GROWTH AND YIELD OF BLACKGRAM AS AFFECTED BY LEAF CLIPPING

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CERTIFICATE

*This is to certify that thesis entitled, "**GROWTH AND YIELD OF BLACKGRAM AS AFFECTED BY LEAF CLIPPING**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (M.S.) in AGRONOMY**, embodies the result of a piece of bona-fide research work carried out by **Ajmary Sultana,** Registration no. **18-09271** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Date:

Place: Dhaka, Bangladesh

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Dedicated

To

My Beloved Parents

And Respected Teachers

Whose Prayers, Efforts

And Wishes

Are an

Inspiration

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The Author

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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 during March to June-2019. The experiment was consisted of two factors. Factor A: Blackgram variety (3); V_1: BARI Mash-1, V_2: BARI Mash-2 and V_3: BARI Mash-3, and Factor B: 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. The experiment was laid out in split plot design with three replications. Growth, yield and yield contributing characteristics like plant height, branches plant^{-1}, above ground dry weight plant^{-1}, pod length, pods plant^{-1}, seeds pod^{-1}, thousand seed weight, seed yield, stover yield, biological yield and harvest index were compared under different treatments. Results indicated that variety and leaf clipping had significant effect on most of the growth and yield contributing characteristics of blackgram. In case of variety maximum 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 V_3 (BARI Mash-3) treatment. In 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 observed in C_1 (Clipping of 1st basal leaf) treatment. In case of combined effect, V_3C_1 (BARI Mash-3 and clipping of 1st basal leaf of blackgram) treatment 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}). The corresponding lowest values were obtained in V_1C_3 (BARI Mash-1 along with clipping of total apical leaves having no inflorescence) treatment combination. So, BARI Mash-3 along with clipping of 1st basal leaf may improve growth & yield of blackgram.

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LIST OF ACRONYMS

AEZ	Agro-Ecological Zone
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
Co	Cobalt
CV%	Percentage of coefficient of variance
cv.	Cultivar
DAE	Department of Agricultural Extension
DAS	Days after sowing
^{0}C	Degree Celsius
et al	And others
FAO	Food and Agriculture Organization
G	gram(s)
ha^{-1}	Per hectare
HI	Harvest Index
Kg	Kilogram
Max	Maximum
Mg	Milligram
Min	Minimum
MoP	Muriate of Potash
N	Nitrogen
No.	Number
NS	Not significant
%	Percent
SAU	Sher-e-Bangla Agricultural University
SRDI	Soil Resources Development Institute
TSP	Triple Super Phosphate
UPOV	Union for the Protection of Plant Varieties
Wt.	Weight

CHAPTER 1

INTRODUCTION

Agricultural sector is the backbone of Bangladesh economy providing employment to 45 % of the total population and contributes about 14.79% of GDP (BER, 2017). Pulses constitute an integral part of human diet and are potential source of protein for the millions of people of Bangladesh. Pulses provide significant nutritional and health benefits, and are known to reduce several non-communicable diseases such as colon cancer and cardiovascular diseases (Yude *et al.,* 1993; Jukanti *et al.,* 2012). They contribute 2.3% value added to agriculture in Bangladesh (Niaz *et al.,* 2013). Pulses are considered as "the meat of the poor" because still pulses are the cheapest source of protein (Hamjah, 2014). Pulses are popular and common food, people take this food almost alternate a day, so, this can play an important role to reduce the malnutrition for the poor people of the country. The per capita consumption of pulse in Bangladesh is only 14.3 g day^{-1}, which is much lower than WHO recommendation of 45 g day^{-1} and Indian Council of Medical Research recommendation of 60 g day-^{1} (HIES, 2010; Afzal *et al.,* 1999). With the increase production of nutrient-rich crops like more pulses and oilseeds, farmers can ensure reduction of poverty at grass root-level with increase nutritional food security (Rahman and Zilani, 2009). 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, 2014). Blackgram is very nutritious as it contains high levels of protein (25 g), potassium (983 mg), calcium (138 mg), iron (7.57 mg), niacin (1.447 mg), thiamine (0.273 mg), and riboflavin (0.254 mg) per 100g. Among the pulses, 45-50 % area covered by black gram in Jamalpur and 75-80% area in Sherpur district. Total cultivated area in Bangladesh is 9805360 hectares of which 44.63%, 18.28% and 10.20% are suitable, moderately suitable and marginally suitable respectively for blackgram production (BARC, 2016). The main constraints faced by black gram grower were lack of irrigation facility, non-availability of HYV seeds, low output price, labour scarcity, lack of knowledge about improved varieties with their production technology, excessive rainfall after flowering and weak research-extension farmers linkage etc. Farmers also faced some marketing related problems such as limited buyers, price instability, lack of storage facilities and high market toll.

As leguminous crop, blackgram fixes up atmospheric nitrogen (N) for its growth and development and also improved soil fertility and productivity. Corp growth and yield depend on availability of HYV seeds and its cultivation with optimum agronomic management practices.

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 krishi projukti hatboi-2019). Bangladesh Institute of Nuclear Agriculture (BINA) has also developed several blackgram varieties. But farmers generally grow the local varieties, which affected the seed yield. Therefore, attention should be given to increasing yield through the proper selection of high yielding varieties (Singh *et al.,* 2009).

For better growth and development cutting leaves from the plant in known as leaf clipping. There is a general trend that pulses often possess excessive vegetative growth and cause reduction in dry matter production and yield due to shading effects (Ezedinma, 1973; Patel *et al*., 1992) in one hand and utilizing reserves as a respiratory burden of those parasitic leaves on the other (Beevers and Cooper, 1964). Defoliation up to certain limit may, therefore, be useful to overcome this problem of, excessive vegetative growth. Rao and Ghildiyal (1985) stated that the remaining leaves of defoliated plant had high net photosynthetic rate (Pn) than intact plant and this improved yield. The high sink-source ratio increased the photosynthetic rates in the remaining leaves by 33-39% in mungbean (Pandey and Singh, 1984), 20-40% in soybean (Chen and Lia, 1991) and 30-40% in groundnut (Ghosh and Sengupta, 1986). Legume seed yield is primarily dependent on source ability during flowering to early pod-filling (Kokubun and Asahi, 1984). The source ability could be improved through plant architectural manipulation (Kokubun and Watanabe, 1982). Greater light penetration in the canopy through defoliation has reduced the abortion of flowers and immature pods and increased seed yield in pulse crop (Mondal, 2007; Fakir and Biswas, 2001). In Bangladesh few studies have been conducted to find out the effect of variety and leaf clipping on the growth and yield of blackgram.

Considering the above facts, the present study was undertaken to find out the suitable variety and optimum level of leaf clipping on blackgram seed production with the following objectives:

i. To evaluate the performance of three varieties of blackgram.

ii. To determine the effect of leaf clipping on growth and yield of blackgram.

iii. To study the combined effect of variety and leaf clipping towards maximum yield of blackgram.

CHAPTER 2

REVIEW OF LITERATURE

An attempt was made in this section to collect and study relevant information available regarding the effect of variety and leaf clipping on the growth and yield of blackgram to gather knowledge helpful in conducting the present piece of work.

2.1 Effect of variety

2.1.1 Plant height

Siddikee *et al.* (2018) conducted a field experiment at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from September 2014 to January 2015 to find out the effect of N sources on the yield of different blackgram varieties. The experiment was laid out in a split-plot Design with three replications. Nitrogen source was assigned to main plots and varieties to sub-plots. The experiment consisted of two factors such as N sources and blackgram varieties. The treatments were as follows: Factor A: nitrogen sources (3 types) viz. T_1: prilled urea, T_2: biofertilizer, T_3: no nitrogen (control) and Factor B: varieties (4 types) viz. V_1: BARI Mash-1, V_2: BARI Mash-2, V_3: BARI Mash-3 and V_4: local mash. Among the blackgram varieties result showed that at 30, 45, 60, 75 DAS and at harvest; BARI Mash-3 produced the tallest plant (34.20, 43.82, 53.31, 57.93 and 60.95 cm, respectively). In comparison, the shortest plant height (27.03, 37.37, 41.62, 43.89 and 46.93 cm, respectively) was recorded from local variety.

Patidar and Singh (2018) carried out a field experiment during rainy season of 2017 at the Instructional Farm, A.K.S. University, Satna (M.P.) to study the effect of varieties and dates of sowing on growth, yield and quality of black gram [*Vigna mungo* (L.) Hepper]. The treatments consisting of four varieties (IPU-94-1, Sekhar-2, T-9 and PU-19) and three dates of sowing (1st week of July, 2nd week of July, 3rd week of July) were evaluated in factorial randomized block design with three replications. The results revealed that the variety T-9 recorded significantly higher growth and yield-attributes, yield and nutritional quality of blackgram. Amongst the four varieties, T-9 resulted in significantly taller plants (35.5 cm) over other varieties.

2.1.2 Branches plant^{-1}

Sunil *et al.* (2020) was carried out a field experiment at Krishi Vigyan Kendra Chamarajanagar, Karnataka to study the performance of blackgram varieties under rainfed condition of Chamarajanagar district. The experiment was replicated seven times in randomized complete block design (RCBD). The experiment included three varieties namely LBG 625 (Check), LBG 791 and KU14-8. Experiment result revealed that among the varieties tested, the check LBG 791 has significantly recorded higher number of branches (4.92) compared to KU 14-8 (1.68). The probable reason for this may be the genetical potential of the genotype that has helped in producing more number branches on blackgram variety.

2.1.3 Dry matter weight plant^{-1}

Sing *et al*. (2017) set up a field trial during summer season of 2015-16 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Allahabad. The experiment consisted of two different varieties of blackgram (Type-9 and Sekhar-2) and five sources of nutrient (100% Organic, 100% Inorganic, 75% Organic + 25% Inorganic, 50% Organic + 50% Inorganic and 25% Organic + 75% Inorganic on the basis of N & K), which was laid out in randomized block design (RBD) consisting of ten treatment combinations (T_1. var. Type 9 + 100% Organic (FYM + BM), T_2. var. Type 9 +100% Inorganic (DAP + MOP), T_3. var. Type 9 + 75% Organic + 25% Inorganic, T_4. var. Type 9 + 50% Organic + 50% Inorganic, T_5. var. Type 9 + 25% Organic + 75% Inorganic, T_6. var. Sekhar-2 + 100% Organic (FYM + BM), T_7. var. Sekhar-2 + 100% Inorganic (DAP + MOP), T_8. var. Sekhar-2 + 75% Organic + 25% Inorganic, T_9. var. Sekhar-2 + 50% Organic + 50% Inorganic, and T_{10}. var. Sekhar-2 + 25% Organic + 75% Inorganic) with three replications. Plot size was 3 x 3 m for crop seed rate is 25 kg ha^{-1} [*V. mungo* (L.) Hepper]. Result indicated that treatment T_8 (Var. Sekhar-2 + 75% Organic + 25% Inorganic) was significantly influenced on dry weight (12.49g) and it was 21.13% higher compared to lowest dry weight (9.85g) was observed in treatment T_5 (Var. Type 9 + 25% Organic + 75% Inorganic) sources. Favorable effect on dry weight is mainly due to the fact that balanced and combined use of various plant nutrient sources *viz*., 75% Organic + 25% Inorganic results in proper absorption, translocation and assimilation of those nutrients, ultimately increasing the dry-matter

accumulation and nutrient contents of plant and thus showing more uptake of elemental nutrients.

Jadhav *et al.* (2014) conducted a field experiment during Kharif season 2012-13 at experimental farm, AICRP on Water Management, MKV, Parbhani, to entitled the performance of blackgram [*V. mungo* (L.) Hepper] varieties to different sowing dates .The experiment conducted with four sowing dates in main plot viz., D_1: Onset of monsoon (20th June), D_2: 10 days after onset of monsoon (30th June), D_3: 20 days after onset of monsoon (10th July), D_4 : 30 days after onset of monsoon (20th July) and three varieties in sub plot viz., V1 -TAU-1, V2 -BDU-1, V3 -TPU-4. Gross and net plot size viz., 4.5 m x 4.4 m and 3.9 m x 4.0 m, respectively. The soil was medium black, clayey in texture, alkaline in reaction and higher in total soluble salt concentration, low in nitrogen and rich in phosphorus, potassium and lime, alkaline in reaction with high base saturation. Sowing was done by dibbling method. From the result of experiment, it can be concluded that the mean total dry matter per plant was influenced due to black gram varieties. Variety BDU-1 Produce significantly more dry matter as compared to TAU-1 and TPU-4 at all growth stages. This might be due to higher biomass potential of the variety such differential dry matter production in different black gram variety BDU-1 produced significantly more dry matter as compared to TAU-1 and TPU-4 at all growth stages.

2.1.4 Pod length

Sunil *et al.* (2020) completed a field experiment at Krishi Vigyan Kendra Chamarajanagar, Karnataka to study the performance of blackgram varieties under rainfed condition of Chamarajanagar district. The experiment was replicated seven times in randomized complete block design (RCBD). The experiment included three varieties. The varieties included in the test were LBG 625 (Check), LBG 791 and KU14-8. From the experiment result revealed that among the varieties tested, the check LBG 791 has significantly recorded maximum pod length (5.5) compared to LBG 625 (4.9) of blackgram varieties. The probable reason for this may be the genetical potential of the genotype that has helped in increasing pod length of blackgram variety.

Siddikee *et al.* (2018) carried out a field experiment was conducted at the Agronomy field of Central Research Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from September 2014 to January 2015 to study the effect of nitrogen sources on the yield of different black gram varieties. The experiment was laid out in a split-plot Design with three replications. Nitrogen source was assigned to main plots and varieties to sub-plots. The experiment consisted of two factors such as nitrogen sources and blackgram varieties. The treatments were as follows: Factor A: nitrogen sources (3 types) viz. T_1: prilled urea, T_2: biofertilizer, T_3: no nitrogen (control) and Factor B: varieties (4 types) viz. V_1: BARI Mash-1, V_2: BARI Mash-2, V_3: BARI Mash-3 and V_4: local mash. Among the blackgram varieties result showed that varieties showed a significant effect on pod length (cm) of blackgram. The longest pod (5.28 cm) was recorded from BARI Mash-3 and shortest pod length (4.40 cm) was recorded from local variety.

2.1.5 Pods plant^{-1}

Siddikee *et al.* (2018) set up a field experiment to know the the effect of nitrogen sources on the yield of different black gram varieties. The experiment laid out at the Agronomy field of Central Research Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from September 2014 to January 2015 to find out the experiment was laid out in a split-plot Design with three replications. Nitrogen source was assigned to main plots and varieties to sub-plots. The experiment consisted of two factors such as nitrogen sources and blackgram varieties. The treatments were as follows: Factor A: nitrogen sources (3 types) viz. T_1: prilled urea, T_2: biofertilizer, T_3: no nitrogen (control) and Factor B: varieties (4 types) viz. V_1: BARI Mash-1, V_2: BARI Mash-2, V_3: BARI Mash-3 and V4: local mash. Among the blackgram varieties result showed that varieties showed a significant effect on number of pods plant^{-1} of blackgram. The highest number of pods plant^{-1} (39.93) was recorded from BARI Mash-3 and the lowest number of pods plant^{-1} (20.73) was recorded from local variety.

Mane *et al. (*2018) conducted an experiment was at Department of Agril. Meteorology, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, during Kharif season 2016 entitled "Performance of black gram [*V. mungo* (L.) Hepper] varieties in changing weather condition" to find out most suitable week for sowing of blackgram in kharif season, and to study the relationship between meteorological

parameters and different dates of sowing in black gram. The experiment was conducted in split plot design with three replications. Treatments comprised of four sowing dates in main plot treatment i.e., D_1 (25th MW), D_2 (27th MW), D_3 (29th MW) and D_4 (31th MW), with three varieties in sub plot viz. TAU-1, BDU-1 and AKU-15. The experiment was sown with spacing 30×10 cm. Gross and net plot size viz. 4.2 m x 3.5 m and 3.6 m x 3.1 m respectively. The sowing was done by dibbling method on respective dates of sowing. The results obtained from the experiment revealed that the blackgram variety BDU-1 was found to be highly productive as compared to TAU-1 and AKU-15. Variety BDU-1 produced maximum pods plant^{-1} i.e., 24.54 was significantly superior over variety TAU-1 i.e.,23.77, and variety AKU-15 i.e., 21.83.

2.1.6 Seeds pod^{-1}

Sunil *et al.* (2020) directed a field experiment at Krishi Vigyan Kendra Chamarajanagar, Karnataka to study the performance of blackgram varieties under rainfed condition of Chamarajanagar district. The experiment was replicated seven times in randomized complete block design (RCBD). The experiment included three varieties namely LBG 625 (Check), LBG 791 and KU14-8. from the experiment result revealed that among the varieties tested, the check LBG 791 has significantly recorded maximum seeds pod^{-1} (7.65) compared to LBG 625 (6.40) of blackgram varieties.

2.1.7 1000 seed weight

Mane *et al. (*2018) led an experiment to find out the performance of black gram [*V. mungo* (L.) Hepper] varieties in changing weather condition. The experiment was conducted at Department of Agril. Meteorology, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, during Kharif season 2016 entitled. The experiment was conducted in split plot design with three replications. Treatments comprised of four sowing dates in main plot treatment i.e., D_1 (25th MW), D_2 (27th MW), D_3 (29th MW) and D_4 (31th MW), with three varieties in sub plot viz. TAU-1, BDU-1 and AKU-15. The experiment was sown with spacing 30×10 cm. Gross and net plot size viz. 4.2 m x 3.5 m and 3.6 m x 3.1 m respectively. The sowing was done by dibbling method on respective dates of sowing. The results obtained from the experiment revealed that the black gram variety BDU-1 was found to be highly productive as compared to TAU-1 and AKU-15. Variety BDU-1 produced maximum

1000 seed weight i.e. (43.26g) was significantly superior over TAU-1 (42.15g) and AKU-15 (39.93g) variety of blackgram.

Siddikee *et al.* (2018) set up a field experiment at the Agronomy field of Central Research Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from September 2014 to January 2015 to find out the effect of nitrogen sources on the yield of different black gram varieties. The experiment was laid out in a split-plot Design with three replications. Nitrogen source was assigned to main plots and varieties to sub-plots. The experiment consisted of two factors such as nitrogen sources and blackgram varieties. The treatments were as follows: Factor A: nitrogen sources (3 types) viz. T_1: prilled urea, T_2: biofertilizer, T_3: no nitrogen (control) and Factor B: varieties (4 types) viz. V_1: BARI Mash-1, V_2: BARI Mash-2, V_3: BARI Mash-3 and V_4: local mash. Among the blackgram varieties result showed that different variety had a significant effect on 1000 seed weight (g), result revealed that the maximum 1000 seeds weight (45.73 g) was recorded from BARI Mash-3 and the minimum1000 seeds weight (26.50 g) was recorded from local variety.

