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Morphological Characterization of Greengram Germplasm using DUS Descriptors

S. Mounika, J. V. Ramana*, M. Lal Ahamed and D. Ratna Babu

Department of Molecular Biology and Biotechnology, Advanced Post Graduate Centre, Acharya N G Ranga Agricultural University, Lam, Guntur, Andhra Pradesh, India

**Corresponding author*

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A B S T R A C T

Forty eight mungbean genotypes collected from different parts of the country were morphologically characterized using PPV & FRA descriptors. The descriptors, plant habit, time of flowering, stem pubescence and pod pubescence, showed no variation among the genotypes in the studied 26 descriptors. The characters like growth habit, stem colour, leaf colour, vein colour, leaf size, petiole colour, plant height, curvature of pod, pod position, pod colour, flower colour, days to maturity, seed colour, seed luster, seed size and seed colour showed variation and were recorded during different growth stages of crop. Thus, the present clearly indicated the utilization of the PPV & FRA descriptors for the purpose of registration, maintenance and protection of lines.

Introduction

Green gram is a self-pollinating diploid grain legume (2n=2x=22) crop with genome size of 543 Mb (Kang *et al.*, 2014) and the most important crop in India after chick pea and pigeon pea. It is a widely cultivated pulse crop, because of its adaptation to low water requirement, low soil fertility, short growth duration and can also be used in crop rotation practices. Other properties like easy digestibility and low proportions of flatulence factors also added to its value among the pulse crops. India is the primary producer of greengram and contributes to about 75% of the world production. In India, it contributes to about 14% of total pulse cultivation area and 7% of total production.

In India greengram is cultivated in an area of 4326.8 ha (957.21 ha in *rabi* and 3369.59 ha in *kharif*) with a production of 2165.36 tons (522.18 tons in *rabi* and 1643.18 tonns in *kharif*) and productivity of 1046 kg/ha (546 kg/ha in *rabi* and 500 kg/ha in *kharif*). In Andhra Pradesh, green gram productivity is 990 kg/ha (*rabi* is 490 kg/ha and 500 kg/ha in *kharif*) (Indiastat, 2016-17).

Genetic diversity is the base for crop genetic improvement and important for the conservation, evaluation and utilization of

crop germplasm (Rao and Hodgkin, 2002; Wang *et al.,* 2015 and Anumalla *et al.,* 2015). Mung bean gene pool can be best utilized for development of promising or superior varieties by exhaustive characterization of the various germplasm holdings and collections that constitute the gene pools to identify the useful genetic diversity. The crosses between the parents with maximum genetic divergence are generally the most responsive for genetic improvement (Arunachalam, 1981). However, it is necessary to screen and characterize the germplasm for the nature and extent of genetic diversity to know the traits present in the selected parental genotypes.

Characterization and cataloguing of germplasm have been traditionally carried out by using morpho-agronomic traits. BioVersity International and PPV & FRA (Protection of Plant Varieties and Farmers' Rights Authority) have come up with a set of DUS (Distinctiveness, Uniformity and Stability) descriptors for characterization of the lines for their registration and protection. Thus, in the present study, fifty genotypes collected from different parts of the country were characterized using PPV & FRA descriptors to know the extent variability present in these genotypes.

Materials and Methods

The experimental material consisted of 48 mungbean genotypes collected from different parts of the country was evaluated at Advanced Post Graduate Centre, Lam, Guntur, Andhra Pradesh, India, to get the clear idea of variability present for different traits. The genotypes were planted in one row of 2m length in three replications in a randomized block design. The plant to plant distance was 10cm and row to row distance was 30cm. Standard agronomic practices were followed to raise a good crop and need based plant protection measures were adopted for managing good crop stand. The observations on morphological characters were recorded during different growth stages of the plant. The anthocyanin pigmentation at cotyledonary stages was observed at unfolded stages (5days after sowing). The characters like growth habit, plant habit, stem colour, leaf colour, vein colour, leaf size, petiole colour and stem pubescence were observed at 50% flowering stage. The characters like plant height and premature pod colour were observed when pods were fully developed while, pod colour at maturity, pod curvature, pod position, mature pod length were observed at maturity stage. Seed characters like seed colour, seed size, seed coat luster, seed shape were observed after harvest. All morphological observations were conducted as per the DUS testing guidelines issued by Protection of Plant Varieties & Farmers Rights Authority (2007).

