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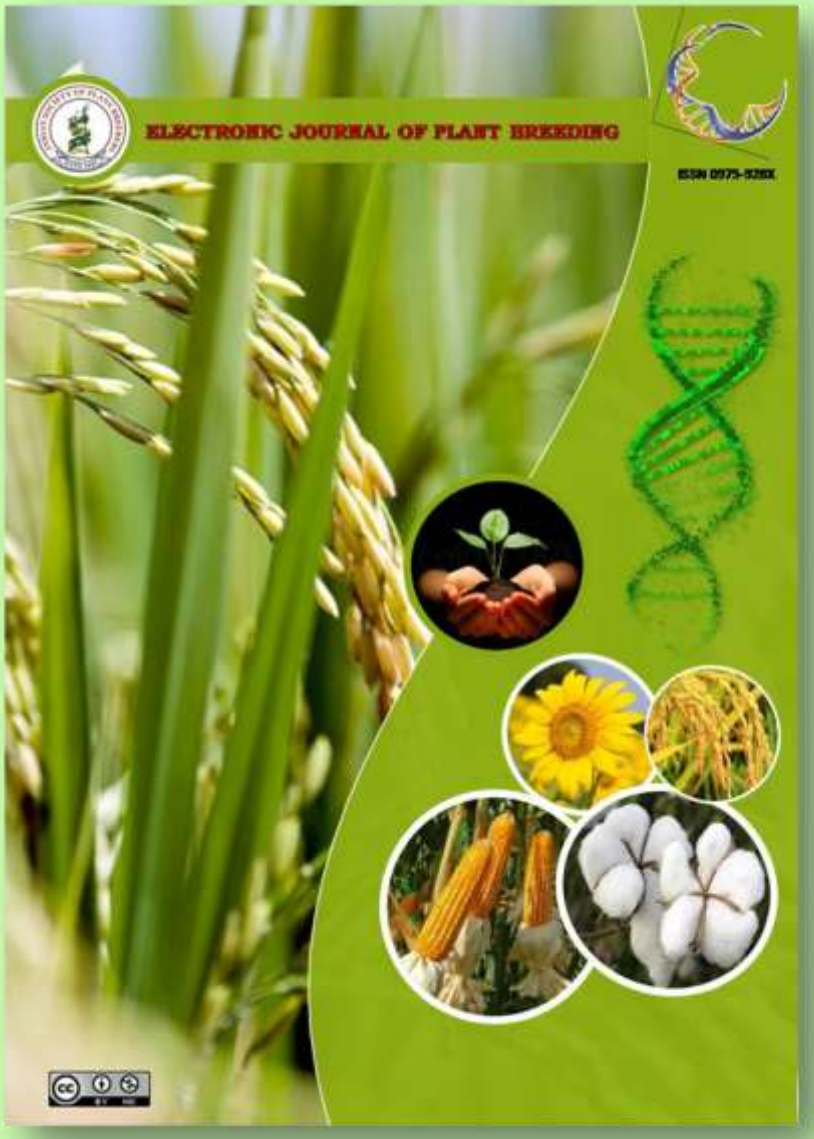

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Research Article

Studies on genetic parameters, correlation and causation among biometrical traits in bhendi

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Abstract
The present investigation was conducted to estimate genetic parameters *viz.*, genotypic coefficient variation (GCV), phenotypic coefficient variation (PCV), heritability and genetic advance (GA) along with correlation and path coefficient analysis, from data collected from fifty eight genotypes. High GCV and PCV were observed for fruit yield per plant, number of node to first fruiting and fruit girth. High heritability coupled with high GA was observed for almost all the characters of interest. These traits could well be improved by resorting to simple selection. The Fruit yield per plant evinced positive significant phenotypic and genotypic association with plant height and average fruit weight. Path coefficient analysis revealed that number of fruit per plant and average fruit weight exerted maximum positive direct effects which were equal to genetic correlation coefficient towards fruit yield per plant. Hence, number fruits per plant and average fruit weight may be good indicator traits for fruit yield improvement in okra breeding.