2.1.8 Seed yield

Sunil *et al.* (2020) conducted a field experiment at Krishi Vigyan Kendra Chamarajanagar, Karnataka to study the performance of blackgram varieties under rainfed condition of Chamarajanagar district. The experiment was replicated seven times in randomized complete block design (RCBD). The experiment included three varieties. The varieties included in the test were LBG 625 (Check), LBG 791 and KU14-8. From the experiment result revealed that the maximum grain yield was obtained with LBG791 (727 kg ha^{-1}) followed by KU14-8 (627 kg ha^{-1}) and (363 kg ha^{-1}).

Mane *et al. (*2018) carried out an experiment to find out the performance of black gram [*V. mungo* (L.) Hepper] varieties in changing weather condition. The experiment was conducted at Department of Agril. Meteorology, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, during Kharif season 2016 entitled. The experiment was conducted in split plot design with three replications. Treatments comprised of four sowing dates in main plot treatment i.e., D_1 (25th MW), D_2 (27th MW), D_3 (29th MW) and D_4 (31th MW), with three varieties in sub plot viz. TAU-1, BDU-1 and AKU-15. The experiment was sown with spacing 30×10 cm. Gross and net

plot size viz. 4.2 m x 3.5 m and 3.6 m x 3.1 m respectively. The sowing was done by dibbling method on respective dates of sowing. The results obtained from the experiment revealed that the black gram variety BDU-1 was found to be highly productive as compared to TAU-1 and AKU-15. Variety BDU-1 produced maximum seed, stover and biological yield (1163kg ha^{-1}), (2312kg ha^{-1}) and (3475kg ha^{-1}) respectively which was significantly superior over rest of varieties.

Panotra *et al.* (2016) directed a field experiment at Agricultural Research Farm, Baruat, U.P during 2008 and 2009 to assess the performance of black gram under different varieties (T-9, PU-19 and PU-35). These varieties were sown on different dates of sowing *viz* 5th August, 15th August and 25th August. From the result of experiment, it can be concluded that variety of black gram PU-35 produce maximum grain yield (11.07 qha^{-1}) followed by PU-19 (10.67 qha^{-1}) and minimum grain yield (10.33 qha^{-1}) was for T-9 variety.

Jadhav *et al.* (2014) carried out a field experiment during Kharif season 2012-13 at experimental farm, AICRP on Water Management, MKV, Parbhani, to entitled the performance of blackgram [*V. mungo* (L.) Hepper] varieties to different sowing dates .The experiment conducted with four sowing dates in main plot viz., D_1 : Onset of monsoon (20th June), D_2 : 10 days after onset of monsoon (30th June), D_3 : 20 days after onset of monsoon (10th July), D_4 : 30 days after onset of monsoon (20th July) and three varieties in sub plot viz., V_1-TAU-1, V_2-BDU-1, V_3-TPU-4. Gross and net plot size viz., 4.5 m x 4.4 m and 3.9 m x 4.0 m, respectively. The soil was medium black, clayey in texture, alkaline in reaction and higher in total soluble salt concentration, low in nitrogen and rich in phosphorus, potassium and lime, alkaline in reaction with high base saturation. Sowing was done by dibbling method. From the result of experiment, it can be concluded that the performance of black gram varieties in respect of seed yield was very encouraging and followed a similar trend that of yield attributes. The black gram variety BDU-1 recorded higher seed yield of (930 kg ha^{-1}) which was significantly superior over varieties TAU-1 and TPU-4. This increase in seed yield of BDU-1 genotype might be due to the higher production efficiency that has been reflected through improvement in different yield attributing characters.

Yadahalli and Palled (2004) conducted a field experiment at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during kharif, 2001. Experiment was laid out in a randomized complete block design with factorial concept. There were 18 treatment combinations consisting of three blackgram genotypes (TAU-1, Manikya and K-3), three dates of sowing (16th June ,1st July and 16th July) and two phosphorus levels (50 kg and 75 kg P2O5 ha^{-1}) with three replications. The study revealed that the yield, yield components, nutrient uptake as well as economics were significantly influenced by blackgram genotypes and dates of sowing. Result showed that from the three genotypes of blackgram (TAU-1, Manikya and K-3) were tried on vertisols under transition tract during Kharif 2001. Genotype TAU-1 recorded significantly higher seed yield (845.41 kg ha^{-1}) compared to K-3 and Manikya. The increase in seed yield of TAU-1 over Manikya and K-3 was to an extent of 10.39% and 22.39% respectively.

2.1.9 Stover yield

Mane *et al. (*2018) carried out an experiment to find out the performance of black gram (*Vigna mungo* (L.) Hepper) varieties in changing weather condition. The experiment was conducted at Department of Agril. Meteorology, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, during Kharif season 2016 entitled. The experiment was conducted in split plot design with three replications. Treatments comprised of four sowing dates in main plot treatment i.e., D_1 (25th MW), D_2 (27th MW), D_3 (29th MW) and D_4 (31th MW), with three varieties in sub plot viz. TAU-1, BDU-1 and AKU-15. The experiment was sown with spacing 30×10 cm. Gross and net plot size viz.4.2 m x 3.5 m and 3.6 m x 3.1 m respectively. The sowing was done by dibbling method on respective dates of sowing. The results obtained from the experiment revealed that the black gram variety BDU-1 was found to be highly productive as compared to TAU-1 and AKU-15. Variety BDU-1 produced maximum seed, stover and biological yield (1163kg ha^{-1}), (2312kg ha^{-1}) and (3475kg ha^{-1}) respectively which was significantly superior over rest of varieties.

2.1.10 Biological yield

Mane *et al. (*2018) led an experiment at Department of Agril. Meteorology, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, during Kharif season 2016 entitled “Performance of black gram [*V. mungo* (L.) Hepper] varieties in

changing weather condition" to find out most suitable week for sowing of black gram in kharif season, and to study the relationship between meteorological parameters and different dates of sowing in black gram. The experiment was conducted in split plot design with three replications. Treatments comprised of four sowing dates in main plot treatment i.e., D_1 (25th MW), D_2 (27th MW), D_3 (29th MW) and D_4 (31th MW), with three varieties in sub plot viz. TAU-1, BDU-1 and AKU-15. The experiment was sown with spacing 30×10 cm. Gross and net plot size viz.4.2 m x 3.5 m and 3.6 m x 3.1 m respectively. The sowing was done by dibbling method on respective dates of sowing. The results obtained from the experiment revealed that the black gram variety BDU-1 was found to be highly productive as compared to TAU-1 and AKU-15. Variety BDU-1 produced maximum seed, stover and biological yield (1163kg ha^{-1}), (2312kg ha^{-1}) and (3475kg ha^{-1}) respectively which was significantly superior over rest of varieties.

Siddikee *et al.* (2018) carried out a field experiment at the Agronomy field of Central Research Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from September 2014 to January 2015 to find out the effect of nitrogen sources on the yield of different black gram varieties. The experiment was laid out in a split-plot Design with three replications. Nitrogen source was assigned to main plots and varieties to sub-plots. The experiment consisted of two factors such as nitrogen sources and blackgram varieties. The treatments were as follows: Factor A: nitrogen sources (3 types) viz. T_1: prilled urea, T_2: biofertilizer, T_3: no nitrogen (control) and Factor B: varieties (4 types) viz. V_1: BARI Mash-1, V_2: BARI Mash-2, V_3: BARI Mash-3 and V4: local mash. Among the blackgram varieties result showed that different variety had a significant effect on seed yield (t ha^{-1}), haulm yield (t ha^{-1}), biological yield (t ha^{-1}) and harvest index (t ha^{-1}) of blackgram. The maximum seed yield (1.49 t ha^{-1}), biological yield (3.68 t ha^{-1}), harvest index (40.49%) was recorded from BARI Mash-3 and corresponding lower value was observed from recorded from local variety.

2.1.11 Harvest index

Jadhav *et al.* (2014) conducted a field experiment to know the performance of blackgram [*Vigna mungo* (L.) Hepper] varieties to different sowing dates during Kharif season 2012-13 at experimental farm, AICRP on Water Management, MKV, Parbhani. The experiment conducted with four sowing dates in main plot viz., D_1: Onset of monsoon (20th June), D_2: 10 days after onset of monsoon (30th June), D_3: 20 days after

onset of monsoon (10th July), D_4: 30 days after onset of monsoon (20th July) and three varieties in sub plot viz., V_1 -TAU-1, V_2 -BDU-1, V_3 -TPU-4. Gross and net plot size viz., 4.5 m x 4.4 m and 3.9 m x 4.0 m, respectively. The soil was medium black, clayey in texture, alkaline in reaction and higher in total soluble salt concentration, low in nitrogen and rich in phosphorus, potassium and lime, alkaline in reaction with high base saturation. Sowing was done by dibbling method. From the result of experiment, it can be concluded that black gram varieties differed significantly in harvest index. The genotype BDU-1 recorded higher harvest index (31.93%) as compared to TAU-1 (31.37 %) and TPU-4 (31.34) which might be due to its higher production efficiency

Yadahalli and Palled (2004) set up a field experiment at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during kharif, 2001. Experiment was laid out in a randomized complete block design with factorial concept. There were 18 treatment combinations consisting of three blackgram genotypes (TAU-1, Manikya and K-3), three dates of sowing (16th June,1st July and 16th July) and two phosphorus levels (50 kg and 75 kg P_2O_5 ha^{-1}) with three replications. The study revealed that the yield, yield components, nutrient uptake as well as economics were significantly influenced by blackgram genotypes and dates of sowing. Result showed that the harvest index of the TAU-1 (37.12 %) and Manikya (38.02 %) were on par and both were significantly higher over K-3 (25.43 %) genotype.

2.2 Effect of leaf clipping

2.2.1 Plant height

Shohana (2018) conducted an experiment at Sher-e-Bangla Agricultural University, Dhaka during the period of March to June 2018 to study the effect of leaf clipping and nitrogen fertilizer on growth and yield of mungbean. The treatment consisted of two leaf clipping *viz*. C_0 = No leaf clipping (Control), C_1 = Leaf clipping (Removal of leaves having no inflorescence) and five nitrogen fertilizer doses *viz.* N_0= 0 kg urea ha^{-1}, N_1= 25 kg urea ha^{-1}, N_2= 50 kg urea ha^{-1}, N_3 = 75 kg urea ha^{-1}, N_4 = 100 kg urea ha^{-1}. The experiment was laid out in split-plot design having three replications. Leaf clipping, levels of nitrogen fertilizer and their interaction had significant influence on growth, yield and yield components of mungbean. There was a significant variation in plant height at 45 and 60 DAS (DAS) due to leaf clipping. The tallest plant (25.94, 41.24 and

43.41cm at 30, 45 and 60 DAS, respectively) was obtained from C_1 (Removal of empty leaf) and the shortest plant (25.53, 39.87 and 42.09 cm at 30, 45 and 60 DAS, respectively) from C_0 (Control)

Ahmed (2017) directed an experiment at the research plot of Sher-e-Bangla Agricultural University Farm, Dhaka during the period from February 2017 to June 2017 to study the effect of leaf clipping and variety on growth and yield of mungbean. The treatment consisted of two leaf clipping *viz*. Co=No leaf clipping (control), C_1=Leaf clipping (Removal of leaves having no inflorescence) and six mungbean varieties *viz.* V_1 = BARI Mung-1, V_2 = BARI Mung-2, V_3 = BARI Mung-3, V_4 = BARI Mung-4, V_5 = BARI Mung-5, V_6 = BARI Mung-6. The experiment was laid out in two factors randomized complete block design (RCBD) design with three replications. From the experiment result revealed that there was a significant variation in plant height at 45 and 55 DAS (DAS) due to the leaf clipping. The tallest plant (12.16, 23.74, 38.339, 51.67 and 57.80 cm at 15, 25, 35, 45 and 55 DAS, respectively) were obtained from C_1 (Removal of empty leaf) and the shortest plant (12.11, 23.71, 38.08, 47.59, and 54.15 cm at 15, 25, 35, 45 and 55 DAS, respectively) from C_0 (Control).

2.2.2 Branches plant^{-1}

Ahmed (2017) conducted an experiment at the research plot of Sher-e-Bangla Agricultural University Farm, Dhaka during the period from February 2017 to June 2017 to study the effect of leaf clipping and variety on growth and yield of mungbean. The treatment consisted of two leaf clipping *viz*., Co= No leaf clipping (control), C_1= Leaf clipping (Removal of leaves having no inflorescence) and six mungbean varieties *viz.* V_1 = BARI Mung-1, V_2 = BARI Mung-2, V_3 = BARI Mung-3, V_4 = BARI Mung-4, V_5 = BARI Mung-5, V_6 = BARI Mung-6. The experiment was laid out in two factors randomized complete block design (RCBD) design with three replications. From the experiment result revealed that the number of branches plant^{-1} was significantly varied with leaf clipping at 45 and DAS. The maximum number of branches plant^{-1}(0.68, 1.42, 2.05 2.51, 2.76 and at15, 25, 35, 45 and 55 DAS, respectively) was obtained from C_1 (leaf clipping) treatment and the minimum number of branches plant^{-1} (0.68, 1.42, 2.05 2.39 and 2.64 at 15, 25, 35, 45 and 55 DAS, respectively) from C_0 (control condition) treatment.

2.2.3 Dry matter weight

Mondal *et al.* (2011) carried out a pot experiments at the pot yard of Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh, during the period, February to May 2007 and 2008 to investigate the effect of defoliations on morphological characters, yield and yield attributing characters in mungbean. Experiment consisted of nine defoliation treatments viz., control, 2, 3, 4, 5 leaves removal from base and from top out of 7 leaves, during flowering stage. Results showed that plant The effect of different degree of defoliation on morpho-physiological characters is plant height, number of raceme bearing nodes, leaf area (LA) and total dry mass (TDM), and reproductive characters rachis length, flower number and reproductive efficiency (RE) was significant. Results revealed that TDM production, were decreased (7.82, 8.66, 7.68, 5.44, 4.11, 5.70, 3.87, 2.80, and 1.55 g plant^{-1}) with increasing the degree of defoliation both from base and top except basal two leaves defoliation in uniculm mungbean plant.

Sultana *et al.* (2013) conducted a field experiment at the experimental farm of Sher-e-Bangla Agricultural University (SAU), Dhaka, during the period from March 2007 to June 2007 to study the influence of different leaf clipping and fertilizer doses on growth and seed yield of mungbean. The trial comprised four treatments on leaf clipping (No removal, removal of new leaves developed after first flowering, removal of subtending leaves beneath the inflorescences and removal of empty leaves), and three treatments on fertilizer doses per hector (10 kg N + 20 kg P_2O_5 + 15 kg K_2O, 20 kg N + 40 kg P_2O_5 + 30 kg K_2O and 30 kg N + 60 kg P_2O_5 + 45 kg K_2O). Results showed that the leaf clipping treatments had significant effect on growth and yield parameters. Leaf clipping exerted significant effect on stover yield (t ha^{-1}) (Table 4). Removal of empty leaves (C_3) obtained stover yield of 2.018 t/ha and removal of new leaves (C_1) of 1.993 t ha^{-1}. Removal of subtending leaves (C_2) had stover yield of 1.800 t ha^{-1}. Such happened because the subtending leaves were major source of assimilates for the reproductive sink.

2.2.4 Pod length plant^{-1}

Sultana *et al.* (2013) set up a field experiment at the experimental farm of Sher-e-Bangla Agricultural University (SAU), Dhaka, during the period from March 2007 to June 2007 to study the influence of different leaf clipping and fertilizer doses on growth and

seed yield of mungbean. The trial comprised four treatments on leaf clipping (No removal, removal of new leaves developed after first flowering, removal of subtending leaves beneath the inflorescences and removal of empty leaves), and three treatments on fertilizer doses per hector (10 kg N + 20 kg P_2O_5 + 15 kg K_2O, 20 kg N + 40 kg P_2O_5 + 30 kg K_2O and 30 kg N + 60 kg P_2O_5 + 45 kg K_2O). Results showed that the leaf clipping treatments had significant effect on growth and yield parameters. Leaf clipping had significant effect on pod length. The tallest pod (11.53 cm) was obtained from C_3 which was similar to C_0 (10.22 cm) and C_1 (10.35 cm) and the shortest pod (9.12 cm) from C_2.

Ibrahim *et al.* (2010) driven a field experiment in 2006 and 2007 on the experimental farm of the Institute for Agricultural Research, Ahmadu Bello University, Samaru, Zaria to determine the effect of stage and intensity of defoliation on the performance of vegetable cowpea. The treatments were laid out in a randomized complete block design replicated three times. The treatment consisted of factorial combination of three growth stages (vegetative, flowering and podding) and five defoliation intensity (0, 25, 50, 75 and 100). Artificial defoliation was carried out at each of the stages at different intensities. Defoliation for vegetative, flowering and podding were carried out at 5, 7 and 9 weeks after sowing respectively. From the experiment result revealed that the intensity of defoliation significantly affected the yield parameters. Pod length was reduced by 100% defoliation. Maximum pod length (12.33 cm) was observed in 0% defoliation which was similar with 25, 50 and 75 % defoliation and minimum pod length (9.11 cm) 100% defoliation.

Biswas *et al*. (2005) conducted an experiments at the field laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh (at 24°75 N latitude and 90°75 E longitude), during the period from November 1999 to April 2000 with the following treatments employed at vegetative stage (55 DAS, DAS): i) control (0%, no leaflet was clipped), ii) 33% defoliation (terminal leaflets of fully expanded pinnately trifoliate leaves were clipped), iii) 66% defoliation (two lateral leaflets of fully expanded pinnately trifoliate leaves were clipped), and iv) 100% defoliation (all leaflets of fully expanded pinnately trifoliate leaves were clipped). Defoliation alters phenology, morphology, and dry mass production and partition. Leaf is the major source of assimilate supply for developing vegetative organs, and young pods and seeds in pulse crops. 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. From the experiment result revealed that Yield contributing characters were also significantly ($P > 0.05$) affected by different defoliation treatments. Number of pod plant^{-1} was greater in 66% defoliation (27) than in 33% defoliation (25), control (22) and 100% defoliation (17.0). Pod length was the highest in control and 33% defoliation (average of 16.2 cm) and the lowest in 66% defoliation (13.5 cm) with pod length being intermediate in 100% defoliation (14.9 cm). Number of seed pod^{-1} was fewer in 66% defoliation than in the others.

