ADVANCE, CORRELATION AND PATH ANALYSIS IN OKRA

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ABSTRACT : A field experiment was conducted with twenty diverse genotypes of Okra (Pusa Makhamali, VRO-6, VRO-5, Selection-10, IIVR-10, HRB-10, IIVR-11, Perkins Long Green,VRO-4, HRB-9-2, Parbhani Kranti, RS-410, Punjab-7, DOV-91-4, D-1-87-1, EMS-8-1,Bhindi Vaphy, 315, and BO-2) in randomized block design with three replications. Analysed data revealed that among all the genotypes, Pusa Makhamali, Perkins Long Green, Parbhani Kranti, VRO-6, VRO-5 and Selection-10 gave promising results.

Keywords: *Okra, genetic variability, heritability, genetic advance, path analysis.*

Okra [*Abelmoschus esculentus* (L.) Moench] belongs to family Malvaceae with 2n =130 chromosomes. It is one of the most important vegetable crops, which is grown throughout the tropical and subtropical parts of the world. Being a day neutral plant, it is cultivated in every season in one or other parts of the country. Being a multipurpose, okra is valued for its tender delicious fruits. Its dry seed are a rich source of iodine, carbohydrate, protein, oil and vegetable curd. Seeds are also used as coffee additive or substitute. Its dry seeds contain 13-22% edible and 20-24% crude protein (Thamburaj and Singh, 9), foliage can be used for biomass and dried stem as the source of paper pulp or fuel. Its roots are used to clean sugarcane juice to make jaggery. Okra is praised for its medicinal values, as its fruits are useful in genito-urinary disorders, spermatorrhoea and chronic dysentery. Okra is often cross-pollinated where the natural cross-pollination occurs from 8.75 to 9.61%. Okra is highly susceptible to frost and requires warm climate for fruit production. The improvement in genetic make up *i.e.,* growing habit of the plant increases the harvest index and improvement in resistance to insect-pest and diseases ultimately increase the yield. There are great prospects and possibilities for the further increase in productivity and production of okra. Increase in genetic yield potential gives a boost to okra production. Some biometrical techniques like variability, correlation and path analysis provide relative contribution of various yield related traits. Genotypic and phenotypic coefficients of variance suck out the association between yield and yield contributing traits in okra. If the association is positive and significant, simultaneous important and association is possible and significant. As the correlation measures the mutual relationship between different traits of a plant, it helps to determine the best yield contributing traits. Path analysis deals with a close system of variables that are linearly related. It specifies the causes and generally measures their relative importance. Path analysis split the correlation coefficient in to the measures of direct and indirect effect and determines direct and indirect contribution of various characters towards the yield.

Received : 23.12.2011 Revised : 18.2.2012 Accepted : 20.3.2012

MATERIALS AND METHODS

The experimental material included 20 diverse genotypes viz. (Pusa Makhamali, VRO-6, VRO-5, Selection-10, IIVR-10, HRB-10, IIVR-11, Perkins Long Green, VRO-4, HRB-9-2, Parbhani Kranti, RS-410, Punjab-7, DOV-91-4, D-1-87-1, EMS-8-1, Bhindi Vaphy, 315, and BO-2) and were sown during rainy season of the year 2005-06 in randomized block design with there replications at Vegetable Research Farm, Institute of Agricultural Sciences, BHU, Varanasi (U.P.). Row -to -row and plant-to-plant spacings were maintained 60 cm and 30 cm, respectively. All the agronomic packages of practices were adopted to grow a healthy crop in each replication. Randomly 5 plants in each

genotype were marked for observation. Observations were recorded in 12 characters viz, plant height (cm), no. of branches /plant, no. of flowers/ plant, no. of fruits/ plant, no. of fruits/ branch, length of fruit (cm), weight of fruit/ plant(g), diameter of fruit (cm) and yield/plant. The recorded data were analyzed as suggested by Panse and Sukhatme (8) for analysis of variance. The genotypic and phenotypic coefficient of variance was calculated as per the formula suggested by Burton (3). Johnson and Comstock (5) for heritability and genetic advance, Al – Jibouri *et al.,* (1) for correlation coefficient and Deway and Lu (4) for path coefficient.

