Biological Forum – An International Journal **15(8): 77-89(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Assessment of Mungbean Germplasm through Morphological Characterization using DUS Criteria

Sunny Thakur* and Stuti Sharma
Department of Plant Breeding & Genetics,
JNKVV, Jabalpur (Madhya Pradesh), India.

(Corresponding author: Sunny Thakur)*
(Received: 26 May 2023; Revised: 22 June 2023; Accepted: 16 July 2023; Published: 15 August 2023)
(Published by Research Trend)

ABSTRACT: The goal of the research was to use DUS descriptors to describe 303 green gram germplasm lines. Twenty-one DUS descriptors, including anthocyanin colour at the cotyledonary stage, plant, stem, leaf, flower, pod, and seed traits, were used for evaluation. The fact that 18 out of the 21 descriptors showed variation, demonstrates the usefulness of these descriptors in identifying genotypes and, more importantly, suggests that there is a significant amount of genetic differentiation that can be exploited for the improvement of individual genotypes as well as for protection and identification. The time of flowering, plant growth habits, petiole colour, pod size, seed colour, and seed size are six of the morphological DUS traits that were found to indicate trimorphic variation; eleven characters, such as the anthocyanin coloration of cotyledons, plant habits, stem colour, leaf colour, leaf vein colour, flower colour, pod colour of premature pods, pod position, pod curvature, seed lustre, and seed shape, clearly indicates dimorphic categorization. The genotype diversity for key plant characteristics including plant growth habit and determinate types suggests the use of novel germplasm for improvement utilising these characteristics. The registration with PPV & FRA and seed purity testing may be done using the DUS descriptor data produced with distinctive profiles of the improved genotypes.

Keywords: Characterization, DUS, Diversity, Germplasm, Mungbean, Morphology.

INTRODUCTION

[*Vigna radiata* (L.) Wilczek] (2n=22) or green gram or mungbean is indigenous, self-pollinating plant with a genome size of 579 Mb (Kang *et al*., 2014). Similar to many pulse crops, it binds atmospheric nitrogen into the soil. It is an important source of protein and other nutrients for the vegetarian population of India. Its value among pulse crops has been strengthened by properties such as simple digestion and a low incidence of flatulence induction. India account for the bulk of the world's mungbean, which is grown in almost every state. The mung bean output in India was 2.85 million tonnes, of which 1.48 million tonnes were produced in kharif and 1.37 million tonnes were produced in rabi, accounting for 10 percent of total pulse production (Anonymous, 2022). However, the production is rather sluggish. Numerous biotic and abiotic factors are responsible for these productivity constraints. To surpass the agricultural production plateau and achieve sustained advances, breeders must use a diverse germplasm line for their breeding efforts. Morphological characteristics are used for visual identification and classification of germplasm. In order to limit the use of repeating parents and help breeders in developing better varieties with a broader genetic base, morphological characterisation might be employed to indicate the evolutionary relationships between different lines. However, the amount of germplasm available for utilization by breeders for crop improvement is limited. Lack of germplasm characterization is one reason for this underuse (Thakur *et al*., 2022). Based on phenotypic research, the first easy and cost-effective morphological marker-based polymorphism assessment to quantify diversity has been established. Before combining lines with similar features and employing them in breeding schemes, lines must be described in order to appreciate the intrinsic diversity of the lines (Piyada *et al*., 2010).

As lines are noticeable to the untrained eye during physical purity maintenance, agro-morphological indicators are frequently employed to detect lines. In the age of intellectual property laws, characterisation employing Distinctness, Uniformity, and Stability (DUS) is of crucial concern for the protection of lines in addition to quality seed production and certification (Janghel *et al*., 2020). These descriptors are inexpensive and simple in comparison to complex laboratory approaches. It is vital to establish and evaluate elite line characteristics in order to improve both qualitative and quantitative characteristics. The present experiment was undertaken to describe the mungbean germplasm employing DUS descriptors in order to ascertain the variability characteristics among germplasm and the categorization of genotypes for mungbean improvement. As the commonly acknowledged descriptors for DUS (distinctness, uniformity, and stability) testing and varietal characterisation, morphological characterization is just as important for

varietal identification (Joshi *et al*., 2018). The present research describes the physical characteristics of 303 mungbean lines predicated on DUS descriptors to facilitate their identification and usage in crop improvement programmes.

MATERIALS AND METHODS

During the summer of 2022, 303 mungbean lines, including three check varieties, received from IIPR, Kanpur, Uttar Pradesh, PAU, Ludhiana, Punjab, and JNKVV, Jabalpur, Madhya Pradesh, were evaluated in the fields of Breeder Seed Production Unit at College of Agriculture, Jabalpur. Utilizing Augmented Block Design, the experimental study was conducted. The 303 lines were split into 6 blocks of 50 lines, with 3 checks replicated across all blocks. The row length was 4 metres, and the gap between rows was 30 centimetres and the distance between plants was 10 centimetres.

Table 1: List of Morphological Descriptors according to DUS guideline.

Sr. No.	Descriptors	States	Stage of observation
1.	Hypocotyl: Anthocyanin colouration	Absent	Cotyledons unfolding stage
		Present	
2.	Time of flowering	Early (<40days)	50% flowering
		Medium (40-50 days)	
		Late (>50days)	
3.	Plant: growth habit	Erect	50 % flowering
		Semi erect	
		Spreading	
4.	Plant: habit	Determinate	50 % flowering
		Indeterminate	
5..	Stem: color	Green	50 % flowering
		Green with purple splashes	
		Purple	
6.	Stem: pubescence	Absent	50 % flowering
		Present	
7.	Leaflet: lobes	Absent	50 % flowering
		Present	
8.	Leaf: shape	Deltoid	50 % flowering
		Ovate	
		Lanceolate	
		Cuneate	
9.	Leaf: colour	Green	50 % flowering
		Dark green	
10.	Leaf: vein colour	Green	50 % flowering
		Greenish purple	
		Purple	
11.	Petiole: colour	Green	50 % flowering
		Green with purple splashes	
		Purple	
12.	Flower: colour	Yellow	50 % flowering
		Light yellow	
13.	Pod: colour of premature pod	Green	Fully developed green pods
		Green with pigmented suture	
14.	Pod: pubescence	Absent	Fully developed green pods
		Present	
15.	Pod: position	Above canopy	Fully developed green pods
		Intermediate	
		Not visible	
16.	Pod: size (Mature pod)	Short (<8 cm)	Harvest maturity
		Medium (8-10 cm)	
		Long (>10 cm)	
17.	Pod: curvature of mature pod	Straight	Harvest maturity
		Curved	
18.	Seed: colour	Yellow	Mature seed
		Green	
		Mottled	
		Black	
19.	Seed: lusture	Shiny	Mature seed
		Dull	
20.	Seed: shape	Oval	Mature seed
		Drum	
21.	Seed: size (Based on 100 seed weight)	Small (<3 g)	Mature seed
		Medium (3-5 g)	
		Large (>5 g)	

The data for 21 descriptor characteristics were recorded on 10 randomly chosen plants for each character at certain phases of crop development, i.e., distinct growth stages when the traits under research were fully expressed in each plot, in accordance with the DUS guidelines for green gram (Table 1).

