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Comparison of Yield & Agronomical Characteristics of four Local Mung Bean Varieties under Climatic Conditions of Kabul, Afghanistan

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ABSTRACT: Mung bean (Vigna radiata L.) is an important pulse crop with considerable potential to enhance food and nutritional security, improve soil fertility, and increase farmers' incomes in Afghanistan. However, its productivity remains constrained by the widespread use of low-yielding varieties and the challenges associated with semi-arid climatic conditions. This study evaluated the Agronomic performance and yield potential of four mung bean varieties under the Agro climatic conditions of Kabul, Afghanistan, where low annual precipitation, high summer temperatures, and climatic variability limit crop production. The experiment was conducted using a Randomized Complete Block Design (RCBD) consisting of four treatments: Helmandi (T1), Local (T2), 08 Certified (T3), and 07 Certified (T4), with six replications. Data were analysed using analysis of variance (ANOVA), and treatment means were compared using an appropriate mean separation test.

The results demonstrated significant differences ($P < 0.05$) among the evaluated varieties. The 07 Certified variety (T4) produced the highest mean grain yield (1,833.77 kg ha^{-1}), followed by 08 Certified (T3) (1,720.72 kg ha^{-1}), Local (T2) (1,378.87 kg ha^{-1}), and Helmandi (T1) (643.56 kg ha^{-1}). Mean comparison analysis confirmed significant differences among all varieties, with the performance ranking as T4 > T3 > T2 > T1. The superior yield performance of the 07 Certified variety indicates its greater adaptability and productivity under the semi-arid conditions of Kabul. These findings highlight the importance of promoting improved certified mung bean varieties to enhance crop productivity, support climate resilient agricultural systems, and contribute to improved food security and rural livelihoods in Afghanistan. Further multi location and multi-season evaluations are recommended to assess the stability, adaptability, and potential for wider adoption of the 07 certified variety.

KEYWORDS: mung bean varieties, varietal performance, Climatic Conditions, pulse crop

INTRODUCTION

Mung bean (Vigna radiata L. Wilczek) is an important grain legume crop cultivated extensively in tropical and subtropical regions of the world. It belongs to the family Fabaceae and is recognized as a valuable source of plant-based protein, carbohydrates, vitamins, minerals, and bioactive compounds. The seeds generally contain 20–28% protein and approximately 50–60% carbohydrates, contributing significantly to dietary quality and nutritional security, particularly in developing countries where affordable sources of animal protein are often limited (Nair et al., 2019; Keatinge et al., 2011). Due to its high nutritional value, good digestibility, and versatility in food preparation, mung beans have become an important component of human diets across Asia and Africa (AVRDC, 2015).

In addition to its role as a food crop, mung bean contributes to sustainable agricultural systems through biological nitrogen fixation in symbiotic association with Rhizobium bacteria. This ability improves soil fertility, enhances nitrogen availability, and reduces dependence on synthetic nitrogen fertilizers, thereby supporting environmentally sustainable crop production systems (Graham and Vance, 2003; Peoples et al., 2009). Globally, mung beans are cultivated on more than 7 million hectares, with production concentrated mainly in South and Southeast Asia (FAOSTAT, 2023). India, Myanmar, China, Bangladesh, Pakistan, Thailand, and Indonesia are among the major producers of this crop (Nair et al., 2019). The increasing importance of mung bean in global agriculture is associated with its short growth duration, relatively low input requirements, drought tolerance, and adaptability to diverse Agro-ecological environments. These characteristics allow the crop to be cultivated successfully under resource-limited conditions and incorporated into cereal-based cropping systems, where it contributes to crop diversification and improved soil productivity (AVRDC, 2015; Keatinge et al., 2011). Furthermore, under changing climatic conditions characterized by increasing temperatures, irregular rainfall distribution, and water scarcity, resilient crops such as mung bean are becoming increasingly important for strengthening food security and improving the sustainability of agricultural systems (Nair et al., 2019; Varshney et al., 2019).

In Afghanistan, grain legumes play an important role in agricultural production, rural livelihoods, and household nutrition. Among pulse crops, mung beans have considerable potential because of its adaptation to warm environments, short maturity duration, and economic value. The crop can be cultivated as a summer pulse and integrated into crop rotations following winter cereals, where it contributes to soil fertility improvement through biological nitrogen fixation and enhances overall cropping system productivity (FAO, 2022). However, despite these advantages, mung bean production in Afghanistan remains limited and its productivity is below its potential. Major constraints include the widespread cultivation of traditional farmer-maintained varieties, limited access to improved cultivars, inadequate availability of quality seed, insufficient adoption of recommended Agronomic practices, and environmental stresses associated with drought and temperature fluctuations (FAO, 2022; MAIL, 2021).

