



## Morphological observation and characterisation through dus in green gram (*Vigna radiata*. L) genotypes

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### Abstract

A field study was conducted to observe the DUS characters of 20 green gram (*Vigna radiata* L. Wilzeck) genotypes, during *rabi* season of 2019 at Varagoorpettai village and in Sivapuri Village during 2020, near Annamalai University (T.N), India. The present study was laid out in Randomized Block Design with three replications. The anthocyanin colouration was present in all 20 genotypes. Based on time of flowering, the genotypes were grouped as early (15 genotypes) and medium (5 genotype). Time of flowering varied with the genotype 30.15 days with (Chidambaram Local-1) to 44.33 days (DGGV 7) with an average of 37.84 days. Flower colour of petal was yellow in Maruvathur Local-1 while it was light yellow in 19 genotypes. Based on plant growth habit, the genotypes were grouped as erect (6 genotypes), semi erect (6 genotypes) and spreading (8 genotypes). Based on the plant habit, genotypes were grouped as indeterminate (16 genotypes) and determinate with (4 genotypes). Based on petiole colour, the genotypes were grouped as green (4 genotypes) and green with purple with (16 genotypes). Based on plant height, was long in DGGV 2 (73.57 cm), TAP 7 (73.47 cm), MH 421 (73.47 cm), CO 1(73.43 cm), Maruvathur Local-1 (72.33 cm) and Pusa Vishal (70.43 cm) and the lowest plant height was observed in ADT 3(51.47 cm). Based on stem morphology, stem colour was green (13 genotypes), whereas it was observed green with purple in (7 genotypes). All the 20 green gram genotypes evaluated did not show any variation for stem pubescence. Based on leaf morphology, the genotype Pusa Vishal was distinct genotype. On the basis of pod morphological characteristics, genotypes Maruvathur Local-1, KM 2, DGGV 2 were distinct. Seed colour was brown and seed lusture was shiny in 20 genotypes. For seed shape it was drum shape in (9 genotypes) and oval shape seeds in 11 genotypes.

**Keywords:** DUS, green gram, morphology and variability

### Introduction

Green gram (*Vigna radiata*. L Wilczek) ( $2n=22$ ) is a major pulse crop and called as “Queen of pulses”. It is originated from Southeast Asia and it is a rainy season autogamy crop cultivated in tropics and subtropics. The United Nations, declared 2016 as “International Year of Pulses” (IYP) to heighten public awareness of the nutritional benefits of pulses as part of sustainable food production aimed at food security and nutrition (Poehlman, 1991) [16]. Mungbean are primarily grown for the protein rich edible seeds as foods due to easy digestibility by human, to most of the vegetarian population.

The seeds, sprouts and young pods of mungbean are consumed broadly as sources of protein (26%), amino acids, vitamins (3%) and minerals (4%) and plant parts are used as fodder and green manure (Khan, 1981). In adding up, it is a good complementary food for rice-based diets due to low fat, high fibre and high protein specifically high lysine, the first limiting amino acids, content ( $504 \text{ mg g}^{-1}$ ) (Chen *et al.*, 1987; Saini *et al.*, 2010) [6, 17]. Mung bean has a lively role in atmospheric nitrogen fixation in the root nodules through rhizobium bacterium thereby improving its soil physical properties by sustaining the soil fertility.

The production of mungbean in India is about 10.13 MT during 2018-2019 and yield is about 1073 kilogram per hectare. Then the total production of pulses in India is 23.40 MT and yield is about 806 kg per hectare. In Tamilnadu, total pulse production is about 0.57 MT and yield is 806 kg

per hectare (Agricultural Statistics at a Glance, 2019) [1]. The legally recognized traditional method in India for cultivar identification and genetic purity assessment is based on field plot or Grow out test (GOT) including only the morphological characteristics of a variety. Such methods have been highly successful and efficient. Understanding its prominence, the development of DUS descriptors of green gram has necessitated differentiating the varieties from each with the objective to register the varieties with PPV and FR Authority, New Delhi.

A variety is identified on the basis of a set of morphological characteristics differing from other known varieties of that species. Therefore, present study was undertaken to develop DUS test guidelines required for describing a variety assessing the level of uniformity of characteristics and stability of expression of those mung bean varieties. Many research and activities have been carried in green gram based on DUS characters. This will be useful and effective in utilization of green gram genetic resources for DUS testing and further crop improvement.

