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Assessment of Genetic Variability, Heritability and Genetic Advance for Yield and Associated 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 the experimental research farm of the Department of Horticulture, College of Agriculture, Latur, during the *rabi* season of 2022 (selfing) and the *kharif* season of 2023 (evaluation). The study aimed to explore the genetic characteristics of the F4 and F5 generations of Okra [*Abelmoschus esculentus* (L.) Moench] derived from three crosses, employing a Randomized Block Design with two replications. Analysis of quantitative traits revealed that the genotypic coefficients of variation were consistently lower than the phenotypic coefficients, underscoring a pronounced environmental influence on trait expression. High magnitude of both genotypic and phenotypic coefficients of variation for number of branches per plant, number of nodes per plant, fruit yield per plant, fruit yield per plot, and fruit yield per hectare. High heritability coupled with substantial genetic advance for plant height (cm), fruit yield per hectare (q) indicated the involvement of additive gene action and more chances of fixing by selection to improve such traits in the F4 and F5 generations of the cross Kashi Pragati × Varsha Uphar (C-2: P3 × P2).

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 (13 mg/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 sun dried 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 F4 progenies of cross Kashi Pragati × Varsha Uphar (C2) 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 F5 generation. The F4 and F5 generation of cross Kashi Pragati × Varsha Uphar (C2) 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 20 tones 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 F5 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 F4 and F5 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 number of branches per plant, number of nodes per plant, fruit yield per plant, fruit yield per plot and fruit yield per hectare in the F4 and F5 generations of the cross Kashi Pragati × Varsha Uphar (C-2: P3 × P2). Setu (2023); Shwetha *et al.,* (2022) and Vani *et al.,* (2021) reported similar results. 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.

The Moderate values of both genotypic and phenotypic coefficients of variation were observed for Plant height (cm), Inter nodal length (cm), Node at which first flower appear, Days required for first picking, Length of fruit (cm), Fruit diameter (mm) and Fruit weight (g). in the F4 and F5 generations of the cross Kashi Pragati × Varsha Uphar (C-2: P3 × P2). Kumar *et al.,* (2021); Mohammed and Shiferaw (2022) and Reddy *et al.,* (2022) reported similar results.

The lowest values of both genotypic and phenotypic coefficients of variation were observed for the Days required to 50 % flowering in the F4 and F5 generations was noted. The low GCV and PCV for this feature show that environmental influences have an impact on the expression. For this parameter, there was limited genetic advancement and high heritability. It suggests that genes function in an non-additive manner.

Table.1 Mean, range, GCV, PCV, heritability, genetic advance and per cent mean of genetic advance of two parents and F_4 population of okra cross Kashi Pragati × Varsha Uphar (C2: P3 x P2)

Sr. no.	Character	Mean	Range	GCV (%)	PCV (%)	h^2bc (%)	GA	GAM (%)
1.	**Plant height (cm)**	136.46	134.00-	14.11	15.70	81.03	35.70	**26.20**
2.	**No. of branches per plant**	1.34	0.95-1.75	20.91	23.89	76.59	0.51	**37.69**
3.	**Inter nodal length (cm)**	8.00	7.15-9.75	14.36	14.67	95.90	2.32	**28.98**
4.	**No. of nodes per plant**	19.52	17.20-22.15	21.12	26.76	88.36	26.38	**20.59**
5.	**Node at which first flower appear**	6.16	3.80-7.80	15.75	12.68	88.65	2.73	**19.41**
6.	**Days required to 50 % flowering**	47.85	47.00-49.50	1.81	2.25	64.52	1.43	**10.43**
7.	**Days required for first picking**	53.30	51.75-55.80	12.71	17.93	85.64	2.75	**5.17**
8.	**Length of fruit (cm)**	9.52	7.85-11.00	14.24	16.00	79.24	2.49	**26.11**
9.	**Fruit diameter (mm)**	20.20	15.50-34.50	13.05	17.51	93.19	1.58	**18.75**
10.	**Fruit weight (g)**	11.90	10.50-14.75	14.68	16.11	82.99	3.28	**27.54**
11.	**Fruit yield per plant**	1.11	0.88-1.35	21.69	23.10	85.00	0.35	**31.69**
12.	**Fruit yield per plot (kg)**	7.45	5.91-9.11	21.82	23.19	85.44	2.39	**32.02**
13.	**Fruit yield per hectare**	**110.20**	**87.48-134.85**	**21.75**	**23.17**	**84.97**	**35.05**	**31.81**

