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Influence of three varieties on growth and yield of Blackgram

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Abstract
The field experiment was carried out during the *kharif* (March to June) 2015 at the Agronomy Field Laboratory of Sher-e-Bangla Agricultural University, Dhaka. The objective was to identify the most productive variety and appropriate spacing combination suited to local agroecological conditions. Blackgram (*Vigna mungo* L.), a vital pulse crop in Bangladesh, offered a protein-rich dietary source and supported sustainable agriculture through nitrogen fixation. However, its yield remained below potential due to low-performing varieties and suboptimal agronomic practices. This study was conducted to evaluate the growth and yield performance of three blackgram varieties under the System of Crop Intensification (SCI). The experiment employed a split-plot design with three replications, testing three varieties-Munshigonj Local, BARI Mash-2, and BARI Mash-3-under different spacing treatments. Results showed that variety significantly influenced all growth and yield parameters. BARI Mash-2 exhibited superior performance with the highest number of pods plant^{-1} (66.87), 1000-seed weight (40.31 g), seed yield (1.38 t ha^{-1}), and harvest index (45.17%). Munshigonj Local showed greater vegetative growth but lower yield attributes. The study concluded that BARI Mash-2 was the most promising variety for higher productivity under SCI in the *kharif* season. These findings highlighted the importance of varietal selection and crop management in enhancing pulse production and contributing to national food security.

Keywords: Blackgram (*Vigna mungo* L.), planting geometry, system of crop intensification (SCI), seed yield

1. Introduction

Meeting the global food security challenge of the 21st century necessitates sustainable intensification of crop production. The System of Crop Intensification (SCI), an approach to enhance productivity by altering management practices such as spacing and input use, has gained significant traction across Asia and Africa (Pooniya *et al*., 2015 [23]; Marimuthu *et al*., 2024) [20]. SCI principles have shown promise in improving land, water, and nutrient use efficiency, particularly in resource-constrained settings (Ayub *et al*., 2019 [6]; Anonymous, 2018) [5]. Unlike high-input systems, SCI emphasizes ecological principles and farmer-led innovation, making it particularly relevant for smallholder agriculture.

In Bangladesh, pulses are a crucial component of the diet, providing an affordable source of protein, especially for low-income populations. Among pulses, blackgram (*Vigna mungo* L.) is an important legume crop of the Fabaceae family, valued for its nutritional richness-high in protein, carbohydrates, and essential micronutrients-and agronomic benefits, including nitrogen fixation and compatibility with intercropping systems (Gowda *et al*., 2009 [16]; Adarsh *et al*., 2019 [1]; Ahlawat and Srivastava, 1997) [2]. Blackgram's short maturity period makes it suitable for inclusion in multiple cropping systems and as a catch crop (Singh and Praharaj, 2020 [31]; Choudhary *et al*., 2014) [12]. Its cultivation has expanded in recent years due to increasing demand from the processing and export sectors, as well as government initiatives promoting pulse self-sufficiency. Moreover, blackgram contributes significantly to rural livelihoods by offering short-duration crop options that fit into fallow periods, thus enhancing overall farm income and sustainability in diversified farming systems (Singh and Praharaj, 2020 [31]; Choudhary *et al*., 2014) [12].

It is also gaining attention in climate-resilient agriculture for its drought tolerance and low water requirement, adding further relevance under changing climatic scenarios.

Despite these advantages, the average yield of blackgram in Bangladesh remains suboptimal at 756 kg ha⁻¹ (Anonymous, 2016) [4], largely due to the use of low-yielding traditional varieties and suboptimal agronomic practices, particularly plant spacing. Previous studies have demonstrated that yield potential can be significantly improved through the use of genetically superior varieties and optimization of plant geometry (Marimuthu *et al*., 2024 [20]; Mahilane *et al*., 2017 [19]; Joseph *et al*., 2015 [18]; Dinkins *et al*., 2021) [14]. However, findings vary across agroecological zones, necessitating localized research (Chandra, 2010 [11]; Badhan *et al*., 2021 [7]; Rajni *et al*., 2014) [25].

