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Evaluation of the Performance of Okra (*Abelmoschus esculentus* l. Moench) Genotypes for Growth, Yield, and Quality Parameters

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation was carried out to evaluate the performance of okra genotypes for growth, yield and quality parameters. Okra is often cross-pollinated and is grown primarily for its fruits, which have various culinary uses. Tender fruits are commonly boiled or used in sliced and fried dishes. Okra fruits are also dried in the sun, canned, or dehydrated for preservation during the off-season. The study was carried out at New Orchard, Main Agricultural Research Station, UAS,

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Raichur, during late *Kharif* 2021-22 using thirty-one genotypes (including the check variety Arka Anamika) and laid out in Randomized Block Design (RBD) with three replications. The analysis of variance revealed significant differences ($p < 0.05$) among genotypes for all traits studied. Genotype OPL-2127 recorded the highest plant height (96.52 cm), stem girth (14.26 mm), number of leaves per plant (23.20), leaf area index (3.08), number of nodes per plant (13.60), chlorophyll content (59.61 SPAD readings), fruit length (18.69 cm), fruit yield per plant (293.53 g), fruit yield per hectare (16.4 t) and it is found to be superior over the other okra genotypes under the study. The highest fruit girth (41.36 mm) was noted in the genotypes OPL-2108. The genotype OPL-2119 recorded the minimum number of days to 50 per cent flowering (38.00) which indicates the earliness of the genotypes. OPL-2023 recorded the highest fibre content (16.09 %). The genotypes OPL-2127, OPL-2121, OPL-2116, OPL-2115 and OPL-2113 were found to be superior okra genotypes for yield and quality and they can be used in future breeding and crop improvement program.

Keywords: Okra genotypes; evaluation; earliness; superior.

1. INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench), also referred to as lady's finger and bhendi, is a significant vegetable crop grown in tropical and subtropical regions during the spring-summer and rainy seasons. It can also be cultivated year-round in areas with mild winters. India, the largest producer of okra globally, yields an annual production of 6.35 million tonnes from 521 thousand hectares, achieving a productivity of 12.19 tonnes per hectare [1]. Major okra cultivating states include Uttar Pradesh, Bihar, Orissa, West Bengal, Andhra Pradesh, Karnataka, and Assam.

Okra is an annual plant that belongs to the Malvaceae family and the Malvales order. It has a chromosome number of 2n=130 and is considered an amphidiploid. Okra is often cross-pollinated and is grown primarily for its fruits, which have various culinary uses. Tender fruits are commonly boiled or used in sliced and fried dishes. Okra fruits are also dried in the sun, canned, or dehydrated for preservation during the off-season. The ripe seeds are roasted, ground, and used as a coffee substitute. Okra fruits contain protein (2.10%), fat (0.2%), carbohydrate (8.2%), fiber (1.70%), ash (0.8%), vitamin C (30 mg/100g), calcium (84.00 mg/100g), and iron (1.20 mg/100g). The seeds contain 13-22% edible oil and 20-24% protein, which are used to produce refined edible oil [2]. Additionally, okra is an excellent natural source of iodine (2.33-6.33 µg/100 g).

There are many genotype(s)/cultivar(s) of okra having diverse characters in different parts of the country. The detailed morphological and genetical characters of okra genotypes are necessary to know. Evaluation of potentialities of the existing genotypes is essential because it depicts the genetic diversity of the base materials on which depends the promise for further improvement. Therefore, the present investigation was carried out to evaluate the performance of okra genotypes for growth, yield and quality parameters.

