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Genetic Variability, Heritability and Genetic Advance of Yield and Related Traits in F_4 and F_5 Generations of Okra (*Abelmoschus esculentus* [L.] Moench)

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A B S T R A C T

The present investigation was conducted at experimental research farm of Department of Horticulture, College of Agriculture Latur, during *rabi*-2022 (Selfing) and *kharif* - 2023 (evaluation), with a view to Genetic studies of F_4 and F_5 generations in Okra (*Abelmoschus esculentus* [L.] Moench) of three crosses in a Randomized block design with two replications. For all quantitative characteristics, the genotypic coefficient of variation was smaller than the phenotypic coefficient of variation indicating a significant environmental influence on trait expression. Notably, high values of both genotypic and phenotypic coefficients of variation were observed for number of branches per plant, number of nodes per plant, fruit diameter and fruit yield per plant. High heritability and high genetic advance as a *percentage* of the mean for several traits including plant height, number of branches per plant, internodal length, number of nodes per plant, node at which the first flower appears, fruit length, fruit yield per plant, fruit yield per plot and fruit yield per hectare in theF_4 and F_5 generations of the cross Kashi Pragati × Arka Abhay (C-1: P3 × P1). Presented in Table 1 and 2.

Introduction

Okra (*Abelmoschus esculentus* [L.] Moench) is one of the most popular vegetables of the family Malvaceae, with a chromosome number 2n=130 has good nutritional value, particularly the high content of vitamin C (13mg/100g), calcium (66 mg/100g) and iron (0.35 mg/100g) in the edible fruit.

Also rich in protein and minerals with about 88% moisture, 7.7% carbohydrate, 1.1% fiber, 0.7% mineral matter, 0.08% phosphorous and 41 (kcal) calorific values. The vitamin content is 58 IU vitamin A, 0.06 mg vitamin B, 0.06 mg Nicotinic acid and 0.06 mg Riboflavin. The tender fruits are consumed as cooked vegetable, mostly fresh but sometimes sundried and frozen. It has also has been put to several domestic and medicinal uses. Commercially cultivated in West Africa, India, South East Asia, Southern United States, Brazil and Turkey.

In India, Uttar Pradesh, Assam, Bihar, Orissa, Maharashtra, West Bengal and Karnataka are the important okra producing states. Among the vegetables grown in India, okra occupies an area of 549 (000 Ha) with annual production of 7158 (000 MT) (Anon, 2023).

In Maharashtra okra is grown in an area of 13.82 (000 ha) with production of 171.56 (000 MT) (Anon, 2023). It is a potential export earner, accounting for 13 per cent of export of fresh vegetables.

Materials and Methods

Four Okra genotypes along with seeds of F_4 progenies of cross Kashi Pragati × Arka Abhay (C1) provided from the previous M.Sc. research work carried out at Instructional-cum Research Farm, Department of Horticulture, College of Agriculture, Latur were grown in a Randomized block design in *rabi* 2022 and selfed to obtained F_5 generation. The F_4 and F_5 generation of cross Kashi Pragati × Arka Abhay (C1) were evaluated during *kharif* 2023. The experimental plot size was 14.8 m × 12 m and seed sown at 45 cm × 30 cm spacing between rows and plants randomized block design (RBD) for each cross. The recommended dose of fertilizer for okra is 20tones FYM + 100:50:50 kg NPK per ha was applied.

The dose of FYM 20 tones per hectare and the 50 *per cent* recommended dose of nitrogen (50 kg/ha) and full dose of phosphorus (50 kg/ha) and potassium (50 kg/ha) were incorporated in the soil at the time of sowing the crop. The remaining dose of 50 *per cent* of nitrogen (50 kg/ha) was applied one month after sowing. The plant protection measures were applied as per recommendation. The gap filling and thinning was done.

Observations were made in F_5 generation on five randomly chosen plants from each progenies, and the mean value was used for statistical analysis for thirteen characters: The plant height (cm), inter nodal length (cm), number of branches per plant, node at which the first flower appeared, number of nodes per plant, number of days required to 50% flowering, days required for first picking, fruit length (cm), fruit diameter (mm), fruit weight (g), fruit yield per plant (kg), fruit yield per plot (kg), fruit yield per hectare (q).