RESULTS AND DISCUSSION

An effort was made to classify the 303 germplasm lines using the 21 criteria listed in the DUS recommendations (PPV&FRA, 2007) and based on the variation of morphological features, 18 of the descriptor attributes exhibited variation, demonstrating the value of these descriptors in distinguishing genotypes. The scoring for various traits is given in Table 3.

Plant characters: Anthocyanin coloration of the hypocotyl, which is seen at the cotyledon unfolding stage, and plant habit combined with growth habit, which were observed at the 50% flowering stage, may be utilized as markers in maintaining and identifying the varietal purity. Hypocotyl anthocyanin was found to be present in 282 genotypes, or 93.07 percent, whereas it was lacking in 21 genotypes. Out of 303 genotypes, 18 or 5.94% had an erect growth habit; 281 or 92.74% were semi-erect types; and only 4 or 1.32% were found to be spreading types. Similar trends were seen in plant habits, where 279 germplasm lines, or 92.08 percent, had indeterminate growth and 24 lines, or 7.92 percent, were of the determinate type. Erect plant kinds are often preferred since they get enough sunlight and are better at producing food for the growth of the plant. Additionally, plants with a determinate growth habit are preferred to indeterminate ones because they encourage synchronous plant maturation. In order to advance development, it is necessary to include these features in new, better genotypes.

Stem characters: At the days to 50% flowering stage, the stem's morphological characteristics, including colour and pubescence, were noted. No difference was observed in the stem pubescence since this trait was noticeable in all the genotypes. The deviation in stem colour was encouraging because 137 genotypes, or 45.21 percent, had green stems with purple splashes while 54.79 percent, or 166 genotypes, had green stem. This indicates that all genotypes are similar for pubescence and therefore this trait is not useful for identification or maintaining purity, but stem colour assessment could be done successfully.

Leaf characters: Given that the plants' leaves serve as both a location for transpiration and a source of food synthesis, these traits have a substantial impact on the genotypes' capacity to produce yield.

With the exception of leaf shape, all of these characteristics were variable and grouped into several categories (Table 1). Leaflet lobes were missing in all of the genotypes. All 303 genotypes had ovate-shaped leaves. In 251 genotypes, the leaf colour was green, and in the remaining 52 genotypes, it was dark green. In 256 genotypes, the leaf vein colour was greenish purple, in 47 genotypes it was green, and in none of the genotypes was purple leaf vein colour observed. Regarding petiole colour, it was found that 47 genotypes had green petioles, 255 or 84.16 percent had petioles with purple splashes, and one genotype had petioles that were purple in colour. The leaf traits—leaf colour, leaf shape, leaf vein colour, and petiole color—showed extremely excellent variation and are helpful in characterizing plants, but since they are polygenically regulated, their vulnerability to environmental influences is quite high.

Flower characters: Flower characteristics, such as colour and time of the flowering, were recorded when the plant was at 50 percent flowering stage. One significant attribute for which there is significant variety is the time of flowering. Early and medium duration classes each included 150 genotypes, or 49.50 percent, of the total genotypes studied, whereas three genotypes belonged to the late flowering type. Flower colour is a trustworthy morphological diagnostic for identifying different genotypes of green gram. Out of the 303 genotypes, 64 or 21.12 percent of the genotypes had yellow flower petals, while 239 genotypes, or 78.88 percent, displayed pale yellow petals. Therefore, in the current material, this feature may be utilized to distinguish between the genotypes. The value of floral features in characterizing green gram germplasm was described by Jain *et al*. (2002).

Pod characters: The features of green gram pods are very helpful in determining the genotypes. At the completely formed green pod stage, the pod characteristics such as premature pod colour, pod pubescence, and pod position were noted, while the size and pod curvature were documented at the maturity stage before harvest (Table 1). These features are regarded as the primary yield-attributing traits since they have an impact on the plant's capacity for seed yield. These characters all had unique traits and belonged to various classes. Since pod pubescence was observed in all genotypes, this feature is of little value in identifying lines in the datasets. In another research, Kaur *et al*. (2017) also noted a similar tendency for this feature. Although pod colour is a useful morphological marker that can be used to track the blending of other varieties in quality seed production programmes, the majority of the lines—261 or 86.14 percent—showed green pods, with the exception of 42 or 13.86 percent genotypes that had green pods with pigmented sutures. Only 27 out of 303 genotypes had intermediate pod positions, making up the bulk of genotypes (91.09%), whose pods were located above the canopy. In the current material, pod length varied as well, with 206 genotypes, or 67.99 percent, having small pods, 96 having medium-length pods, and just one genotype having large pods. Only 61 genotypes possessed curved pods at harvest maturity, whereas the majority of genotypes had straight pods (Table 2). As a result, these pod traits may be used for identification and characterisation, but they are dynamic since a larger number of genes and the environment have an impact on their expression.

Table 2: Frequency distribution for various morphological traits of mungbean germplasm.