Table.2 Mean, range, GCV, PCV, heritability, genetic advance and *per cent* mean of genetic advance of two parents and F5 population of okra cross Kashi Pragati × Varsha Uphar (C2: P3 x P2)

Sr. no.	Character	Mean	Range	GCV (%)	PCV (%)	h^2bc (%)	GA	GAM (%)
1.	**Plant height (cm)**	140.71	138.05-144.00	16.20	17.60	84.88	43.33	**30.80**
2.	**No of branches per plant**	1.29	0.85-1.75	28.27	30.57	85.53	0.69	**53.86**
3.	**Inter nodal length (cm)**	8.42	7.20-9.75	11.53	12.27	88.28	1.88	**22.31**
4.	**No. of nodes per plant**	17.62	15.90-20.00	27.18	31.79	86.60	2.76	**23.68**
5.	**Node at which first flower appear**	6.05	4.25-7.80	19.06	13.22	76.96	2.27	**19.77**
6.	**Days required to 50 % flowering**	47.50	46.50-49.00	1.76	2.16	66.67	1.41	**2.96**
7.	**Days required for first picking**	53.68	49.90-56.25	17.66	15.87	89.81	3.84	**7.15**
8.	**Length of fruit (cm)**	9.20	7.50-11.75	16.35	17.45	87.78	2.90	**31.56**
9.	**Fruit diameter (mm)**	17.50	13.50-32.00	12.01	19.37	97.96	1.48	**16.07**
10.	**Fruit weight (g)**	11.58	9.63-13.25	11.86	12.16	68.01	2.76	**23.80**
11.	**Fruit yield per plant (kg)**	1.11	1.0-1.45	22.59	25.32	82.88	0.37	**32.99**
12.	**Fruit yield per plot (kg)**	7.48	6.41-9.75	22.36	25.22	81.52	2.41	**32.28**
13.	**Fruit yield per hectare**	**110.70**	**94.59-144.35**	**22.40**	**25.28**	**81.47**	**35.82**	**32.36**

Figure.1 GVC, PVC of two parent and F_4 population of okra cross Kashi pragati x Arka abhay (C2:P3xP2)

