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Studies on genetic variability, heritability and genetic advance for yield and yield contributing traits in okra [*Abelmoschus esculentus* (L) Moench]

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Abstract
The purpose of the current study was to evaluate the genetic advance, heritability, and genetic variability of 26 genotypes for seventeen traits. Fruit length, fruit diameter, fruit length, fruit yield per plot, and TSS all had high phenotypic and genotypic coefficients of variation. For traits such as plant height, first fruiting node, and fruit yield per hectare, moderate phenotypic and genotypic coefficients of variation were discovered. Low phenotypic and genotypic coefficients of variation were found for traits like fruit weight, number of internodes per plant, days to 50% flowering, leaf area, and days to first harvest. All of the traits under study showed higher heritability estimates. However, traits like plant height, leaf area, IFSB, and fruit length showed high genetic advance as a percentage of the mean.

Keywords: GCV, genetic advance, genetic variability, heritability, okra, PCV, range

Introduction
Okra [*Abelmoschus esculentus* (L.) Moench.] is a member of the Malvaceae family and a major vegetable crop farmed across the world's tropical and subtropical climates. Most of the cultivated verities of okra are amphidiploid with 2n = 130. The range of *Abelmoschus coccineus* (2n=38) to *Abelmoschus manihot,* Guinean type (2n=185-198) was reported (Jambhale and Nerkar, 1986) [9]. The okra's green, soft fruits are a wonderful source of calcium, potassium, and other minerals as well as carbohydrates, protein, vitamins A, B, and C. Per 100 g of the edible part, it has 1.9 g of protein, 1.2 g of fibre, 1.5 mg of iron, and 88 IU of vitamin A. India produces the majority of the world's okra, accounting for 72% of the total area planted with vegetables.
Okra leaves are used in inflammation and dysentery. Okra fruits are considered useful for goitre because of their high iodine content. Also helps in cases of renal colic, leucorrhoea and general weakness. mucilage is obtained from the roots and stem soaked in water overnight and is used for clarifying sugarcane juice in jaggery or *gur* making (Chauhan, 1972) [4].
The huge presence of variability offers scope for crop improvement. Selection of high-yielding genotype is the pre-requisite for a successful breeding programme. The study of parameters of genetic variability *viz*., GCV, PCV, heritability (h2bs) genetic advance help for proper genotype selection. Therefore, the present investigation was carried out to study the genetic variability for nineteen traits in okra heritability is the heritable portion of phenotypic variance.

Materials and Methods
The present investigation was undertaken at Instructional cum- Research Farm, Department of Horticulture, Custard apple Research Station Ambajogai, in the period of *Kharif*-2021. The observations on nineteen yield and yield contributing characters were recorded on five randomly selected by competitive plants from each genotype from every replication. The average mean value of each trait was determined from these observational plants.
The data were analysed using descriptive statistics and an analysis of variance was performed (Cocheran and Cox 1957) [5] and the following genetic parameters were computed for the character having a significant mean square due to the genotypes. Phenotypic and genotypic coefficient of variation was estimated as recommended by Burton (1952) [3], heritability (broad sense) by lush (1949) [11], and genetic advance by Johnson *et al.* (1955) [10]. As suggested by Robinson H. F. *et al.* (1949) [12], heritability was categorized as less than 30% as low, 30%-60% as moderate and more than 60% as high. GAM was categorized by Johnson *et al.*, (1955) [10] as less than 10% as low, 10-20% as moderate and more than 20% as high.

Result and Discussion

Analysis of variance was carried out for all the seventeen characters and data was presented in table 1. The result indicated highly significant differences among the genotype for all the characters studied, which revealed the existence of sufficient variations in all the characters for effective selection in the material under study.

