



## Characterization of bottle gourd genotypes for DUS traits

Sourav Mahapatra, A. K. Sureja\*, T. K. Behera<sup>1</sup> and Manjusha Verma<sup>2</sup>

Division of Vegetable Science, ICAR-Indian Agricultural Research Institute, New Delhi-110012, Delhi, India.

### ABSTRACT

Ninety-one bottle gourd genotypes were characterized for 13 different qualitative traits and 4 quantitative traits as per the DUS (Distinctiveness, Uniformity and Stability) guidelines of PPV&FRA. The observations pertaining to the morphological descriptor and quantitative traits, the genotypes were grouped into different categories. All the genotypes were monoecious with tri-lobed leaves except JBG-51, which had penta-lobed leaves. Ovary length (on the day of anthesis) and peduncle length were maximum in IC-0146365 and Pusa Santusthi, respectively. Fruit shape at marketable maturity was elongated, curved in the maximum number of genotypes and the check Arka Bahar. Most (79.1%) of the genotypes had straight necks, a few (2.2%) had crooked necks, and 18.7% had no necks at the marketable maturity stage. Variability was also observed for fruit skin colour at the marketable maturity stage. Seventy-one (78%), 13 (14.28%) and 4 (4.39%) genotypes had light green, mottled and green skin colour, respectively. Based on the shape of apex at peduncle end of the fruit, the genotypes were grouped as raised, flat and depressed. There was variation in the intensity of pubescence on the fruit surface of different genotypes. Seed texture at marketable maturity stage, seed shape, and brown colour intensity of seed testa were also recorded to differentiate the genotypes morphologically. The expression of characters remained consistent over two consecutive seasons indicating their uniformity. These genotypes can be used as a reference for protecting other varieties under PPV&FR Act, identifying and grouping bottle gourd varieties, and developing elite varieties/hybrids.

**Keywords:** *Lagenaria*, Fruit shape, Ovary, Peduncle, Seed colour, Leaf morphology.

### INTRODUCTION

Bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] is an ancient cucurbitaceous vegetable crop grown all over India, and is popularly known as *lauki*, calabash or white flowered gourd. Its green tender fruits are edible and have several health benefits *viz.* digestion of food, blood sugar reduction, curing of constipation, insomnia and urinary tract infection. Pulp of the fruit is a good source of fibre free carbohydrates. Dried shell of mature fruit is used in making of Indian musical instruments and utensil. India being a secondary centre of origin of bottle gourd, a large variability exists in relation to its fruit shape, size, colour, rind pattern, leaf shape, size, intensity of pubescence on fruit and stem, seed colour, texture and other morphological characters.

Characterization and understanding of the diversity of the available germplasm is important to develop an efficient breeding programme. It is also useful to identify and avoid duplication among the gene bank accessions. India has formulated and enforced an effective *sui generis* system to protect its plant genetic resources. The testing for Distinctness, Uniformity and Stability (DUS) is the basis for grant of protection to new plant varieties, hybrids and parental

lines of F<sub>1</sub> hybrids under the Protection of Plant Varieties and Farmer's Right Act, 2001 (PPVFR, 6) enacted by Government of India. In the present study, descriptors for DUS testing of bottle gourd developed by Protection of Plant Varieties and Farmers Rights Authority (PPV&FRA) were used to characterize the bottle gourd genotypes.

### MATERIALS AND METHODS

The present study was carried out at Division of Vegetable Science, ICAR-IARI, New Delhi during the spring summer and *khariif* season. The experimental material consists of eighty-six germplasm of bottle gourd and five check varieties from various location of the country and maintained at the Division of Vegetable Science, IARI, New Delhi. They were evaluated for 17 morphological and quantitative DUS characters *viz.* leaf blade margin, leaf blade number of lobes (at complete maturity stage), sex type (at blooming stage), ovary length (on the day of anthesis), peduncle length, fruit shape in longitudinal section, fruit neck, fruit skin colour, fruit shape of base at blossom end, fruit shape of apex at peduncle end, fruit pubescence, fruit flesh taste (at marketable stage), fruit length (cm), fruit diameter (cm), seed texture (at marketable stage), seed shape and seed intensity of brown colour of testa at a specified stage

\*Corresponding author's Email: aksureja@gmail.com

<sup>1</sup>ICAR-Indian Institute of Vegetable Research, Varanasi-221 305, U.P., India