Key words
Okra, Fruit yield, GCV, PCV, Correlation, Path analysis.

Introduction

Bhendi (*Ablemoschus esculentus* (L.) Moench) commonly known as okra and lady's finger in India is grown for its tender fruit in tropical, subtropical and warmer parts of temperate region. Okra has a prominent position among fruit vegetables due to it multiple virtues like high nutritive and medicinal value wider adaptability, year round cultivation, good portability, export potential with bountiful returns (Reddy, 2010). Improvement in bhendi is being made by exploiting the available source of variability. In any crop improvement programme, germplasm serves as a valuable source of base population, which offers much scope for further improvement. The primary aim of the breeder is to evolve superior varieties from the available genotypes.

Evolving superior genotypes would be effective, only if the existing variability in the chosen material is wider. The observed variability for any character is the result of interaction of heredity effects of concerned genes and the influence of environment. Hence, it becomes necessary to partition the overall phenotypic variability into heritable and non-heritable components to have an effective selection for superior genotype. Estimation of co-efficient of variation helps to assess the variability in a population. Heritable variation can be effectively used with greater degree of accuracy when heritability is studied in conjunction with genetic advance. Manithan (2016) studied correlation and path coefficient analysis in bhendi. As the yield is influenced by a number of other quantitative characters, it is necessary to understand the association between them. This knowledge would help in selecting suitable traits. The genotypic and phenotypic correlation coefficients are calculated to measure the degree of association between yield and its contributing traits. Path co-efficient analysis developed by Wright (1921) help in partitioning the correlation co-efficient into direct and indirect effects, thereby, providing the relative importance of each of the causal factors.

Materials and Methods

Fifty eight genotypes of diverse origin were grown in on Randomized Block Design with three replications, with a spacing of 45 × 30 cm, in two row plots of 4.5 m length. The experiment was conducted at Plant Breeding Farm, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University during 2018. The genotypes were collected from National Bureau of Plant Genetic Resources (NBPGR), New Delhi. Observations were recorded on five randomly selected plants per entry, per replication on 10 agronomic traits *viz.*, days to first flowering, plant height at maturity (cm), number of nodes to first fruiting, days to first fruit harvest, number of branches per plant, number

of fruits per plant, average fruit weight (g), fruit length (cm), fruit girth (cm) and fruit yield per plant (g). Recommended agronomic practices and need based plant protection measures were judiciously followed. Multivariate analysis (D^2) was carried out by adopting Mahalanobis' D^2 statistic. Grouping of genotypes into different clusters was carried out following Tocher's method (Rao, 1952). The relative contribution of different traits towards total genetic divergence was calculated as per Singh and Choudary (1985). The statistical analyses were done with Indo state package, licensed at NRRI, Cuttack, Odissa, India.

The genetic parameters among the traits of interest were calculated as per the method suggested by Al-Jibouri *et al.* (1958) and Johnson *et al.* (1955). Path co-efficient analysis, suggested by Wright (1921), and Dewey and Lu (1959) was carried out to know the direct and indirect effects of the agronomic traits on fruit yield per plant

Results and Discussion

The analysis of variance indicated significant variation among the fifty eight genotypes for all the ten traits studied. This suggested that further analysis is appropriate (Table 1). The present investigation was conducted to estimate genetic parameters such as genotypic coefficient variation (GCV), phenotypic coefficient variation (PCV), heritability and genetic advance as per cent of mean (GA) as well as correlation and causation. The GCV was higher (23.87) for fruit yield per plant followed by fruit girth (20.51) and number of node to first fruiting (21.82). The PCV was also higher (24.62) for fruit yield per plant followed by fruit girth (21.11) and number of node to first fruiting (22.39). There was a close correspondence between GCV and PCV, indicating the lesser influence of the environment. Almost all the characters showed least ECV (<10 per cent). The heritability estimates were always higher for all the trait of interest. The genetic advance as percentage over mean was higher for fruit yield per plant, fruit girth, average fruit weight, fruit length, number of fruit per plant, number of branches per plant, number of node first fruiting and plant height at maturity. High heritability estimates coupled with high genetic advance were recorded for the traits *viz.*, fruit yield per plant, fruit girth, average fruit weight, fruit length, number of fruit per plant, number of branches per plant, number of node first fruiting and plant height at maturity (Table 2). It indicated that the above mentioned traits were under the influence of additive gene action. Hence, simple selection for these traits would be rewarding. On the contrary, the trait *viz.*, days to firs flowering and days to first fruit harvest which were endowed with high heritability estimates but with low genetic advance, indicated that these traits were under the influence of non-additive gene action. Hence, immediate selection will not be rewarding.

