Bangladesh Agron. J. 2023, 26(1): 9-17

EFFECT OF LEAF CLIPPING ON GROWTH AND YIELD OF BLACKGRAM (*Vigna mungo* L.)

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(Received: 18 April 2023, **Accepted:** 11 September 2023**)**

Keywords: Pulse crop, source-sink relationship, leaf clipping, blackgram, seed yield

Abstract

An experiment was conducted at Sher-e-Bangla Agricultural University farm, Dhaka to investigate the effect of variety and leaf clipping on the growth and yield of blackgram (*Vigna mungo* L.*)* from March to June-2019. The experiment was laid out in a split-plot design with three replications. The treatments were Blackgram variety (3); V_1: BARI Mash-1, V_2: BARI Mash-2 and V_3: BARI Mash-3, and leaf clipping (4); C_0: No leaf clipping (control), C_1: Clipping of 1st basal leaf, C_2: Clipping of 2nd basal leaves and C_3: Clipping of total apical leaves having no inflorescence. Growth, yield and yield contributing characteristics were compared under different treatments. Results indicated that variety and leaf clipping significantly affected most of the growth and yield contributing characteristics of blackgram. In the case of variety, mthe aximum value of the yield and yield contributing characteristics such as pod^{-1} length (8.99 cm), pods plant^{-1} (14.00), number of seeds pod^{-1} (9.78), 1000 seeds weight (48.58 g), and seed yield (1381.70 kg ha^{-1}), were observed in var. BARI Mash-3. In the case of leaf clipping, maximum pod length (8.44 cm), pods plant^{-1} (15.18), seeds pod (9.32), 1000- seeds weight (48.33 g), seed yield (1306.7 kg ha^{-1}), was recorded in Clipping of 1st basal leaf treatment. The blackgram var. BARI Mash-3 and clipping of 1st basal leaf was found superior in producing maximum pod length (9.32 cm), number of pods plant^{-1} (16.87), number of seeds pod^{-1} (10.80), 1000- seeds weight (51.67 g), and seed yield (1456.70 kg ha^{-1}). So, var. BARI Mash-3 and clipping of 1st basal leaf may improve the growth and yield of blackgram.

Introduction

Pulses constitute an integral part of the human diet and are a potential source of protein for the millions of people of Bangladesh. The per capita pulse consumption in Bangladesh is only 14.3 g day $^{-1}$, much lower than the WHO recommendation of 45 g day^{-1} and the Indian Council of Medical Research recommendation of 60 g day^{-1} (Afzal *et al.,* 1999; HIES, 2010). Among the pulses, blackgram is very much popular in Bangladesh and ranks 3rd in terms of consumption and total area in which different varieties of this crop are cultivated (BBS, 2021). Bangladesh Agricultural Research Institute (BARI) developed several high-yielding varieties such as BARI Mash-1, BARI Mash-2, BARI Mash-3, and BARI Mash-4 (BARI, 2019). But farmers generally grow the local varieties, which affects the seed yield. Cutting leaves from the plant is known as leaf clipping for better growth and development. Photosynthetic active radiation is the major factor regulating photosynthesis and other physiological processes in plants. The dry matter production and yield depends on it to a greater extent. Shading at both 50 and 75% of the full sunlight had significant negative effect on leaf area index (16 - 35%), total dry matter production (11 - 18%), grain yield (19 - 32%) of pulses over full sunlight (Monoj *et al.,* 2019). Defoliation or leaf damage can decreases assimilate availability during grain filling, seed and biological yield (Echarte *et al.,* 2006).

Defoliation up to a certain limit may be useful to overcome this problem of excessive vegetative growth. Rao and Ghildiyal (1985) stated that the remaining leaves of defoliated plant had higher net photosynthetic rate (Pn) than intact plant improving yield. In Bangladesh, few studies have been conducted to determine the effect of variety and leaf clipping on the growth and yield of blackgram. Considering the above facts, the study was undertaken to find out the suitable variety and optimum level of leaf clipping on blackgram seed production.