The Agro-climatic conditions of Kabul province present both opportunities and challenges for mung bean cultivation. The region is characterized by semi-arid conditions, low and uneven rainfall, high summer temperatures, temperature fluctuations, and a relatively short crop-growing period. These environmental stresses can substantially influence crop establishment, vegetative growth, reproductive development, and final grain yield. Previous studies have demonstrated that mung bean growth and productivity are strongly affected by environmental conditions, particularly temperature, moisture availability, and genotype × environment interactions (Singh et al., 2013; Nair et al., 2019). Therefore, identifying varieties with superior adaptation, yield potential, and stable performance under local environmental conditions is essential for improving mung bean production in Kabul and other similar Agro-ecological regions of Afghanistan.

Genetic variability among mung bean varieties plays a critical role in determining crop productivity and environmental adaptation. Evaluation of available genotypes under specific Agro-ecological conditions is therefore an essential component of crop improvement programs because it enables the identification of superior varieties with desirable Agronomic traits. Differences among varieties in plant height, number of branches, pods per plant, seeds per pod, seed size, and grain yield directly influence productivity and provide valuable selection criteria for breeding and production purposes (Aslam et al., 2016; Nair et al., 2019). Field evaluation of locally available and improved varieties also provides essential information for researchers, extension services, and farmers regarding cultivar suitability and production potential under specific environmental conditions (Singh et al., 2013).

Although mung bean has considerable potential for improving pulse production and food security in Afghanistan, limited research has been conducted to evaluate the performance of different varieties under the specific environmental conditions of Kabul. The absence of locally generated information regarding varietal adaptation, yield potential, and Agronomic performance represents an important limitation for developing appropriate production recommendations and promoting improved mung bean cultivation. Comparative evaluation of available varieties under field conditions is therefore necessary to identify suitable cultivars and support sustainable pulse production in Afghanistan.

The present study was conducted to evaluate the yield performance and Agronomic characteristics of four mung bean varieties under the Agro-climatic conditions of Kabul, Afghanistan. The specific objectives were to evaluate differences among varieties for growth and yield-related traits, identify the variety with superior productivity and adaptability under local conditions, and generate baseline information to support future mung bean improvement programs, varietal recommendations, and sustainable agricultural development in Afghanistan.

MATERIALS AND METHODS

Experimental Site and Design: A field experiment was conducted during the 2025 cropping season at the Kabul Research Field, Afghanistan, to evaluate the yield performance and Agronomic characteristics of four mung bean (Vigna radiata L. Wilczek) varieties under the Agro-climatic conditions of Kabul. The experiment was arranged in a Randomized Complete Block Design (RCBD) with three replications. Four mung bean varieties were evaluated as treatments: T1 (Helmandi variety), T2 (Local variety), T3 (08 Certified variety), and T4 (07 Certified variety). Treatments were randomly assigned within each replication to minimize the effects of field variability and ensure reliable comparisons among the tested varieties.

Each experimental plot measured 2 m × 2 m, providing a total plot area of 4 m². Land preparation was carried out using standard cultivation practices to obtain a uniform and well-prepared seedbed for crop establishment. The mung bean varieties were sown in May 2025 with a row spacing of 30 cm and a plant-to-plant spacing of 15 cm. All experimental plots received uniform Agronomic

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management practices throughout the growing season. Nitrogen and phosphorus fertilizers were applied using urea and diammonium phosphate (DAP), respectively. Both urea and DAP were applied at a rate of 60 kg ha^{-1}. Fertilizer application was carried out according to standard Agronomic practices to support crop growth and development. Irrigation was provided six times during the crop growth period to maintain adequate soil moisture and ensure normal plant development.

Data Collection and Measurements: Data were collected on growth, yield, and yield-related traits to evaluate the performance of the tested mung bean varieties. The recorded parameters included plant height (cm), number of branches per plant, number of pods per plant, number of seeds per pod, 1000-seed weight (g), and grain yield (kg ha^{-1}). Plant height was measured at the maturity stage from the soil surface to the tip of the main stem. The number of branches and pods per plant was recorded from randomly selected plants within each plot. The number of seeds per pod was determined by counting seeds from randomly selected pods. After harvesting, seeds were dried to a uniform moisture content, and 1000-seed weight was measured using a precision balance. Grain yield was calculated based on the harvested area of each plot and converted into kilograms per hectare (kg ha^{-1}).