In the present study, the genotypic correlation co-efficient were higher than the corresponding phenotypic correlation co-efficient for most of the traits studied (Table 3). At phenotypic level, fruit yield per plant found to be significantly and positively correlated with plant height (0.333), number of fruit per plant (0.761), fruit weight (0.635), and fruit girth (0.540). Similar results were earlier reported by Neeraj Singh *et al.* (2017). At genotypic level, fruit yield per plant recorded significant and positive correlation with plant height (0.344), number of fruits per plant (0.774), average fruit weight (0.638), fruit length (0.334) and plant height (0.470).

Days to first flowering showed positive significant phenotypic as well as genotypic association with average fruit weight and showed not significant association with all other traits of interest. Plant height at maturity evinced positive significant phenotypic and genotypic association with average fruit weight and fruit yield per plant. Number of nodes to first fruiting was positively associated with average fruit weight at both phenotypic and genotypic level. Days to first fruit harvest also showed positive significant association with average fruit weight. Number of fruits per plant envisaged positive significant association at phenotypic and genotypic level with fruit yield per plant. Average fruit weight had positive significant phenotypic and genotypic association with fruit yield per plant. It also expressed negative significant association with fruit girth at genotypic level only. Fruit girth had positive significant association with fruit yield per plant at phenotypic level only. All the other characters pairs witness neutral association.

The path analysis furnishing direct and indirect effects for the observed agronomical characters towards fruit yield per plant were worked out and the results are presented in Table 4. The causal basis of the genetic coefficient among the genetically associated traits was elucidated with the aid of path analysis, suggested by Dewey and Lu (1959). Days to first flowering, plant height at maturity, number of nodes to fruit fruiting, number of branches per plant, fruit girth exerted negligible direct effects towards fruit yield per plant. Interestingly, number of fruits per plant (0.76270) and average fruit weight (0.61699) exerted maximum positive direct effect towards fruit yield per plant, which were more less equal to the genetic correlation coefficients (0.774; 0.638

respectively). Hence, they may be declared as choice of traits for fruit yield improvement in bhendi. Similar results earlier reported by Niraja *et al.* (2018) for number of fruit per plant and Yadav *et al.* (2017) for average fruit weight.

Days to first flowering exerted positive indirect effect towards fruit yield per plant through average fruit weight. Plant height at maturity exerted positive indirect effect towards fruit yield per plant through number of fruits per plant and average fruit weight. Number of nodes to first fruiting exerted positive indirect through average fruit weight towards fruit yield per plant. Days to first fruit harvest exerted maximum positive indirect effect towards fruit yield per plant through average fruit weight. However, the high positive indirect effect exerted by average fruit weight towards fruit yield per plant was nullified by its negative indirect effect through number of fruits per plant. Number of fruits per plant exerted positive indirect effect through fruit yield per plant. Number of fruits per plant exerted negligible effects towards fruit yield per plant through all the traits of interest. Average fruit weight exerted negligible indirect effect towards fruit yield per plant. All the other traits exerted negligible indirect effect towards fruit yield per plant.