Materials and Methods

The experiment was conducted in the Agronomy field of Sher-e-Bangla Agricultural University (SAU). The experimental site is geographically situated at 23 77′ N latitude and 90 33′ E longitude and the Agro-ecological zone (AEZ) of "The Modhupur Tract", AEZ-28. The treatments were Blackgram variety (3): V_1=BARI Mash-1 V_2=BARI Mash-2 V_3=BARI Mash-3 and Leaf clipping (5): C_0=No leaf clipping (control), C_1=Clipping of 1st basal leaf, C_2=Clipping of 2nd basal leaf and C_3=Clipping of total apical leaves having no inflorescence. The experiment was laid out in a split-plot design having 3 replications. Blackgram varieties are assigned in the main plot, and leaf clipping treatment is in sub- plot. Fertilizers were applied in the doses of 45, 90, 40, 55, and 10 kg ha^{-1} for urea, TSP, MoP, gypsum, and boric acid, respectively. Seeds were sown at the rate of 35 kg ha^{-1} in the furrow 30cm apart rows at about 2-3 cm depth and treated with bavistin before sowing the seeds to control the seed-borne diseases. Leaf clipping was done at 30 DAS according to treatment variables. Harvesting was done once when 90% of the pods became brown to black in color. Harvest index was calculated on dry basis with the help of following formula.

$$\text{Harvest index (HI\%)} = \frac{\text{Seed yield}}{\text{Biological yield}} \times 100$$

The collected data were compiled and analyzed statistically using comuter package program Statistix 10 Data analysis software and the mean differences were adjusted by Least Significant Difference (LSD) test at a 5% level of probability (Gomez and Gomez, 1984).

Results and Discussion

Plant height

Variety, leaf clipping and treatment combination has showed significant variation on plant height of blackgram at different days after sowing (DAS) (Table 1). The maximum plant height (11.88, 28.35, 47.75, and 53.75 cm at 15, 30, 45 DAS and harvest, respectively) was observed from var. BARI Mash-3 t, which was statistically similar to var. BARI Mash-2 at 30 DAS (26.99 cm) and at harvest (51.67 cm) respectively. Whereas the minimum plant height was observed from BARI Mash-1. The probable reason for this may be the varietal potentiality of the plant. The present study was similar to the findings of Siddikee *et al.* (2018). At 15 DAS maximum plant height (11.50 cm) was observed in clipping of 1st basal leaf treatment, at 30 DAS maximum plant height (27.80 cm) was observed in no leaf clipping treatment which was statistically similar to clipping of 2nd basal leaves and clipping of 1st basal leaf treatment, and at 45 DAS and harvest, respectively the maximum plant height (48.24 cm and 55.20 cm) was observed in clipping of 1st basal leaf treatment. Whereas the minimum plant height at 15 days (10.96 cm) was observed in clipping of 2nd basal leaves treatment which was statistically similar with clipping of total apical leaves having no inflorescence and no leaf clipping, and at 30, 45 DAS, and at harvest, respectively, the minimum plant height (25.51, 41.24, and 47.22 cm, respectively) was observed in clipping of total apical leaves having no inflorescence treatment. Removal of leaves in certain levels may influence growth if the old or bacterial or pest infested leaves or sunburned leaves were

removed. The maximum plant height (12.19 cm and 29.32 cm) at 15 DAS and 30 DAS was observed in BARI Mash-3 with no leaf clipping and (53.07 cm and 58.23 cm) at 45 DAS and at harvest was observed in BARI Mash-3 with clipping of 1st basal leaf treatment combination. Whereas the minimum (10.07 cm) at 15 DAS was observed in BARI Mash-2 with no leaf clipping. At 30, 45 DAS, and harvest, the minimum plant height (24.03, 38.63, and 45.20 cm, respectively) was observed in BARI Mash-1 with clipping of total apical leaves having no inflorescence.