<sup>2</sup>CAR-NBPGR, New Delhi-110 012, Delhi, India

of crop growth period over two consecutive seasons (spring-summer and *Kharif* season). The experiment was laid out in augmented block design. Two-to-three seeds of each genotype were sown in the hills on the ridges at a spacing of 3.0m × 60cm. The standard cultural practices suggested by Thamburaj and Singh (10) were followed for healthy crop stand. Out of 10 plants in each genotype, 5 were marked at random for taking observations. All the 13 morphological characteristics were visually assessed and data on 4 quantitative characters were recorded. All observations on leaf were recorded on one leaf above the first fruit set node. All observations on leaf blade were recorded on a fully developed leaf blade, from the 15<sup>th</sup> node upwards to 20<sup>th</sup> node. Observations on flowers were noted on flowers between 10<sup>th</sup> to 20<sup>th</sup> nodes. Observations on marketable mature fruit were recorded 8-14 days after anthesis. Seed parameters were recorded at fully developed stage in washed and dried seeds; seed colour characteristics were assessed by using Royal Horticultural Society (RHS) colour chart.

## RESULTS AND DISCUSSION

Morphological characterization is the first step in the description and classification of genetic resources

(Smith and Smith, 9). In the present study, ninety-one genotypes of bottle gourd were characterized for thirteen morphological traits and four quantitative traits following the DUS descriptor of bottle gourd developed by PPV&FRA. The traits were stable for two consecutive experimental seasons for the respective genotypes, which shows their uniformity and stability. According to Sit and Sirohi (7) greater the variability in available germplasm, better would be the chances of selecting superior genotypes.

The perusal of data (Table 1) revealed that there was very less difference observed for the character leaf blade margin as most of the genotypes had entire leaf blade. Only JBG-51 has serrated leaf margin with deep lobes. It had dark green leaves with clear cut incision in it. There was large variation for leaf size. Leaf lobing pattern is an important feature for differentiating the variability between the germplasm. All genotypes have tri-lobed leaves except JBG-51 having penta-lobed leaves with prominent incisions, thus making it very distinct from rest of the genotypes. The studied genotypes were not diverse for their leaf lobbing pattern except JBG-51 (Fig. 1).

Eighty-four genotypes and five checks expressed monoecious sex form throughout the flowering period. Two genotypes, IC-0385814 and KP/PKS-



Fig. 1. Variation in leaf characters of bottle gourd genotypes.

Table 1. Characterization of bottle gourd genotypes based on leaf and flower characters.

Characteristic	States	No. of genotypes	Per cent of genotypes	Genotypes	Type of assessment
Leaf blade margin	Serrated	1	1.09	JBG-51	VS
	Entire	90	98.9	All genotypes except JBG-51	
Leaf blade: Number of lobes	Penta-lobed	1	1.09	JBG-51	VS
	Tri-lobed	90	98.9	All genotypes except JBG-51	
Sex type	Tri-monoecious	2	2.19	IC-0385814, KP/PKS -1168	VS
	Monoecious	89	97.8	All genotypes except IC-0385814, KP/PKS-1168	

1168 produced few bisexual (hermaphrodite) flowers (Table 1). They showed a male phase during initial flowering period followed by a female phase with male phase as in most other genotypes, then a few days of male and hermaphrodite flower towards the end of flowering period. The genotype, IC-0417704 had two female flowers per node (Fig. 2) and IC-0385814 had hermaphrodite flower (Fig. 3). A significant variability has been observed for ovary shape and size among bottle gourd genotypes

(Fig. 4) which gives a clear indication towards the existence of variability in fruit shape and size.

The ovary length of female flower on the day of anthesis showed significant variations ranging from 1.82 cm to 4.48 cm (Table 2). The longest ovary was recorded in IC-0146365 (4.48 cm) whereas shortest in IC-0588087 (1.82 cm) which was similar with check Pusa Sandesh (1.82 cm). Peduncle length of fruit at



Fig. 2. Bottle gourd genotype IC-0417704 showing two female flowers per node.

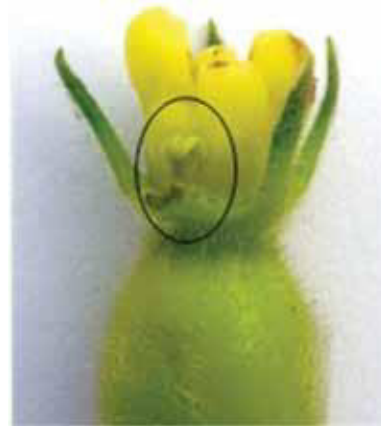


Fig. 3. Hermaphrodite flower in bottle gourd genotype IC-0385814.



Fig. 4. Variation in ovary shape and size and peduncle length in bottle gourd genotypes.

