GROWTH AND YIELD OF BLACKGRAM AS AFFECTED BY MANAGEMENT PACKAGES

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CERTIFICATE

This is to certify that the thesis entitled ‘**‘GROWTH AND YIELD OF BLACKGRAM VARIETIES AS AFFECTED BY MANAGEMENT PACKAGES”** 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** in **Agronomy**, embodies the result of a piece of bonafide research work carried out by **SWAPNA DAS**, Registration number: **16-07544** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated:
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DEDICATED

TO

MY BELOVED PARENTS

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The Author

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ABSTRACT

A field experiment was carried out at the research field of Sher-e-Bangla Agricultural University, Dhaka during the period of March to June 2017 to study the effect of variety and management packages on growth and yield of blackgram. The experiment comprised of two factors; Factor A: Variety (3) viz. BARI mash-3 (V_1), BARI mash-2 (V_2) and BINA mash-1(V_3) and Factor B: management packages (3) viz. Low management: Fertilizer 0-0-0 NPK + 40 kg seed/ha in broadcasting + no pesticide application + no weeding (M_1), medium management: Fertilizer 20-10-20 NPK kg/ha + 24 kg seeds/ha in line sowing (30cm×continuous) + pesticide application + one hand weeding after 15 DAS (M_2), high management: Fertilizer 40-20-40 NPK kg/ha + 24 kg seed/ha in line sowing + pesticide application (ripcord) + two hand weedings at 15 and 25 DAS (M_3). The experiment was laid out in split-plot design with three replications. Data on different growth parameters, yield attributes and yield of blackgram were significantly varied for different parameters. The highest emergence percentage (33.44%), plant height (53.54 cm), number of leaflet plant^{-1}(19.89), dry weight (8.95 g plant^{-1}), branches plant^{-1} (2.22), 1000-seed weight (33.74g) and seed weight (0.58 t ha^{-1}) was found from BARI mash-2. The management packages resulted highest emergence percentage (41.11%), plant height (79.39 cm), leaflet plant^{-1} (52.13), dry weight plant^{-1} (8.95g), branches plant^{-1} (3.00) and seed yield (0.63 t ha^{-1}) from high management (M_3). The highest leaflet plant^{1} (56.8 cm) was revealed in V_2M_3, and the highest seed yield (1.06 t ha^{-1}) and higher harvest index (49.75) was obtained from V_2M_3. From the above results it was appeared that BARI mash-2 with high management provided the best yield attributes and yield of blackgram.

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LIST OF ACRONYMS

AEZ	**=**	**Agro-Ecological Zone**
BARI	=	Bangladesh Agriculture Research Institute
BBS	=	Bangladesh Bureau of Statistics
cm	=	Centimeter
CV%	=	Percentage of coefficient of variance
DAS	=	Days After Sowing
et al.	=	And others
G	=	Gram
ha^{-1}	=	Per hectare
HI	=	Harvest Index
IRRI	=	International Rice Research Institute
kg	=	Kilogram
LSD	=	Least Significant Difference
MoP	=	Muriate of Potash
N	=	Nitrogen
no.	=	Number
NPK	=	Nitrogen, Phosphorus and Potassium
NS	=	Non-significant
Plant^{-1}	=	Per plant
Plot^{-1}	=	Per plot
SAU	=	Sher-e-Bangla Agricultural University
t ha^{-1}	=	Ton per hectare
TSP	=	Triple Super Phosphate
Wt.	=	Weight
%	=	Percent

CHAPTER I

INTRODUCTION

Pulses mention to dried, edible seeds of leguminous crop, which comprise more protein (20-25% by weight) than any other plant (cereals). They assist as a low cost protein to meet the needs of the large section of the people. They have, therefore, been justifiably described as the "**Poor man's meat**." Pulse crops conquer a high place in farming system because of their low water requirement and ability to survive environmental stress. Pulses are alike to a mini fertilizer factory as it restores soil fertility by fixing atmospheric nitrogen and thus producing nitrogen equivalent of around 50-60 kg ha^{-1}. They have unique capability of deep root system, mobilization of insoluble soil nutrients and bringing qualitative change in soil physical property. Addition of pulses in intensive cereal based cropping system acts as a component of integrated nutrient supply. Therefore pulses have emerged as a viable option to improve soil health, conserve the natural resources and sustain the agricultural productivity. Besides, being rich and cheapest source of dietary proteins and valuable animal feeds, they also play key role in improving and sustaining soil productivity with an account of biological nitrogen fixation and addition of high amount of organic matter.

A large number of pulse crops are grown in Bangladesh in respect of area and production (BBS, 2016). Among pulses blackgram (*Vigna mungo* L.) is one of the most important crop grown in Bangladesh. It is one of the leading pulse crop in Bangladesh due to its significant value as food, fodder and green manure. The green parts of blackgram are used as animal feed and the residues as manure. Blackgram is very much popular in Bangladesh and ranks 4th in terms of consumption and total area in which different varieties of this crop are cultivated (Gowda and Kaul, 1982). It ranks second in respect of yield and production of seed protein (Mian, 1976).

Blackgram locally known as maskalai belongs to the family Fabaceae and it is a self-pollinating and widely cultivated grain legume (Naga *et al*., 2006). It is a deep rooted drought hardy crop, source of fodder, green mannuring, pluses and lavish iron and zinc rich minerals (Singh *et al*., 2013). Blackgram is originated in south and southeast Asia but widely grown in India, Pakistan, Bangladesh, Myanmar, Thailand, Philippines, China and

Indonesia (Poehlman, 1991). It is an important pulse crop of Bangladesh and ranks the fourth position considering both acreage and production (MoA, 2014).

Blackgram is cultivated in the area of 26,913 ha contributing 9.5% of total pulse production (BBS, 2012). It has been reported that the average yield of blackgram is about 1000 kg ha^{-1} and the protein content is 25-26% (BINA, 2004). In spite of its various uses, its cultivation is decreasing day by day both in acreage and yield (BBS, 2016). Unfortunately the average yield of blackgram is 714 kg ha^{-1} (BBS, 2010) which is very low compare to other blackgram producing countries having its high potential yield. This crop is grown in Bangladesh in cropping systems as a mixed crop, cash crop, sequential crop besides growing as sole crop under residual moisture conditions after the harvest of rice and also before and after the harvest of other summer crops under semi irrigated and dry land conditions (Parveen *et al*., 2011). The crop is resistant to adverse climatic conditions and improves the soil fertility by fixing atmospheric nitrogen in the soil.

As an excellent source of plant protein blackgram is cultivated extensively in the tropics and subtropics. It's grain contains 59% carbohydrates, 24% protein, 10% moisture, 4% mineral and 3% vitamins (Khan, 1981 and Kaul, 1982). According to FAO (2013) recommendation, a minimum intake of pulse by a human should be 80 g day^{-1}, whereas it is 7.92 g in Bangladesh (BBS, 2012). Bangladesh needs more than 2299 thousand tons of pulses to meet the demand of a population of millions at present situation (FAO, 2012; BBS, 2012). However, the country produced only 474 thousand tons which was only *29.53%* of the total demand. In 2011-2012, the country produced only 18,000 tons of blackgram which was less than 5.26% of the immediate previous year (BBS, 2012). In Bangladesh, it can be grown both in summer and winter seasons.

Blackgram plays an important role to supplement protein in the cereal-based low-protein diet of the people of Bangladesh, but the average production of blackgram is gradually declining day by day (BBS, 2012). The average yield of blackgram is 0.7 t ha^{-1} which is incomparable with the average yield of developed countries of the world (BBS, 2013). Basically it is cultivated with minimum tillage, local varieties with no or minimum fertilizers, no pesticides, no weed management and very early or very late sowing, no practicing of irrigation and drainage facilities etc., which are responsible for low yield of blackgram. The low yield of blackgram besides other factors may partially be due to lack

of knowledge regards to suitable production technology of this crop (Hossain *et al*., 2008). Application of judicious levels of nitrogen and suitable plant density is prerequisite for increasing the production of blackgram in Bangladesh. Blackgram has been universally accepted as responsive crop to the application of Nitrogen, Phosphorus and Potash. It requires less amount of nitrogen as it is synthesized by nodulation process; phosphorus is required in large quantity by this crop. Phosphorus contributes directly to both the yield and quality of the black gram. Potash influences root growth, number and weight of root nodules per plant and quality of grains (Singh and Singh, 1989).

Blackgram mostly grown in the kharif season and as such weed infestation is the most serious problem which affects growth, nutrient uptake and yield of this crop. Besides, less use of biofertilizer, non-adoptions of improved technologies are the major constraint for poor yield of black gram, (Kandasamy and Vijayaraghavan, 2008).

The loss caused by weeds exceeds the losses from any other category of agricultural pests like insect, nematodes disease, rodents etc. Weeds have been observed to cause losses in a silent and unnoticed manner. The extent of damage instigated by weeds primarily depends upon the nature and intensity of weeds the losses in yield is up to76% as reported by Sumathi *et al.* (2000).

Traditional method of weed control convoluted a considerable amount of labor, time and cost. Moreover on large holding it is not possible to get enough labor to complete weeding at the proper stage as one has to be governed by the availability of labors. In Bangladesh, hand weeding is the most common method of weed control even today, but it is essential to find out apposite alternative to cover the need of the large farm and the need of future. Besides manual hand weeding, use of weedicides is also achievement importance in black gram cultivation due to their effectiveness. However use of chemical / weedicides also touches soil physico-chemical properties, nutrient availability and soil microbial population, the activity of nodule bacteria and consequently symbiotic traits, which also wishes to be determined.

Blackgram is the least researched crop among pulses despite its in elevation nutritive and economic value due to which its area and production declined continuously. The lack of suitable and high yielding varieties is foremost inhibitor. It grows on marginal land, where other crops accomplish poorly. The worldwide yield of black gram is very low because

mostly indigenous land contests are cultivated and also because the crop is often grown on a tad fertile land with insufficient water. The indigenous land contests have many hitches like low yield potential, shattering habit, susceptibility to disease and insect pest. Other hand, Variety is one of the important factors which ultimately affect growth and yields of plant. One variety differs from another variety by its genetic difference .Due to genetical differences one variety gives high yield whereas another variety gives low yield. Local variety perform poor than other variety. Therefore it is necessary to suggest suitable and high yielding variety to get maximum profit. Keeping the above facts in consideration this experiment entitled "Growth and yield of blackgram as affected by management packages" was done with the following objectives:

1. To identify the suitable blackgram varieties
2. To study the effect of management packages on growth and yield attributes of blackgram
3. To find out the interaction management packages on yield and other yield attributes of two blackgram varieties

CHAPTER II

REVIEW OF LITERATURE

Blackgram is an important pulse crop in Bangladesh as well as in many countries of the world although the crop has conventional less attention by the researchers on various aspects. Basically it grows in fallow land or as intercropped without or minimum care. Although varieties and management packages of blackgram play an important role in improving yield but research works related to blackgram varieties and management packages on blackgram are limited and not conclusive in the context of Bangladesh. Review of literature is a necessary step for any scientific study. It provides a theoretical framework, previous work and the basic interpretation of findings to the study. An attempt has been made to review the literature, which is meaningful and had direct relevance to this study. The available relevant references have been reviewed under this chapter are mentioned below:

2.1 Performance of varieties

2.1.1 Growth parameters

Nag *et al.* (2000) successfully did a research on three blackgram (*Vigna mungo*) cultivars viz.Barimash-1, Barimash-2 and Barimash-3 to evaluate their yield and yield attributes. Among the three cultivars, Barimash-1 blackgram cultivar had the highest plant height and number of branches per plant.