RESULTS AND DISCUSSION

The mean sum of square was highly significant for all traits, indicating the presence of wide variability in the present genotypes of okra (Table 1). Yield /plant (g) showed a widest range (307.41 – 702.67), the minimum and maximum yield /plant at edible stage was recorded in genotypes Bhindi Vaphy and Pusa Makhamali, respectively with a mean value 401.48. Maximum plant height (cm) was recorded in Pusa Makhamali, (114.71) while minimum in Punjab selection (72.17), with a mean value 90.15. Days to flower appearance ranged from 45.32 to 65.32 (Parbhani Kranti and IIVR-10). Number of leaves/ plant and no. of flowers/plant also registered considerable variability, which ranged from 40.39 to (BO-2) to 77.55 (Pusa Makhamali) and 29.90 (BO-2) to 77.67 (Pusa Makhamali) maximum no. of fruits/plant was recorded in VRO-6 and minimum in EMS-8-1, maximum diameter of fruits was recorded in Pusa Makhamali (10.53) and minimum in BO-2 with a mean 8.60. Maximum length of fruits was recorded in Pusa Makhamali (9.60 cm), while minimum in BO-2 (6.19 cm) with a mean value 8.25. The maximum no. of fruits/ branch (9.10) was recorded in VRO-6 and minimum in Larm (5.93). The maximum no. of branches/plant was recorded in VRO-6 and minimum in Perkins Long Green, respectively. The maximum weight of fruit was recorded in Pusa Makhamali and minimum in Bhindi Vaphy.

In general, the phenotypic variance and phenotypic coefficient of variance were higher than their respective genotypic variance and genotypic coefficient of variance for all the traits (Table 2), indicating considerable effects of environment on their expression. In the present investigation, genotypes were found to possess a high to moderate phenotypic variance for various characters as revealed by PCV. Phenotypic coefficient of variance varied from 7.53 (weight of fruits) to 25.63 (no. of fruits/plant). The PCV expressed in form of percentage were high for no. of fruits/plant followed by yield/plant, no. of flowers/plant, no. of branches/plant, no. of leaves/plant, length of fruit, no. of fruits/branch, diameter of fruit (mm) and plant height (cm).

As the estimate of phenotypic variability cannot differentiate between the effect of genetic and environmental effects, so the study of genetic variability is effective in partioning out the real genetical differences. Higher the GCV, more the chances of improvement in that characters. In the present experiment, GCV were comparatively high for no. of fruits/ plant followed by yield/ plant, no. of flowers/plant, no. of leaves/plant, no. of branches/plant, plant height and stem diameter. The GCV was less than the corresponding PCV, indicating the role in the expression of the traits under the observation.

The difference between GCV and PCV was more in case of no. of branches/plant followed by no. of days to flower and length of fruits. The large difference between GCV and PCV indicated that environment affects to a large extent influence the traits having high GCV possessed better potential for further gain and improvement. Burton (3) has suggested that GCV together with heritability estimates would give the best option expected for the selection. Heritability estimates were high (>90%) for plant height, no. of leaves/ plant, no. of flowers/plant, no. of fruits/plant and yield/plant. Moderate heritability (70-90%) for no. of days to flower, diameter of stem , no. of fruits/branch and

Table 1: Estimates of range, general mean, standard error of mean, PCV, GCV and C.D. value for 12 characters in Okra.

S. No.	Characters	Range		Means	Standard error of mean	PCV (%)	GCV (%)	C.D. (P=0.05)
		Min.	Max.					
1.	Plant height (cm)	72.17(PB-7)	114.77(Pusa Makhamali)	90.15	2.102	14.45	14.16	4.248
2.	No. of branches/plant	3.99(BO-2)	9.72(VRO-5)	7.21	1.046	23.15	14.83	2.113
3.	No. of days to flower	45.32(P.Kranti)	65.32(IIVR-10)	53.83	1.634	11.41	10.79	3.302
4.	Diameter of stem	1.63(PLG)	2.84(VK-06)	1.989	0.125	11.92	13.93	0.252
5.	No. of leaves of/plant	40.39(BO-2)	77.55(Pusa (Makhamali)	57.56	1.753	19.64	19.28	5.542
6.	No. of flower/plant	25.90(BO-2)	77.67(Pusa Makhamali)	56.18	1.867	23.51	23.15	3.773
7.	No. of fruits/branch	5.93(Larm-1)	9.10(VRO-6)	74.56	0.431	16.18	14.55	0.871
8.	No. of fruits/plant	22.92(Ems-8-1)	75.93(VRO-6)	53.96	1.995	25.63	25.22	4.032
9.	Length of fruit (cm)	6.19(BO-2)	9.60 (P. Makhamali)	8.265	1.094	17.71	7.12	2.210
10.	Diameter of fruit (cm)	6.96 (BO-2)	10.53(P. Makhamali)	8.601	0.433	15.74	11.15	0.875
11.	Weright of fruits (g)	1.27 (Bhindi vaphy)	1.64 (Bhindi Vaphy)	1.479	0.105	7.53	5.73	0.101
12.	Yield/plant (g)	307.41 (Bhindi Vaphy)	702.67(Pusa (Makhamali	481.48	11.349	25.52	25.18	2.726