### Materials and Methods

A total of 20 green gram genotypes was collected from different resources are given in (Table 1). Twenty varieties were grown in Randomized Block Design with three replications during the *rabi* season of 2019 at Varagoorpettai Village and in Sivapuri Village during 2020, Near Annamalai University, Tamil Nadu. The study was

laid down in Randomized Block Design (RBD) with 20 green gram genotypes at a spacing of 45 cm between rows and 15 cm between plants. Observations, were recorded on five randomly selected plants of each genotypes per replication for 23 morphological traits according to the

National test guidelines for DUS test in green gram (Table 2).

Data were recorded at different plant morphological characters with appropriate procedures and the genotypes were grouped.

**Table 1:** List of green gram genotypes used for study

Genotypes	Name of the Genotypes	Geographical Location
G1	Chidambaram Local-1	Chidambaram, Tamil Nadu
G2	Maruvathur Local-1	Thanjavur, Tamil Nadu
G3	Kambam Local-1	Theni, Tamil Nadu
G4	Paiyur 1	Regional Research Station, Paiyur
G5	ADT 2	TNAU, Coimbatore
G6	ADT 3	TNAU, Coimbatore
G7	VBN 2	National Pulse Research Centre, Vamban
G8	VBN 3	National Pulse Research Centre, Vamban
G9	CO 1	TNAU, Coimbatore
G10	CO 2	TNAU, Coimbatore
G11	CO 7	TNAU, Coimbatore
G12	CO 8	TNAU, Coimbatore
G13	VRM 1	TNAU, Coimbatore,
G14	KM 2	TNAU, Coimbatore,
G15	DGGV 2	UAS, Dharwad
G16	DGGV 7	UAS, Dharwad
G17	Pusa Vishal	IARI, New Delhi
G18	AKM 8803	Pulse Research Unit, Akola
G19	Tap 7	Pulse Research Unit, Akola
G20	MH – 421	HAU, Haryana

**Table 2:** DUS guidelines for green gram genotypes

S. No	Characteristics	Stages of observation	States
1.	Anthocyanin colour on hypocotyls	Cotyledons unfolded	Absent/Present
2.	Time of flowering	At 50% plants with at least one open flower	Early(<40days)/Medium (40-50days) / Late (>50 days)
3.	Plant growth habit	At 50% flowering	Erect / Semi Erect/ Spreading
4.	Plant habit	At 50% flowering	In-determinate / Determinate
5.	Stem colour	At 50% flowering	Green / Green with purple splashes/purple
6.	Stem pubescence	At 50% flowering	Absent /Present
7.	Leaflet lobes	At 50% flowering	Absent /Present
8.	Leaf shape	At 50% flowering	Deltoid/Ovate/Lanceolate/Cuneate
9.	Leaf colour	At 50% flowering	Green/Dark green
10.	Vein colour	At 50% flowering	Green/Greenish purple/Purple
11.	Petiole colour	At 50% flowering	Green/Green with purple splashes / Purple
12.	Leaf size	At 50% flowering	Small/Medium/Large
13.	Flower (Standard petal) colour:	At 50% flowering	Yellow/Light Yellow
14.	Plant height	Fully developed green pods	Dwarf/(<50cm) /Medium/(50cm)/ Tall/ (<70 cm)
15.	Pod -colour of premature pod	Fully developed green pods	Green / Green with pigmented sutures
16.	Pod pubescence	Fully developed green pods	Absent/Present
17.	Pod position	Fully developed green pods	Above canopy/Intermediate/ Not Visible
18.	Pod Colour	Harvest maturity	Brown/Black
19.	Pod -curvature of mature pod	Harvest maturity	Straight/ Curved
20.	Pod length	Harvest maturity	Short (<8cm)/ (Medium 8- 10cm)/Long(>10cm)
21.	Seed colour	Mature seeds	Green/Yellow/Mottled
22.	Seed coat lusture	Mature seeds	Shiny/Dull
23.	Seed shape	Mature seeds	Oval/Drum Shaped

## Result and Discussion

### Anthocyanin colouration

The anthocyanin coloration was observed at the cotyledons unfolded stage and the presence of anthocyanin was recorded in all the genotypes. (Table 3 and Fig 1).