Khan and Asif (2001) gave their opinion that the genotype ES-1 gave significantly higher branches per plant than other genotypes. Different genotypes did not show any significant differences in plant population and plant height.

Chaudhary *et al*. (1988) said that dry matter/plant was 5.0, 4.0 and 11.2% higher in variety T-9 than UG218, Pant U-19 and UPU9-40-4 respectively. Similarly the yield was also higher in T-9.

Vijayalakshmi *et al.* (1993) studied plant growth and leaf production in 12 high, medium and low seed yielding black gram (*Vigna mungo*) cultivars. Dry matter yield was related mainly to growth achieved by 45 days after sowing and the subsequent rate of leaf production.

Chaudhary *et al* (1994) researched that maximum height, number of branches, leaves as well as dry matter accumulation per plant were recorded in early (6th July) planted crop. However, variety WG 218 attained maximum height; trifoliate leaves and dry matter per plant were associated with variety Type 9.

Reddy *et al.* (2003) determined the performance of 13 blackgram cultivars (LBG 685, LBG 648, LBG 611, LBG 645, LBG 22, LBG 623, LBG 695, LBG 703, LBG 708, LBG 709, LBG 719, LBG 17 and LBG 402). LBG 645 recorded the highest number of branches/plant (6.3), biomass production (4.80), number of pods/plant (11.4), seed yield (10.82 q/ha) and nitrogen reductase activity (51.80 nmol/h/g). LBG 703, LBG 685 and LBG 719 shown as the tallest plants (37.9 cm), highest number of seeds per pod (6.73) and harvest index (37.2).

Maragatham *et al.* (2000) performed a research on path analysis on 32 genotypes of blackgram. They showed that branches per plant and pod length exerted high positive direct effect on grain yield. Also pods per plant had indirect effect through plant height and number of branches per plant.

Parmeswar and Setty (1993) examined six blackgram varieties together with the local standard K-3 to study days to maturity, number of pods per plant. Varieties LBG 642 and 2 BG 17 with respective mean yield of 1255 and 1222 kg/ha, significantly out yielded as compared to K3 (1083 kg/ha). LBG 642 recorded the highest number of pods /plant (15.5).

Patra *et al.* (2000) found that variety 'Nayagarh Local' offered the maximum seed yield (978 kg/ha), followed by 'Sujata' (937 kg/ha) and 'PAM 54' (878 kg/ha). Sowing on 10th September was the best date with seed yield of 969 kg/ha. A delay of 10 and 20 days in shows the reduction of seed yield by 14.2 and 30.0% respectively. Most yield components varied significantly due to varieties but not due to dates of sowing. Incidence of yellow mosaic virus, cercospora leaf-spot and powdery mildew was the minimum in 'PAM 54' and in the crop sown on 10 September.

Patel and Munda (2001) reported that the growth pattern and yield potential of five cultivars (T-9, PU-19, PDU-1, DPU-88-1 and DPU-88-31) of blackgram. Results showed high potential for blackgram cultivation. Plant height (42.2 and 41.6 cm), root length (20.1

and 19.3 cm), days to flowering (42.7 and 41.3) and maturity duration (84.3 and 84.7) were highest in DPU88-1 for 1998 and 1999, respectively. DPU-88-31 showed the lowest plant height (25.7 and 24.7 cm), days to 50% flowering (38.3 and 36.3) and maturity (82.7 and 81) respectively. The number of pods per plant was highest with T-9 (47.6) and lowest in PU-19 (33.3. Highest number of seeds per pod, 1000seed weight, seed yield per plant, biomass per plant and yield were recorded by PDU-1.

Singh and Rana (1992) showed that Pant U-30 being at par with Pant U-19 recorded significantly higher dry matter accumulation per plant than T-9. Yadahalli *et al*. (2006) studied on the growth and yield of the blackgram genotypes TAU-1, Manikya and K-3. TAU-1 recorded highest values as result for seed yield and its components, whereas K-3 recorded the highest values for most growth attributes.

2.1.2 Physiological parameters

Biswas *et al.* (2002a) carried a field experiment to evaluate the growth and yield performance of two blackgram varieties i.e., BARI mash 3 and BINA mash 1 under three different population densities. Both the blackgram varieties which gave identical results in LAI, CGR, NAR, RGR as well as grain yield.

Khan and Asif (2001) studied the response of ten mashbean genotypes namely 9010, 98-CM-525, 98-CM-524, 9006, ES-1, 9081, 98-CM-523, Mash-3, 9092 and 98-CM-522 and showed that the LAI differed significantly due to genotypes.

Pandey and Singh (2000) declared that early vegetative growth has not any direct influence on grain yield and that plant height at and after flowering should takes attention as choose criteria. The outcomes are contrary to the concept of competition between foliar development and grain, indicating that vigorous growth after an thesis should be encouraged. The correlation between total plant dry matter and grain yield was significant, while harvest index with grain yield showed no relation in either season. Further, the coefficient of determination appears that the contribution of total plant dry matter to grain yield was 50% in kharif season and 20% in summer season. These finding recommends that in order to attain maximum grain yield, vigorous plant growth is must.

Mahalakshmi *et al.* (2002) studied on the performance of 5 black gram genotypes (LBG 20, LBG 623, LBG 685, LBG 708 and LBG 709) under rainfed conditions in the field (on deep Vertisols) in Andhra Pradesh. LBG 708 was taller (43.5 cm) and had higher total biomass production (15 g/plant), number of leaves/ plant (12.4), number of branches/plant (7.0), leaf area index (5.62 dm2), nitrate reductase activity (65.0 moles of NO2/h g-1), number of pods per plant (27), harvest index (28.5) and seed yield (10.3 q/ha) under rainfed conditions compared to the other genotypes.

Patil and Salimath (2003) reported that significant genotypic differences were found for all the physiological traits, i.e. total dry matter (TDM) at 25, 45 and 75 days after sowing (DAS), crop growth rate (CGR) at 25-45 and 45-75 DAS, biomass duration (BMD) at 25-45 and 45-75 DAS, relative growth rate (RGR) at 25-45 and 45-75 DAS, leaf area index (LAI) at 25 and 45 DAS and harvest index.

Nag *et al.* (2000) published that all the cultivars manifested the highest leaf area index at 52 days after emergence, total dry matter per unit area at 66 DAE and crop growth rate at 59 DAE. Relative growth and net assimilation rates were high at 31 DAE. The highest leaf area index (4.42), crop growth rate (0.2269 g m-2 day-1), relative growth rate (13.057 g/g/day), net assimilation rate and total dry matter (303.84 g m-2) were recorded from Barimash-1.

Ahamed and Salimath (2002) did an experiment on sixteen elite black gram cultivars to elicit information on the possibility of utilizing important physiological traits for improving productivity. Harvest index (HI) and test weight (TW) gave positive and significant association with seed yield. Physiological parameters like leaf area duration (30-50 days after sowing, DAS and 50 DAS harvest), crop growth rate (CGR, 30-50 DAS), biomass duration (BMD, 3050 DAS and 50 DAS-harvest) manifested as positive correlation with TW indicating their contribution towards higher seed weight. Mondal *et al.* (2012) found that a relatively smaller portion of total dry matter (TDM) was produced before flower initiation and the bulk of it after an thesis. The maximum CGR was observed during pod filling stage in all the varieties due to maximum leaf area (LA) improvement at this stage. Two plant characters such as LA and CGR results the higher TDM production.

Mondal *et al.* (2011) reported that growth rate of mung bean was very slow during the vegetative phase in all the four genotypes (MB-35, MB-45, MB-16 and MB-43). The maximum crop growth rate (CGR) was found due to maximum leaf area (LA) development during the pod filling stage in all the genotypes. LA.

2.1.3 Yield and yield attributes

Miah *et al.* (2009) conducted an experiment on four mungbean (*Vigna radiata* (L.) Wilczek) varieties viz BINA moog2, BINA moog5, BINA moog6 and BINA moog7 to identify the suitable variety(s) of summer mungbean. Among the varieties BINA moog7 gave significantly higher pods per plant and seed and straw yield than other varieties. Reddy (1992) found that to LBG402 recorded significantly higher grain yield then examined genotype except with LBG611 and LBG20.

Patel and Munda (2001) studied to evaluate the growth pattern and yield potential of five cultivars (T-9, PU-19, PDU-1, DPU-88-1 and DPU-88-31) of blackgram. The number of pods per plant was highest with T-9 (47.6) and lowest in PU-19 (33.3), whereas highest number of seeds per pod, 1000-seed weight, seed yield per plant, biomass per plant and yield were recorded by PDU-1.

Selim (1999) did a field trials during summer season of 1995 and 1996 at Beni-Swef Governorate, Egypt to evaluate productivity of six Vigna radiata genotypes (Kawmy-1, Giza-1, Vc-1000, Vc- 2719, T-44 and M- 53). Growth, yield and yield components as well as chemical analysis of seeds were studied. The highest seed yield per feddan (1088 kg/feddan) was obtained by Kawmy-1 followed by T-44 (1056 kg/feddan) and Vc-1000 (981 kg/feddan).

Mishra (1993) carried a field experimenton farmer's field on sandy loam soil during the rainy seasons of 1986-87 at Sidhi, Madhya Pradesh, where 3 blackgram cultivars were given 0, 20, 40 and 60 kg P2O5/ha. This gave seed yields of 592, 655, 751 and 846 kg/ha, respectively. Cultivar RU-2, BP-1 and Local had seed yields of 765, 739 and 635 kg/ha, respectively. Sekhon *et al.* (1993) announced that the grain yield was influenced significantly by genotypes during experimental years. During 1988, 'Mash218' gave higher yield than 'UG518' but during 1989 'UG414' gave the maximum yield and it was better than 'UG518'.

Gupta and Namdeo (1999) announced that the performance of blackgram genotypes viz. TPU-4, TAU-5, Pant U-30 and T9 was found better and superior to JU 77-41 and LBG20 in respect of grain yield. Nag *et al.* (2000) conducted a research on three black gram (*Vigna mungo*) cultivars (Barimash-1, Barimash-2 and Barimash-3) to evaluate their yield and yield attributes. Among the three cultivars, Barimash-1 and Barimash-3 recorded the highest (1601.4 kg/ha) and lowest seed yield (1455.0 kg/ha), respectively. Barimash1 blackgram cultivar had the highest pods per plant and seeds per pod.

Singh *et al.* (1999) promulgate that cultivars UG 606 produced maximum seed yield followed by UG 841. The seed yield of recommended cultivars UG 414 and UG 218 was lower than UG 841 and UG 606. Reddy (1997) published that the genotypic and phenotypic variation were highest for branches/plant along with the grain yield/plant and pods/plant. Days to maturity followed by plant height and pod length had the highest heritability's and were least affected by the environment. Clusters/plant, pods/cluster, seeds/pod, 100-seed weight and grain yield showed high differences in phenotypic and genotypic variation, indicating that the expression of these traits was affected by environmental components.

Maragatham *et al*. (2000) showed the positive and significant correlation of number of seeds per pod and 100-seed weight with grain yield and their positive direct effect these characters were observed to be the real components of grain yield.