Table 2: Estimate of phenotypic variation and genotypic variation, heritability and genetic advance for 12 characters of Okra.

S. No.	Characters	Phenotypic variation	Genotypic variation	Heritability (%)	Genetic advance	Genetic advance of mean
1.	Plant height (cm)	1.3 88	1.328	0.961	25.79	1226.92
2.	No. of branches /plant	0.945	0.373	0.411	1.41	134.79
3.	No. of days to flower	0.263	0.229	0.894	11.31	692.16
4.	Diameter of stem	0.440	0.408	0.766	0.50	399.68
5.	No. of leaves / plant	94.316	93.18	0.964	22.45	1280.66
6.	No. of flowers /plant	0.255	0.078	0.970	26.39	1413.49
7.	No. of fruits /branch	8.065	7.987	0.808	2.01	466.35
8.	No. of fruits /plant	1.385	0.866	0.969	27.60	1383.45
9.	Length of fruit (cm)	0.482	0.296	0.462	0.49	44.78
10.	Diameter of fruit (cm)	0.405	0.396	0.766	1.73	399.44
11.	Weight of fruits (g)	0.917	0.737	0.578	0.13	260.00
12.	Yield / plant (g)	227.29	226.40	0.973	246.43	2171.38

Table 3 : Estimates of phenotypic (P) and genotypic (G) correlation coefficient for different characters in Okra.

Characters		Plant height (cm)	No. of branches /plant	No. of days to flower	Dia-meter of stem	No. of leaves/ plant	No. of flowers/ plant	No. of fruits/ branch	No. of fruits/ plant	Length of fruit (cm)	Dia-meter of fruit (cm)	Weight of fruits (g)	Yield/ plant
Plant height (cm)	P		0.097	0.068	0.005	0.180	0.614**	0.510**	0.775**	0.316	0.246	0.592**	0.347
	G		0.064	0.059	0.008	0.174	0.402*	0.069	0.159	0.164	0.496*	0.006	0.141
No. of branches/plant	P			0.060	0.321	0.045	0.061	0.183	0.118	0.272	0.349	0.404*	0.276
	G			0.692**	0.162	0.003	0.525**	0.639**	0.484*	0.464*	0.326	0.508**	0.507**
No. of days to flower	P				0.008	0.054	0.624**	0.441**	0.435*	0.445*	0.525**	0.418*	0.0515*
	G				0.024	0.657**	0.0456*	0.595**	0.514**	0.439*	0.431*	0.643**	0.591**
Diameter of stem	P					0.133	0.462*	0.499*	0.047	0.089	0.161	0.045	0.389
	G					0.423*	0.419*	0.658**	0.427*	0.420*	0.220	0.520**	0.636**
No. of leaves/plant	P						0.645**	0.103	0.198	0.454*	0.212	0.453*	0.465*
	G						0.632**	0.468*	0.382	0.111	0.448*	0.446*	0.665**
No. of flowers/plant	P							0.155	0.450*	0.567**	0.493*	0.595**	0.793**
	G							0.007	0.616**	0.673**	0.263	0.456*	0.687**
No. of fruits/branch	P								0.541**	0.191	0.571**	0.470*	0.661**
	G								0.584**	0.423*	0.330	0.545**	0.511**
No. of fruits/plant	P									0.151	0.438*	0.588**	0.627**
	G									0.534**	0.300	0.484*	0.610**
Length of fruit (cm)	P										0.525**	0.478*	0.519**
	G										0.301	0.066	0.601**
Diameter of fruit (cm)	P											0.448*	0.523**
	G											0.335	0.347
Weight of fruit (g)	P												0.614**
	G												0.650**