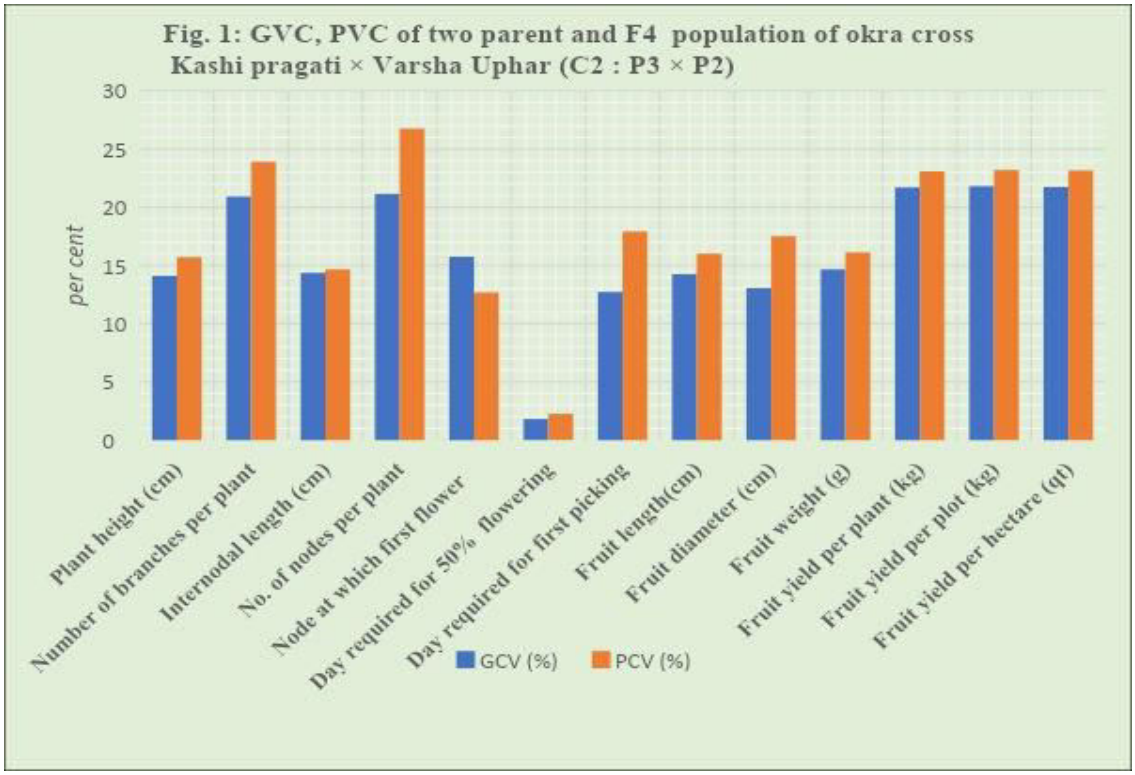


Figure.2 Heritability and percent mean of genetic advance of two parent and F_4 population of okra cross Kashi pragati x Arka abhay (C2:P3xP2)

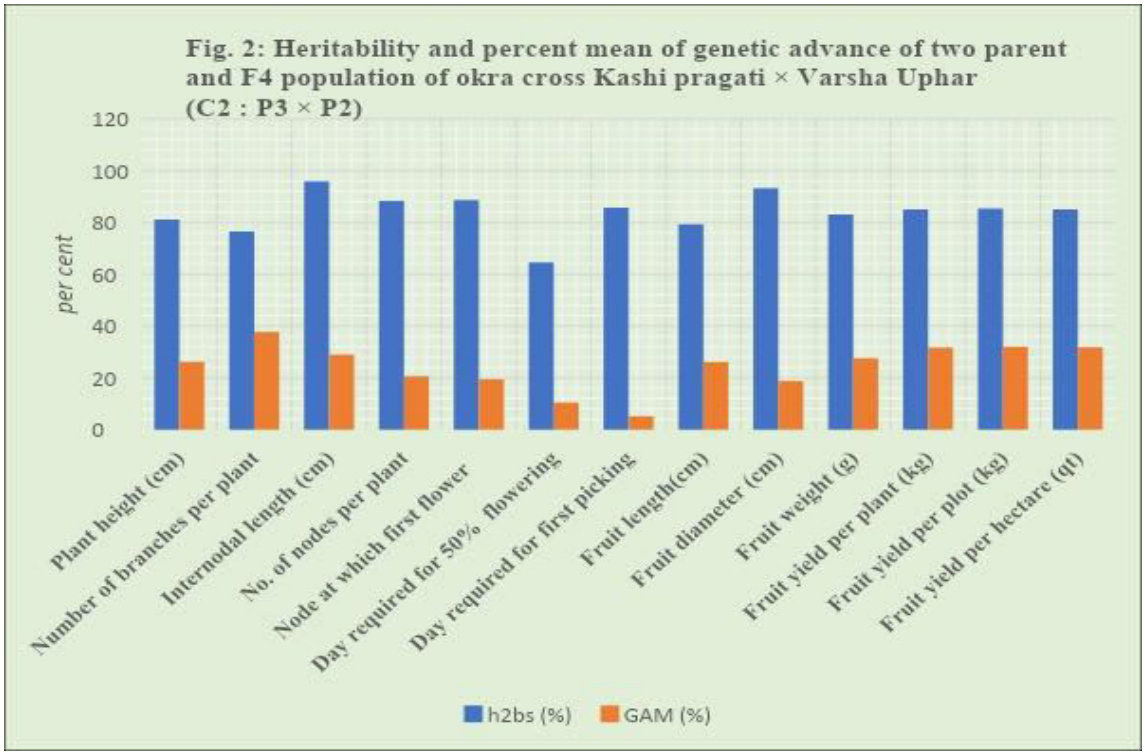


Figure.3 GVC, PVC of two parent and F_5 population of okra cross Kashi pragati x Arka abhay (C2:P3xP2)