Results and Discussion

Morphological characteristics provide the basic information about the magnitude of genetic variability. 26 morphological characters were recorded in 48 greengram genotypes and variability was observed in 22 characters indicating the usefulness of these traits in differentiating the genotypes (Table - 1 and 2). The trait, anthocyanin colouration, was recorded at seedling stage and was noticed in the genotypes, TM 96-2, GGG-1, IPM 2-14, LGG-617, WGG-42, LGG-450, LGG-625, LGG-605, OBGG-56, LGG-595, VBN-2, TARM-1, LGG-634, LGG-636, RM 16-9, OBGG-58, PM-5, Pusa Vishal. Pusa Ratna, IPM-288,IPM 02-3, IPM 02-14, MH 2-15,MH 96-1, MH-318, ML 1464, HUM-1, EC-398885, EC-398891, EC-520024, EC-520026, EC-520029, China Mung, Butan LM -1, Prakash Nepal and VGG 15-30. Anthocyanin colouration was absent in 13 genotypes.

Table.1 DUS descriptors of 48 Mungbean genotypes

S.No.	Entry name	Hypocotyl colour	Time of flowering	Growth habit	Plant habit	Stem colour	Stem pubescence	Leaf lobe	Leaf Shape	Leaf colour	Pod colour	Curvature of pod	Vein colour	Petiole colour	Leaf Size	Flower colour	Colour of premature pod	Pod pubse scence	Pod Position	Pod length	Days to maturity	Plant height	Seed colour	Seed luster	Seed shape	Seed size
1	LGG - 600	1	3	3	1	3	9	9	4	2	2	1	3	1	5	3	1	9	1	3	3	3	2	1	3	5
2	TM 96 -2	2	3	3	1	3	9	1	2	2	2	1	1	1	7	3	1	9	1	3	3	5	2	2	1	5
3	LGG - 610	1	3	3	1	3	9	1	2	2	2	1	3	2	7	3	1	9	1	3	3	5	2	1	3	5
4	LGG - 604	1	3	3	1	3	9	1	2	2	2	1	1	1	7	3	1	9	1	3	5	5	2	1	1	5
5	GGG – 1	2	3	3	1	1	9	1	2	1	2	1	3	2	7	3	1	9	2	3	3	5	2	1	1	3
6	IPM 2-14	2	3	3	1	1	9	1	2	2	2	1	3	1	7	3	1	9	1	3	3	3	2	1	3	5
7	LGG -617	2	3	3	1	1	9	1	2	2	2	1	1	1	7	3	1	9	1	3	3	3	2	1	3	5
8	WGG -42	2	3	3	1	1	9	1	2	2	2	1	3	1	5	3	1	9	1	5	3	3	2	2	3	7
9	LGG - 450	2	3	5	1	1	9	1	2	2	1	1	3	2	5	3	1	9	1	3	3	5	2	1	3	3
10	LGG - 509	1	3	5	1	1	9	1	2	2	2	1	3	2	7	3	1	9	1	3	3	5	1	2	1	5
11	LGG - 625	2	3	5	1	1	9	1	2	1	1	1	3	2	7	3	1	9	1	3	3	5	1	1	3	5
12	PM – 110	1	3	3	1	1	9	1	2	1	2	3	1	1	7	3	1	9	1	3	3	5	2	1	1	5
13	LGG - 605	2	3	3	1	1	9	1	2	1	2	1	2	3	5	5	1	9	1	3	3	5	2	1	3	5
14	OBGG- 56	2	3	5	1	3	9	1	2	2	2	1	1	2	5	3	1	9	1	3	3	3	2	1	1	5
15	MGG - 385	1	3	3	1	1	9	1	2	2	1	1	3	1	5	3	1	9	1	3	3	5	2	1	1	5
16	LGG - 595	2	3	3	1	1	9	1	2	2	2	1	3	1	7	3	1	9	1	3	3	3	2	1	1	5
17	LGG - 630	1	3	3	1	1	9	1	2	1	1	1	1	2	7	3	1	9	1	3	3	5	2	1	3	5
18	VBN -2	2	3	3	1	1	9	9	4	1	2	1	1	2	7	3	1	9	1	3	3	3	2	1	3	5
19	TARM -1	2	3	5	1	1	9	1	2	2	2	1	3	2	5	3	1	9	1	3	3	3	2	1	3	3
20	LGG -634	2	3	5	1	1	9	1	2	1	2	1	1	1	5	3	1	9	1	3	3	3	2	1	1	5
21	LGG -636	2	3	5	1	1	9	1	2	1	2	1	1	1	5	3	1	9	1	3	3	5	2	2	1	3
22	LGG -607	1	3	5	1	1	9	1	2	1	2	3	1	1	7	3	2	9	1	5	5	5	2	1	3	5
23	RM 16 - 9	2	3	5	1	1	9	9	4	1	1	1	3	1	5	3	1	9	1	3	5	5	1	1	3	3
24	LGG - 603	1	3	5	1	1	9	1	2	1	2	1	3	2	5	3	1	9	1	3	3	5	2	1	1	5
25	OBGG - 58	2	3	3	1	1	9	1	2	1	1	3	3	2	5	3	1	9	1	3	3	3	2	2	1	5
26	LGG - 578	1	3	5	1	1	9	1	2	1	2	1	1	1	5	3	1	9	1	3	5	3	2	2	1	5
27	PM – 5	2	3	3	1	1	9	1	2	2	2	1	3	1	5	3	1	9	1	5	3	3	2	1	3	5
28	Pusa Vishal	2	3	3	1	1	9	1	2	2	2	1	3	2	5	3	1	9	2	3	5	3	2	1	1	3
29	Pusa Ratna	2	3	5	1	1	9	1	2	1	2	1	3	2	7	3	1	9	1	3	5	3	2	2	3	5
30	IPM - 288	2	3	5	1	2	9	1	2	1	1	1	1	1	5	3	1	9	1	3	3	3	2	2	1	5
31	IPM 02 -3	2	3	5	1	1	9	1	2	1	1	1	3	2	3	3	1	9	2	3	5	3	2	1	3	5
32	MH 2 -15	2	3	5	1	1	9	1	2	2	2	3	1	1	3	5	1	9	1	3	5	3	1	1	3	5
33	MH 96 - 1	2	3	3	1	3	9	1	2	1	1	1	3	2	3	3	1	9	1	3	5	3	2	1	3	3
34	MH -318	2	3	5	1	1	9	1	2	1	1	1	3	2	5	3	1	9	1	3	3	3	2	2	1	5
35	ML - 1464	2	3	5	1	1	9	1	2	1	2	1	1	2	5	3	1	9	2	3	3	3	2	2	3	5
36	HUM – 1	2	3	5	1	1	9	1	2	2	2	1	1	1	5	3	1	9	1	3	3	3	2	1	3	5
37	EC - 39885	2	3	5	1	1	9	1	2	1	2	1	1	1	3	3	1	9	1	3	5	3	2	1	3	5
38	EC - 398891	2	3	5	1	1	9	1	2	1	2	1	2	1	5	3	1	9	1	3	5	3	2	1	3	5
39	EC -	2	3	3	1	1	9	1	2	1	2	1	1	2	5	3	1	9	1	3	3	3	2	1	3	5

