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MORPHOLOGICAL CHARACTERIZATION OF CLUSTER BEAN (*CYAMOPSIS TETRAGONOLOBA* L.) GENOTYPES BASED ON LEAF, FLOWER, POD AND SEED TRAITS

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SUMMARY

The DUS (Distinctness, Uniformity and Stability) testing is the basis of granting protection of newly developed varieties under PPV & FR Act, 2001 which makes the morphological characterization essential. Keeping this in view present study was conducted using 25 genotypes which were characterized for ten morphological traits under eight environments. The characters were found stable over different environments. Majority of the genotypes were found branched with dark green and pubescent leaves with serrated leaf margins. Pink flower colour, short tipped and pubescent pods, short clusters and square shaped seed were found in most of the genotypes. The seed colour displayed great variability comprising five distinct classes with most of the genotypes with light grey coloured seed. These morphological markers can be utilized for the purpose of registration, maintenance, protection and diversity study of the genotypes in cluster bean.

Keywords : Morphological characterization, cluster bean, morphological markers

Cluster bean (*Cyamopsis tetragonoloba* L.) popularly known as *guar* is an important crop for arid and semi-arid areas of India, Pakistan, U.S.A, China and Africa. Cluster bean (2n=2x=14) belongs to the family *Fabaceae*, genus *Cyamopsis* and species *tetragonoloba. Cyamopsis serrata* and *C. senegalensis* are the other members of genus *Cyamopsis*. In India, cluster bean is cultivated during *kharif i.e.* rainy season in arid and semi-arid regions of Rajasthan, Haryana, Punjab, Gujarat and Madhya Pradesh. Its cultivation can be done summer season with short duration (85-90 day maturity) and thermo-photo insensitive varieties (Satpal *et. al.,* 2018) and (Panchta *et. al.,* 2016).

Cluster bean is a multi-purpose crop which is used as vegetable (green pods), as fodder (foliage), green manure and primarily as grain crop. The seed of cluster bean consists of 35-42% endosperm which contains galactomannan gum. The bye product of gum extraction process is called *churi* which may contain protein upto 60% and is used to feed cattles and poultry (Benakanahalli *et. al.*2021). Various derivatives can be synthesized from the Galactomannan gum which has versatile uses in textiles, pharmaceuticals, cosmetics, paper, food processing, oil and gas extraction and explosive industries (Tripathy *et al*., 2018).

The extent of variability available in the germplasm for various economic important characters is the key to success of a crop improvement programme. In the crop like cluster bean in which there are no descriptors available till date serious efforts need to be made towards effective characterization of the genotypes. DUS characterization based on well framed descriptor will not only be helpful in distinguishing the different breeding lines but also be useful in protection of a variety under PPV FR Act 2001 and maintenance of seed purity during seed production. For effective characterization the descriptors should be well defined, simple and easily identifiable with any laboratory test. Keeping this view, the present study was conducted to study morphological characterization of leaf, flower, pod and seed traits of different 25 cluster beangenotypes on the basis of qualitative characters.

MATERIALS AND METHODS

Twenty five cluster bean genotypes collected from different parts of India (Table 1) which have been maintained at Forage section, Genetics and Plant Breeding Department, CCS Haryana Agricultural

TABLE 1
List of cluster bean genotypes evaluated along with their sources

S. No.	Genotype	Source/Origin	S. No.	Genotype	Source/Origin
1.	HG 2-20	CCSHAU, Hisar	14.	GG 2	SDAU Gujarat
2.	HG 884	CCSHAU, Hisar	15.	RGC 1017	RARI, Durgapura
3.	HG 870	CCSHAU, Hisar	16.	RGC 1038	RARI, Durgapura
4.	HG 563	CCSHAU, Hisar	17.	RGC 936	RARI, Durgapura
5.	HG 365	CCSHAU, Hisar	18.	RGC 1055	RARI, Durgapura
6.	HG 3-52	CCSHAU, Hisar	19.	RGC 1002	RARI, Durgapura
7.	HG 6	CCSHAU, Hisar	20.	RGC 1003	RARI, Durgapura
8.	HVG 2-30	CCSHAU, Hisar	21.	RGC 1066	RARI, Durgapura
9.	HG 100	CCSHAU, Hisar	22.	RGS 3	RARI, Durgapura
10.	FS 277	CCSHAU, Hisar	23.	M 83	RARI, Durgapura
11.	X 10	Shaktivardhak Seeds	24.	HG 75	CCS HAU, Hisar
12.	PNB	IARI, New Delhi	25.	RGC 1033	RARI, Durgapura
13.	GG 1	SDAU Gujarat			

University, Hisar were used in this study. Each genotype was grown with four rows of 4 m length and row to row of 45 cm and plant to plant of 15 cm spacing. The experiment was carried out in a randomized block design with three replications at Dry land research area, and Regional Research Station, Bawal, CCS Haryana Agricultural University, Hisar, during summer and *kharif* seasons of year 2019 and 2020.