2.2.5 Pods plant^{-1}

Mondal *et al.* (2011) carried out a pot experiments to investigate the effect of defoliations on morphological characters, yield and yield attributing characters in mungbean.The experiment was carried out at the pot yard of Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh, during the period, February to May 2007 and 2008. Experiment consisted of nine defoliation treatments viz., control, 2, 3, 4, 5 leaves removal from base and from top out of 7 leaves, during flowering stage. Results showed that plant The effect of different degree of defoliation on morpho-physiological characters is plant height, number of raceme bearing nodes, leaf area (LA) and total dry mass (TDM), and reproductive characters rachis length, flower number and reproductive efficiency (RE) was significant. Results revealed that the effect of defoliation on yield and yield attributes was significant. In general, number of pods and seed yield plant^{-1} was higher in 2009 (22.85 and 6.28 g plant^{-1} for pod number and seed yield, respectively) than in 2008 (20.19 and 5.04 g plant^{-1} for pod number and seed yield, respectively). The number of pods and seed yield was higher in high yielding genotypes (30.01-31.64 plant^{-1} for pod number and 7.59-8.48 g plant^{-1} for seed yield) than in low yielding ones (6.49-13.93 plant^{-1} for pod number and 2.65-3.93 g plant^{-1} for seed yield). The number of pods and seed yield was decreased with increasing defoliation. This decrease was significant only beyond 25% basal defoliation when compared to undefoliated control. Pod number and seed yield were higher in basal defoliated plants than the corresponding top defoliated ones. Contrarily, the reduction of pod number and seed yield were greater in top defoliated

2.2.6 Seeds pod^{-1}

Sultana *et al.* (2013) led a field experiment at the experimental farm of Sher-e-Bangla Agricultural University (SAU), Dhaka, during the period from March 2007 to June 2007 to study the influence of different leaf clipping and fertilizer doses on growth and seed yield of mungbean. The trial comprised four treatments on leaf clipping (No removal, removal of new leaves developed after first flowering, removal of subtending leaves beneath the inflorescences and removal of empty leaves), and three treatments on fertilizer doses per hector (10 kg N + 20 kg P_2O_5 + 15 kg K_2O, 20 kg N + 40 kg P_2O_5 + 30 kg K_2O and 30 kg N + 60 kg P_2O_5 + 45 kg K_2O). Results showed that Higher HI describes the greater partitioning of accumulated dry matter into the economic sink i.e., seed. The HI in mungbean was significantly influenced by both leaf clipping and fertilizer dose treatments. Harvest index was significantly influenced by leaf clipping treatments. Leaf clipping significantly influenced the number of seeds pod^{-1}. Of the leaf clipping treatments, the removal of empty leaves produced the highest number of seeds pod^{-1}(13.18) which was statistically similar to control (11.22) and new leaves removal treatments C_1 (11.10), while the lowest (9.05) was recorded from subtending leaf removal treatment of C_2.

2.2.7 1000 seed weight (g)

Sultana *et al.* (2013) set up a field experiment at the experimental farm of Sher-e-Bangla Agricultural University (SAU), Dhaka, during the period from March 2007 to June 2007 to study the influence of different leaf clipping and fertilizer doses on growth and seed yield of mungbean. The trial comprised four treatments on leaf clipping (No removal, removal of new leaves developed after first flowering, removal of subtending leaves beneath the inflorescences and removal of empty leaves), and three treatments on fertilizer doses per hector (10 kg N + 20 kg P_2O_5 + 15 kg K_2O, 20 kg N + 40 kg P_2O_5 + 30 kg K_2O and 30 kg N + 60 kg P_2O_5 + 45 kg K_2O). Results showed that Higher HI describes the greater partitioning of accumulated dry matter into the economic sink i,e, seed. The HI in mungbean was significantly influenced by both leaf clipping and fertilizer dose treatments. Harvest index was significantly influenced by leaf clipping treatments. Leaf clipping also exerted significant effect on thousand seed weight. The removal of new leaves (C_1) and the removal of lower empty leaves (C_3) significantly increased the 1000 seed weight (38.57g and 39.32g) respectively. While the removal of subtending leaves (C_2) significantly reduced the 1000 seed weight. The new leaves and the lower empty leaves might have played the role of relative sink as new leaves

consume energy for their development and lower shaded leaves require energy for their existence. During seed development, there might have existed a competition for assimilates among the developing seeds and the relative sinks (new leaves and lower shaded empty leaves). The removal of these relative sinks probably reduced this competition resulting in significant increase in 1000 seed weight

2.2.8 Seed yield

Sultana *et al.* (2013) carried out a field experiment at the experimental farm of Sher-e-Bangla Agricultural University (SAU), Dhaka, during the period from March 2007 to June 2007 to study the influence of different leaf clipping and fertilizer doses on growth and seed yield of mungbean. The trial comprised four treatments on leaf clipping (No removal, removal of new leaves developed after first flowering, removal of subtending leaves beneath the inflorescences and removal of empty leaves), and three treatments on fertilizer doses per hector (10 kg N + 20 kg P_2O_5 + 15 kg K_2O, 20 kg N + 40 kg P_2O_5 + 30 kg K_2O and 30 kg N + 60 kg P_2O_5+ 45 kg K_2O). Results showed that higher HI describes the greater partitioning of accumulated dry matter into the economic sink i,e, seed. Leaf clipping exerted significant effect on grain yield (t ha^{-1}). Removal of empty leaves increased grain yield 1.044 t ha^{-1}. Removal of new leaves also increased yield (0.9933 t ha^{-1}). However, due to the removal of subtending leaves a decreased grain yield (0.8167 t ha^{-1}) was obtained. This was expected as the subtending leaves were the major source of assimilates for the reproductive sink. The decrease in grain yield in this treatment might be due to limitation of source for proper development and formation of seeds during pod development stage. As a result of this source removal, probably the number of pods per plant, number of seeds per pod and the individual seed size were reduced which in term leaded to decreased seed yield

Mondal *et al.* (2011) conducted a pot experiment to investigate the effect of defoliations on morphological characters, yield and yield attributing characters in mungbean. The experiment was carried out at the pot yard of Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh, during the period, February to May 2007 and 2008. Experiment consisted of nine defoliation treatments viz., control, 2, 3, 4, 5 leaves removal from base and from top out of 7 leaves, during flowering stage. Results showed that the effect of different degree of defoliation on morpho-physiological characters is plant height, number of raceme bearing nodes, leaf area (LA) and total dry mass (TDM), and reproductive characters rachis length, flower number and reproductive efficiency

(RE) was significant. 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 reduction only 35.3% seed yield than control whereas top four leaves defoliation caused 61.6% yield reduction. These results indicate that upper leaves contribute more assimilate to the sink than the basal leaves. This is possible because of upper leaves are younger and capture more sunlight than the basal leaves, and produce more assimilate.

Rao and Ghildiyal (1985) analyzed source and sink relationship in mungbean var. PS-16 using source and sink alteration technique. Effect of source and sink variation on photosynthesis nodulation, leaf nitrogen and chlorophyll content were examined in relation to growth and yield characters. The data indicated the possible limitation of source in determining the sink yield in Mungbean var PS-16. It appeared however, that sink itself was instrumental in hastening the decrease in photosynthesis and leaf senescence by affecting directly mobilization and utilization of leaf nitrogen and indirectly nodulation.

Mariko and Hogetsu (1987) suggested that the defoliation of sunflower plants showed higher rates of photosynthesis than those of under foliated plants. Defoliation tends to influence the ageing of the remaining or new leaves. Old leaves can be allowed to rejuvenate, matter ones to maintain their vigor and young ones to develop their photosynthesis rapidly. Physiological approaches in breeding for higher yield in mungbean are often directed to increase the total dry matter production and better redistribution of photosynthesis. Plant with high dry matter production capacity does not mean high seed yield potential. Increase in yields over the past decade has been possible mainly through favorable partitioning into grains. It may be shown tor mungbean also the partioning of dry matter seemed to be more favorable for increasing harvest index. Genotypes of a number of crop species with profuse branching often show poor harvest index in spite of high dry matter yield.

2.2.9 Stover yield

Sultana *et al.* (2013) directed a field experiment at the experimental farm of Sher-e-Bangla Agricultural University (SAU), Dhaka, during the period from March 2007 to June 2007 to study the influence of different leaf clipping and fertilizer doses on growth and seed yield of mungbean. The trial comprised four treatments on leaf clipping (No removal, removal of new leaves developed after first flowering, removal of subtending

leaves beneath the inflorescences and removal of empty leaves), and three treatments on fertilizer doses per hector (10 kg N + 20 kg P_2O_5 + 15 kg K_2O, 20 kg N + 40 kg P_2O_5 + 30 kg K_2O and 30 kg N + 60 kg P_2O_5 + 45 kg K_2O). Results showed that leaf clipping exerted significant effect on stover yield (t ha^{-1}) (Table 4). Removal of empty leaves (C_3) obtained stover yield of 2.018 t/ha and removal of new leaves (C_1) of 1.993 t/ha. Removal of subtending leaves (C_2) had stover yield of 1.800 t ha^{-1}. Such happened because the subtending leaves were major source of assimilates for the reproductive sink.

2.2.10 Harvest index

Naznin *et al.* (2020) conducted research to investigate the effect of leaf clipping on growth, flower production, and yield of mungbean [*V. radiata* (L.) Wikzek]. A field experiment was carried out in four mungbean genotypes viz. BINA moog-5, Mutant E4I-915, Mutant N2M-402, and BINA moog-7. The leaf clipping levels of 0%, 33%, and 66% imposed at the vegetative stages (40 DAS) in all four genotypes. The morphological, reproductive, and yield attributes estimated in the study had shown substantial differences for the leaf clipping treatments in all four mungbean genotypes. Leaf area, leaf dry weight, stem dry weight, total dry matter, plant height, number of branches $plant^{-1}$, number of open flowers $plant^{-1}$, number of pods $plant^{-1}$, pod length, number of seed pod^{-1}, 100-seed weight, single pod weight, straw yield, seed yield, and harvest index varied significantly in four mungbean genotypes. Almost all the studied parameters showed statistically identical performance at 0% and 33% leaf clipping level of the mungbean genotypes, and the least performance recorded at 66% leaf clipping. Therefore, mungbean genotypes appeared to compensate for their yield attributes up to 33% leaf clipping at 40 DAS.

Sultana *et al.* (2013) carried out a field experiment at the experimental farm of Sher-e-Bangla Agricultural University (SAU), Dhaka, during the period from March 2007 to June 2007 to study the influence of different leaf clipping and fertilizer doses on growth and seed yield of mungbean. The trial comprised four treatments on leaf clipping (No removal, removal of new leaves developed after first flowering, removal of subtending leaves beneath the inflorescences and removal of empty leaves), and three treatments on fertilizer doses per hector 10 kg N + 20 kg P_2O_5 + 15 kg K_2O, 20 kg N + 40 kg P_2O_5 + 30 kg K_2O and 30 kg N + 60 kg P_2O_5 + 45 kg K_2O). Results showed that higher HI

describes the greater partitioning of accumulated dry matter into the economic sink i,e, seed. The HI in mungbean was significantly influenced by both leaf clipping and fertilizer dose treatments. Harvest index was significantly influenced by leaf clipping treatments. The highest HI (34.08) was obtained with the removal of empty leaves (C_3), while the lowest (31.20) with the removal of subtending leaves (C_2). Removal of subtending leaves had detrimental effect on HI, whereas the removal of empty leaves exerted positive effects on HI.

Mondal *et al.* (2011) set up a pot experiments at the pot yard of Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh, during the period, February to May 2007 and 2008 to investigate the effect of defoliations on morphological characters, yield and yield attributing characters in mungbean. Experiment consisted of nine defoliation treatments viz., control, 2, 3, 4, 5 leaves removal from base and from top out of 7 leaves, during flowering stage. Results showed that plant The effect of different degree of defoliation on morpho-physiological characters is plant height, number of raceme bearing nodes, leaf area (LA) and total dry mass (TDM), and reproductive characters rachis length, flower number and reproductive efficiency (RE) was significant. The effect of defoliation on harvest index (HI) was significant but not consistent with yield and related traits. The highest HI (43.8%) was recorded in top five leaves defoliated plants while it was the lowest (38.0%) in basal four leaves defoliated plants.

Biswas *et al*. (2005) conducted a experiments at the field laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh (at 24°75 N latitude and 90°75 E longitude), during the period from November 1999 to April 2000 with the following treatments employed at vegetative stage (55 DAS, DAS): i) control (0%, no leaflet was clipped), ii) 33% defoliation (terminal leaflets of fully expanded pinnately trifoliate leaves were clipped), iii) 66% defoliation (two lateral leaflets of fully expanded pinnately trifoliate leaves were clipped), and iv) 100% defoliation (all leaflets of fully expanded pinnately trifoliate leaves were clipped). From the experiment result revealed that the effect of defoliation on harvest index varied significantly ($P > 0.05$) with the clipping treatments. It was higher in 33% and 66% defoliation (average of 24.5%) than in control and -100°/0 defoliation (average of 22.7%).

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka to investigate the effect of variety and leaf clipping on the growth and yield of blackgram. Materials used and methodologies followed in the present investigation have been described in this chapter.

3.1 Experimental period

The experiment was conducted during the period from March to June-2019 in Kharif-I season.

3.2 Description of the experimental site

3.2.1 Geographical location

The experiment was conducted at 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 at an altitude of 8.6 meter above sea level (Anon., 2004).

3.2.2 Agro-Ecological Zone

The experimental field belongs to the Agro-ecological zone (AEZ) of "The Modhupur Tract", AEZ-28 (Anon., 1988 a). This was a region of complex relief and soils developed over the Modhupur clay, where floodplain sediments buried the dissected edges of the Modhupur Tract leaving small hillocks of red soils as 'islands' surrounded by floodplain (Anon., 1988 b). For better understanding about the experimental site has been shown in the Map of AEZ of Bangladesh in Appendix-I.

3.2 Soil

The soil texture was silty clay with pH 6.1. The morphological, physical and chemical characteristics of the experimental soil have been presented in Appendix- II.

3.3 Climate and weather

The climate of the experimental site was subtropical, characterized by the winter season from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October (Edris *et al.*, 1979). Meteorological data related to the temperature, relative humidity and rainfall during the experiment period of was collected from Bangladesh Meteorological Department (Climate division), Sher-e-Bangla Nagar, Dhaka and has been presented in Appendix- III.

3.4 Description of the planting materials

BARI Mash-1

Name of the Crop	Blackgram (Mashkalai)
Varity Name	BARI Mash-1
Developed by	Bangladesh Agriculture Research Institute (BARI), Gazipur, Bangladesh
Year of release	1990
Main characteristic	It is a medium statured (45-50cm), semi erect cultivar with basal primary branches, stem pigmentation absent at the seedling stage, but it becomes light green at the late vegetative stage, leaves are dark green with slightly pubescence, leave size is medium with dark green color, short petiole and rachis that forms no tendrils, flowers are white, and pods and leaves turns to straw, seed coat is ash and testa pattern is dotted with smooth seed surface, and cotyledon is yellow. Seed is large, 1000 seed weight 38-43 g compared to 21.5 g or less for the local cultivars. Day neutral, for this reason it is cultivated in kharif-1 and kharif-2, cooking time 30-35 min, planting season August to September.
Crop duration	65-70 days
Yield	1400-1500kg ha^{-1}

BARI Mash-2

Name of the Crop	Blackgram (Mashkalai)
Varity Name	BARI Mash-2
Year of release	1996
Developed By	Pulses Research Centre, Ishurdi, Pabna
Main characteristics	BARI Mash-2 erect, attains a height of 33 to 35cm, it flowers 35 to 40 days after emergence and reaches physiological maturity 70 to 75 days after emergence. Leaves are trifoliate, alternate, and green. Leaf pubescence is present. Potioles are short and purple-green the corolla is yellowish green. The raceme position is above the canopy Mature pods are black and have hair Seeds are drum-shaped and blackish.1000 seed weight 32-36 g,crop duration 65-70 days, sowing time Last February to mid-March (Kharif-I), Mid-August to last August (Kharif-II) and harvesting from Last February to mid-March (Kharif-I), Mid-August to last August (Kharif-II)
Crop Duration	65-70 days
Yield	1400-1500

BARI Mash-3

Name of the Crop	Blackgram (Mashkalai)
Varity Name	BARI Mash-3
Year of release	1996
Developed By	Pulses research centre, Ishurdi, pabna
Main characteristics	BARI Mash-3 has an erect growth habit and attains of 35-37cm. It flowers 35-40 d after emergence and reaches physiological maturity 70-75 days after emergence. Leaves are trifoliate, alternate, and green. Leaf pubescence is present, Petioles are short and purple-green. The corolla is yellowish-green. The raceme position is under the canopy. Mature pods are black with dense pubscence. Seeds are drum-shaped and blackish. Sowing time Last February to mid-March (Kharif-1), Mid-August to last August (Kharif-II) and harvesting time from Last May (Kharif-I), to Last October (Kharif-II).
Crop Duration	65-70 days
Yield	1500-1600

3.5 Treatments under investigation

There were two factors in the experiment namely Blackgram variety and Leaf clipping as mentioned below:

Factor-A: Blackgram variety (3):

a) V_1=BARI Mash-1
b) V_2=BARI Mash-2
c) V_3=BARI Mash-3

Factor-B: Leaf clipping (5):

a) C_0=No leaf clipping (control)
b) C_1=Clipping of 1st basal leaf
c) C_2=Clipping of 2nd basal leaf
d) C_3=Clipping of total apical leaves having no inflorescence

3.6 Experimental design and layout

The experiment was laid out in split-plot design having 3 replications. Black gram varieties assigned in main plot and leaf clipping treatment in sub plot. There are 12 treatment combinations and 36 unit plots. The unit plot size was 5.4 m^2 (2.7 m × 2 m). The blocks and unit plots were separated by 1.0 m and 0.50 m spacing, respectively. the layout of the experimental field was shown in Appendix- IV.

3.7 Land preparation

The experimental land was opened with a power tiller on 25th March, 2019. Ploughing and cross ploughing were done with power tiller followed by laddering. Land preparation was completed on 28th March, 2019 and was ready for sowing seeds.

3.8 Fertilizer application

Urea, triple superphosphate (TSP), Muriate of potash (MoP), zinc sulphate and boric acid fertilizers were used as sources of nitrogen, phosphorus, potassium, zinc, and boron respectively. The doses of fertilizers were 45, 90, 40, 55, and 10 kg ha^{-1} for urea, TSP, MP, Gypsum and boric acid, respectively. Total amount of urea, TSP, MoP,

Gypsum and boric acid were applied at basal doses during final land preparation (BARI krishi projukti hatboi-2019 recommendation). All fertilizers were applied by broadcasting and mixed thoroughly with soil.

3.9 Sowing of seeds

Seeds were sown at the rate of 35 kg ha^{-1} in the furrow on 28th March, 2019 and the furrows were covered with the soils soon after seeding. Seeds were being treated with bavistin before sowing the seeds to control the seed borne disease. The seeds were sown continuously in 30cm apart rows at about 2-3 cm depth in afternoon and covered with soil.

3.10 Intercultural operation

3.10.1 Thinning and weeding

Thinning and weeding were done at 20 DAS when the plant attained at a height of about 10 cm. Plant to plant distance was maintained at 6-7 cm. Second weeding was done at 35 DAS when the plants attained about 30-40 cm height.

3.10.2 Application of irrigation water

The field was irrigated twice- one at 20 days and the other one at 35 DAS.

3.11 Plant protection measures

3.11.1 Insect and pest infestation

Plant was infested with insect and pest at early stage of growth, few worms (*Agrotis ipsilon*) and virus vectors (jassid) attacked the young plants, and at latter stage of growth pod borer (*Maruca testulalis*) attacked the plant.

