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Morphological Characterisation of Mungbean Minicore Collection

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Abstract

Mungbean [*Vigna radiata (L.) Wilczek*] is a nutritionally important short-duration grain legume with a significant potential for genetic enhancement, which, however, is constrained by the narrow genetic base. Minicore collection, representing a small yet genetically diverse subset of globally available mungbean accessions, can be deployed for its genetic improvement. The present study undertook the morphological characterisation of mungbean minicore set to assess the wide range of diversity of the collection and to identify potential donor lines for breeding. A total of 261 accessions, including checks, were evaluated across two locations, ICAR-IIPR, Kanpur and ICRISAT, Hyderabad, for ten traits. At ICRISAT, plant height ranged from 22.50 to 55.90cm, primary branches from 4 to 11, and 100-seed weight from 1.47 to 7.70g. Meanwhile, at ICAR-IIPR, plant height ranged from 19.50 to 51.60cm, and 100-seed weight from 2.22 to 5.78g. Accessions with desirable agronomic features were identified, which could be valuable donors for yield improvement. Evidently, the minicore accessions harbour a wide spectrum of morphological diversity that could be effectively harnessed to broaden the genetic base of cultivated mungbean.

Keywords: Crop Improvement, Minicore Collection, Morphological Characters, *Vigna radiata*

Mungbean [*Vigna radiata (L.) R. Wilczek*], commonly referred to as green gram, is a short-duration, self-pollinated diploid legume (2n = 2x = 22) known for its nutritional and environmental values. It is primarily cultivated in the Asian cereal-based farming systems, with India being its largest producer. However, its adaptability has enabled its gradual expansion to other regions, including Africa and Australia (Pratap *et al.* 2022). Taxonomically, mungbean belongs to the tribe *Phaseoleae*, family *Fabaceae*, and subgenus *Ceratotropis*, and shares close phylogenetic relationships with several Asiatic legumes such as rice bean (*V. umbellata*), adzuki bean (*V. angularis*), moth bean (*V. aconitifolia*), and black gram (*V. mungo*) (Kim *et al.* 2015). Genome size within the genus varies from 416 to 1,394 Mb, with mungbean comprising ~579 Mb (Kang *et al.* 2014). India is recognised as the centre of origin for mungbean (Vavilov 1926). The major mungbean-producing countries include India, China, the Philippines, Australia, Myanmar, Indonesia, Bangladesh, Pakistan and Sri Lanka (Sinha *et al.* 2023).

Mungbean is predominantly cultivated as a warm-season crop and thrives well under tropical and subtropical conditions with temperatures ranging

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between 10-40 °C (Pratap *et al.* 2021). It is valued for its resilience to drought and heat stress, short growth duration of 55–70 days, and its compatibility with cereal-based cropping systems (Singh *et al.* 2022; Pratap *et al.* 2019). Being a legume crop, it also serves as a green manure, cover crop, and nitrogen fixer through symbiosis with *Rhizobium* spp., thereby enhancing soil fertility and contributing to sustainable agricultural practices (Pratap *et al.* 2019; Sharma *et al.* 2025). Additionally, the incorporation of crop residues further improves soil organic matter content. From a nutritional perspective, mungbeans are a rich source of easily digestible protein (~24%), starch, vitamins, minerals, antioxidants and bioactive phytochemicals (Wang *et al.* 2021). Mungbean sprouts are enriched with essential vitamins, including niacin, thiamine, folate, and ascorbic acid. These attributes collectively made mungbean a crucial crop for not only nutritional security but also as a functional food legume with therapeutic potential.

Globally, mungbeans occupy ~7.3 million hectares with an annual production of ~5.3 million tons (Nair & Schreinemachers 2020). India is both the largest producer and consumer, while Myanmar leads in exports, primarily to India (Pratap *et al.* 2024). Despite its importance, productivity remains low, ~650 kg/ha relative to the potential yield of improved cultivars (1200–1500 kg/ha) in the country. Constraints include limited access to quality seed, biotic and abiotic stresses, poor agronomic practices and post-harvest losses (Pratap *et al.* 2019; 2020). Bridging this gap requires the development of improved cultivars with higher yield potential (>2000 kg/ha), enhanced nutritional value, and resilience to stresses.

Effective crop improvement programs rely fundamentally on the availability and utilisation of diverse germplasm resources (Sekhon *et al.* 2019). *Ex situ* collections for mungbean are maintained at institutions such as the World Vegetable Centre (Taiwan), ICAR–National Bureau of Plant Genetic Resources (India), and the Chinese Academy of Agricultural Sciences (China), which serve as valuable repositories of mungbean genetic diversity (Schafleitner *et al.* 2015; Pratap *et al.* 2021). However, the comprehensive evaluation of this large germplasm is often laborious, time-consuming, and resource-intensive. To address this challenge, core and minicore collections have been developed, representing approximately 10% and 1% of the total accessions, respectively, while capturing the maximum possible genetic diversity in smaller, manageable subsets (Schafleitner *et al.* 2015).