The formula of Panse and Sukhatme (1985) will be used to calculate variation for all of the features under consideration. The mean squares from the variance table will be used to determine genotypic and phenotypic variances (Johnson *et al.,* 1955). The GCV and PCV will be determined using Burton and De vane (1953) approach. Heritability (in the broad sense) will be calculated using the method proposed by Allard (1960). Johnson *et al.,* (1955) proposed a formula for calculating genetic advance.

Results and Discussion

All thirteen okra traits exhibited a broad range of variability across the three crosses in both the F_4 and F_5 generations. For all quantitative characteristics, the genotypic coefficient of variation was smaller than the phenotypic coefficient of variation indicating a significant environmental influence on trait expression. Notably, high values of both genotypic and phenotypic coefficients of variation were observed for plant height, number of branches per plant, number of nodes per plant, fruit diameter and fruit yield per plant in the F_4 and F_5 generations of the cross Kashi Pragati × Arka Abhay (C-1: P3 × P1). Genetic variability is a crucial part of any system in which selection occurs to evolve superior genotype. As a result, the more the genetic variety in these traits, the greater the potential for improvement through selection. To improve any crop, particularly its yield, it is vital to understand genetic variability and the production-related characteristics. Table 1 and Table 2 displays the data.

The character fruit diameter have greater values of GCV and PCV, indicating that there is a significant degree of genetic variability and that the environment has less influence, making them appropriate for selection. Chandramauli *et al.,* (2016) found similar results. The Days required to 50 % flowering estimates lower GCV and PCV, indicating low variability and substantial environmental influence, making selection undesirable. Verma *et al.,* (2018) found similar results. GCV and PCV have a significant trait difference, indicating that these traits are heavily influenced by environmental influences and the lower difference between GCV and PCV showing environmental influence on trait expression and revealed that most of the features are mostly under genetic control.

All thirteen traits demonstrated high heritability as a percentage of mean. This suggests that heritability is caused by additive gene effects and that selection may be effective. Similar results were achieved by Vani *et al.,* (2021). There is opportunity for enhancement of these traits through selection, as seen by the high heritability and low genetic advance as a percentage of mean for the trait Days required to 50 % flowering and Days required for first picking. This suggests additive gene action. Jadhav *et al.,* (2022) discovered comparable outcomes. According to the findings of the current study, there is more variability in the material for all of the traits, which can be seen in the future through easy selection.

Table.1 Mean, range, GCV, PCV, heritability, genetic advance and percent mean of genetic advance of two parents and F_4 population of okra cross Kashi Pragati×Arka Abhay (C1:P3xP1)

Sr. no.	Character	Mean	Range	GCV(%)	PCV(%)	h^2bc(%)	GA	GAM(%)
1.	**Plant height (cm)**	132.95	131.75-135.75	18.80	19.80	89.77	48.80	**36.70**
2.	**No. of branches per plant**	1.32	0.75-2.00	33.02	37.61	77.058	0.79	**59.72**
3.	**Internodal length (cm)**	7.04	6.25-8.00	11.12	12.43	80.08	1.44	**20.50**
4.	**No. of nodes per plant**	19.32	17.95-20.90	28.80	32.13	75.21	20.38	**26.53**
5.	**Node at which first flower appear**	5.57	4.25-6.43	18.39	19.80	78.19	22.86	**33.51**
6.	**Daysrequiredto50% flowering**	47.80	45.00-50.00	4.13	4.65	78.99	3.62	**7.56**
7.	**Days required for first picking**	52.75	50.75-54.75	10.28	13.67	72.96	2.12	**4.02**
8.	**Length of fruit (cm)**	9.32	7.50-11.00	14.93	17.31	74.38	2.47	**26.52**
9.	**Fruit diameter (mm)**	20.40	14.00-38.00	46.37	51.20	82.03	1.77	**86.53**
10.	**Fruit weight (g)**	10.85	9.90-12.50	9.18	10.75	88.73	1.93	**17.81**
11.	**Fruit yield per plant(kg)**	0.89	0.74-1.05	22.05	25.36	95.10	0.24	**26.66**
12.	**Fruit yield per plot(kg)**	6.01	4.93-7.08	13.40	13.72	95.49	1.62	**26.98**
13.	**Fruit yield per hectare(q)**	**88.83**	**73.03-104.43**	**13.24**	**13.55**	**95.47**	**23.68**	**26.66**