**Table 2.** Characterization of bottle gourd genotypes based on ovary and fruit characters.

Characteristic	States	No. of genotypes	Per cent of genotypes	Genotypes	Type of assessment
Ovary length (on the day of anthesis)	Short (<2.5cm)	17	18.68	IC-0588087, Pusa Sandesh, IC-0320183, IC-330126, IC-342424, IC-0146349, IC-297541, IC-330121, IC-0395756, IC-321392, IC-0092362, IC-275892, IC-319470, JBG-51, IC-0092390, IC-0322278, IC-0265025	MS
	Medium (2.5-5.0cm)	74	81.31	IC-0336825, IC-0276413, IC-0322274, IC-0276396, IC-0266904, IC-0519467, IC-0092398, IC-0338867, IC-0345591, IC-0146312, IC-0278349, IC-0536536, IC-0262187, IC-0279678, IC-0264799, IC-330110, 177-1, IC-324148, IC-0522210, IC-0284925, IC-0413688, IC-0519464, IC-0551041, IC-0146384, Pusa Naveen, Pusa Santushti, Arka Bahar, Narendra Dharidar, IC-0411764, IC-0398547, IC-0284933, IC-297566, IC-0418264, IC-0279811, IC-0398535, IC-0371672, IC-0317583, IC-0418251, IC-0092465, IC-0519463, IC-0385814, IC-0317670, IC-0146327, IC-0417704, IC-331990, IC-0346128-A, IC-0522870, IC-0519457, IC-0522875, IC-0278793, IC-0522867, IC-0413446, IC-0284891, IC-0522861, IC-0321591, IC-0398544, KP/PKS-1168, IC-0146322, IC-0284898, IC-0522869, IC-330150, IC-274599, SKY/AC-268, IC-0092409, IC-0505649, IC-0398543, IC-0522865, KP/PKS-1161, IC-347276, IC-0284892, KP/PKS-1215, IC-276565, IC-0092443, IC-0146365	
	Long (>5.0cm)	0			
Peduncle length	Short (<10cm)	16	17.58	IC-0336825, IC-0278793, IC-0385814, IC-0279678, IC-0265025, IC-0265025, IC-0317670, IC-0411764, IC-0317583, IC-0338867, KP/PKS-1161, IC-0536536, IC-330110, IC-324148, IC-0146327, IC-0519463	MS
	Medium (10-15cm)	61	67.03	IC-0519467, IC-0284933, IC-0266904, IC-274599, IC-0505649, IC-0146384, IC-275892, IC-330121, KP/PKS-1215, IC-0522875, IC-0395756, IC-0092443, IC-0092362, IC-331990, IC-319470, IC-0522865, IC-0418251, IC-0519464, IC-330126, IC-0276396, IC-0146312, IC-0146365, IC-342424, IC-0345591, IC-0522861, IC-0413688, JBG-51, IC-0522869, IC-0264799, IC-0413446, IC-0322274, IC-0346128-A, IC-0398547, IC-0278349, IC-330150, IC-0398544, IC-0588087, IC-321392, KP/PKS-1168, IC-347276, IC-0284925, IC-0322278, IC-297566, IC-0262187, IC-0320183, Arka Bahar, Pusa Sandesh, IC-0522210, IC-297541, IC-0284892, IC-276565, IC-0321591, IC-0522870, IC-0398543, IC-0284898, IC-0519457, IC-0092398, IC-0146322, IC-0092409, IC-0371672, IC-0522867, SKY/AC-268	

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Table 2 contd...

