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Qualitative and Phenotyping Characterization among Okra [*Abelmoschus esculentus* (L.) Moench] Genotypes

J. Pranay Reddy[1], V. Anbanandan[1], B. Sunil Kumar[1], K. Saravanan[1]

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ABSTRACT

Background: In contrast to field crops, quality is often more essential than yield in vegetable crops. As a result, this research began with the objective of assessing the diversity and novelty of okra genotypes.

Methods: A field investigation was carried out at Sivapuri Village, Chidambaram, Cuddalore District, Tamil Nadu, India, in the summer of 2020-2021. To match with distinctiveness, uniformity and stability, qualitative data for 18 characters were collected based on vegetative and reproductive characters.

Result: Results obtained in this study revealed a high level of variability among the genotypes for the majority of the qualitative traits, except for plant growth habit, branching position, leaf blade colour between veins, fruit type and seed size. The fruit-related characters exhibited a large diversity in the genotypes studied. Mature fruit colour was obtained with 8.3% of yellowish green, 23.3% of green and 68.4% of dark green fruits recorded for genotypes. Based on genetic variation, the ultimate objective of vegetable breeding programmes is to generate new varieties exhibiting elite combinations of many desired qualitative attributes in okra using traditional breeding procedures.

Key words: Breeding, Genetic variability, Genotypes, Okra, Qualitative traits.

INTRODUCTION

Vegetables are important components of Indian agriculture and food security because of their short growing season, higher fruit yield, nutrient content, commercial viability and potential to generate on-and off-farm employment (Kumar, 2020). Okra, or Bhendi [*Abelmoschus esculentus* (L.) Moench], is India's most important-vegetable and frequently utilised crop in the Malvaceae family (Mohammed *et al*., 2022; Reddy *et al*., 2016). It is also a dicotyledon, warm-season annual vegetable crop with a 90-100 day growing season that survives in tropical and subtropical areas of the globe on sandy to clayey soil (Melaku *et al*., 2020; Bagwale *et al*., 2016; Singh *et al*., 2015), mostly in Africa and Asia (Temam *et al*., 2021; Oppong-Sekyere *et al*., 2011).

The characterization of germplasm provides information on the characteristics possessed by each genotype, ensuring maximal use of the germplasm collection by end users (Reddy *et al*., 2016). In okra, morphological markers (Duzyaman and Vural, 2003), cytological markers (Merita *et al*., 2013), biochemical markers (Hamon and Yapo, 1986) and molecular markers (Martinello *et al*., 2001) have all been used to characterise germplasm. Morphological features are the oldest and most commonly used genetic markers and they may still be appropriate for certain germplasm management applications (Bretting and Widrlechner, 1995). Morphological characterization is the initial stage in the description, classification and arrangement of germplasm collections (Arslanoglu *et al*., 2011). Plant characterisation identifies unique accessions required by gene bank curators and plant breeders (Torkpo *et al*., 2006). Landraces, germplasms, genotypes and local cultivars must be morphologically characterised by vegetable breeders seeking novel trait genes (Reddy *et al*., 2016). The characterization of genetic resources is the means of selecting, differentiating, or distinguishing accessions depending on their traits (Priyanka, 2014; Oppong-Sekyere *et al*., 2011). Qualitative trait characterization of newly collected germplasm is necessary for crop improvement. It also gives information on genetic diversity for agricultural development, use of plant genetic resources and conservation.

Several researchers stressed the potential for improvement of okra through the study of its genetic-resources (Oppong-Sekyere *et al*., 2011). Martinello *et al*. (2001) and Reddy *et al*. (2016) emphasise the importance of including qualitative characters in the characterization, identification and description of variability of okra genotypes. In view of the preceding, the current study aims to characterise, appraise and compare the precise morphological aspects of okra genotypes to determine their variability and uniqueness. The main aim of the research

[1]Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Chidambaram-608 002, Tamil Nadu, India.

Corresponding Author: B. Sunil Kumar, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Chidambaram-608 002, Tamil Nadu, India.
Email: sunil62@gmail.com

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work was for okra breeders to get acquainted with the desirable morphological descriptor states to be used as potential breeding traits for designing farmer-driven okra varieties. This is very important for the use and preservation of common okra, as well as for how it will be used in the future.