3.11.2 Management

Dimacron 50EC (Emulsifiable concentrate) was sprayed at the rate of 1litre ha^{-1} to control worms, virus vectors, and pod borer insects.

3.12 Leaf clipping

Leaf clipping was done at 30 DAS according to treatment variables.

3.13 Crop sampling and data collection

Ten (10) plants were selected randomly from each plot and were uprooted for data recording. The data of plant height, number of branches, and above ground dry weight (g) plant^{-1} were recorded from sampled plants at an interval of fifteen days which was started from after seed sowing.

3.14 Harvest and post-harvest operations

Harvesting was done when 90% of the pods became brown to black in color. In this experiment harvesting was done at 2nd June 2019 and harvesting was done only one time. The matured pods were collected by hand picking from a pre demarcated area of 1 m^2 at the center of each plot**.**

3.15 Data collection

The data were recorded on the following parameters

a) Plant height
b) Above ground dry matter weight plant^{-1}
c) Branches plant^{-1}
d) Pods plant^{-1}
e) Seeds pod^{-1}
f) 1000-seed weight
g) Seed yield
h) Stover yield
i) Biological yield and
j) Harvest index

3.16 Procedure of recording data

i. Plant height (cm)

The height of the selected plant was measured from the ground level to the tip of the plant at 15, 30, 45 DAS and harvest.

ii. Branches plant^{-1} (no.)

The branches plant^{-1} was counted from ten randomly sampled plants. It was done by counting total number of branches of all sampled plants then the average data were recorded.

iii. Above ground dry matter weight plant^{-1}(g)

Ten plants were collected randomly from each plot at 15, 30, 45 DAS and harvest. The sample plants were oven dried for 72 hours at 70°C and then dry matter content plant^{-1} was determined.

iv. Pods plant^{-1} (no.)

Pods plant^{-1} was counted from the 10 selected plant sample and then the average pod number was calculated.

v. Seeds pod^{-1} (no.)

Seeds pod^{-1} was counted from 20 selected pods of plants and then the average seed number was calculated.

vi. 1000-seed weight (g)

1000-grains were counted which were taken from the grain sample of each plot separately, then weighed in an electrical balance and data were recorded.

vii. Seed yield (kg ha^{-1})

1. Seed yield was recorded on the basis of total harvested grains plot^{-1} and was expressed in terms of yield (kg ha^{-1}). Grain yield was adjusted to 12% moisture content.

viii. Stover yield (kg ha^{-1})

After separation seeds from the plant, the left pats of the plant are known as stover. Stover obtained from each individual plot was dried, weighed carefully and the yield expressed in kg ha^{-1}.

ix. Biological yield (t ha^{-1})

The summation of seed yield and stover yield was the biological yield. Biological yield =Seed yield + Stover yield.

x. Harvest index (%)

Harvest index was calculated on dry basis with the help of following formula.

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

Here, Biological yield = Seed yield + stover yield

3.17 Data analysis technique

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

CHAPTER 4

RESULTS AND DISCUSSION

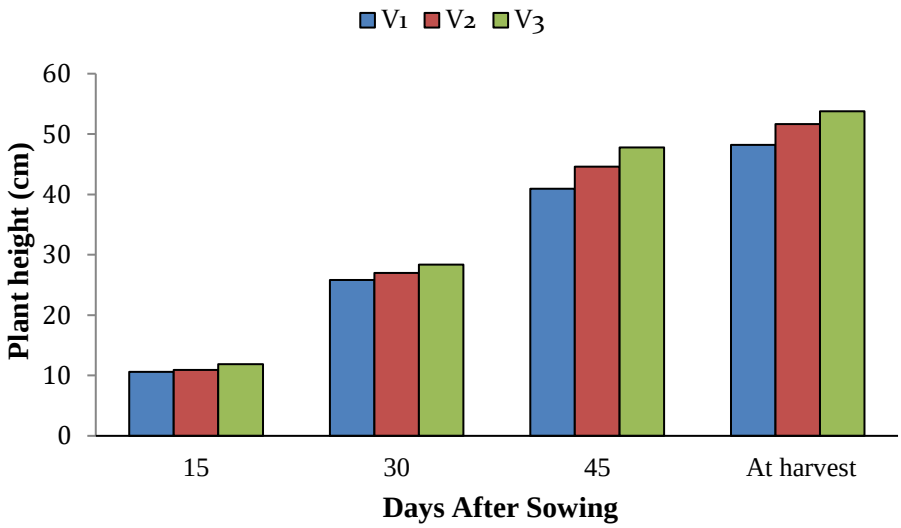
The data on different growth, yield contributing characters and yield were recorded to find out the suitable variety and leaf clipping on blackgram. The results have been presented and discussed and possible explanation have been given under the following headings:

4.1 Plant growth parameters

4.1.1 Plant height

4.1.1.1 Effect of variety

Plant height is an important morphological character that acts as a potential indicator of availability of growth resources in its approach. From this experiment, result revealed that variety showed significant effect on plant height of blackgram at different DAS (Fig. 1 and Appendix V). From the experiment 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 V_3 treatment, which was statistically similar with V_2 treatment at 30 DAS (26.99 cm) and at harvest (51.67 cm) respectively. Whereas the minimum plant height (10.61, 25.84, 40.96 and 48.19 cm at 15, 30, 45 DAS and at harvest respectively) was observed from V_1 treatment. The probable reason for this may be the varietal potentiality of the plant that helped in utilizing more its surrounding resources such as nutrients, water, sun light etc which influences the growth of blackgram variety. The result obtained from the present study was similar with the findings of Siddikee *et al.* (2018), and Patidar and Singh (2018).



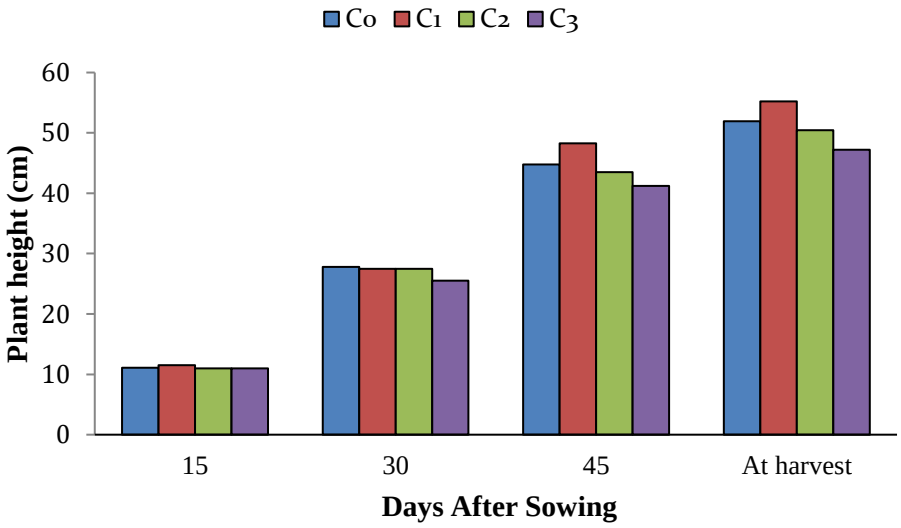
V_1: BARI Mash-1, V_2: BARI Mash-2, and V_3: BARI Mash-3

Figure 1 Effect of variety on the plant height of blackgram at different DAS ($LSD_{(0.05)}$= 0.52, 1.55, 2.11 and 2.34 at 15, 30, 45 DAS and harvest respectively).

4.1.1.2 Effect of leaf clipping

A cutting consisting of a leaf instead of a shoot commonly used in propagating a plant in known as leaf clipping. Plant height of blackgram significantly differed due to the leaf clipping (Fig 2 and Appendix V). At 15 DAS maximum plant height (11.50 cm) was observed in C_1 treatment, at 30 DAS maximum plant height (27.80 cm) was observed in C_0 treatment which was statistically similar with C_2 (27.47 cm) and C_1 (27.46 cm) treatment, and at 45 DAS and harvest respectively the maximum plant height (48.24 cm and 55.20 cm) was observed in C_1 treatment. Whereas the minimum plant height at 15 days (10.96 cm) was observed in C_2 treatment which was statistically similar with C_3 (11.01 cm) and C_0 (11.07 cm) treatment, 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 C_3 treatment. Leaves are known as source from where photosynthesis takes place and producing products were transferred to the sinks as a result, dry matter increasing which influence the growth of specific plant. Removal of leaves in certain levels may influences on 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

translocated to the others part which influence the growth of plant but if the sources were removes excessively then its cause detritions of the plant. Shohana (2018) and Ahmed (2017) also found similar result which supported the present finding.



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

Figure 2 Effect of leaf clipping on the plant height of blackgram at different DAS ($LSD_{(0.05)}$= 0.40, 1.21, 1.67 and 1.83 at 15, 30, 45 DAS and harvest respectively).

4.1.1.3 Combined effect of variety and leaf clipping

Combined of variety and leaf clipping showed significant variation on plant height at different days after showing (Table 1). Result exhibited that the maximum plant height (12.19 cm and 29.32 cm) at 15 DAS and 30 DAS was observed in V_3C_0 treatment combination, which was statistically similar with V_2C_1 (12.05 cm) followed by V_3C_2 (12.03 cm), V_3C_1 (11.73 cm), and V_3C_3 (11.59 cm) treatment combination at 15 DAS, statistically similar result also observed in V_3C_1 (29.15 cm), V_3C_2 (28.09 cm), V_2C_2 (27.73 cm) and V_2C_0 (27.49 cm) treatment combination at 30 DAS, at 45 DAS and at harvest respectively the maximum plant height (53.07 cm and 58.23 cm) was observed in V_3C_1 treatment combination, which was statistically similar with V_3C_0 (56.20 cm) at harvest. Whereas the minimum plant height (10.07 cm) at 15 DAS was observed in V_2C_0 treatment combination which was statistically similar with V_1C_2 (10.36 cm), V_1C_3 (10.41 cm), V_2C_2 (10.49 cm), and V_1C_1 (10.73 cm) treatment combination. At 30, 45

DAS and harvest respectively, the minimum plant height (24.03, 38.63, and 45.20 cm) was observed in V_1C_3 treatment combination which was statistically similar with V_2C_3 (25.67 cm) and V_1C_1 (26.11 cm) treatment combination at 30 DAS; with V_1C_0 (40.00 cm) and V_1C_2 (41.50 cm) treatment combination at 45 DAS, and with V_1C_0 (45.97 cm), V_2C_3 (48.23 cm) and V_3C_3 (48.23 cm) at harvest respectively.

Table 1 Combined effect of variety and leaf clipping on the plant height of blackgram at different DAS

Treatment	Plant height (cm)			
Combinations	**15**	**30**	**45**	**At harvest**
V_1C_0	10.93 cd	26.60 cd	40.00 ef	45.97 fg
V_1C_1	10.73 de	26.11 c-e	43.70 cd	52.53 cd
V_1C_2	10.36 de	26.60 cd	41.50 d-f	49.07 ef
V_1C_3	10.41 de	24.02 e	38.63 f	45.20g
V_2C_0	10.07 e	27.49 a-d	45.90 bc	53.60 bc
V_2C_1	12.05 a	27.11 b-d	47.97 b	54.83 bc
V_2C_2	10.49 de	27.73 a-d	42.93 d	50.00 de
V_2C_3	11.03 b-d	25.67 de	41.53 de	48.23 e-g
V_3C_0	12.19 a	29.32 a	48.40 b	56.20 ab
V_3C_1	11.73 ab	29.15 ab	53.07 a	58.23 a
V_3C_2	12.03 a	28.09 a-c	46.00 bc	52.33 cd
V_3C_3	11.59 a-c	26.83 cd	43.55 cd	48.23 e-g
$LSD_{(0.05)}$	0.70	2.10	2.89	3.17
CV(%)	3.67	4.53	3.79	3.61

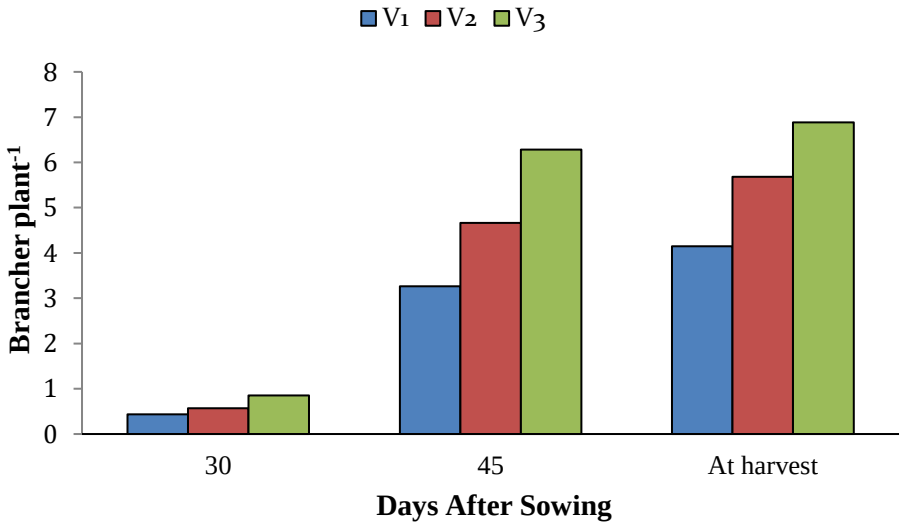
In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

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

4.1.2 Branches plant^{-1}

4.1.2.1 Effect of variety

Statistically significant variation was found in the branches plant^{-1} of blackgram due to the effect of varietal performance (Fig 3 and Appendix VI). From the experiment result revealed that 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 V_3 treatment. Whereas numerically the minimum number of branches plant^{-1} (0.43, 3.27 and 4.15 at 30, 45 DAS and at harvest respectively) was observed from V_1 treatment. Probably the varietal performance was responsible for the variation in branches plant^{-1} of blackgram. Sunil *et al.* (2020) also found similar result which supported the present finding.



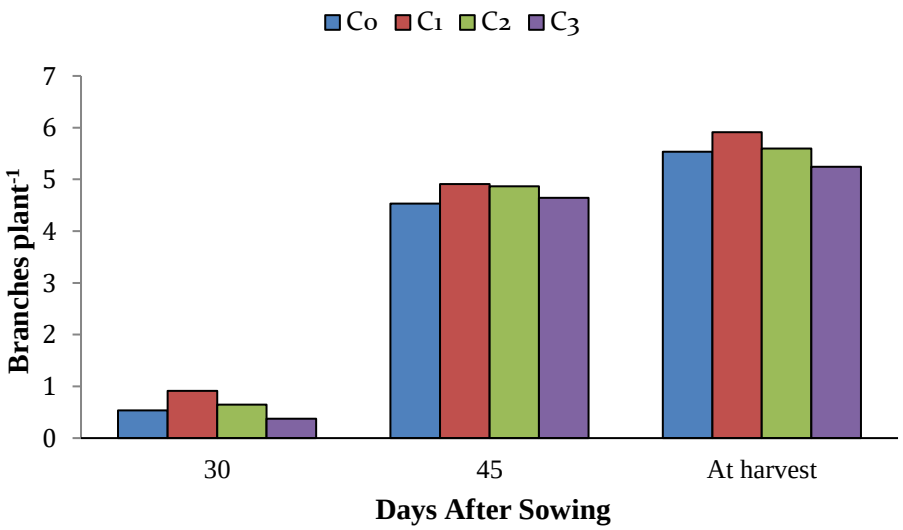
V_1: BARI Mash-1, V_2: BARI Mash-2, and V_3: BARI Mash-3

Figure 3 Effect of variety on the branches plant^{-1} of blackgram at different DAS ($LSD_{(0.05)}$= 0.05, 0.18, and 0.35 at 30, 45 DAS and at harvest respectively).

4.1.2.1 Effect of leaf clipping

Leaf clipping showed significant effect on number of branches plant^{-1} of blackgram (Fig 4 and Appendix VI). From the experiment result revealed that 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 C_1 treatment, which was statistically similar with C_2 (4.87) treatment at 45 DAS. Whereas the minimum number of branches plant^{-1} (0.38)

at 30 DAS was observed in C_3 treatment, at 45 DAS the minimum number of branches plant^{-1} (4.53) was observed in C_0 treatment, which was statistically similar with C_3 (4.64) treatment and, at harvest respectively the minimum number of branches plant^{-1} (5.24) was observed in C_3 treatment, which was statistically similar with C_0 (5.53) treatment during harvest. This could be that in 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 cause injury damages of the plant as a result energy were being lost for makeup the injury as a result plant growth become detritions and as a result number of branches become pore in this part. Ahmed (2017) also found similar result which supported the present finding.



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

Figure 4 Effect of leaf clipping on the branches plant^{-1} of blackgram at DAS ($LSD_{(0.05)}$= 0.04, 0.14 and 0.29 at 30, 45 DAS and at harvest respectively).

4.1.2.3 Combined effect of variety and leaf clipping

Combined of variety and leaf clipping showed significant variation on number of branches plant^{-1} at different days after showing (Table 2). From the experiment result revealed that 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 V_3C_1 treatment combination, which

was statistically similar with V_3C_2 (6.47) and V_3C_3 (6.47) treatment combination at 45 DAS, and with V_3C_2 (6.80) and V_3C_0 (6.8) treatment combination at harvest respectively. 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 V_1C_3 treatment combination, which was statistically similar with V_1C_2 (0.40), V_2C_2 (0.40), V_2C_3 (0.40) and V_3C_3 (0.40) treatment combination at 30 DAS; and with V_1C_0 (4.13) , V_1C_2 (4.27) and V_1C_1 (4.33) at harvest respectively.