Statistical Analysis: The collected data were subjected to analysis of variance (ANOVA) using the statistical model appropriate for a Randomized Complete Block Design (RCBD) to determine the significance of differences among mung bean varieties. Statistical analyses were performed using R software. When significant treatment effects were observed, treatment means were compared using the Least Significant Difference (LSD) test at the 5% probability level.

RESULTS

The evaluation of four mung bean (Vigna radiata L.) varieties under the agro-climatic conditions of Kabul, Afghanistan, revealed significant differences among the evaluated agronomic traits ($P \leq 0.05$), indicating variation in growth and yield performance among the tested varieties.

Plant Height: Plant height differed significantly among the four varieties ($P \leq 0.05$). The highest mean plant height was recorded in Certified 08 (29.46 cm), followed by Certified 07 (28.00 cm), and these two varieties did not differ significantly according to the mean separation test. The Local variety produced an intermediate plant height (25.04 cm), which was significantly lower than the two certified varieties but significantly higher than the Helmandi variety. The lowest mean plant height was recorded in the Helmandi variety (15.58 cm).

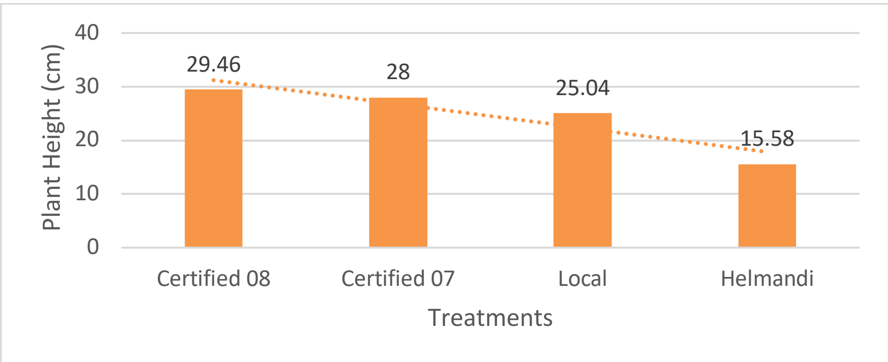

Figure 1. Plant height of different mung bean varieties.

Number of branches per plant : The number of branches per plant was also significantly affected by varietal differences ($P \leq 0.05$). The Local variety produced the highest mean number of branches per plant (11.33), followed by Certified 07 (10.46) and Certified 08 (10.29), which did not differ significantly from each other. The Helmandi variety recorded the lowest number of branches per plant (6.29), differing significantly from the other evaluated varieties.

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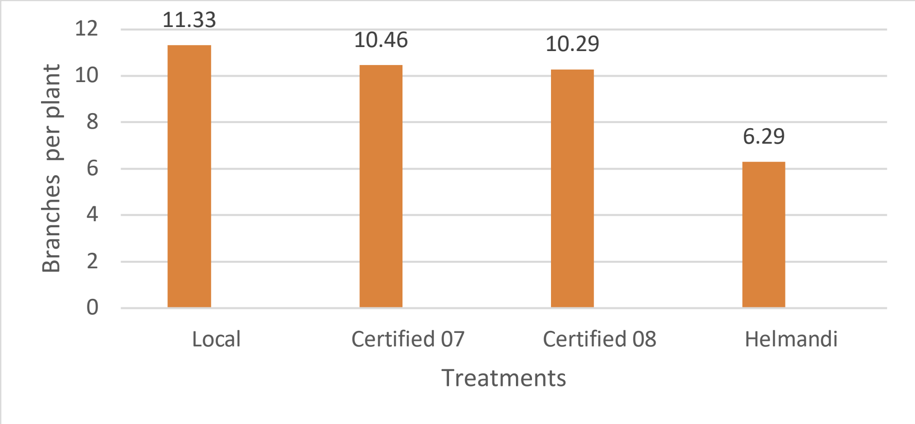

Figure 2. Number of branches per plant of mung bean under different seed sources.