**Fig 1:** Anthocyanin colouration

**Flower morphological characters**

Based on the Flower morphological characteristic such as time of flowering, the genotypes could be grouped into different categories (Table 3). Time of flowering varied with the genotypes ranging from 30.15 days with (Chidambaram Local-1) to 44.33 days (DGGV 7) with an average of 37.84 days. Based on time of flowering, the genotypes were grouped as early (< 40 days) with fifteen genotypes (Chidambaram Local-1, Maruvathur Local-1, Kambam Local-1, Paiyur 1, ADT 2, ADT 3, VBN 2, VBN 3, CO 7, CO 8, VRM -1, KM 2, Pusa Vishal, AKM 8803, TAP 7),

medium (40-50 days) with 5 genotype. The flower colour of petal varied among different green gram genotypes (Table 9).

Among 20 genotypes, flower colour of petal was yellow in Maruvathur Local-1 genotype, while it was light yellow in all the remaining 19 genotypes (Fig 11). Similar findings and grouping of genotypes based on flower morphological characters were made by Joshi and Yasin (2014) [8] in chickpea; Kanaka Durga *et al.* (2015) [9] in horse gram; Kumar and Shrikant (2016) [12] in cowpea; Kaur *et al.* (2017) [10] in mungbean.

**Table 3:** Identification of green gram based on time of flowering (days) and anthocyanin colouration

S. No	Genotypes	Time of Flowering (days)	Anthocyanin colouration	S. No	Genotypes	Time of flowering	Anthocyanin colouration
1.	Chidambaram Local-1	30.15	Present	11.	CO 7	37.63	Present
2.	Maruvathur Local-1	35.15	Present	12.	CO 8	37.83	Present
3.	Kambam Local-1	36.47	Present	13.	VRM 1	37.43	Present
4.	Paiyur 1	36.20	Present	14.	KM 2	37.50	Present
5.	ADT 2	34.80	Present	15.	DGGV 2	41.43	Present
6.	ADT 3	37.03	Present	16.	DGGV 7	44.33	Present
7.	VBN 2	38.50	Present	17.	Pusa Vishal	38.40	Present
8.	VBN 3	35.73	Present	18.	AKM 8803	36.70	Present
9.	CO 1	40.23	Present	19.	Tap 7	37.70	Present
10.	CO 2	43.33	Present	20.	MH – 421	40.30	Present
	Mean	37.84					
	S.Em ±	0.14					
	C.D at 5 %	0.40					
	CV %	0.65					

**Note:** Time of flowering (days), 1. Early: (< 40 days), 2. Medium: (40-50 days), 3. Late: (>50 days).

**Plant Morphological characteristics**

On the basis of plant morphological characters such as plant growth habit, plant habit, petiole colour and plant height were grouped into different categories (Table 4 and 5). Based on plant growth habit, the genotypes were grouped as erect with six genotypes (Chidambaram Local-1, CO 7, CO 8, VRM -1, Pusa Vishal and TAP 7), semi erect with six genotypes (Kambam Local-1, Paiyur 1, VBN 2, VBN 3, AKM 8803, MH 421) and spreading with eight genotypes (Maruvathur Local-1, ADT 2, ADT 3, CO 1, CO 2, KM 2, DGGV 2, DGGV 7). (Fig 2). Based on the plant habit, genotypes were grouped as indeterminate (Chidambaram Local-1, Maruvathur Local-1, Kambam Local-1, Paiyur 1, ADT 2, ADT 3, VBN 2, VBN 3, CO 7, CO 1, CO 2, CO 8, VRM -1, KM 2, Pusa Vishal, TAP 7) and determinate (DGGV 2, DGGV 7, AKM 8803, MH - 421) genotypes. Based on petiole colour, the genotypes were grouped as green with Kambam Local-1, CO 7, DGGV 2, and AKM 8803 genotypes and green with purple with sixteen genotypes (Table 6) (Fig 9).