Table 1. Effect of variety, leaf clipping and combination of treatment on the plant height and branch no. plant^{-1} of blackgram at different DAS

	Plant height (cm)				Branch no plant^{-1}		
	15 DAS	30 DAS	45 DAS	At harvest	30 DAS	45 DAS	At harvest
Variety							
V_1	10.61c	25.83b	40.96c	48.19b	0.43c	3.27c	4.15c
V_2	10.91b	26.99a	44.58b	51.67a	0.57b	4.67b	5.68b
V_3	11.88a	28.34a	47.75a	53.75a	0.85a	6.28a	6.88a
LSD (0.05)	0.52	1.55	2.11	2.34	0.05	0.18	0.35
Leaf clipping							
C_0	11.06b	27.80a	44.77b	51.92b	0.53c	4.53b	5.33b
C_1	11.50a	27.46a	48.24a	55.20a	0.91a	4.91a	5.91a
C_2	10.96b	27.47a	43.48b	50.47b	0.64b	4.87a	5.60b
C_3	11.01b	25.51b	41.24c	47.22c	0.38d	4.64b	5.24c
LSD (0.05)	0.40	1.21	1.67	1.83	0.04	0.14	0.29
Combination of treatment							
V_1C_0	10.93 cd	26.60 cd	40.00 ef	45.97 fg	0.47 ef	3.33 ef	4.13 e
V_1C_1	10.73 de	26.11 c-e	43.70 cd	52.53 cd	0.53 e	3.53 e	4.33 e
V_1C_2	10.36 de	26.60 cd	41.50 d-f	49.07 ef	0.40 fg	3.27 f	4.27 e
V_1C_3	10.41 de	24.02 e	38.63 f	45.20g	0.33 g	2.93 g	3.87 e
V_2C_0	10.07 e	27.49 a-d	45.90 bc	53.60 bc	0.67 d	4.73 cd	5.67 cd
V_2C_1	12.05 a	27.11 b-d	47.97 b	54.83 bc	0.80 c	4.53 d	6.13 c
V_2C_2	10.49 de	27.73 a-d	42.93 d	50.00 de	0.40 fg	4.87 c	5.73 c
V_2C_3	11.03 b-d	25.67 de	41.53 de	48.23 e-g	0.40 fg	4.53 d	5.20 d
V_3C_0	12.19 a	29.32 a	48.40 b	56.20 ab	0.47 ef	5.53 b	6.80 ab
V_3C_1	11.73 ab	29.15 ab	53.0 7 a	58.23 a	1.40 a	6.67 a	7.27 a
V_3C_2	12.03 a	28.09 a-c	46.00 bc	52.33 cd	1.13 b	6.47 a	6.80 ab
V_3C_3	11.59 a-c	26.83 cd	43.55 cd	48.23e-g	0.40 fg	6.47 a	6.67 b
LSD (0.05)	0.70	2.10	2.89	3.17	0.07	0.25	0.51
CV (%)	3.67	4.53	3.79	3.61	6.62	3.05	5.28

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. V_1: BARI Mash-1, V_2: BARI Mash-2, and V_3: BARI Mash-3, and C_0: No leaf clipping (control), C_1: Clipping of 1st basal leaf, C_2: Clipping of 2nd basal leaves and C_3: Clipping of total apical leaves having no inflorescence

Branches plant^{-1}

Variety, leaf clipping and treatment combination has showed significant variation on the branches plant^{-1} of blackgram (Table 1). The maximum number of branches plant^{-1} (0.85, 6.28 and 6.88) at 30, 45 DAS, and at harvest, respectively) was observed in BARIMash-3 treatment. Whereas numerically, the minimum number of branches plant^{-1} (at 30, 45 DAS, and at harvest,