Characters	Score	Genotype Frequency	Percentage Contribution (%)
Hypocotyl: Anthocyanin colouration			
Absent	1	21	6.93
Present	9	282	93.07
Time of flowering			
Early	3	150	49.50
Medium	5	150	49.50
Late	7	3	0.99
Plant: growth habit			
Erect	3	18	5.94
Semi erect	5	281	92.74
Spreading	7	4	1.32
Plant: habit			
Determinate	1	24	7.92
Indeterminate	3	279	92.08
Stem: color			
Green	1	166	54.79
Green with purple splashes	2	137	45.21
Purple	3	-	0.00
Stem: pubescence			
Absent	1	-	0.00
Present	9	303	100.00
Leaflet: lobes			
Absent	1	303	100.00
Present	9	.	0.00
Leaf: shape			
Deltoid	1	-	0.00
Ovate	2	303	100.00
Lanceolate	3	-	0.00
Cuneate	4	-	0.00
Leaf: colour			
Green	1	251	82.84
Dark green	2	52	17.16
Leaf: vein colour			
Green	1	47	15.51
Greenish purple	2	256	84.49
Purple	3	-	0.00
Petiole: colour			
Green	1	47	15.51
Green with purple splashes	2	255	84.16
Purple	3	1	0.33
Flower: colour			
Yellow	3	64	21.12
Light yellow	5	239	78.88
Pod: colour of premature pod			
Green	1	261	86.14
Green with pigmented suture	2	42	13.86
Pod: pubescence			
Absent	1	-	0.00
Present	9	303	100
Pod: position			
Above canopy	1	276	91.09
Intermediate	2	27	8.91
Not visible	3	-	0.00
Pod: size			
Short	3	206	67.99
Medium	5	96	31.68
Long	7	1	0.33
Pod: curvature of mature pod			
Straight	1	242	79.87
Curved	3	61	20.13
Seed: colour			
Yellow	1	-	0.00

Green	2	301	99.34
Mottled	3	1	0.33
Black	4	1	0.33
Seed: lusture			
Shiny	1	283	93.40
Dull	2	20	6.60
Seed: shape			
Oval	1	35	11.55
Drum	3	268	88.45
Seed Size			
Small	3	82	27.06
Medium	5	160	52.81
Large	7	61	20.13

Seed characters: The qualities of the seeds, such as colour, lustre, shape, and size, determine a variety's price or customer acceptability (Pratap *et al*., 2018). In contrast to dull, brown, or black and drum-shaped grains; varieties with oval, glossy green grains of medium size are preferred. In the current experiment, at mature seed stage morphological characteristics such as colour, shine, and shape were assessed (Table 1). These characters were divided up into several categories. There were 301 genotypes with green seeds, one with mottled seeds, one with a black seed, and none with yellow seeds. According to studies, yellow seeded genotypes had low phytic acid content and might be utilized as a donor for improving the quality of green gram seeds since seed colour influences the amount of phytic acid in the seed (Tajoddin *et al*., 2011). 283 genotypes had shiny or glossy, whereas 20 genotypes had dull seeds. 35 genotypes had oval seeds, whereas 268 genotypes had drum-shaped seeds. In the current material, it was noted that 61 genotypes had large seeds, 82 genotypes had small seeds, and 160 genotypes had medium seeds. Therefore, seed morphological characteristics serve as excellent indicators for determining purity and identifying seeds. Some of the lines include features in their seeds that have been preferred by consumers, which allows them to sell for higher prices. The importance of seed features in the characterisation of lines in green gram was also covered by Venkateswarlu (2001) and Khajudparn (2011).

Six of the morphological DUS traits observed indicated trimorphic variation, including the time of flowering, plant growth habit, petiole colour, pod size, seed colour, and seed size; eleven characters, including the anthocyanin coloration of cotyledons, plant habit, stem colour, leaf colour, leaf vein colour, flower colour, pod colour of premature pods, pod position, pod curvature, seed lustre, and seed shape, indicated dimorphic grouping. The grouping denotes the presence of a significant amount of genetic diversity in these genotypes, which has a great deal of potential to assign distinctive morphological profiles from a combination of morphological DUS traits. These characteristics could be used for improved line identification and characterization, as well as selection of a variety of parents in a hybridization programme for a more heterotic response and the production of better segregants in mungbean breeding.

Anthocyanin coloration at the cotyledonary stage, plant, leaf, pod, and seed characteristics are having a lot of variability that can be exploited for the genotypes identification and utilisation as reported by Patel *et al*., (2019), and smoothen the process of the easy identification with these distinct characters present in the genotype. In the current investigation, stem pubescence, leaf shape, and pod pubescence are the same in all the lines and are not useful for discrimination. The classification of the germplasm and its effective use in the breeding programme are aided by morphological characterisation.

For the release of variety, NDUS (Novelty, Distinctness, Uniformity, and Stability) are crucial. In order to discover and transmit desirable features to genotypes, morphological characterisation is helpful. The morphological descriptors displayed overlapping expression to varying extents and in varied combinations, but they were nevertheless very useful in determining the genotype identities of all the samples. Rahangdale *et al*. (2023), Joshi *et al*., (2022), Elahi *et al*. (2022), Sabatina *et al*. (2021), and Mounika *et al*. (2020) all reported on similar morphological characteristics.

Table 3: Morphological Characterization of mungbean germplasm with Scoring based on DUS descriptors.

Sr. No.	Entry Name	AC	TF	GH	PH	ST:C	SP	LL	LS	LC	LVC	PC	FC	PPC	PP	PPS	PS	PCMP	SC	SL	SSH	SZ
C1	Virat	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
C2	Shikha	1	3	5	3	1	9	1	2	2	1	1	3	1	9	1	3	1	2	1	3	5
C3	MH421	9	3	5	3	2	9	1	2	1	2	2	3	1	9	1	3	1	2	1	3	5
1	IPM 2-14	9	3	3	3	2	9	1	2	1	1	2	3	1	9	1	3	1	2	1	3	3
2	IPM 512-1	9	3	5	3	2	9	1	2	1	2	2	3	1	9	1	5	3	2	1	3	3
3	KH 2241	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
4	IPM 2K-14-9	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	3
5	IC 314523	1	3	5	3	2	9	1	2	1	2	2	5	1	9	2	3	3	2	1	3	7
6	SML 668	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	7
7	ADT-3	1	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	5
8	MH-3-18	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
9	IC 348964	9	3	5	3	2	9	1	2	1	2	2	3	2	9	1	3	1	2	1	1	7
10	IPM 410-4	1	3	5	3	1	9	1	2	1	1	1	5	1	9	1	3	3	2	1	3	5
11	IPM 99-125	1	5	3	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
12	IPM 205-7	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
13	Taram-2	9	5	5	3	2	9	1	2	2	2	2	3	2	9	2	3	1	2	1	3	5
14	COGG-8	1	3	5	3	1	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	7
15	PUSA 0672	9	5	5	3	2	9	1	2	2	2	1	5	1	9	1	5	1	2	1	3	3
16	IC 314854	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	5
17	OBGG-52	9	3	5	3	1	9	1	2	1	2	1	5	1	9	1	3	3	2	1	3	5
18	RMG-1028	9	3	5	3	1	9	1	2	1	2	1	5	1	9	1	3	1	2	1	3	7
19	PDM-11	9	3	5	3	2	9	1	2	1	1	2	5	1	9	2	3	1	2	1	3	3
20	IC 76499	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	5
21	PUSA 9070	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
22	IPM 2-17	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	1	5
23	MGG 352	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	1	5
24	CO 4	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	5	3	2	1	3	5
25	HUM-16	9	3	5	3	1	9	1	2	1	2	1	5	1	9	1	3	1	2	1	3	7
26	IC 103821	9	3	3	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	3
27	IPM 2-16	9	3	5	3	2	9	1	2	1	2	1	5	1	9	1	3	3	2	1	3	5
28	KM-2241	9	3	3	3	1	9	1	2	1	1	1	5	1	9	1	3	1	2	1	3	5
29	DGGV-2	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	7
30	IC 305291	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
31	TMB 37	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	1	7
32	IPM 312-2	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
33	BDYR-1	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	1	3
34	MH-521	9	3	5	3	1	9	1	2	1	1	2	5	1	9	1	3	1	2	1	1	5
35	IC 305284	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	7
36	PANT MUNG-4	9	5	5	3	1	9	1	2	1	1	2	5	1	9	1	3	1	2	2	3	7
37	IC 314512	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	3
38	COGG-912	9	3	5	3	1	9	1	2	1	1	2	5	1	9	1	3	1	2	1	1	5
39	HUM-1	1	5	5	1	1	9	1	2	1	1	1	5	1	9	1	3	3	2	1	3	5
40	ML-1808	9	5	5	3	1	9	1	2	1	1	1	5	1	9	1	3	1	2	1	3	5