Borah (1994) experimented with five *Vigna radiata* varieties at seed rates of 20, 30 and 35 kg/ha during 1990 and 1992 and grown under rainfed conditions. These varieties varied significantly for 100-seed weight and seed yield in both years and for pods per plant in 1992 only. Seed rate also changed yield significantly in both years. A consistent increase of seed yield was observed with increase in sowing rate. Variety- seed rate interaction influences were not significant.

Sayao *et al.* (1993) reported that among 25 mungbean varieties, VC 3012 B and VC 3301 A produced the highest seed yields (1.52 and 1.48 t/ha, respectively, compared with an average yield of 1.24 t/ha for all varieties). Nodulation was particularly high in VC4049-B-3-1-1-1-B (41 nodules/plant) and VC3061A (39.7 nodules/plant). Nodule dry weight per plant was greatest for cv VC2331A (75.2 mg.).

Ihsanullah *et al.* (2002a) proclaimed that various mash bean varieties were significantly different in pods per plant, seeds per pod, biological yield and grain yield. The highest number of pods per plant (20.6) for NARC Mash-1, higher number of seeds per pod (4.9) for NARC Mash-3, greatest biological yield (4400 kg ha-1) for NARC Mash-4 and more grain yield (557.1 kg ha-1) for NARC Mash-1 were found.

Kandasamy and Kuppuswamy (2007) reported that among the six varieties (T9, ADT3, ADT5, VBN2, VBN3 and CO5), ADT3 recorded the highest values of all growth and yield parameters. It registered the highest seed yield of 811 kg/ha.

Ghafoor *et al.* (2002) reported that the suitable and economically viable cultivation method of black gram. Among the treatment BARI Mash-2 and BARI Mash-1 that found was the highest grain yield BARI Mash-2 (1044 kg/ha) compare to lowest grain yield of BARI Mash-1 (475 kg/ha).

Biswas *et al.* (2002b) discovered that pooled analysis gives a significant variation among the varieties in respect of seed yield. Barimash-3 produced the highest seed yield (977 kg/ha) which was statistically similar to that of Binamash-1 (960 kg/ha). Barimash-2 gives the lowest seed yield (866 kg/ha).

Manivannan *et al.* (2005) said that the black gram genotype VBG 55 is a hybrid derivative of CO 4 x PDU 102. It matures in 75-80 days. It has recorded an average seed yield of 782, 737 and 793 kg/ha during kharif, rabi and summer seasons respectively.

Gupta *et al.* (2006) reported that UG-218 urdbean variety produces significantly higher pods/plant, 1000 seed weight, seed yield as well as straw yield over other two varieties (Type-9 & Pant-U19).

Mondal *et al.* (2011) performed an experiment on four genotypes of mung bean (MB-35, MB-45, MB-16 and MB-43) and found the significant differences in pods per plant, yield per plant and seed index due to varieties.

Aher *et al.* (2006) showed that the genotypes significantly differed for grain yield per plant. The highest grain yield was recorded by the genotype TAU-1 (19.91 q/ha). Numbers

of clusters per plant, number of pods per plant, number of pods per clusters, number of grain per pod, number of grain per plant and test weight were appeared to be the most important yield contributing characters for enhancing higher grain yield.

2.2 Performance of management packages

2.2.1 Growth parameters

Vasudevan *et al.* (2008) researched on the performance of various insecticides viz., fenvalarate 20EC, fenvalarate dust, malathion 25 EC, malathion dust, quinolphos 25 EC, quinolphos dust, neem seed kernel extract (NSKE) and commercial neem seed pesticide (SPIC) on seed yield and quality of blackgram cv. TAU-1. Among the various organic and inorganic chemicals used, quinolphos 25EC recorded maximum seed yield of 9.8 q/h.

Khan and Asif (2001) studied the response of ten mashbean genotypes to three planting densities viz. 10, 15 and 20 cm and reported that the planting densities significantly affected the number of branches/plant. But height was not influenced by various densities. Shrivastava *et al.* (1980) documented that in blackgram yield and yield characters, including root nodulation were favourably influenced by wider row spacing.

Bhattacharya *et al.* (2004) documented that the hand weeding at 20 and 40 DAS resulted in the lowest weed dry matter production. They also reported that two hand weeding at 20 and 40 DAS showed highest weed control efficiency (WCE) of 95.65 and 96.29 % during 2001 and 2002, respectively.

Sathyamoorthi *et al.* (2008b) conducted an experiment to study the effect of increased plant density and nutrient management on the growth and yield of greengram. Three inter row spacing of 20 cm, 25 cm and 30 cm with a constant intra row spacing of 10 cm accommodating 5.0, 4.0 and 3.33 lakh plants/ha were tried in the main plot. They reported that higher plant density favored the plant height, total dry matter production (TDMP) and grain yield. At lower plant density, leaf area and DMP per plant were more and they also reported that root length increased with increasing population density from the recommended level of 3.33 to 5.0 lakh plants/ha at all stages and seasons. Root volume was more with less population and it decreased with higher population at all stages and

seasons. Functional root nodules were higher with recommended plant population of 3.33 lakh plants/ha.

Patel *et al.* (2005) documented that in blackgram planting geometry had no significant effects on growth and seed yield. Planting geometry of 40×15 cm recorded the highest plant height, root length, leaf number per plant, branches per plant and biomass per plant than rest of the planting geometries.

2.2.2 Physiological parameters

Sathyamoorthi *et al.* (2008c) documented that Leaf area index (LAI) and crop growth rate (CGR) were greater under a narrow spacing of 20x10 cm than under a row spacing of 30 cm. The relative growth rate (RGR) was higher under recommended spacing (30x10 cm), whereas the net assimilation rate (NAR) was higher under wider spacing. Shekhawat *et al*. (2002) in a weed management trial in black gram concluded that pendimethalin @ 1 and 1.25 kg/ha respectively) enhanced plant height, leaf area index at 60 days after sowing.

Biswas *et al.* (2002a) performed a field experiment to evaluate the growth and yield performance of two blackgram varieties i.e., BARI mash 3 and BINA mash 1 under three different population densities of 40 x 10 cm2, 30 x 10 cm2 and 40 x 5 cm2 representing 25, 33 and 50 plants m2. Planting density had significant effects on LAI and CGR of the blackgram varieties. The highest planting density showed the highest LAI and CGR. The NAR and RGR did not differ due to different population densities.

2.2.3 Yield and yield attributes

Singh and Yadav (1994) documented that Pant U 35 produced seed yields of 1.13, 1.37 and 1.36 t/ha with 15, 22.5 and 30 cm row spacing, respectively. The seed and straw yields recorded at 22.5cm and 30cm row spacing were statistically at par, but showed significant increase of 21.13 and 20.60 and 8.36 and 8.67% over 15cm. row spacing respectively.

Mishra and Misra (1995) found that seed yield of black gram [*Vigna mungo*] cv. T 9 was not affected by various row spacings 10, 20 or 30 cm. Khan and Asif (2001) documented that the planting densities significantly affected the seed yield (kg/ha), biomass (kg/ha) and harvest index (%). Yadav *et al.* (1994) documented that higher seed yield of blackgram with 20 kg N ha^{-1}, 40 kg P ha^{-1} and 40 kg K ha^{-1}.

Govinda and Yadav (2001) documented that yield difference due to row spacing variations was significant. Row spacing of 30 and 40 cm gave comparable yield (351.8 and 374.0 kg/ha, respectively) and significantly higher than closure row spacing.

Bialy and Samie (2001) researched on the blackgram cultivars (Kawmy-1 and Giza-1) with herbicides pendimethalin treatments and hand hoeing twice in a field experiment conducted in Egypt. Hand hoeing showed the highest control of the weeds (89.5%) plots planted with Kawmy-1 recorded 16.4% lowest weed dry weight compared to plots planted with Giza-1. Weeded treatments recorded taller plants and higher number of branches and pods per plant, number of seeds per pod, pod length, 100- seed weight and crop yield over the control. Application of resulted in the highest yield hand weeding and pendimethalin treatment.

Kumar *et.al.* (2001) documented that hand weeding at 20 and 40 DAS resulted in the highest number of pods/plant, 1000 grain weight, grain yield (17.15 q/ha) and weed control efficiency (63.07 %). Biswas *et al.* (2002a) documented that the highest grain yield was recorded from intermediate population density (30×10 cm^2) due to the highest number of pods per unit area. The seeds per pod did not differ due to different population densities.

Subramani *et al*. (2005) delineate that application of green manure and 100% NPK fertilizer to advance kharif season rice, raising rice fallow black gram before pishanam season rice and application of 75% or 100% NPK fertilizer to pishanam season rice recorded high yield and yield attributes. Application of 75% of the recommended NPK rate to pishanam season rice offer the highest benefit: cost ratio.

Ihsanullah *et al.* (2002b) documented that maximum pods/plant (28.25), number of seeds/pod (10.25), grain yield per plant (6.87g), 100-seed weight (4.27g), biological yield (3854kg/ha), grain yield (921kg/ha) were recorded at 20cm X 15cm spacing.

Sumachandrika *et al.* (2003) documented that weeding at 20 and 40 DAS resulted in the lowest number of weeds and weed dry weight and highest number of pods/plant as well as seed yield in urd bean.

Hemlata (2012) researched on black gram and said that highest number of pod plant1, number of seed plant-1, number of seed pod-1, seed yield, stover yield and harvest index were obtained under hand weeding twice (20 and 40 DAS), and minimum was obtained under unweeded check.

Patel *et al.* (2005) documented that planting geometry had no significant effects on growth and seed yield. Planting geometry of 40x15 cm recorded the highest pods per plant, seeds per pod and 1000-seed weight than rest of the planting geometries. Planting geometry of 30x10 cm and 30x15 cm gave higher seed yield over the rest of the planting geometries.

Achakzai and Panizai (2007) detailed that except harvest index all the parameters consisting growth, yield and yield components were not affected significantly by various levels of row spacing. Maximum harvest index (61.44%) was got in row spacing of 40 cm which is statistically at par with four other spacing viz; 20, 25, 30 and 35 cm. Results further gives that number of pods/plant (0.744) and grain yield/plant (0.888) were highly-remarkable and positively correlated with grain yield.

Abdelhamid and Elmetwally (2008) give an account of two hand hoeing treatment gave the highest values of number of pods per plant^{-1}, weight of pods per plant^{-1} and number of seeds per plant^{-1} by 140.7, 150.0 and 59.8%, respectively, compared to the non-weeded treatment.

Budhar *et al.* (1991) researched on *Vigna mungo* cv. ADT 5 sown at spacings of 30 cm x 10 cm (33,000 plants/ha) or 30 cm ×5 cm (666,000 plants) produced seed yields of 0.61 and 0.84 t/ha, respectively. Singh *et al.* (1993) documented increased pod and seed yield of blackgram with N 20 kg ha^{-1} and P 40 kg ha^{-1}.

Tomar *et al.* (1988) researchedon 4 *Vigna mungo* cultivars grown at 2 spacing, cv. JU-78-4 gave the highest av. seed yields of 0.96 t/ha compared with 0.81-0.86 t for other cultivars. Crops grown in rows 20 or 30 cm apart gave similar yields. Kumar and Sharma (1989) studied *Vigna mungo* cv. Pant U 19 sown in rows 15, 20, 25 or 30 cm apart. Row spacing of 15 or 20 cm gave higher seed yields than wider row spacing.