Significantly the highest plant height was observed in DGGV 2 (73.57 cm), TAP 7 (73.47 cm), MH 421 (73.47 cm), CO 1(73.43), Maruvathur Local-1 (72.33) and Pusa Vishal (70.43) and the lowest plant height was observed in ADT 3 (51.47 cm). Among 20 genotypes, plant height was medium (50 -70 cm) in fourteen genotypes, while it was

long (70 cm) in six genotypes. On the basis of plant morphological characteristics, genotype Maruvathur Local-1 and CO1 were having similar plant morphology *viz.*, green with purple colour petiole colour, intermediate plant height, spreading plant growth habit and tall plant height. The genotype DGGV 2 was distinct with tall plant height with green petiole, determinate plant habit, spreading type plant growth. The other genotypes characters were observed and given in (Table 4 and 5). Similar characterization and grouping of genotypes based on plant morphological characters were made by Kumar *et al.* (2013) [13] in guar; Das *et al.* (2014) [7] in French bean; and Kanaka Durga *et al.* (2015) [9] in horse gram and Kumar and Shrikant (2016) [12] in cowpea.



**Fig 2:** Plant growth habit

**Table 4:** Identification of green gram based on plant height (cm) and plant growth habit

S. No	Genotypes	Plant height (cm)	Plant growth habit	S. No	Genotypes	Plant height (cm)	Plant growth habit
1.	Chidambaram Local-1	53.57	Erect	11.	CO 7	52.60	Erect
2.	Maruvathur Local-1	72.33	Spreading	12.	CO 8	52.57	Erect
3.	Kambam Local-1	51.47	Semi erect	13.	VRM 1	51.53	Erect
4.	Paiyur 1	54.60	Semi erect	14.	KM 2	53.60	Spreading
5.	ADT 2	56.40	Spreading	15.	DGGV 2	73.57	Spreading

6.	ADT 3	51.47	Spreading	16.	DGGV 7	55.67	Spreading
7.	VBN 2	54.60	Semi erect	17.	Pusa Vishal	70.43	Erect
8.	VBN 3	55.60	Semi erect	18.	AKM 8803	57.33	Semi erect
9.	CO 1	73.43	Spreading	19.	Tap 7	73.47	Erect
10.	CO 2	69.53	Spreading	20.	MH – 421	73.47	Semi erect
	Mean	60.6					
	S. Em ±	0.11					
	C.D at 5 %	0.32					
	CV %	0.32					

Note: Plant height (cm) 1. Short: (< 50 days), 2. Medium: (50-70 days), 3. Long: (>70 days).

Table 5: Identification of green gram based on Plant habit and Stem colour

S. No	Genotypes	Plant habit	Stem colour	S. No	Genotypes	Plant habit	Stem colour
1.	Chidambaram Local-1	Indeterminate	Green with purple splashes	11.	CO 7	Indeterminate	Green
2.	Maruvathur Local-1	Indeterminate	Green with purple splashes	12.	CO 8	Indeterminate	Green
3.	Kambam Local-1	Indeterminate	Green	13.	VRM 1	Indeterminate	Green
4.	Paiyur 1	Indeterminate	Green	14.	KM 2	Indeterminate	Green
5.	ADT 2	Indeterminate	Green with purple splashes	15.	DGGV 2	Determinate	Green
6.	ADT 3	Indeterminate	Green with purple splashes	16.	DGGV 7	Determinate	Green with purple splashes
7.	VBN 2	Indeterminate	Green	17.	Pusa Vishal	Indeterminate	Green
8.	VBN 3	Indeterminate	Green	18.	AKM 8803	Determinate	Green
9.	CO 1	Indeterminate	Green	19.	Tap 7	Indeterminate	Green
10.	CO 2	Indeterminate	Green with purple splashes	20.	MH – 421	Determinate	Green with purple splashes

Table 6: Identification of green gram based on Stem Pubescence and Leaflet lobes

S. No	Genotypes	Stem Pubescence	Leaflet lobes	S. No	Genotypes	Stem Pubescence	Leaflet lobes
1.	Chidambaram Local-1	Present	Absent	11.	CO 7	Present	Present
2.	Maruvathur Local-1	Present	Present	12.	CO 8	Present	Absent
3.	Kambam Local-1	Present	Present	13.	VRM 1	Present	Absent
4.	Paiyur 1	Present	Absent	14.	KM 2	Present	Absent
5.	ADT 2	Present	Absent	15.	DGGV 2	Present	Absent
6.	ADT 3	Present	Absent	16.	DGGV 7	Present	Absent
7.	VBN 2	Present	Present	17.	Pusa Vishal	Present	Absent
8.	VBN 3	Present	Absent	18.	AKM 8803	Present	Absent
9.	CO 1	Present	Absent	19.	Tap 7	Present	Absent
10.	CO 2	Present	Absent	20.	MH – 421	Present	Present