Characteristic	States	No. of genotypes	Per cent of genotypes	Genotypes	Type of assessment
Fruit: Shape in longitudinal section	Long (>15cm)	14	15.38	177-1, IC-0551041, IC-0398535, IC-0279811, IC-0092390, IC-0284891, IC-0418264, IC-0276413, IC-0417704, IC-0146349, Pusa Naveen, IC-0092465, Narendra Dharidar, Pusa Santushti	VS
	Club	13	14.28	IC-0264799, IC-0266904, IC-0279678, IC-0278793, IC-0536536, IC-297566, IC-0336825, IC-0338867, IC-0398544, IC-0092409, IC-0146327, IC-0505649, Narendra Dharidar	
	Conical	1	1.09	IC-0092390	
	Cylindrical	10	10.98	IC-0371672, IC-0417704, IC-0413688, IC-0519463, IC-0413446, IC-0146384, 177-1, IC-0284933, IC-0418251, Pusa Naveen	
	Depressed round	1	1.09	IC-0146349	
	Dumbbell	1	1.09	KP/PKS-1168	
	Elongated straight	6	6.59	IC-0522210, IC-331990, IC-0398535, IC-0092465, IC-0322278, IC-0398543, IC-0398547, IC-0345591, IC-0522867, IC-0522870	
	Elongated curved	32	35.16	IC-0278349, IC-0279811, IC-0317670, IC-0522861, IC-0522865, IC-0522869, IC-0522875, IC-0519457, IC-0519464, IC-0551041, IC-0411764, IC-274599, IC-276565, IC-324148, IC-330150, IC-347276, IC-0092398, SKY/AC-268, KP/PKS-1161, KP/PKS-1215, IC-0092443, IC-0146322, IC-0146365, IC-0262187, IC-0321591, IC-0284891, IC-0284892, IC-0284898, IC-0284925, IC-0346128, IC-0418264, Arka Bahar	
	Kamandal	1	1.09	IC-0385814	
	Oval	9	9.89	IC-275892, IC-321392, IC-330110, IC-330121, IC-330126, IC-342424, IC-0276396, IC-0146312, Pusa Sandesh	
	Pyriform	7	7.69	IC-0317583, IC-0519467, IC-0395756, IC-297541, IC-0322274, JBG-51, Pusa Santushti	
	Round	6	6.59	IC-0265025, IC-319470, IC-0092362, IC-0276413, IC-0320183, IC-0588087	
Fruit neck	Straight	72	79.12	IC-0398547, IC-0371672, IC-0264799, IC-0266904, IC-0278349, IC-0279678, IC-0279811, IC-0317583, IC-0317670, IC-0345591, IC-0417704, IC-0278793, IC-0413688, IC-0522861, IC-0522865, IC-0522867, IC-0522869, IC-0522870, IC-0522875, IC-0519457, IC-0519463, IC-0519464, IC-0519467, IC-0551041, IC-0395756, IC-0411764, IC-0413446, IC-0522210, IC-0536536, IC-274599, IC-276565, IC-297541, IC-297566, IC-324148, IC-330150, IC-331990, IC-347276, IC-0146384, IC-0092398, IC-0336825, IC-0338867, IC-0398535, IC-0398544, SKY/AC-268, KP/PKS-1161, KP/PKS-1215, IC-0092443,	VS

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DUS characterization in bottle gourd

Table 2 contd...

Characteristic	States	No. of genotypes	Per cent of genotypes	Genotypes	Type of assessment
Fruit skin colour				IC-0146322, IC-0146365, IC-0092409, IC-0092465, IC-0146327, IC-0505649, IC-0262187, IC-0321591, IC-0284891, IC-0284892, IC-0284898, IC-0284925, 177-1, IC-0284933, IC-0322274, IC-0322278, IC-0346128, IC-0418251, IC-0418264, IC-0398543, JBG-51, Narendra Dharidar, Arka Bahar, Pusa Naveen, Pusa Santushti	
	Crooked	2	2.19	IC-0385814, KP/PKS-1168	
	Absent	17	18.68	IC-0265025, IC-275892, IC-319470, IC-321392, IC-330110, IC-330121, IC-330126, IC-342424, IC-0092390, IC-0146349, IC-0092362, IC-0276396, IC-0276413, IC-0320183, IC-0146312, IC-0588087, Pusa Sandesh	
	Light green	71	78.02	IC-0398547, IC-0371672, IC-0264799, IC-0266904, IC-0278349, IC-0279678, IC-0279811, IC-0317583, IC-0417704, IC-0278793, IC-0413688, IC-0522861, IC-0522865, IC-0522867, IC-0522869, IC-0522870, IC-0522875, IC-0519457, IC-0519463, IC-0519464, IC-0519467, IC-0551041, IC-0411764, IC-0413446, IC-0522210, IC-0536536, IC-276565, IC-297541, IC-297566, IC-321392, IC-324148, IC-330121, IC-330126, IC-330150, IC-331990, IC-347276, IC-0146384, IC-0092398, IC-0398535, IC-0398544, KP/PKS-1161, KP/PKS-1168, KP/PKS-1215, IC-0092390, IC-0092443, IC-0146322, IC-0146349, IC-0146365, IC-0092409, IC-0092465, IC-0146327, IC-0505649, IC-0092362, IC-0321591, IC-0284891, IC-0284892, IC-0284898, IC-0284925, 177-1, IC-0284933, IC-0320183, IC-0322274, IC-0322278, IC-0346128, IC-0418264, IC-0588087, IC-0398543, JBG-51, Arka Bahar, Pusa Naveen, Pusa Sandesh	VG
	Green	4	4.39	IC-0395756, IC-274599, IC-319470, Pusa Santushti	
Striped green	3	3.29	IC-0276396, IC-0418251, Narendra Dharidar		
	Mottle green	13	14.28	IC-0385814, IC-0265025, IC-0317670, IC-0345591, IC-275892, IC-330110, IC-342424, IC-0336825, IC-0338867, SKY/AC-268, IC-0262187, IC-0276413, IC-0146312	
Fruit: Shape of base at blossom end	Acute	17	18.68	IC-0278349, IC-0279811, IC-0317670, IC-0522867, IC-0522869, IC-0522210, IC-275892, IC-324148, IC-330121, IC-330126, IC-330150, IC-331990, KP/PKS-1215, IC-0092443, IC-0146365, IC-0284933, IC-0398543	VS
	Semi-blunt	38	41.75	IC-0398547, IC-0371672, IC-0317583, IC-0345591, IC-0278793, IC-0522861, IC-0522865, IC-0522870, IC-0522875, IC-0519457, IC-0519464, IC-0411764, IC-274599, IC-276565, IC-321392, IC-330110,	