MATERIALS AND METHODS

Description of study area

The experimental study was done at Sivapuri Village, Chidambaram, Cuddalore District, Tamil Nadu, India, in the summer of 2020-2021.

Experimental material and design

The experiment included 60 distinct genotypes of Okra raised in a randomised block design with three-replications. 2 to 3 seeds per hill were dibbled with a spacing of 60cm between rows and 30 cm among plants in a row. Thinning was done on the tenth day, leaving one vigorous and robust seedling per hill.

Qualitative observations recorded

Qualitative data were collected based on vegetative and reproductive characteristics that corresponded to the Distinctiveness, Uniformity, Stability guideline descriptors of NBPGR (Mahajan *et al*., 2000), IPGRI (1991), UPOV (1999) and some published papers (Table 1). Plant vigour and architecture, whole plant pigmentation, pubescence and fruit traits were all measured. For each genotype in each replication, data on 30 characteristics was collected from five randomly chosen tagged plants. The Royal Horticultural Society (RHS) colour chart (1986) was used to analyse colour qualities such as stem colour, mature leaf colour, petiole colour, petal colour, petal blotch and fruit colour. Data for 17 characteristics were collected by visual assessment of a single observation of a group of plants or parts of plants (VG), whereas data for one character were collected via visual assessment of observations of individual plants or parts of plants (VS).

RESULTS AND DISCUSSION

In breeding programmes, variation is an intrinsic part. The results of this research demonstrated a significant amount of variability among genotypes for the majority of the qualitative traits. Variations in characters of okra genotypes viz., leaf lobing, leaf colour, petal colour, petal blotch, mature fruit colour, fruit surface between ridges, fruit constriction of basal part, fruit: shape of fruit apex and fruit axis are depicted in Table 2.

Leaf characters

In the study, the depth of leaf lobing (Fig 1) was found to be 33.4% shallow, 48.3% medium and 18.3% deep in genotypes. Leaf blade serration was 31.7 % weak, 26.6% medium and 41.6% high in the genotypes. Similar reports were reported by Singh *et al*. (2015) that 16.67% of shallow, 27.78% of medium and 52.78% of deeply lobed leaves, besides 13.89%, 22.22% and 63.89% of cultivars had weak, medium and strong serration in their leaves, respectively, in his 36 okra cultivars studied.

Colouring of various plant parts

In the present study, variation was expressed in all colour traits studied. The pigmentation of the vegetative (stem and leaf) and reproductive (flower and fruit) organs is remarkably diverse in this study.

Stem colour was recorded as 71.7% green and 28.3% green with a purple tinge for the genotypes, respectively. Temam *et al*. (2021) reported 32%, 24% and 44% showing green, green with a purple tinge and purple colour in the okra stems of 36 genotypes studied. In the study, the intensity of colour between veins on the leaf blade was recorded as 38.4% light, 33.3% medium and 28.3% dark. Singh *et al*. (2015) found 80.56% light green and 19.44% purple vein colour, as well as 27.78, 50 and 22.22% light, medium and dark intensity green between veins in his 36 okra cultivars tested.

Mature leaf colour was recorded as 43.4% light green and 56.6% dark green for the genotypes. Similarly, Reddy *et al*. (2016) reported 80 and 20% of light and dark green colour of mature leaves, in 20 landraces tested.

In the study, petal colour (Fig 2) was observed in the cream (40%) and yellow (60%) petals of the genotypes studied, respectively. Petal base colour (purple) (Fig 3) was recorded at 31.6% inside only and 68.4% on both sides in the study. Singh *et al*. (2015) also reported similar results, finding that 11.11 and 88.89% of cream and yellow petals, besides 22.22 and 77.78% of inside purple and both purple petal base colours, among 36 cultivars examined.