**Stem morphological characters**

Among 20 genotypes, stem colour was green in thirteen genotypes (Kambam Local-1, Paiyur 1, VBN 2, VBN 3, CO 1, CO 7, CO 8, VRM -1, KM 2, DGGV 2, Pusa Vishal, AKM 8803, TAP 7), whereas it was observed green with purple in seven genotypes (Chidambaram Local-1, Maruvathur Local-1, ADT 2, ADT 3, CO2, DGGV 7, MH 421) (Fig 3). All the 20 green gram genotypes evaluated did not show any variation for stem pubescence (Fig 4) (Table 5 and 6). Therefore, the evaluated 20 green gram genotypes can be differentiated on the basis of stem colour only. Similar characterization and grouping of genotypes based on plant morphological characters were made by Chakrabarty *et al.* (2012) in rice, Kumar *et al.* (2013) [13] in guar; Das *et al.* (2014) [7] in French bean; and Kanaka Durga *et al.* (2015) [9] in horse gram and Kumar and Shrikant (2016) [12] in cowpea, Patel *et al.* (2019) [15] in mungbean



Fig 3: Stem colour



**Fig 4:** Stem pubescence

### Leaf morphological characters

The leaf morphological characters observed are leaflet lobes, leaf shape, leaf colour, leaf size and leaf vein colour contribute towards the yield ability of the genotypes as leaves are the food accumulating region in the plants. In this study, the characteristics related with leaves have been recorded and based on these characteristics, the genotypes were categorized into different groups (Table 6, 7, 8 and 9). The leaflet lobes varied among the genotypes. Among 20 genotypes, leaflet lobes were present in five genotypes (Maruvathur Local-1, Kambam Local-1, VBN 2, CO 7, MH 421), where it was absent in remaining all the fifteen genotypes (Fig 5). Leaf colour was dark green in eight genotypes (Fig 8). Based on leaf vein colour, the genotypes were grouped as green with nine genotypes (Kambam Local-1, ADT 2, VBN 3, CO7, CO8, DGGV 2, DGGV 7, AKM 8803 and Tap 7) and purple with 11 genotypes (Fig 6). Among 20 genotypes, shape of leaf was ovate in 16 genotypes, whereas it was cuneate in three genotypes (Kambam Local-1, CO 7 and MH -421) and was lanceolate in Pusa Vishal genotype (Fig 7). Based on leaf size, the genotypes were grouped as small, medium and large sized leaves (Fig 10). Leaf size was large in two genotypes (Maruvathur Local-1 and Kambam Local-1), while it was observed medium in eighteen genotypes. The genotype Pusa Vishal was distinct genotype amongst 20 genotypes based on leaf morphology with medium leaf size, lanceolate leaf shape, green leaf, purple leaf vein and absent of leaflet lobes. Similarly, Kambam Local-1 was distinct with large leaf size, cuneate leaf shape, dark green leaf, greenish purple leaf vein and present of leaflet lobes. Genotypes Paiyur-land ADT 3 had similar leaf morphology with medium leaf size, ovate leaf shape, green leaf, purple vein and absent of leaflet lobes. Genotypes CO 8, DGGV 2 and DGGV 7 with respect to leaf colour were green, ovate leaf shape, medium size leaf, green vein colour, absent of leaflet lobes. Similar studies were reported by Parikh *et al.* (2012) <sup>[14]</sup> in rice, Tirkey *et al.* (2013) <sup>[22]</sup> in rice, Singh *et al.* (2014) <sup>[18]</sup> in mung bean, Sunil Kumar *et al.* (2014) <sup>[12]</sup> in chickpea, Patel *et al.* (2019) <sup>[15]</sup> in mungbean.