In mungbean, the minicore collection established at the World Vegetable Centre has undergone preliminary characterisation using morphological descriptors and a limited set of molecular markers (Schafleitner *et al.* 2015). The strategic use of genetically diverse germplasm, including wild relatives, holds significant potential for enhancing mungbean improvement. Nevertheless, it warrants the evaluation of these germplasm accessions for the identification of robust and stable donors for various traits under the local agroclimatic conditions. Accordingly, the present study was undertaken to conduct a comprehensive morphological characterisation of mungbean minicore accessions with the objective of identifying promising donor lines for broadening the genetic base of cultivated varieties and strengthening future crop improvement strategies.

MATERIALS AND METHODS

The plant materials for the present study comprised 296 accessions of the mungbean minicore set, along with four checks: Virat, Soorya, Heera, and Shikha. The field experiments were carried out under natural conditions at two locations, *i.e.*, ICAR, Indian Institute of Pulses Research (ICAR-IIPR) Kanpur and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Hyderabad, during the *kharif* season of 2024.

The experimental layout followed an alpha lattice design with two replications. Each accession was sown in a single-row plot of 3 m length, maintaining a spacing of 30 cm between rows and 10 cm between the plants. Due to germination issues in some accessions and non-survival due to diseases in a few others, data from 261 accessions, including checks, were finally available across both locations. Observations were recorded for seven qualitative and three quantitative traits, including hypocotyl pigmentation, leaf pubescence, stem colour, pod pubescence, pod colour, seed colour, seed lustre, plant height (cm), number of primary branches per plant, and 100-seed weight (g). Observations on qualitative traits were recorded following the descriptors outlined in the National

Test Guidelines of the All India Coordinated Research Project on Kharif Pulses, ICAR–IIPR, Kanpur, with minor modifications, using five randomly tagged competitive plants from each accession. Based on the data recorded at each location, range and mean were worked out using simple statistics for each quantitative trait, while for qualitative traits, clear categorisation was performed. Comparisons were done with respect to the check varieties used.

RESULTS AND DISCUSSION

Several studies on the mungbean minicore set have been undertaken in countries such as Taiwan (Aski *et al.* 2021) and Australia (Kyu *et al.* 2024) with a primary focus on yield parameters and tolerance to abiotic and biotic stresses. In contrast, evaluations in India have thus far been limited to biotic stress responses (Pandey *et al.* 2021). Consequently, no comprehensive report exists on the morphological performance of this collection under Indian agro-climatic conditions or on the identification of accessions with potential to broaden the genetic base of cultivated mungbean varieties. Therefore, prior to identifying donors for specific traits, it is imperative to establish a thorough morphological characterisation to provide baseline information on variability and to guide effective utilisation of the identified donors in breeding programs (Sharma *et al.* 2025). This is more important, especially during the current scenario of climate change, which also affects the disease and insect-pest dynamics drastically. The impact of climate change on mungbean can be more conspicuous when its reproductive phase coincides with the terminal heat and drought stresses, especially during the spring/summer season (Pratap *et al.* 2019).

The morphological evaluation of the mungbean minicore collection in the present study revealed considerable variation for most of the qualitative traits, underscoring the genetic diversity encompassed within the set. Notably, all traits except leaf and pod pubescence exhibited substantial variability. For instance, hypocotyl pigmentation was observed in most accessions (219), while 42 accessions lacked this trait (Table 1). Hypocotyl pigmentation is a very useful trait as it acts as a morphological marker during the maintenance breeding of the released varieties. Further classification of the minicore accessions based on

Table 1. Characterisation of the mungbean minicore collection based on seven qualitative traits at ICRISAT, Hyderabad and ICAR-IIPR, Kanpur

S. No.	Trait	Category	Accession No.
1	Hypocotyl Pigmentation	Absent	42
		Present	219
2	Leaf Pubescence	Absent	-
		Present	261
3	Stem Colour	Green	258
		Green with purple splashes	VI002173 BG, VI002274 B-BL, VI002529 B-BL
		Purple	-
4	Pod Pubescence	Absent	-
		Present	261
5	Pod Colour	Brown	VI000470 AG, VI001221 AG, VI001244 AG, VI002432 AG, VI002739 AG
		Black	256
6	Seed Colour	Yellow	VI000020 AY, VI000175 BY, VI000542 BY, VI003886 BY, VI005030 BY
		Green	228
		Mottled	VI000188 A-BLM, VI001403 B-BR, VI001448 A-BLM, VI001520 A-BLM, VI003019 A-BLM, VI003212 B-BLM, VI003251 A-BL, VI003734 B-DG, VI003882 A-BLM, VI004006 A-GM, VI004045 A-DGM, VI004048 A-DGM, VI005066 A-GM
		Black	VI000212 A-BLM, VI002274 B-BL, VI002529 B-BL, VI003135 B-BL, VI003251 A-BLM, VI003894 B-BLM, VI003929 A-BL, VI003958 B-BLM
		Brown	VI000625 B-BR, VI001509 AG, VI003734 B-BR, VI003886 B-BR, VI004243 B-BR, VI004244 B-BR, VI004432 B-BR
7	Seed Lusture	Shiny	137
		Dull	124