Sr. No.	Entry Name	AC	TF	GH	PH	ST:C	SP	LL	LS	LC	LVC	PC	FC	PPC	PP	PPS	PS	PCMP	SC	SL	SSH	SZ
41	BM 63	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
42	PANT MUNG-6	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
43	IPM 302-2	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	7
44	ML 2570	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
45	IC 121301	9	3	5	3	1	9	1	2	1	2	1	5	1	9	1	3	1	2	1	3	5
46	EC 396399	9	3	7	3	1	9	1	2	1	2	2	5	1	9	1	5	3	2	1	3	7
47	IC 52078	9	3	7	3	1	9	1	2	1	2	1	5	1	9	1	3	3	2	1	3	3
48	IC 73395	9	3	5	3	1	9	1	2	1	2	1	5	1	9	1	5	3	2	1	3	3
49	CHINA MUNG-1	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	5
50	IC 314841	9	5	7	3	1	9	1	2	1	2	2	5	1	9	1	5	3	2	1	3	3
51	IPM 312-20	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
52	OMG-1045(PMR)	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
53	UPM 02-18	9	5	5	3	1	9	1	2	2	2	2	5	1	9	1	3	3	2	1	3	3
54	CO 6	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	7
55	IC 373199	9	3	5	1	1	9	1	2	1	1	2	5	1	9	1	3	1	4	2	3	3
56	IC 488524	9	5	7	1	1	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	7
57	IC 73401	9	5	5	1	1	9	1	2	1	1	1	5	1	9	1	3	1	2	1	3	3
58	IC 417873	1	3	5	1	1	9	1	2	1	1	2	5	1	9	1	5	1	2	1	3	3
59	IC 314419	9	3	3	3	1	9	1	2	1	1	1	5	1	9	1	3	1	2	1	3	3
60	CO 7	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	3
61	IC 314649	9	5	5	3	1	9	1	2	1	2	2	3	2	9	1	3	1	2	1	1	3
62	JBT46/28	9	3	3	3	1	9	1	2	1	2	2	5	1	9	2	3	1	2	1	3	5
63	NARENDRA MUNG-1	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	3
64	IC 56112	9	5	5	1	1	9	1	2	2	2	2	5	1	9	1	5	1	2	1	3	3
65	LGG-460	9	5	5	3	1	9	1	2	2	2	2	3	1	9	1	5	3	2	1	3	5
66	GM-4	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	3
67	IC 314568	1	5	5	1	1	9	1	2	2	2	2	5	1	9	1	3	3	2	1	3	5
68	CO 8	1	5	5	3	2	9	1	2	1	2	2	5	1	9	1	5	3	2	2	3	7
69	IC 314595	9	3	5	1	1	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	5
70	IC 15567	1	3	3	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	2	3	3
71	IC 282141	9	3	5	1	1	9	1	2	2	2	2	5	1	9	1	3	3	2	1	3	5
72	MH-2-15	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	3
73	PDM 54	9	3	5	3	1	9	1	2	1	2	2	5	1	9	2	3	1	2	1	1	3
74	IC 119020	9	5	5	1	1	9	1	2	2	2	2	5	1	9	1	3	1	2	2	3	3
75	IC 394000	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
76	ASHA MUNG	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	3
77	JALORE LOCAL	1	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	3	2	2	3	5
78	IPM 06-5	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	5	3	2	1	3	3
79	EC 520041	9	3	5	3	1	9	1	2	1	2	1	5	1	9	1	3	3	2	2	3	7
80	ML 818	9	3	5	3	1	9	1	2	2	2	2	5	1	9	1	3	1	2	1	3	5
81	IC 119033	9	3	5	1	1	9	1	2	1	2	1	5	1	9	1	3	3	2	1	3	5
82	IC 314697	9	3	5	1	1	9	1	2	1	2	1	5	1	9	1	3	1	2	2	3	7
83	SML 32	9	5	5	3	1	9	1	2	1	2	1	5	1	9	1	3	1	2	2	3	5
84	SML 134	9	5	5	3	1	9	1	2	2	2	2	5	1	9	1	5	3	2	1	3	7
85	SML 832	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	3