respectively) was observed from BARI Mash-1. Probably the varietal performance was responsible for the variation in branches plant^{-1} of blackgram. Sunil *et al.* (2020) was also found similar results which supported the finding. The maximum number of branches plant^{-1} (0.91, 4.91, and 5.91 at 30, 45 DAS, and at harvest, respectively) was observed in clipping of 1st basal leaf treatment, which was statistically similar to clipping of 2nd basal leaves treatment at 45 DAS. Whereas the minimum number of branches plant^{-1} (0.38) at 30 DAS was observed in clipping of total apical leaves having no inflorescence treatment, at 45 DAS, the minimum number of branches plant^{-1} (4.53) was observed in no leaf clipping, which was statistically similar with clipping of total apical leaves having no inflorescence and, at harvest, respectively, the minimum (5.24) was observed in clipping of total apical leaves having no inflorescence treatment, which was statistically similar with no leaf clipping (5.53) treatment during harvest. This could be that these lower leaves, only use photo assimilate for their maintenance apart from losing carbon for respiration. Their removal has certainly helped to get more assimilate on the other parts and thereby enhance plant growth and development, but clipping of total apical leaves having no inflorescence caused injury damages to the plant. As a result, energy was being lost to makeup the injury and plant growth became detritions as a result the number of branches became pore in this part. Ahmed (2017) was also found similar results. The maximum number of branches plant^{-1} (1.40, 6.67, and 7.27 at 30, 45 DAS, and at harvest, respectively) was observed in BARI Mash-3 with clipping of 1st basal leaf treatment combination. Whereas numerically, the minimum number of branches plant^{-1} (0.33, 2.93, and 3.87 at 30, 45 DAS, and at harvest, respectively) was observed in BARI Mash-1 with clipping of total apical leaves having no inflorescence treatment combination.

Above ground dry weight plant^{-1}

The above-ground dry matter weight plant^{-1} of blackgram was not significantly influenced blackgram variety except for leaf clipping and treatment interaction (Table 2). The maximum above-ground dry-weight plant^{-1} (1.59 g) was observed from no leaf clipping treatment at 15 DAS, which was statistically similar to clipping of 1st basal leaf treatment (1.57 g), at 30 DAS, numerically the maximum above-ground dry weight plant^{-1} (4.78 g) was observed form clipping of 1st basal leaf treatment which was statistically similar with no leaf clipping. At 45 DAS and harvest, respectively, the maximum above-ground dry-weight plant^{-1} (6.48 and 8.73 g) was observed in no leaf clipping treatment, which was statistically similar to all other treatments except clipping of total apical leaves having no inflorescence treatment at 45 DAS. Whereas the minimum above-ground dry weight plant^{-1} (1.51 g) was observed from clipping of 2nd basal leaves at 15, 30, 45 DAS, and at harvest respectively, the minimum above-ground dry-weight plant^{-1} (4.61, 6.19, and 7.22 g) was observed form clipping of total apical leaves having no inflorescence, which was statistically similar with clipping of 2nd basal leaves at 30 DAS and at harvest respectively. Sultana *et al.* (2013) was also found similar results. The maximum above-ground dry weight plant^{-1} (1.67, 5.63, 8.03, and 10.13 g at 15 DAS, 30 DAS, 45 DAS, and at harvest, respectively) was observed in BARI Mash-3 with no leaf clipping treatment combination, whereas the minimum above-ground dry weight plant^{-1} (1.47 g) was observed in BARI Mash-2 with clipping of total apical leaves having no inflorescence at 15 DAS, at 30 DAS (4.07 g) was observed in BARI Mash-2 with clipping of 2nd basal leaves, at 45 DAS (4.80) was observed in BARI Mash-1 with clipping of 1st basal leaf and at harvest (5.94 g) was observed in BARI Mash-1 with clipping of 2nd basal leaves treatment combination.

Pod length plant^{-1}

Variety, leaf clipping and treatment combination has showed significant variation on pod length of blackgram (Table 2). The maximum pod length of blackgram (8.99 cm) was observed in BARI Mash-3. In contrast, the minimum pod length plant^{-1} of blackgram (7.67 cm) was observed in BARI Mash-1 which was statistically similar with BARI Mash-2. The probable reason for this

may be the genetically potential of the variety that has helped in increasing pod length of blackgram variety. Sunil *et al.* (2020) and Siddikee *et al.* (2018) found similar result.