2. MATERIALS AND METHODS

The study was conducted at New Orchard, Department of Horticulture, Main Agricultural Research Station, University of Agricultural Sciences, Raichur, during the late Kharif season of 2021-22. The experimental location is situated in North Eastern Dry Zone (Zone-II) of Karnataka 16˚15 N' latitude, 77˚21 E' longitude at an altitude of 389 m above mean sea level having red sandy loamy soil. Average rainfall of the site is 660 mm. The mean maximum temperature is more than 31.2˚C throughout the year. The relative humidity is high in monsoon months which ranged from 55 to 70 per cent. The major rainfall is confined to late kharif to early rabi (August to December). The experimental material consisted of 31 okra genotypes (including the check variety Arka Anamika) obtained from ICAR-National Bureau of Plant Genetic Resources (NBPGR), New Delhi, and ICAR-Indian Institute of Horticultural Research (IIHR), Bengaluru. These genotypes were evaluated by planting each entry in plots measuring 3.6 m in length and 2.4 m in width, spaced at 60 cm × 45 cm intervals, using a Randomized Block Design (RBD) with three replications. Recommended agronomic practices and plant protection measures were implemented following the package of practices from UHS, Bagalkot [3].

Data were collected from five randomly selected plants per plot within each replication for twelve growth (at 75 DAS), flowering, yield, and quality traits, including plant height, stem girth, number of leaves per plant, leaf area index, number of nodes per plant, chlorophyll content (SPAD readings), days to 50 percent flowering, fruit length, fruit girth, fruit yield per plant, fruit yield per hectare, and fiber content. Statistical analysis for significant treatment effects, standard error of means (S.Em ±), and critical differences at the 5 percent significance level was conducted using OPSTAT software. Genotypic comparisons were also performed statistically.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

Table 1 presents the comparison of okra genotypes for various growth parameters. The evaluation study showed significant differences in plant height among the genotypes. Genotype OPL-2127 exhibited the tallest plants at 96.52 cm, significantly surpassing all others, with OPL-2121 at 88.02 cm, OPL-2116 at 71.11 cm, and OPL-2113 at 69.60 cm following closely behind. Genotype OPL-2127 recorded a 10.10 per cent higher plant height as compared to check cultivar Arka Anamika. Genotype OPL-2103 had the shortest plants at 40.04 cm. The variation in plant height among genotypes may stem from genetic factors, including inheritance patterns, as well as differences in apical dominance, cell division, and cell elongation. These findings align with previous studies by Saleem et al. [4]. and Kelemage et al. [5] for significant difference in plant height in okra.

The stem girth of okra genotypes exhibited significant variation. Genotype OPL-2127 displayed the highest stem girth (14.26 mm), followed by OPL-2121 (12.87 mm), OPL-2113 (12.34 mm), and OPL-2116 (12.25 mm), while genotype OPL-2103 had the smallest stem girth (7.71 mm). Genotype OPL-2127 recorded 11.58 per cent higher stem girth as compared to check cultivar Arka Anamika. The observed differences among genotypes in stem girth may be attributed to genetic factors influencing endogenous hormone balance, which in turn regulates processes such as cell division, enlargement, and differentiation, affecting branching and ultimately stem girth. These findings align with those reported by Kumar et al. [6,7] Singh et al. [8] and Meena et al. [9] significant variation in stem girth in okra.

There was significant variation in the number of leaves per plant among okra genotypes. The genotype OPL-2127 recorded the maximum number of leaves per plant (23.20) which is 24.73 per cent higher as compared to check cultivar Arka Anamika, followed by genotype OPL-2122 (21.40), OPL-2128 (21.40) and OPL-2111 (20.90), whereas genotype OPL-2105 recorded the minimum number of leaves per plant (15.10). The differences observed in leaf numbers among genotypes may be attributed to the expression of temporal and spatial enzymes of genes and the production of endogenous plant hormones such as cytokinins, which regulate auxin synthesis and transport to facilitate leaf primordia emergence. Additionally, genetic variability among okra genotypes could also contribute to this variation. These findings of significant difference in number of leaves per plant are consistent with previous studies by Saleem et al. [4] Hasan et al. [10] Meena et al. [9] and Walling et al. [11] in okra.

There was notable variation in leaf area index among the okra genotypes. Genotype OPL-2127 exhibited the highest leaf area index (3.08), followed by OPL-2128 (2.27), OPL-2109 (2.13), OPL-2110 (2.22), and OPL-2115 (2.19). In contrast, genotype OPL-2101 had the lowest leaf area index (0.57). Genotype OPL-2127 showed a 43.92% higher leaf area index compared to the reference cultivar Arka Anamika. The observed variation in leaf area index may be attributed to the number of leaves per plant and the area of individual leaves since, they have the positive correlation with leaf area index [12] influenced by genetic interactions such as additive × additive, additive × dominance, or dominance × dominance gene actions. Similar findings were reported by Walling et al. [11] in okra.