Five competitive plants were randomly selected excluding border plants in each genotype from each replication. The data were recorded on ten qualitative traits. All the morphological traits namely, plant growth habit, leaf pubescence, leaf margin, leaf colour, flower colour,seed colour, seed shape, cluster length, pod shape and pod pubescence were recorded after the 50% flowering stage.

RESULTS AND DISCUSSION

Variation showing for ten qualitative characters among 25 cluster bean genotypes was presented in Fig. 1. Morphological characterization of cluster bean genotypes was presented in Table 2. There was no effect of different environment on the expression of these characters. The genotypes with branching, dark green & pubescent leaves and with serrated leaf margins were common. Most of the genotypes were found with pink flower colour, short tipped & pubescent pods, short clusters and square shaped. Significant variability was seen in seed colour which could be categorized into five distinct classes with most of the genotypes with light grey coloured seed. Similar studies were also conducted by Manivannan *et al.* (2016), Umesha *et al.* (2015), Kumar *et al.* (2013) and Arora *et al.* (2011) in cluster bean; Kalaiyarasi & Padmavathi (2021), Mounika *et al.* (2020) and Kaur *et al.* (2017) in *Vigna radiata;* Oo *et al.* (2022), Arya *et al.* (2021) Hutchinson *et al.* (2017) in cowpea. The results from these studies are similar to the results of present study.

Plant Growth Habit

The cluster bean genotypes were classified into three groups *i.e.*, unbranched (0-1 branch), sparsely branched (2-5 branches) and branched (> 5 branches) types for plant grow habit. Increase in number of branches per plant tends to compensate for clusters on main stem andpods per cluster by bearing small but more clusters on branches and consequently contribute in yield (Dadheech *et al.* 2020).There were three genotypes each with unbranched and sparsely branched grow habit and remaining 19 genotypes were branched. These results are in concurrence with the findings of Manivannan *et al.* (2016), Umesha *et al.* (2015) and Kumar *et al.* (2013) in cluster bean.

Leaf pubescence

Leaf pubescence is dominant among the released varieties of cluster bean. Leaf pubescence protects the plant during various abiotic stresses, namely ultra-violet injury, drought tolerance, radiation heat load reduction etc. (Sharma *et al.*2021 and Karabourniotis *et al.*2021). Based on the presence/ absence of leaf pubescence the genotypes are divided into two groups *i.e.* pubescent and glabrous. Out of 25 genotypes 22 were found pubescent while, three

TABLE 2
Classification and grouping of 25 cluster bean genotypes based on qualitative characters

