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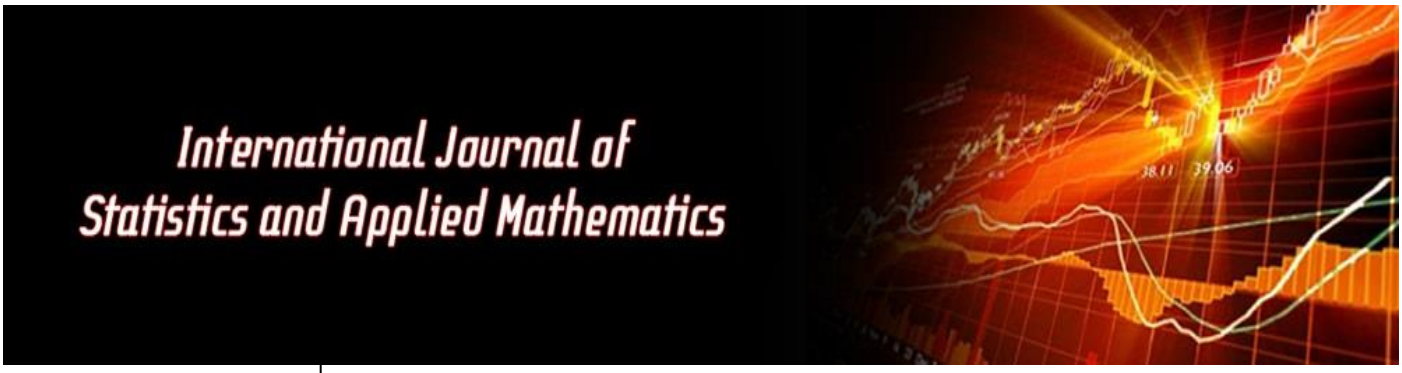

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Genetic variability studies in okra (*Abelmoschus esculentus* (L) Moench.)

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Abstract
The extent to which a crop can be improved is contingent upon the level of genetic variability found in the available germplasm. Thus, in order to investigate the genetic advancement, heritability, and variability of okra, four crosses were assessed during the kharif 2021-2022.The traits were studied plant height, days to 50% flowering, fruit length, number of fruits per plant, number of seeds per pod. For every character under study, the genotypes varied significantly, according to the analysis of variance. High heritability coupled with high genetic advance expressed as percent of mean were observed for number of seeds per pod and high heritability coupled with moderate genetic advance expressed as percent of mean were recorded for fruit length, number of fruits per plant. High heritability coupled with low genetic advance expressed as percent of mean were recorded for plant height, days to 50% flowering suggesting that selection could be effectively enhanced.

Keywords: Genetic variability, heritability, genetic advance, okra

Introduction
Okra is one of the important vegetable crop grown during spring summer and rainy season. It is one of the choicest fruit vegetable grown extensively in the subtropical to tropical warm area of the world including India, Africa, Turkey and other neighbouring countries. It is widely grown during summer and rainy seasons for its tender green fruits, is one of the most important vegetable crops of India, however its tender green leaves are also eaten in the Far East countries. It has cultivation, export potential and high nutritive value. Okra is a powerhouse of variable prominent position among vegetables due to its wide adoptability, year round nutrients. It is commonly known as bhindi or lady"s finger, belongs to the class dicotyledonae, order Malvales and family Malvaceae. Okra flowers are often cross-pollinated crop with somatic chromosome number 2n=130, with out-crossing to an extent of 4-19 per cent with the maximum of 42.2 per cent under insect assisted pollination. In India 60 per cent share of export goes to okra among fresh vegetables. In India, okra is commercially grown in the states of Gujrat, Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka. It is an introduced vegetable crop in India. It is extensively grown for its tender pods, which are used as a very popular, tasty and gelatinous vegetable. It is a powerhouse of valuable nutrients. It has huge socio-economic potential for enhancing livelihoods in both rural and urban areas. It is used in curries, stewed with meat and cooked into soups. Fruits are also canned, green or dried for off season. The roots and stems of okra are used for cleaning the cane juice from which *gur* or brown sugar is prepared. Mature fruits and stems containing crude fiber are used in paper industry. Extracts from the seeds of okra is viewed as alternative source for edible oil. The oil content of the seed is quite high at about 40%. It is quite popular in India because of easy cultivation, dependable yield and adaptability to varying moisture conditions. Tender okra fruits are used as vegetable in India, Brazil, West Africa and many other countries. It is also available in dehydrated and canned forms. Okra has tremendous export potential as fresh vegetable. Okra contains good alkaline pH which contributes to its relieving effect in gastrointestinal ulcer by neutralizing digestive acid. Mucilage from okra has been reported to be effective as blood volume expander and has the potential to alleviate renal disease, reduce proteinuria and improve renal function.

