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MORPHO-PHYSIOLOGICAL ATTRIBUTES OF BLACKGRAM VARIETIES AS INFLUENCED BY PLANTING GEOMETRY

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Abstract

The study was carried out at the research field of Sher-e-Bangla Agricultural University, Dhaka during March to June 2021 in Kharif-I season to evaluate the effect of varieties and different plant spacing of blackgram. The trial comprised of three varieties of blackgram viz., V_1=BINA mash1, V_2=BARI mash2, V_3=BARI mash4 and four different plant spacing viz., P_1= Broadcast, P_2=Paired row (15 cm × 10 cm), P_3= Square planting (20 cm × 20 cm) and P_4= Row sowing (30 cm × 15 cm). The experiment was laid out in a RCB design with three replications. The results revealed that the blackgram variety BARI mash4 produced the highest seed yield (1.83 t ha-1), whereas BINA mash1 produced the lowest seed yield (1.27 t ha^{-1}). In case of different plant spacing the seed yield ranges between (1.27 -1.83 t ha^{-1}) where maximum seed yield was recorded in spacing of (30 cm × 15 cm). When compared to other treatment combinations, the combination of variety BARI mash4 and 30 cm × 15 cm spacing had an impact on plant growth and yield-contributing characteristics; thus, the results indicated that this combination (30 cm × 15 cm) was suitable for blackgram's maximum growth, seed yield, and yield-contributing parameters.

Keywords: Blackgram, Harvest index, Planting geometry, Variety.

Introduction

Blackgram (*Vigna mungo*) is one of important pulse crop and protein sources for predominately vegetarian populations of our country. Among the pulses, blackgram is one of the most consumed pulses in our country and is the third most widely grown crop in terms of both total cultivated area and consumption (BBS, 2021). The area under pulse crop is 0.406 million hectare with a production of 0.322 million tone (BBS, 2005), where blackgram is cultivated in the area of 0.188 million ha with production of 9.5% of total pulse production (BBS. 2005). Reddy (1997) reported that the genotypic and phenotypic variation of blackgram were significant for branches/plant, 100-seed weight, pods/plant and grain yield/plant. Days to maturity, Clusters/plant, pods/cluster and seeds/pod also varied significantly due to genotypic variation. Plant density can have a major effect on

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the final yield of most of the legumes and the general response of yield to increasing population is well documented (Kumar *et al.,* 2013)

Several high yielding varieties, such as BARI mash2, and BARI mash4 were developed by the Bangladesh Agricultural Research Institute (BARI) (Islam *et al*., 2019) whereas Bangladesh Institute of Nuclear Agriculture (BINA) has developed one variety i.e., BINA mash1. Plant density can have a major effect on the final yield of most of the legumes. To get the maximum yield potential of blackgram during summer and rainy season, maintenance of optimum space made available to individual plant is of prime importance. The spacing requirement depends upon the growth behaviour of genotype (Amanullah *et al.,* 2016). Optimum spacing between rows is required to utilize efficiently the available production factors such as moisture, nutrients, sunlight and space which impact on seed yield (Amare and Gebremedhin, 2020). So, it is required to maintain spacing for obtaining higher yield (Veeramani, 2019).