Table 2 Combined effect of variety and leaf clipping on the number of branches plant^{-1} of blackgram at different DAS

Treatment	Branch no plant^{-1}		
Combinations	**30**	**45**	**At harvest**
V_1C_0	0.47 ef	3.33 ef	4.13 e
V_1C_1	0.53 e	3.53 e	4.33 e
V_1C_2	0.40 fg	3.27 f	4.27 e
V_1C_3	0.33 g	2.93 g	3.87 e
V_2C_0	0.67 d	4.73 cd	5.67 cd
V_2C_1	0.80 c	4.53 d	6.13 c
V_2C_2	0.40 fg	4.87 c	5.73 c
V_2C_3	0.40 fg	4.53 d	5.20 d
V_3C_0	0.47 ef	5.53 b	6.80 ab
V_3C_1	1.40 a	6.67 a	7.27 a
V_3C_2	1.13 b	6.47 a	6.80 ab
V_3C_3	0.40 fg	6.47 a	6.67 b
$LSD_{(0.05)}$	0.07	0.25	0.51
CV(%)	6.62	3.05	5.28

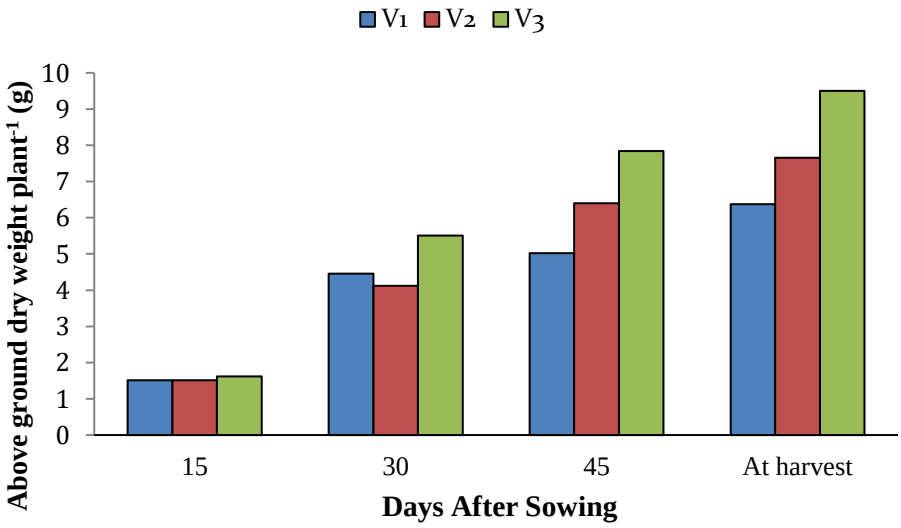
In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

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

4.1.3 Above ground dry weight plant^{-1}

4.1.3.1 Effect of variety

The above ground dry matter weight plant^{-1} of blackgram was significantly influenced blackgram varieties during all growth period (Fig 5 and Appendix VII). From the experiment result revealed that numerically the maximum above ground dry weight plant^{-1} (1.62 g, 5.51 g, 7.84 g and 9.51 g at 15 DAS 30 DAS, 45 DAS and at harvest respectively) was observed in V_3 treatment. Whereas minimum above ground dry weight plant^{-1} (1.51, and 4.12 at 15 DAS and 30 DAS respectively) was observed in V_2 treatment which was statistically similar with V_1 (1.52 g) treatment at 15 DAS. Whereas numerically the minimum above ground dry matter weight plant^{-1} at 45 DAS and at harvest respectively (5.03 and 6.38 g) was observed in V_1 treatment. This might be due to higher biomass potential of the variety. Jadhav *et al.* (2014) found similar result which supported the present study.

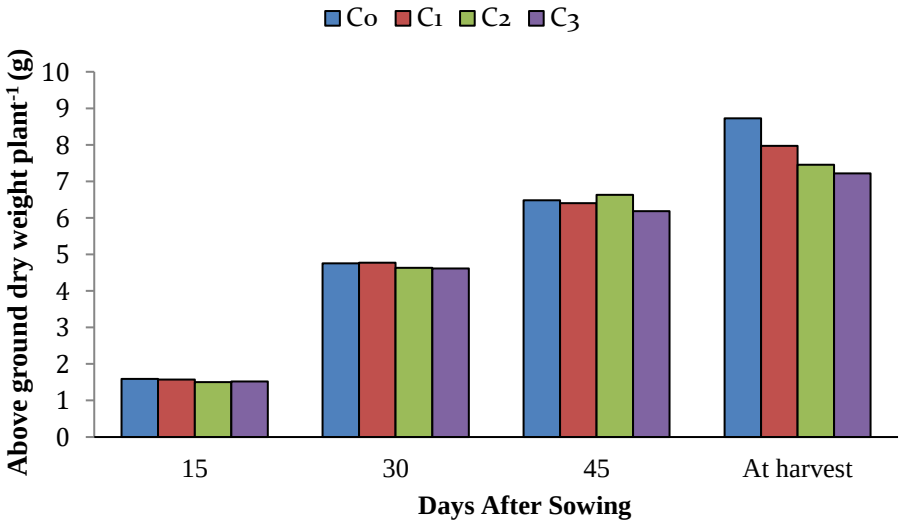


V_1: BARI Mash-1, V_2: BARI Mash-2, and V_3: BARI Mash-3

Figure 5 Effect of variety on the above ground dry weight plant^{-1} of blackgram at different DAS ($LSD_{(0.05)}$= 0.08, 0.18, 0.30 and 0.52 at 15, 30, 45 DAS and at harvest respectively).

4.1.3.1 Effect of leaf clipping

Leaf clipping of blackgram showed significant effect on above ground dry matter weight plant^{-1} at different DAS (Fig 6 and Appendix VII). From the experiment result expressed that, the maximum above ground dry weight plant^{-1} (1.59 g) was observed form C_0 treatment at 15 DAS, which was statistically similar with C_1 (1.57 g) treatment, at 30 DAS numerically the maximum above ground dry weight plant^{-1} (4.78 g) was observed form C_1 treatment which was statistically similar with C_0 (4.76 g) treatment. And at 45 DAS and harvest respectively the maximum above ground dry weight plant^{-1} (6.48 and 8.73 g) was observed in C_0 treatment, which was statistically similar with all other treatment except C_3 (6.19 g) treatment at 45 DAS. Whereas the minimum above ground dry weight plant^{-1} (1.51 g) was observed form C_2 treatment at 15 DAS, at 30 DAS, 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 C_3 treatment, which was statistically similar with C_2 (4.63 and 7.45 g) at 30 DAS and at harvest respectively. Such happened because the subtending leaves were major source of assimilates for the reproductive sink. Sultana *et al.* (2013) found similar results with the present study.



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

Figure 6 Effect of leaf clipping on the above ground dry weight plant^{-1} of blackgram at different DAS ($LSD_{(0.05)}$= 0.06, 0.14, 0.24 and 0.40 at 15, 30, 45 DAS and at harvest respectively).

4.1.3.3 Combined effect of variety and leaf clipping

The above ground dry matter weight plant^{-1} of blackgram was significantly influenced by combined effect of blackgram variety and leaf clipping (Table 3). From the experiment result revealed that 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) observed in V_3C_0 treatment combination, which was statistically similar with V_3C_1 (1.64 g), V_3C_3 (1.59 g), V_1C_0 (1.59 g), V_2C_1 (1.58 g) and V_3C_2 (1.57 g) at 15 DAS; with V_3C_1 (5.55 g) and V_3C_2 (5.51 g) at 30 DAS; with V_3C_1 (7.84 g),V_3C_2 (7.82 g) and V_3C_2 (7.68 g) at 45 DAS, and with V_3C_1 (9.92 g) at harvest respectively. Whereas the minimum above ground dry weight plant^{-1} (1.47 g) was observed in V_2C_3 treatment combination at 15 DAS, which was statistically similar with V_2C_2 (1.48 g), V_1C_2 (1.48 g), V_1C_1 (1.49 g), V_1C_3 (1.51 g), and V_2C_0 (1.51 g) treatment combination; at 30 DAS minimum above ground dry matter weight plant^{-1} (4.07 g) was observed in V_2C_2 treatment combination which was statistically similar with V_2C_2 (4.07) , V_2C_0 (4.14) , V_2C_1 (4.17), and V_1C_2 (4.31 g), treatment combination; at 45 DAS minimum above ground dry matter weight plant^{-1} (4.80) was observed in V_1C_1 treatment combination which was statistically similar with V_1C_0 (4.84) and V_1C_3 (4.89) treatment combination; and at harvest minimum above ground dry weight plant^{-1} (5.94 g) was observed in V_1C_2 treatment combination which was statistically similar with V_1C_3 (6.17) and V_1C_1 (6.20) V_1C_2 treatment combination.

Table 3 Combined effect of variety and leaf clipping on above ground dry weight plant^{-1} of blackgram at different DAS

Treatment	Above ground dry weight/plant (g)			
Combinations	**15**	**30**	**45**	**At harvest**
V_1C_0	1.59 ab	4.51 cd	4.84 e	7.19 de
V_1C_1	1.49 bc	4.61 c	4.80 e	6.20 fg
V_1C_2	1.48 bc	4.31 d-f	5.57 d	5.94 g
V_1C_3	1.51 bc	4.39 c-e	4.89 e	6.17 fg
V_2C_0	1.51 bc	4.14 ef	6.57 b	8.87 c
V_2C_1	1.58 a-c	4.17 ef	6.55 b	7.80 d
V_2C_2	1.48 bc	4.07 f	6.49 b	7.19 de
V_2C_3	1.47 c	4.09 f	5.99 c	6.74 ef
V_3C_0	1.67 a	5.63 a	8.03 a	10.13 a
V_3C_1	1.64 a	5.55 ab	7.84 a	9.92 ab
V_3C_2	1.57 a-c	5.51 ab	7.82 a	9.22 bc
V_3C_3	1.59 ab	5.35 b	7.68 a	8.75 c
$LSD_{(0.05)}$	0.11	0.25	0.42	0.70
CV(%)	4.17	3.07	3.84	5.20

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

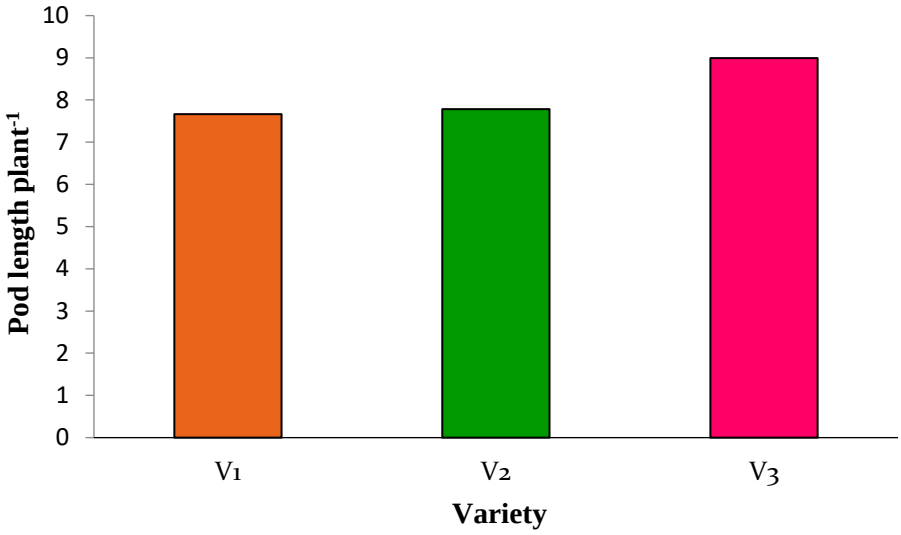
4.2 Yield contributes characters

4.2.1 Pod length plant^{-1}

4.2.1.2 Effect of variety

Variety showed significant effect on pod length of blackgram (Fig 7 and Appendix VIII). Result revealed that the maximum pod length plant^{-1} of blackgram (8.99 cm) was observed in V_3 treatment. Whereas the minimum pod length plant^{-1} of blackgram (7.67 cm) was observed in V_1 treatment which was statistically similar with V_2 (7.78 cm) treatment. Pod length differed from variety to variety. The probable reason for this may be the genetical 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 which supported the present study.

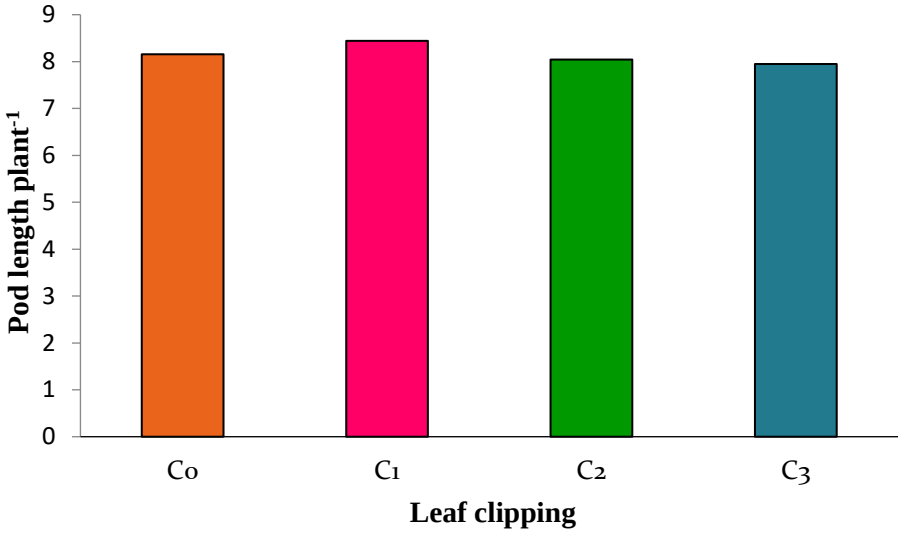


V_1: BARI Mash-1, V_2: BARI Mash-2, and V_3: BARI Mash-3

Figure 7 Effect of variety on the pod length plant^{-1}of blackgram ($LSD_{(0.05)}$= 0.38).

4.2.1.2 Effect of leaf clipping

Leaf clipping significantly effect on pod length of black gram (Fig 8 and Appendix VIII). From the experiment result revealed that the maximum pod length plant^{-1} of blackgram (8.44 cm) was observed in C_1 treatment which was statistically similar with C_0 (8.16 cm) treatment. Whereas the minimum pod length plant^{-1} of blackgram (7.95 cm) was observed in C_3 treatment which was statistically similar with C_2 (8.04 cm) treatment. Defoliation alters phenology, morphology, and dry mass production and partition. Leaf is the major source of assimilate supply for developing vegetative organs, and young pods and seeds in pulse crops. 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).



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

Figure 8 Effect of leaf clipping on the pod length plant^{-1}of blackgram ($LSD_{(0.05)}$= 0.31).

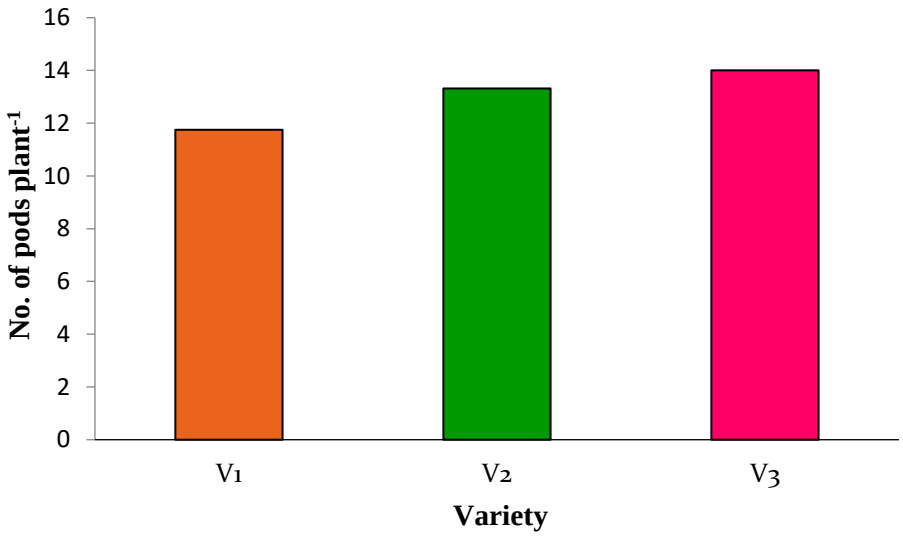
4.2.1.3 Combined effect of variety and leaf clipping

Combined effect of variety and leaf clipping showed significant difference in respect of pods length plant^{-1} of blackgram (Table 4). Among the treatment combinations, the maximum pod length of blackgram (9.32 cm) was observed in V_3C_1 treatment combinations which was statistically similar with V_3C_2 (9.09 cm) and V_3C_0 (8.93 cm) treatment combination. Whereas the minimum pod length plant^{-1} (7.42 cm) was observed in V_1C_3 treatment combinations which was statistically similar with V_1C_2 (7.49 cm), V_2C_2 (7.56 cm), V_2C_0 (7.70 cm), V_2C_3 (7.79 cm), V_1C_0 (7.83 cm), and V_1C_1 (7.92 cm) treatment combinations.

4.2.2 Number of pods plant^{-1}

4.2.2.1 Effect of variety

Variety showed significant effect on number of pods plant^{-1} of blackgram (Fig 9 and Appendix VIII). Result revealed that the maximum number of pods plant-^{1} of blackgram (14.0) was observed in V_3 treatment. Whereas the minimum number of pods plant-^{1} of blackgram (11.75) was observed in V_1 treatment. Siddikee *et al.* (2018) and Mane *et al. (*2018) also found similar result which supported the present finding.

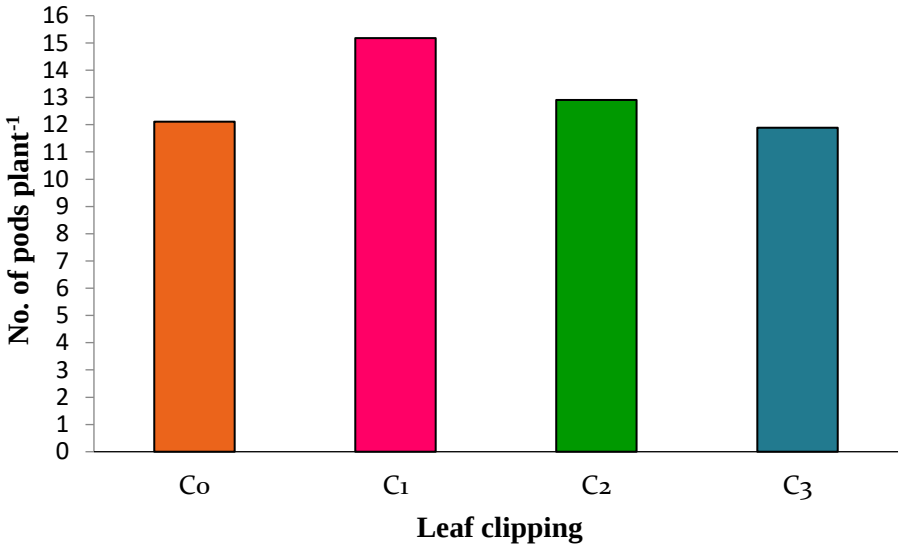


V_1: BARI Mash-1, V_2: BARI Mash-2, and V_3: BARI Mash-3

Figure 9 Effect of variety on the number of pods plant^{-1}of blackgram ($LSD_{(0.05)}$= 0.52).

4.2.2.2 Effect of leaf clipping

Leaf clipping significantly effect on number of pods plant^{-1} of blackgram (Fig 10 and Appendix VIII). From the experiment result revealed that the maximum number of pods plant^{-1} of blackgram (15.18) was observed in C_1 treatment. Whereas the minimum number of pods plant-^{1} of blackgram (11.89) was observed in C_3 treatment which was statistically similar with C_0 (12.11) treatment. The result obtained from the present study was similar with the findings of Mondal *et al.* (2011)



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

Figure 10 Effect of leaf clipping on the number of pods plant^{-1}of blackgram ($LSD_{(0.05)}$= 0.40).