There was significant variability in the number of nodes per plant among the different okra genotypes. Genotype OPL-2127 displayed the highest number of nodes per plant (13.60), followed by OPL-2121 (12.30), OPL-2116 (11.80), and OPL-2115 (11.10). Genotype OPL-2118 showed the lowest number of nodes per plant (6.30). Genotype OPL-2127 produced 14.28 per cent more number of nodes per plant as compared to check cultivar Arka Anamika. In okra, the number of nodes and internodes corresponds to the number of leaves, as all originate from the same phytomer. An increase in the number of nodes per plant results in a greater number of leaves and fruits per plant, while a larger leaf area per plant translates to a

higher active photosynthetic area, ultimately leading to increased biomass and yield. These findings are consistent with those reported by Morey et al. [13] Kelemoge et al. [5] and Mourya et al. [14] for significant variation in number of nodes per plant in okra.

The maximum SPAD value of 59.61 was recorded in genotype OPL-2127, which is at par with the genotypes OPL-2115 (56.57), OPL-2118 (55.88), OPL-2106 (55.88), OPL-2112 (54.79), OPL-2119 (54.58), Arka Anamika (54.05), OPL-2114 (53.92), OPL-2121 (53.84), OPL-2113 (53.75), OPL-2103 (53.67), OPL-2117 (53.69), OPL-2123 (53.50), OPL-2110 (53.35), OPL-2124 (53.21) and OPL-2116 (52.95). The minimum SPAD value (38.91) was observed in genotype OPL-2126. The variation in leaf chlorophyll content (SPAD readings) among okra genotypes may stem from their specific genetic makeup, influencing nitrogen uptake and the production of endogenous hormones such as gibberellins and cytokinins. These hormones contribute to chloroplast development, where chlorophyll pigments are synthesized, crucial for photosynthesis. The findings regarding chlorophyll content in this study align with those reported by Morey et al. [13] Kelemoge et al. [5] and Mourya et al. [14] in okra.

3.2 Flowering Parameters

There was significant variation in days to 50% flowering among different okra genotypes, ranging from 38.00 to 44.50 days. Genotype OPL-2119 exhibited the shortest duration (38.00 days) to reach 50% flowering, while the reference cultivar Arka Anamika took the longest (44.50 days). The variation in flowering time among genotypes may be attributed to differences in genetic potential, phenological characteristics, and growth parameters influenced by genetic interactions such as additive × additive, additive × dominance, or dominance × dominance gene actions. These findings are consistent with studies by Osekita et al. [15], Morey et al. [13] and Kumari et al. [7] in okra.

3.3 Yield Parameters

The yield parameter data are presented in Table 2. Fruit length varied significantly among different okra genotypes, ranging from 7.93 cm to 18.69 cm. Genotype OPL-2127 exhibited the longest fruits at 18.69 cm, followed by OPL-2121 (16.92 cm), OPL-2116 (16.84 cm), and OPL-2115 (16.80 cm). The shortest fruit length (7.93 cm) was recorded in genotype OPL-2108, while the fruit length in the reference cultivar Arka Anamika was 16.00 cm. Variations in fruit length may be attributed to inherent transferable parental traits among okra genotypes. Similar findings were reported by Saleem et al. [4] Kelemoge et al. [5] and Ashraf et al. [16] in okra.

There was significant variation in fruit girth among different okra genotypes, ranging from 15.21 mm to 41.36 mm. Genotype OPL-2108 recorded the highest fruit girth at 41.36 mm, followed by OPL-2118 (21.54 mm), OPL-2122 (20.68 mm), and OPL-2126 (20.60 mm). The smallest fruit girth (15.21 mm) was observed in genotype OPL-2116. The fruit girth recorded in check cultivar Arka Anamika was 16.21 mm. Variations in fruit girth may be attributed to differences in levels of endogenous hormones such as GA3 and NAA, which stimulate cell elongation and contribute to the growth of okra fruits. These traits are directly influenced by the genetic makeup and inherent characteristics of the genotypes. These findings of significant variation in fruit girth are consistent with previous studies by Saleem et al. [4] Kelemoge et al. [5] Ashraf et al. [16] Hasan et al. [10] Meena et al. [9] Thakur et al. [17] and Walling et al. [11] in okra.