Thousand-seeds weight : Thousand-seed weight was significantly influenced by varietal differences ($P \leq 0.05$). The highest 1000-seed weight was recorded in Certified 08 (66.6 g), followed by Certified 07 (64.2 g). These two varieties did not differ significantly according to the mean separation test but produced significantly greater 1000-seed weights than the Local and Helmandi varieties. The Local and Helmandi varieties recorded 1000-seed weights of 59.0 g and 55.5 g, respectively, and did not differ significantly from each other.

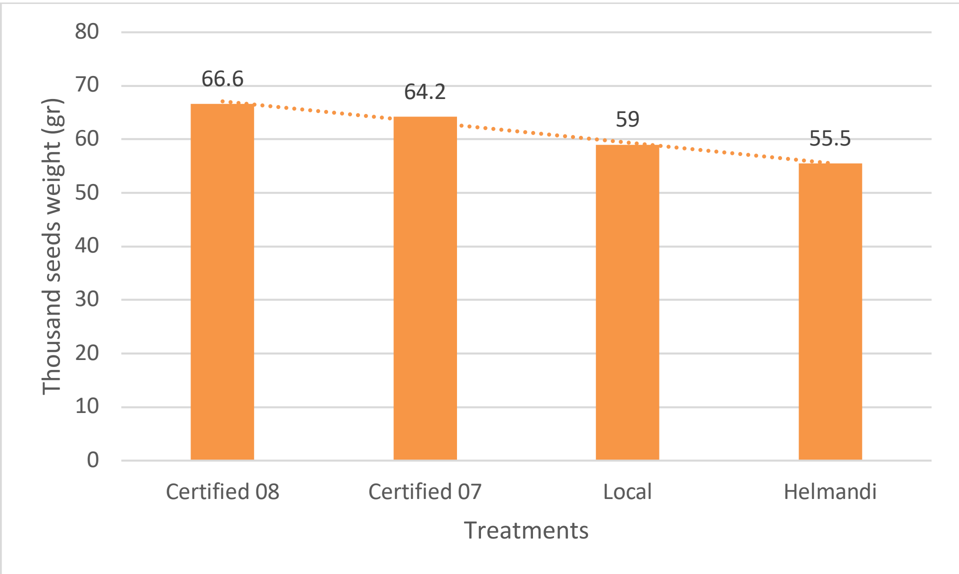

Figure 3. Thousand-seeds weight (gr) of mung bean as affected by different varieties.

DISCUSSION

The present study demonstrated considerable variation among four mung bean (Vigna radiata L.) varieties evaluated under the Agro-climatic conditions of Kabul, Afghanistan. Significant differences observed among varieties for plant height, number of branches per plant, thousand-seed weight, and grain yield indicate the presence of substantial genetic variability influencing growth and productivity under semi-arid conditions. Similar variability among mung bean genotypes has been reported in previous studies, where differences in genetic makeup and genotype × environment interactions were identified as major factors affecting crop performance, adaptation, and yield potential.

Plant height: Plant height is an important morphological characteristic that reflects vegetative growth and the ability of plants to utilize available environmental resources during crop development. In the present study, Certified 08 and Certified 07 recorded the

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highest plant heights (29.46 and 28.00 cm, respectively), whereas Helmandi produced the shortest plants (15.58 cm). The significant differences among varieties suggest that plant stature was strongly influenced by varietal characteristics under the environmental conditions of Kabul. The greater plant height of the certified varieties may be associated with their improved genetic background and better adaptation to the prevailing growing conditions. Previous studies on mung bean have also reported significant variation in plant height among genotypes, emphasizing the importance of genetic effects and environmental interactions in determining vegetative growth. However, the results also indicate that taller plants do not necessarily guarantee higher grain yield, as yield performance depends on the combined contribution of several growth and reproductive traits.

Number of branches per plant: Branch production is an important yield-related trait in mung bean because it influences canopy structure and the potential number of reproductive sites. In this study, the Local variety produced the highest number of branches per plant (11.33), followed by Certified 07 (10.46) and Certified 08 (10.29), while Helmandi produced the fewest branches (6.29). The differences among varieties demonstrate variation in branching ability and vegetative development. The higher branching capacity of the Local variety suggests strong expression of this trait under the conditions of Kabul. Similar findings have been reported in mung bean, where branching characteristics vary considerably among genotypes due to genetic differences and environmental influences. However, despite producing more branches, the Local variety did not achieve the highest grain yield, indicating that branching alone was not the primary determinant of productivity. Instead, grain yield resulted from the interaction of multiple yield components, including seed weight, reproductive efficiency, and overall plant performance.