	520024																								
40	EC - 520026	2	3	5	1	3	9	1	2	1	2	1	3	1	3	3	1	9	1	3	3	3	2	1	3	5
41	EC - 520029	2	3	3	1	1	9	1	2	1	2	1	3	1	5	3	1	9	1	3	3	3	2	1	3	5
42	China Mung	2	3	5	1	1	9	1	2	1	2	1	1	1	3	3	1	9	1	3	3	3	2	1	3	5
43	Butan LM - 1	2	3	3	1	1	9	1	2	1	2	3	1	1	5	3	2	9	1	3	3	3	2	1	3	5
44	Prakash Nepal	2	3	3	1	1	9	1	2	1	2	1	3	1	3	3	1	9	1	3	3	3	2	1	3	3
45	LGG - 460	1	3	5	1	1	9	1	2	1	2	1	3	1	3	3	1	9	1	3	3	3	2	1	1	3
46	LGG - 644	1	3	5	1	1	9	1	2	1	2	1	3	2	5	3	1	9	1	3	7	3	2	1	3	5
47	LGG -407	1	3	3	1	1	9	1	2	1	2	1	3	2	5	3	1	9	1	3	7	3	2	2	1	5
48	VGG 15 - 30	2	3	5	1	3	9	9	4	1	2	1	3	2	5	3	1	9	1	3	3	3	2	1	1	3
		Absent-1	Early-3	Erect-3	Determinate-1	Green-1	Absent-1	Absent-1	deltoid- 1	Green-1	Brown-1	Straight-1	Green-1	Green-1	Small-3	Yellow-3	Green-1	Absent-1	Above canopy-1	Short-3	Early-3	small-3	Yellow-1	Shiny-1	Oval-1	Small-3
		Present -2	Medium-5 Late-7	Semi erect-5 Spreading-7	In determinate-3	Green with purple-2 purple-3	Present-9	Present-9	Ovate-2 Lanceolate-3 Cuneate-4	Dark green-2	Black-2	Curved-3	Greenish purple-2 Purple-3	Greenish with purple - 2 Purple -3	Medium-5 Large-7	Light yellow-5	Green with pigmented -2	Present-9	Intermediate-2 Not visible-3	medium-5 Large-7	medium-7 5 large-7	medium-5 large-	Green-2 mottled-3 Black-4	Dull-2	Drum-3	Medium-5 Large-7