Sr. No.	Entry Name	AC	TF	GH	PH	ST:C	SP	LL	LS	LC	LVC	PC	FC	PPC	PP	PPS	PS	PCMP	SC	SL	SSH	SZ
86	SML 11781	9	5	3	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
87	SML 1817	9	5	3	3	1	9	1	2	2	2	2	5	1	9	1	5	1	2	1	3	7
88	SML 1820	9	5	5	3	2	9	1	2	2	2	2	5	1	9	1	5	1	2	1	3	5
89	SML 1822	9	3	3	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
90	SML 1825	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	5
91	SML 1827	9	5	5	3	1	9	1	2	2	1	2	5	1	9	1	3	1	2	1	3	5
92	SML 1829	9	5	5	3	1	9	1	2	2	2	2	5	1	9	1	3	1	2	1	3	7
93	SML 1831	9	3	5	3	1	9	1	2	1	2	1	5	1	9	1	3	1	2	1	3	5
94	SML 1839	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	7
95	SML 1901	9	3	5	3	1	9	1	2	2	2	1	5	1	9	1	3	1	3	1	1	5
96	SML 1918	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	1	5
97	SML 1921	9	5	3	3	1	9	1	2	2	2	1	5	1	9	1	5	1	2	1	3	5
98	SML 1922	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
99	SML 1927	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
100	SML 1932	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
101	SML 1933	9	3	5	3	1	9	1	2	2	2	2	3	2	9	1	5	1	2	1	3	7
102	SML 2032	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	1	5
103	SML 2015	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
104	SML 2016	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
105	SML 2031	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	3
106	SML 2033	9	5	5	3	1	9	1	2	1	1	2	5	1	9	1	3	1	2	1	3	3
107	SML 2082	9	5	5	3	1	9	1	2	1	2	2	3	2	9	1	5	1	2	1	3	3
108	SML 2084	9	3	5	3	1	9	1	2	1	2	1	3	2	9	1	3	1	2	1	3	5
109	SML 2085	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
110	SML 2086	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	1	3
111	SML 2088	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	5	3	2	1	3	5
112	SML 2102	9	3	5	3	1	9	1	2	1	2	2	5	2	9	1	3	3	2	1	3	3
113	SML 2103	9	3	5	3	1	9	1	2	1	2	1	5	1	9	1	5	1	2	1	3	5
114	SML 2104	9	3	5	3	1	9	1	2	1	2	1	5	1	9	1	5	3	2	1	3	3
115	SML 2107	9	3	5	3	1	9	1	2	1	2	2	3	2	9	1	5	1	2	1	3	3
116	SML 2108	9	5	5	3	1	9	1	2	1	2	1	3	2	9	1	5	1	2	1	3	3
117	SML 2112	9	5	5	3	1	9	1	2	1	1	2	5	1	9	1	3	1	2	1	3	3
118	SML 2114	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	3
119	SML 2116	9	3	5	3	2	9	1	2	1	2	2	3	2	9	1	3	3	2	1	3	3
120	SML 2117	9	3	5	3	2	9	1	2	1	1	2	3	2	9	1	3	1	2	1	3	3
121	SML 2119	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	1	5
122	SML 2120	9	3	5	3	2	9	1	2	1	1	2	5	1	9	1	3	1	2	1	3	3
123	SML 2121	9	3	5	3	1	9	1	2	1	1	1	5	1	9	1	3	1	2	1	3	5
124	SML 2122	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	5
125	SML 2130	9	3	5	3	1	9	1	2	1	2	2	3	2	9	1	3	3	2	1	3	3
126	SML 2132	9	5	5	3	2	9	1	2	1	2	2	3	2	9	1	5	1	2	1	1	7
127	SML 2135	9	3	5	3	2	9	1	2	1	2	2	3	2	9	1	5	3	2	1	3	3
128	SML 2142	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
129	SML 2147	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
130	SML 2159	9	3	5	3	1	9	1	2	1	2	1	5	1	9	1	3	1	2	1	3	5

Sr. No.	Entry Name	AC	TF	GH	PH	ST:C	SP	LL	LS	LC	LVC	PC	FC	PPC	PP	PPS	PS	PCMP	SC	SL	SSH	SZ
131	SML 2160	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	1	5
132	SML 2166	9	3	5	3	1	9	1	2	1	2	1	5	1	9	1	5	1	2	1	1	5
133	SML 2168	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	7
134	SML 2169	9	3	5	3	1	9	1	2	1	1	1	5	1	9	1	5	1	2	1	3	5
135	SML 2171	9	3	5	3	1	9	1	2	1	2	2	3	2	9	1	5	1	2	1	3	5
136	SML 2191	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	1	5
137	SML 2192	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	7
138	SML 2206	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	3
139	SML 2208	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	3
140	SML 2209	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
141	SML 2213	9	3	5	3	1	9	1	2	1	2	2	3	2	9	1	3	3	2	1	3	5
142	SML 2215	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
143	SML 2216	9	3	5	3	1	9	1	2	1	2	1	5	1	9	1	3	1	2	1	3	5
144	SML 2217	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	3
145	SML 2219	9	5	5	3	1	9	1	2	1	2	2	3	2	9	1	3	1	2	1	3	7
146	SML 2221	9	5	5	3	1	9	1	2	2	1	1	5	1	9	1	3	1	2	1	3	3
147	SML 2226	9	5	5	3	1	9	1	2	1	1	1	5	2	9	1	3	1	2	1	3	3
148	SML 2248	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	1	5
149	SML 2249	9	3	5	3	1	9	1	2	2	1	2	3	2	9	1	5	1	2	1	3	5
150	SML 2255	9	5	5	3	1	9	1	2	2	1	2	3	2	9	1	3	1	2	1	3	3
151	PUSA 9531	9	3	5	3	1	9	1	2	2	1	2	5	1	9	1	5	1	2	1	3	3
152	PUSA 1501	9	5	5	3	1	9	1	2	1	2	2	3	1	9	1	5	1	2	1	3	7
153	PUSA 1502	9	3	5	3	1	9	1	2	1	2	2	3	1	9	1	3	3	2	1	3	5
154	IPM 02-3	9	3	5	3	1	9	1	2	1	2	2	3	1	9	1	5	1	2	1	3	5
155	IPM 205-4	9	3	5	3	1	9	1	2	1	2	1	5	1	9	1	5	3	2	1	3	5
156	IPM 207-7	9	3	5	3	1	9	1	2	2	1	1	5	1	9	1	5	3	2	1	3	5
157	MH 565	9	5	5	3	2	9	1	2	1	1	2	5	1	9	1	5	1	2	1	3	7
158	MH 1142	9	3	5	3	1	9	1	2	1	2	1	5	1	9	1	3	1	2	1	1	5
159	MH 1315	9	5	5	3	1	9	1	2	1	1	2	5	1	9	1	3	1	2	1	3	7
160	MH 1703	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	5
161	TMB163	9	5	5	3	1	9	1	2	2	2	2	5	1	9	1	3	1	2	1	1	5
162	TMB 196	9	5	5	3	1	9	1	2	1	2	1	5	1	9	1	3	1	2	1	3	5
163	PANT MUNG-5	9	5	5	3	1	9	1	2	1	1	2	5	1	9	1	3	1	2	1	3	3
164	PUSA BAISAKHI	9	5	5	3	1	9	1	2	1	2	2	5	1	9	2	3	1	2	1	3	5
165	PUSA RATNA	9	5	5	3	1	9	1	2	1	2	2	5	1	9	2	3	1	2	1	3	5
166	PS-16	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
167	PUSA 1053	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	7
168	PUSA 1133	9	5	5	3	2	9	1	2	2	2	2	3	2	9	1	5	1	2	1	1	5
169	IPM 02-17	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
170	IPM 288	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	3
171	IPM 409-4	9	5	5	3	1	9	1	2	1	1	2	5	1	9	1	3	1	2	1	3	3
172	TM 96-25	9	5	5	1	1	9	1	2	1	2	1	5	1	9	1	3	3	2	1	3	5
173	EC 398885	1	3	3	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	2	3	3
174	EC 398891	9	3	3	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
175	EC 520026	9	3	5	1	2	9	1	2	1	2	2	3	2	9	1	3	1	2	1	3	5