Genetic parameters *viz*. the genotypic variance, phenotypic variance, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (broad sense) and genetic advance as percent of mean (GAM) were recorded and are presented in Table 2. WA wide range of variability was observed among twenty-six genotypes for yield, yield contributing and quality traits under study which indicates good scope for selection of genotypes for particular traits. The genotypic variance was found to be lower than the phenotypic variance for all the characters. However, a higher magnitude of genotypic variance was recorded for plant height (459.60), and incidence of fruit and shoot borer (456.30). the moderate genotypic variance was recorded for Days to first harvest (23.03), Days to first flower open (23.64), and Harvest duration (26.07). while remaining traits fruit yield per plot (0.11), Fruit weight (0.04), and First fruiting node (0.68) recorded lower genotypic variance. Similar results were reported by Adeoluwa *et al.* (2021) [1].

The similarly higher phenotypic variance was observed for characters incidence of fruit and shoot borer (472.92), Leaf area (383.42), and Plant height (469.43). Moderate phenotypic variance was recorded for Harvest duration (26.74), Days to first flower open (24.20). while lower values were obtained for Fruit yield per plot (0.11), Fruit weight (0.06), First fruiting node (0.73), and a number of internodes per plant (2.24). Similar results were reported by Adeoluwa *et al.* (2021) [1]. A high magnitude of (Genotypic coefficient of variation) GCV was observed in traits of Fruit length (58.17), Fruit diameter (48.63), and Incidence of fruit and shoot borer (22.21). while moderate GCV was observed for traits number of fruits per plant (19.62), fruit yield per hectare (17.88), and Plant height (17.7The lowest GCV was observed in fruit weight (2.99), number of internodes per plant (7.00) and days to 50% flowering (7.29). Similar results were reported by Duggi *et al.* (2013) [7], *and* Akotkar *et al.* (2010) [2]. The phenotypic coefficient of variation was observed greater than the Genotypic coefficient of variation for all traits. The highest PCV was observed for the trait in fruit weight (60.91) followed by fruit length (58.9and 3), fruit diameter (50.30). while moderate PCV was observed for trait Incidence of YVMV (22.89), Incidence of F&SB, (22.61) and fruit yield per plot (22.0). The lowest PCV was observed in the number of internodes per plant (7.44), days to 50% flowering (8.03), and leaf area (8.42). Similar results were reported by Duggi *et al.* (2013) [7], and Akotkar *et al*. (2010) [2].

The high heritability estimates were observed in traits Days to 50% flowering (98.86) followed by several of fruits per plant (98.26) and plant height (97.90). while moderate heritability was observed for traits fruit yield per hectare (85.76), a number of internodes per plant (88.15). The lowest heritability was observed in fruit weight (57.43). Similar results were reported by Akotkar *et al*. (2010) [2], and Gandhi *et al.* (2000) [8]. The highest genetic advance (%) was observed in character plant height (43.69) followed by the incidence of F&SB (43.22) and leaf area (39.11). while moderate genetic advance was observed for a number of fruits per plant (5.40) and fruit yield per plot (4.43). The lowest genetic advance was observed for fruit weight (0.30) followed by the first fruiting node (1.63). Similar results were reported by Akotkar *et al.* (2010) [2], Gandhi *et al.* (2000) [8], and Dhall *et al.* (2003) [6] The highest GA (%) of mean was observed in character fruit length (118.28) followed by fruit diameter (96.85), the incidence of fruit and shoot borer (44.94). while moderate GA (%) of mean was observed for trait plant height (36.25), fruit yield per plot (42.51), and incidence of YVMV (42.94). and lower genetic advance (%) mean was observed in a number of fruits per plant (4.07) and fruit weight (9.36).Similar results were reported by Singh *et al.* (2020) [13], Akotkar *et al.* (2010) [2], and Verma *et al.* (2018) [14].

Table 1: Analysis of variance (ANOVA) for different characters in Okra.