The maximum pod length of blackgram (8.44 cm) was observed in clipping of 1st basal leaf treatment which was statistically similar with no leaf clipping and the minimum (7.95 cm) in clipping of total apical leaves having no inflorescence treatment which was statistically similar with clipping of 2nd basal leaves. Leaf removal, may, therefore, influence yield and yield contributing characters through photosynthate production and its distribution into plant parts depending on the magnitude of clipping of leaves. (Biswas *et al.*, 2005). The maximum pod length of blackgram (9.32 cm) was observed in BARI Mash-3 with clipping of 1st basal leaf, whereas the minimum pod length plant^{-1} (7.42 cm) was observed in BARI Mash-1 with clipping of total apical leaves having no inflorescence treatment combinations.

Number of pods plant $^{-1}$

Variety, leaf clipping and treatment combination has showed significant variation on number of pods plant $^{-1}$ of blackgram (Table 2).

Table 2. Effect of variety, leaf clipping and combination of treatment on the above ground dry weight/plant (g), pod length (cm) and pod plant $^{-1}$ of blackgram

Treatment	Above ground dry weight/plant (g)				Pod length (cm)	Pods plant^{-1} (No)
	15 DAS	30 DAS	45 DAS	At harvest		
Variety						
V_1	1.52b	4.45b	5.03c	6.38c	7.66b	11.75c
V_2	1.51b	4.11c	6.40b	7.65b	7.82b	13.32b
V_3	1.62a	5.51a	7.84a	9.50a	8.99a	14.00a
LSD$_{(0.05)}$	0.08	0.18	0.30	0.52	0.38	0.54
Leaf clipping						
C_0	1.59a	4.76ab	6.48a	8.73a	8.16ab	12.11c
C_1	1.57a	4.78a	6.40ab	7.98b	8.44a	15.18a
C_2	1.51b	4.63b	6.63a	7.45c	8.04b	12.91b
C_3	1.52b	4.61b	6.19b	7.22c	7.95b	11.89c
LSD$_{(0.05)}$	0.06	0.14	0.24	0.40	0.31	0.40
Combination of treatment						
V_1C_0	1.59 ab	4.51 cd	4.84 e	7.19 de	7.83 cd	11.47 de
V_1C_1	1.49 bc	4.61 c	4.80 e	6.20 fg	7.92 cd	12.40 c
V_1C_2	1.48 bc	4.31 d-f	5.57 d	5.94 g	7.49 d	12.13 cd
V_1C_3	1.51 bc	4.39 c-e	4.89 e	6.17 fg	7.42 d	11.00 e
V_2C_0	1.51 bc	4.14 ef	6.57 b	8.87 c	7.70 cd	12.40 c
V_2C_1	1.58 a-c	4.17 ef	6.55 b	7.80 d	8.08 c	16.27 a
V_2C_2	1.48 bc	4.07 f	6.49 b	7.19 de	7.56 cd	12.40 c
V_2C_3	1.47 c	4.09 f	5.99 c	6.74 ef	7.79 cd	12.20 c
V_3C_0	1.67 a	5.63 a	8.03 a	10.13 a	8.93 ab	12.47 c
V_3C_1	1.64 a	5.55 ab	7.84 a	9.92 ab	9.32 a	16.87 a
V_3C_2	1.57 a-c	5.51 ab	7.82 a	9.22 bc	9.09 ab	14.20 b
V_3C_3	1.59 ab	5.35 b	7.68 a	8.75 c	8.63 b	12.47 c
LSD$_{(0.05)}$	0.11	0.25	0.42	0.70	0.53	0.70
CV (%)	4.17	3.07	3.84	5.20	3.82	3.14

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. V_1: BARI Mash-1, V_2: BARI Mash-2, and V_3: BARI Mash-3, and C_0: No leaf clipping (control), C_1: Clipping of 1st basal leaf, C_2: Clipping of 2nd basal leaves and C_3: Clipping of total apical leaves having no inflorescence