Table 4 : Direct (diagonal) and indirect effects of different traits contributing to yield in Okra (phenotypic level)

Character	Plant height (cm)	No. of branches/plant	No. of days to flower	Diameter of stem (cm)	No. of leaves/ plant	No. of flower/ plant	No. of fruits/ branch	No. of fruits/ plant	Length of fruit (cm)	Diameter of fruit (cm)	Weight of fruits (g)	Genotypic Correlation Coefficient of Yield
Plant height (cm)	**0.295**	0.019	0.017	0.002	0.051	0.090	0.020	0.047	0.048	0.146	0.019	0.141
No. of branches/ plant	0.005	**0.077**	0.007	0.012	0.000	0.002	0.011	0.006	0.013	0.025	0.016	0.507
No. of days to flower	0.007	0.011	**0.117**	0.003	0.007	0.012	0.011	0.013	0.016	0.015	0.005	0.591
Diameter of stem (cm)	0.003	0.062	0.009	**0.074**	0.042	0.157	0.137	0.010	0.008	0.034	0.008	0.336
No. of leaves/ plant	0.037	0.001	0.012	0.026	**0.055**	0.133	0.014	0.038	0.023	0.094	0.073	0.165
No. of flower/ plant	0.023	0.052	0.008	0.030	0.047	**0.328**	0.000	0.150	0.005	0.019	0.012	0.687
No. of fruits/ branch	0.004	0.008	0.005	0.200	0.004	0.000	**0.210**	0.270	0.007	0.018	0.019	0.511
No. of fruits/plant	0.115	0.061	0.083	0.019	0.132	0.012	0.351	**0.726**	0.025	0.218	0.133	0.610
Length of fruit (cm)	0.035	0.035	0.029	0.004	0.024	0.016	0.026	0.007	**0.212**	0.264	0.014	0.601
Diameter of fruit (cm)	0.094	0.062	0.025	0.190	0.085	0.050	0.063	0.057	0.057	**0.190**	0.063	0.347
Weight of fruit (g)	0.005	0.017	0.004	0.002	0.029	0.013	0.029	0.015	0.006	0.028	**0.083**	0.650

diameter of fruit suggested that the environmental effects constitute a major portion of the total phenotypic variation and hence direct selection for these characters will be less effective. High heritability for the characters controlled by polygene might be useful to plant breeder for making effective selection. Johnson *et al.* (5) reported that the heritability estimates along with genetic advance is more useful than the resultant effect for selecting best genotypes, as it suggests the presence of additive gene effects. High estimates of genetic advance were recorded for yield/plant followed by no. of fruits/plant, no. of flowers/plant, plant height and no. of leaves/plant.

The information on heritability alone may be misleading but when used in combination with genetic advance, the utility of heritability estimates increases. In the present investigation, high genetic advance alongwith high heritability was observed for yield/plant followed by no. of flowers/ plant, no. of fruits /plant, no. of leaves/plant, plant height and no. of days to flower. It indicated that additive gene effects were more important than these characters, so the improvement in these traits would be more efficiently done through selection in the present materials. Depending upon the variability, heritability and genetic advance estimates, it could be predicted that improvement by direct selection was possible in okra for traits like no. of flowers/plant, length of fruit, no. of branches/plant, plant height and no. of fruits/plant. Results are in consonance with Yadav *et al.* (10).

Fruit yield/plant in okra is the result of the interaction of no. of inter – related characters . Therefore, selection should be based on these components characters after assessing their relation with fruit yield/plant. In the present experiment, the values of correlation at genotypic level were high than the phenotypic correlation, indicating that there is a strong inherent association between the various characters studied. The yield/plant showed positive and significant correlation with no. of flowers/plant, no. of fruits/branches, no. of fruits/plant, length of fruit and weight of fruit at genotypic and phenotypic levels (Table 3&4). This indicated that fruit could be improved by making selection on the basis of no. of flowers/plant, no. of fruit/branch, no. of fruits/plant and length of fruits. These finding are also similar with those Bendale (2), Mishra *et al*. (6) and Osekita *et al*. (7).

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