Materials and Methods

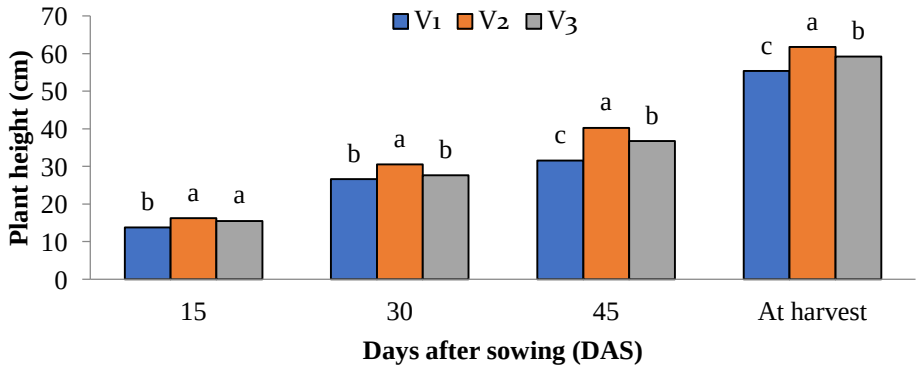
A field experiment was conducted in the field of Sher-e-Bangla Agricultural University (SAU) during the Kharif-1 season of 2021. The soil of the experimental plot belongs to the agro ecological zone of Madhupur Tract (AEZ-28). A soil sample from 0-15 cm depth was collected from experimental field. The experimental area was under the subtropical climate. Usually the rainfall was heavy during Kharif-1 season and scanty in Rabi season. The atmospheric temperature increased as the growing period proceeded towards Kharif season. The experiment was laid out in factorial RCB design with 3 replications. The unit plot size was 5.4 m^2 (2.7 m × 2 m). There were two factors: Factor A. Blackgram varieties (three): V_1= BINA mash1, V_2= BARI mash2, V_3= BARI mash4 and Factor B. Different planting methods (four), P_1= Broadcast, P_2= Paired row (15 cm × 10 cm), P_3= Square planting (20 cm × 20 cm) and P_4= Row sowing (30 cm × 15 cm). The fertilizers namely Urea, Triple Superphosphate (TSP), Muriate of Potash (MoP), Zinc Sulphate, and Boric acid were given as sources of nitrogen, phosphorus, potassium, zinc, and boron as per FRG, 2018. The seeds were sown in broadcast and in solid rows in the furrows having a depth of 2-3 cm from the soil surface. Row to row distance was 30 cm and plant to plant distance was according to the treatments. Before sowing, the seeds is treated with bavistin to control the seed borne disease. Thinning was done at 10 DAS. Pre sowing irrigation was done to maintain equal germination. After sowing two irrigations were applied during the life cycle. First irrigation and second irrigation were done at 15 DAS and 30 DAS respectively. The data were recorded from 15 DAS and continued until the end of recording of yield contributing characters of the crop after harvest. The heights of five plants were measured and expressed in cm. The leaves were separated from each sampled plant and counted and then averaged to express at per plant. Number of nodules $plant^{-1}$ was counted from each selected plant sample at 45 DAS and at harvest respectively. For measuring the dry matter weight $plant^{-1}$, the parts of the plants were separated and then dried in oven at 60 °C for 72 hours and weight was taken carefully. The data collected on different parameters were statistically analyzed at 5% level of significance (Gomez and Gomez, 1984) to compare the mean differences among the treatments following DMRT method.

Results and Discussion

Results obtained from the study have been presented and discussed with a view to study the response of blackgram varieties as affected by different plant spacing. The results have been discussed, and possible interpretations are given under the following headings.

Effects of varieties on plant height at different growth stages

Plant height varied greatly depending on the variety at day after sowing (DAS). Experimental result revealed that at harvest, the highest plant height (16.27, 30.52, 40.27 and 61.74 cm) at 15, 30, 45 DAS and respectively was observed in V_2 treatment BARI mash2 (Fig. 1) which was statistically similar with V_3 (15.52 cm) treatment (BARI mash4) at 15 DAS. Whereas the lowest plant height at 15 DAS, 30 DAS, 45 DAS and at harvest respectively was observed in V_1 treatment (BARI mash1) which was statistically similar with V_3 (27.67 cm) treatment (BARI mash4) at 30 DAS.

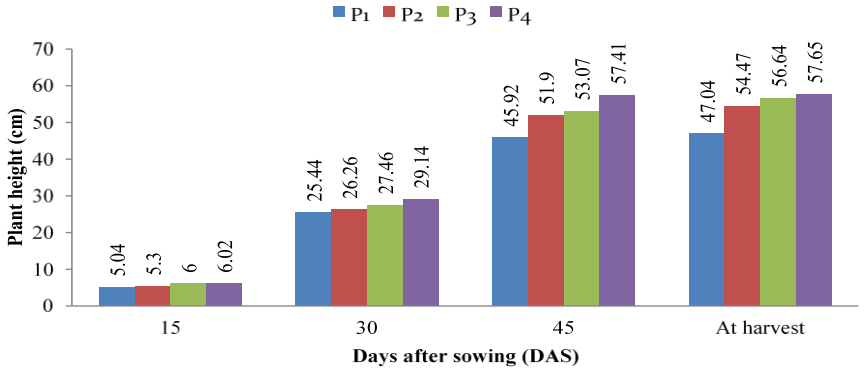


Here, V_1 = BINA mash1, V_2 = BARI mash2 and V_3 = BARI mash4

Fig. 1. Effects of varieties on plant height at DAS

Effects of planting geometry

Significant variation in blackgram plant height was observed on different days after sowing because of different planting geometry (Fig. 2). Experimental results showed that the treatment P_1 (Broadcasting) had the lowest plant height 5.04, 25.44, 45.92 and 47.04 cm at 15 DAS, 30 DAS, 45 DAS and at harvest, respectively which was statistically similar with P_2 treatment (5.30 cm) at 15 DAS. The highest plant height 6.02, 29.14, 57.41 and 57.65 cm was observed in P_4 (30 cm × 10 cm) treatment at 15 DAS, 30 DAS, 45 DAS and at harvest, respectively which was statistically similar with P_3 treatment (6.00 and 56.64 cm) at 15 DAS and at harvest, respectively.