Thousand-seed weight: Thousand-seed weight is an important component of grain yield and is commonly associated with seed size, grain quality, and dry matter accumulation. In the present study, certified 08 recorded the highest thousand-seed weight (66.6 g), followed by Certified 07 (64.2 g), while the Local and Helmandi varieties recorded lower values (59.0 and 55.5 g, respectively). The superior thousand-seed weight of the certified varieties indicates differences in seed development characteristics among the tested genotypes. Previous studies have reported significant genetic variation for thousand-seed weight in mung bean, confirming that this trait is largely controlled by varietal characteristics. Although higher seed weight generally contributes positively to grain yield, its effect depends on other yield components, such as pod number, seed number per pod, and plant productivity. In the present study, the higher thousand-seed weight of Certified 08 contributed to its competitive yield performance; however, certified 07 produced the highest grain yield, demonstrating the importance of balanced expression of multiple agronomic traits.

Grain yield: Grain yield is the most important indicator of varietal performance and is influenced by the combined effects of genetic potential and environmental conditions. In this study, significant differences were observed among varieties, with Certified 07 producing the highest grain yield (1,833.77 kg ha^{-1}), followed by Certified 08 (1,720.72 kg ha^{-1}). The Local variety produced an intermediate yield (1,378.87 kg ha^{-1}), while Helmandi recorded the lowest yield (643.56 kg ha^{-1}). The $LSD_{0.05}$ value for grain yield was 233.96 kg ha^{-1}, and the coefficient of variation was 13.34%, indicating reliable experimental precision. The superior yield performance of Certified 07 suggests that this variety possesses a favourable combination of yield-contributing traits under the Agro-climatic conditions of Kabul. Although Certified 08 exhibited greater plant height and higher thousand-seed weight, certified 07 achieved higher grain yield, indicating that yield performance is determined by the interaction of several agronomic characteristics rather than a single trait. Similar observations have been reported in mung bean studies, where high-yielding genotypes were associated with improved adaptation and favourable combinations of yield components.

The findings of this study provide valuable information for mung bean production improvement in Kabul and similar semi-arid regions of Afghanistan. Certified 07 and Certified 08 demonstrated superior agronomic performance compared with the Local and Helmandi varieties and may serve as promising options for increasing mung bean productivity. In addition, these varieties could be considered useful materials for future breeding programs aimed at improving yield potential and adaptation. A major strength of this study is the evaluation of both improved certified varieties and locally cultivated materials under actual agro-climatic conditions of Kabul, providing practical information for variety selection. However, the study was conducted at a single location and during one growing season, which may limit the generalization of the findings across different environments and years. Future research should include multi-location and multi-year trials to evaluate yield stability, environmental adaptability, and consistency of performance. Further studies incorporating physiological traits, disease resistance, and farmers' preference assessments would also strengthen recommendations for wider adoption of improved mung bean varieties.

CONCLUSION

The present study demonstrated significant differences among the evaluated mung bean (Vigna radiata L.) varieties for grain yield performance under the agro-climatic conditions of Kabul, Afghanistan. The observed variation among varieties indicates differences in their productivity potential under the tested environmental conditions. Among the evaluated varieties, Certified 07 and Certified 08 showed superior grain yield performance compared with the Local and Helmandi varieties. Certified 07 recorded the highest mean grain yield (1,833.77 kg ha^{-1}), followed by Certified 08 (1,720.72 kg ha^{-1}); however, these two varieties did not differ significantly according to the LSD test. The Local variety produced an intermediate grain yield (1,378.87 kg ha^{-1}), whereas the Helmandi variety recorded the lowest yield (643.56 kg ha^{-1}). The $LSD_{0.05}$ value for grain yield was 233.96 kg ha^{-1}, and the coefficient of variation was 13.34%, indicating acceptable experimental precision.

Based on the findings of this study, certified 07 and Certified 08 can be considered promising mung bean varieties for cultivation under the Agro-climatic conditions of Kabul and similar environments. Their higher grain yield performance compared with the Local and Helmandi varieties highlights their potential contribution to improving mung bean productivity. However, multi-location and multi-season evaluations are recommended to confirm yield stability, adaptability, and wider suitability of these varieties across diverse production environments.

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