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Rakshitha Pallakki

M.Sc. Scholar, Department of Vegetable Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Dhananjay Sharma

Senior Scientist, Department of Vegetable Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

C Suneetha

Assistant Professor, Department of Horticulture, University of Agricultural Sciences, Gandhi Krishi Vigyana Kendra, Bengaluru, Karnataka, India

Corresponding Author:

Rakshitha Pallakki

M.Sc. Scholar, Department of Vegetable Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Morphological characterization of okra [*Abelmoschus Esculentus* (L) Moench] genotypes

Rakshitha Pallakki, Dhananjay Sharma and C Suneetha

Abstract

A total of 14 genotypes of okra [*Abelmoschus Esculentus* (L.) Moench] were evaluated for 23 morphological characters (9 quantitative and 14 qualitative). All the genotypes showed variation for the characters studied. Genotypes P-2, P-4, P-5 and P-6 showed red stem colour while others have green. Purple vein colour was observed in P-5 and P-6, rest of the genotypes had light green vein colour. Petal base colour inside only is seen in P-2, P-6 and H-3 while others showed purple petal base colour on both the sides. Light green fruit colour was seen in genotypes P-1, P-2, P-3 and P-4 while Arka Anamika and Jamkhandi local had medium green fruits, light red and dark red fruits were observed in P-5 and P-6 rest of the genotypes had dark green fruits. Half of the genotypes had green seed colour and remaining half had brown seed colour. Plant height varied in all genotypes from 84.03 to 130.21cm with an average of 109.80 cm. Average fruit weight was 14.57g, it varies from 10.04 g to 33.86g. Total yield per plant varied from 261.33 to 641.33g with an average of 422.39g. Yield per hectare ranges from 14.50 to 35.61t/ha with a mean of 23.45t/ha.

Keywords: Okra, Morphological characters, genotypes, yield

Introduction

Okra [*Abelmoschus Esculentus* (L.) Moench] also called as lady's finger, bhendi and gumbo It is a popular vegetable crop grown in tropical and subtropical regions of the world belongs to Malvaceae, originated in Ethiopia (Aladele *et al.* 2008; Ali *et al.*, 2014; Eshiet and Brisibe, 2014) [2, 3, 9]. The crop grows well in hot weather especially in areas with warm nights (>20°C). It can be grown as garden crop, as well as in large commercial farms (Ndunguru and Rajabu, 2004) [17]. Okra fruits are highly nutritious which contains proteins, carbohydrates, fat, vitamin and minerals like vitamin A, thiamine, riboflavin, pyridoxine, vitamin C, calcium, iron, potassium, zinc and folic acid emphasising the importance of okra in human diet (Gopalan *et al.*, 2007) [12]. Pods contain adequate amount of iodine which is used in curing Goitre. Roots are used in clearing cane juice used in preparation of jaggery. Pods used to treat bladder blockage, diarrhea, dysentery, gonorrhoea and urinary problems and seeds possess anticancer and fungicidal properties (Ansori, 2021) [4].

Characterization of available germplasm is a crucial activity that allows researchers to use the germplasm in breeding programmers by providing information on the various features that each accession possesses (Hartwig, 1972; Frankel, 1976; Omohinmin and Osawaru, 2005) [13, 10, 19]. Molecular markers, morphological markers, cytological markers, biochemical markers, and molecular markers have been used to characterise germplasm, whereas the fundamental step in the description, classification, and arranging of germplasm accessions is morphological characterisation (Arslanoglu *et al.*, 2011) [5]. Characterization aids gene banks and plant breeders in finding unique accessions. For vegetable breeders looking for new gene resources, morphological characterisation of local germplasm is crucial (Ren *et al.*, 1995) [21]. Characterization of genetic resources is the process of recognising, differentiating, or distinguishing accessions based on their character or quality (Reddy *et al.*, 2016) [20]. The PPV and FR Act of 2001 allows for a comparison of the candidate cultivar to reference/extent cultivars based on a set of pertinent features outlined in the Draft National Test Guidelines for DUS testing of okra. Considering the importance and demand for okra, it is necessary to characterize the available genotypes based on morphological characters to develop cultivars that are different from the existing cultivars.