Here, P_1= Broadcast, P_2=Paired row (15 cm × 10 cm), P_3= Square planting (20 cm × 20 cm) and P_4= Row sowing (30 cm × 15 cm)

Fig. 2. Effects of plant spacing on plant height of blackgram at different DAS

At different times after sowing, the height of blackgram plants was significantly impacted by plant variety and spacing (Table 1). The V_2P_4 treatment interaction showed maximum plant height in V_3P_4 (19.00, 34.32, 46.56 and 68.60 cm) at 15 DAS, 30 DAS, 45 DAS and harvest respectively. While V_1P_1 treatment combination showed the lowest plant height (10.34, 20.13, 22.10 and 41.13 cm) 15, 30, 45 DAS and at harvest respectively which was statistically comparable to V_3P_1 and V_2P_1 respectively.

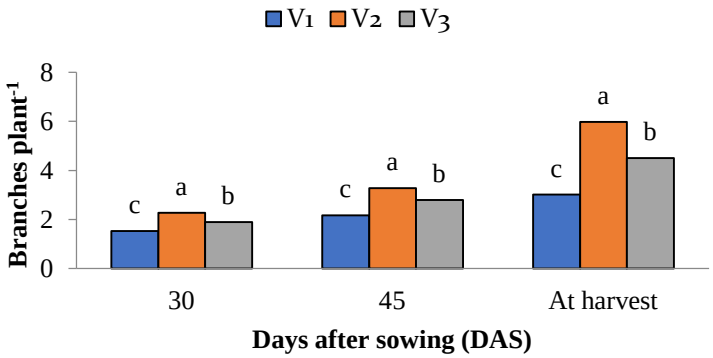
Table 1. Interaction effects of variety and planting geometry on plant height of blackgram at different DAS

Treatment combinations	Plant height (cm)			
	15 DAS	30 DAS	45 DAS	At harvest
V_1P_1	10.34 f	20.13 g	22.10 e	41.13 g
V_1P_2	13.43 de	26.34 e	31.60 cd	59.17 de
V_1P_3	15.13 cd	28.90 d	32.24 cd	58.78 de
V_1P_4	16.27 bc	31.19 c	40.20 b	62.49 cd
V_2P_1	13.33 de	27.57 de	34.17 c	44.60 g
V_2P_2	15.83 bc	27.52 de	34.72 c	63.83 bc
V_2P_3	16.32 bc	32.40 bc	42.45 b	67.40 ab
V_2P_4	19.60 a	34.60 a	49.73 a	71.12 a
V_3P_1	12.52 ef	22.44 f	30.07 d	53.57 f
V_3P_2	12.56 ef	22.60 f	31.30 cd	57.52 ef
V_3P_3	18.00 ab	31.32 c	38.98 b	57.11 ef
V_3P_4	19.00 a	34.32 ab	46.56 a	68.60 a
$LSD_{(0.05)}$	2.29	2.22	3.57	4.32
CV (%)	7.83	4.48	5.59	4.42

Here, V_1 = BINA mash1, V_2 = BARI mash2, V_3 = BARI mash4, P_1= Broadcast, P_2=Paired row (15 cm × 10 cm), P_3= Square planting (20 cm × 20 cm) and P_4= Row sowing (30 cm × 15 cm)

Effects of variety on branches plant^{-1}

The experimental results showed that, the V_2 (BARI mash3) treatment had the highest number of branches plant^{-1} (2.27, 3.28 and 5.98) at 30 DAS, 45 DAS and at harvest respectively. While the V_1 (BARI mash2) treatment, had the lowest number of branches plant^{-1} (1.52, 2.17 and 3.02) at 30 DAS, 45 DAS and at harvest respectively (Fig. 3).

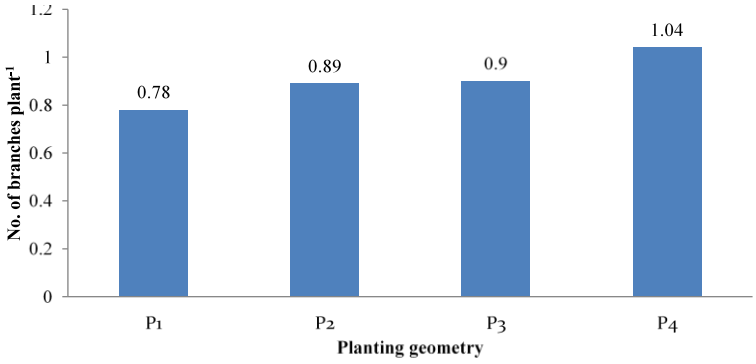


Here, V_1 = BINA mash1, V_2 = BARI mash2 and V_3 = BARI mash4

Fig. 3. Effects of varieties on branches plant^{-1}of blackgram at different DAS

Effects of planting geometry on branches plant^{-1} of blackgram

Different planting geometry had shown significant effect in respect of number of branches plant^{-1} of blackgram at different days after sowing (DAS) (Fig. 4). According to the experimental results, the P_4 (30 cm × 10 cm) treatment had the highest number of branches plant^{-1} (1.04) at harvest (Fig. 4). While the lowest number of branches plant^{-1} (0.78) at harvest, was found in P_1 (broadcast) treatment.