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Table 2 contd...

Characteristic	States	No. of genotypes	Per cent of genotypes	Genotypes	Type of assessment
Fruit: Shape of apex at peduncle end	Blunt	27	29.67	IC-347276, IC-0092398, IC-0336825, IC-0338867, SKY/AC-268, KP/PKS-1161, KP/PKS-1168, IC-0146322, IC-0092465, IC-0146327, IC-0505649, IC-0262187, IC-0321591, IC-0276396, IC-0284891, IC-0284925, IC-0322278, IC-0146312, IC-0346128, IC-0418251, IC-0418264, Narendra Dharidar	VG
				Pusa Santushti, IC-0385814, IC-0264799, IC-0266904, IC-0279678, IC-0417704, IC-0413688, IC-0519463, IC-0551041, IC-0413446, IC-0536536, IC-297541, IC-297566, IC-342424, IC-0146384, IC-0398535, IC-0398544, IC-0092409, IC-0276413, IC-0284892, IC-0284898, 177-1, IC-0322274, JBG-51, Arka Bahar, Pusa Naveen, Pusa Sandesh	
	Depressed	9	9.89	IC-0265025, IC-0519467, IC-0395756, IC-319470, IC-0092390, IC-0146349, IC-0092362, IC-0320183, IC-0588087	
	Raised	58	63.73	IC-0398547, IC-0385814, IC-0264799, IC-0265025, IC-0266904, IC-0278349, IC-0279678, IC-0279811, IC-0317583, IC-0317670, IC-0345591, IC-0278793, IC-0413688, IC-0522861, IC-0522865, IC-0522867, IC-0522869, IC-0522870, IC-0522875, IC-0519464, IC-0395756, IC-0522210, IC-0536536, IC-274599, IC-275892, IC-276565, IC-297541, IC-297566, IC-321392, IC-324148, IC-330110, IC-330121, IC-330126, IC-330150, IC-331990, IC-342424, IC-347276, IC-0092398, IC-0338867, IC-0398535, IC-0398544, SKY/AC-268, KP/PKS-1161, KP/PKS-1215, IC-0092443, IC-0146322, IC-0146365, IC-0092409, IC-0262187, IC-0284891, IC-0284892, IC-0322274, IC-0322278, IC-0346128, IC-0418264, JBG-51, Narendra Dharidar, Arka Bahar	
	Flat	27	29.67	IC-0371672, IC-0417704, IC-0519457, IC-0519463, IC-0551041, IC-0411764, IC-0413446, IC-319470, IC-0146384, IC-0336825, KP/PKS-1168, IC-0092465, IC-0146327, IC-0505649, IC-0321591, IC-0276396, IC-0276413, IC-0284898, IC-0284925, 177-1, IC-0284933, IC-0146312, IC-0418251, IC-0398543, Pusa Naveen, Pusa Santushti, Pusa Sandesh	
	Depressed	6	6.59	IC-0519467, IC-0092390, IC-0146349, IC-0092362, IC-0320183, IC-0588087	
Fruit pubescence	Present	91	100	All genotypes	VG
	Absent	0	0		
Fruit length (<20cm)	Short	17	18.68	IC-0320183, IC-0336825, IC-0338867, IC-0092362, IC-319470, IC-275892, IC-0146327, IC-0588087, IC-0385814, Pusa Sandesh, IC-0146312, IC-0265025, IC-321392, IC-0146349, IC-0317583, KP/PKS-1168, IC-330121	MS

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Table 2 contd...