Fruit colour observations were recorded for immature and mature fruits. In immature fruit colour, 20% of the genotypes recorded yellowish-green, 41.6% green and 38.4% dark-green fruits. Whereas in mature fruit colour (Fig 4), 8.3% of yellowish-green, 23.3% of green and 68.4% of dark-green fruits were recorded for genotypes. Binalfew and Alemu (2016) reported that 56.1% had yellowish-green, 25.8% were green, 12.1% were green with red, 3% were dark-green and 3% had dark-red immature fruit colours. Besides, 42.1% had yellowish-green, 1.8% were green, 38.6% were green with red, 14% were dark-green and 3.5% had dark red mature fruit colours in 25 germplasms studied.

Colour traits in okra include vegetative and reproductive structures. These colour features indicate pigmentation in the genotypes' organs. identified qualitative colour features that are seldom changed by environmental conditions. Due to colour variances, colour attributes are difficult to quantify, even in a homogenous accession. Except for the interior petal blotch, this is true for all green and red varieties. Colour combinations are frequent in okra, with the green or red background being impacted by other colours. Due to the complexity of pigmentation genetics, it is rare to discover a perfectly homogenous accession.

Table 1: Qualitative descriptors used in morphological characterization of okra genotypes.

Character code	Character measured	Descriptor states and codes	Type of assessment
SC	Stem colour	Green (G), Green with purple tinge (GPT), Purple (P)	VG
SP	Stem pubescence	Downy (D), Slightly rough (SR), Prickly(P)	VG
DLL	Depth of leaf lobing	Shallow (S), Medium (M), Deep (D)	VG
MLC	Mature leaf colour	Light green (LG), Dark green (DG)	VG
LP	Leaf pubescence	Downy (D), Slightly rough (SR), Prickly (P)	VG
LBSM	Leaf blade: Serration of margin	Weak (W), Medium (M), Strong (S)	VS
LBICBV	Leaf blade: Intensity of colour between veins	Light (L), Medium (M), Dark (D)	VG
PuP	Peduncle pubescence	Downy (D), Slightly rough (SR), Prickly (P)	VG
PIC	Petal colour	Cream (C), Yellow (Y), Purple (P)	VG
FPBC (P)	Flower: Petal base colour (Purple)	Inside only (IS), Both sides (BS)	VG
FP	Fruit pubescence	Downy (D), Slightly rough (SR), Prickly (P)	VG
FCI	Immature fruit colour	Yellowish Green (YG), Green (G), Dark Green (DG), Red (R), Deep Red (DR)	VG
FCM	Mature fruit colour	Yellowish Green (YG), Green (G), Dark Green (DG), Red (R), Deep Red (DR)	VG
FSBR	Fruit: Surface between ridges	Concave (CC), Flat (F), Convex (CV)	VG
FA	Fruit axis	Straight (S), Curved (C)	VG
FPMS	Fruit: Position on main stem	Erect (E), Semi-erect (SE), Horizontal (H), Slightly falling (SF) Drooping (D)	VG
FSA	Fruit: Shape of apex	Narrow acute (NA), Acute (A), Broad acute (BA)	VG
FCBP	Fruit: Constriction of basal part	Absent (A), Weak (W), Strong (S)	VG

VG: Visual assessment by a single observation of a group of plants or parts of plants; VS: Visual assessment by observations of individual plant or parts of plants.

Table 2: Qualitative morphological characteristics of okra genotypes.