Here, P_1= Broadcast, P_2=Paired row (15 cm × 10 cm), P_3= Square planting (20 cm × 20 cm) and P_4= Row sowing (30 cm × 15 cm)

Fig. 4. Effects of planting geometry on branches plant

Interaction effect of variety and plant spacing had significant variation of the number of branches plant^{-1} of blackgram at various days after sowing (Table 2). The treatment V_2P_4 combination, had the highest number of branches plant^{-1} (3.00, 6.30 and 12.30) at 30 DAS, 45 DAS and harvest respectively. While the lowest number of branches plant^{-1} of blackgram (1.33, 1.80 and 2.47) at 30 DAS, 45 DAS and at harvest respectively was found in V_1P_1 treatment combination which was statistically similar with V_1P_2 (1.47) treatment combination at 30 DAS and with V_1P_2 (2.60) and V_1P_3 (2.87) treatment combination and harvest, respectively.

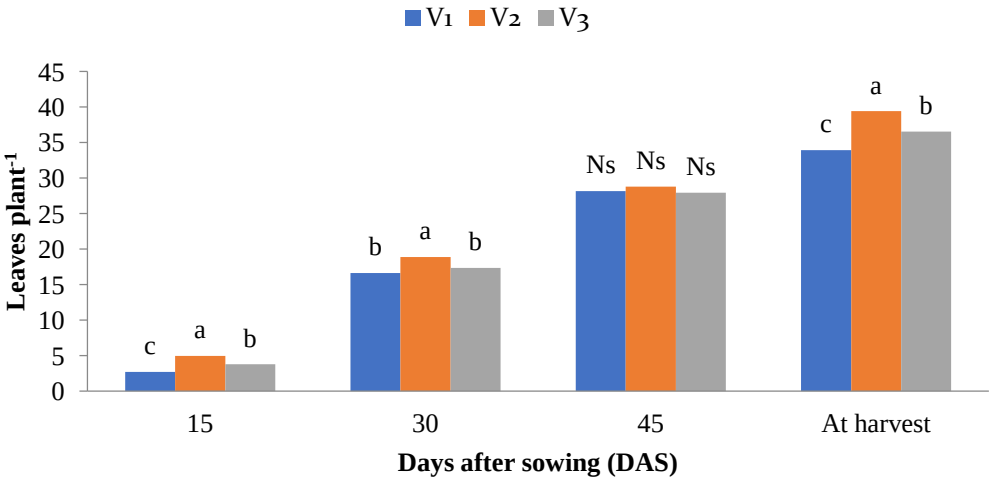
Table 2. Interaction effects of variety and planting geometry on number of branches plant^{-1}

Treatment combinations	Branches plant^{-1} (no)		
	30 DAS	45 DAS	At harvest
V_1P_1	1.33 h	1.80 g	2.47 g
V_1P_2	1.47 gh	2.14 ef	2.60 g
V_1P_3	1.53 g	2.27 e	2.87 fg
V_1P_4	1.74 ef	2.47 d	4.14 d
V_2P_1	1.63 e-g	2.07 f	2.86 g
V_2P_2	1.80 de	2.14 ef	3.46 e
V_2P_3	2.66 b	2.60 cd	5.30 c
V_2P_4	3.00 a	6.30 a	12.30 a
V_3P_1	1.60 fg	2.07 f	2.54 g
V_3P_2	1.74 ef	2.73 c	2.67 g
V_3P_3	1.94 d	2.60 cd	3.34 ef
V_3P_4	2.27 c	3.76 b	9.46 b
$LSD_{(0.05)}$	0.17	0.16	0.47
CV (%)	5.50	3.48	5.91

Here, V_1 = BINA mash1, V_2 = BARI mash2 and V_3 = BARI mash4, P_1= Broadcast, P_2= Paired row (15 cm × 10 cm), P_3= Square planting (20 cm × 20 cm) and P_4= Row sowing (30 cm × 15 cm)

Effects of variety on leaves plant^{-1}of blackgram at different DAS

The number of leaves plant^{-1} of blackgram at various days after sowing varied greatly depending on the varieties (Fig. 5). The V_2 (BARI Mash-4) treatment had the highest number of leaves plant^{-1} (4.96, 18.89, 28.79 and 39.41) at 15, 30, 45 DAS and at harvest respectively. While at 15 DAS, 30 DAS, 45 DAS and at harvest respectively the V_1 (BARI mash2) treatment had the lowest number of leaves plant^{-1}.