Table.2 Mean, range, GCV, PCV, heritability, genetic advance and *percent* mean of genetic advance of two parents and F_5 population of okra cross Kashi Pragati×Arka Abhay (C1:P3xP1)

Sr. no.	Character	Mean	Range	GCV(%)	PCV(%)	h^2bc(%)	GA	GAM(%)
1.	**Plant height (cm)**	135.65	131.25-138.75	21.20	22.90	93.22	57.12	**42.11**
2.	**No of branches per plant**	1.36	0.85-1.75	22.96	25.58	80.58	0.58	**42.46**
3.	**Internodal length (cm)**	7.50	7.00-8.75	12.09	13.27	82.99	1.70	**22.69**
4.	**No. of nodes per plant**	18.99	17.95-20.30	25.71	29.77	66.61	15.00	**22.92**
5.	**Node at which first flower appear**	5.86	4.25-7.80	24.14	26.22	84.81	2.68	**45.80**
6.	**Days required to 50% flowering**	46.20	45.50-48.75	2.72	2.93	85.99	2.48	**5.19**
7.	**Days required for first picking**	53.73	50.90-56.25	11.70	13.95	87.87	3.84	**7.15**
8.	**Length of fruit (cm)**	9.45	8.00-11.75	14.73	15.52	90.12	2.72	**28.80**
9.	**Fruit diameter (mm)**	18.80	14.00-32.00	39.61	40.05	97.80	1.25	**18.29**
10.	**Fruit weight (g)**	11.38	9.93-12.75	10.00	10.96	83.23	2.14	**18.79**
11.	**Fruit yield per plant (kg)**	0.93	0.91-1.05	23.61	25.25	79.58	0.23	**25.01**
12.	**Fruit yield per plot (kg)**	6.26	4.93-7.09	13.78	15.38	80.25	1.59	**25.43**
13.	**Fruit yield per hectare (q)**	**92.74**	**73.03-104.95**	**13.78**	**15.38**	**80.29**	**23.58**	**25.43**

Figure.1 GVC, PVC of two parent and F_4 population of okra cross Kashi pragati x Arka abhay (C1:P3xP1)

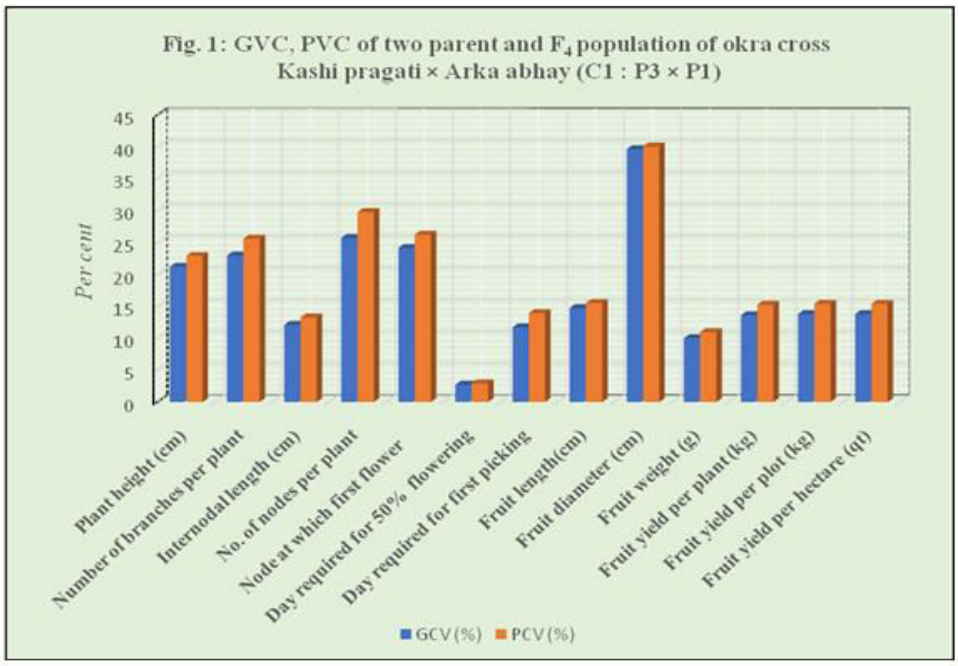


Figure.2 Heritability and percent mean of genetic advance of two parent and F_4 population of okra cross Kashi pragati x Arka abhay (C1:P3xP1)