Materials and Methods

The experiment includes fourteen different okra genotypes. Table 1 shows the genotypes that were evaluated along with their source of collection. The cultivars were evaluated at Vegetable Science Research Block, Department of Horticulture, University of Agricultural Sciences, Gandhi Krishi Vigyana Kendra (GKVK), Bengaluru, Karnataka in a Randomized Complete Block Design (RCBD) with 3 replications. Genotypes were evaluated for 23 economically important characters (14 qualitative) viz. stem colour, dentation of leaf margin, depth of lobbing, colour between veins, intensity of colour between veins, vein colour, leaf colour, petal base colour, fruit colour, surface between ridges, constriction of basal part of fruit, fruit shape apex, number of locules per fruit, seed colour and (9 quantitative traits) viz. plant height (cm), number of branches per plant, stem diameter (cm), days to 50 % flowering, fruit length (cm), fruit diameter (cm), average fruit weight (g), yield per plant(g), yield per hectare (t/ha). To record observations on various parameters, five competitive plants were selected randomly from each replication. The morphological observations were made using the Guidelines given by PPVFRA (Protection of Plant Varieties and Farmer's Rights Act), Government of India.

Table 1: Details of the okra genotypes along with their sources

Sl. No.	Genotypes	Sources
1	P-1	Periyapatna, Mysuru, Karnataka
2	P-2	Periyapatna, Mysuru, Karnataka
3	P-3	Periyapatna, Mysuru, Karnataka
4	P-4	Periyapatna, Mysuru, Karnataka
5	P-5	Periyapatna, Mysuru, Karnataka
6	P-6	Periyapatna, Mysuru, Karnataka
7	H-1	Byadagi, Haveri, Karnataka
8	H-2	Byadagi, Haveri, Karnataka
9	H-3	Byadagi, Haveri, Karnataka
10	H-4	Byadagi, Haveri, Karnataka
11	H-5	Byadagi, Haveri, Karnataka
12	H-6	Byadagi, Haveri, Karnataka
13	Jamkhandi local	Bagalkot, Karnataka
14	Arka Anamika	IIHR, Bengaluru, Karnataka

Results and Discussion

Okra genotypes were evaluated for a set of morphological characters. Wide range of variation of observed for all the characters studied (Table 2).

Stem and leaf characters

Majority of the genotypes had green stem colour (71.43%) except for P-2, P-4, P-5, P-6 (28.57%) which had red stem colour. These findings were consistent with previous studies by Adeoluwa and Kehinde (2011) [1], Das *et al.* (2012) [8], Asare *et al.* (2016) [6], Binalfew and Alemu, (2016) [7]. Dentation of leaf margin was divided as weak in 2 genotypes

(14.29%), medium in 7 genotypes (50%) and strong in 5 genotypes (35.71%). Four genotypes (28.57%) had shallow leaf lobbing, six genotypes (42.86%) had medium leaf lobbing, and the rest of the genotypes (28.57%) had deep leaf lobbing. Genotypes exhibited 3 types of leaf colour (green, light green, dark green) where 8 genotypes had dark green (57.14%), 4 genotypes had light green (28.57%) and 2 genotypes had green leaf colour (14.29%). Vein colour was characterized into two groups (light green and purple) where most of the genotypes had light green vein colour (85.71%) and remaining had purple vein colour (14.29%). Genotypes did not show any variation for colour between veins, all the 14 genotypes had green colour between veins. Intensity of colour between veins is of 3 types (light green, medium green and dark green), 2 genotypes had light green (14.29%), 4 genotypes had medium green (28.57%) and remaining 8 genotypes had dark green (57.14%) colour between veins. Results obtained are in similar with the findings of Singh *et al.* (2015) [24], Gangopadhyay *et al.* (2016) [11], Reddy *et al.* (2016) [20], Kumari *et al.* (2017) [14] and Temam *et al.* (2021) [25].

Flower and fruit characters

A proportionate of 78.57% genotypes had both side petal base colour and 21.43% genotypes had petal base colour inside only. Similar work was done by Saifullah and Rabbani (2009) [22], Gangopadhyay *et al.* (2016) [11], Muluken *et al.* (2016) [16], Kumari *et al.* (2017) [14] and Ogwu *et al.* (2018) [18]. Fruit colour varies from light green, medium green, dark green, light red and dark red and majority genotypes had dark green fruit colour (42.86%), 4 genotypes had light green (28.57%), 2 genotypes had medium green (14.29%), 1 with light red fruits (7.14%) and other with dark red fruits (7.14%). The genotypes are classified as concave, flat and convex based on surface between ridges. 6 genotypes (42.86%) had concave, 6 genotypes (42.86%) had flat, while P-1 and P-5 had convex surface between ridges of fruit. Shape of fruit apex can be divided into narrow acute, acute and blunt. Most of the genotypes had narrow acute fruit shape apex (64.28%), 2 genotypes (14.29%) had acute and 3 genotypes (21.43%) had blunt shape of fruit apex. Constriction of basal part of fruit is very weakly expressed in 8 genotypes (57.14%), weakly expressed in 3 genotypes (21.43%) and strongly expressed in 3 genotypes (21.43%). Most of the genotypes (78.57%) had number of locules <6 and the remaining genotypes (21.43%) had 6-7 locules. Results were in consonance with the findings of Singh *et al.* (2015) [24], Gangopadhyay *et al.* (2016) [11], Reddy *et al.* (2016) [20], Kumari *et al.* (2017) [14] and Temam *et al.* (2021) [25]. Half of the genotypes had green seed colour and the remaining half had brown seed colour. Results are in similar with the research findings of Singh *et al.* (2015) [24], Reddy *et al.* (2012) [20], Ogwu *et al.* (2018) [18] and Samim *et al.* (2018) [23].