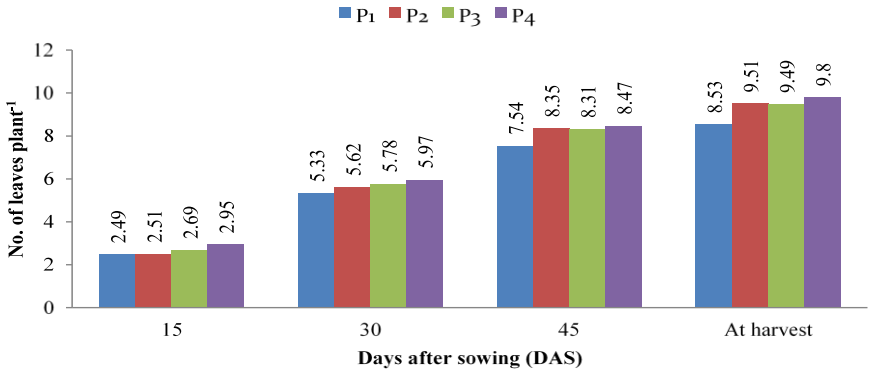


Here, V_1 = BINA mash1, V_2 = BARI mash2 and V_3 = BARI mash4

Fig. 5. Effects of variety on leaves plant^{-1}of blackgram at different DAS

Effects of planting geometry on leaves plant^{-1} at different DAS

The number of leaves plant^{-1} of blackgram at different days after sowing varied significantly due to different planting geometry (Fig. 6). Experimental results showed that the P_4 (30 cm × 10 cm) treatment had the highest number of leaves plant^{-1} of 2.95, 5.97, 8.47 and 9.80 at 15 DAS, 30 DAS, 45 DAS and at harvest, respectively which was statistically similar with P_3 (8.31 and 9.49) and P_2 (8.35 and 9.51) at 45 DAS and harvest, respectively. On the other hand, the P_1 (Broadcast) treatment had the lowest number of leaves plant^{-1} of 2.49, 5.33, 7.54 and 8.53 at 15 DAS, 30 DAS, 45 DAS and at harvest, respectively.



Here, P_1= Broadcast, P_2=Paired row (15 cm × 10 cm), P_3= Square planting (20 cm × 20 cm) and P_4= Row sowing (30 cm × 15 cm)

Fig. 6. Effects of plant spacing on leaves plant^{-1}of blackgram at different DAS

Interaction effects of varieties and plant spacing

The V_2P_4 treatment combination had the highest number of leaves plant^{-1} (7.40, 22.40, 36.13 and 49.66) at 15, 30, 45 DAS and harvest respectively (Table 3) which was statistically comparable to V_3P_4 (48.27) treatment combination at harvest respectively.

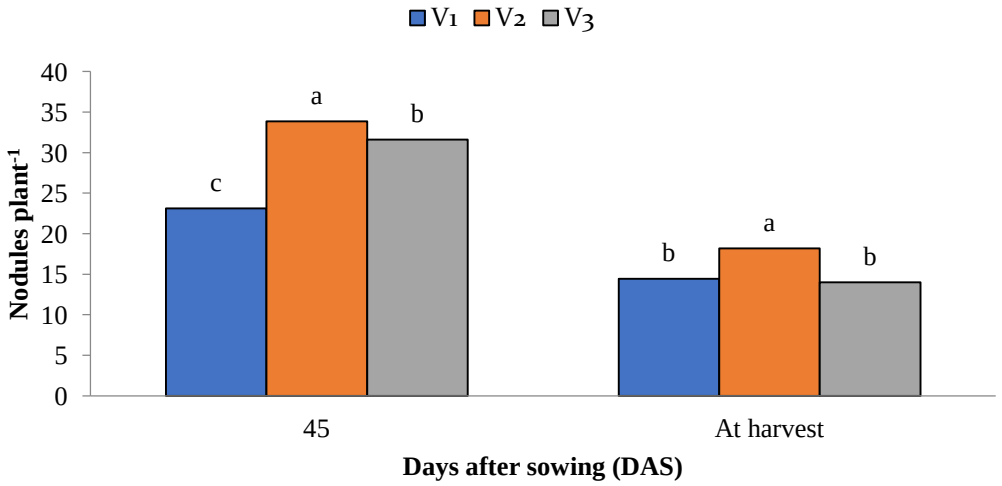
Table 3. Interaction effects of variety and planting geometry on number of leaves plant^{-1}of blackgram at different DAS