Characteristic	States	No. of genotypes	Per cent of genotypes	Genotypes	Type of assessment
Fruit diameter	Medium (20–45cm)	74	81.31	IC-0276413, IC-0395756, IC-0092390, IC-330126, IC-0279678, IC-330110, IC-0322278, IC-0322274, IC-0264799, IC-0276396, IC-342424, IC-0413688, IC-0536536, IC-297566, IC-297541, Pusa Santushti, JBG–51, IC-0519464, IC-0519467, SKY/AC-268, IC-0345591, IC-0371672, IC-0266904, IC-0284933, IC-0284925, Narendra Dharidar, IC-0519463, IC-0146322, IC-347276, IC-0505649, IC-0418264, IC-0146384, IC-324148, IC-0418251, Arka Bahar, KP/PKS-1215, IC-0398547, Pusa Naveen, IC-0092398, IC-0522210, IC-274599, IC-0522870, IC-0262187, IC-0398543, IC-0321591, IC-0411764, IC-0398535, IC-0278793, IC-0092465, IC-0519457, IC-0417704, IC-0551041, IC-0284891, IC-0092409, IC-0346128-A, IC-0522865, IC-0398544, KP/PKS-1161, 177-1, IC-0317670, IC-0284898, IC-0284892, IC-0522869, IC-0413446, IC-330150, IC-276565, IC-0522861, IC-0279811, IC-0522867, IC-331990, IC-0522875, IC-0278349, IC-0146365, IC-0092443	
	Long (>45cm)	0			
	Small (<8cm)	75	82.41	IC-297541, IC-0522865, IC-0092443, IC-274599, IC-0146365, IC-0146327, IC-0346128-A, IC-0317670, IC-331990, IC-276565, IC-0519457, KP/PKS-1215, IC-0092409, IC-0284892, IC-0284898, IC-0398543, Arka Bahar, 177-1, IC-0522875, SKY/AC-268, KP/PKS-1161, IC-347276, IC-0371672, IC-0398547, IC-0284925, IC-0418264, IC-0522210, IC-0519464, KP/PKS-1168, IC-0321591, IC-0519463, IC-0284891, IC-0092465, Pusa Naveen, IC-0522869, IC-0522870, IC-0411764, IC-0398535, IC-0505649, IC-0092398, IC-0279811, IC-0522867, IC-0278349, IC-0146384, IC-0336825, IC-330150, IC-0284933, IC-297566, IC-0551041, IC-0417704, IC-0264799, IC-0413688, IC-0398544, IC-0146322, IC-0522861, IC-324148, IC-0322278, IC-0146312, IC-0385814, IC-0279678, IC-0418251, IC-0278793, IC-0262187, IC-0338867, Narendra Dharidar, IC-0317583, IC-0413446, IC-0345591, IC-275892, C-0266904, IC-0536536, JBG–51, IC-0276396, IC-330110, IC-330126	MS
	Medium (8 -12cm)	15	16.48	Pusa Santushti, IC-0146349, IC-0092362, IC-330121, IC-0395756, IC-0322274, IC-0092390, IC-0588087, IC-0519467, Pusa Sandesh, IC-0320183, IC-0276413, IC-0265025, IC-321392, IC-342424	
	Large (>12cm)	1	1.09	IC-319470	



harvest maturity varied from 5.32 cm to 18.77 cm. Longest peduncle was recorded in Pusa Santushti (18.77 cm), followed by Narendra Dharidar (18.70 cm), IC-0092465 (18.08 cm), Pusa Naveen (17.80 cm) while shortest in IC-0336825 (5.32 cm).

The observations for fruit shape at marketable maturity (Table 2) showed that maximum 31 genotypes and check Arka Bahar were elongated curved; thirteen were club shaped including check Narendra Dharidar; ten were cylindrical including check Pusa Naveen; ten were elongate-straight; nine were oval including Pusa Sandesh; seven were pyriform including Pusa Santushti; six were round, and one each having kamandal, dumbbell, conical and depressed-round shape. Considerable diversity was observed among the genotypes for fruit shape at marketable maturity stage. Due to a large variable shape and size of fruits it is easier to morphologically differentiate them from each other. The shape of neck at marketable maturity stage was straight in sixty-eight genotypes and four checks viz., Narendra Dharidar, Arka Bahar, Pusa Naveen and Pusa Santushti. Crooked-neck was observed in two genotypes, IC-0385814 and KP/PKS-1168. No neck was observed in 17 genotypes including all oval and round types. Fruit neck has low variability as most genotypes were straight. Sivaraj and Pandravada (8) reported wide variation in fruit shape, luster, blossom-end and ridges in bottle gourd germplasm from tribal pockets of Telangana region.