Sr. No.	Entry Name	AC	TF	GH	PH	ST:C	SP	LL	LS	LC	LVC	PC	FC	PPC	PP	PPS	PS	PCMP	SC	SL	SSH	SZ
176	EC 520029	1	3	5	1	2	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	5
177	EC 520038	9	3	5	1	2	9	1	2	2	1	2	5	1	9	1	5	1	2	1	3	5
178	VGG-15-030	1	3	3	3	2	9	1	2	1	1	2	5	1	9	1	5	1	2	1	3	5
179	SM-11-75	9	3	5	1	2	9	1	2	1	2	2	3	2	9	1	5	1	2	1	3	3
180	M-209	9	5	3	3	2	9	1	2	2	2	2	5	1	9	1	3	3	2	1	3	5
181	V-1138	9	5	5	1	1	9	1	2	1	2	2	5	1	9	2	3	3	2	1	3	5
182	BM-GP-1	9	5	5	1	1	9	1	2	1	2	2	3	1	9	1	5	1	2	1	3	7
183	TJM 37	9	5	5	3	2	9	1	2	1	2	2	3	1	9	1	5	1	2	1	3	5
184	AKM-8801	9	5	5	3	1	9	1	2	2	2	2	5	1	9	1	3	3	2	1	3	5
185	ML-1907	9	5	5	3	1	9	1	2	1	2	2	3	2	9	1	3	1	2	1	1	5
186	AKM-10-13	1	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	3
187	TJM-3	9	3	5	3	2	9	1	2	2	2	2	3	1	9	1	3	1	2	1	3	5
188	DGG-5	9	3	5	3	2	9	1	2	2	2	2	5	1	9	1	5	1	2	1	3	3
189	IPM-410-3	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	7
190	BM 4 X MH 421	9	3	5	3	2	9	1	2	1	1	2	3	1	9	1	3	3	2	1	3	5
191	PUSA 9072 X MH 521	9	3	5	3	1	9	1	2	1	2	2	3	2	9	1	3	1	2	1	3	5
192	IPM 409-4 X IPM 02-3	9	5	5	3	2	9	1	2	2	1	2	3	1	9	1	3	1	2	1	3	3
193	IPDM 1604	9	5	5	3	1	9	1	2	1	2	2	5	1	9	2	3	1	2	1	3	5
194	IPM 1603-1	9	3	5	3	2	9	1	2	2	2	2	3	2	9	1	5	1	2	1	3	5
195	TBMB 117-5	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
196	IPDM 101-2	9	5	5	3	1	9	1	2	1	2	1	5	1	9	2	3	1	2	1	3	5
197	PUSA M 2131	9	5	5	3	2	9	1	2	1	2	2	3	2	9	1	3	1	2	1	3	5
198	IPM 1103-1	9	5	5	3	1	9	1	2	2	1	2	3	2	9	1	3	1	2	1	3	3
199	TCADM20-5	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	3
200	IPM 140-3	9	3	5	3	2	9	1	2	2	2	2	5	1	9	1	5	3	2	1	3	3
201	MHBC 20-7	9	3	3	3	1	9	1	2	1	2	2	3	2	9	1	3	1	2	1	3	3
202	PM 504-20-27	9	3	5	3	2	9	1	2	2	1	2	3	2	9	1	3	1	2	1	3	3
203	TBMB 17-2	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	1	3
204	PUSA BM 16	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	3
205	PM 1624	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	3
206	IPM 1610-1	9	3	5	3	2	9	1	2	2	2	2	3	2	9	1	3	1	2	1	3	3
207	PUSA M 2132	9	3	5	3	2	9	1	2	2	2	2	5	1	9	1	3	1	2	1	3	3
208	MH 1830	9	3	5	3	1	9	1	2	2	2	2	5	1	9	1	3	1	2	1	3	7
209	RMG 1132	9	3	5	3	2	9	1	2	2	2	2	5	1	9	1	3	1	2	1	3	5
210	RMG 1166	9	3	5	3	1	9	1	2	1	2	2	3	2	9	1	3	1	2	1	3	3
211	MH 1871	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
212	MH 1890	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
213	PMD 10	9	3	5	3	2	9	1	2	1	2	2	3	2	9	1	5	1	2	1	3	5
214	PUSA M 2142	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	3
215	OBGG 106	9	3	5	3	2	9	1	2	2	2	2	3	2	9	1	3	1	2	1	1	3
216	PUSA M 2141	9	3	5	3	1	9	1	2	1	2	2	3	2	9	1	5	1	2	1	3	5
217	ANDGG 1301	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
218	MHBC 20-3	9	3	5	3	2	9	1	2	1	1	2	5	1	9	1	3	1	2	1	3	3
219	PMD 7	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
220	OBGG 105	9	3	5	3	1	9	1	2	1	2	2	3	2	9	1	5	1	2	1	1	7