Table.2 Grouping of 48 mungbean genotypes based on DUS descriptors

Morphological characters	Character state	Genotypes
Hypocotyl Anthocyanin colouration	Absent	LGG-600, LGG-610, LGG-604, LGG-509, PM-110, MGG-385, LGG6-30, LGG-607, LGG-603, LGG-578, LGG-460, LGG6-44, LGG-407
	Present	TM 96-2, GGG-1, IPM 2-14, LGG-617, WGG-42, LGG-450, LGG-625, LGG-605, OBGG-56, LGG-595, VBN-2, TARM-1, LGG-634, LGG-636, RM 16-9, OBGG-58, PM-5, PUSA VISHAL, PUSA RATNA, IPM-288, IPM 02-3, MH 2-15, MH 96-1, MH-318, ML-1464, HUM-1, EC-39885, EC-398891, EC-520024, EC-520026, EC-520029, CHINA MUNG, BUTAN LM-1, PRAKASH NEPAL, VGG 15-30
Plant growth habit	Erect	LGG-600, TM 96-2, LGG-610, LGG-604, GGG-1, IPM 2-14, LGG-617, WGG-42, PM-110, LGG-605, MGG-385, LGG-595, LGG-630, VBN-2, OBGG-58, PM-5, PUSA VISHAL, MH 96-1, EC-520024, EC-520029, BUTAN LM-1, PRAKASH NEPAL, LGG-407
	Semi- erect	LGG-450, LGG-509, LGG-625, OBGG-56, TARM-1, LGG-634, LGG-636, LGG-607, RM 16-9, LGG-603,LGG-578, PUSA RATNA, IPM-288, IPM 02-3, MH- 215, MH-318, ML-1464, HUM-1, EC-39885, EC-398891, EC-520026 CHINA MUNG, LGG-460, LGG-644, VGG 15-30

Plant habit	Determinate	All genotypes
Petiole colour	Green	LGG-600, TM 96-2, LGG-604, IPM 2-14, LGG-617, WGG-42, PM-110, MGG-385, LGG-595, LGG-634, LGG-636, LGG-607, RM 16-9, LGG-578, PM-5, IPM-288, MH 2-15, HUM-1, EC-39885, EC-398891, EC-520026, EC-520029, CHINA MUNG, BUTAN LM-1, PRAKASH NEPAL, LGG-460
	Green with purple splashes	LGG-610, GGG-1, LGG-450, LGG-509, LGG-625, OBGG-56, LGG-630, VBN-2, TARM-1, LGG-603, OBGG-58, PUSA VISHAL, PUSA RATNA, IPM 02-3, MH 96-1, MH-318, ML-1464, EC-520024, LGG-644, LGG-407, VGG 155-30
	Purple	LGG-605
Plant height	Short	LGG-600, IPM 2-14, LGG-617, WGG-42, OBGG-56, LGG-595,, VBN-2, TARM-1, LGG-634, LGG-636, LGG-607, PM-5, PUSA VISHAL, PUSA RATNA, IPM-288, IPM 02-3, MH-215, MH 96-1, MH-318, ML-1464, HUM-1, EC-39885, EC-398891, EC-520024, EC-520026 EC-520029, CHINA MUNG, BUTAN LM-1, PRAKASH NEPAL, LGG-460, LGG-644, LGG-407, VGG 15-30
	Medium	TM 96-2, LGG-610, LGG-604, GGG-1, LGG-450, LGG-509, LGG-625, PM-110, LGG-605, MGG-385, LGG-630, RM 16-9, LGG-603, OBGG-58, LGG-578,
Stem colour	Green	GGG-1, IPM 2-14, LGG-617, WGG42, LGG-450, LGG-509, LGG-625, PM-110, LGG-605, OBGG-56, MGG-385, LGG-595, LGG-630, VBN-2, TARM-1, LGG-634, LGG-636, LGG-607, RM 16-9, LGG-603, OBGG-58, LGG-578, PM-5, PUSA VISHAL, PUSA RATNA, IPM 02-3, MH-215, MH-318, ML-1464, HUM-1, EC-39885, EC-398891, EC-520024, EC-520029, CHINA MUNG, BUTAN LM-1, PRAKASH NEPAL, LGG-460, LGG-644, LGG-407
	Green with purple splashes	IPM-288
	Purple	LGG-600, TM 96-2, LGG-610, LGG-604, MH 96-1, EC-520026, VGG 15-30
Stem pubescence	Present	All genotypes
Leaflet lobes (terminal)	Absent	TM 96-2, LGG-610, LGG-604, GGG-1, IPM 2-14, LGG-617, WGG-42, LGG-450, LGG-590, LGG-625, PM-110, LGG-605, OBGG-56, MGG-385, LGG-595, LGG-630, TARM-1, LGG-634, LGG-636, LGG-607, LGG-603, OBBGG-58, LGG-578, PM-5, PUSA VISHAL, PUSA RATNA, IPM-288, IPM 02-3, MH-215, MH 96-1, MH-318, ML-1464, HUM-1, EC-39885, EC-398891, EC-520024, EC-520026, EC-520029, CHINA MUNG, BUTAN LM-1, PRAKASH NEPAL, LGG-460, LGG-644, LGG-407
	Present	LGG-600, VBN-2, RM 16-9, VGG 15-30
Leaf shape (terminal)	Ovate	TM 96-2, LGG-610, LGG-604, GGG-1, IPM 2-14, LGG-617, WGG-42, LGG-450, LGG-509, LGG-625, PM-110, LGG-595, LGG-630, TARM-1, LGG-634, LGG-636, LGG-607, LGG-603, OBBGG-58, LGG-578, PM-5, PUSA VISHAL, PUSA RATNA, IPM-288, IPM 02-3, MH-215, MH 96-1, MH-318, ML-1464, HUM-1, EC-39885, EC-398891, EC-520024, EC-520026, EC-520029, CHINA MUNG, BUTAN LM-1, PRAKASH NEPAL, LGG-460, LGG-644, LGG-407