Treatment combinations	Leaves plant^{-1}			
	15 DAS	30 DAS	45 DAS	At harvest
V_1P_1	1.33 i	9.00 g	19.52 f	25.40 h
V_1P_2	1.86 h	18.00 de	29.00 c	31.87 f
V_1P_3	3.73 ef	19.27 b-d	31.94 b	34.20 e
V_1P_4	3.90 e	20.20 b	32.27 b	44.34 b
V_2P_1	3.00 g	16.60 e	22.20 e	29.50 g
V_2P_2	4.27 d	16.86 e	26.46 d	37.26 d
V_2P_3	5.20 b	19.73 bc	30.40 bc	41.20 c
V_2P_4	7.40 a	22.40 a	36.13 a	49.66 a
V_3P_1	1.80 h	14.40 f	23.93 e	28.67 g
V_3P_2	3.59 f	16.80 e	24.20 e	32.40 ef
V_3P_3	4.62 c	18.60 cd	31.47 b	36.74 d
V_3P_4	5.03 b	19.60 bc	32.20 b	48.27 a
LSD $_{(0.05)}$	0.26	1.59	2.21	2.25
CV (%)	4.08	5.18	4.56	3.25

Here, V_1 = BINA mash1, V_2 = BARI mash2 and V_3 = BARI mash4, P_1= Broadcast, P_2=Paired row (15 cm × 10 cm), P_3= Square planting (20 cm × 20 cm) and P_4= Row sowing (30 cm × 15 cm)

Effects of varieties on nodules plant^{-1}

The findings of the experiment showed that the V_2 (BARI mash2) treatment had the highest number of nodules plant^{-1} (33.87 and 18.20 at 45 DAS and harvest, respectively). At harvest the lowest number of nodules plant^{-1} (14.00) was observed in V_3 treatment which was statistically comparable to V_1 (14.42) treatment. According to Singh *et al.* (2013), there was a substantial variation in the number of nodules per plant among different urd bean varieties.

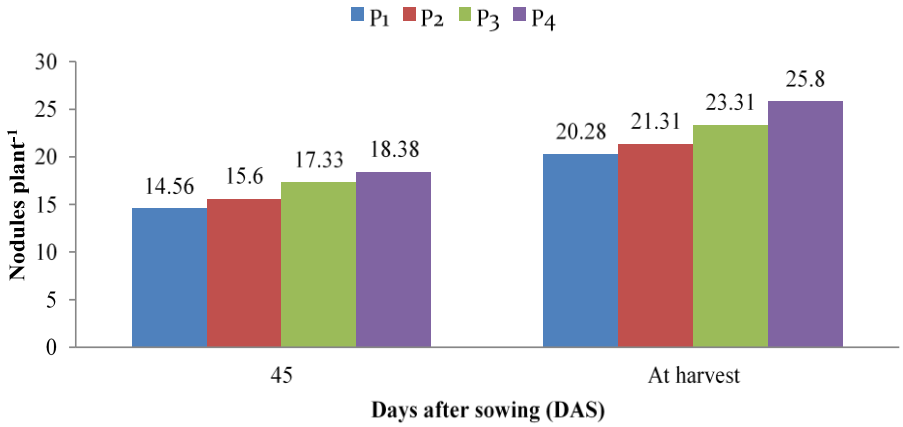


Here, V_1 = BINA mash1, V_2 = BARI mash2 and V_3 = BARI mash4

Fig. 7. Effects of variety on nodules plant^{-1} of blackgram at different DAS

Effects of plant spacing

The P_4 treatment had the maximum number of nodules plant^{-1} (38.82 and 23.34) at 45 DAS and harvest respectively. Rasul *et al*. (2012) also reported that the highest nodules per plant (11.34) of blackgram was found with 30 cm row spacing, which was similar with present findings.



Here, P_1= Broadcast, P_2=Paired row (15 cm × 10 cm), P_3= Square planting (20 cm × 20 cm) and P_4= Row sowing (30 cm × 15 cm)

Fig. 8. Effects of plant spacing on nodules plant^{-1} of blackgram at different DAS

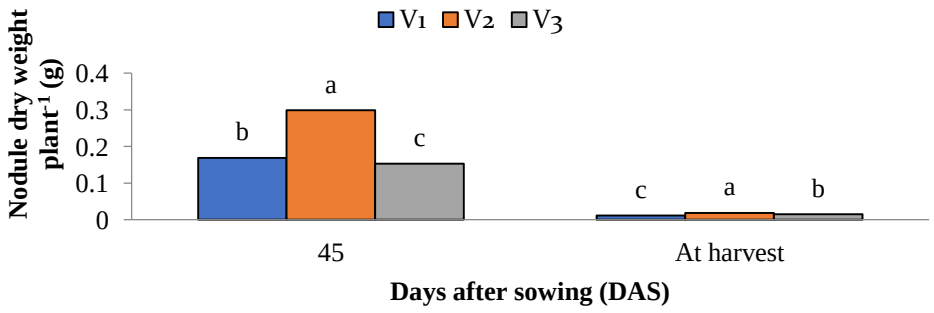
Combined effects of varieties and plant spacing