Diagnostic Characters	Descriptors	Number of genotypes	Name of genotypes
1. Plant growth habit	Unbranched	3	FS 277, PNB and RGC 1066
	Sparsely Branched	3	HG 6, HVG 2-30 and M 83
	Branched	19	HG 2-20, HG 884, HG 870, HG 563, HG 365, HG 3-52, HG 100, X 10, GG1, GG 2, RGC 1017, RGC 1038, RGC 936, RGC 1055, RGC 1002, RGC 1003, RGS 3, HG 75 and RGC 1033
2. Leaf pubescence	Pubescent	22	HG 2-20, HG 884, HG 870, HG 563, HG 365, HG 3-52, HG 6, HG 100, X 10, GG1, GG 2, RGC 1017, FS 277, RGC 1038, RGC 936, RGC 1055, RGC 1002, RGC 1003, RGS 3, RGC 1066, HG 75 and RGC 1033
	Glabrous	3	HVG 2-30, PNB and M 83
3. Leaf margin	Serrated	17	HG 2-20, HG 884, HG 365, HG 3-52, HG 6, GG 2, RGC 1017, FS 277, RGC 1038, RGC 936, HVG 2-30, PNB, M 83, RGC 1055, RGC 1002, RGC 1003, RGS 3 and RGC 1066
	Smooth	8	HG 870, HG 563, HG 100, X 10, GG 1, RGC 1003, HG 75 and RGC 1033
4. Leaf colour	Dark green	21	HG 2-20, HG 884, HG 870, HG 563, HG 365, HG 3-52, HG 6, HG 100, X 10, GG1, GG 2, RGC 1017, FS 277, RGC 1038, RGC 936, RGC 1055, RGC 1002, RGC 1003, RGS 3, RGC 1066 and RGC 1033
	Light green	4	HVG 2-30, PNB, HG 75 and M 83
5. Flower colour	Pink	20	HG 2-20, HG 884, HG 870, HG 563, HG 365, HG 3-52, HG 6, HG 100, X 10, GG 1, RGC 1017, PNB, FS 277, RGC 1038, RGC 1055, RGC 1002, RGC 1003, RGS 3, RGC 1066 and RGC 1033
	White	5	HVG 2-30, GG 2, RGC 936, HG 75 and M 83
6. Pod pubescence	Pubescent	21	HG 2-20, HG 884, HG 870, HG 563, HG 365, HG 3-52, HG 6, HG 100, X 10, GG1, GG 2, RGC 1017, RGC 1038, RGC 936, RGC 1055, RGC 1002, RGC 1003, RGS 3, RGC 1066, HG 75 and RGC 1033
	Glabrous	4	HVG 2-30, FS 277, PNB and M 83
7. Pod tip shape	Short	22	HG 2-20, HG 884, HG 870, HG 563, HG 365, HG 3-52, HG 6, HG 100, X 10, GG1, GG 2, RGC 1017, RGC 1038, RGC 936, RGC 1055, RGC 1002, RGC 1003, RGS 3, RGC 1066, HG 75, FS 277 and RGC 1033
	Long	3	PNB, HVG 2-30 and PNB
8. Cluster length	Short (<5cm)	21	HG 2-20, HG 884, HG 870, HG 563, HG 365, HG 3-52, HG 6, HG 100, X 10, GG1, GG 2, RGC 1017, RGC 1038, RGC 936, RGC 1055, RGC 1002, RGC 1003, RGS 3, RGC 1066, HG 75 and RGC 1033
	Long (>5 cm)	4	FS 277, PNB, HVG 2-30 and M 83
9. Seed colour	Sepia	4	HG 563, RGC 936, HG 75 and M 83
	Greyish sepia	3	HG 365, X 10 and GG 2
	Dark grey	4	HG 884, RGC 1017, RGC 1002 and RGC 1033
	Grey	9	HG 2-20, HG 870, HG 3-52, HG 6, HVG 2-30, FS 277, PNB, RGC 1003 and RGS 3
	Light grey	5	HG 100, GG 1, RGC 1038, RGC 1055, RGC 1066
10. Seed shape	Square	21	HG 2-20, HG 884, HG 870, HG 563, HG 365, HG 3-52, HG 6, HG 100, X 10, GG1, RGC 1017, FS 277, RGC 1038, RGC 936, RGC 197, RGC 1055, RGC 1002, RGC 1003, RGS 3, RGC 986, RGC 1066, HG 75 and RGC 1033
	Flat & Round	4	HVG 2-30, GG 2, PNB and M 83

were found with glabrous leaves. Similar results were obtained by Umesha *et al.* (2015) and Kumar *et al.* (2013) in cluster bean.

Leaf margin

Leaf serration is a sophisticated mechanism controlled by species dependent interactions with environmental factors like temperature, light, phytochrome and precipitation (Bar and Ori, 2013). Leaf serration not only contribute towards the biodiversity of plant but also related to mitigate biotic and abiotic stresses (Kong *et al.,* 2019; Higuch and Kawakita, 2019). In present study two types of leaf margin were observed among the genotypes under study *i.e.* serrated and smooth. Out all the genotypes 17 were found with serrated leaf margin and remaining eight were found with smooth leaf margin. Similar results were obtained by Manivannan *et al.* (2016) and Kumar *et al.* (2013) in cluster bean.

1: Unbranched **2: Sparsely branched** **3: Branched**

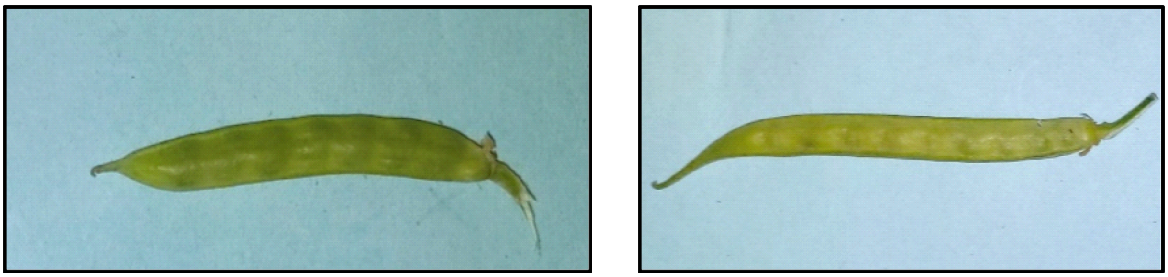
Fig. 1.1. Plant growth habit.