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Table 1. Analysis of variance for 58 bhendi genotypes

Source	df	Mean sum of square (MSS)									
		Days to first flowering	Plant height at maturity	Number of nodes to first fruiting	Days to first fruit harvest	Number of branches per plant	Number of fruits per plant	Average fruit weight	Fruit length	Fruit girth	Fruit yield per plant
Replication	2	6.23	219.99	0.03	16.70	0.01	0.85	0.05	0.58	0.05	461.13
Genotype	57	35.81**	995.87**	2.41**	68.75**	0.84*	43.32 **	21.84**	16.95**	2.06**	23901.23**
Error	114	4.50	47.15	0.04	11.70	0.02	0.96	0.91	0.55	0.04	497.94

* Significant at 5 per cent level ** Significant at 1 per cent level

Table 2. Genetic variability for ten traits of 58 bhendi genotypes

Variability parameters / Traits	GCV (%)	PCV (%)	ECV (%)	h^2 (BS) (%)	GA as % of mean
Days to first flowering	7.27	8.70	4.78	69.87	12.52
Plant height at maturity	13.81	14.80	5.33	87.02	26.54
Number of nodes to first fruiting	21.82	22.39	5.01	94.99	43.80
Days to first fruit harvest	8.58	10.91	6.73	61.09	13.91
Number of branches per plant	18.70	19.47	5.41	92.29	37.02
Number of fruits per plant	18.17	18.78	4.74	93.64	36.23
Average fruit weight	14.75	15.69	5.33	88.45	28.58
Fruit length	16.40	17.21	5.22	90.81	32.20
Fruit girth	20.51	21.11	4.98	94.44	41.06
Fruit yield per plant	23.87	24.62	6.03	94.01	47.67

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Table 3. Phenotypic (P) and Genotypic (G) correlation co-efficient among fruit yield and its component traits in bhendi

S. No.	Characters	Type of correlation	Plant height at maturity	Number of nodes to first fruiting	Days to first fruit harvest	Number of branches per plant	Number of fruits per plant	Average Fruit weight	Fruit Length	Fruit Girth	Fruit yield per plant
1.	Days to first flowering	(P)	-0.010	0.142	0.189	0.021	-0.007	0.345**	0.222	-0.026	0.211
		(G)	-0.099	0.032	0.242	-0.126	-0.137	0.445**	0.087	-0.183	0.168
2.	Plant height at maturity	(P)		0.065	0.042	-0.129	0.163	0.327**	0.185	0.033	0.333**
		(G)		0.041	0.044	-0.176	0.151	0.373**	0.163	-0.001	0.344**
3.	Number of nodes to first fruiting	(P)			0.206	0.144	0.004	0.253*	0.260	-0.115	0.175
		(G)			0.250*	0.098	-0.041	0.274*	0.211	-0.174	0.152
4.	Days to first fruit harvest	(P)				-0.007	-0.197	0.383**	0.102	-0.334**	0.102
		(G)				-0.021	-0.261*	0.477**	0.111	0.451**	0.108
5.	Number of branches per plant	(P)					0.153	-0.002	0.124	0.052	0.127
		(G)					0.116	-0.002	0.062	-0.001	0.100
6.	Number of fruits per plant	(P)						-0.004	0.116	0.209	0.761**
		(G)						0.020	0.066	0.173	0.774**
7.	Average fruit weight	(P)							0.155	-0.248	0.635**
		(G)							0.173	-0.266*	0.638**
8.	Fruit length	(P)								0.146	0.202
		(G)								0.106	0.183
9.	Fruit girth	(P)									0.540**
		(G)									-0.023

P - Phenotype correlation co-efficient; G - Genotype correlation co-efficient *, ** - Significant at 5% & 1% level respectively.