The maximum number of pods plant^{-1} of blackgram (14.0) was observed in BARI Mash-3 and the minimum (11.75) in BARI Mash-1 treatment. Siddikee *et al.* (2018) and Mane *et al.* (2018) was also found similar result. The maximum number of pods plant^{-1} of blackgram (15.18)

was observed in clipping of 1st basal leaf treatment and the minimum number of pods plant $^{-1}$ of blackgram (11.89) was observed in clipping of total apical leaves having no inflorescence which was statistically similar with no leaf clipping. The result obtained from the study was similar with the findings of Mondal *et al.* (2011). The maximum number of pods plant^{-1} of blackgram (16.87) was observed in BARI Mash-3 with clipping of 1st basal leaf, whereas the minimum (11.00) was observed in BARI Mash-1 with clipping of total apical leaves having no inflorescence treatment combinations.

Number of seeds pod^{-1}

Variety, leaf clipping and treatment combination has showed significant variation on the number of seeds pod^{-1} of blackgram (Table 3). The maximum number of seeds pod^{-1} of blackgram (9.78) was observed in BARI Mash-3. In contrast, the minimum (7.93) was observed in BARI Mash-1. The probable reason for this may be the genetic potential of the genotype that has helped produce more seeds pod^{-1} on blackgram variety. The result obtained from the study was similar to the findings of Sunil *et al.* (2020). The maximum number of seeds pod^{-1} of blackgram (9.32) was observed in clipping of 1st basal leaf, and the minimum (8.31) was observed in clipping of total apical leaves having no inflorescence, which was statistically similar with no leaf clipping. Removal of leaves in certain levels may influence growth such as if the old or bacterial or pest infested leaves or sun burn leaves were removed, it helps the plant for saving energy, which may be translocated to the others part, which influences the yield contributing characters to plant, but if the sources were removed excessively then its cause detritions and low yield of the plant. The result obtained from the present study was similar to Sultana *et al.* (2013). The maximum number of seeds pod^{-1} of blackgram (10.80) was observed in BARI Mash-3 with clipping of 1st basal leaf, whereas the minimum (7.27) was observed in BARI Mash-1 with Clipping of total apical leaves having no inflorescence treatment combinations.

1000-seed weight

Variety, leaf clipping and treatment combination has showed significant variation on 1000 seeds weight of blackgram (Table 3). The maximum 1000-seed weight of blackgram (48.58 g) was observed in BARI Mash-3, and the minimum (39.0 g) was observed in BARI Mash-1 treatment. The probable reason for this may be the genetic potential of the genotype that has helped in producing more seeds pod^{-1} on blackgram variety. The maximum 1000-seed weight of blackgram (48.33 g) was observed in clipping of 1st basal leaf, and the minimum (40.33 g) was observed in clipping of total apical leaves having no inflorescence treatment. Removing these relative sinks probably reduced this competition, resulting in a significant increase in 1000-seed weight (Sultana *et al.,* 2013). The maximum 1000-seed weight of blackgram (51.67 g) was observed in BARI Mash-3 with clipping of 1st basal leaf, whereas the minimum was observed in BARI Mash-1 with clipping of total apical leaves having no inflorescence treatment combination.

Seed yield

Variety, leaf clipping and treatment combination has showed significant variation on grain yield (kg ha^{-1}) of blackgram (Table 3). The maximum grain yield of blackgram (1381.70 kg ha^{-1}) was numerically observed in BARI Mash-3, and the minimum (1115.50 kg ha^{-1}) was observed in BARI Mash-1 treatment. This increase in seed yield of blackgram varieties might be due to the higher production efficiency that has been reflected through improvement in different yield attributing characters. Sunil *et al.* (2020), Mane *et al. (*2018), and Jadhav *et al.* (2014) also found similar results in the study. The maximum grain yield of blackgram (1306.70 kg ha^{-1}) was observed in clipping of 1st basal leaf, and the minimum (1127.30 kg ha^{-1}) was observed in clipping of total apical leaves having no inflorescence treatment. Seed yield was greater in basal 2 leaves defoliated plant (5.95 t ha $^{-1}$) than the top defoliated ones (0.90 t ha $^{-1}$) i.e., defoliation of basal four leaves