The fruit yield per plant and fruit yield per hectare differed significantly among genotypes. Fruit yield was recorded significantly highest in OPL-2127 when compared to all other genotypes, followed by genotypes OPL-2121, Arka Anamika, OPL-2116 and OPL-2115. Genotype OPL-2127 produced 16.40 per cent higher fruit yield per hectare as compared to check cultivar Arka Anamika. The lower fruit yield was recorded in genotype OPL-2108. The maximum fruit yield was observed in genotype OPL-2127 might be due to higher leaf area per plant which provide more active photosynthetic area leading to higher production photosynthates, highest fruit length (18.69 cm), more number of fruits per plant (16.10) and highest fruit yield per plant (293.53 g). This could also be due to the genetic makeup of the genotypes. These results of the present investigation are in agreement with the earlier findings of Singla et al. (2018), Kolemoge et al. [5] Hasan et al. [10] Hayati et al. [18] Walling et al. [11] and Kumar et al. [19] in okra.

Table 1. *Per se* performance for growth and flowering parameters of different okra genotypes

Genotypes	Plant height (cm)	Stem girth (mm)	Number of leaves per plant	Leaf area index	Number of nodes per plant	Chlorophyll content (SPAD readings)	Days to 50 per cent flowering
OPL-2101	53.56	9.36	17.30	0.57	8.60	50.33	39.50
OPL-2102	48.14	9.28	17.50	1.52	9.10	49.89	38.50
OPL-2103	40.04	7.71	15.80	1.35	7.50	53.67	39.00
OPL-2104	45.83	9.17	17.40	1.17	8.00	48.15	39.00
OPL-2105	43.92	9.81	15.10	2.12	8.00	53.97	39.00
OPL-2106	41.46	11.18	17.70	2.13	7.90	55.28	40.50
OPL-2107	41.88	9.53	17.40	2.14	8.80	51.74	42.00
OPL-2108	50.32	10.49	16.50	1.86	6.20	49.95	39.50
OPL-2109	57.30	10.40	19.70	2.13	8.30	52.32	41.50
OPL-2110	51.65	10.75	20.10	2.22	8.50	53.35	39.00
OPL-2111	45.20	10.78	20.90	1.71	8.80	50.42	40.00
OPL-2112	47.18	10.89	19.00	1.81	9.00	54.79	39.00
OPL-2113	69.60	12.34	19.30	1.68	10.20	53.75	42.00
OPL-2114	55.22	11.34	20.10	2.14	9.80	53.92	38.50
OPL-2115	66.52	12.05	20.90	2.19	11.10	56.57	39.00
OPL-2116	71.11	12.25	18.50	2.07	11.80	52.95	39.50
OPL-2117	47.06	10.49	19.60	1.56	7.90	53.69	39.50
OPL-2118	40.59	9.89	19.30	1.93	6.30	55.88	39.50
OPL-2119	46.80	10.88	19.50	1.68	8.70	54.58	38.00
OPL-2120	47.02	11.27	19.70	1.64	8.50	53.17	40.00
OPL-2121	88.02	12.87	20.20	1.95	12.30	53.84	38.50
OPL-2122	44.82	10.32	21.40	1.91	7.60	51.24	42.50
OPL-2123	61.40	11.73	20.40	1.27	9.70	53.50	43.00
OPL-2124	61.22	11.71	18.50	1.78	10.60	53.21	42.00
OPL-2125	49.53	10.20	19.50	1.44	8.00	40.03	41.50
OPL-2126	45.89	10.80	20.00	2.13	8.80	38.91	41.50
OPL-2127	96.52	14.26	23.20	3.08	13.60	59.61	38.50
OPL-2128	42.74	10.57	21.40	2.27	7.70	43.18	44.00
OPL-2129	42.01	10.01	17.90	1.51	8.10	41.91	43.00
OPL-2130	41.15	10.14	19.20	1.45	8.20	40.83	43.00
Arka Anamika	87.59	12.78	18.60	2.14	11.90	54.05	44.50
Mean	54.29	10.63	19.08	1.81	9.14	51.25	40.31
S.Em. ±	7.92	0.40	0.71	0.08	0.41	2.46	1.17
CD @ 5%	7.13	1.15	2.04	0.23	1.19	7.10	3.38