Fruit skin color at immature stage was recorded dark green, medium green, light green, mottled green and green background with light stripes on skin (Table 2). Variability was observed for fruit colour in different genotypes among which maximum seventy-one genotypes including three checks Arka Bahar, Pusa Naveen and Pusa Sandesh were light green; thirteen mottled green; four green including Pusa Santushti and three were striped green including check Narendra Dharidar. This makes it easy to morphologically differentiate the genotypes from each other. Mahato *et al.* (3) grouped the bottle gourd genotypes based on the colour of fruit skin. On the basis of fruit skin colour at immature stage, Nagar *et al.* (5) classified 76 pumpkin genotypes into four groups, dark-green, medium-green, light-green and cream coloured. The variability for fruit shape, size and colour of bottle gourd genotypes is shown in Fig. 5. At marketable maturity of fruits, shape of base at blossom end was semi-blunt in thirty-eight genotypes including check Narendra Dharidar; blunt in twenty-seven genotypes including check cultivars Arka Bahar, Pusa Naveen, Pusa Santushti and Pusa Sandesh; acute in seventeen and depressed in nine genotypes. The shape of apex at peduncle end of

fruit was raised in fifty-eight genotypes including two checks, Narendra Dharidar and Arka Bahar; flat in twenty-seven genotypes including three checks, Pusa Naveen, Pusa Santushti and Pusa Sandesh and depressed in six genotypes. At edible maturity of fruits, the shape of base at blossom end and peduncle end varied significantly according to genotype. These visible differences and associated traits help in easy differentiation of genotypes into different groups/ clusters. Sivaraj and Pandravada (8) observed variations for fruit traits viz. shape, luster, blossom-end and ridges in bottle gourd germplasm from tribal pockets of Telangana region.

Fruit pubescence which is an indicator of fruit maturity in bottle gourd was present in all the genotypes including five checks. There was variation in intensity of pubescence on the fruit surface of different genotypes. No genotype was bitter in taste. Fruit length in the genotypes ranged from 15.32 cm to 38.26 cm (Table 2). The genotype IC-0092443 (38.26 cm) had maximum fruit length whereas IC-0320183 (15.32 cm) was shortest. Fruit diameter ranged from 3.36 cm (IC-297541) to 12.37 cm (IC-319470). Kumar

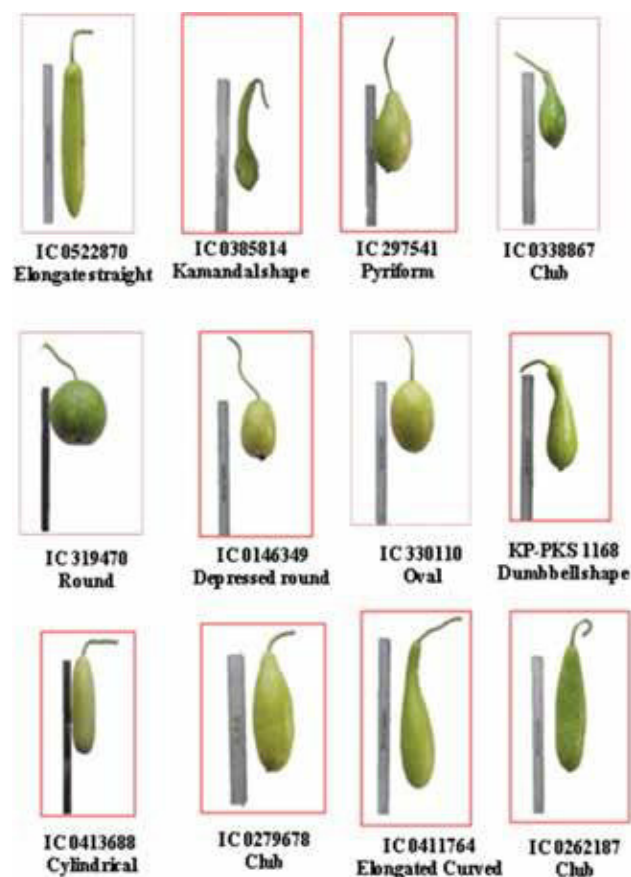


Fig. 5. Different fruit shapes observed in the bottle gourd genotypes.