**Fig 5:** Leaflet lobes



**Fig 6:** Leaf vein colour



**Fig 7:** Leaf shape



**Fig 8:** Leaf colour



**Fig 9:** Petiole colour



**Fig 10:** Leaf size

**Table 7:** Identification of green gram based on Leaf shapes and Leaf colour

S.No	Genotypes	Leaf shapes	Leaf colour	S.No	Genotypes	Leaf shapes	Leaf colour
1.	Chidambaram Local-1	Ovate	Green	11.	CO 7	Cuneate	Green
2.	Maruvathur Local-1	Ovate	Dark Green	12.	CO 8	Ovate	Green
3.	Kambam Local-1	Cuneate	Dark Green	13.	VRM 1	Ovate	Dark Green
4.	Paiyur 1	Ovate	Green	14.	KM 2	Ovate	Green
5.	ADT 2	Ovate	Dark Green	15.	DGGV 2	Ovate	Green
6.	ADT 3	Ovate	Green	16.	DGGV 7	Ovate	Green
7.	VBN 2	Ovate	Green	17.	Pusa Vishal	Lanceolate	Green
8.	VBN 3	Ovate	Dark Green	18.	AKM 8803	Ovate	Dark Green
9.	CO 1	Ovate	Dark Green	19.	Tap 7	Ovate	Dark Green
10.	CO 2	Ovate	Green	20.	MH – 421	Cuneate	Green

**Table 8:** Identification of green gram based on Leaf vein colour and Leaf colour

S.No	Genotypes	Leaf vein colour	Petiole colour	S.No	Genotypes	Leaf vein colour	Petiole colour
1.	Chidambaram Local-1	Greenish Purple	Green with purple splashes	11.	CO 7	Green	Green
2.	Maruvathur Local-1	Greenish Purple	Green with purple splashes	12.	CO 8	Green	Green with purple splashes
3.	Kambam Local-1	Green	Green	13.	VRM 1	Greenish Purple	Green with purple splashes
4.	Paiyur 1	Greenish Purple	Green with purple splashes	14.	KM 2	Greenish Purple	Green with purple splashes
5.	ADT 2	Green	Green with purple splashes	15.	DGGV 2	Green	Green
6.	ADT 3	Greenish Purple	Green with purple splashes	16.	DGGV 7	Green	Green with purple splashes
7.	VBN 2	Greenish Purple	Green with purple splashes	17.	Pusa Vishal	Greenish Purple	Green with purple splashes
8.	VBN 3	Green	Green with purple splashes	18.	AKM 8803	Green	Green
9.	CO 1	Greenish Purple	Green with purple splashes	19.	Tap 7	Green	Green with purple splashes
10.	CO 2	Greenish Purple	Green with purple splashes	20.	MH – 421	Greenish Purple	Green with purple splashes

**Table 9:** Identification of green gram based on Leaf size and Flower colour

S.No	Genotypes	Leaf size	Flower colour	S.No	Genotypes	Leaf size	Flower colour
1.	Chidambaram Local-1	Medium	Light yellow	11.	CO 7	Medium	Light yellow
2.	Maruvathur Local-1	Large	Yellow	12.	CO 8	Medium	Light yellow
3.	Kambam Local-1	Large	Light yellow	13.	VRM 1	Medium	Light yellow
4.	Paiyur 1	Medium	Light yellow	14.	KM 2	Medium	Light yellow
5.	ADT 2	Medium	Light yellow	15.	DGGV 2	Medium	Light yellow
6.	ADT 3	Medium	Light yellow	16.	DGGV 7	Medium	Light yellow
7.	VBN 2	Medium	Light yellow	17.	Pusa Vishal	Medium	Light yellow
8.	VBN 3	Medium	Light yellow	18.	AKM 8803	Medium	Light yellow
9.	CO 1	Medium	Light yellow	19.	Tap 7	Medium	Light yellow
10.	CO 2	Medium	Light yellow	20.	MH – 421	Medium	Light yellow

**Table 10:** Identification of green gram based on premature pod colour and Pod pubescence

S.No	Genotypes	Premature pod colour	Pod pubescence	S.No	Genotypes	Premature pod colour	Pod pubescence
1.	Chidambaram Local-1	Green with pigmented suture	Present	11.	CO 7	Green	Present
2.	Maruvathur Local-1	Green	Present	12.	CO 8	Green	Present
3.	Kambam Local-1	Green with pigmented suture	Present	13.	VRM 1	Green with pigmented suture	Present
4.	Paiyur 1	Green	Present	14.	KM 2	Green	Present
5.	ADT 2	Green	Present	15.	DGGV 2	Green	Present
6.	ADT 3	Green	Present	16.	DGGV 7	Green	Present
7.	VBN 2	Green	Present	17.	Pusa Vishal	Green	Present
8.	VBN 3	Green	Present	18.	AKM 8803	Green	Present
9.	CO 1	Green	Present	19.	Tap 7	Green	Present
10.	CO 2	Green	Present	20.	MH – 421	Green	Present