Additionally, efforts such as the "Pulse Research and Development Program" under ICAR-IIPR and various NGO-led extension campaigns have promoted region-specific agronomic packages tailored for marginal farmers. These include trials on integrated nutrient management, foliar feeding under drought conditions, and early-maturing cultivars that align with regional climatic constraints. The success of such models highlights the importance of local adaptation in bridging the research-to-field application gap and enhancing yield potential sustainably.

Varietal response to spacing is a critical determinant of yield, as it influences photosynthetic efficiency, canopy architecture, nutrient uptake, and competition for light and moisture (Banerjee *et al*., 2021 [8]; Ray *et al*., 2023 [27]; Baroowa and Gogoi, 2016) [9]. Different blackgram genotypes may exhibit variable growth and yield responses under SCI, thereby necessitating empirical evaluations (Venugopalan *et al*., 2021 [32]; Chaitieng *et al*., 2006 [10]; Marimuthu *et al*., 2024) [20]. Several studies have explored varietal interactions within SCI frameworks across different agroclimatic zones of South Asia, demonstrating the potential for tailored spacing strategies to enhance both resource efficiency and genotype-specific performance under varying environmental conditions.

Given these considerations, the present study was undertaken to assess the effect of different planting geometries on the growth and yield performance of three blackgram varieties under SCI. The objective was to identify the optimal variety-spacing combination for maximizing productivity under local agroecological conditions. This investigation also seeks to contribute evidence-based recommendations for region-specific agronomic packages that support food security and smallholder profitability.

2. Materials and methods

The experiment was carried out during *Kharif* (March, 2015-June2015)at the Agronomy Field Laboratory of Sher-e-Bangla Agricultural University (SAU), Dhaka, to evaluate the performance of blackgram *(Vigna mungo L.)* under the System of Crop Intensification (SCI) method. This section described the materials used and the methodologies employed during the study.

2.1 Description of the Experimental Site

2.1.1 Site and Soil

The experimental site was located at 23°77′ N latitude and 90°33′ E longitude, at an elevation of 9 m above sea level. The soil belonged to the Modhupur Tract, Agro-Ecological Zone (AEZ-28), with a silty clay texture and a pH of 6.1.

2.1.2 Climate and Weather

The region experiences a subtropical climate, with high temperatures and heavy rainfall during the *Kharif* season (April to September), and relatively cooler, drier conditions during the *Rabi* season (October to March).

2.1.3 Plant Materials

Three blackgram varieties were used:

2.1.3.1 Munshigonj Local

- Sourced from local farmers, this variety was bushy with vigorous vegetative growth and yields up to 1.0 t ha⁻¹.
  2.1.3.2 BARI Mash-2:
- Released by BARI in 1996, this variety had an average plant height of 33-35 cm and yields 1.4-1.5 t ha⁻¹. Seeds were drum-shaped and black.
  2.1.3.3 BARI Mash-3:
- Also released in 1996, this variety was introduced from India and showed an erect growth habit. It matured in 70-75 days, with a yield potential of 1.5-1.6 t ha⁻¹ and was tolerant to Yellow Mosaic Virus.

2.2 Treatments

2.2.1 Variety (3 levels)

V_1: Munshigonj Local
V_2: BARI Mash-2
V_3: BARI Mash-3

2.3 Experimental Design and Layout

The experiment was laid out in a split-plot design with three replications. Variety was assigned to the main plots, and spacing to the subplots, totaling 45 unit plots (each 3× 2 m² = 6 m²). Main plots and unit plots were separated by 1.0 m and 0.5 m, respectively.