*et al.* (2), Sit and Sirohi (7) and Mahato *et al.* (3) grouped the bottle gourd accessions on the basis of fruit length and diameter. Nagar *et al.* (5) classified 76 genotypes of pumpkin based on fruit length and diameter.

Seed texture at marketable maturity stage of fruit was soft in ninety genotypes except Pusa Naveen which has medium texture (Table 3). All genotypes were harvested at complete maturity to check the seed shape which was rectangular, with size variation among them. The intensity of brown colour of seed testa was recorded after drying the fruits. Seeds of forty-five genotypes including check Arka Bahar were medium-brown in colour; thirty-four were light in colour including three checks, Narendra Dharidar, Pusa

Naveen and Pusa Santushti. Only twelve genotypes including check Pusa Sandesh were dark. Though the seed in all genotypes was rectangular in shape, variations were observed for size and intensity of color of testa. Testa color, a trait for differentiation among genotypes, varied from light to dark brown. Morimoto *et al.* (4) studied the diversity in 425 landraces of bottle gourd and its wild relatives in Kenya and reported that the general size factor of fruit and seed, shape factor of fruit and seed were the principal causes of variation. Nagar *et al.* (5) classified 76 genotypes of pumpkin based on seed length and seed width.

Thus, morphological descriptors could be used to establish distinctiveness among different genotypes of bottle gourd. Similar attempts for establishment of

**Table 3.** Characterization of bottle gourd genotypes based on seed characters.

Characteristic	States	No. of genotypes	Per cent of genotypes	Genotypes	Type of assessment
Seed shape	Rectangular	91	100	All the genotypes	VG
Seed: texture at marketable stage	Triangular	0	0		
	Soft	90	98.90	All the genotypes except Pusa Naveen	VS
Seed: intensity of brown colour of testa	Medium	1	1.09	Pusa Naveen	
	Light	34	37.36	IC-0398547, IC-0385814, IC-0278349, IC-0417704, IC-0278793, IC-0413688, IC-0522861, IC-0522865, IC-0519463, IC-0519464, IC-0519467, IC-0395756, IC-275892, IC-330110, IC-330121, IC-331990, IC-0092398, IC-0398535, SKY/AC-268, KP/PKS-1161, IC-0146322, IC-0146365, IC-0146327, IC-0505649, IC-0276396, IC-0284891, 177-1, IC-0146312, IC-0418251, IC-0588087, JBG-51, Narendra Dharidar, Pusa Naveen, Pusa Santushti	VS
	Medium	45	49.45	IC-0371672, IC-0264799, IC-0265025, IC-0266904, IC-0279678, IC-0317583, IC-0317670, IC-0345591, IC-0522867, IC-0522869, IC-0522870, IC-0519457, IC-0551041, IC-0411764, IC-0413446, IC-0522210, IC-0536536, IC-274599, IC-276565, IC-297541, IC-297566, IC-321392, IC-324148, IC-330126, C-330150, IC-342424, IC-347276, IC-0146384, IC-0338867, KP/PKS-1215, IC-0092390, IC-0092443, IC-0146349, IC-0092409, IC-0092465, IC-0092362, IC-0262187, IC-0321591, IC-0276413, IC-0284933, IC-0320183, IC-0346128, IC-0418264, IC-0398543, Arka Bahar	
Dark	12	13.18	IC-0279811, IC-0522875, IC-319470, IC-0336825, IC-0398544, KP/PKS-1168, IC-0284892, IC-0284898, IC-0284925, IC-0322274, IC-0322278, Pusa Sandesh		

MS: Measurement of a number of individual plants or parts of plants, VG: Visual assessment by a single observation of a group of plants or parts of plants, VS: Visual assessment by observations of individual plants or parts of plants

distinctiveness have also been made by Tsivelikas *et al.* (11) in squash, Choudhary *et al.* (1) in muskmelon, and Nagar *et al.* (5) in pumpkin.

The present investigation concluded that the presence of wide variations for various DUS traits in 91 bottle gourd genotypes offered a good scope of selecting the suitable genotypes for the economic traits. The identified diverse genotypes may be used as parents in the bottle gourd improvement programme for developing elite genotypes/ hybrids. Further, DUS testing of different characters will be useful for identification of varieties, registration of varieties, plant variety protection (PVP), varietal information system, classification of varieties into different groups, and for developing database for bottle gourd.

### AUTHORS' CONTRIBUTION

Conceptualization of research (AKS, TKB); Execution of field experiment and data collection (SM); Analysis and interpretation of data (SM, AKS, MV); Preparation of manuscript (SM, AKS, MV).

### DECLARATION

The authors declare no conflict of interest.

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