### Pod morphological characters

The pod morphological characteristics influence the yielding ability of the plant. The genotypic variation was observed for various characteristic of pods such as colour of mature and premature pods, pod pubescence, length of mature pods and pod position, which helps in classifying the genotypes into different groups (Table 10, 11 and 12). All the 20 mung bean genotypes evaluated did not show any variation for pod pubescence, pod position, matured pod colour (Fig 14), pod length. All the genotypes evaluated were having green with pigmented suture and green premature pod colour (Fig 13) with pubescence on pods (Fig 12). The pod position were above the canopy for all 20 genotypes. Based on the pod length of mature pods,

genotypes were short for all 20 genotypes, The pod length at maturity varied among the mung bean genotypes (Fig 16). The mean mature pod length of the genotypes was 4.73 cm. Pod curvature was straight in 16 genotypes and remaining genotypes were curved (Maruvathur Local-1, VRM -1, KM-2, DGGV 2) pod shaped (Fig 15). On the basis of pod morphological characteristics, genotypes Maruvathur Local-1, KM 2, DGGV 2 were distinct with brown color pod, curved pod shaped, presence of pod pubescence, green premature pod colour, pod position were above canopy, short pod length. Similar observations and grouping of genotypes based on pod morphological characters were made by Singh *et al.* (2014) <sup>[18]</sup> in mung bean; Bayahi and Rezgui (2015) <sup>[3]</sup> in chickpea and Kaur *et al.* (2017) <sup>[10]</sup> in mung bean.



**Fig 11:** Flower colour



**Fig 12:** Pod pubescence



**Fig 13:** Colour of premature pod



**Fig 14:** Pod colour



**Fig 15:** Pod Curvature



**Fig 16:** Pod length



**Fig 17:** Seed colour



**Fig 18:** Seed shape

**Table 11:** Identification of green gram based on Pod position and Pod colour

S. No	Genotypes	Pod position	Pod colour	S. No	Genotypes	Pod position	Pod colour
1.	Chidambaram Local-1	Above canopy	Brown	11.	CO 7	Above canopy	Brown
2.	Maruvathur Local-1	Above canopy	Brown	12.	CO 8	Above canopy	Brown
3.	Kambam Local-1	Above canopy	Brown	13.	VRM 1	Above canopy	Brown
4.	Paiyur 1	Above canopy	Brown	14.	KM 2	Above canopy	Brown
5.	ADT 2	Above canopy	Brown	15.	DGGV 2	Above canopy	Brown
6.	ADT 3	Above canopy	Brown	16.	DGGV 7	Above canopy	Brown
7.	VBN 2	Above canopy	Brown	17.	Pusa Vishal	Above canopy	Brown
8.	VBN 3	Above canopy	Brown	18.	AKM 8803	Above canopy	Brown

9.	CO 1	Above canopy	Brown	19.	Tap 7	Above canopy	Brown
10.	CO 2	Above canopy	Brown	20.	MH – 421	Above canopy	Brown

**Table 12:** Identification of green gram based on Pod curvature and Pod length

S. No	Genotypes	Pod length	Pod curvature	S. No	Genotypes	Pod length	Pod curvature
1.	Chidambaram Local-1	4.30	Straight	11.	CO 7	4.90	Straight
2.	Maruvathur Local-1	4.80	Curved	12.	CO 8	4.70	Straight
3.	Kambam Local-1	4.47	Straight	13.	VRM 1	5.21	Curved
4.	Paiyur 1	4.60	Straight	14.	KM 2	4.70	Curved
5.	ADT 2	4.80	Straight	15.	DGGV 2	4.60	Curved
6.	ADT 3	4.70	Straight	16.	DGGV 7	4.82	Straight
7.	VBN 2	4.60	Straight	17.	Pusa Vishal	4.70	Straight
8.	VBN 3	4.70	Straight	18.	AKM 8803	4.83	Straight
9.	CO 1	4.97	Straight	19.	Tap 7	4.45	Straight
10.	CO 2	5.08	Straight	20.	MH – 421	4.73	Straight
	Mean	4.73					
	S. Em ±	0.01					
	C.D at 5 %	0.05					
	CV %	0.70					