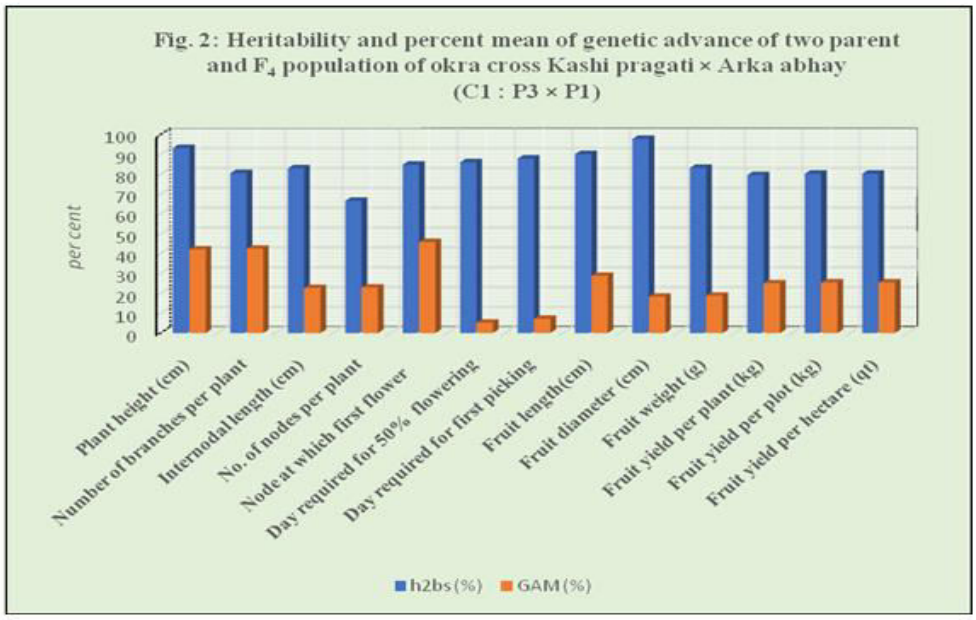


Figure.3 GVC, PVC of two parent and F_5 population of okra cross Kashi pragati x Arka abhay (C1:P3xP1)