Asaduzzaman *et al.* (2010) proclaimed that the plant spacing did not show remarkable differences in dry matter production at early stages of crop growth. The spacing of 30×10 cm showed its advantages by producing 7.96-16.19% higher yield compared to other spacing. Singh *et al.* (1992) documented that seed yield kg /ha, straw yield kg /ha and seed protein content were increased with increasing row spacing (15, 22.5 and 30 cm) in *Vigna mungo* cv. Pant U-35.

CHAPTER III

MATERIALS AND METHODS

The experiment was accompanied to find out the performance of blackgram in response of different varieties and management packages. The materials and methods for this experiment comprises a short description of the location of experimental site, soil and climatic condition of the experimental area, materials used for the experiment, design of the experiment, data collection and data analysis procedure. The details report of the materials and methods for this experiment have been presented below under the following headings-

3.1 Description of the experimental site

3.1.1 Experimental period

The experiment was conducted during the period from March to June, 2017.

3.1.2 Experimental location

The experiment was conducted at the Research Farm of Sher-e-Bangla Agricultural University (SAU), Dhaka and it was located in 23° 77' N latitude and $90^0$35'E longitudes. As per the Bangladesh Meteorological Department, Agargaon, Dhaka-1207 the altitude of the location was 8 m from the sea level.

3.1.3 Characteristics of soil

The general soil type of the experimental field is Deep Red Brown Terrace soil and the soil belongs to the Tejgaon series under the Agro-ecological Zone, Madhupur Tract (AEZ-28). A composite sample of the experimental field was made by collecting soil from several spots of the field at a depth of 0-15 cm before beginning of the experiment. The composed soil was air-dried, grind and passed through 2 mm sieve and analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka for some important physical and chemical properties. The soil was consuming a texture of silty clay with pH and organic matter 5.7 and 1.13%, respectively. The results presented that the soil composed of 27% sand, 43% silt and 30% clay, details have been presented in Appendix I.

3.1.4 Climatic condition

The climate of experimental site was under subtropical climate and characterized by three distinct seasons, the *Rabi* from November to February and the *Kharif-I*, pre-monsoon period or hot season from March to April and the *Kharif-II* monsoon period from May to October. The monthly average temperature, relative humidity and rainfall during the crop growing period were together from Weather Yard, Bangladesh Meteorological Department, and presented in Appendix II. During the experimental period the maximum temperature (40^0C), highest relative humidity (100%) and highest rainfall (227 mm) was recorded in the month of June 2017, whereas the minimum temperature (17^0C), minimum relative humidity (15%) and no rainfall was recorded for the month of March 2017.

3.2 Experimental details

3.2.1 Treatments of the experiment

The experiment comprised of two factors

Factor A: Variety-3:

i) V_1: BARI Mash-3

ii) V_2: BARI Mash-2

iii) V_3: BINA Mash-1

Factor B: Management Packages-3:

i. M_1: Low management (Fertilizer 0-0-0 NPK + 40 kg seed/ha in broadcasting + no pesticide application + no weeding)
ii. M_2: Medium Management (Fertilizer 20-10-20 NPK kg ha^{-1} + 24 kg seeds/ha in line sowing (30 cm×continuous) + pesticide application + one hand weeding after 15 DAS)
iii. M_3: High management (Fertilizer 40-20-40 NPK kg ha^{-1} + 24 kg seed/ha in line sowing + pesticide application + two hand weedings at 15 and 25 DAS)

There were total 9 (3×3) treatment combinations as, V_1M_1, V_1M_2, V_1M_3, V_2M_1, V_2M_2, V_2M_3, V_3M_1, V_3M_2, and V_3M_3.

3.2.2 Planting material

Blackgram varieties BARI Mash-3,BARI Mash-2 and BINA Mash-1 were used as planting material for the study. The seeds of BARI mash-3 and BARI Mash-2 were collected from the Pulse Seed Division of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. The yellow mosaic virus resistant BARI mash-3 variety was released by BARI in 1996 in farmers' level and it was developed through hybridization between line BMA-2140 and BMA-2038.Another variety seeds BINA Mash-1 were collected from Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh.

3.2.3 Land preparation

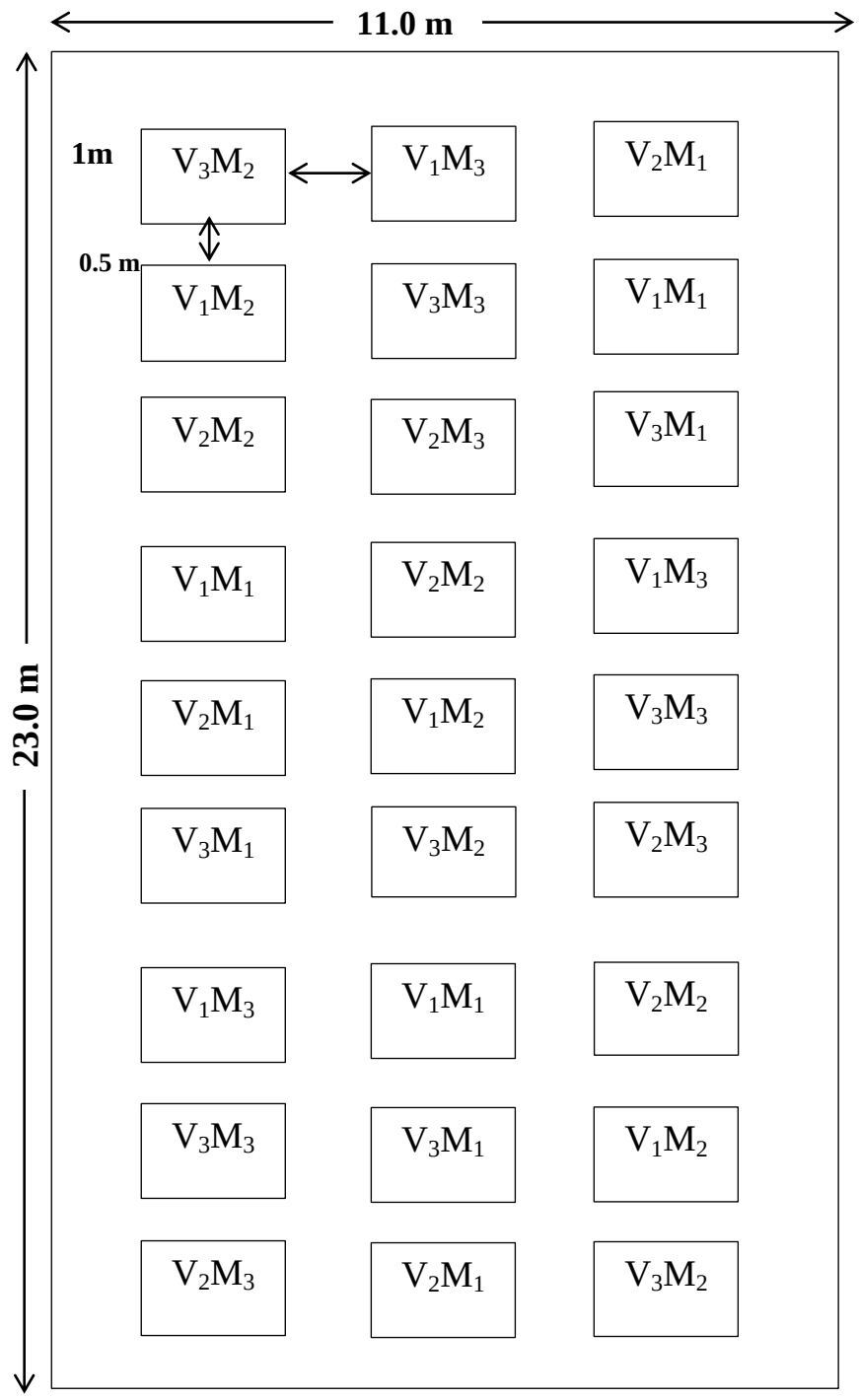
The land where the experiment was conducted it was opened on the 5th March, 2017 with the tractor drawn disc plough. Ploughed soil again and again to brought into desirable tilth by cross-ploughing, harrowing and laddering. The stubble and weeds were removed from the tilth soil. The first ploughing and the final land preparation were done on the 15th and 16th March, 2017, respectively. Experimental land was allocated into unit plots following the experimental design of this experiment.

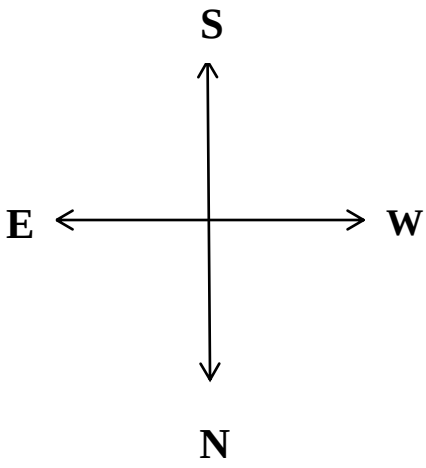
3.2.4 Fertilizer application

Urea, Triple super phosphate (TSP) and Muriate of potash (MOP) were used in the experimental soil as a source of nitrogen (N), phosphorous (P) and potassium (K), respectively. Urea was applied 0, 20 and 40 kg N ha^{-1} in the soil as per treatment of the experiment. TSP was applied at the rate of 0,10 and 20kg ha^{-1}as per treatment. MOP was applied at the rate of 0,20 and 40kg ha^{-1} as per treatment. All of the fertilizers were applied in final land preparation as basal dose as per treatment.

3.2.5 Experimental design and layout

The two factors experiment was laid out in a split-plot design with three replications. An area of 23.0 m × 11.0 m was divided into three blocks. Different varieties were assigned in the main plot and management packages in sub-plot. The size of the each unit plot was 3.0 m × 2.0 m. The space between two blocks and two plots were 1.0 m and 0.5 m, respectively. The layout of the experimental plot is shown in Figure 1.





Plot size: 2.0 m × 3.0 m

Block to block distance: 1m

Plot to plot distance: 0.5 m

Factor A: Variety

V_1= BARI mash-3

V_2 = BARI mash-2

V_3 = BINA mash-1

Factor B: Management packages

M_1 = Low management

M_2 = Medium management

M_3 = High management

Figure 1: Layout of the experimental plot

3.3 Growing of crops

3.3.1 Sowing of seeds in the field

The seeds of blackgram were sown on March 17, 2017 in solid rows in the furrows having a depth of 2-3 cm and row to row distance was 30 cm.

3.3.2 Intercultural operations

3.3.2.1 Mulching

A natural mulching was done with breaking down the top soil on 31 March, 2017 which was 15 days after sowing.

3.3.2.2 Thinning

Seeds started germination on 4 days after sowing (DAS). Thinning was done one times; the thinning was done at 15 DAS to maintain optimum plant population in each plot.

3.3.2.3 Irrigation, drainage and weeding

Irrigation was delivered before 15 and 30 DAS for optimizing the vegetative growth of blackgram to the experimental plots as per treatment but additionally supplementary irrigation was delivered as per treatment before flowering. The crop field was weeded as per treatment. Proper drain also made for drained out excess water from irrigation and also rainfall from the experimental plot. The field was weeded at 15 and 25 DAS by hand weeding as per treatment.

3.3.2.4 Plant protection measures

At early stage of growth few worms (*Agrotis ipsilon*) infested the young plants and at later stage of growth pod borer (*Maruca testulalis*) attacked the plant. Ripcord 10 EC was sprayed at the rate of 1 ml with 1 liter water to 5 decimal lands for two times at 15 days interval after seedlings germination as per treatment to control the insects. Before sowing seeds were treated with Bavistin 50 WP to protect seed borne diseases.

