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SHORT COMMUNICATION

Estimation of inbreeding depression for fruit yield and related attributes in okra [*Abelmoschus esculentus* (L.) Moench]

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Okra [*Abelmoschus esculentus* (L.) Moench is a significant vegetable crop propagated from seeds, primarily cultivated in tropical and subtropical regions globally. It belongs to the Malvaceae family with a chromosome number 2n=130 and is an amphidiploid in nature. This crop can thrive both in home gardens and on large-scale commercial farms. It is a versatile crop with a broad range of adaptability, owing to its ease of cultivation, short duration, high export potential, and suitability to diverse environmental conditions and soil types (Priyanka et al., 2018). The green, non-fibrous fruits of okra, whose round seeds are harvested while still immature, before fiber develops and are consumed as a vegetable. Okra can be used in various culinary dishes, while its leaves are consumed similarly to spinach in some African cultures. Additionally, the roots and stems are utilized in purifying cane juice for producing jaggery or brown sugar (Chauhan, 1972). The greenish-yellow oil derived from okra seeds is viewed as an alternative to edible oil, noted for its richness in oleic acid and linoleic acid. It also possesses substantial nutritional value, containing vitamin C (30 mg/100 g), vitamin A (20 mg/100 g), zinc (6 mg/100 g), β-carotene (300 µg/100 g), and folic acid (300 µg/100 g) (Liu et al., 2021). With its high dietary fiber content, low calorie count and abundance of minerals such as Ca, P, K, and Mg, okra is a valuable addition to human nutrition. It is known to be a good iodine source and acts as a diuretic to ease gastric discomfort largely due to its high polysaccharide content that creates a mucilaginous texture. Inbreeding depression is defined as the reduction or loss in vigour and fertility due to the inbreeding effect. Inbreeding occurs as a result of mating between individuals that are closely related. This phenomenon typically leads to a significant decrease in both fertility and vigour within the species affected (Singh et al., 2009). It increases homozygosity in the genotype by continuous selfing. It results from the fixation of undesirable recessive genes in F_2.

The experimental material in the present study consisted of five contrasting parental lines, *viz.,* Arka Anamika, Konkan

Bhindi, Arka Abhay, IC-42464, IC-42470, and IC-42472 obtained from various sources, IIHR, Bangalore, Dr. BSKKV Dapoli and NBPGR, New Delhi. The F_1 progeny of three crosses, *viz.,* Arka Anamika × IC-42464 (Cross-I), Konkan Bhindi × IC 42470 (Cross-II) and Arka Abhay × IC-42472 (Cross-III), hereafter referred to as C-I, C-II, and C-III, respectively, along with their parental line were sown during the *kharif* season of 2024 at Oilseeds Research Station, Latur. The crosses were developed by mating the contrasting parents, *viz.,* Arka Anamika × IC-42464, Konkan Bhindi × IC-42470 and Arka Abhay × IC-42472. The seeds of parents and F_2 were produced by selfing, while fresh F_1 seeds were developed by hand emasculation followed by pollination. The experiment was conducted at Oilseeds Research Station, Latur, during the summer season of 2025. The parents and their respective F_1's were sown in separate blocks with three replications and the F_2 population was sown without replication. Each entry of Parents and F_1 was sown in a single row of three meters in length with a row-to-row spacing of 60 cm and plant-to-plant spacing of 30 cm in each replication. Each row accommodated ten plants. The parents and hybrids were evaluated following a randomized block design with three replications and the F_2 population was unreplicated. The experiment was sown on 23 January 2025. The observation was recorded following standard procedures from five plants per parent and hybrid cross. The mean of these five plants was considered for statistical analysis. With respect to F_2, observations were recorded on 158 plants in C-I, 143 plants in C-II and 142 plants in C-III on the ten characters *viz.,* days to flowering, plant height (cm), internodal length (cm), number of nodes per plant, number of primary branches per plant, fruit length(cm), fruit diameter (cm), fruit weight (g), number of fruits per plant, fruit yield per plant (g).

Inbreeding depression was computed by using the following formulae:

$$\text{Inbreeding depression (\%)} = \frac{(\bar{F}_1 - \bar{F}_2)}{(\bar{F}_1)} \times 100$$

Where, $\bar{F}_1$ = mean of F_1, $\bar{F}_2$ = mean of F_2

The inbreeding depressions from F_1 to F_2 generation in okra are presented in (Tables 1-3) for crosses Arka Anamika × IC-42464, Konkan Bhindi × IC-42470 and Arka Abhay × IC-42472, respectively.