**Note:** Pod length (cm), 1. Short (< 8 cm), 2. Medium: (8- 10 cm), 3. Long: (> 10 cm).

**Table 13:** Identification of green gram based on Seed colour, Seed lusture and seed shape

S. No	Genotypes	Seed colour	Seed lusture	seed shape	S. No	Genotypes	Seed colour	Seed lusture	seed shape
1.	Chidambaram Local-1	Green	Shiny	Drum	11.	CO 7	Green	Shiny	Oval
2.	Maruvathur Local-1	Green	Shiny	Drum	12.	CO 8	Green	Shiny	Oval
3.	Kambam Local-1	Green	Shiny	Drum	13.	VRM 1	Green	Shiny	Drum
4.	Paiyur 1	Green	Shiny	Oval	14.	KM 2	Green	Shiny	Oval
5.	ADT 2	Green	Shiny	Oval	15.	DGGV 2	Green	Shiny	Oval
6.	ADT 3	Green	Shiny	Oval	16.	DGGV 7	Green	Shiny	Oval
7.	VBN 2	Green	Shiny	Drum	17.	Pusa Vishal	Green	Shiny	Oval
8.	VBN 3	Green	Shiny	Drum	18.	AKM 8803	Green	Shiny	Drum
9.	CO 1	Green	Shiny	Oval	19.	Tap 7	Green	Shiny	Drum
10.	CO 2	Green	Shiny	Oval	20.	MH – 421	Green	Shiny	Drum

### Seed morphological characters

On the basis of seed morphological characteristics are grouped into such as seed colour, seed lusture, seed shape (Table 13). Seed colour was green in all 20 genotypes (Fig 17). Seed lusture was shiny in 20 genotypes. For seed shape (Fig 18) it was drum shape in nine genotypes (Chidambaram Local-1, Maruvathur Local-1, Kambam Local-1, VBN 2, VBN 3, VRM 1, AKM 8803, Tap 7, MH-421) and oval shape seeds in remaining 11 genotypes. Similar studies were reported by Chakrabarthy *et al* (1989)<sup>[4]</sup> in black gram, Temesgen (2015)<sup>[21]</sup> in chickpea, Basavaraj *et al.* (2013)<sup>[2]</sup> in cowpea, Sinha *et al.* (2013)<sup>[19]</sup> in rice and Patel *et al.* (2019)<sup>[15]</sup> mungbean.

### Conclusion

In the present study, it was found that Maruvathur Local-1 was distinct with yellow colour flower petal. Based on plant morphological characteristics, Maruvathur Local-1 and CO1 were distinct with greenish purple colour petiole colour, intermediate plant height, spreading plant growth habit and tall plant height. The genotype DGGV 2 was distinct with tall plant height with green petiole, determinate plant habit, spreading type plant growth. Based on stem morphological characters, stem colour was green in thirteen VBN 2 genotypes and green with purple was observed in MH 421. Based on the leaf morphology character the genotype Pusa Vishal was distinct with medium leaf size, lanceolate leaf shape, green leaf, purple leaf vein and absent of leaflet lobes and Kambam Local-1 was distinct with large leaf size, cuneate leaf shape, dark green leaf, greenish puple leaf vein and present of leaflet lobes. Genotypes Paiyur-1 and ADT 3

had similar leaf morphology with medium leaf size, ovate leaf shape, green leaf, purple vein and absent of leaflet lobes. Genotypes CO 8, DGGV 2 and DGGV 7 with respect to leaf colour were green, ovate leaf shape, medium size leaf, green vein colour, absent of leaflet lobes. Based on pod morphological characteristics, genotypes Maruvathur Local-1, KM 2, DGGV 2 were distinct with brown color pod, curved pod shaped, presence of pod pubescence, green premature pod colour, pod position were above canopy, short pod length. Maruvathur Local-1 was distinct with green. Based on seed morphology, the genotype Chidambaram Local-1 was distinct with green seed colour, shiny seed lustre, drum seed shaped and genotype ADT 2 was distinct with green seed colour, shiny seed lustre and oval seed shaped.

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