Combination of variety and plant spacing had shown significant difference in the number of nodule plant^{-1} of blackgram at various days after sowing (Table 4). The highest number of nodules plant^{-1} (40.12 and 25.34) at 45 DAS and harvest, respectively was found in the V_2P_4 treatment combination, which was statistically comparable with the V_3P_4 (38.34). While the lowest number of nodule plant^{-1} (10.0 and 4.34) at 45 DAS and at harvest, respectively was found in the V_1P_1 treatment combination.

Nodules dry weight plant^{-1} (g)

Effects of varieties

The results showed that the V_2 (BARI mash2) had the highest nodule dry weight plant^{-1} (0.299 and 0.019 g) at 45 DAS and at harvest, respectively (Fig. 9). However, at 45 DAS, the V_3 treatment had the lowest nodule dry weight plant^{-1} (0.153 g).

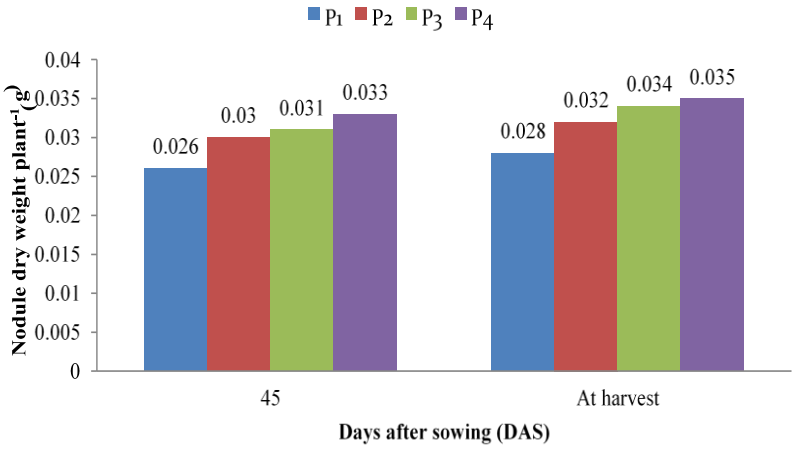


Here, V_1 = BINA mash1, V_2 = BARI mash2 and V_3 = BARI mash4

Fig. 9. Effects of variety on nodules dry weight plant^{-1} of blackgram at different growth stages

Effects of plant spacing

The results showed that the P_4 treatment had the maximum nodules dry weight plant^{-1} (0.298 and 0.023g) at 45 DAS and harvest, respectively (Fig. 10). The result from the findings of Singh *et al.* (2009) revealed that the highest number and dry weight of nodules per plant were 30 cm × 10 cm spacing.



Here, P_1= Broadcast, P_2=Paired row (15 cm × 10 cm), P_3= Square planting (20 cm × 20 cm) and P_4= Row sowing (30 cm × 15 cm)

Fig. 10. Effects of plant spacing on nodules dry weight plant^{-1} at different growth stages

Interaction effects of varieties and plant spacing

Due to the combined effects of plant spacing and variety at different times after planting, the nodule dry weight plant^{-1} of blackgram varied (Table 4). The V_2P_4 treatment combination had the highest nodule dry weight plant^{-1} (0.497 and 0.034 g) at 45 DAS and at harvest. However, at 45 DAS and harvest, respectively, the V_1P_1 treatment combination had the lowest nodule dry weight plant^{-1} (0.098 and 0.007 g).

Table 4. Interaction effects of varieties and plant spacing on number of nodules and nodules dry weight plant^{-1}of blackgram at different DAS

Treatment combinations	Nodule plant^{-1}(no)		Nodules dry weight plant^{-1}(g)	
	45 DAS	At harvest	45 DAS	At harvest
V_1P_1	10.00 h	4.34 g	0.098 e	0.007 f
V_1P_2	19.12 g	12.67 d	0.179 c	0.013 d
V_1P_3	25.34 ef	19.00 c	0.199 c	0.014 d
V_1P_4	38.00 ab	21.67 b	0.199 c	0.014 d
V_2P_1	27.00 e	10.34 e	0.150 d	0.009 e
V_2P_2	34.00 d	12.00 d	0.150 d	0.010 e
V_2P_3	34.34 cd	25.12 a	0.398 b	0.021 b
V_2P_4	40.12 a	25.34 a	0.497 a	0.034 a
V_3P_1	23.67 f	5.00 g	0.130 d	0.009 e
V_3P_2	27.67 e	8.67 f	0.133 d	0.014 d
V_3P_3	36.67 bc	19.34 c	0.149 d	0.016 c