3.4 Crop sampling and data collection

Five plants from each treatment were randomly selected and marked with sample card. Plant height, number of branches plant^{-1}, number of leaves plant^{1}, dry matter content plant^{-1} and number of nodules plant^{-1} were recorded at different DAS and at harvest. All of the yield parameters were recorded in 2 times and total or average was estimated as per the nature of yield parameters.

3.5 Harvest and post-harvest operations

Harvesting was done when 90% of the pods became brown to black in color and it was carried out for two times namely 1st harvest at 26 May, 2017 and last harvest at 6 June, 2017**.** The matured pods were collected by hand picking from each plot. The collected pods were sun dried, threshed and weighted to a control moisture level. The seeds were separated, cleaned and dried in the sun for 3 to 5 consecutive days for achieving safe moisture of seed.

3.6 Threshing

The pod was sun dried for three days by placing them on the open threshing floor. Seeds were separated from the pods by thrashing with bamboo sticks.

3.7 Drying, cleaning and weighing

The seeds thus collected were dried in the sun for tumbling the moisture in the seeds to a constant level. The dried seeds and straw were cleaned and weighed.

3.8 Data collection

The data were recorded on the following parameters during the experimentation.

A. Crop growth characters

a. Seedling emergence (no. m^{-2})
b. Plant height (cm)
c. Number of leaves plant $^{-1}$
d. Dry matter content $plant^{-1}$ (g)
e. Number of nodules $plant^{-1}$
f. Dry weight of nodules $plant^{-1}$ (mg)
g. Days required to 1st flowering

B. Yield and other crop characters

a. Number of branches $plant^{-1}$
b. Number of pods $plant^{-1}$ at 1st harvest
c. Number of pods $plant^{-1}$ at last harvest
d. Number of total pods $plant^{-1}$
e. Number of seeds pod^{-1} at 1st harvest

f. Number of seeds pod^{-1} at last harvest
g. Pod length at 1st harvest (cm)
h. Pod length at last harvest (cm)
i. 1000-seed weight at 1st harvest (g)
j. 1000-seed weight at last harvest (g)
k. Seed yield (t ha^{-1})
l. Stover yield (t ha^{-1})
m. Biological yield (t ha^{-1})
n. Harvest index (%)

3.9 Procedure of data collection

3.9.1 Crop growth characters

i. Seedling emergence (no. m^{-2})

An area of 1 m^2 was selected from each plot where emerged plants were counted at 4 DAS.

ii. Plant height

The height of plant was recorded in centimeter (cm) at 15, 30, 45 DAS and at harvest. Data were recorded from randomly selected 5 plants from each plot and average height plant^{-1} was documented as per treatment. The height was measured from the ground level to the tip of the leaf of main shoot..

iii. Number of leaves plant^{-1}

Number of leaves of five selected plants from each plot was counted at 15, 30, 45 DAS and at harvest. The number of leaves plant^{-1} was completed by counting total number of leaves of all sampled plants then the average data were recorded.

iv. Dry matter content plant^{-1}

Five randomly selected plants were collected randomly from each plot at 15, 40 DAS and at harvest. After taking fresh weight, the sample was sliced into very thin pieces and put into envelop then placed in oven maintained at 70 ^{0} C for 72 hours. The sample was then transferred into desiccators and allowed to cool down at room temperature.

v. Nodules plant^{-1}(no.)

Five randomly selected plants from each plot was uprooted carefully using Nirani along with sufficient surrounding soils at 40 DAS then washed out with water and made clean. The total number of nodules plant^{-1} were observed and counted from each plot and average number of nodules plant^{-1} was recorded as per treatment.

vi. Nodule dry weight plant^{-1}

The collected nodules from five randomly selected plants of each plot were oven dried for 24 hours at 70°C and then nodule dry weight plant^{-1} was determined.

vii. Days to flowering

Days to 1st flowering were recorded by counting the number of days required to start flower initiation of blackgram plant in each plot and recorded.

3.9.2 Yield and other crop characters

i. Number of branches plant^{-1}

The number of branches was counted at 30, 45 DAS and at harvest. The branches plant^{-1} was counted from five randomly sampled plants. It was done by counting total number of branches of all sampled plants then the average data were recorded.

ii. Number of pods plant^{-1} at 1st and last harvest

The number of pods plant^{-1} from the 5 randomly selected plant sample at 1st harvest was counted and then the average pod number was calculated. Similar procedure was followed for counting number of pods plant^{-1} at last harvest.

iii. Number of total pods plant^{-1}

The total numbers of pods of five selected plants plot^{-1} at 1st and last harvest were counted and the average values were recorded.

iv. Pod length (cm)

The Lengths of pods were measured from the ten randomly selected plants of each plot. Then the average values were recorded.

v. Number of seeds pod^{-1} at 1st and last harvest

The Pods from each of five randomly selected plants plot^{-1} were separated from which ten pods were selected randomly. The number of seeds pod^{-1} was counted and average values were recorded. Similar procedure was followed for counting number of seeds pod^{-1} at last harvest.

vi. Pod length at 1st and last harvest (cm)

The pod length at 1st harvest was measured by meter scale from 10 randomly selected pods of each plot at 1st harvesting time and then the average seed number was calculated. Similar procedure was followed for measuring pod length at the last harvest.

vii. 1000 seed weight at 1st and last harvest (g)

The 1000 seeds were counted manually, which were taken from the seeds sample of each plot separately during 1st harvest, then weighed in an electrical balance and data were recorded in gram. Similar procedure was followed for measuring 1000 seed weight at last harvest.

viii. Seed yield (t ha^{-1})

The pods from harvested area were harvested as per experimental treatments and were threshed. Seeds were cleaned and properly dried under sun. Then seed yield plot^{-1} was recorded at 12% moisture level & converted into t ha^{-1}.

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

After separation of seeds from plant, the straw and shell of harvested area from each plot was sun dried and The weight of stover was taken and converted the yield in t ha^{-1}.

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

Seed yield and stover yield together were considered as biological yield. The biological yield was calculated with the following formula:

Biological yield = Seed yield + Stover yield.

xi. Harvest index (%)

Harvest index was calculated from the seed yield and stover yield of blackgram for each plot and expressed in percentage.

$$HI\ (\%) = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

3.10 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 cropstat and the mean differences were adjudged by Least Significance Difference (LSD) test at 5% level of significance (Gomez and Gomez, 1984).

CHAPTER IV

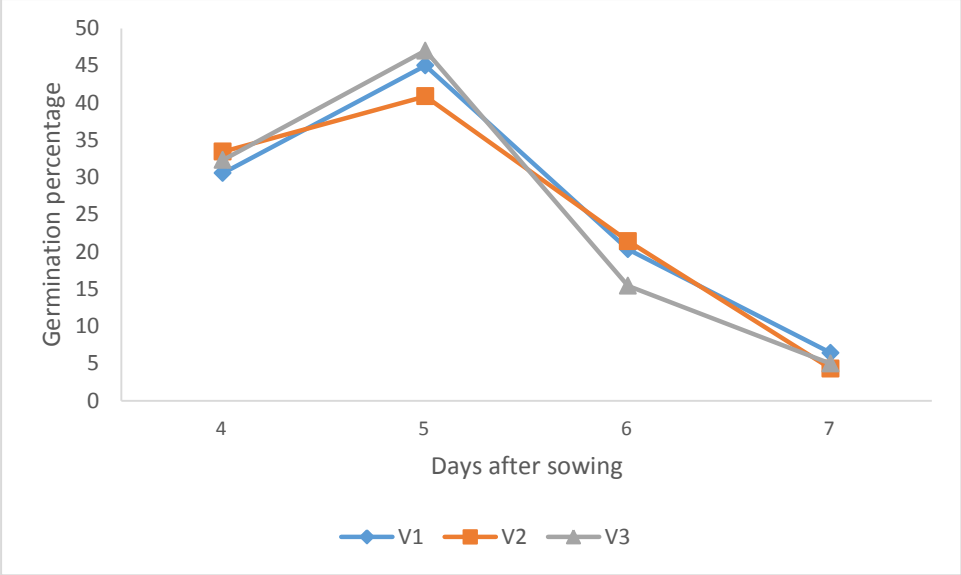
RESULTS AND DISCUSSION

The experiment was conducted to determine the effect of different varieties and management packages on the performance of blackgram. The analyses of variance (ANOVA) of the data on different growth, yield contributing characters and yield of blackgram are presented in Appendix III-XVII. The results have been offered with the help of table and graphs and possible interpretations given under the following headings:

4.1 Germination percentage

4.1.1 Effect of variety

Germination percentage of blackgram varieties were counted at different days and marked as individual from where the date wise germination was calculated. Germination percentage of blackgram was not significantly influenced by varieties at 4, 6 and 7 DAS but significantly influenced at 5 DAS (Fig. 2 and Appendix IV). At 4 DAS, germination percentage was maximum in V_2 (33.44%) which was statistically similar with V_3 (32.33%) and the minimum in V_1 (30.56%). At 5 DAS, germination percentage was highest in V_3 (47.00 %) and the lowest result in V_2 (40.89%). At 6 DAS, germination percentage was maximum in V_2 (21.44%) and the minimum result in V_3 (15.44%). At 7 DAS, germination percentage was higher in V_1 (6.44%) and the lower result in V_2 (4.33%). These results were matched with the findings of Ghosh (2007) who found that germination percentage was significantly influenced by varieties. He also established the highest germination percentage in Sona mung (100%) and the lowest in BARI mung-6 (94.66%).

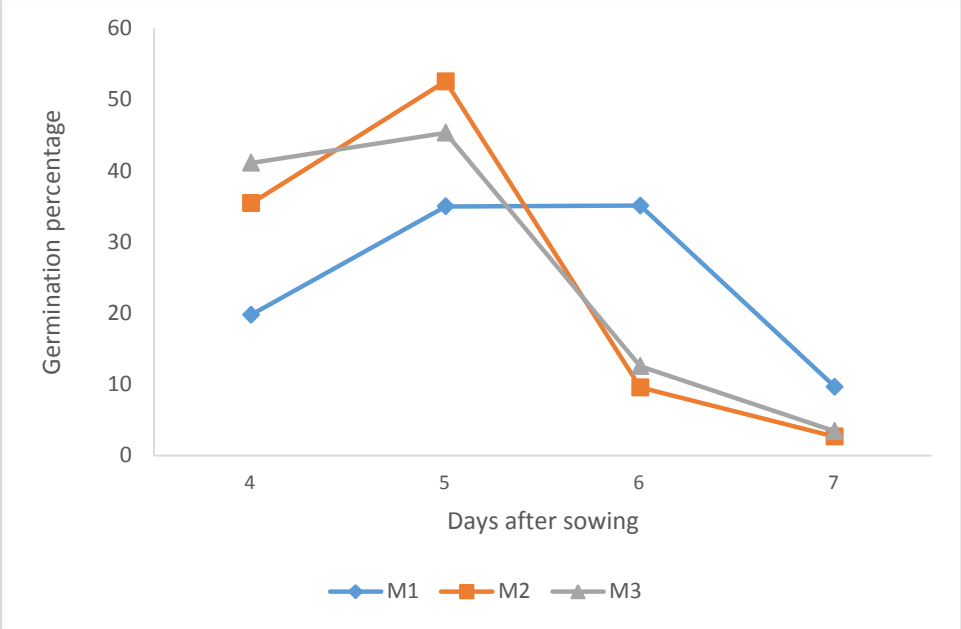


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 2: Germination percentage of blackgram as influenced by variety ($LSD_{(0.05)}$ at 5 DAS = 4.62).