Genotypes	SC	SP	DLL	MLC	LP	LBSM	LBICBV	PuP	PIC	FPBC(P)	FP	FCI	FCM	FSBR	FA	FPMS	FSA	FCBP
EC 305768	G	D	S	DG	SR	W	L	D	Y	BS	D	DG	DG	CC	S	E	BA	S
EC 359637	GPT	D	M	LG	D	S	L	SR	C	BS	SR	YG	YG	F	S	SE	A	W
IC 014026	GPT	D	M	LG	D	M	L	D	C	BS	SR	YG	YG	F	S	SE	A	A
Arka Anamika	G	D	D	DG	SR	W	L	D	Y	IS	D	DG	DG	F	S	E	NA	W
Arka Abhay	G	D	D	LG	P	M	M	SR	Y	BS	P	G	YG	CC	S	E	NA	W
Hisar Unnat	G	D	S	LG	SR	W	L	SR	Y	IS	SR	YG	G	F	S	E	NA	S
Pusa Sawani	G	D	M	DG	P	M	L	SR	Y	BS	SR	G	YG	CC	S	E	A	W
Pusa Makhmali	G	D	D	LG	P	M	L	SR	Y	BS	SR	G	G	F	S	E	BA	S
Punjab 8	G	D	D	LG	D	S	D	D	Y	BS	P	G	DG	CC	S	E	NA	A
Punjab 7	G	SR	S	DG	P	M	M	P	Y	IS	D	G	DG	CC	C	E	NA	W
Pusa 5	G	SR	M	DG	SR	M	D	SR	Y	IS	D	DG	DG	CC	S	E	NA	S
Varsha Uphar	G	D	D	LG	D	S	M	P	Y	BS	SR	G	G	F	S	E	NA	W
Punjab no.13	G	SR	M	LG	SR	S	D	SR	Y	BS	SR	DG	DG	CC	S	E	A	A
Hina RCH	G	D	M	DG	SR	S	M	SR	C	BS	D	DG	DG	CC	S	E	A	S
BS-51	GPT	D	S	DG	P	S	D	SR	Y	BS	SR	DG	DG	CC	C	SE	NA	S
Hari Pari	GPT	SR	S	DG	SR	S	D	SR	C	BS	P	DG	DG	F	S	SE	A	S
MH 310	G	D	M	DG	D	M	D	P	C	IS	SR	G	DG	F	S	E	A	A
Rani 792	G	D	D	DG	SR	S	D	SR	C	BS	SR	DG	DG	CC	S	SE	A	A
Palam Komal	GPT	D	M	DG	SR	W	M	P	C	BS	D	G	G	CC	S	E	NA	S
Salkeerthi	G	D	M	DG	SR	W	M	SR	Y	IS	SR	DG	YG	CC	S	E	A	A
Hari Kranti	G	D	S	DG	SR	W	M	D	Y	IS	SR	G	G	CC	S	E	A	S
Pusa A4	G	D	D	DG	P	S	D	SR	Y	BS	SR	DG	DG	F	S	E	NA	W
MDU-1	G	SR	S	DG	P	S	D	SR	Y	BS	SR	G	DG	F	C	SE	NA	S
VRO - 4	G	D	D	LG	SR	S	L	D	Y	BS	SR	G	DG	F	S	SE	NA	W
NRB 208	G	SR	M	DG	SR	S	M	D	Y	IS	SR	G	DG	F	S	E	A	W
VRO – 6	G	P	M	DG	SR	S	M	SR	Y	BS	D	G	G	F	S	SE	BA	W
Gold 207	G	P	M	DG	D	W	D	SR	C	BS	D	G	G	CC	S	E	A	W
NOL 303+	G	P	M	DG	SR	M	D	SR	Y	BS	D	G	DG	F	S	SE	NA	A
V-4	G	SR	M	LG	SR	M	L	D	C	IS	D	DG	DG	CC	S	E	BA	W
NOL 1307	G	D	M	DG	SR	W	L	D	C	BS	D	DG	DG	F	S	E	A	W
DHANVI 66	G	D	M	DG	SR	S	M	D	Y	IS	D	G	G	CC	S	E	A	W
SC-55	GPT	SR	S	LG	SR	S	L	SR	Y	BS	P	DG	G	CC	S	E	A	W
Ruchi	G	D	S	DG	SR	M	M	D	Y	IS	SR	DG	DG	CC	S	E	BA	S
Ajeet-121	G	D	S	LG	P	S	L	P	C	BS	SR	YG	G	CC	C	E	A	A
Anima	G	SR	S	DG	P	W	L	P	C	BS	D	G	DG	CC	S	E	A	S
Harika	GPT	D	M	DG	P	S	D	SR	C	BS	P	DG	DG	CC	S	E	BA	S

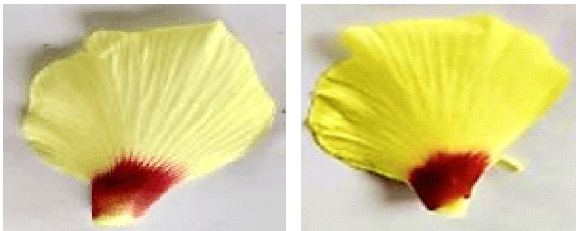
Table 2: Continue.....