Sr. No.	Characters	Source of variance		
		Replication	Treatment	Error
		D.F 1	25	25
1.	Days to 50% flowering	0.262	31.535**	0.180
2.	First fruiting node	0.096	1.426**	0.056
3.	Number of internodes per plant	0.103	4.235**	0.267
4.	Plant height (cm)	8.424	929.027**	9.846
5.	Days to first harvest (Days)	1.194	46.710**	0.657
6.	Harvest duration (Days)	2.009	52.822**	0.672
7.	Leaf area (cm^2)	3.620	755.196**	11.661
8.	Days to first flower open	0.079	47.843**	0.567
9.	Fruit length (cm)	0.075	6.250**	0.082
10.	Fruit diameter(cm)	0.571	5.608**	0.190
11.	Fruit weight (g)	0.005	0.106**	0.029
12.	Number of fruits per plant	0.171	14.115**	0.123
13.	Fruit yield per plot (kg)	0.005	0.242**	0.008
14.	Fruit yield per hectare (q/ha)	4.502	11.687**	0.896
15.	TSS (%)	0.048	8.519**	0.256
16.	Incidence of yellow vein mosaic virus (%)	0.088	4.848**	0.227
17.	Incidence of fruit and shoot borer (%)	58.533	929.251**	16.609

*and **, indicates significance at 5% and 1% respectively

Table 2: Parameters of genetic variability for yield and yield contributing characters in okra

Characters	Range	Mean	GV	PV	EV	GCV	PCV	Heritability (%)	GA (%)	GAM (%)
Days to 50% flowering	42.52-55.80	49.53	15.67	15.85	0.18	7.29	8.03	98.86	8.11	16.37
First fruiting node	03.49-6.42	5.34	0.68	0.73	0.05	15.49	16.11	92.40	1.63	30.68
Number of internodes per plant	17.27-24.65	20.14	1.98	2.24	0.26	7.00	7.44	88.15	2.72	13.52
Plant height (cm)	76 -166.83	120.51	459.6	469.43	9.84	17.78	17.97	97.90	43.69	36.25
Days to first harvest (Days)	43.85-60.35	53.55	23.03	23.68	0.65	8.96	9.08	97.22	9.74	18.20
Harvest duration (Days)	43.30-60.85	48.80	26.07	26.74	0.67	10.46	10.59	97.47	10.38	21.27
Leaf area (cm^2)	184.15-250	232.33	371.7	383.42	11.66	8.29	8.42	96.95	39.11	16.83
Days to first flower open	35.54-51.37	45.12	23.64	24.20	0.56	10.77	10.90	97.65	9.89	21.93
Fruit length(cm)	9.18-18.02	03.11	3.08	3.16	0.08	58.17	58.93	97.42	3.57	118.28
Fruit diameter(cm)	1.04-2.16	03.38	2.71	2.90	0.19	48.63	50.30	93.45	3.27	96.85
Fruit weight (g)	8.96-17.91	03.27	0.04	0.06	0.02	5.99	60.91	57.43	0.30	9.36
Number of fruits per plant	9.-17.95	13.47	7.00	7.11	0.12	19.62	19.79	98.26	5.40	4.07
Fruit yield per plot (kg)	5-10.38	01.60	0.11	0.11	0.00	21.31	22.00	93.80	0.68	42.51
Fruit yield per hectare (q/ha)	63.69-139.30	12.98	5.40	6.28	0.89	17.88	19.31	85.76	4.43	34.11
TSS (%)	2.63-3.69	13.34	4.13	4.38	0.25	15.23	15.69	94.17	4.06	30.45
Incidence of yellow vein mosaic virus (%)	0.05-6.75	06.95	2.31	2.53	0.22	21.84	22.89	91.05	2.98	42.94
Incidence of fruit & shoot borer (%)	1.35-6.62	96.17	456.3	472.92	16.60	22.21	22.61	96.48	43.22	44.94

Conclusion

The phenotypic and genotypic coefficients of variation were recorded as high for fruit length, fruit diameter, fruit length, fruit yield per plot and TSS. Moderate phenotypic and genotypic coefficients of variation were obtained for traits like plant height, first fruiting node, and fruit yield per hectare. While characters like fruit weight, number of internodes per plant, days to 50% flowering leaf area and days to first harvest observed low phenotypic and genotypic coefficients of variation. Higher heritability estimates were observed for all the traits under the study. However, high genetic advance as a percent of mean was noted for characters like plant height, leaf area, IFSB and fruit length. wide range of variability, GCV, PCV, heritability and coupled with a high genetic gain was observed for the characters like such as fruit length, fruit weight, days to 50% flowering, harvest duration, and fruit diameter will be better responded for selection.

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