1: Pubescent **2: Glabrous** **3: Serrated** **4: Non-serrated**

Fig. 1.2. Leaf pubescence and leaf margin.

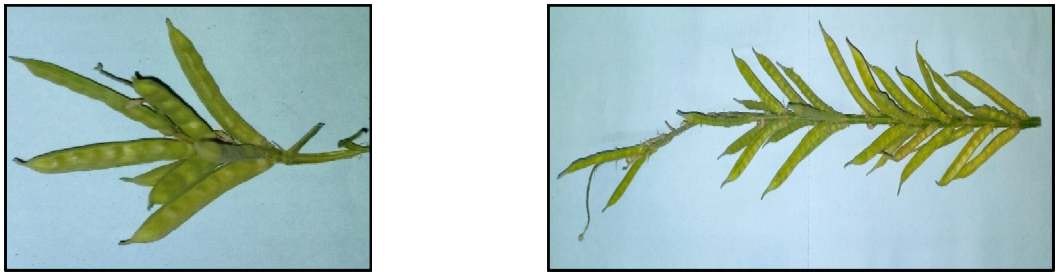
1: Dark green **2: Light green** **3: Pink** **4: white**

Fig. 1.3. Leaf and flower colour.



1: Pubescentwith short tip **2: Glabrouswith long tip**

Fig. 1.4. Pod Pubescence with pod tip shape.



1: Short (< 5 cm) **2: Long (> 5 cm)**

Fig. 1.5. Cluster length.

1: Square **2: Round and flat**

Fig. 1.6. Seed shape.

1: Sepia **2: Greyish sepia** **3: Dark Grey** **4: Grey** **5: Light grey**

Fig. 1.7. Seed colour.

Fig. 1. Variation showing for ten qualitative characters among 25 genotypes.

Leaf colour

Two types of leaf colours were observed among the genotypes *i.e.* dark green and light green. Out all the genotypes dark green coloured leaves were found in 21 genotypes while four genotypes were observed with light green coloured leaves. Similar results were reported by Oo *et al.* (2022) and Arya *et al.* (2021) in cowpea.

Flower colour

Purple/pink flower coloured may provide some resilience in other crops under arid and semi-arid areas by being less preferred by herbivores (Sharma *et al.*, 2021). Two types of flower colours were observed in the study material *i.e.* pink and white. Out all the genotypes pink coloured flowers were found in 20 genotypes while, five genotypes were observed with white coloured flowers. Manivannan *et al.* (2016), Umesha *et al.* (2015), Kumar *et al.* (2013) and Arora *et al.* (2011) also reported similar results in cluster bean.

Pod pubescence

Pod pubescence may provide similar advantage as leaf pubescence but it is undesirable in vegetable type cluster bean. Based on the presence/ absence of pod pubescence the genotypes are divided into two groups *i.e.,* pubescent and glabrous. Out of 25 genotypes 21 were found pubescent while, four were found glabrous pods. Similar results were obtained by Umesha *et al.* (2015) in cluster bean.

Pod tip shape

Pod tip is an extended part of the ovary which is found to be more prominent in vegetable type cluster bean genotypes with long pods. Pod tip of the genotypes was either found short or long. Out of 25 genotypes, pod tip of 22 genotypes was found short and three genotypes were found with long tipped pods.

Cluster length

The cluster is peduncle bearing pod at almost each node of the cluster bean plant. In branched type genotypes the length of cluster was found short. The cluster length of the genotypes were either found short (< 5 cm) or long (>5 cm). Out of 25 genotypes 21 were found with short while, 4 were found with long clusters.

Seed Colour

The genotypes were grouped into five categories *i.e.*, Pale yellow pink, moderate orange, medium grey, light grey and light greenish grey as per the Lilac colour groups by Royal Horticultural Society colour chart. The seed colour of four genotypes each was found pale yellow pink and medium grey, moderate orange was in three genotypes, nine genotypes had light grey coloured seed and light greenish grey seed colour was found in five genotypes. Similar results were obtained by Manivannan *et al.* (2016) and Arora *et al.* (2011) in cluster bean.

Seed Shape

The seed shape under present study was grouped into two categories *i.e.* square and flat & round. The 21 genotypes were found with square shaped seed while, four genotypes had flat & square seed shape. Similar results were obtained by Umesha *et al.* (2015) in cluster bean.

CONCLUSION

All the genotypes were grouped into different categories on the basis of ten qualitative characters studied. Seed colour showed great diversity among all the characters studied. The present study will be helpful during exploration, collection, characterization, evaluation and utilizing the germplasm in future breeding programme. Further, it can be suggested that plant morphological characteristics studied along with new characteristics can be effectively used for DUS testing of cluster bean genotypes.

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