Table 2. *Per se* performance for yield and quality parameters of different okra genotypes

Genotypes	Fruit length (cm)	Fruit girth (mm)	Fruit yield per plant (g)	Fruit yield per hectare (t)	Fibre content (%)
OPL-2101	12.47	19.57	118.95	6.67	12.86
OPL-2102	14.75	18.54	95.17	5.33	8.94
OPL-2103	13.53	17.27	73.57	4.11	7.98
OPL-2104	13.95	19.35	67.92	3.82	10.06
OPL-2105	14.03	18.67	70.26	3.95	9.72
OPL-2106	14.17	19.85	63.96	3.59	12.49
OPL-2107	11.07	18.33	66.85	3.77	13.74
OPL-2108	7.93	41.36	47.81	2.69	13.32
OPL-2109	16.10	18.12	133.16	7.46	12.32
OPL-2110	14.01	18.73	102.89	5.77	11.68
OPL-2111	13.10	17.58	76.87	4.32	8.82
OPL-2112	14.65	17.99	105.63	5.92	8.22
OPL-2113	16.17	18.41	210.14	11.78	8.08
OPL-2114	14.03	20.05	124.18	6.98	14.03
OPL-2115	16.80	18.45	220.3	12.39	6.75
OPL-2116	16.84	15.21	228.7	12.83	12.85
OPL-2117	13.49	15.53	91.27	5.10	13.49
OPL-2118	12.29	21.54	67.07	3.76	7.79
OPL-2119	13.68	16.53	92.77	5.13	13.16
OPL-2120	13.58	15.90	89.43	4.89	12.89
OPL-2121	16.92	15.81	263.71	14.81	12.13
OPL-2122	13.50	20.68	64.21	3.61	10.71
OPL-2123	16.01	19.79	165.44	9.30	16.09
OPL-2124	13.53	20.46	175.3	9.85	13.94
OPL-2125	15.36	16.76	108.82	6.11	13.97
OPL-2126	15.13	20.60	91.59	5.14	11.77
OPL-2127	18.69	18.10	293.53	16.46	12.61
OPL-2128	11.95	18.48	74.91	4.18	12.38
OPL-2129	13.61	18.34	65.35	3.66	13.36
OPL-2130	13.66	19.50	71.22	3.99	9.03
Arka Anamika	16.00	16.21	251.81	14.14	9.81
Mean	14.23	19.09	121.7	6.82	11.45
S.Em. ±	0.51	0.74	10.17	0.59	0.77
CD @ 5%	1.46	2.14	29.38	1.69	2.21