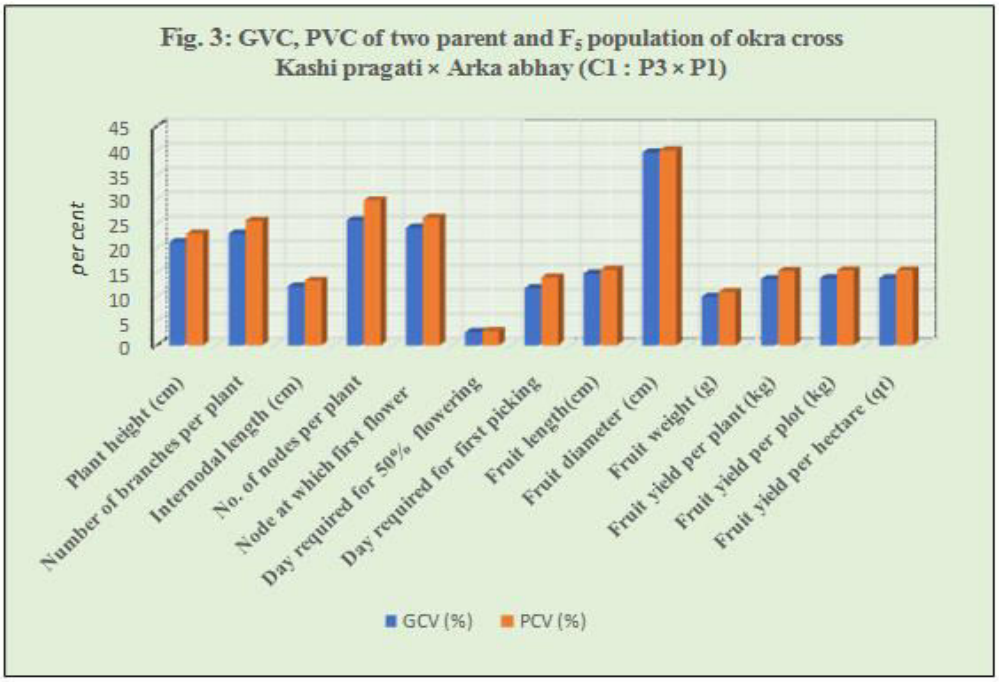
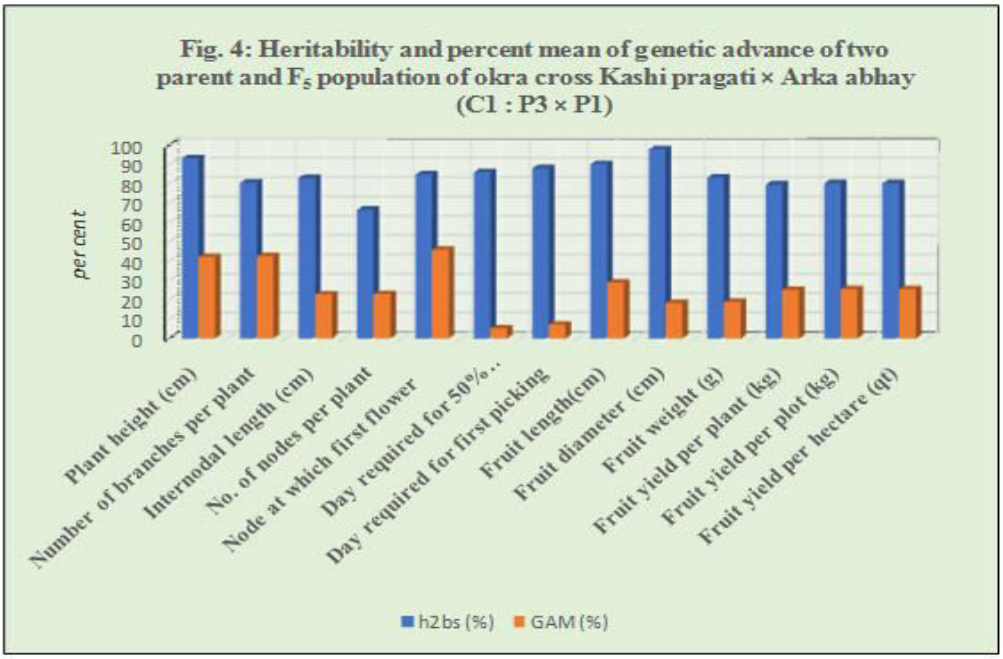


Figure.4 Heritability and percent mean of genetic advance of two parent and F_5 population of okra cross Kashi pragati x Arka abhay (C1:P3xP1)



In okra, traits such as plant height, number of branches per plant, number of nodes per plant, Node at which first flower appear, fruit diameter, fruit yield per plant, fruit yield per plot and fruit yield per hectare displayed a range from modest to high phenotypic and genotypic coefficients of variation (PCV and GCV). In contrast, the

remaining traits showed moderate to low PCV and GCV in the three crosses Kashi Pragati × Arka Abhay (C-1: P3 × P1). In the F_4 and F_5 generations, the phenotypic coefficient of variation (PCV) was consistently greater than the corresponding genotypic coefficient of variation (GCV) for all characters suggesting that environmental factors were influencing the expression of these traits to some extent. A small difference between PCV and GCV indicates that these traits are minimally affected by environmental factors, while a larger gap between PCV and GCV highlights the significant role of environmental influences on these traits. For the characters plant height, number of branches per plant, internodal length, number of nodes per plant, node at which first flower appear, length of fruit (cm), fruit yield per plant, fruit yield per plot and fruit yield per hectare in the F_4 and F_5 generations, high heritability combined with high genetic advance as a *percentage* of the mean was observed. This suggests that selection under pressure is likely to be effective and that the high heritability is primarily due to the influence of additive gene effects.

Author Contributions

V. D. Satpute: Investigation, formal analysis, writing—original draft. V. S. Jagtap: Validation, methodology, writing—reviewing. P. B. Sarvade:—Formal analysis, writing—review and editing. M. R. Swami: Investigation, writing—reviewing. K. N. Gavhale: Resources, investigation writing—reviewing. Y. D. Gavhane: Validation, formal analysis, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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