4.2.2.3 Combined effect of variety and leaf clipping

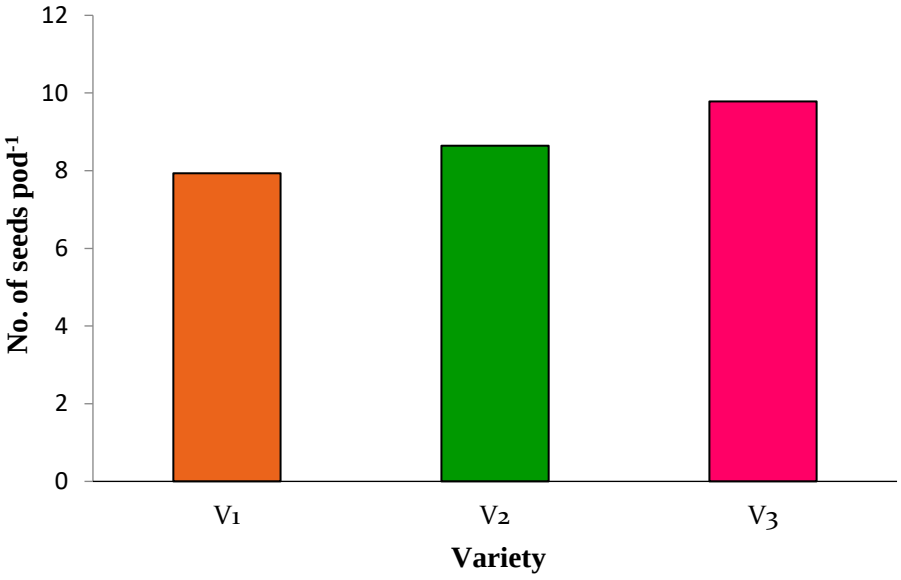
Combined effect of variety and leaf clipping showed significant difference in respect of number of pods plant^{-1} of blackgram (Table 4). Among the treatment combinations, the maximum number of pods plant^{-1} of blackgram (16.87) was observed in V_3C_1 treatment combinations which was statistically similar with V_2C_1 16.27) treatment combination. Whereas the minimum number of pods plant^{-1} of blackgram (11.00) was observed in V_1C_3 treatment combinations which was statistically similar with V_1C_0 (11.47) treatment combination.

4.2.3 Number of seeds pod^{-1}

4.2.3.1 Effect of variety

Variety showed significant effect on number of seeds pod-^{1} of blackgram (Fig 11 and Appendix VIII). Result revealed that the maximum number of seeds pod^{-1} of blackgram (9.78) was observed in V_3 treatment. Whereas the minimum number of seeds pod^{-1} of blackgram (7.93) was observed in V_1 treatment. The probable reason for this may be the genetical potential of the genotype that has helped in producing more seeds pod^{-1}

on blackgram variety. The result obtained from the present study was similar with the findings of Sunil *et al.* (2020).



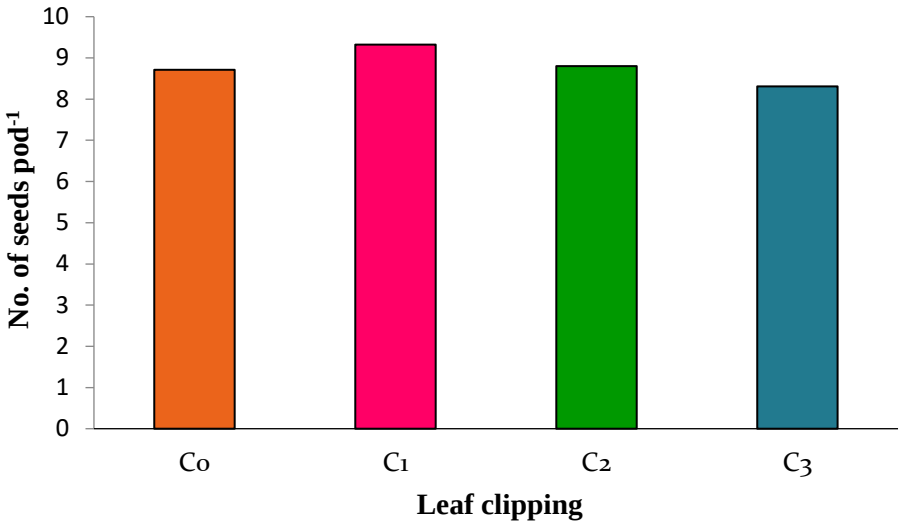
V_1: BARI Mash-1, V_2: BARI Mash-2, and V_3: BARI Mash-3

Figure 11 Effect of variety on the number of seeds pod^{-1} blackgram.

($LSD_{(0.05)}$= 0.54)

4.2.3.2 Effect of leaf clipping

Leaf clipping significantly effect on number of seeds pod-^{1} of blackgram (Fig 12 and Appendix VIII). From the experiment result revealed that the maximum number of seeds pod^{-1} of blackgram (9.32) was observed in C_1 treatment. Whereas the minimum number of seeds pod^{-1} of blackgram (8.31) was observed in C_3 treatment which was statistically similar with C_0 (8.71) treatment. Removal of leaves in certain levels may influences on 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 translocated to the others part which influence the yield contributing characters of plant, but if the sources were removes excessively then its cause detritions and low yield of the plant. The result obtained from the present study was similar with the findings of Sultana *et al.* (2013).



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

Figure 12 Effect of leaf clipping on the number of seeds pod^{-1} blackgram ($LSD_{(0.05)}$= 0.43).

4.2.3.3 Combined effect of variety and leaf clipping

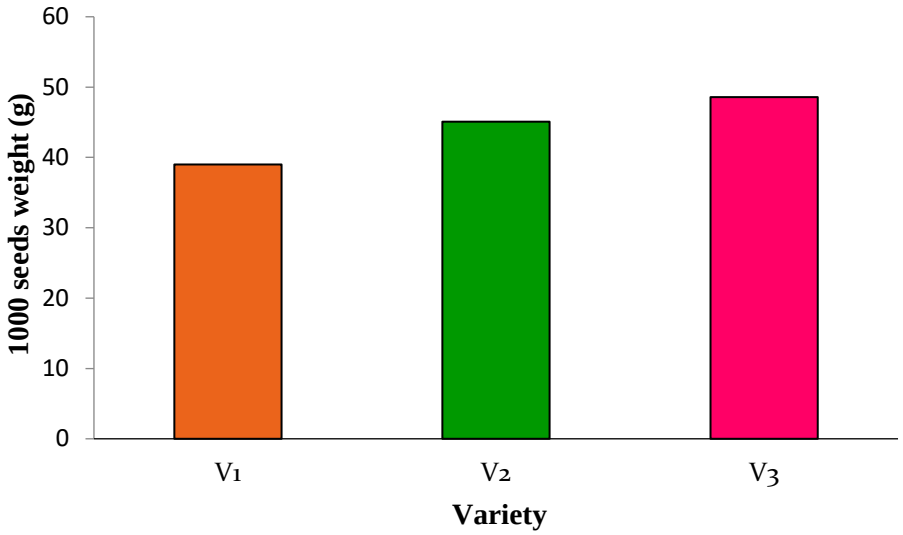
Combined effect of variety and leaf clipping showed significant difference in respect of number of seeds pod^{-1} of blackgram (Table 4). Among the treatment combinations, the maximum number of seeds pod^{-1} of blackgram (10.80) was observed in V_3C_1 treatment combinations which was statistically similar with V_3C_2 (10.13) treatment combination. Whereas the minimum number of seeds pod^{-1} of blackgram (7.27) was observed in V_1C_3 treatment combinations which was statistically similar with V_1C_0 (7.733), and V_2C_2 (7.93) treatment combination.

4.2.4 1000 seeds weight

4.2.4.1 Effect of variety

Variety showed significant effect on 1000 seeds weight of blackgram (Fig 13 and Appendix VIII). Result revealed that the maximum 1000 seeds weight of blackgram (48.58 g) was observed in V_3 treatment. Whereas the minimum 1000 seeds weight of blackgram (39.0 g) was observed in V_1 treatment. The probable reason for this may be

the genetical potential of the genotype that has helped in producing more seeds pod^{-1} on blackgram variety.

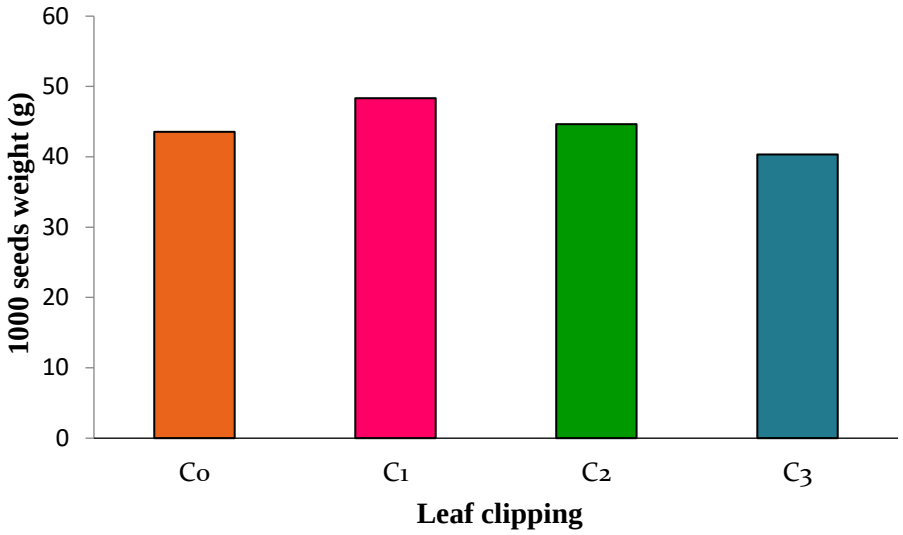


V_1: BARI Mash-1, V_2: BARI Mash-2, and V_3: BARI Mash-3

Figure 1 Effect of variety on the 1000 seeds weight of blackgram ($LSD_{(0.05)}$= 2.91).

4.2.4.2 Effect of leaf clipping

Leaf clipping significantly effect on 1000 seeds weight of blackgram (Fig 14 and Appendix VIII). From the experiment result revealed that the maximum 1000 seeds weight of blackgram (48.33 g) was observed in C_1 treatment. Whereas the minimum 1000 seeds weight of blackgram (40.33 g) was observed in C_3 treatment. The new leaves and the lower empty leaves might have played the role of relative sink as new leaves consume energy for their development and lower shaded leaves require energy for their existence. During seed development, there might have existed a competition for assimilates among the developing seeds and the relative sinks (new leaves and lower shaded empty leaves). The removal of these relative sinks probably reduced this competition resulting in significant increase in 1000 seed weight (Sultana *et al.*, 2013).



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

Figure 14 Effect of leaf clipping on the 1000 seeds weight of blackgram ($LSD_{(0.05)}$= 2.31).

4.2.4.3 Combined effect of variety and leaf clipping

Combined effect of variety and leaf clipping showed significant difference in respect of 1000 seeds weight of blackgram (Table 4). Among the treatment combinations, the maximum 1000 seeds weight of blackgram (51.67 g) was observed in V_3C_1 treatment combinations which was statistically similar with V_3C_2 (51.0 g) and V_2C_1 (49.33 g) treatment combination. Whereas the minimum 1000 seeds weight of blackgram (34.67 g) was observed in V_1C_3 treatment combinations which was statistically similar with V_1C_0 (37.33 g) treatment combination.

Table 4 Combined effect of variety and leaf clipping on the yield contributing characteristics of blackgram

Treatment Combinations	Yield Contributing characters			
	Pod Length(cm)	Number of pods plant^{-1} (no.)	Seeds pod^{-1} (no.)	1000 seed weight(g)
V_1C_0	7.83 cd	11.47 de	7.73 ef	37.33 gh
V_1C_1	7.92 cd	12.40 c	8.40 de	44.00 c-e
V_1C_2	7.49 d	12.13 cd	8.33 de	40.00 fg
V_1C_3	7.42 d	11.00 e	7.27 f	34.67 h
V_2C_0	7.70 cd	12.40 c	9.00 cd	46.33 b-d
V_2C_1	8.08 c	16.27 a	8.77 cd	49.33 ab
V_2C_2	7.56 cd	12.40 c	7.93 ef	43.00 df
V_2C_3	7.79 cd	12.20 c	8.87 cd	41.67 ef
V_3C_0	8.93 ab	12.47 c	9.40 bc	47.00 bc
V_3C_1	9.32 a	16.87 a	10.80 a	51.67 a
V_3C_2	9.09 ab	14.20 b	10.13 ab	51.00 a
V_3C_3	8.63 b	12.47 c	8.80 cd	44.67 c-e
$LSD_{(0.05)}$	0.53	0.70	0.74	3.99
CV(%)	3.82	3.14	4.88	5.26

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

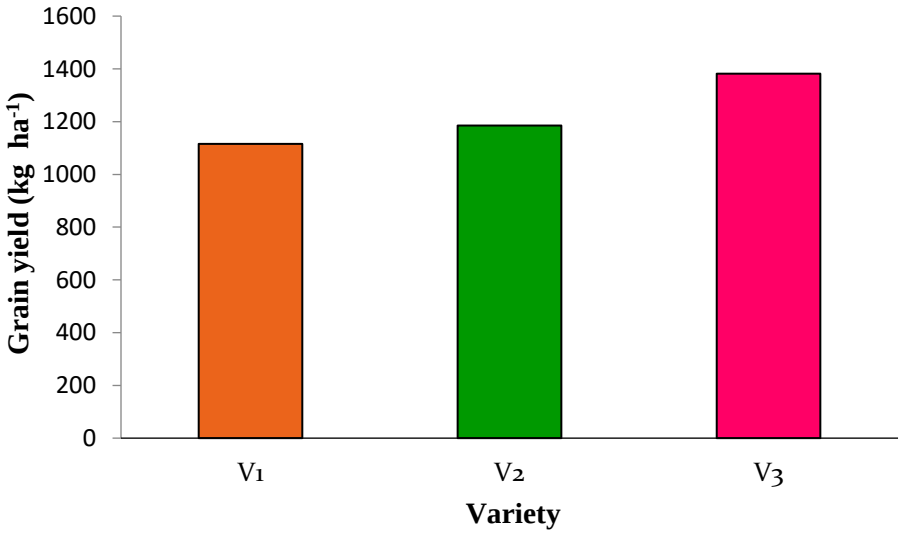
4.3 Yield characters

4.3.1 Seed yield (kg ha^{-1})

4.2.1.1 Effect of variety

Blackgram variety showed significant effect on grain yield (kg ha^{-1}) (Fig 15 and Appendix IX). From the experiment result revealed that numerically the maximum grain yield of blackgram (1381.70 kg ha^{-1}) was observed in V_3 treatment. Whereas numerically the minimum grain yield of blackgram (1115.50 kg ha^{-1}) was observed in V_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 with the present study.



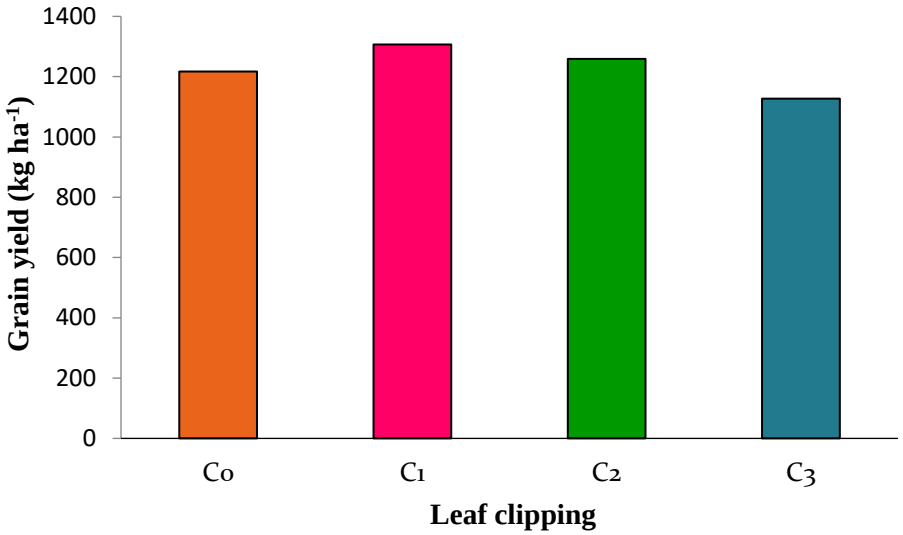
V_1: BARI Mash-1, V_2: BARI Mash-2, and V_3: BARI Mash-3

Figure 15 Effect of variety on the grain yield of blackgram ($LSD_{(0.05)}$= 51.74).

4.3.1.2 Effect of leaf clipping

Leaf clipping significantly effect on grain yield (kg ha^{-1}) of blackgram (Fig 16 and Appendix IX). From the experiment result revealed that the maximum grain yield of blackgram (1306.70 kg ha^{-1}) was observed in C_1 treatment. Whereas the minimum grain yield of blackgram (1127.30 kg ha^{-1}) was observed in C_3 treatment. Mondal *et al.* (2011) observed that the effect of different degree of defoliation on morpho-physiological characters is plant height, number of raceme bearing nodes, leaf area (LA) and total dry mass (TDM), and reproductive characters rachis length, flower number and reproductive efficiency (RE) was significant. 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 reduction only 35.3% seed yield than control whereas top four leaves defoliation caused 61.6% yield reduction. These results indicate that upper leaves contribute more assimilate to the sink than the basal leaves. This is possible because of upper leaves are younger and capture more sunlight than the basal leaves,

and produce more assimilate. Rao and Ghildiyal (1985) and Mariko and Hogetsu (1987) found similar result which supported the present study.



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

Figure 16 Effect of leaf clipping on the grain yield of blackgram ($LSD_{(0.05)}$= 40.432).

4.2.3.3 Combined effect of variety and leaf clipping

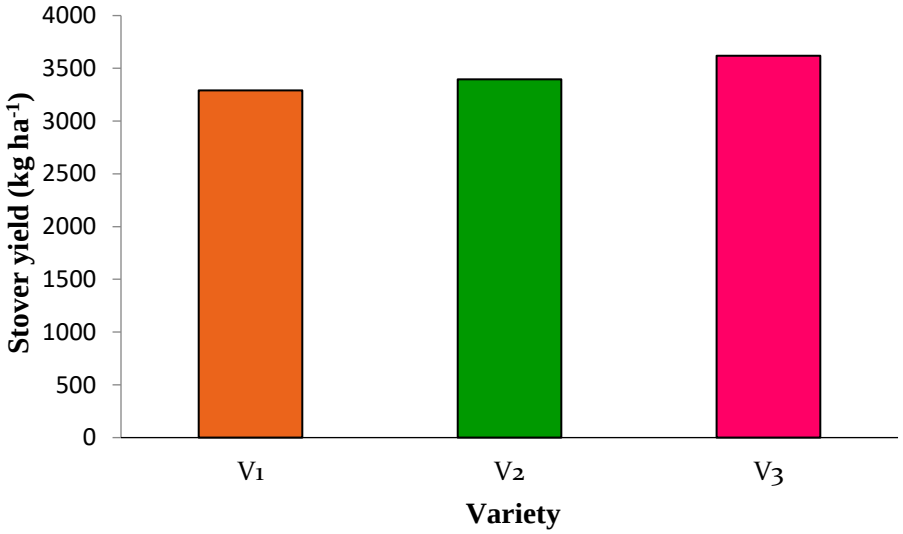
Combined effect of variety and leaf clipping showed significant difference in respect of grain yield (kg ha^{-1}) of blackgram (Table 5). Among the treatment combinations, the maximum grain yield of blackgram (1456.70 kg ha^{-1}) was observed in V_3C_1 treatment combinations which was statistically similar with V_3C_2 (1410.00 kg ha^{-1}) treatment combination. Whereas the minimum grain yield of blackgram (982.00 kg ha^{-1}) was observed in V_1C_3 treatment combinations.