caused a reduction of only 35.3% seed yield than control. In contrast, the top four leaves defoliation caused a 61.6% yield reduction. These results indicate that upper leaves contribute more assimilate to the sink than the basal leaves. This is possible because upper leaves are younger, capture more sunlight than the basal leaves, and produce more assimilation. Rao and Ghildiyal (1985), and Mariko and Hogetsu (1987) was also found similar results. The maximum grain yield of blackgram (1456.70 kg ha^{-1}) was observed in BARI Mash-3 with clipping of 1st basal leaf treatment combinations and the minimum (982.00 kg ha^{-1}) was observed in BARI Mash-1 with clipping of total apical leaves having no inflorescence.

Stover yield

Variety, leaf clipping and treatment combination has showed significant variation on stover yield (kg ha^{-1}) of blackgram (Table 3). The maximum stover yield of blackgram (3620.50 kg ha^{-1}) was observed in BARI Mash-3, and the minimum (3290.80 kg ha^{-1}) in BARI Mash-1 which was statistically similar to BARI Mash-2. Mane *et al.* (2018) found similar result which supported the study. The maximum stover yield of blackgram (3651.10 kg ha^{-1}) was observed in no leaf clipping, and the minimum (3233.30 kg ha^{-1}) was observed in clipping of total apical leaves having no inflorescence, which was statistically similar to the clipping of 1st basal leaf treatment. The maximum stover yield of blackgram (3953.30 kg ha^{-1}) was observed in BARI Mash-3 with no leaf clipping, and numerically the minimum (3073.30 kg ha^{-1}) was observed in BARI Mash-1 with clipping of total apical leaves having no inflorescence combination.

Biological yield

Variety, leaf clipping and treatment combination has showed significant variation on biological yield of blackgram (Table 3). The maximum biological yield of blackgram (5002.20 kg ha^{-1}) was observed in BARI Mash-3, and the minimum (4406.30 kg ha^{-1}) was observed in BARI Mash-1 treatment which was statistically similar to BARI Mash-2. The higher biological yield of BARI Mash-3 as compared to BARI Mash-1 might be due to the accumulation of more dry matter and higher biomass potential. Mane *et al.* (2018) and Siddikee *et al.* (2018) was also found simila results. The maximum biological yield of blackgram (4868.20 kg ha^{-1}) was observed in no leaf clipping, which was statistically similar to clipping of 2nd basal leaves and the minimum (4360.70 kg ha^{-1}) in clipping of total apical leaves having no inflorescence treatment. The maximum biological yield of blackgram (5313.30 kg ha^{-1}) was observed in the BARI Mash-3 with no leaf clipping treatment combination, whereas the minimum in BARI Mash-1 with clipping of total apical leaves having no inflorescence. Excess removal of source (Leaves) reduced dry matter production, ultimately reducing yield. As biological yield is the combination of grains and stover yield, excess removal of leaves alters the growth, which influences the yield contributing characters as a result yield and growth were reduced.

Harvest index

Variety, leaf clipping and treatment combination has showed significant variation on harvest index (%) of blackgram (Table 3). The maximum harvest index of blackgram (27.66%) was observed in the BARI Mash-3 whereas the minimum (25.30%) in BARI Mash-1 which was statistically similar to BARI Mash-2. Jadhav *et al.* (2014) also reported that black gram varieties differed significantly in harvest index. The maximum harvest index of blackgram (27.80%) was observed in clipping of 1st basal leaf treatment. The minimum harvest index of blackgram (24.97%) was observed in no leaf clipping treatment, which was statistically similar to clipping of total apical leaves having no inflorescence (25.77%) treatment. Biswas *et al.* (2005) was reported that the effect of defoliation on the harvest index varied significantly with the clipping treatments. It was higher in 33 and 66% defoliation (average of 24.5%) than in control and 100% defoliation (average of 22.7%). The maximum harvest index of blackgram (28.81%) was observed in the

BARI Mash-3 with clipping of 1st basal leaf treatment combination, whereas the minimum harvest index of blackgram (23.91%) was observed in the BARI Mash-1 with no leaf clipping treatment combination.