Sr. No.	Entry Name	AC	TF	GH	PH	ST:C	SP	LL	LS	LC	LVC	PC	FC	PPC	PP	PPS	PS	PCMP	SC	SL	SSH	SZ
221	VGG 17-036	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
222	KM 2419	9	3	5	3	1	9	1	2	1	2	1	5	1	9	1	3	1	2	1	3	5
223	PMD 9	9	3	5	3	2	9	1	2	2	2	2	5	1	9	1	5	1	2	1	3	5
224	MML 2576	9	5	5	3	2	9	1	2	2	2	2	5	1	9	1	5	1	2	1	3	5
225	SKNM 1911	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
226	VGG 17-019	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	7
227	MH 1801	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	3
228	PMD 8	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
229	PUSA 105	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
230	PDM 139	9	3	5	1	2	9	1	2	1	2	1	5	1	9	2	3	1	2	1	1	3
231	AKM 8802	9	5	5	3	2	9	1	2	2	2	2	5	1	9	1	3	1	2	1	3	5
232	ML-1464	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
233	ML-2037	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
234	PUSA 9072	9	5	5	3	2	9	1	2	1	2	2	3	1	9	1	3	1	2	1	3	7
235	PUSA 1033	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
236	PLM 167	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
237	PUSA VISHAL	9	3	5	1	2	9	1	2	1	2	1	3	1	9	1	7	1	2	1	3	7
238	IPM 02-19	9	7	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
239	DPM 2015-4	1	5	5	3	2	9	1	2	2	2	2	5	1	9	1	3	1	2	1	3	3
240	ML-2236	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	2	3	5
241	MH-96-1	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	2	3	5
242	BHUTAN LM-95	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
243	IPM 406-1	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
244	PUSA 1010	9	5	5	3	2	9	1	2	2	2	2	5	1	9	1	3	1	2	1	3	5
245	PUSA 1271	9	5	5	3	2	9	1	2	1	1	2	5	1	9	1	3	1	2	1	3	7
246	RMG-1087	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	2	3	5
247	AKM 9904	9	3	5	3	1	9	1	2	2	2	2	5	1	9	1	5	1	2	1	3	3
248	MH- 805	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
249	SML 1082	1	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
250	BMGD-1	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	1	5
251	COGG-0912	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
252	PRAKASH NEPAL	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	7
253	GANGA 8	9	5	5	1	2	9	1	2	1	2	2	3	1	9	1	3	1	2	1	3	7
254	BM 2012-9	9	7	5	3	2	9	1	2	2	1	1	5	1	9	1	3	1	2	2	3	5
255	IPM-512-1	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
256	V- 3518	9	7	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	7
257	PANT MUNG 2	9	5	5	3	2	9	1	2	1	1	2	5	1	9	1	3	1	2	1	3	7
258	EC 520024	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	5
259	SSL 668	9	3	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
260	TJM-115	9	5	5	3	2	9	1	2	1	1	2	3	2	9	1	5	1	2	2	3	7
261	TJM-141	9	3	5	1	2	9	1	2	2	1	2	3	2	9	1	3	3	2	2	1	7
262	TJM-146	9	3	5	3	2	9	1	2	2	2	2	3	2	9	2	5	1	2	1	3	7
263	TJM-111	9	3	5	3	1	9	1	2	1	2	1	3	1	9	2	5	1	2	1	1	7
264	TJM-196	9	5	5	3	2	9	1	2	1	2	2	3	1	9	2	3	1	2	1	1	7
265	TJM-124	9	5	5	1	2	9	1	2	1	2	2	3	1	9	2	3	1	2	2	3	5

Sr. No.	Entry Name	AC	TF	GH	PH	ST:C	SP	LL	LS	LC	LVC	PC	FC	PPC	PP	PPS	PS	PCMP	SC	SL	SSH	SZ
266	TJM-123	9	5	5	3	2	9	1	2	1	2	2	3	1	9	1	3	1	2	1	3	5
267	TJM-137	9	3	5	3	1	9	1	2	2	2	2	3	2	9	2	5	1	2	1	3	5
268	TJM-140	9	3	5	3	2	9	1	2	1	2	2	3	1	9	2	3	1	2	1	1	7
269	TJM-155	1	3	5	3	2	9	1	2	1	2	2	3	1	9	2	3	1	2	1	3	7
270	TJM-160	9	3	5	3	1	9	1	2	2	1	2	3	2	9	2	5	1	2	1	3	5
271	TJM-143	9	3	5	3	1	9	1	2	1	2	2	3	2	9	1	5	1	2	1	3	7
272	TJM-136	9	5	5	3	2	9	1	2	1	2	2	3	1	9	1	3	1	2	2	3	5
273	AKM 10-7	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	3
274	SGC 20	9	5	3	3	2	9	1	2	2	2	2	5	1	9	1	3	3	2	1	3	3
275	TBM-45	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	3
276	IPM 312-19	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
277	MUNG LOCAL NASURULLAGANJ	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	7
278	TBM 36	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	3
279	CM-11-02	9	5	3	3	2	9	1	2	1	2	2	5	1	9	2	3	1	2	1	3	3
280	DGG-6	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	7
281	ML1299	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	7
282	ML 2333	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
283	RMG 1004	9	5	5	3	2	9	1	2	1	2	1	5	1	9	1	3	1	2	1	1	5
284	SATYA	9	5	5	3	2	9	1	2	1	2	2	5	1	9	2	3	3	2	1	3	5
285	UNNATI	9	5	5	3	2	9	1	2	1	1	2	5	1	9	2	3	1	2	2	3	7
286	IPM 312-86K-1	9	3	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	3	7
287	TKMC-2-2-1	1	5	5	3	1	9	1	2	1	1	1	5	1	9	2	3	1	2	2	3	7
288	MH 911	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	7
289	KM 2328	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	5	1	2	1	1	7
290	KM 2342	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	5
291	PM-11-20	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	3
292	PM-11-27	9	5	5	3	1	9	1	2	1	2	2	5	1	9	1	3	1	2	1	1	5
293	PUSA 1472	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	3	2	1	3	5
294	NDMK 14-24	9	3	5	3	2	9	1	2	1	2	2	5	1	9	2	5	1	2	1	3	5
295	PUSA 1471	9	5	5	3	2	9	1	2	1	2	2	5	1	9	2	3	1	2	1	3	5
296	NVL 825	9	3	5	3	1	9	1	2	1	2	2	5	1	9	2	3	1	2	1	3	5
297	ML 1907	1	5	5	3	1	9	1	2	1	1	1	5	1	9	1	3	1	2	1	3	5
298	TM 96-2	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	7
299	PM-09-11	9	5	5	3	2	9	1	2	1	2	2	5	1	9	1	3	1	2	1	3	7
300	WBSM 48-5	9	5	5	3	2	9	1	2	1	2	2	3	1	9	2	5	1	2	1	3	7

Where,
AC=hypocotyl: anthocyanin colouration, TF= time of flowering, GH= plant: growth habit, PH= plant: habit, ST:C= stem:color, SP= stem:pubescence, LL= leaflet:lobes, LS= leaf:shape, LC=leaf:color, LVC=leaf:veincolor, PC= petiole:color, FC= flower color, PPC=pod color of premature pod, PP= pod pubescence, PPS= pod position, PS= pod size, PCMP= pod curvature of mature pod, SC=seed color, SL= seed lusture, SSH= seed shape, SZ= seed size.