2.4 Land Preparation to Weighing

Land preparation was conducted from 15-20 March 2015 using a power tiller, followed by cross-ploughing and laddering. Fertilizers (20 kg N, 17.2 kg P, 17.6 kg K ha⁻¹) were applied as a basal dose before sowing on 21 March at a seed rate of 40 kg ha⁻¹, with spacing as per treatments. Standard intercultural operations included hand weeding (at 20 and 35 DAS), three irrigations, and insecticide application (Ripcord at 30 and 45 DAS). Harvesting occurred at 65 DAS, followed by sun-drying, manual threshing, cleaning, and weighing of seeds at safe moisture levels.

2.5 Data were collected on

Data were collected on several growth and yield parameters, including plant height (cm), above-ground dry weight plant⁻¹ (g), crop growth rate (g m⁻² d⁻¹), number of pods plant⁻¹, 1000-seed weight (g), seed yield (t ha⁻¹), and harvest index (%). Measurements were taken from randomly selected plants at 20, 35, and 50 days after sowing (DAS), and at harvest.

2.6 Data Collection Procedures

Data were collected on several growth and yield parameters, including plant height (cm), above-ground dry weight per plant (g), crop growth rate (g m^{-2} d^{-1}), number of pods per plant, 1000-seed weight (g), seed yield (t ha^{-1}), and harvest index (%). Measurements were taken from randomly selected plants at 20, 35, and 50 days after sowing (DAS), and at harvest. Growth parameters were measured using standard procedures. For example, dry weights were taken after oven drying at 70 °C for 72 hrs; CGR and RGR were calculated using standard growth formulas; and seed yield was calculated from a 1.5 m^2 sample area and converted to t ha^{-1}

2.7 Statistical Analysis

Data were analyzed statistically using ANOVA through the MSTAT-C software package. Mean comparisons were performed using the Least Significant Difference (LSD) test at the p=0.05% level, following Gomez and Gomez (1984) [15].

3. Results and discussion

3.1 Plant height (cm): Plant height increased progressively from 20 DAS to harvest. Significant varietal differences were observed at 35, 50 DAS, and harvest (Figure 1). At 35 DAS, the tallest plants (35.40 cm) were recorded in BARI Mash-2 (V_2), statistically similar to BARI Mash-3 (V_3), while the shortest (30.21 cm) was observed in Munshigonj Local (V_1). However, at later stages (50 DAS and harvest), V_1 produced the tallest plants (56.20 cm and 69.13 cm, respectively), whereas V_3 had the shortest plants (41.67 cm at 50 DAS and 56.57 cm at harvest), statistically similar to V_2. These differences were likely attributable to the genetic makeup of the varieties.

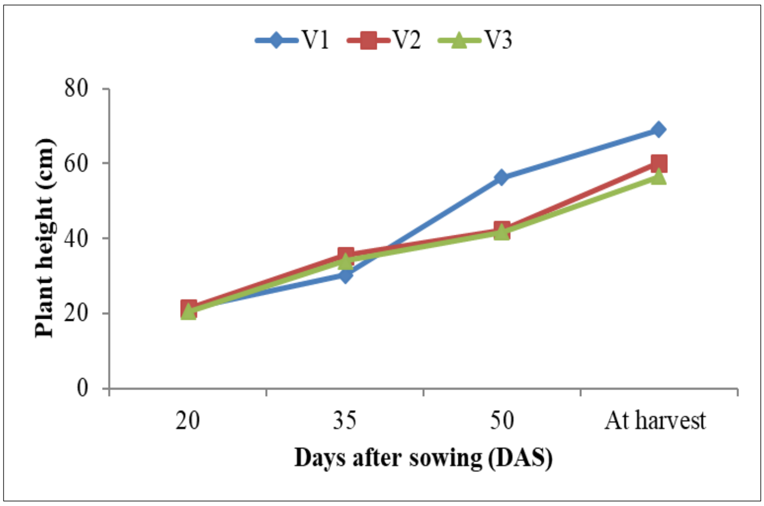

Fig 1: Effect of variety on plant height of blackgram at different days after sowing. LSD (0.05) = NS, 2.57, 6.37, and 6.12 at 20, 35, 50 DAS, and harvest, respectively. V_1 = Munshigonj Local, V_2 = BARI Mash-2, V_3 = BARI Mash-3.