Table 2: Qualitative traits of fourteen okra genotypes

Characters	Particulars	No. of genotypes	% of genotypes	Genotypes
Stem colour	Green	10	71.43	P-1, P-3, H-1, H-2, H-3, H-4, H-5, H-6, Arka Anamika, Jamkhandi local
	Red	4	28.57	P-2, P-4, P-5, P-6
Dentation of leaf margin	Weak	2	14.29	P-4, P-6
	Medium	7	50.00	H-1, H-2, H-3, H-4, H-5, H-6, Arka Anamika
	Strong	5	35.71	P-1, P-2, P-3, P-5, Jamkhandi local
Depth of lobbing	Shallow	4	28.57	P-2, P-4, P-5, Jamkhandi local

	Medium	6	42.86	P-1, P-3, P-6, H-3, H-5, H-6,
	Deep	4	28.57	H-1, H-2, H-4, Arka Anamika
Leaf colour	Green	2	14.29	P-1, P-4
	Light green	4	28.57	P-2, P-3, P-5, P-6
	Dark green	8	57.14	H-1, H-2, H-3, H-4, H-5, H-6, Arka Anamika, Jamkhandi local
Vein colour	Light green	12	85.71	P-1, P-2, P-3, P-4, H-1, H-2, H-3, H-4, H-5, H-6, Arka Anamika, Jamkhandi local
	Purple	2	14.29	P-5, P-6
Colour between veins	Green	14		P-1, P-2, P-3, P-4, P-5, P-6, H-1, H-2, H-3, H-4, H-5, H-6, Arka Anamika, Jamkhandi local
	Red	-	0	-
Intensity of colour between veins	Light green	2	14.29	P-1, P-4
	Medium green	4	28.57	P-2, P-3, P-5, P-6
	Dark green	8	57.14	H-1, H-2, H-3, H-4, H-5, H-6, Arka Anamika, Jamkhandi local
Petal base colour	Inside only	3	21.43	P-2, P-6, H-3
	Both sides	11	78.57	P-1, P-3, P-4, P-5, H-1, H-2, H-4, H-5, H-6, Arka Anamika, Jamkhandi local
Fruit colour	Light green	4	28.57	P-1, P-2, P-3, P-4
	Medium green	2	14.29	Arka Anamika, Jamkhandi local
	Dark green	6	42.86	H-1, H-2, H-3, H-4, H-5, H-6
	Light red	1	7.14	P-5
	Dark red	1	7.14	P-6
Surface between ridges	Concave	6	42.86	P-2, P-4, P-6, H-1, H-5, Jamkhandi local
	Flat	6	42.86	P-3, H-2, H-3, H-4, H-6, Arka Anamika
	Convex	2	14.28	P-1, P-5
Fruit shape apex	Narrow	9	64.28	P-1, P-3, H-1, H-2, H-3, H-4, H-5, H-6, Arka Anamika
	Acute	2	14.29	P-2, P-5
	Blunt	3	21.43	P-4, P-6, Jamkhandi local
Constriction of basal part of fruit	Very weakly expressed	8	57.14	P-3, P-4, P-6, H-2, H-3, H-4, H-5, Arka Anamika
	Weakly expressed	3	21.43	P-2, H-1, H-6
Number of locules	Strongly expressed	3	21.43	P-1, P-5, Jamkhandi local
	<6	11	78.57	P-1, P-2, P-3, P-5, H-1, H-2, H-3, H-4, H-5, H-6, Arka Anamika
Seed colour	6-7	3	21.43	P-4, P-6, Jamkhandi local
	Green	7	50.00	P-1, P-2, P-3, P-6, H-6, Arka Anamika, Jamkhandi local
	Brown	7	50.00	P-4, P-5, H-1, H-2, H-3, H-4, H-5