	Cuneate	LGG-600, VBN-2, RM 16-9, VGG 15-30
Leaf colour	Green	GGG-1, LGG-625, PM-110, LGG-605, LGG-630, VBN-2, LGG-634, LGG-636, LGG-607, RM 16-9, LGG-603, OBGG-58, LGG-578, PUSA RATNA, IPM-288, IPM 02-3, MH 96-1, MH-318, ML-1464,, EC-39885, EC-398891, EC-520024, EC-520026, EC-520029, CHINA MUNG, BUTAN LM-1, PRAKASH NEPAL, LGG-460, LGG-644, LGG-407, VGG 15-30
	Dark green	LGG-600, TM 96-2, LGG-610, LGG-604,, IPM 2-14, LGG-617, WGG-42, LGG-450, LGG-509, OBGG-56, MGG-385, LGG-595, TARM-1, PM-5, PUSA VISHAL,MH-215, HUM-1
Leaf vein colour	Green	TM 96-2, LGG-604, LGG-617, PM-110, MGG-385, VBN-2, TARM-1, LGG-636, RM 16-9, LGG-607, PM-5, IPM 02-3,MH-215,MH 96-1,HUM-1, EC-39885, EC-398891, EC-520026, CHINA MUNG, BUTAN LM-1, PRAKASH NEPAL
	Greenish purple	OBGG-56, LGG-605, EC-520024
	Purple	LGG-600, LGG-610, GGG-1, IPM 2-14, WGG-42, LGG-450, LGG-509, LGG-625, LGG-595, LGG-630, LGG-634, LGG-603, OBGG-58, LGG-578, PUSA VISHAL, PUSA RATNA, IPM-288, MH-318, ML-1464, EC-520029, LGG-460, LGG-644, LGG-407, VGG 15-30
Leaf size	Small	IPM 02-3, MH-215, MH 96-1, EC-39885, EC-520026, CHINA MUNG, PRAKASH NEPAL, LGG-460
	Medium	LGG-600, WGG-42, LGG-450, LGG-605, OBGG-56, MGG-385, TARM-1, LGG-634, LGG-636, RM 16-9, LGG-603, OBGG-58, LGG-578, PM-5, PUSA VISHAL, IPM-288, MH-318, ML-1464, HUM-1, EC-398891, EC-520024, EC-520029, BUTAN LM-1, LGG-644, LGG-407, VGG 15-30
	Large	TM 96-2, LGG-610, LGG-604, GGG-1, IPM 2-14, LGG-617, LGG-509, LGG-625, PM-110, LGG-595, LGG-630,VBN-2, LGG607, PUSA RATNA
Flower colour	Yellow	IPM 02-3,MH 96-1, EC-39885, EC-520026, CHINA MUNG, PRAKASH NEPAL, LGG-460, LGG-600, WGG-42, LGG-450, OBGG-56, MGG-385, TARM-1, LGG-634, LGG-636, RM 16-9, LGG-603, OBGG-58, LGG-578, PM-5, PUSA VISHAL, IPM-288, MH-318, ML-1464, HUM-1, EC-398891, EC-520024, EC-520029, BUTAN LM-1, LGG-644, LGG-407, VGG 15-30, TM 96-2, LGG-610, LGG-604, GGG-1, IPM 2-14, LGG-617, LGG-509, LGG-625, PM-110, LGG-595, LGG-630,VBN-2, LGG607, PUSA RATNA
	Light yellow	LGG-605, MH-215
Time of flowering	Early	All genotypes
Colour of premature pod	Green	IPM 02-3,MH 96-1, EC-39885, EC-520026, CHINA MUNG, PRAKASH NEPAL, LGG-460, LGG-600, WGG-42, LGG-450, OBGG-56, MGG-385, TARM-1, LGG-634, LGG-636, RM 16-9, LGG-603, OBGG-58, LGG-578, PM-5, PUSA VISHAL, IPM-288, IPM 02-14, MH-318, ML-1464, HUM-1, EC-398891, EC-520024, EC-520029, LGG-644, VGG 15-30, TM 96-2, LGG-610, LGG-604, GGG-1, LGG-617, LGG-509, LGG-625, PM-110, LGG-595, LGG-630,VBN-2, LGG607, PUSA RATNA, LGG-605, MH-215