The negative and significant inbreeding depression was observed for days to flowering in cross Arka Anamika × IC-42464 (-4.27%) and cross Arka Abhay × IC-42472 (-1.15%), indicating earlier flowering in the F_2 generation than the F_1 generation. Positive and significant inbreeding depression was recorded for days to flowering in cross Kokan Bhindi × IC-42470 (3.09%.) It indicates better chances to obtain desirable segregants for earliness in the subsequent filial generations of these crosses. Significant and positive inbreeding depression was observed for plant height across all the crosses. The C I (Arka Anamika × IC-42464) showed 19.99% inbreeding depression, C II (Kokan Bhindi × IC-42470) showed a considerable 47.28% and C III Arka Abhay × IC-42472 recorded a 24.57%. Negative and significant inbreeding depression for plant height was considered desirable in the okra breeding programme. Negative and significant inbreeding depression (-18.97%) was observed for internodal length in the cross III (Arka Abhay × IC-42472), which was considered desirable. Shorter internodes are desirable because they restrict excessive growth in plant tallness and maintain an ideal plant height. Cross I (Arka Anamika × IC-42464) and Cross II (Kokan Bhindi × IC-42470)

Table 1: Inbreeding depression in okra for fruit yield and yield-contributing traits from F_1 to F_2 generation in the selected cross Arka Anamika × IC-42464

S. No.	*Characters*	*F_1 Mean*	*F_2 Mean*	*Inbreeding depression (%)*
1.	Days to flowering	44.2	46.1	-4.27
2.	Plant height (cm)	54.6	43.7	19.99
3.	Internodal length (cm)	5.7	4.8	15.28
4.	Number of nodes per plant	11.9	12.8	-7.52
5.	Number of primary branches per plant	2.0	1.4	29.43
6.	Fruit length (cm)	13.6	11.4	15.87
7.	Fruit diameter (cm)	1.5	1.3	15.59
8.	Fruit weight (g)	16.0	15.3	3.98
9.	Number of fruits per Plant	12.1	6.6	45.08
10.	Fruit yield per plant (g)	211.1	101.4	51.97

Table 2: Inbreeding depression in okra for fruit yield and yield-contributing traits from F_1 to F_2 generation in the selected cross Kokan Bhindi x IC-42470

S. No.	*Characters*	*F_1 Mean*	*F_2 Mean*	*Inbreeding depression (%)*
1.	Days to flowering	46.0	44.6	3.09
2.	Plant height (cm)	72.3	38.1	47.28
3.	Internodal length (cm)	6.1	4.1	32.57
4.	Number of nodes per plant	19.9	12.9	35.34
5.	Number of primary branches per plant	2.1	1.5	30.51
6.	Fruit length (cm)	13.0	13.0	0.56
7.	Fruit diameter (cm)	1.7	1.3	21.71
8.	Fruit weight (g)	16.6	12.5	24.58
9.	Number of fruits per plant	16.1	8.1	49.59
10	Fruit yield per plant (g)	203.8	103.0	49.49

Table 3: Inbreeding depression in okra for fruit yield and yield-contributing traits from F_1 to F_2 generation in the selected cross Arka Abhay × IC-42472

S. No.	*Characters*	*F_1 Mean*	*F_2 Mean*	*Inbreeding depression (%)*
1.	Days to flowering	46.0	46.5	-1.15
2.	Plant height (cm)	63.2	47.7	24.57
3.	Internodal length (cm)	4.1	4.9	-18.97
4.	Number of nodes per Plant	17.2	13.8	20.00
5.	Number of primary branches per plant	2.1	1.8	14.13
6.	Fruit length (cm)	14.9	11.8	21.03
7.	Fruit diameter (cm)	1.3	1.4	-7.42
8.	Fruit weight (g)	14.8	13.7	7.55
9.	Number of fruits per plant	15.2	8.1	46.53
10.	Fruit yield per plant (g)	214.9	109.2	49.18