Table 2. Morphophysiological variation in the mungbean minicore set based on three quantitative traits at ICRISAT, Hyderabad and ICAR-IIPR, Kanpur

Trait	ICRISAT, Hyderabad				ICAR-IIPR, Kanpur			
	Mean	Range	Max.	Min.	Mean	Range	Max.	Min.
Plant height (cm)	37.05	20.50-55.90	VI002469AG	VI004710 AG	30.98	19.50-51.60	VI000188 A-BLM	VI004006 A-GM
Number of primary branches	7	4-11	VI000852AG	VI001408BG, VI001471AG, VI002012BG, VI002197BG, VI002877BG, VI003220AG, VI004096AG, VI004937AG, VI004957AG	2	1-2	135	126
100-seed weight (g)	3.65	1.47-7.70	VI001096AG	VI002063 BG	3.67	2.22-5.78	VI000805 BG	VI000175 BY

morphological characteristics such as stem colour, pod colour, seed colour, and seed lustre also highlighted distinct groupings (Table 1). For stem colour, the accessions were classified into distinct groups: green, green with purple splashes and purple. Most accessions (258) exhibited green stems, while only three accessions displayed green stems with purple splashes, and none showed a completely purple stem. Pod colour variation was limited to two categories, with most accessions (256) having black pods and only five accessions bearing brown pods. For seed colour accessions, evaluated were classified into five groups: yellow, green, mottled, black, and brown. Green seed colour was the most frequent, observed in 228 accessions, followed by mottled, black, brown, and yellow types. Similarly, based on seed lustre, the accessions were classified into two categories: shiny and dull. The distribution was nearly balanced, with 137 accessions having shiny seeds and 124 accessions having dull seeds. These findings were corroborated by earlier reports in mungbean (Patel *et al.* 2019).

The results of three quantitative traits evaluated across two locations, ICRISAT, Hyderabad and ICAR-IIPR, Kanpur, further supported the presence of significant morpho-physiological variation. At ICRISAT, the plant height ranged from 20.5 to 55.9 cm, with the accession VI002469 AG exhibiting the highest plant height and accession VI004710 AG the lowest. The number of primary branches ranged from 4 to 11, with the accession VI000852 AG recording the maximum. The 100-seed weight ranged from 1.47 to 7.70 g, with the accession VI001096 AG showing the maximum 100-seed weight (Table 2). On the contrary, at ICAR–IIPR, no significant variation was observed in the number of primary branches. Plant height ranged from 19.5 to 51.6 cm, with the accession VI000188 A-BLM exhibiting the highest plant height and accession VI004006 A-GM the lowest. The 100-seed weight ranged from 2.22 to 5.78 g, with accession VI000805 BG recording the maximum 100-seed weight. The present findings were in consonance with earlier reports in mungbean (Patel *et al.* 2019).

Interestingly, most of the accessions had a conspicuous effect of the environment on the expression of quantitative traits at both locations. This indicates the role of climatic variables, including the soil health status, on the overall performance of the minicore accessions and underlines the need for location-specific evaluation of the different genotypes as well as adapting location-specific breeding strategies for genetic improvement. Seed yield can be enhanced by understanding the correlations of yield-associated traits and identifying potential donor accessions. Previous studies reported that plant height, 100-seed weight, and number of primary branches showed significant positive correlations with seed yield (Dar *et al.* 2024). Therefore, indirect selection for seed yield by choosing accessions with superior performance in these traits can be effective in enhancing mungbean seed yield. Some potential accessions which had having high number of primary branches, plant height and 100-seed weight were identified at both locations (ICRISAT, Hyderabad and ICAR-IIPR, Kanpur). At ICRISAT, Hyderabad, accessions VI002469 AG, VI000852 AG, and VI001096 AG were identified as promising donors for plant height, number of primary branches, and 100-seed weight, respectively. Similarly, at ICAR-IIPR, Kanpur, accessions VI000188 A-BLM and VI000805 BG were recognised as potential donors for plant height and 100-seed weight. These accessions represent valuable genetic

resources that can be strategically utilised in future breeding programmes to achieve yield enhancement in mungbean.

CONCLUSION

Overall, the results confirmed that the mungbean minicore collection harbours a broad range of morphological variability, which can be effectively exploited to broaden the genetic base of cultivated varieties. The identification of accessions VI002469 AG, VI000188 A-BLM, VI000852 AG, VI001096 AG, and VI000805 BG having desirable traits such as higher plant height, increased number of primary branches, and 100-seed weight, provides valuable genetic resources for yield enhancement in future crop improvement programs.

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