Treatment combinations	Nodule plant^{-1}(no)		Nodules dry weight plant^{-1}(g)	
	45 DAS	At harvest	45 DAS	At harvest
V_3P_4	38.34 ab	23.00 b	0.199 c	0.022 b
$LSD_{(0.05)}$	2.62	1.58	0.02	0.001
CV(%)	4.98	5.60	5.32	5.99

Here, V_1= BINA mash1, V_2= BARI mash2 and V_3= BARI mash4, P_1= Broadcast, P_2=Paired row (15 cm × 10 cm), P_3= Square planting (20 cm × 20 cm) and P_4= Row sowing (30 cm × 15 cm)

Table 5. Interaction effects of variety and planting geometry on number of pods plant^{-1}, pod length (cm), seeds pod^{-1} and 1000-seed weight (g) of blackgram

Treatment Combinations	No. of pods plant^{-1}	Pod length (cm)	Seeds pod^{-1}	1000-seed weight (g)
V_1P_1	15.40 g	5.18 d	7.06 g	38.26 f
V_1P_2	18.73 f	6.87 bc	9.67 f	44.30 e
V_1P_3	20.27 ce	7.05 bc	10.13 f	45.13 de
V_1P_4	20.53 ce	7.09 b	11.27 de	46.03 de
V_2P_1	19.60 ef	6.49 c	11.47 cd	45.57 de
V_2P_2	19.73 df	6.51 c	10.46 ef	46.20 de
V_2P_3	21.40 ac	6.49 c	12.13 bc	47.30 cd
V_2P_4	22.07 ab	7.09 b	12.20 bc	48.83 bc
V_3P_1	20.13 ce	6.51 c	10.20 f	47.57 cd
V_3P_2	20.93 bd	6.77 bc	11.53 bd	50.90 a
V_3P_3	22.00 ab	7.26 ab	12.33 b	51.67 a
V_3P_4	22.40 a	7.82 a	16.87 a	52.90 a
LSD (0.05)	1.31	0.57	0.85	2.49
CV (%)	3.29	4.93	4.00	3.33

Here, V_1 = BINA mash1, V_2 = BARI mash2 and V_3 = BARI mash4. Here, P_1= Broadcast, P_2=Paired row (15 cm × 10 cm), P_3= Square planting (20 cm × 20 cm) and P_4= Row sowing (30 cm × 15 cm

Table 6. Effects of variety and planting geometry on seed yield t ha^{-1}, stover yield t ha^{-1}, biological yield t ha^{-1} and harvest index (%) of blackgram

Treatment Combinations	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
V_1P_1	1.27 j	2.39 f-h	3.66 h	34.67 c
V_1P_2	1.31 ij	2.44 ef	3.75 gh	34.93 c
V_1P_3	1.35 hi	2.46 df	3.81 fg	35.43 c
V_1P_4	1.40gh	2.53 bd	3.93 de	35.64 c

Treatment Combinations	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
V_2P_1	1.43 fg	2.32 h	3.75 gh	38.13 b
V_2P_2	1.47ef	2.36 gh	3.83 eg	38.38 b
V_2P_3	1.50 de	2.39 fh	3.89 df	38.56 b
V_2P_4	1.54 d	2.43 fg	3.97 d	38.79 b
V_3P_1	1.70 c	2.51 ce	4.21 c	40.38 a
V_3P_2	1.74 bc	2.56 ac	4.30 bc	40.47 a
V_3P_3	1.78 ab	2.59 ab	4.37 ab	40.73 a
V_3P_4	1.83 a	2.63 a	4.46 a	41.03 a
LSD (0.05)	0.06	0.07	0.11	1.00
CV (%)	3.13	2.18	3.45	2.27

Here, V_1 = BINA mash1, V_2 = BARI mash2 and V_3 = BARI mash 4. P_1= Broadcast, P_2=Paired row (15 cm × 10 cm), P_3= Square planting (20 cm × 20 cm) and P_4= Row sowing (30 cm × 15 cm)

Conclusion

The study showed that the maximum seed yield (1.83 t ha^{-1}) was achieved when BARI mash4 (V_3) was cultivated with 30 cm × 15 cm spacing (P_4), which had an impact on plant growth and yield-contributing traits. Thus, growing BARI mash4 and spacing plants 30 cm by 15 cm (V_3P_4) are suggested as the optimal crop management techniques for optimizing blackgram yield.

Author's contribution

K. Kader: Conceptualized the research and designed the experiments; conducted data analysis and created visualizations; performed the experiments; wrote the paper. M. Ahmed: Analyzed and interpreted the data. A. K. M. R. Amin and M. F. Karim: Supervised the entire experiment and revised the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this manuscript.

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