Stover yield (kg ha^{-1})

4.2.1.2 Effect of variety

Variety showed significant effect on stover yield (kg ha^{-1}) of blackgram (Fig 17 and Appendix IX). Result revealed that the maximum stover yield of blackgram (3620.50 kg ha^{-1}) was observed in V_3 treatment. Whereas the minimum stover yield (kg ha^{-1}) of blackgram (3290.80 kg ha^{-1}) was observed in V_1 treatment which was statistically

similar with V_2 (3395.80 kg ha-^{1}) treatment. Mane *et al.* (2018) found similar result which supported the present study.

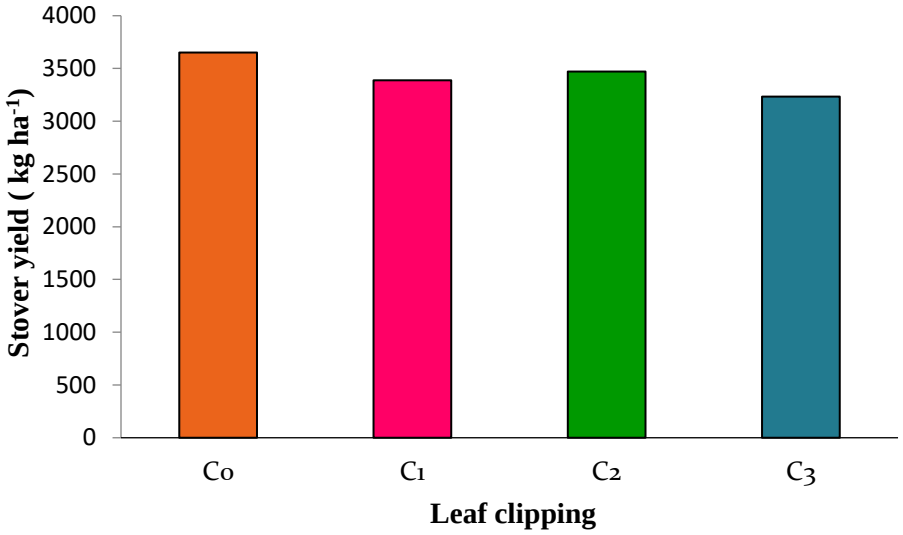


V_1: BARI Mash-1, V_2: BARI Mash-2, and V_3: BARI Mash-3

Figure 17 Effect of variety on the stover yield of blackgram ($LSD_{(0.05)}$= 163.60).

4.2.1.2 Effect of leaf clipping

Leaf clipping significantly effect on stover yield (kg ha^{-1}) of blackgram (Fig 18 and Appendix IX). From the experiment result revealed that the maximum stover yield of blackgram (3651.10 kg ha^{-1}) was observed in C_0 treatment. Whereas the minimum stover yield of blackgram (3233.30 kg ha^{-1}) was observed in C_3 treatment which was statistically similar with C_1 (3387.80 kg ha^{-1}) treatment.



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

Figure 18 Effect of leaf clipping on the stover yield of blackgram ($LSD_{(0.05)}$= 173.91).

4.2.1.3 Combined effect of variety and leaf clipping

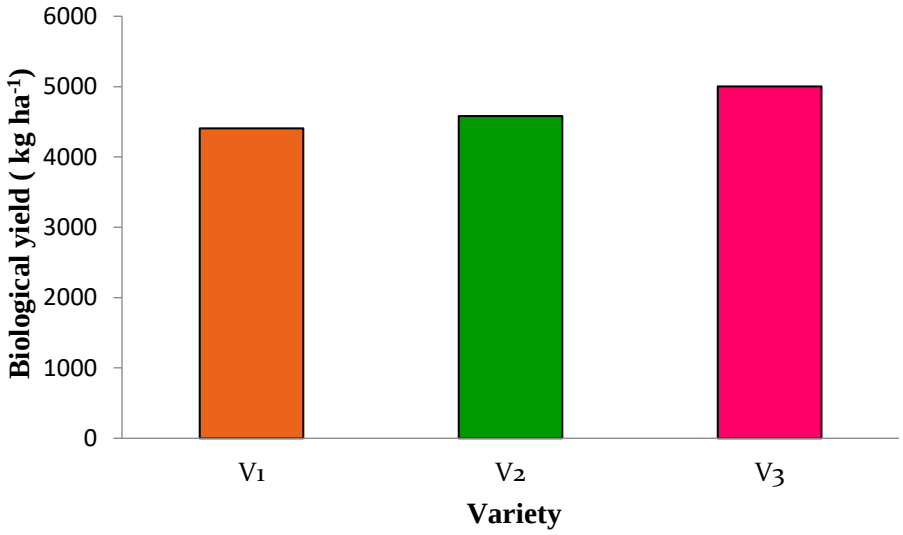
Combined effect of variety and leaf clipping showed significant difference in respect of stover yield (kg ha^{-1}) of blackgram (Table 5). Among the treatment combinations, the maximum stover yield of blackgram (3953.30 kg ha^{-1}) was observed in V_3C_0 treatment combination. Whereas numerically the minimum stover yield of blackgram (3073.30 kg ha^{-1}) was observed in V_1C_3 treatment combination which was statistically similar with V_1C_1 (3266.70 kg ha^{-1}), V_2C_3(3290.00 kg ha^{-1}), V_2C_1 (3296.70 kg ha^{-1}), V_1C_2 (3333.30 kg ha^{-1}), and V_3C_3 (3336.70 kg ha^{-1}) treatment combinations.

Biological yield

4.2.1.2 Effect of variety

Variety showed significant effect on biological yield (kg ha^{-1}) of blackgram (Fig 19 and Appendix IX). Result revealed that the maximum biological yield of blackgram (5002.20 kg ha^{-1}) was observed in V_3 treatment. Whereas the minimum biological yield of blackgram (4406.30 kg ha^{-1}) was observed in V_1 treatment which was statistically similar with V_2 (4581.20 kg ha^{-1}) treatment. The higher biological yield of BARI Mash-

3 as compared to BARI Mash-1 might be due to accumulation of more dry matter and higher biomass potential. Mane *et al. (*2018) and Siddikee *et al.* (2018) found similar result which supported the present study.

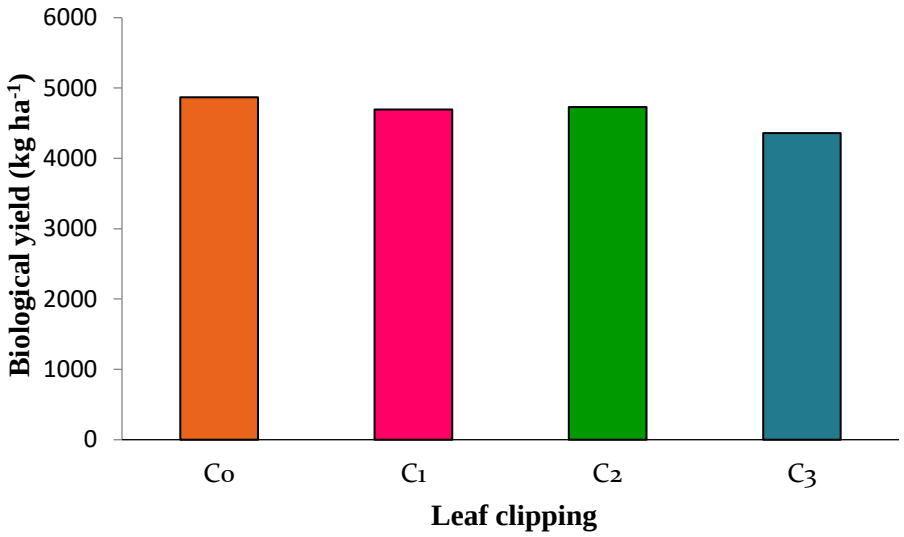


V_1: BARI Mash-1, V_2: BARI Mash-2, and V_3: BARI Mash-3

Figure 19 Effect of variety on the biological yield of blackgram ($LSD_{(0.05)}$= 179.22).

4.2.1.2 Effect of leaf clipping

Leaf clipping significantly effect on biological yield (kg ha^{-1}) of blackgram (Fig 20 and Appendix IX). From the experiment result revealed that the maximum biological yield of blackgram (4868.20 kg ha^{-1}) was observed in C_0 treatment which was statistically similar with C_2 (4729.60 kg ha^{-1}) treatment. Whereas the minimum biological yield of blackgram (4360.70 kg ha^{-1}) was observed in C_3 treatment. Excess removal of source (Leaves) reduced dry matter production which ultimately reduced yield. As biological yield is the combinations 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 being reduced.



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

Figure 20 Effect of leaf clipping on the biological yield of blackgram

($LSD_{(0.05)}$= 168.33).

4.2.1.3 Combined effect of variety and leaf clipping

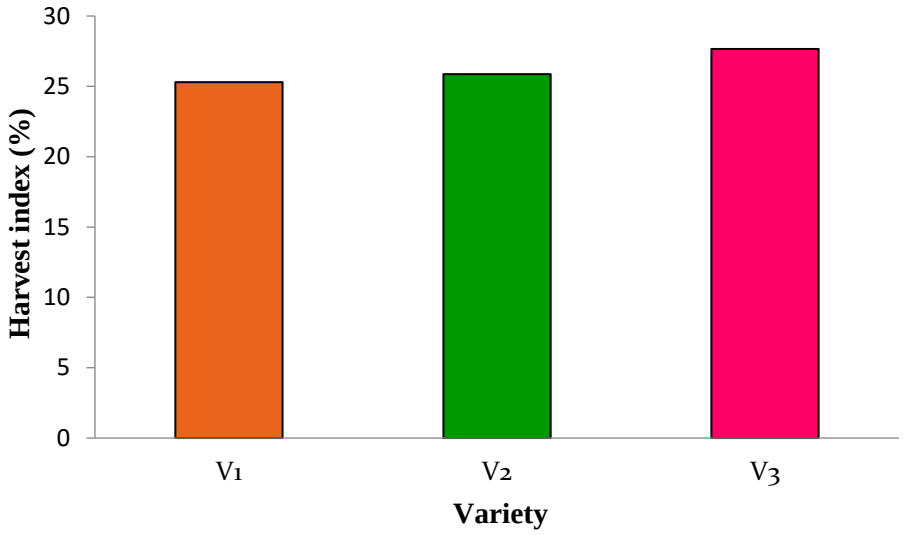
Combined effect of variety and leaf clipping showed significant difference in respect of biological yield (kg ha^{-1}) of blackgram (Table 5). Among the treatment combinations, the maximum biological yield of blackgram (5313.30 kg ha^{-1}) was observed in V_3C_0 treatment combination which was statistically similar with V_3C_1 (5056.70 kg ha^{-1}). Whereas the minimum biological yield of blackgram (4055.3 kg ha^{-1}) was observed in V_1C_3 treatment combination.

Harvest index (%)

4.2.1.2 Effect of variety

Variety showed significant effect on harvest index (%) of blackgram (Fig 21 and Appendix IX). Result revealed that the maximum harvest index of blackgram (27.66 %) was observed in V_3 treatment. Whereas the minimum harvest index of blackgram (25.30 %) was observed in V_1 treatment which was statistically similar with V_2 (25.87 %) treatment. Jadhav *et al.* (2014) reported that that black gram varieties differed significantly in harvest index. The genotype BDU-1 recorded higher harvest index (31.93 %) as compared to TAU-1 (31.37 %) and TPU-4 (31.34) which might be due to

its higher production efficiency. Yadahalli and Palled (2004) also reported that the yield, yield components, nutrient uptake as well as economics were significantly influenced by blackgram genotypes and dates of sowing. Result showed that the harvest index of the TAU-1 (37.12 %) and Manikya (38.02 %) were on par and both were significantly higher over K-3 (25.43 %) genotype.

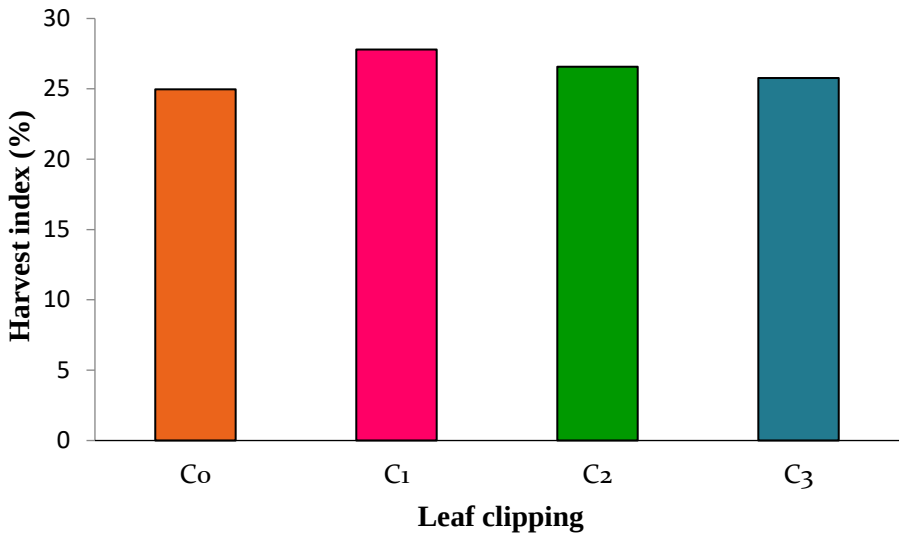


V_1: BARI Mash-1, V_2: BARI Mash-2, and V_3: BARI Mash-3

Figure 21 Effect of variety on the harvest index of blackgram ($LSD_{(0.05)}$= 1.60).

4.2.1.2 Effect of leaf clipping

Leaf clipping significantly effect on harvest index (%) of blackgram (Fig 22 and Appendix IX). From the experiment result revealed that the maximum harvest index of blackgram (27.80 %) was observed in C_1 treatment. Whereas the minimum harvest index of blackgram (24.97 %) was observed in C_0 treatment which was statistically similar with C_3 (25.77 %) treatment. Biswas *et al*. (2005) reported that that the effect of defoliation on harvest index varied significantly ($P > 0.05$) 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%).



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

Figure 22 Effect of leaf clipping on the harvest index of blackgram ($LSD_{(0.05)}$= 0.9904).

4.2.1.3 Combined effect of variety and leaf clipping

Combined effect of variety and leaf clipping showed significant difference in respect of harvest index (%) of blackgram (Table 5). Among the treatment combinations, the maximum harvest index of blackgram (28.81 %) was observed in V_3C_1 treatment combination which was statistically similar with V_3C_2 (28.189 %), V_3C_3 (28.04 %), and V_3C_3 (27.33 %) treatment combinations. Whereas the minimum harvest index of blackgram (23.91 %) was observed in V_1C_0 treatment combination. Which was statistically similar with V_1C_3 (24.22 %), V_2C_3 (25.06 %), V_2C_0 (25.39 %), and V_3C_3 (25.60 %) treatment combinations.

Table 5 Combined effect of variety and leaf clipping on the yield characteristics of blackgram

Treatment	Yield characters			
Combinations	**Seed yield (kg ha^{-1})**	**Stover yield (kg ha^{-1})**	**Biological yield (kg ha^{-1})**	**Harvest index (%)**
V_1C_0	1096.70 g	3490.00 b-d	4586.70 cd	23.91 e
V_1C_1	1223.30 ef	3266.70 de	4490.00 cd	27.26 a-c
V_1C_2	1160.00 fg	3333.30 b-e	4493.30 cd	25.82 b-d
V_1C_3	982.00 h	3073.30 e	4055.30 e	24.22 de
V_2C_0	1194.70 ef	3510.00 b-d	4704.70 c	25.39 de
V_2C_1	1240.00 de	3296.70 c-e	4536.70 cd	27.33 ab
V_2C_2	1206.70 ef	3486.70 b-d	4693.30 c	25.71 b-d
V_2C_3	1100.00 g	3290.00 de	4390.00 d	25.06 de
V_3C_0	1360.00 bc	3953.30 a	5313.30 a	25.60 c-e
V_3C_1	1456.70 a	3600.00 b	5056.70 ab	28.81 a
V_3C_2	1410.00 ab	3592.00 bc	5002.00 b	28.20 a
V_3C_3	1300.00 cd	3336.70 b-e	4636.70 cd	28.04 a
$LSD_{(0.05)}$	70.031	301.21	291.56	1.72
CV(%)	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

CHAPTER 5

SUMMARY AND CONCLUSION

The present piece of work was carried out at the Research Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during March to June-2019, to investigate the effect of variety and leaf clipping on the growth and yield of blackgram. The experimental field belongs to the Agro-ecological zone (AEZ) of "The Modhupur Tract", AEZ-28. The soil of the experimental field belongs to the General soil type, Deep Red Brown Terrace Soils under Tejgaon soil series. The experiment consisted of two factors, and followed split plot design. Factor A: Blackgram variety (3); V_1: BARI Mash-1, V_2: BARI Mash-2 and V_3: BARI Mash-3, and Factor B: 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. The total numbers of unit plots were 36. The size of unit plot was 5.40 m^2 (2.7 m×2 m). Urea, triple superphosphate (TSP), Muriate of potash (MoP), zinc sulphate and boric acid were used as sources of nitrogen, phosphorus, potassium, zinc, and boron respectively. The doses of fertilizers were 45, 90, 40, 55, and 10 kg ha^{-1} for urea, TSP, MoP, Gypsum and boric acid respectively. Total amount of for urea, TSP, MP, Gypsum and boric acid were applied at basal doses during final land preparation (BARI krishi projukti hatboi-2019 recommendation). Data on different yield contributing characters and yield were recorded to find out the suitable variety and optimum level of leaf clipping for the highest yield of Blackgram.