3.2 Above-ground dry weight plant^{-1} (g)

The above-ground dry weight of blackgram plants was significantly influenced by the variety (Figure 2). The highest dry weight at 20 DAS, 35 DAS, 50 DAS, and harvest was recorded in V_1, with values of 0.71 g, 5.90 g, 13.93 g, and 46.93 g, respectively. In contrast, V_3 produced the lowest dry weight at each stage, with values of 0.35 g, 4.41 g, 10.08 g, and 36.73 g, respectively. These variations were attributed to genetic differences among the blackgram varieties. The findings are in agreement with those of Sharma *et al.* (2012) [29], Dasgupta and Das (1991) [13], and Reddy *et al.* (1990).

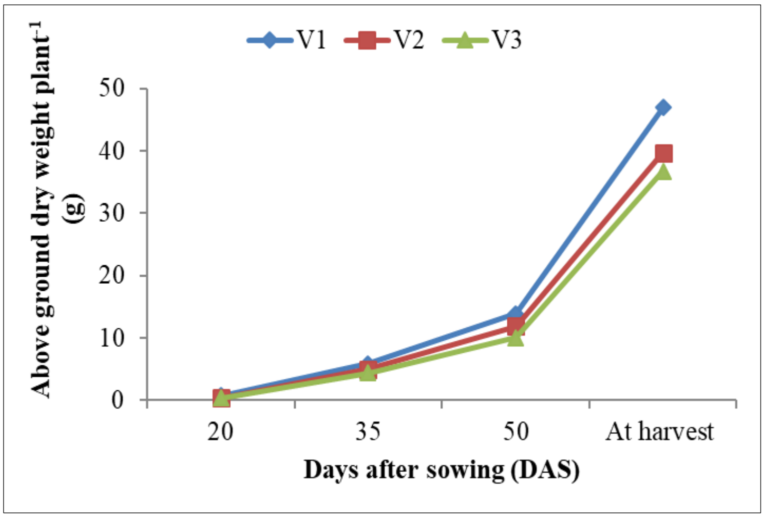

Fig 2: Effect of variety on above-ground dry weight per plant of blackgram at different days after sowing. LSD (0.05) = 0.03, 0.48, 1.33, and 2.11 at 20, 35, 50 DAS, and harvest, respectively.
V_1 = Munshigonj Local, V_2 = BARI Mash-2, V_3 = BARI Mash-3

3.3 Crop growth rate (g m⁻² d⁻¹)

Variety significantly affected the crop growth rate (CGR) of blackgram throughout the growing season (Figure 3). The highest CGR was observed in V_1, with values of 3.46 g m^{-2} d^{-1} during 20-35 DAS, 5.36 g m^{-2} d^{-1} during 35-50 DAS, and 22.00 g m^{-2} d^{-1} during 50 DAS to harvest. In contrast, the lowest CGR was recorded in V_3, with values of 2.71 g m^{-2} d^{-1}, 3.78 g m^{-2} d^{-1}, and 17.77 g m^{-2} d^{-1} over the same intervals, respectively. At the 50 DAS to harvest stage, the CGR of V_3 was statistically similar to that of V_2. These findings were consistent with the results reported by Sharma *et al*. (2012) [29] and Prasad and Srivastava (1999) [24], who also observed significant genotypic differences in CGR.