Table 2: Continue.....

LS-11	G	SR	M	DG	SR	M	M	SR	Y	IS	SR	DG	DG	CC	S	SE	A	S
TS-102	G	D	M	LG	P	W	L	D	C	BS	SR	G	DG	CC	S	E	A	A
VRO - 3	GPT	SR	S	LG	P	W	L	D	Y	BS	SR	DG	DG	F	S	E	NA	W
Hisar Naveen	GPT	D	D	LG	P	S	M	P	Y	BS	P	DG	DG	CC	C	E	NA	W
VRO - 22	G	SR	M	LG	P	S	L	P	Y	BS	SR	YG	G	CC	S	E	A	A
Ankur 41	G	D	M	DG	P	W	M	P	Y	BS	P	G	DG	CC	S	E	A	S
AKO 102	GPT	SR	M	LG	SR	M	L	D	Y	BS	D	YG	G	CC	C	E	NA	W
AKO 111	GPT	D	S	LG	P	S	M	P	Y	BS	P	YG	DG	F	S	E	A	A
Maharani	G	D	M	DG	P	M	D	SR	C	IS	P	DG	DG	F	S	SE	NA	W
Ankur 40	G	SR	M	DG	P	W	D	D	Y	IS	P	G	DG	F	S	E	NA	S
AKO 107	G	SR	M	LG	P	W	L	D	Y	BS	P	G	DG	CC	S	E	A	A
Mahyco 777	G	D	S	LG	P	W	L	D	Y	BS	D	YG	DG	F	S	E	NA	W
Lush green	GPT	P	S	DG	D	M	L	P	C	BS	P	G	DG	CC	S	E	NA	A
Suguna A-51	G	SR	S	LG	SR	M	M	SR	C	IS	SR	DG	DG	CC	S	E	NA	W
Hyveg 155	G	D	M	DG	SR	S	M	D	Y	IS	D	YG	G	CC	S	E	A	S
Super Anamika	G	SR	S	DG	P	W	D	SR	Y	IS	SR	G	DG	F	C	E	NA	A
Super lady lock	G	SR	S	DG	SR	W	D	D	Y	IS	D	G	DG	CC	C	E	BA	A
Hoshiarpur	G	D	S	LG	SR	W	M	SR	C	IS	D	G	DG	CC	C	E	NA	A
Madurai	G	P	M	LG	SR	M	L	D	C	BS	D	YG	G	CC	C	SE	NA	A
Chidambaram	GPT	SR	D	DG	P	S	D	D	C	BS	D	DG	DG	CC	S	SE	NA	W
Raja	GPT	D	D	DG	SR	S	M	D	C	BS	P	DG	DG	CC	S	SE	NA	S
Kiran	GPT	D	M	LG	SR	W	M	D	C	BS	P	DG	DG	CC	S	SE	A	A
Bambeshwari	GPT	SR	S	LG	SR	S	L	SR	C	BS	P	YG	DG	F	S	E	NA	W
Danteshwari	GPT	P	S	LG	D	S	L	SR	C	BS	P	YG	DG	F	S	E	NA	A
Descriptor	**G**	**D**	**S**	**LG**	**D**	**W**	**L**	**D**	**C**	**IS**	**D**	**YG**	**YG**	**CC**	**S**	**E**	**NA**	**A**
No. of cultivars	43	34	20	26	8	19	23	23	24	19	20	12	5	37	50	45	28	19
Per cent of cultivars	71.7	56.7	33.4	43.4	13.3	31.7	38.4	38.4	40	31.6	33.3	20	8.3	61.7	83.4	75	46.7	31.6
Descriptor	**GPT**	**SR**	**M**	**DG**	**SR**	**M**	**M**	**SR**	**Y**	**BS**	**SR**	**G**	**G**	**F**	**C**	**SE**	**A**	**W**
No. of cultivars	17	20	29	34	30	16	20	26	36	41	24	25	14	23	10	15	25	23
Per cent of cultivars	28.3	33.3	48.3	56.6	50	26.6	33.3	43.3	60	68.4	40	41.6	23.3	38.3	16.6	25	41.6	38.4
Descriptor		**P**	**D**		**P**	**S**	**D**	**P**			**P**	**DG**	**DG**				**BA**	**S**
No. of cultivars		6	11		22	25	17	11			16	23	41				7	18
Per cent of cultivars		10	18.3		36.7	41.6	28.3	18.3			26.7	38.4	68.4				11.7	30