	Green with pigmented suture	LGG-607,BUTAN LM-1
Pod pubescence	Present	All genotypes
Pod position	Above canopy	MH 96-1, EC-39885, EC-520026, CHINA MUNG, PRAKASH NEPAL, LGG-460, LGG-600, WGG-42, LGG-450, OBGG-56, MGG-385, TARM-1, LGG-634, LGG-636, RM 16-9, LGG-603, OBGG-58, LGG-578, PM-5, IPM-288, MH-318, HUM-1, EC-398891, EC-520024, EC-520029, BUTAN LM-1, LGG-644, LGG-407, VGG 15-30, TM 96-2, LGG-610, LGG-604, IPM 2-14, LGG-617, LGG-509, LGG-625, PM-110, LGG-595, LGG-630,VBN-2, LGG-607, PUSA RATNA, LGG-605, MH-215
	Intermediate	GGG-1,PUSA VISHAL, IPM 02-3, ML-1464
Pod colour	Brown	LGG-450, LGG-509, LGG-625, MGG-385, LGG-595, LGG-630, RM 16-9, OBGG-58, IPM-288, MH 96-1, MH-318,
	Black	LGG-600, TM 96-2, LGG-610, LGG-604, GGG-1, IPM 2-14, LGG-617, WGG-42, LGG-636, LGG-607, LGG-603, PM-5, PUSA RATNA, ML-1464, EC-398891, EC-520024, EC-520026, EC-520029, CHINA MUNG, BUTAN LM-1, PRAKASH NEPAL, LGG-460, LGG-644, LGG-407, VGG 15-30, IPM 02-3, PM-110, LGG-605, OBGG-56,VBN-2, TARM-1, LGG-634, LGG-578, PUSA VISHAL, MH-215, HUM-1, EC-39885
Curvature of mature pod	Straight	LGG-600, TM 96-2, LGG-610, LGG-604, GGG-1, IPM 2-14, LGG-617, WGG-42, MGG-385, LGG-595, LGG-630, LGG-636, RM 16-9, LGG-603, PM-5, PUSA RATNA, IPM 02-3, MH-318, ML-1464, EC-398891, EC-520024, EC-520026, CHINA MUNG, PRAKASH NEPAL, LGG-460, LGG-644, LGG-407, VGG 15-30, LGG-605, OBGG-56,VBN-2, TARM-1, LGG-634, LGG-578, PUSA VISHAL, MH 96-1, HUM-1, EC-39885, EC-520029,
	Curved	PM-110, LGG-607,OBGG-58, MH-215, BUTAN LM-1,
Pod length	Short	LGG-600, TM 96-2, LGG-610, LGG-604, GGG-1, IPM 2-14, LGG-617, LGG-450, LGG-509, LGG-625, PM-110, LGG-605, OBGG-56, MGG-385, LGG-595, LGG-630, VBN-2, TARM-1, LGG-634, LGG-636, RM 16-9, LGG-603, OBGG-58, LGG-578, PUSA VISHAL, PUSA RATNA, IPM-288, IPM 02-3, MH-215, MH 96-1, MH-318, ML-1464, HUM-1, EC-39885,, EC-398891, EC-520024, EC-520026, CHINA MUNG, BUTAN LM-1, PRAKASH NEPAL, LGG-460, LGG-644, LGG-407, VGG 15-30
	Medium	WGG-42, LGG-607, PM-5
Seed colour	Yellow	LGG-509, LGG-625, RM 16-9, MH-215
	Green	LGG-600, TM 96-2, LGG-610, LGG-604, GGG-1, IPM 2-14, LGG-617, LGG-450, WGG-42, PM-110, LGG-605, OBGG-56, MGG-385, LGG-595, LGG-630, VBN-2, TARM-1, LGG-634, LGG-636, LGG-607, LGG-603, OBGG-58, LGG-578, PUSA VISHAL, PUSA RATNA, IPM-288, IPM 02-3, MH 96-1, MH-318, ML-1464, HUM-1, EC-39885,, EC-398891, EC-520024, EC-520026, CHINA MUNG, BUTAN LM-1, PRAKASH NEPAL, LGG-460, LGG-644, LGG-407, VGG 15-30
Seed luster	Shiny	LGG-600,, LGG-610, LGG-604, GGG-1, IPM 2-14, LGG-617, LGG-450, GG-625, PM-110,LGG-605, OBGG-56, MGG-