Table 3. Effect of variety, leaf clipping and combination of treatment on the seeds pod^{-1}, 1000 -seed weight (g), seed yield (kg ha^{-1}), stover yield (kg ha^{-1}), biological yield (k g ha^{-1}) and harvest index (%) of blackgram

Treatment	Seeds pod^{-1} (no.)	1000 -seed weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Variety						
V_1	1.52b	4.45b	5.03c	6.38c	7.66b	11.75b
V_2	1.51b	4.11c	6.40b	7.65b	7.82b	13.32b
V_3	1.62a	5.51a	7.84a	9.50a	8.99a	14.00a
LSD$_{(0.05)}$	0.08	0.18	0.30	0.52	0.38	0.54
Leaf clipping						
C_0	1.59a	4.76ab	6.48a	8.73a	8.16ab	12.11c
C_1	1.57ab	4.78a	6.40ab	7.98b	8.44a	15.18a
C_2	1.51b	4.63b	6.63a	7.45c	8.04bc	12.91b
C_3	1.52b	4.61b	6.19b	7.22c	7.95c	11.89c
LSD $_{(0.05)}$	0.06	0.14	0.24	0.40	0.31	0.40
Combination of treatment						
V_1C_0	7.73 ef	37.33 gh	1096.70 g	3490.00 b-d	4586.70 cd	23.91 e
V_1C_1	8.40 de	44.00 c-e	1223.30 ef	3266.70 de	4490.00 cd	27.26 a-c
V_1C_2	8.33 de	40.00 fg	1160.00 fg	3333.30 b-e	4493.30 cd	25.82 b-d
V_1C_3	7.27 f	34.67 h	982.00 h	3073.30 e	4055.30 e	24.22 de
V_2C_0	9.00 cd	46.33 b-d	1194.70 ef	3510.00 b-d	4704.70 c	25.39 de
V_2C_1	8.77 cd	49.33 ab	1240.00 de	3296.70 c-e	4536.70 cd	27.33 ab
V_2C_2	7.93 ef	43.00 df	1206.70 ef	3486.70 b-d	4693.30 c	25.71 b-d
V_2C_3	8.87 cd	41.67 ef	1100.00 g	3290.00 de	4390.00 d	25.06 de
V_3C_0	9.40 bc	47.00 bc	1360.00 bc	3953.30 a	5313.30 a	25.60 c-e
V_3C_1	10.80 a	51.67a	1456.70 a	3600.00 b	5056.70 ab	28.81 a
V_3C_2	10.13 ab	51.00a	1410.00 ab	3592.00 bc	5002.00 b	28.20 a
V_3C_3	8.80 cd	44.67 c-e	1300.00 cd	3336.70 b-e	4636.70 cd	28.04 a
LSD $_{(0.05)}$	0.74	3.99	70.03	301.21	291.56	1.72
CV (%)	4.88	5.26	3.33	5.11	3.64	3.81

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. V_1: BARI Mash-1, V_2: BARI Mash-2, and V_3: BARI Mash-3, and C_0: No leaf clipping (control), C_1: Clipping of 1st basal leaf, C_2: Clipping of 2nd basal leaves and C_3: Clipping of total apical leaves having no inflorescence

Conclusion

From the above findings, it can be concluded that most of the growth, yield, and yield-contributing characteristics of blackgram gave the best performance from var. BARI Mash-3. Again, Leaf clipping of 1st basal leaf showed the best performance regarding most yield and yield-contributing characteristics. In the case of combined effect, var. BARI Mash-3 and clipping of 1st basal leaf gave the best result in producing the maximum pod length, number of pods plant^{-1}, number of seeds pod$^{-1,}$ and 1000- seeds weight, which ultimately influences seed yield. The highest seed yield was obtained from BARI Mash-3, and clipping of 1st basal leaf of blackgram treatment combination can be treated as the best treatment combination in this study.

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