CONCLUSIONS

The findings of the morphological characterisation carried out in accordance with the DUS recommendations assisted in the accurate genotype categorization. Based on the results of this research, it can be said that the germplasm has a significant degree of variety for features including flowering time, plant growth habit, petiole colour, pod size, seed lustre, seed colour, and seed size. Marketable consumer features include seed colour, seed size, and seed shape. After determining the stability and heritability of the features, genotypes with this morphology may be chosen as donors in a crossing procedure.

FUTURE SCOPE

To determine the environmental effect on the morphology and their future use in crop development programmes, heritability estimates and other genetic parameters for traits like time of flowering, pod size, and seed size may be calculated.

The creation of core collections at gene banks may be successful in increasing the accessibility of germplasm to breeders.

Marker-based identification and DUS characterisation of mungbean germplasm may aid in preserving the integrity of varieties for long-term gain for both farmers and consumers.

Acknowledgement. The authors are thankful for the support and suggestions provided by the faculty of Department of Plant Breeding and Genetics, College of Agriculture, Jabalpur, JNKVV, Madhya Pradesh.

Conflict of Interest. The authors declare no competing interest.

REFERENCES

Anonymous (2022). Third advance estimates of production of food grains for 2021-22. Directorate of Economsics and Statistics, Department of Agriculture and Farmers Welfare.

Elahi, T., Shukla, R. S., Singh, S.K. and Kumar, P. (2022). Study of Morphological Breeding Traits in Mungbean [*Vigna radiata* (L.) Wilczek] Genotypes as per DUS Guidelines. *Biological Forum – An International Journal*, *14*(1), 976-981.

Jain, S. K., Khare, D., Bhale, M. S. and Raut, N. D. (2002). Characterization of mung bean varieties for verification of genetic purity. *Seed Tech News*, *32*, 200-201.

Janghel, D. K., Kumar, K., Sunil, R. and Chhabra, A. K. (2020). Genetic Diversity Analysis, Characterization and Evaluation of Elite Chickpea (*Cicer arietinum* L.) Genotypes. *International Journal Current Microbiology Applied Science*, *9*(1), 199-209.

Joshi, D., Parmar, L. D., Kumar, R and Patel, L. D. (2022). Morphological Diversity and characterization of Mungbean (*Vigna radiata* L. Wilczek) Genotypes using Distinctiveness, Uniformity and Stability Descriptors. *Biological Forum – An International Journal*, *14*(2), 1102-1110.

Joshi, M. A., Aggarwal, D. and Sanyal, A. (2018). Cultivar identification and diversity analysis based on morphological descriptors and image analysis in chickpea (*Cicer arietinum* L.). *Legume Research-An International Journal*. *41*(5), 647-55.

Kang, Y. T., Kim, S. K. and Lee, S. H. (2014). Genome sequence of mungbean and insight into evolution within Vigna species. *Nature communication. 5*, 1-9.

Kaur, R., Toor, A. K., Geeta, B. and Bains, T. S. (2017). Characterization of mungbean (*Vigna radiata* L. Wilczek) varieties using morphological and molecular descriptors. *Int. J. Curr. Microbiol. App. Sci. 6*, 1609-1618.

Khajudparn, P. and Tantasawat, P. (2011). Relationships and variability of agronomic and physiological characters in mungbean. *African J. Biotechnol.*, *10*, 9992-10000.

Mounika, S., Ramana, J. V., Ahamed, M. L. and Ratna Babu, D. (2020). Morphological Characterization of Greengram Germplasm using DUS Descriptors. *Int. J. Curr. Microbiol. App. Sci.*, *9*(9), 1701-1711.

Patel, J. D., Patel, J. B. and Chetariya, C. P. (2019). Characterization of mungbean (*Vigna radiata* (L.) Wilczek) genotypes based on plant morphology. *Indian J. Pure and App. Biosci. 7*, 433-443.

Piyada, T., Juthamas, T., Thongchai, P., Thanawit, T., Chutamas, P., Worapa, S. and Thitiporn, M. (2010). Variety identification and genetic relationships of mungbean and blackgram in Thailand based on morphological characters and ISSR analysis. *African J. Biotechnology*, *9*, 4452-4464.

Pratap, A., Malviya, N., Gupta, S., Tomar, R., Pandey, V.R. and Prajapati, U. (2018). Field characterization of endemic wild *Vigna* accessions collected from biodiversity hotspots of India to identify promising genotypes for multiple agronomic and adaptive traits. *Legume Research, 41*, 490-499.

Protection of Plant Varieties and Farmers' Rights Authority (PPV & FRA). (2007). Guidelines for the Conduct of Test for Distinctness, Uniformity and Stability on Green gram (*Vigna radiata (*L.*)* Wilczek).

Rahangdale, S., Lakhani, J. P., Singh, S. K. and Barela, A. (2023). Phenotyping and novel traits in mungbean (*Vigna radiata* L. Wilczek) genotypes. *South African Journal of Botany, 156*, 65-71.

Sabatina, S., Ahamed, M. L., Ramana, J. V. and Harisatyanarayana, N. (2021). DUS Characterization of Elite Improved Lines of Greengram [*Vigna radiata* (L.) Wilczek]. *Int. J. Curr. Microbiol. App. Sci.*, *10*(01), 3380-339.

Tajoddin, M., Shinde, M. and Lalitha, J. (2011). Phytic acid and mineral content of mungbean cultivars. *Journal of Food Legumes*, *24*, 163-164.

Thakur, S., Mishra, G., Pachori, S. and Babbar, A. (2022). Characterization of Morphological Traits and Diversity Assessment of Desi Chickpea (*Cicer arietinum* L.) Lines. *Biological Forum – An International Journal*, *14*(1), 481-486.

Venkateshwarlu, O. (2001). Correlation and path analysis in greengram. *Legume Research*, *24*, 115-117.

How to cite this article: Sunny Thakur and Stuti Sharma (2023). Assessment of Mungbean Germplasm through Morphological Characterization using DUS Criteria. *Biological Forum – An International Journal*, *15*(8): 77-89.