Materials and Methods

The experimental material comprised of F4 and F5 generations each of four different okra crosses. These four crosses along with parents were sown during *Kharif* 2022 and summer 2023. The 116 number of progenies selected from each generations of these four crosses were evaluated during *Kharif* at Experimental Farm, Horticulture Research Scheme (Vegetable), Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experimental plot size 2.7m X 2.4 m and spaced at 60 X 45 cm between two rows and plants in Augmented Block Design (ABD) for each cross. The analysis of variance was carried out as suggested by Panse and Sukhatme (1967) [26]. The coefficients of variation, heritability in broad sense and expected genetic advance were estimated as suggested by Fisher (1950) [23] and Johnson *et al.* (1955) [24].

Results and Discussion

The results of the analysis of variance indicated that for every trait examined in this study, there were significant differences between genotypes. The mean, genotypic and phenotypic coefficient of variations, heritability and genetic advance as percentage of mean for all traits and all crosses are presented. An approximate measure of the variation in the degree of divergence between various genotypes can be obtained from the range of mean values. However, when figuring out how variable the material is, the estimates of the genotypic and phenotypic coefficients are more helpful. Adequate variation for each character among the crosses, P_1 x P_3 exhibited highest mean values for plant height (F_4= 152. 50, F_5= 149.13) (Table no. 1), days to 50% flowering (F_4= 49.66, F_5= 47.84) (Table no. 2), fruit length (F_4= 24.66, F_5= 21.84) (Table no. 3), number of fruits per plant (F_4= 13.17, F_5= 14.40) (Table no. 4). The phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were low in all the crosses in both generations. Similar variability result were reported by (Majumdar *et al.*, 1974) [13], Doddankatte *et al.* (2016) [3]. All the crosses showed highest heritability for plant height Table no.1 (Cross 1: F_4= 97.78, F_5= 94.48, Cross 2: F_4= 98.14, F_5= 96.34, Cross 3: F_4= 96.29, F_5= 91.37, Cross 4: F_4= 96.34, F_5= 96.35), days to 50% flowering Table no.2 (Cross 1: F_4= 95.36, F_5= 81.89, Cross 2: F_4= 92.90, F_5= 91.29, Cross 3: F_4= 99.42, F_5= 89.91, Cross 4: F_4= 88.36, F_5= 92.38), fruit length Table no.3 (Cross 1: F_4= 95.81, F_5= 94.22, Cross 2: F_4= 83.15, F_5= 81.28, Cross 3: F_4= 83.02, F_5= 80.33, Cross 4: F_4= 88.25, F_5= 86.51), number of seeds per pod Table no.5 (Cross 1: F_4= 89.65, F_5= 88.81, Cross 2: F_4= 81.92, F_5= 80.24, Cross 3: F_4= 80.54, F_5= 75.25, Cross 4: F_4= 87.75, F_5= 85.67). This is in agreement with the results of Rana *et.al.* (2020) [25], Mehta *et.al.* (2006) [12], Kerure *et.al.* (2017) [10], Doddankatte *et.al.* (2016) [3]. Genetic advance as percentage of mean was high for number of seeds per pod Table no.5 (Cross 1: F_4= 27.69, F_5= 25.65, Cross 4: F_4= 21.13, F_5= 20.67). Moderate genetic advance as percentage of means for number of fruits per plant Table no.4 (Cross 1: F_4= 12.55, F_5=11.19, Cross 2: F_4= 14.26, F_5= 15.26, Cross 3: F_4= 12.44, F_5= 11.72, Cross 4: F_4= 12.03, F_5= 10.36). Genetic advance as percentage of mean was low for plant height Table no.1 (Cross 1: F_4= 3.15, F_5=1.09, Cross 2: F_4= 2.41, F_5= 0.93, Cross 3: F_4= 2.39, F_5= 0.70, Cross 4: F_4= 2.12, F_5= 1.76), days to 50% flowering (Cross 1: F_4= 4.38, F_5=2.49, Cross 2: F_4= 3.11, F_5= 2.35, Cross 3: F_4= 9.68, F_5= 1.58, Cross 4: F_4= 2.93, F_5= 1.87).

Table 1: Mean, variance and other genetic parameters of crosses for plant height

Parameters		Cross 1 (P_1 X P_3)	Cross 2 (P_2 X P_3)	Cross 3 (P_1 X P_5)	Cross 4 (P_1 X P_4)
Mean	F4	152.50	139.08	131.04	146.93
	F5	149.13	137.12	120.22	142.56
PV	F4	18.63	16.89	15.87	18.39
	F5	16.78	14.29	13.65	15.36
GV	F4	14.63	12.68	10.87	12.44
	F5	13.35	10.55	8.09	10.24
PCV	F4	1.56	1.19	0.42	1.07
	F5	0.56	1.07	1.21	0.89
GCV	F4	1.54	1.18	0.37	1.05
	F5	0.54	1.07	1.18	0.87
Heritability (%)	F4	97.78	98.14	96.29	96.34
	F5	94.48	96.34	91.37	96.35
Genetic advance	F4	6.56	5.89	5.39	6.45
	F5	6.41	5.15	4.57	6.22
GA as % of mean	F4	3.15	2.41	2.39	2.12
	F5	1.09	0.93	0.70	1.76

Table 2: Mean, variance and other genetic parameters of crosses for days to 50% flowering