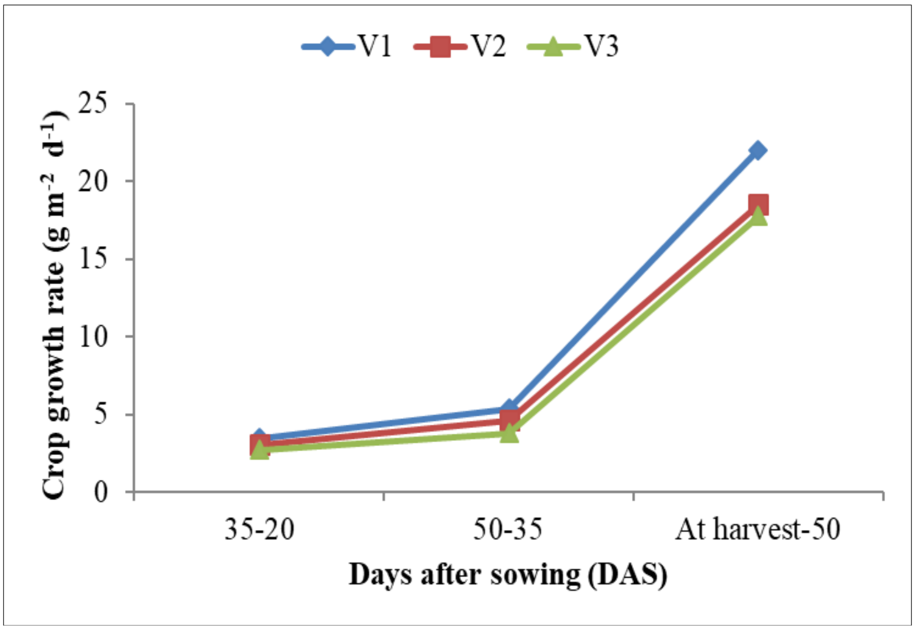

Fig 3: Effect of variety on crop growth rate of blackgram at different growth intervals. LSD (0.05) = 0.29, 0.40, and 0.85 at 20-35 DAS, 35-50 DAS, and 50 DAS to harvest, respectively.
V_1 = Munshigonj Local, V_2 = BARI Mash-2, V_3 = BARI Mash-3.

3.4 Relative growth rate (g g⁻¹ d⁻¹)

No significant differences were found among the varieties regarding relative growth rate (RGR) throughout the growing period of blackgram (Figure 4). The highest RGR was recorded in V_3, with values of 0.170, 0.085, and 0.085 g g^{-1} d^{-1} at 20-35 DAS, 35-50 DAS, and 50 DAS to harvest, respectively. The lowest RGR values were observed in V_1 and V_2, both recording 0.141, 0.080, and 0.080 g g^{-1} d^{-1} at the corresponding growth intervals.

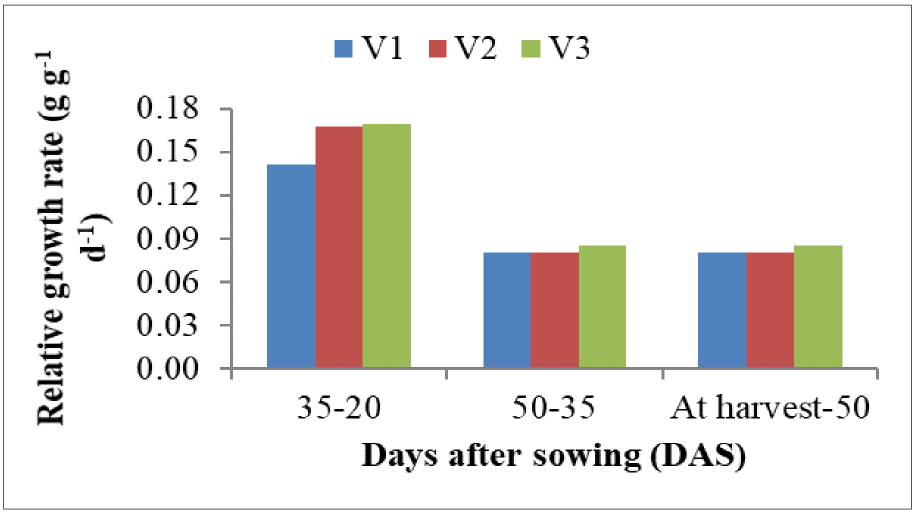

Fig 4: Effect of variety on relative growth rate of blackgram at different growth intervals. LSD (0.05) = NS, NS, and NS at 20-35 DAS, 35-50 DAS, and 50 DAS to harvest, respectively.
V_1 = Munshigonj Local, V_2 = BARI Mash-2, V_3 = BARI Mash-3.