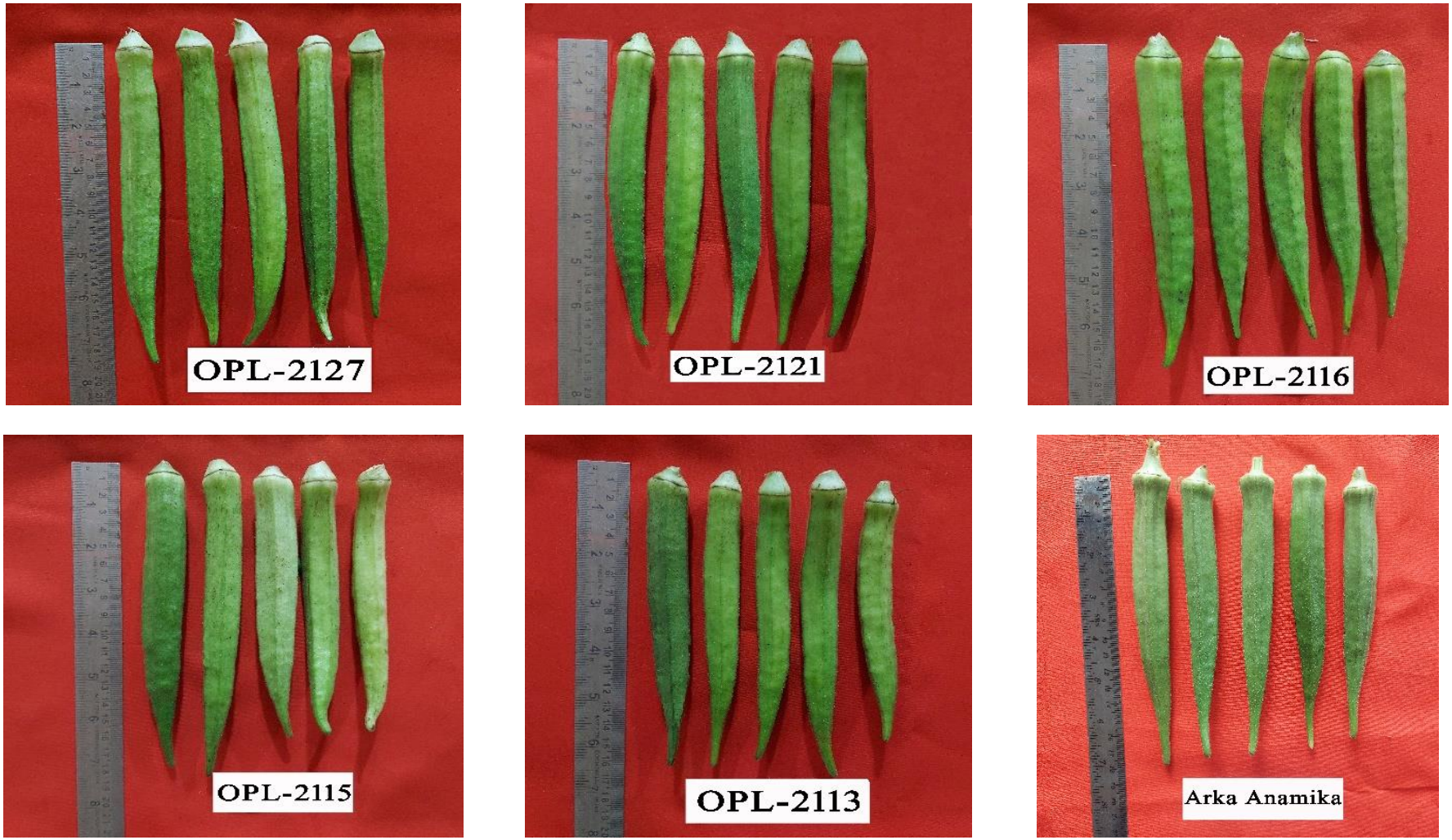

Plate 1. Top five superior genotypes with check cultivar (Arka Anamika)

3.4 Quality Parameter

The quality parameters data are presented in Table 2. Fibre content varied among okra genotypes, with genotype OPL-2123 recording the highest at 16.09%, equivalent to genotypes OPL-2114 (14.03%), OPL-2125 (13.97%), and OPL-2124 (13.94%). The lowest fibre content (6.75%) was observed in genotype OPL-2115. The fibre content in the reference cultivar Arka Anamika was 9.81%. Variation in fruit fibre content among okra genotypes may be attributed to their genetic makeup and inherited traits. Similar findings have been reported by Morey et al. [13] Rambabu et al. [20] and Walling et al. [11] in okra.

4. CONCLUSION

The present investigation on okra genotypes concluded that, wide range of variation was observed by among the genotypes for all the characters studied. Genotype OPL-2127 recorded significantly highest fruit yield per plant, fruit yield per plot, fruit yield per hectare and it is found to be superior over all other okra genotypes under study. The genotypes OPL-2127, OPL-2121, OPL-2116, OPL-2115 and OPL-2113 were considered as superior okra genotypes for yield and quality and they can be used in future breeding and crop improvement program.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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