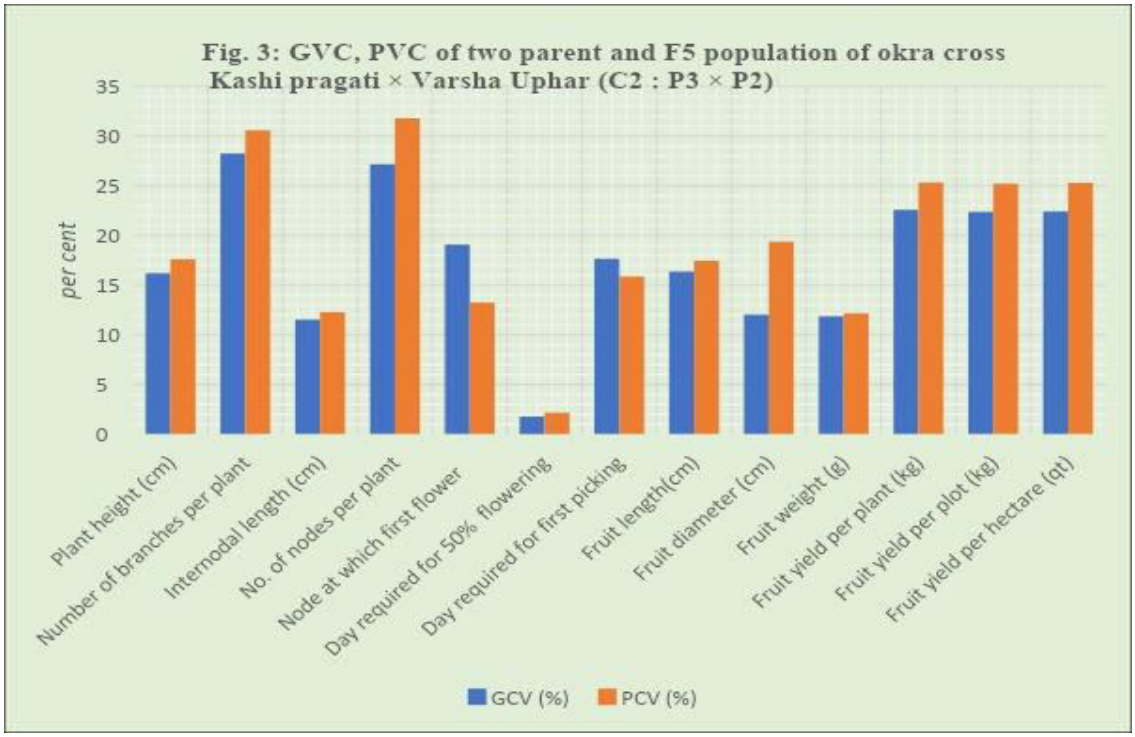
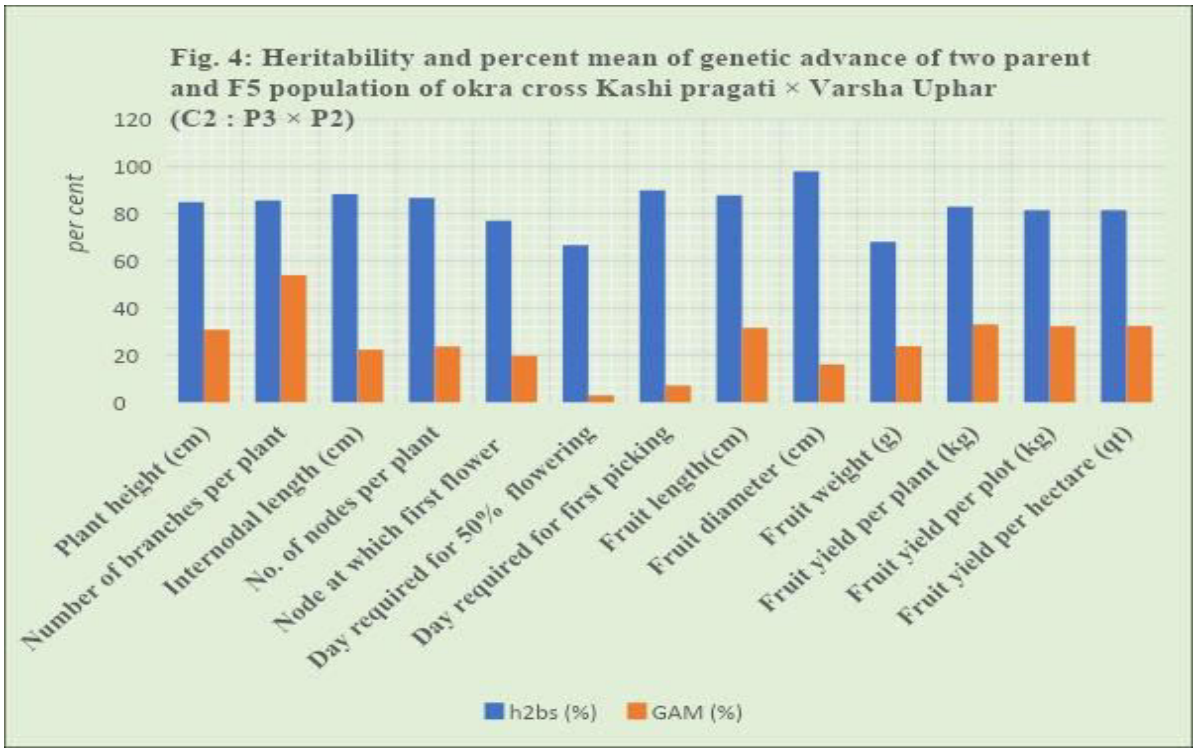