3.5 Pods plant⁻¹ (no.)

Varietal differences significantly influenced the number of pods per plant in blackgram (Figure 5). The highest number of pods per plant (66.87) was recorded in variety V_2, while the lowest (50.29) was observed in V_1. These findings were consistent with those of Nair *et al* (2024) [21] and Ambreen *et al*. (2022) [3], who also reported notable genotypic variation in pod production.

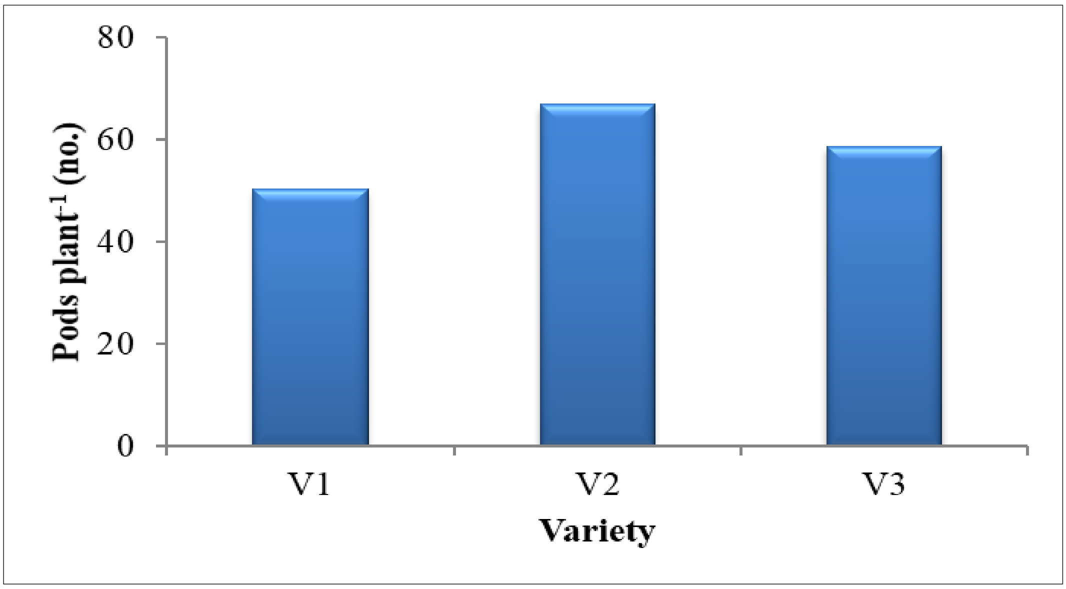

Fig 5: Effect of variety on number of pods plant⁻¹ in blackgram. LSD (0.05) = 4.56.
V_1 = Munshigonj Local, V_2 = BARI Mash-2, V_3 = BARI Mash-3.

3.6 1000-seed weight (g)

Thousand-seed weight of blackgram varied significantly among the three varieties (Figure 6). The highest weight (40.31 g) was recorded in V_2, while the lowest (30.31 g) was observed in V_1. These findings are consistent with those of Sharma *et al*. (2012) [29] and Ambreen *et al*. (2022) [3], who also reported significant genotypic differences in 1000-seed weight.