A. Shallow B. Medium C. Deep

Fig 1: Depth of leaf lobbing.



A. Cream B. Yellow

Fig 2: Petal colour.

A. Insides B. Both sides

Fig 3: Flower: Petal base colour (purple).

Pubescence (hairiness/spininess) of various plant parts

In this study, diversity was expressed in pubescence traits like stem, leaf, peduncle and fruit (Table 2). This research found that stem pubescence was 56.7% downy, 33.3% slightly rough and 10% prickly for genotypes. In okra, Reddy *et al*. (2016) observed 40% downy and 60% slightly rough pubescence.

Leaf pubescence was recorded at 50% slightly rough, 36.7% prickly and 13.3% downy for the genotypes. Temam *et al*. (2021) found 86.11% slight, 8.33% glabrous and 5.56% conspicuous leaf pubescence in genotypes. For genotypes, peduncle pubescence was downy with 38.4%, slightly rough with 43.3% and prickly with 18.3%. The peduncle pubescence is novel and no identical discoveries were found.

For genotypes, fruit pubescence was 33.3% of genotypes were downy, 40% slightly rough and 26.7% prickly. The environment, as well as the age of the fruit, impacted the fruit's hairiness. In 25 okra germplasms investigated, Binalfew and Alemu (2016) found that 29.6% of fruit pubescence was downy and 35.2% of each was slightly rough and prickly.

Hairy leaves of okra are said to be susceptible to leaf rollers (Reddy *et al*., 2016). In contrast, hairy okra genotypes helped lower jassid populations. Although pubescence is commonly utilised in taxonomy, evolutionists and ecologists have mostly neglected its adaptive importance.

Fruit characters

In the study, fruit characteristics like fruit surface between ridges, fruit axis, fruit: position on main stem, fruit: shape of apex and fruit: constriction of basal part expressed large diversity in genotypes (Table 2).

The fruit surface between the ridges (Fig 5) of genotypes varied between concave with 61.7% and flat with 38.3%. The fruit axis (Fig 6) varied greatly in the research, with 83.4% straight and 16.6% curved. Reddy *et al*. (2016) observed that 80% and 20% of landraces had concave and flat surfaces between fruit ridges and 85% and 15% of landraces had straight and curved fruit axis, respectively. Binalfew and Alemu (2016) also reported that 27.3% of the concave and 36.4% of each flat and convex surface between fruit ridges in the accessions tested. The fruits of okra cultivars with concave surfaces between the ridges contain small grooves. Most commercial okra varieties now feature grooves on the sides of the fruits.

Fruit position on the main-stem displays 75% erect and 25% semi-erect positions of fruit on the main-stem in the genotypes studied. Temam *et al*. (2021) observed 69.44% erect, 27.78% intermediate and 2.78% horizontal fruit positions on the main stem. Muluken *et al*. (2016) reported that erect fruit posture was found in 68% of genotypes, whereas intermediate fruit position was found in 32%. The erect position of fruit on the main stem enhances fruit visibility and adaptability to improve harvest. Erect fruits are simple to pick and snap off the stem. A farmer prefers an erect fruit position on the main stem.

In this study, genotypes displayed variation in fruit shape of apex (Fig 7), with 46.7% narrow acute, 41.6% acute and 11.7% broad acute types of fruit apex. Genotypes displayed great variation in fruit constriction of the basal part (Fig 8), which was reported as 31.6% absent, 38.4% weakly expressed and 30% strongly expressed under the genotypes studied. Similarly, Singh *et al*. (2015) reported that 41.67, 47.22 and 11.11% of genotypes showed narrow acute, acute and blunt types of fruit apex. They observed that 13.9% of the basal fruit constriction was absent, 61.11% was weakly expressed and 25.00% was strongly expressed.