4.1.2 Effect of management packages

Management packages showed significant effect on germination percentage of blackgram at 4, 5, 6 and 7 DAS (Figure 3 and Appendix IV). At 4 DAS, the germination percentage was highest (41.11%) in M_3 treatment (high management) but the result was statistically similar with M_2 treatment (medium management) (35.44%). The lowest (19.78%) germination percentage was found in M_1 treatment (low management). At 5 DAS, the highest germination percentage (52.56%) was recorded in M_2 treatment (medium management) but the result was statistically similar with M_3 (high management) (45.33%) treatments. Germination percentage was lowest (35.00%) in M_1 treatment (low management). At 6 DAS, the germination percentage was highest (35.11%) in M_1 treatment (low management) but the result was statistically similar with M_3 treatment (high management) (12.56%). The lowest (9.56%) germination percentage was found in M_2 treatment (medium management). At 7 DAS, the highest germination percentage (9.67%) was recorded in M_1 treatment (low management). The lowest (9.56%) germination percentage was found in M_2 treatment (medium management) but the result was statistically similar with M_3 treatment (high management) (3.44%).



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 3: Germination percentage of blackgram as influenced by management packages (LSD $_{(0.05)}$ at 4, 5, 6 and 7 DAS = 9.36, 11.00, 8.32 and 2.72 respectively).

4.1. 3 Interaction effect of variety and management packages

Interaction of variety and management packages showed significant effect on germination percentage of blackgram at 4, 5, 6 and 7 DAS (Table 1 and Appendix IV). At 4 DAS, the highest germination percentage (47.00%) was recorded in V_2M_3 treatment (BARI mash-2 with high management) which was statistically similar with V_3M_3 (BINA mash-1 with high management) (41.33%), V_1M_2 (BARI mash-3 with medium management) (38.00%), V_3M_2 (BINA mash-1 with medium management) (35.33%), V_1M_3 (BARI mash-3 with high management) (34.67%) and V_2M_2 (BARI mash-2 with medium management) (33.00%) treatments. Germination percentage was lowest (19.00%) in V_1M_1 (BARI mash-3 with low management) which was statistically similar with V_2M_1 (BARI mash-2 with low management) (20.00%), V_3M_1 (BINA mash-1 with low management) (20.33%), V_2M_2 (BARI mash-2 with medium management) (33%), V_1M_3 (BARI mash-3 with high management) (34.67%) and V_3M_2 (BINA mash-1 with medium management) (35.33%) treatments. At 5 DAS, the highest germination percentage (56.00%) was recorded in V_2M_2 (BARI mash-2 with medium management) which was statistically similar with all treatment except V_1M_1 (33.67%), V_2M_1 (27.67%) and the germination percentage was lowest (27.66%) in V_2M_1 (BARI mash-2 with low management) treatment. At 6 DAS the

highest germination percentage (43.33%) was recorded in V_2M_1which was statistically similar with V_1M_1 (34.67%) and the germination percentage was lowest (7.00%) in V_3M_2 (BINA mash-1 with medium management), V_2M_2 (9.67%), V_2M_3 (11.33%), V_1M_2 (12.00%),V_3M_3 (12.00%) and V_1M_3 (14.33%) treatment. At 7 DAS, the highest germination percentage was recorded in V_1M_1 (12.67%) which was statistically similar with V_2M_1 (8.67%) and the germination percentage was lowest in V_2M_2 (1.33%) which was statistically similar with V_3M_2 (2.67%), V_1M_3 (2.67%), V_2M_3 (3.00%), V_1M_2 (4.00%) and V_3M_3 (4.67%).

Table 1: Interaction effect of variety and management packages on germination percentage of blackgram at different days after sowing

Treatment combination	Germination percentage at			
	4 DAS	5 DAS	6 DAS	7 DAS
V1M1	19.00 c	33.67 b	34.67 ab	12.67 a
V1M2	38.00 a	46.33 ab	12.00 d	4.00 b-d
V1M3	34.67 a-c	55.00 a	14.33 cd	2.67 d
V2M1	20.00 bc	27.67 b	43.33 a	8.67 ab
V2M2	33.00 a-c	56.00 a	9.67 d	1.33 d
V2M3	47.00 a	39.00 ab	11.33 d	3.00 cd
V3M1	20.33 bc	43.67 ab	27.33 bc	7.67 bc
V3M2	35.33 ab	55.33 a	7.00 d	2.67 d
V3M3	41.33 a	42.00 ab	12.00 d	4.67 d
LSD $_{(0.05)}$	16.21	19.06	14.41	4.72
CV (%)	28.37	24.18	42.48	50.44

In a column means having similar letter(s) are statistically similar

NS = Not significant, CV = Coefficient of variation, LSD $_{(0.05)}$ = Least significant difference at 5% level,

DAS = Days after sowing

V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

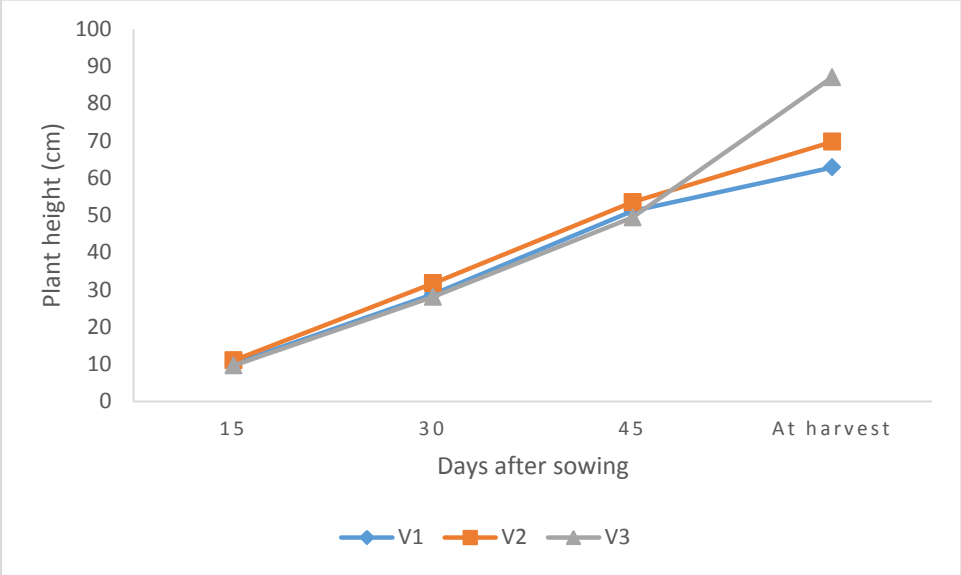
M_1 = Low management, M_2 = Medium management and M_3 = High management

4.2 Plant height at different growth stages

4.2.1 Effect of variety

Plant height at 15, 45 DAS and at harvest showed significant variation for different varieties (Figure 3) but at 30 DAS did not show any significant variation (Appendix V and

Figure 4). The result revealed that at 15 DAS, the highest plant height (11.01cm) was obtained from BARI mash-2 (V_2) and the lowest plant height obtained from (9.65 cm) at BINA mash-1 (V_3). At 45 DAS, the highest plant height (53.54 cm) was obtained from BARI mash-2 (V_2) and the lowest plant height obtained from (49.40 cm) BINA mash-1 (V_3). At harvest, the highest plant height (87.06 cm) was obtained from BINA mash-1 (V_3) and the lowest plant height obtained from (62.87 cm) BARI mash-3 (V_1). The maximum plant height (31.74 cm) was recorded at 30 DAS from BARI mash-2 and minimum (28.09 cm) from V_3 (BINA mash-1) which was statistically similar with BARI mash-3 (V_1) (28.81cm). These results were similar with the findings of Nag *et al.* (2000) who conducted a research on three blackgram (*Vigna mungo*) cultivars viz.Barimash-1, Barimash-2 and Barimash-3. Among the three cultivars, Barimash-1 cultivar had the highest plant height.



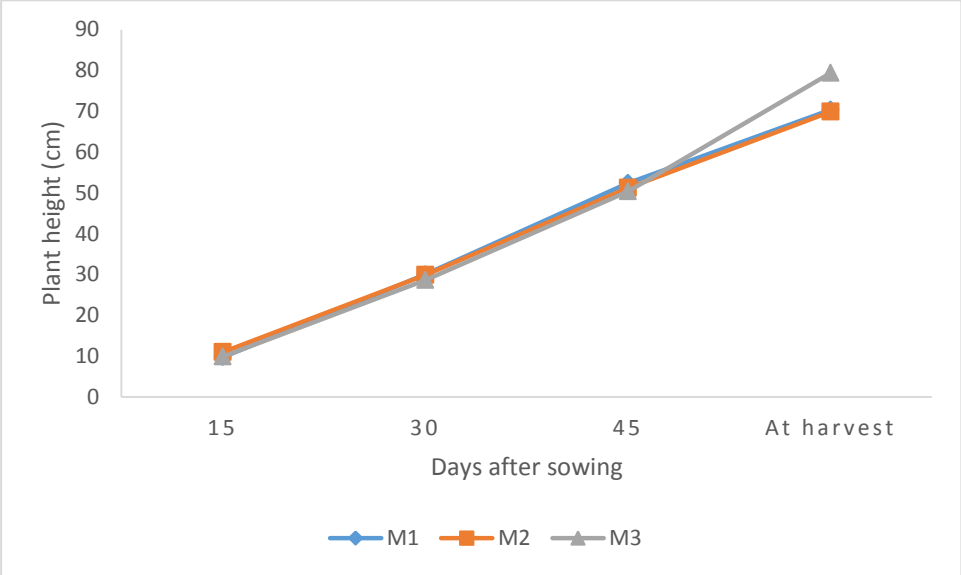
V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 4: Plant height of blackgram as influenced by variety (LSD $_{(0.05)}$ at 15, 45 DAS and at harvest = 1.12, 3.78 and 13.21 respectively).

4.2.2 Effect of management packages

Management packages showed significant effect on plant height at 15 DAS but showed insignificant effect on plant height at 30, 45 DAS and at harvest (Appendix V and Figure 5). At 15 DAS, the highest plant height (11.03 cm) was obtained from (medium management) M_2. The lowest plant height (9.94 cm) was obtained from M_3 (high

management) which was statistically similar with the height of M_1 (low management) (9.79 cm).



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 5: Plant height (cm) of blackgram as influenced by management packages ($LSD_{(0.05)}$ at 15 DAS = 0.92).

At 30 DAS, the maximum plant height (30.05 cm) was obtained from M_1 (high management) which was statistically similar with M_2 (medium management). The minimum plant height (28.66 cm) was obtained from M_3 (high management). At 45 DAS, the maximum plant height (52.45 cm) was obtained from M_1 (low management). The minimum plant height (50.38 cm) was obtained from M_3 (high management), which was statistically similar with the height of M_2 (medium management) (51.24 cm). At harvest, the maximum plant height (79.39 cm) was obtained from M_3 (high management). The minimum plant height (69.90 cm) was obtained from M_2 (medium management), which was statistically similar with the height of M_1 (low management) (70.37 cm). Similar result was showed by Rajput (1994) who reported that fertilizing with P_2O_5 @ 50 kg/ha improved the leaves per plant significantly as compared to 0 kg P_2O_5 /ha^{-1}.