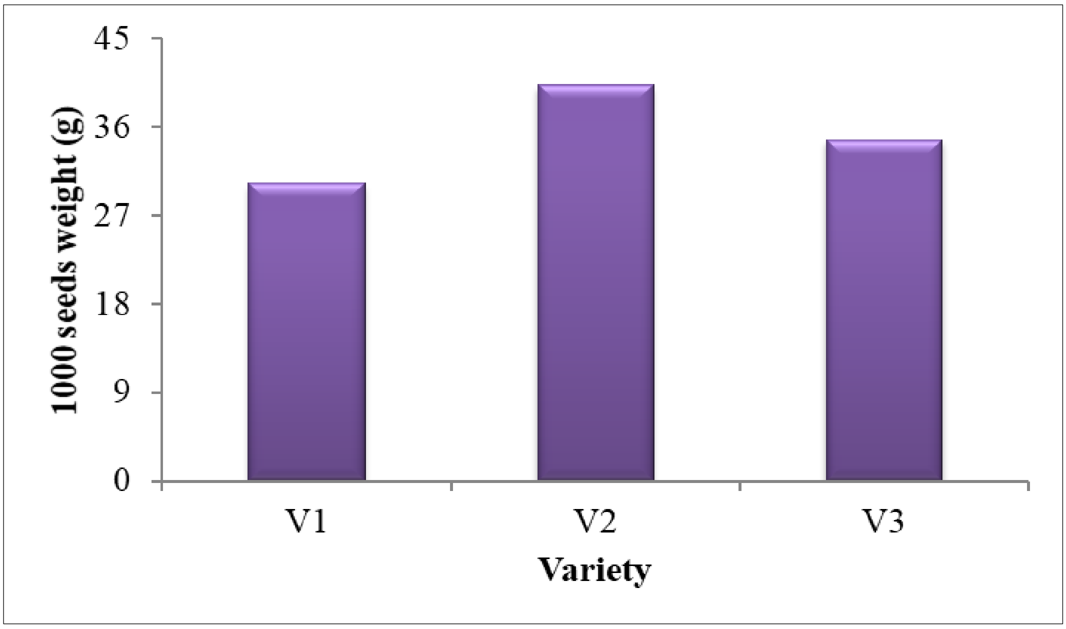

Fig 6: Effect of variety on 1000-seed weight of blackgram. LSD (0.05) = 1.49. V_1 = Munshigonj Local, V_2 = BARI Mash-2, V_3 = BARI Mash-3.

3.7 Seed yield (t ha⁻¹)

Significant variation in seed yield was observed among the blackgram varieties (Figure 7). The highest seed yield (1.38 t ha⁻¹) was recorded in V_2, while the lowest yield (0.92 t ha⁻¹) was obtained from V_1. Notably, V_2 produced 51.09% higher yield compared to V_1. The higher yield in V_2 could be attributed to enhanced yield components such as more pods plant⁻¹, more grains pod⁻¹, and greater 1000-seed weight. These findings were consistent with previous studies (Jagannath *et al*., 2014 [17]; Yadahalli and Palled, 2004; Rao and Konda, 1988) [26], which reported that higher-yielding varieties like TAU-1 and Mash 338 possessed superior vegetative and reproductive traits. A strong positive correlation between yield and traits such as pods plant⁻¹and seeds pod⁻¹ (r = 0.999) further supported this result. Similar varietal differences in production potential have been documented by Sharma *et al*. (2000) [28], Singh and Singh (2000) [30], and Panotra *et al*. (2016) [22].