Figure.4 Heritability and percent mean of genetic advance of two parent and F_5 population of okra cross Kashi pragati x Arka abhay (C2:P3xP2)



Selection would therefore not be feasible. For this parameter a pedigree technique is to be applied rather than selection. Verma *et al.,* (2018); Awasthi *et al.,* (2022); Jadhav *et al.,* (2022) and Kumar *et al.,* (2022) discovered similar results. Table 1 and Table 2 displays the data.

In the F4 and F5 generations the trait for plant height (cm), fruit yield per hectare (q) shows high heritability along with high genetic advance which showing a diverse genetic background and predomince of additive gene control for these thereby providing a great scope for selection. Similar result was found by Kumar *et al.,* (2021); Reddy *et al.,* (2022) and Shwetha *et al.,* (2022) all reported results that were similar.

In the F4 generations the trait for number of nodes per plant shows high heritability along with high genetic advance also. Similar result was found by Alam *et al.,* (2020); Setu (2023) and Prakash *et al.,* (2022). The trait for Days required to 50 % flowering in the F4 and F5 generations there was limited genetic advancement and high heritability. It suggests that genes function in an non-additive manner. Selection would therefore not be feasible. For this parameter a pedigree technique is to be applied rather than selection. Verma *et al.,* (2018); Awasthi *et al.,* (2022); Jadhav *et al.,* (2022) and Kumar *et al.,* (2022) discovered similar results.

In okra, traits such as number of branches per plant, number of nodes per plant, fruit yield per plant, fruit yield per plot and fruit yield per hectare displayed the 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 cross Kashi Pragati × Varsha Uphar (C-2: P3 × P2). In the F4 and F5 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. High heritability coupled with substantial genetic advance for plant height (cm), fruit yield per hectare (q) indicated the involvement of additive gene action and more chances of fixing by selection to improve such traits in the F4 and F5 generations of the cross Kashi Pragati × Varsha Uphar (C-2: P3 × P2).

Author Contributions

V. D. Satpute: Investigation, formal analysis, writing—original draft. V. S. Jagtap: Validation, methodology, writing—reviewing. P. D. Bele:—Formal analysis, writing—review and editing. A. P. Nerkar: Investigation, writing—reviewing. K. N. Gavhale: Resources, investigation writing—reviewing. S. D. Wandhare: 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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