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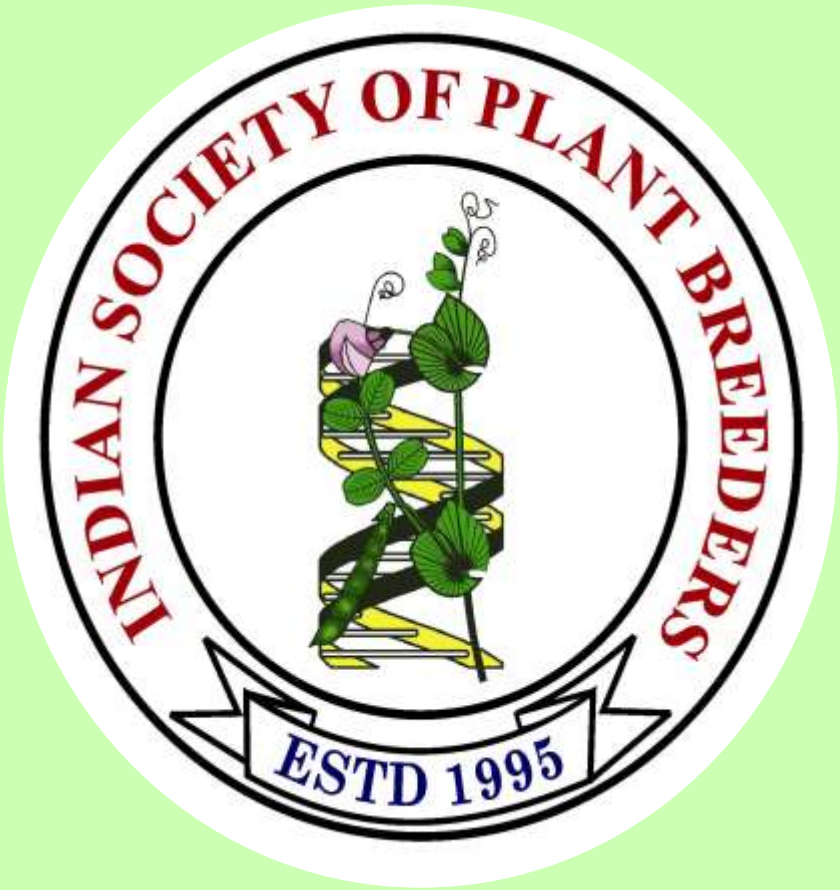
Table 4. Direct and indirect effects of various characters on fruit yield per plant as partition by path analysis in bhendi

S. No.	Characters	Days to first flowering	Plant height at maturity	Number of nodes to first fruiting	Days to first fruit harvest	Number of branches per plant	Number of fruits per plant	Average Fruit weight	Fruit length	Fruit girth	Genotypic correlation with yield
1.	Days to first flowering	-0.00518	0.00030	0.00025	0.00260	-0.00124	-0.10446	0.27479	0.00118	-0.00019	0.1680
2.	Plant height at maturity	0.00051	-0.00303	0.00031	0.00047	-0.00173	0.11545	0.22993	0.00222	-0.0000	0.3440**
3.	Number of nodes to first fruiting	-0.00017	-0.00012	0.00763	0.00268	0.00096	-0.03112	0.16905	0.00286	-0.000118	0.1520
4.	Days to first fruit harvest	-0.00125	-0.00013	0.00190	0.01073	-0.00020	-0.19883	0.29429	0.00151	-0.00046	0.1080
5.	Number of branches per plant	0.00065	0.00053	0.00074	-0.00022	0.00982	0.8838	-0.00114	0.00083	-0.0000	0.1000
6.	Number of fruits per plant	0.00071	-0.00046	-0.0031	-0.00280	0.00114	0.76270	0.01209	0.00090	0.00018	0.774**
7.	Average fruit weight	-0.00231	-0.00113	0.00209	0.00512	-0.0002	0.01494	0.61699	0.00235	-0.00027	0.638**
8.	Fruit length	-0.00045	-0.00050	0.00161	0.00119	0.00061	0.05039	0.10696	0.01355	0.00009	0.183
9.	Fruit girth	0.00095	0.0000	-0.00133	-0.00484	-0.00484	0.00001	0.13224	0.00115	0.00102	-0.023

Residual effect = 0.07.

* - Significant at 5 per cent level and **- Significant at 1 per cent level



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