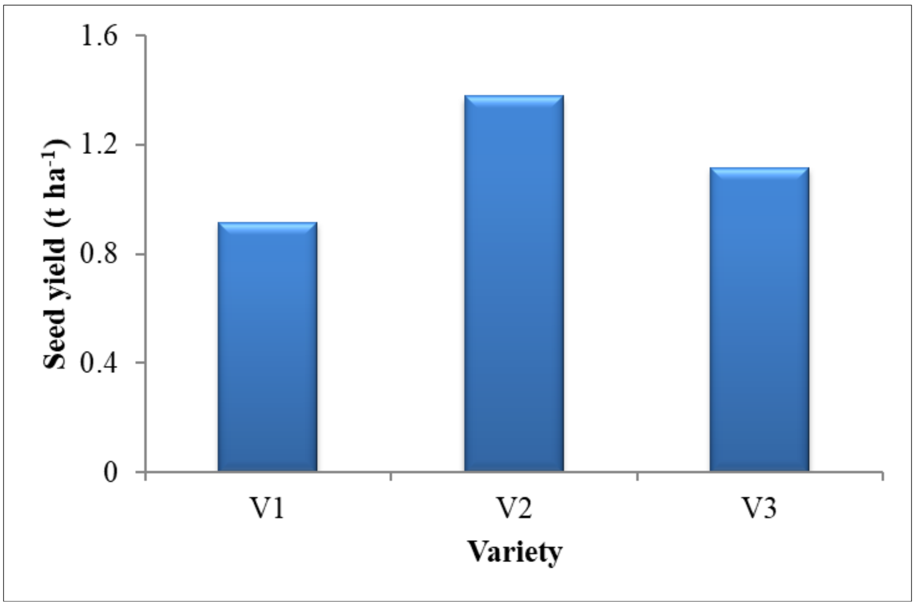

Fig 7: Effect of variety on seed yield of blackgram. LSD (0.05) = 0.03. V_1 = Munshigonj Local, V_2 = BARI Mash-2, V_3 = BARI Mash-3.

3.8 Harvest index (%)

The harvest index of blackgram was significantly influenced by variety (Figure 8). The highest harvest index (45.17%) was recorded in V_2, while the lowest (32.47%) was observed in V_1. Notably, the harvest index of V_2 was 39.11% higher compared to V_1.

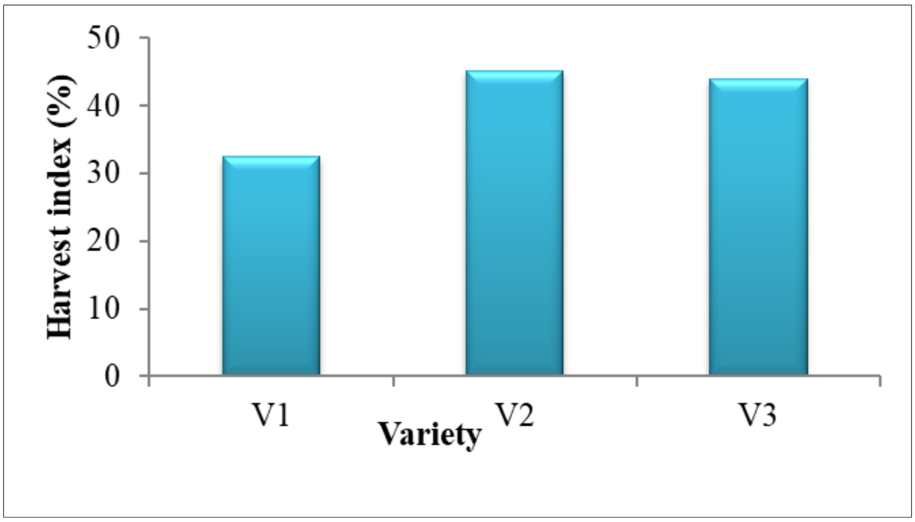

Fig 8: Effect of variety on harvest index of blackgram. LSD (0.05) = 0.84. V_1 = Munshigonj Local, V_2 = BARI Mash-2, V_3 = BARI Mash-3.

4. Conclusion

The importance of selecting appropriate blackgram varieties and optimizing plant spacing for enhanced growth and yield was understood. BARI Mash-2 emerged as the most promising variety, exhibiting superior performance in all major yield attributes.

5. Conflict of interests

The authors have declared that no conflict of interest exists

6. Data availability statement: Due to legal restrictions, the raw data cannot be made publicly available. However, the authors retain the right to share the data upon reasonable request, provided such sharing complies with the conditions of the original participant consent and the scope of the original research study. Furthermore, any data access request must demonstrate compliance with relevant ethical and legal requirements, particularly those governing the secondary use of data outside the context of the original study.

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