Different growth, yield and yield contributing characters were significantly influenced by different blackgram varieties. From the experiment, result revealed that, numerically the maximum plant height (11.89 ,28.35, 47.75 and 53.75 cm at 15 , 30, 45 DAS and at harvest respectively), number of branches $plant^{-1}$ (0.85, 6.28, and 6.88 at 30, 45 DAS and at harvest respectively), above ground dry weight $plant^{-1}$ (1.62 g, 5.51 g, 7.84 g and 9.51 g at 15 DAS, 30 DAS, 45 DAS and at harvest respectively), pod length $plant^{-1}$ (8.99 cm), number of pods $plant^{-1}$ (14.00), number of seeds pod^{-1} (9.78), 1000 seeds weight (48.58 g), seed yield (1381.70 kg ha^{-1}), stover yield (3620.50 kg ha^{-1}), biological yield (5002.20 kg ha^{-1}) and harvest index (27.66 %) were observed in V_3 (BARI Mash-3) treatment and the minimum plant height (10.61, 25.84, 40.96 and 48.19 cm at 15, 30, 45 DAS and at harvest respectively), number of branches $plant^{-1}$ (0.43, 3.27 and 4.15

at 30, 45 DAS and at harvest respectively) were observed in V_1 (BARI Mash-1)treatment, the minimum above ground dry matter plant^{-1} (1.51, and 4.12 at 15 DAS and 30 DAS respectively) was observed in V_2 (BARI Mash-2) treatment and at 45 DAS and harvest respectively (5.03 and 6.38 g) was observed in V_1 treatment, the minimum pod length plant^{-1} (7.67 cm), number of pods plant^{-1} (11.75), number of pods plant^{-1} (11.89), minimum number of seeds pod^{-1} (7.93), 1000 seeds weight (39.00 g), seed yield (1115.50 kg ha^{-1}), stover yield (3290.80 kg ha^{-1}), biological yield (4406.30 kg ha^{-1}), and harvest index (25.30 %) were observed in V_1 (BARI Mash-1) treatment.

Different growth, yield and yield contributing characters were significantly influenced by leaf clipping. From the experiment, result revealed that, at 15 DAS the maximum plant height (11.50 cm) was observed in C_1 treatment, at 30 DAS the maximum plant height (27.80 cm) was observed in C_0 treatment, and at 45 DAS and harvest, the maximum plant height (48.24 and 55.20 cm) was observed in C_1 treatment. 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 C_1 treatment, the maximum above ground dry weight plant^{-1} (1.59 g) was observed in C_0 treatment at 15 DAS, at 30 DAS the maximum above ground dry weight plant^{-1} (4.78 g) was observed in C_1 treatment, and at 45 DAS and harvest respectively the maximum above ground dry weight plant^{-1} (6.48 and 8.73 g) was observed in C_0 treatment, the maximum pod length plant^{-1} (8.44 cm) , number of pods plant^{-1} (15.18), number of seeds pod^{-1} (9.32), 1000 seeds weight (48.33 g), seed yield (1306.70 kg ha^{-1}), were observed in C_1 treatment. The maximum stover yield (3651.10 kg ha^{-1}) and biological yield (4868.20 kg ha^{-1}) were observed in C_0 treatment, and the maximum harvest index (27.80 %) was observed in C_1 treatment. Whereas the minimum plant height at 15 days (10.96 cm) was observed in C_2 treatment and at 30, 45 DAS and at harvest respectively, the minimum plant height (25.51, 41.24 and 47.22 cm) was observed in C_3 treatment, the minimum number of branches plant^{-1} (0.38) at 30 DAS was observed in C_3 treatment, at 45 DAS the minimum number of branches plant^{-1} (4.53) was observed in C_0 treatment, and at harvest the minimum number of branches plant^{-1} (5.24) was observed in C_3 treatment, the minimum above ground dry weight plant^{-1} (1.51 g) was observed form C_2 treatment at 15 DAS, at 30 DAS, 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 C_3 treatment, the minimum pod length plant^{-1} (7.95 cm), number of pods plant^{-1} (11.89), number of seeds pod^{-1} (8.31), 1000 seeds weight of

blackgram (40.33 g), seed yield (1127.30 kg ha^{-1}), stover yield (3233.30 kg ha^{-1}), biological yield (4360.70 kg ha^{-1}) were observed in C_3 treatment, and finally the minimum harvest index (24.966 %) was observed in C_0 treatment.

Different growth, yield and yield contributing characters were significantly influenced by the combined application of blackgram varieties and leaf clipping. From the experiment result revealed that the maximum plant height (12.19 cm and 29.32 cm) at 15 DAS and 30 DAS was observed in V_3C_0 treatment combination and, at 45 DAS and harvest respectively the maximum plant height (53.067 cm and 58.233 cm) was observed in V_3C_1 treatment combination, 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 V_3C_1 treatment combination, 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) observed in V_3C_0 treatment combination, the 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), seed yield (1456.70 kg ha^{-1}) were observed in V_3C_1 treatment combinations, the maximum stover yield (3953.30 kg ha^{-1}) and biological yield of blackgram (5313.30 kg ha^{-1}) were observed in V_3C_0 treatment combination, and the maximum harvest index (28.81 %) was observed in V_3C_1 treatment combination. Whereas the minimum plant height (10.07 cm) at 15 DAS was observed in V_2C_0 treatment combination and at 30, 45 DAS and at harvest respectively numerically the minimum plant height (24.03, 38.63, and 45.20 cm) was observed in V_1C_3 treatment combination, 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 V_1C_3 treatment combination, the minimum above ground dry weight $plant^{-1}$ (1.47 g) was observed in V_2C_3 treatment combination at 15 DAS, at 30 DAS numerically the minimum above ground dry weight $plant^{-1}$ (4.07 g) was observed in V_2C_2 treatment combination, at 45 DAS the minimum above ground dry weight $plant^{-1}$ (4.80) was observed in V_1C_1 treatment combination and at harvest the minimum above ground dry weight $plant^{-1}$ (5.94 g) was observed in V_1C_2 treatment combination, numerically the minimum pod length $plant^{-1}$ (7.42 cm), number of pods $plant^{-1}$ (11.00) , number of seeds pod^{-1} (7.27), 1000 seeds weight (34.67 g), seed yield (982.00 kg ha^{-1}), stover yield (3073.30 kg ha^{-1}), and biological yield (4055.30 kg ha^{-1}) were observed in V_1C_3 treatment combination, and finally the minimum harvest index (23.91 %) was observed in V_1C_0 treatment combination.

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 which was achieved from BARI Mash-3 (V_3). Again, Leaf clipping (C_1= Clipping of 1st basal leaf) showed the best performance regarding most of the yield and yield contributing characteristics. In case of combined effect, BARI Mash-3 (V_3) and clipping of 1st basal leaf (C_1) gave the best result in producing the maximum pod length (9.32 cm), number of pods plant^{-1} (16.87), number of seeds pod^{-1} (10.80), and 1000 seeds weight (51.67 g), which ultimately influences seed yield. The highest seed yield 1456.70 kg ha^{-1} was obtained from BARI Mash-3 and clipping of 1st basal leaf of blackgram treatment combination (V_3C_1). So, this treatment combination (V_3C_1) can be treated as the best treatment combination under the present study.

Recommendations

The following recommendations are proposed here under:

- Before making final conclusion, further trials with the same treatment combinations on different locations of Bangladesh would be useful. However, further investigation is necessary for the other soil types under different AEZ in Bangladesh.

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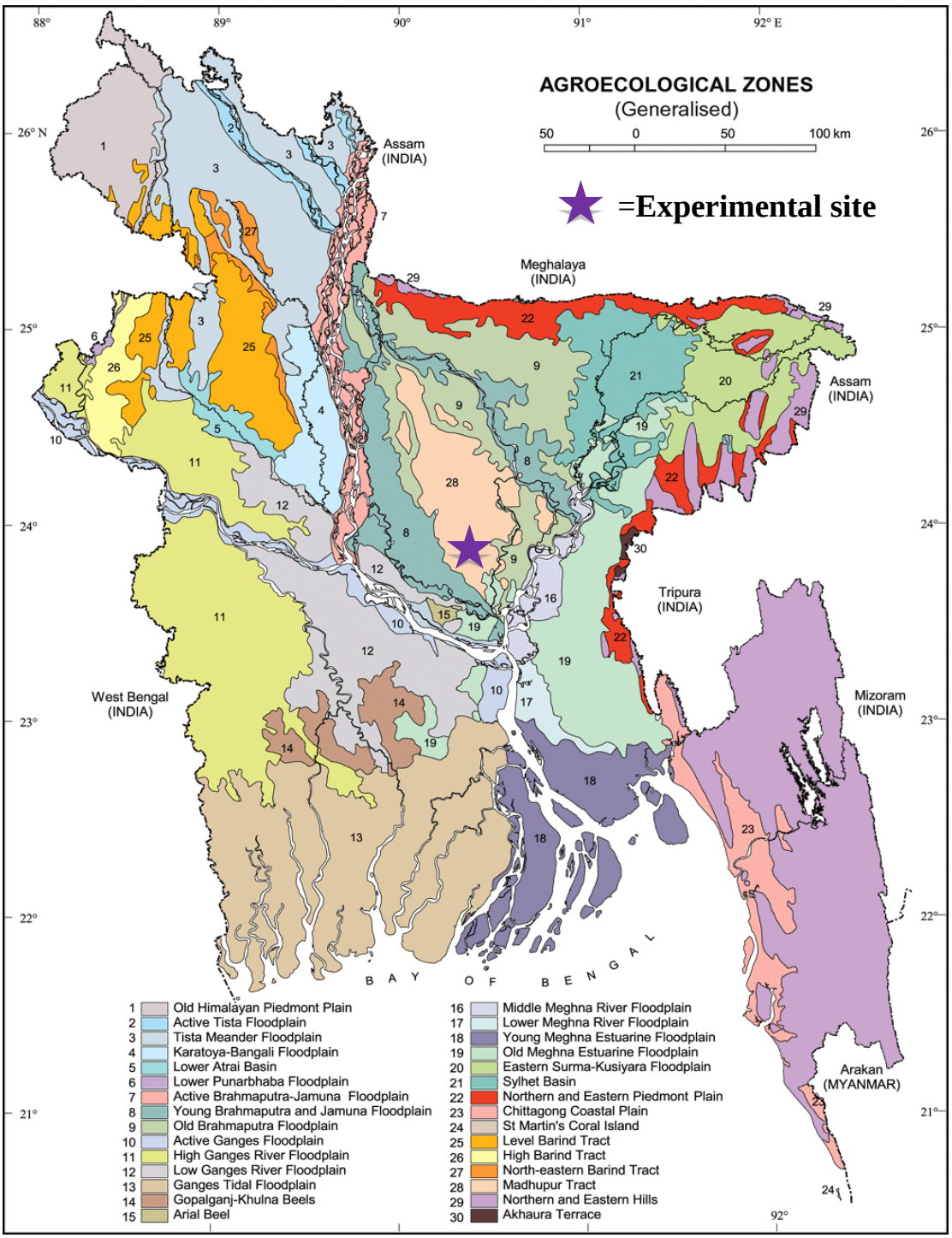
APPENDICES

Appendix I. Map showing the experimental site under study



Appendix II. Characteristics of soil of experimental field

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Sher-e-Bangla Agricultural University Agronomy research field, Dhaka
AEZ	AEZ-28, Modhupur Tract
General Soil Type	Shallow Red Brown Terrace Soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled

B. The initial physical and chemical characteristics of soil of the experimental site (0 - 15 cm depth)

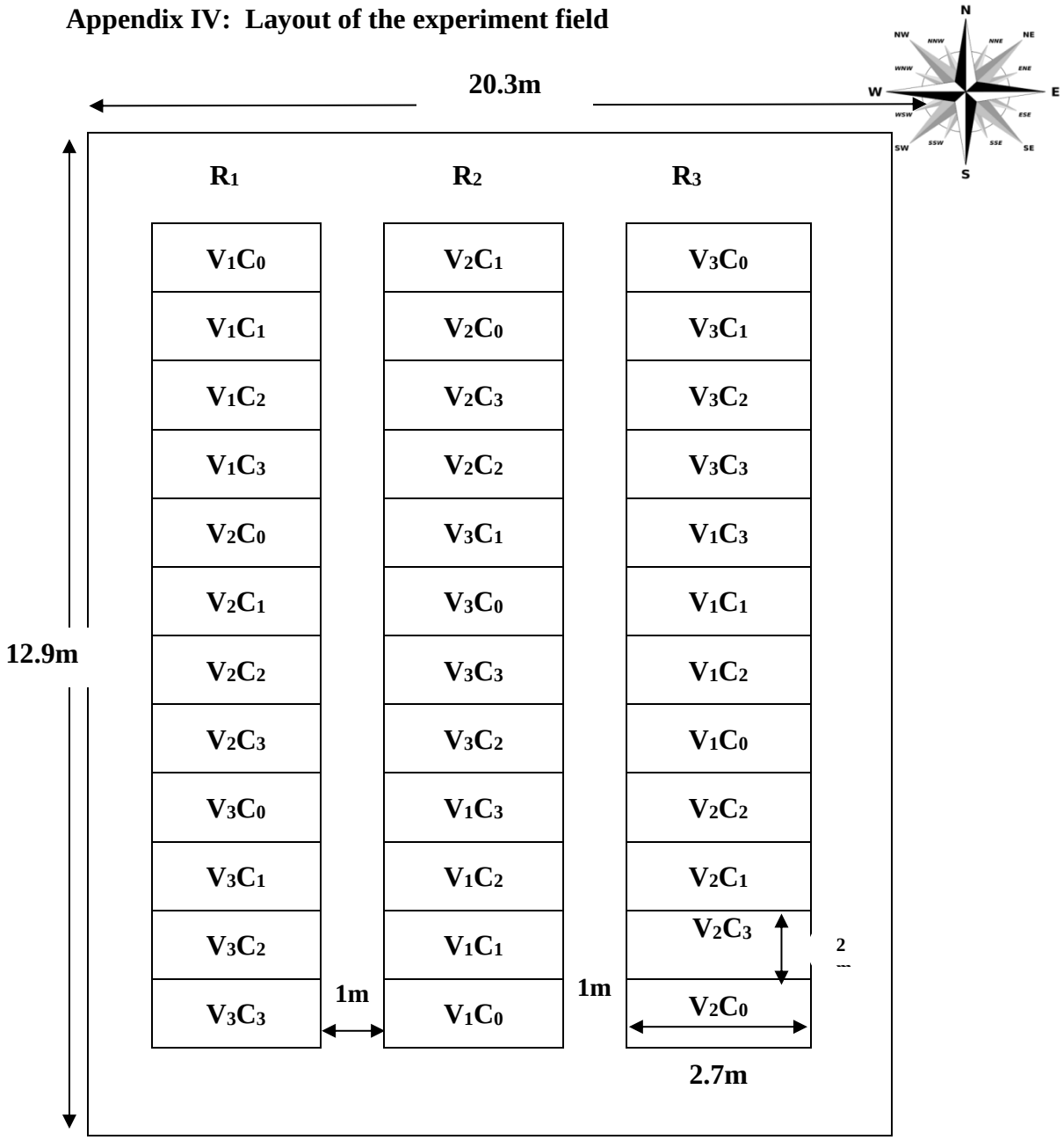
Physical characteristics	
Constituents	**Percent**
Sand	26
Silt	45
Clay	29
Textural class	Silty clay
Chemical characteristics	
Soil characteristics	**Value**
Ph	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total nitrogen (%)	0.03
Available P (ppm)	20.54
Exchangeable K (mg/100 g soil)	0.10

Appendix III. Monthly meteorological information during the period from February, 2019 to June, 2019

Year	Month	Air temperature (^{0}C)		Relative humidity (%)	Total rainfall (mm)
		Maximum	Minimum		
2019	February	22.75	14.26	37.90	0.0
	March	35.20	21.00	52.44	20.4
	April	34	24	54	225.1
	May	37	28	61	259.3
	June	39	29	67	273.6

Source: Metrological Centre, Agargaon, Dhaka (Climate Division)

Appendix IV: Layout of the experiment field



Legend

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

Appendix V. Analysis of variance of the data of plant height of blackgram at different DAS

Mean square of plant height at					
Source	Df	**15 DAS**	**30 DAS**	**45 DAS**	**At Harvest**
Replication (A)	2	0.08333	0.7500	1.583	1.7500
Variety (V)	2	5.36330*	18.9590*	138.756*	94.6219*
Error I	4	0.20833	1.8750	3.458	4.2500
Clipping (C)	3	0.56352*	9.8550*	77.260*	98.6462*
V×C	6	1.03671*	0.5901*	5.736*	10.8723*
Error II	18	0.16667	1.5000	2.833	3.4167
Total	35				

*: Significant at 0.05 level of probability

Appendix VI. Analysis of variance of the data of above ground dry weight plant^{-1} of blackgram at different DAS

Mean square of above ground dry weight plant^{-1} at					
Source	Df	**15 DAS**	**3 0DAS**	**45 DAS**	**At Harvest**
Replication (A)	2	0.00250	0.01083	0.0408	0.0833
Variety (V)	2	0.04423*	6.32959*	23.8339*	29.7105*
Error I	4	0.00500	0.02583	0.0708	0.2083
Clipping (C)	3	0.01346*	0.06647*	0.3063*	4.0279*
V×C	6	0.00347*	0.01630*	0.1942*	0.3231*
Error II	18	0.00417	0.02083	0.0608	0.1667
Total	35				

*: Significant at 0.05 level of probability

Appendix VII. Analysis of variance of the data of branches plant^{-1} of blackgram at different DAS

Mean square of branches plant^{-1} at				
Source	Df	**30 DAS**	**45 DAS**	**At Harvest**
Replication (A)	2	0.00083	0.0108	0.0700
Variety (V)	2	0.54333*	27.3478*	22.5244*
Error I	4	0.00208	0.0258	0.0950
Clipping (C)	3	0.45444*	0.2915*	0.6737*
V×C	6	0.21000*	0.3759*	0.0504*
Error II	18	0.00167	0.0208	0.0867
Total	35			

*: Significant at 0.05 level of probability

Appendix VIII. Analysis of variance of the data on Pod Length, Number of pods plant^{-1}, Seeds pod^{-1}, and 1000 seed weight of blackgram

Mean square of					
Source	Df	**Pod Length**	**Number of pods plants^{-1}**	**Seeds pod^{-1}**	**1000 seeds weight**
Replication (A)	2	0.06317	0.0833	0.0925	3.083
Variety (V)	2	6.48879*	15.9678*	10.4553*	282.194*
Error I	4	0.11217	0.2083	0.2300	6.583
Clipping (C)	3	0.41103*	20.3200*	1.5566*	98.000*
V×C	6	0.08628*	2.7411*	1.1360*	9.194*
Error II	18	0.09695	0.1667	0.1842	5.417
Total	35				

*: Significant at 0.05 level of probability

Appendix IX. Analysis of variance of the data on grain yield (kg ha^{-1}), stover yield, (kg ha^{-1}), biological yield (kg ha^{-1}), and harvest index (%)

Mean square of					
Source	Df	**Grain Yield (Kg ha^{-1})**	**Stover yield (Kg ha^{-1})**	**Biological yield (kg ha^{-1})**	**Harvest index (%)**
Replication (A)	2	833	30833	30000	1.0000
Variety (V)	2	228536*	340360*	1125650*	18.1744*
Error I	4	2083	20833	25000	2.0000
Clipping (C)	3	52182*	272620*	416819*	13.0998*
V×C	6	1991*	25817*	26607*	1.5565*
Error II	18	1667	30833	28889	1.0000
Total	35				

*: Significant at 0.05 level of probability

PLATES

Plate 1: Seed sowing in the experimental field

Plate 2: Blackgram plant after germination

Plate 3: Flowering stage of blackgram