		385, LGG-595, LGG-630, VBN-2, TARM-1, LGG-634, LGG-607, RM 16-9, LGG-603, PM-5, PUSA VISHAL, IPM 02-3, MH-215, MH 96-1, HUM-1, EC-39885, EC-398891, EC-520024, EC-520026, EC-520029, CHINA MUNG, BUTAN LM-1, PRAKASH NEPAL, LGG-460, LGG-644, VGG 15-30
	Dull	TM 96-2, WGG-42, LGG-509, LGG-636, OBGG-58, LGG-578, PUSA RATNA, IPM-288, MH-318, ML-1464, LGG-407
Seed shape	Oval	TM 96-2, LGG-604, GGG-1, LGG-509, PM-110, OBGG-56, MGG-385, LGG-595, LGG-634, LGG-636, LGG-603, OBGG-58, LGG-578, PUSA VISHAL, IPM-288, MH-318, LGG-460, LGG-407, VGG 15-30
	Drum	LGG-600, LGG-610, IPM 2-14, LGG-617, LGG-450, WGG-42, LGG-625, LGG-605, LGG-630, VBN-2, TARM-1, LGG-607, RM 16-9, PM-5, PUSA RATNA, IPM 02-3, MH-215, MH 96-1, ML-1464, HUM-1,, EC-39885, EC-398891, EC-520024, EC-520026, EC-520029,, CHINA MUNG, BUTAN LM-1, PRAKASH NEPAL, LGG-644
Seed size	Small	GGG-1, LGG-450, TARM-1, LGG-636, RM 16-9, PUSA RATNA, MH-215, MH-318, LGG-460, LGG-644
	Medium	LGG-600, TM 96-2, LGG-610, LGG-604, IPM 2-14, LGG-617, LGG-509, LGG-625, PM-110, LGG-605, OBGG-56, MGG-385, LGG-595, LGG-630, VBN-2, LGG-634, LGG-607, LGG-603, OBGG-58, LGG-578, PUSA VISHAL, IPM-288, IPM 02-3, MH 96-1, ML-1464, HUM-1, EC-39885, EC-398891, EC-520024, EC-520026, EC-520029, CHINA MUNG, BUTAN LM-1, PRAKASH NEPAL, LGG-407, VGG 15-30
	Large	WGG-42

This is the trait which is highly used in the breeding programmes for differentiation of genotypes and also useful in maintenance breeding and Intellectual property protection. Similar exploitation of morphological traits in mungbean was reported by Mukherjee and Pradhan (2002), Khattak *et al.*, (2000) and Patel *et al.*, (2019).

The characters, time of flowering, plant habit and stem pubescence, were recorded at 50% flowering stage and variation among the genotypes was not observed. All the genotypes showed early flowering, determinate plant habit and presence of stem pubescence indicating they are not useful in characterization of these genotypes. The trait, growth habit, was semi erect type in most of the genotypes i.e., LGG-450, LGG-509, LGG-625, OBGG-56, TARM-1, LGG-634, LGG-636, LGG-607, RM 16-9, LGG-603, LGG-578, Pusa Ratna, IPM-288, IPM 02-3, IPM 02-14, MH 2-15, MH-318, ML-1464, HUM-1, EC-398885, EC-398891, EC-520026, China Mung, LGG-460, LGG-644 and VGG 15-30 while, other genotypes exhibited erect growth habit. The character, stem colour was recorded at 50% flowering stage and exhibited variation among the genotypes. The genotypes, LGG-600, TM 96-2, LGG-610, LGG-604, OBGG-56, MH 96-1, EC-520026 and VGG 15-30, stem colour was purple while the genotype, IPM-288, exhibited green with purple stem colour. The other genotypes recorded green stem colour.

Leaf lobes were present in the genotypes, LGG-600, VBN-2, RM 16-9 and VGG 15-30, while leaf lobes were absent in other genotypes. Leaf shape of the genotypes, LGG-600, VBN-, RM 16-9 and VGG 15-30, was cuneate while, other genotypes exhibited ovate shape. The genotypes, LGG-600, TM 96-2, LGG-610, LGG-604, IPM 2-14, LGG-617, WGG-42, LGG-450, LGG-509, OBGG-56, MGG-385, LGG-595, TARM-1, PM-5, Pusa Vishal, MH 2-15 and HUM-1 showed dark green leaf colour while remaining genotypes recorded green colour. Leaf size of the genotypes, IPM 02-3, MH 2-15, MH 96-1, EC-398885, EC-520026, China Mung, Prakash Nepal and LGG-460, was small while, large leaf size was noticed in the genotypes, TM 96-2, LGG-610, LGG-604, GGG-1, IPM 2-14, LGG-617, LGG-509, LGG-625, PM-110, LGG-625, LGG-630, VBN-2, LGG-607 andvPusa Ratna. The remaining genotypes recorded medium leaf size.