4.2.3 Interaction effect

Interaction between variety and management packages showed significant differences on plant height at 15, 45 DAS and at harvest but insignificant in 30 DAS (Appendix V and Table 2). At 15 DAS, the highest plant height was observed in V_2M_2 (BARI mash-2 with

medium management*)* which was statistically similar withV_1M_2, V_2M_1, V_2M_3 and V_3M_2. The lowest plant height was observed in V_3M_1 (BINA mash-1 with low management) which was statistically similar with V_1M_3, V_3M_3, V_1M_1 and V_3M_2.

Table 2: Interaction effect of variety and management packages on plant height of blackgram at different growth stages

Treatment combination	Plant height (cm) at			
	15 DAS	30 DAS	45 DAS	At harvest
V1M1	9.85 bc	29.34	50.29 a-c	57.62 c
V1M2	10.83 ab	27.57	53.24 a	62.95 c
V1M3	9.63 bc	29.52	49.85 a-c	68.04 bc
V2M1	10.71 ab	31.37	54.20 a	69.94 bc
V2M2	11.88 a	34.58	53.02 a	72.37 bc
V2M3	10.45 ab	29.25	53.39 a	66.91 bc
V3M1	8.82 c	29.44	52.86 ab	83.55 ab
V3M2	10.37 a-c	27.63	47.46 bc	74.39 bc
V3M3	9.76 bc	27.21	47.09 c	103.29 a
LSD $_{(0.05)}$	1.60	7.81 (NS)	5.48	20.41
CV (%)	8.77	14.86	5.99	15.66

In a column means having similar letter(s) are statistically similar

NS = Not significant, CV = Coefficient of variation, LSD $_{(0.05)}$ = Least significant difference at 5% level, DAS = Days after sowing

V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

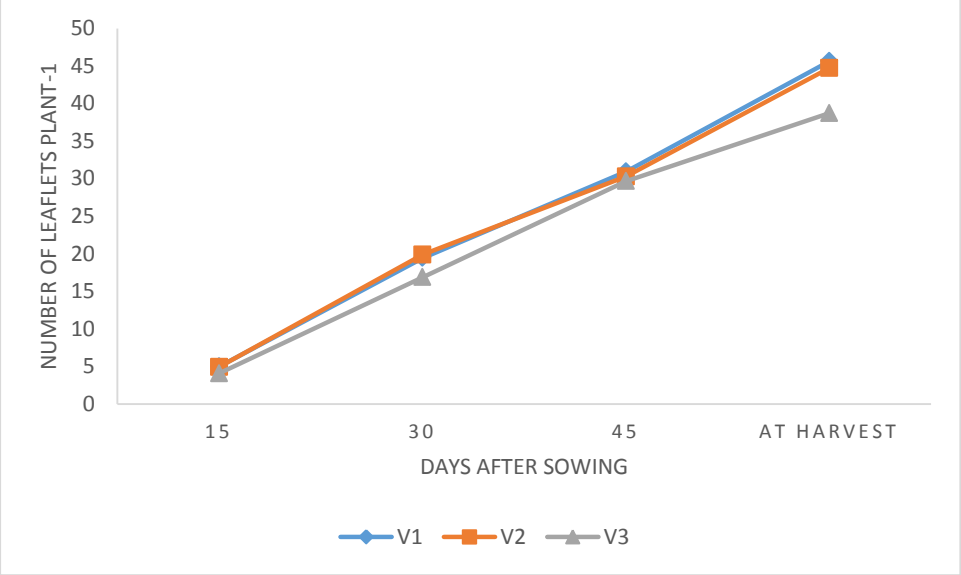
M_1 = Low management, M_2 = Medium management and M_3 = High management

At 30 DAS, the maximum plant height was observed in V_2M_2 (BARI mash-2 with medium management). The minimum plant height was observed in V_3M_3. But at 45 DAS, plant height was highest in V_2M_1 (BARI mash-2 with medium management) and lowest plant height was observed in V_3M_3 (BINA mash-1 with high management). At harvest, the highest plant height was found in V_3M_3 (BINA mash-1 with high management). The lowest plant height was observed in V_1M_1 (BARI mash-3 with low management).

4.3 No. of leaflets plant^{-1} at different growth stages

4.3.1 Effect of variety

Number of leaflets plant^{-1} of blackgram was significantly influenced by varieties at 15 and 30 days after sowing (DAS) but at 45 DAS and at harvest, varieties had no significant effect because number of leaflets plant^{-1} of BARI mash-3, BARI mash-2 and BINA mash-1 were statistically similar (Appendix VI and Figure 6). The result revealed that at 15 DAS, number of leaflets plant^{-1} was highest (5.0) in BARI mash-3 (V_1) compared to BARI mash-2 (V_2) and BINA mash-1 (V_3). At 30 DAS, number of leaflets plant^{-1} was highest (19.89) in BARI mash-2 (V_2) and number of leaflets plant^{-1} was lowest (16.89) in BINA mash-1 (V_3).



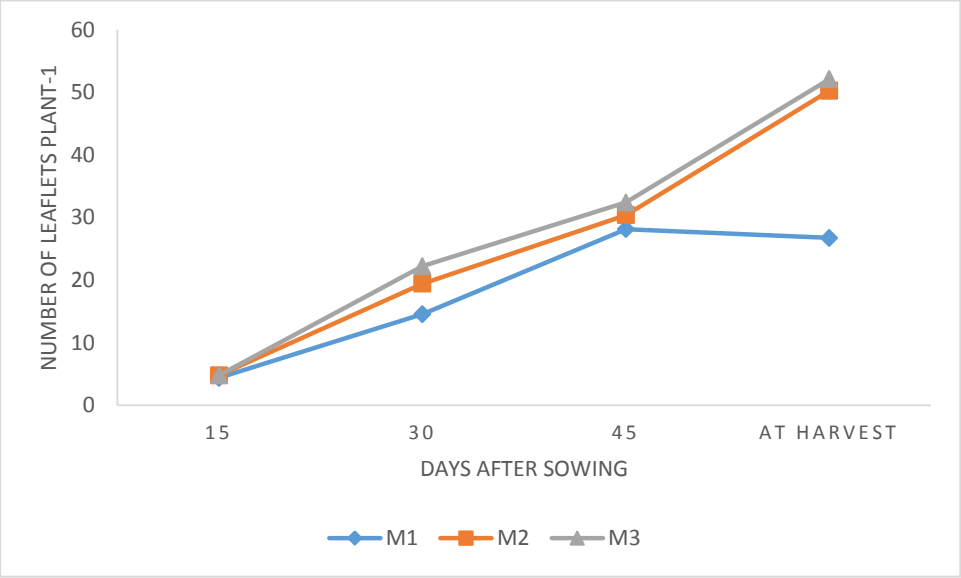
V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 6: Number of leaflets plant^{-1} of blackgram as influenced by variety (LSD $_{(0.05)}$ at 15, 30 DAS = 0.59 and 1.4 respectively).

At 45 DAS and at harvest, number of leaflets plant^{-1} was maximum (30.95 and 45.66 respectively) in BARI mash-3 (V_1) and number of leaflets plant^{-1} was minimum (29.68 and 38.73 respectively) in BINA mash-1 (V_3). Ansary (2007) reported that varieties differ significantly in respect of number of leaflets plant^{-1}. He found two varieties BARI mung-6 and BU mung-2 had significant effect on number of leaflets plant^{-1} at 30 and 45 DAS.

4.3.2 Effect of management packages

Management packages showed significant effect on number of leaflets plant^{-1} of blackgram at 30 and 45 DAS and at harvest (Appendix VI and Figure 7). At 30, 45 DAS and at harvest, the number of leaflets plant^{-1} was highest (22.22, 32.40 and 52.13 respectively) in M_3 (high management) and the number of leaflets plant^{-1} was lowest (14.55, 28.13 and 26.73) in M_1 (low management). Management packages had no significant effect on number of leaflets plant^{-1} of blackgram at 15 DAS. At 15 DAS, number of leaflets plant^{-1} was maximum (4.82) in M_3 (high management) and minimum (4.38) in M_1 (low management) but the results were statistically similar as no significant variation observed on number of leaflets plant^{-1} due to application of management packages. Similar result was showed by Rajput (1994) who reported that fertilizing with P_2O_5 @ 50 kg/ha improved the leaves per plant significantly as compared to 0 kg P_2O_5 /ha.



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 7: Number of leaflets plant^{-1} of blackgram as influenced by management packages at different days after sowing (LSD $_{(0.05)}$ = 2.42,1.55 and 13.32 at 30, 45 DAS and at harvest respectively).

4.3.3 Interaction effect of variety and management packages

Interaction between variety and management packages showed significant effect on number of leaflets plant^{-1} observed at 15, 30, 45 DAS and at harvest (Appendix VI and

Table 3). At 15 DAS, the highest number of leaflets plant^{-1} was observed in V_1M_3 (BARI mash-3 with high management) treatment which was statistically similar with V_2M_3 (BARI mash-2 with high management), V_2M_2 (BARI mash-2 with medium management), V_1M_1 (BARI mash-3 with low management), V_1M_2 (BARI mash-3 with medium management), V_2M_1 (BARI mash-2 with low management) and V_3M_2 (BINA mash-1 with medium management). The lowest number of leaflets plant^{-1} observed in V_3M_1 (BINA mash-1with low management) treatment which was statistically similar with V_3M_3 (BINA mash-1 with high management)) treatment.

Table 3: Interaction effect of variety and management packages on number of leaflets plant^{-1} of blackgram at different growth stages

Treatment combination	Number of leaflets plant^{-1} at			
	15 DAS	30 DAS	45 DAS	60 DAS
V1M1	4.93 a	16.00 bc	28.13 de	30.20 bc
V1M2	4.80 ab	19.67 ab	31.40 a-c	51.40 ab
V1M3	5.27 a	22.67 a	33.33 a	55.40 a
V2M1	4.60 ab	14.33 c	28.73 c-e	25.40 c
V2M2	5.00 a	22.67 a	30.53 a-d	52.00 ab
V2M3	5.20 a	22.67 a	31.60 ab	56.80 a
V3M1	3.60 c	13.33 c	27.53 e	24.60 c
V3M2	4.60 ab	16.00 bc	29.27 b-e	47.40 a-c
V3M3	4.00 bc	21.33 a	32.27 a	44.20 a-c
LSD $_{(0.05)}$	0.86	4.19	2.68	23.80
CV (%)	10.27	12.58	4.97	30.14

In a column means having similar letter(s) are statistically similar

NS = Not significant, CV = Coefficient of variation, LSD $_{(0.05)}$ = Least significant difference at 5% level, DAS = Days after sowing, V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