revealed positive and significant inbreeding depression of 15.28 and 32.57%, respectively, for this trait. The inbreeding depression for the number of nodes per plant ranged from -7.52% in cross I (Arka Anamika × IC-42464) to 20.00% in cross III (Arka Abhay × IC-42472) and 35.34% in Cross II (Kokan Bhindi × IC-42470) and was recorded as non-significant and negative in cross I and significant and positive in cross II and III. All three crosses exhibited non-significant and positive inbreeding depression for the number of primary branches per plant. Cross I (Arka Anamika × IC-42464), cross II (Kokan Bhindi × IC-42470) and cross III (Arka Abhay × IC-42472) recorded positive and non-significant inbreeding depression of 29.43, 30.51, and 14.13%, respectively, for this trait. A higher number of branches per plant was considered desirable as it increases the yield. None of the crosses illustrated negative and significant inbreeding depression for this trait. Fruit length showed positive and non-significant inbreeding depression with varying percentages. cross III (Arka Abhay × IC-42472), cross I (Arka Anamika × IC-42464) and Cross II (Kokan Bhindi × IC-42470) recorded non-significant and positive inbreeding depression of 21.03, 15.87 and 0.56%, respectively. The negative and significant inbreeding depression is considered to be beneficial to get the better segregants. This type of result was obtained for fruit diameter in cross III (Arka Abhay × IC-42472), which recorded inbreeding depression of (-7.42%). In contrast, Cross I (Arka Anamika × IC-42464) and Cross II (Kokan Bhindi × IC-42470) recorded significant and positive inbreeding depression of 15.59 and 21.71%, respectively. Positive and significant inbreeding depression was obtained for fruit weight in the cross I (Arka Anamika × IC-42464) 3.98%, cross II (Kokan Bhindi × IC-42470) 24.58% and cross III (Arka Abhay × IC-42472), 7.55%. The traits, such as the number of fruits per plant and fruit yield per plant, are considered to be most important in the okra crop. Significant and positive inbreeding depression was recorded for the number of fruits per plant in the cross II (Kokan Bhindi × IC-42470), 49.59%, cross III (Arka Abhay × IC-42472) 46.53% and cross I (Arka Anamika × IC-42464), 45.08%. Significant and positive inbreeding depression for fruit yield per plant was observed in the cross I (Arka Anamika × IC-42464), 51.97%, cross II (Kokan Bhindi × IC-42470) 49.49% and Cross III (Arka Abhay × IC-42472), 49.18%. The negative and significant inbreeding depression is considered to be useful for okra crop improvement programmes. None of the crosses depicted significant inbreeding depression in a negative direction for fruit length, fruit weight, number of fruits per plant, and fruit yield per plant. Similar results were noted by Khanorkar and Kathiria (2010), who found a positively significant inbreeding depression for days to first flowering in the cross GO-2 x AOL 04-3 and also reported negatively significant inbreeding depression for fruit girth (diameter) in the cross HRB-55 x AOL-05-4. Gediya et al. (2023) found desirable inbreeding depression signifying earliness in Pusa Sawani × AOL 10-22 and GAO 5 × AOL 13-144 for days to flowering and also reported that all crosses showed positive and non-significant inbreeding depression for branches per plant. Aware et al. (2014) found that a reduction in vigor for plant height was significant in the cross-PK x AKO107 (13.16%). Neetu et al. (2015) recorded 23.66% inbreeding depression for plant height, 58.49% inbreeding depression for the number of branches per plant and 43.08% inbreeding depression for the number of fruits per plant. Chavan et al. (2018) noted that the number of nodes per plant and fruit yield per plant showed the highest and significant inbreeding depression in the F_2 generation. Tonde et al. (2016) found the maximum inbreeding depression for the number of branches per plant (20.69%) and fruit yield per plant (8.53%) in the cross GDO-6 x Julie. Sabesan et al. (2016) noted that fruit length was among the characters for which inbreeding depression was high in good-performing hybrids. Srikanth et al. (2019) observed inbreeding depression in the F_2 generation for fruit yield per plant, ranging up to 37.16%.

The F_2 Population of all three okra crosses exhibited notable positive inbreeding depression for key yield traits such as fruit yield per plant, number of fruits per plant and fruit weight, indicating reduced performance in the F_2 generation due to increased homozygosity. Negative inbreeding depression for days to flowering suggests potential for breeding earlier-maturing okra varieties.

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