Mean performance of okra genotypes

Plant height varied in all genotypes from 84.03 to 130.21cm with an average of 109.80cm. Arka Anamika had highest plant height (130.21cm), while P-1 had the lowest height (84.03cm). Number of branches per plant ranged from 2.47 to 6.00 with an average of 4.22. The highest number of branches per plant was produced by P-2 (6.00) and lowest was in H-6 (2.47). Stem diameter ranged from 1.44 to 2.68 cm with a mean of 1.86cm. Genotype P-6 recorded the highest stem diameter of 2.68cm and lowest stem diameter was recorded in H-6 (1.44cm). Number of days taken to produce 50% flowers varies from 44.33 to 57.67 days with a grand mean of 49.24 days. H-4 (44.33 days) took minimum number of days for 50% flowering, while P-5 (57.67 days) took maximum days to produce 50% flowers. Length of fruit ranges from 7.73 to 11.34 cm with an overall average of 9.36 cm. longest fruit

length was recorded in genotype P-1 (11.34cm) and smallest fruit length was seen in P-4 (7.73cm). Fruit diameter ranged from 1.26 to 2.41cm with an overall mean performance of 1.58cm. Genotype P-6 recorded a highest fruit diameter of 2.41cm and least was observed in P-1 (1.26cm). Average fruit weight was 14.57g it varies from 10.04g to 33.86g. Maximum fruit weight was recorded in genotype P-6 (33.86g) and minimum weight of fruit was in H-4 (10.04g). Total yield per plant varied from 261.33 to 641.33g with an average of 422.39g. High yielding genotype was P-2 (641.33g) and lowest yield per plant was produced by H-6 (261.33g). Yield per hectare ranges from 14.50 to 35.61t/ha with a mean of 23.45t/ha. Highest yield per hectare was produced by genotype P-2 (35.61t/ha) and least was recorded in H-6 (14.50t/ha).

Table 3: Mean performance of okra genotypes for quantitative traits

Sl. No.	Genotypes	PH	NBPP	SDI	D50%F	FL	FD	AFW	YPP	YPH
1	P-1	84.03	5.40	1.74	51.67	11.34	1.26	15.39	439.57	24.41
2	P-2	90.81	6.00	1.88	48.33	8.99	1.36	12.75	641.33	35.61
3	P-3	115.38	4.83	2.09	49.67	8.89	1.46	10.89	407.67	22.63
4	P-4	128.07	4.70	1.88	50.33	7.73	1.94	22.18	418.70	23.26
5	P-5	84.22	5.93	2.31	57.67	10.09	1.38	14.81	522.13	28.98
6	P-6	101.30	4.40	2.68	54.33	7.95	2.41	33.86	580.50	32.20
7	H-1	117.95	3.87	1.71	46.67	9.01	1.45	10.17	378.53	21.02
8	H-2	120.38	4.93	1.66	47.33	9.60	1.67	10.85	461.53	25.61
9	H-3	122.26	2.60	1.84	45.33	9.05	1.41	12.16	316.77	17.57
10	H-4	124.32	2.53	1.55	44.33	8.91	1.34	11.17	290.83	16.13

11	H-5	112.18	3.73	1.59	44.67	10.15	1.47	12.07	365.93	20.31
12	H-6	98.27	2.47	1.44	47.33	10.05	1.50	10.04	261.33	14.50
13	Jamkhandi local	107.84	4.00	1.91	53.33	9.03	1.79	17.10	468.17	26.00
14	Arka Anamika	130.21	3.63	1.77	48.33	10.27	1.65	10.52	360.40	20.00
	Grand Mean	109.80	4.22	1.86	49.24	9.36	1.58	14.57	422.39	23.45
	Sem ±	2.59	0.26	0.11	1.73	0.37	0.09	0.56	25.18	1.40
	CD (5%)	7.52	0.75	0.32	5.03	1.06	0.28	1.61	75.20	4.07
	CV	4.08	10.63	10.23	6.09	6.77	10.42	6.60	10.33	10.34

PH-Plant height (cm), NBPP-Number of branches per plant, SDI-Stem diameter (cm), D50% F-Days to 50% flowering, FL-Fruit length (cm), FD-Fruit diameter (cm), AFW-Average fruit weight (g), YPP-Yield per plant (g), YPH-Yield per hectare (t/ha)

Conclusion

Among all the studied genotypes P-2 and P-6 were found to be better and unique in both morphological characters and also in yield parameters. Genotype P-2 produced highest yield when compared to other genotypes. Genotype P-5 and P-6 can be used in character specific breeding. In-depth work has to be done on collection, characterization and evaluation of okra genotypes from different geographical region of states. Genotypes that fall under separate category can be used in future breeding programme to develop phenotypically different varieties, to increase fruit yield per plant, number of fruits per plant and other important attributes.

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