The genotypes, TM 96-2, LGG-604, LGG-617, PM-110, OBGG-56, LGG-630, VBN-2, LGG-634, LGG-636, LGG-607, LGG-578, IPM-288, IPM-288, IPM 02-14, MH 2-15, ML-1464, HUM-1, EC-398885, EC-520024, China Mung, Butan LM-1, showed purple coloured vein and greenish purple vein was observed in the genotypes, LGG-605 and EC-398891. The remaining genotypes exhibited green vein colour. Petiole colour of the genotypes, LGG-610, GGG-1, LGG-450, LGG-509, LGG-625, OBGG-56, LGG-630, VBN-2, TARM-1, LGG-603, OBGG-58, PusaVisahl, Pusa Ratna, IPM 02-3, IPM 02-14, MH 96-1, MH-318, ML-1464, EC-520024, LGG-644, LGG-407 and VGG 15-30, was greenish with purple colour, while LGG-605 exhibited purple petiole colour. Flower colour was light yellow in LGG-605 and MH 2-15, while other genotypes showed yellow colour flower. Jain *et al.*, (2002) reported the usefulness of flower characteristics in characterization of mungbean germplasm.

Premature pod colour was recorded when pods were fully developed and the colour was green with pigmented in Butan LM-1 while other genotypes recorded green colour of premature pod. Pod pubescence was present in all genotypes and there was no variation. Pod colour of the genotypes, LGG-450, LGG-

625, MGG-385, LGG-630, RM 16-9, OBGG-58, IPM-288,IPM 02-3, MH 96-1 and MH-318, was brown and the remaining genotypes showed black pod colour. Curvature of pod of the genotypes, PM-110, LGG-607, OBGG-58, MH 2-15 and BUTAN LM-1, was curved while other genotypes exhibited straight pods. Similar report of straight pods without curvature was reported by Sunil *et al.*, (2014) in their study in greengram. Pod position was intermediate in GGG-1, Pusa Vishal, IPM 02-3, IPM 02-14 and ML-1464, while other genotypes exhibited above canopy pod position. Pod length of WGG-42, LGG-607 and PM-5 genotypes was medium while, other genotypes exhibited short pod length.

Days to maturity was medium in LGG-610, LGG-607, RM 16-9, LGG-578, Pusa Vishal, Pusa Ratna, IPM 02-3, IPM 02 -14, MH 2-15, MH 96-1, EC-398885 and EC-398891 while, LGG-644 and LGG-407 recorded late maturity. Remaining genotypes showed early maturity. Plant height of the genotypes, TM 96-2, LGG-610, LGG-604, GGG-1, LGG-450, LGG-509, LGG-625, PM-110, LGG-605, MGG-385, LGG-630, LGG-636, LGG-607, RM 16-9 and LGG-603, was medium and the other genotypes exhibited short plant height. Sunil *et al.*, (2013) reported the variability in plant height in their study involving accessions from Andhra Pradesh.

The genotypes, LGG-509, LGG-625, RM 16-9 and MH 2-15, recorded yellow seed colour while, other genotypes exhibited green seed colour. Seed luster of TM 96-2, WGG-42, LGG-509, LGG-636, OBGG-58, LGG-578, Pusa Ratna, IPM-288, IPM 02-14, MH-318, MH-1464 and LGG-407 was dull and the other genotypes exhibited shiny seed luster. Seed shape of the genotypes, TM 96-2, LGG-604, GGG-1, LGG-509, PM-110, OBGG-56, MGG-385, LGG-595, LGG-634, LGG-636, LGG-603, OBGG-58, LGG-578, Pusa Vishal, IPM-288, MH-318, LGG-460, LGG-407 and VGG 15-30, was oval while other genotypes exhibited drum seed shape. The trait, seed size (100 seed weight) was small in LGG-450, TARM-1, LGG-636, RM 16-9, Pusa Vishal, IPM 02-14, MH 96-1, Prakash Nepal, LGG-460 and VGG 15-30 while WGG-42 genotype exhibited large seed shape. Remaining genotypes exhibited small seed shape (100 seed weight). Similar reports of exploiting the seed characters variability in mungbean was reported by Venkateswarlu (2001) and Khajudparn and Tantasawat (2011).

Thus, the present study indicated the importance of morphological characterization using DUS descriptors for the registration, maintenance and protection of genotypes. Anthocyanin pigmentation at seedling stage, stem, leaf, flower, pod and seed characters showed lot of variability among the genotypes.

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