Parameters		Cross 1 (P_1 X P_3)	Cross 2 (P_2 X P_3)	Cross 3 (P_1 X P_5)	Cross 4 (P_1 X P_4)
Mean	F4	49.66	46.78	43.34	46.10
	F5	47.84	43.42	42.94	44.06
PV	F4	2.89	2.75	2.15	2.66
	F5	2.72	2.65	1.28	1.48
GV	F4	2.49	2.35	1.58	1.87
	F5	1.08	1.64	1.81	2.25
PCV	F4	0.97	2.35	1.58	1.87
	F5	2.23	2.35	4.73	1.61
GCV	F4	1.43	2.36	2.52	1.12
	F5	2.18	2.13	4.71	1.52
Heritability (%)	F4	95.36	92.90	99.42	88.36
	F5	81.89	91.29	89.91	92.38
Genetic advance	F4	1.82	4.19	3.35	4.29

	F5	2.86	2.75	2.89	2.72
GA as % of mean	F4	4.38	3.11	9.68	2.93
	F5	2.49	2.35	1.58	1.87

Table 3: Mean, variance and other genetic parameters of crosses for fruit length

Parameters		Cross 1 (P_1 X P_3)	Cross 2 (P_2 X P_3)	Cross 3 (P_1 X P_5)	Cross 4 (P_1 X P_4)
Mean	F4	24.66	21.84	21.41	22.67
	F5	21.84	20.72	19.65	21.34
PV	F4	3.31	2.37	1.67	0.96
	F5	2.77	2.22	1.61	0.85
GV	F4	3.19	2.27	1.55	0.83
	F5	2.65	1.26	0.51	0.72
PCV	F4	7.42	4.96	4.89	5.48
	F5	7.38	4.93	4.55	5.47
GCV	F4	7.25	4.57	3.98	5.18
	F5	7.16	4.54	3.62	5.14
Heritability (%)	F4	95.81	83.15	83.02	88.25
	F5	94.22	81.28	80.33	86.51
Genetic advance	F4	3.97	2.39	2.25	2.74
	F5	3.55	2.29	2.24	2.6
GA as % of mean	F4	13.55	7.67	7.48	9.03
	F5	13.24	7.54	6.44	8.87

Table 4: Mean, variance and other genetic parameters of crosses for number of fruits per plant

Parameters		Cross 1 (P_1 X P_3)	Cross 2 (P_2 X P_3)	Cross 3 (P_1 X P_5)	Cross 4 (P_1 X P_4)
Mean	F4	13.17	12.35	12.24	12.99
	F5	14.40	11.33	11.24	13.31
PV	F4	1.72	1.42	1.20	0.59
	F5	1.69	1.26	0.20	0.54
GV	F4	1.58	2.26	0.08	0.45
	F5	1.55	3.26	0.06	0.40
PCV	F4	7.89	4.26	3.77	7.69
	F5	7.19	5.26	3.51	6.50
GCV	F4	7.27	6.26	2.10	6.50
	F5	6.53	7.26	1.74	6.69
Heritability (%)	F4	81.62	8.26	30.8	75.77
	F5	80.68	10.26	24.35	73.55
Genetic advance	F4	2.41	12.26	0.31	1.2
	F5	2.36	13.26	0.23	1.11
GA as % of mean	F4	12.55	14.26	12.44	12.03
	F5	11.19	15.26	11.72	10.36

Table 5: Mean, variance and other genetic parameters of crosses for number of seeds per pod

Parameters		Cross 1 (P_1 X P_3)	Cross 2 (P_2 X P_3)	Cross 3 (P_1 X P_5)	Cross 4 (P_1 X P_4)
Mean	F4	66.42	61.24	46.21	79.36
	F5	63.12	46.21	44.65	77.62
PV	F4	93.41	55.66	41.46	79.21
	F5	80.55	43.15	36.42	73.15
GV	F4	82.74	74.31	40.65	68.49
	F5	68.68	60.75	37.85	63.48
PCV	F4	15.62	13.74	13.98	12.22
	F5	14.33	11.34	12.24	12.21
GCV	F4	14.76	11.10	11.32	11.45
	F5	14.35	10.67	11.24	11.04
Heritability (%)	F4	89.65	81.92	80.54	87.75
	F5	88.81	80.24	75.25	85.67
Genetic advance	F4	18.52	13.39	12.67	16.94
	F5	16.91	12.76	11.24	16.76
GA as % of mean	F4	27.69	19.75	16.48	21.13
	F5	25.65	18.68	14.55	20.67

Conclusion

Phenotypic coefficient of variation (PCV) was higher than genotypic coefficient variation for plant height, fruit length, number of fruits per plant, number of seeds per pod in all the crosses. Heritability and genetic advance estimates for various characters showed that highest heritability was observed in plant height, days to 50% flowering, fruit length, number of fruits per plant in the cross P_1 x P_3 and P_1 x P_4 number of seeds per pod. Maximum genetic advance as percentage of mean was observed in number of fruits per plant, number of seeds per pod and minimum genetic advance as percentage of

mean was observed in plant height, days to 50% flowering, fruit length.

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