Morphological descriptors were developed by various okra researchers based on their perceptions and practical experience observing morphological variation in okra genotypes. The primary advantages of carrying out morphological characterization are that published descriptor lists for major crop species are readily available; it is relatively simple to carry out, simplicity, rapidity and relatively inexpensive assays, even from herbarium specimens and other dead tissues (Bretting *et al*., 1995), very easy to identify, can be carried out in situ (on-farm) and does not require special skills in most cases. Lack of polymorphism, environmental interference due to their polygenic nature, large populations of plants, growing the plants to full maturity prior to identification, dependence on crop growth state, masking of recessive characters and limited numbers limit the use and effectiveness of phenotypic characters (Costa *et al*., 2009). A new cultivar may also emerge as a result of hybridization between members of popular but genetically similar varietal groupings. The degree of visually visible genetic diversity among newly created cultivars is expected to become even less in this circumstance (Rahman *et al*., 2009 and Priyanka, 2014). This complicates the challenge


A. Yellowish green B. Green C. Dark green

Fig 4: Mature fruit colour.

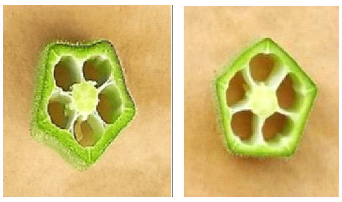

A. Concave B. Flat

Fig 5: Fruit surface b/w ridges.


A. Straight B. Curved

Fig 6: Fruit axis.


A. Narrow acute B. Acute C. Broad acute

Fig 7: Fruit: shape of apex.

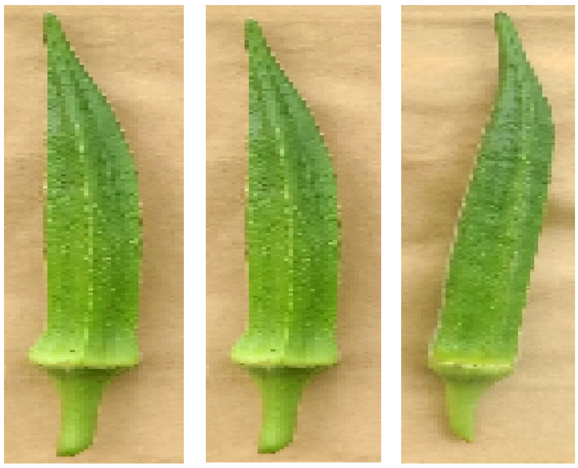

A. Strong B. Weak C. Absent

Fig 8: Fruit: constriction of basal part.

of precisely recognising novel cultivars using just traditional features. However, the method has remained valuable as a crucial initial step prior to more in-depth biochemical or molecular research in the use of okra germplasm. Morphological characterisation is therefore a highly suggested initial step in any diversity study that should be conducted before further in-depth biochemical or molecular research are used. The use of DNA-based molecular markers allows for a high throughput way of measuring genetic variability between genotypes (Reddy *et al*., 2016). India's okra breeders want a quick, strong and dependable method for variety identification. However, combining isozyme, pigment, morphological and agronomic markers might provide guidance on how to effectively manage landrace germplasm in common okra.

CONCLUSION

Vegetable product innovation is necessary to maintain the interest of today's consumers. Unlike field crops, quality generally dominates yield with vegetable crops. Market acceptability is required for farmers to survive. Thus, quality typically trumps productivity. Vegetable breeding programmes aim to create new varieties with exceptional combinations of desirable horticultural traits. Along with fruit yield, there are fruit attributes that influence okra's productivity and marketability. The economic value of okra depends on both fruit output and quality, which is a combination of horticultural features. The okra genotype was linked to fruit greenness, length and weight. So, okra is traded based on its quality and size. The deployment of desirable traits from these genotypes into existing varieties helps to develop culture, which could be exploited for designing a customer-driven variety. This is the only way out possible by traditional breeding approaches in okra.

Conflict of interest: None.

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