M_1 = Low management, M_2 = Medium management and M_3 = High management

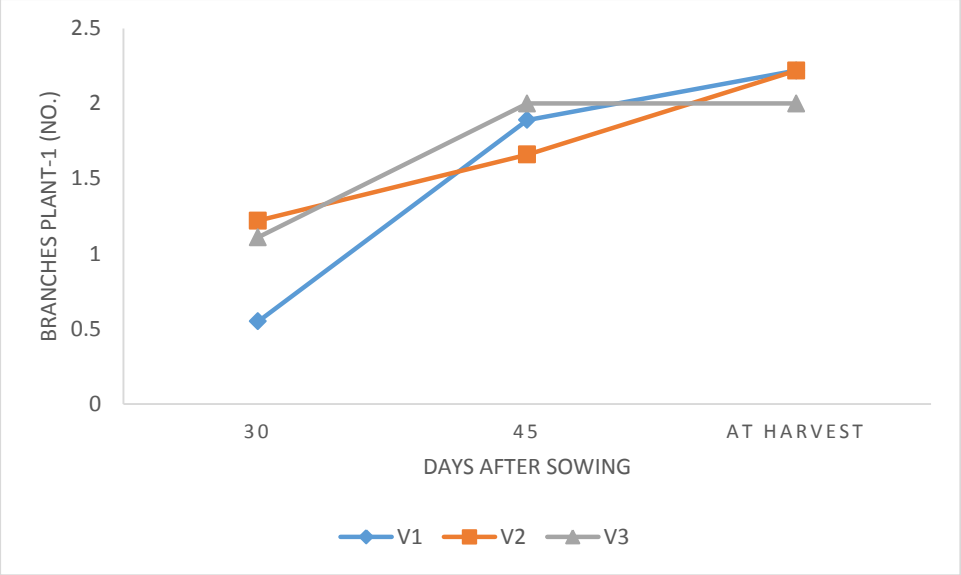
At 30 DAS, the highest number of leaflets plant^{-1} was observed in V_2M_2 (BARI mash-2 with medium management) treatment, V_2M_3 (BARI mash-2 with high management) and

V_1M_3 (BARI mash-3 with high management) treatment. Number of leaflets plant^{-1} was lowest in V_3M_1 (BINA mash-1 with low management) treatment. At 45 DAS, the highest number of leaflets plant^{-1} was observed in V_1M_3 (BARI mash-3 with high management) treatment and number of leaflets plant^{-1} was lowest in V_3M_1 (BINA mash-1 with low fertilizer) treatment. At harvest, number of leaflets plant^{-1} was highest inV_2M_3 (BARI mash-2 with high management) treatment and number of leaflets plant^{-1} was lowest in V_3M_1 (BINA mash-1 with low management) treatment.

4.4 Number of branches plant^{-1}

4.4.1 Effect of variety

Number of branches plant^{-1} of blackgram variety showed significant variation at 30 DAS but non-significant variation at 45 DAS and at harvest (Appendix VII and Figure 8). At 30 DAS, highest number of branches plant^{-1} (1. 22) was observed from V_2 (BARI mash-2) and the lowest number (0.55) from V_1 (BARI mash-3). At 45 DAS, maximum number of branches plant^{-1} (2.00) was observed from V_3 (BINA mash-1) and the minimum number (1.66) from V_2 (BARI mash-2). At harvest, maximum number of branches plant^{-1} (2. 22) was observed from both V_1 (BARI mash-3) and V_2 (BARI mash-2) and the minimum number (2.0) from V_3 (BINA mash-1). The variation in the production of branches plant^{-1} might be due to genetic constituents of the crop. The result agreed with Islam (1983) who observed significant variation in branches number plant^{-1} in different studied varieties of mungbean and the highest number of branches plant^{-1} was in the variety Faridpur-1 followed by Mubarik, BM-7715 and BM-7704. The result also agreed with the findings of Ghosh (2007) who observed varieties differ significantly in respect of number of branches plant^{-1}. He found the higher number of branches plant^{-1} in Sona mung and the lower in BARI Mung-6.

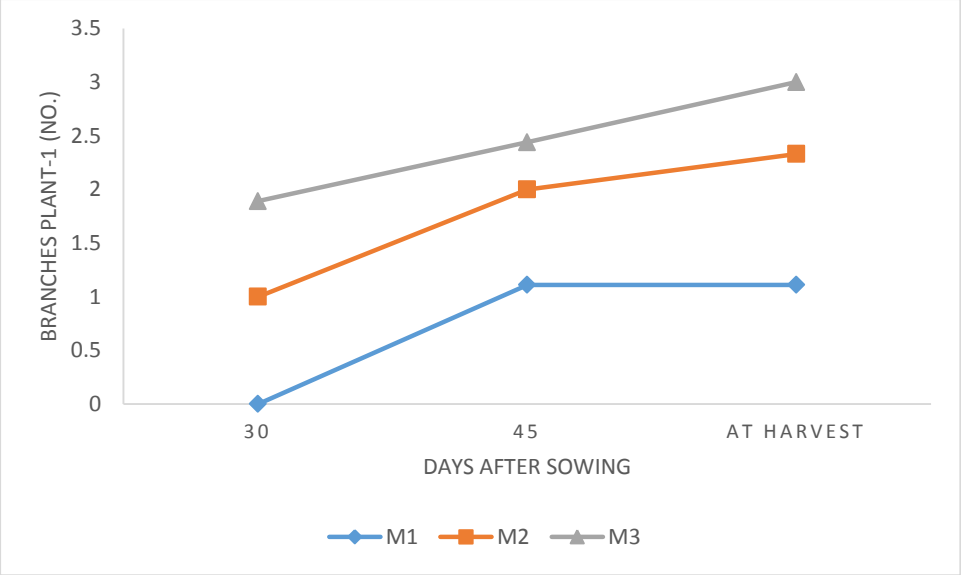


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 8: Number of branches plant^{-1} of blackgram as influenced by variety (LSD $_{(0.05)}$ at 30 DAS = 0.66)

4.4.2 Effect of management packages

Different managements that applied as urea, TSP, MOP, seed rate, irrigation and weeding showed significant variation for number of branches plant^{-1} at 30, 45 DAS and at harvest (Appendix VII and Figure 9). At 30 DAS, the highest number of branches plant^{-1} (1.89) was recorded from M_3 (high management), while the lowest number (0.00) was found from M_1 (low management). At 45 DAS, the highest number of branches plant^{-1} (2.44) was recorded from M_3 (high management), while the lowest number (1.11) was found from M_1 (low management). At harvest, the highest number of branches plant^{-1} (3.00) was recorded from M_3 (high management), while the lowest number (1.11) was found from M_1 (low management). Hasan *et al*. (2010) showed that the application of nitrogen fertilizer from urea did not show any significant effect on branching of plant. Similar opinion was given by Singh and Jain (1996) that Phosphorus application increased the number of branches per plant of cowpea, but other characters were unaffected.



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 9: Number of branches plant^{-1} of blackgram as influenced by management Packages at different days after sowing (LSD $_{(0.05)}$ = 0.48, 0.52 and 0.5 at 30, 45 DAS and at harvest, respectively).

4.4.3 Interaction effect of variety and management packages

Blackgram variety and different management packages interaction showed significant differences on number of branches plant^{-1} at 30 & 45 DAS and at harvest (Appendix VII and Table 4). At 30 DAS, the highest number of branches plant^{-1} (2.33) was found in V_3M_3 (BINA mash-1 with high management) and the lowest number of branches (0.00) found in between V_1M_1 (BARI mash-3 with low management), V_2M_1 (BARI mash-2 with low management), V_3M_1 (BINA mash-1 with low management). At 45 DAS, the highest number of branches plant^{-1} (2.67) was attained from both V_1M_3 (BARI mash-3 with high management) and V_3M_3 (BINA mash-1 with high management), whereas the lowest number of branches plant^{-1} (1.00) from both V_1M_1 (BARI mash-3 with low management) and V_3M_1 (BINA mash-1 with low management). At harvest, the highest number of branches plant^{-1} (3.33) was attained from V_1M_3 (BARI mash-3 with high management), whereas the lowest number of branches plant^{-1} (1.00) from both V_1M_1 (BARI mash-3 with low management) and V_3M_1 (BINA mash-1 with low management). Shah *et al.* (1994) noted that the plant height at 45 days after sowing and at harvest and number of primary branches per plant in blackgram showed significant response to application of 30 kg and 60 kg P_2O_5 per ha as compared to the control. Saini and Thakur (1996) also noticed that

branches per plant of vegetable pea were higher due to the application of phosphorus at 39.60 kg ha^{-1}.

Table 4: Interaction effect of variety and management packages on number of branches $plant^{-1}$ of blackgram at different growth stages

Treatment combination	Number of branches $plant^{-1}$ at		
	30 DAS	45 DAS	At harvest
V1M1	0.00 e	1.00 d	1.00 c
V1M2	0.33 de	2.00 a-c	2.33 b
V1M3	1.33 bc	2.67 a	3.33 a
V2M1	0.00 e	1.33 cd	1.33 c
V2M2	1.66 a-c	1.67 b-d	2.33 b
V2M3	2.00 ab	2.00 a-c	3.00 ab
V3M1	0.00 e	1.00 d	1.00 c
V3M2	1.00 cd	2.33 ab	2.33 b
V3M3	2.33 a	2.67 a	2.66 ab
$LSD_{(0.05)}$	0.84	0.90	0.87
CV (%)	48.86	27.56	22.78

In a column means having similar letter(s) are statistically similar

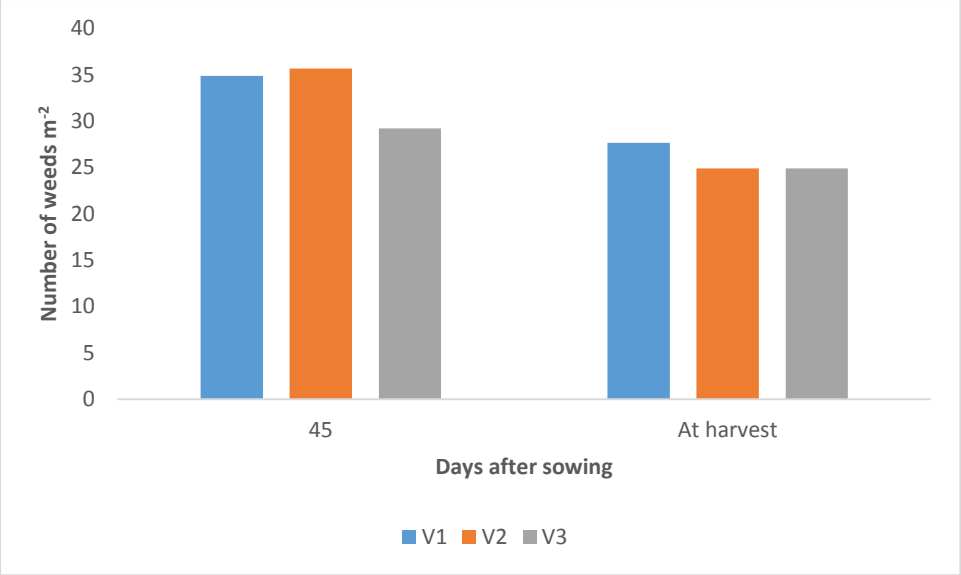
NS = Not significant, CV = Coefficient of variation, $LSD_{(0.05)}$ = Least significant difference at 5% level, DAS = Days after sowing, V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

M_1 = Low management, M_2 = Medium management and M_3 = High management

4.5. Number of weeds m^{-2}

4.5.1 Effect of variety

The number of weeds m^{-2} was not significantly influenced by the variety at 45 DAS and at harvest (Appendix X and Figure 10). The maximum number of weeds m^{-2} (35.67) was found in BARI Mash-2 (V_2) and the minimum number of weeds m^{-2} (29.22) was observed in BINA Mash-1 (V_3) at 45 DAS. At harvest, the maximum number of weeds m^{-2} (27.67) was found in BARI Mash-3 (V_3) and the minimum number of weeds m^{-2} (24.89) was observed in both BARI mash-2 (V_2) and BINA Mash-1 (V_3).

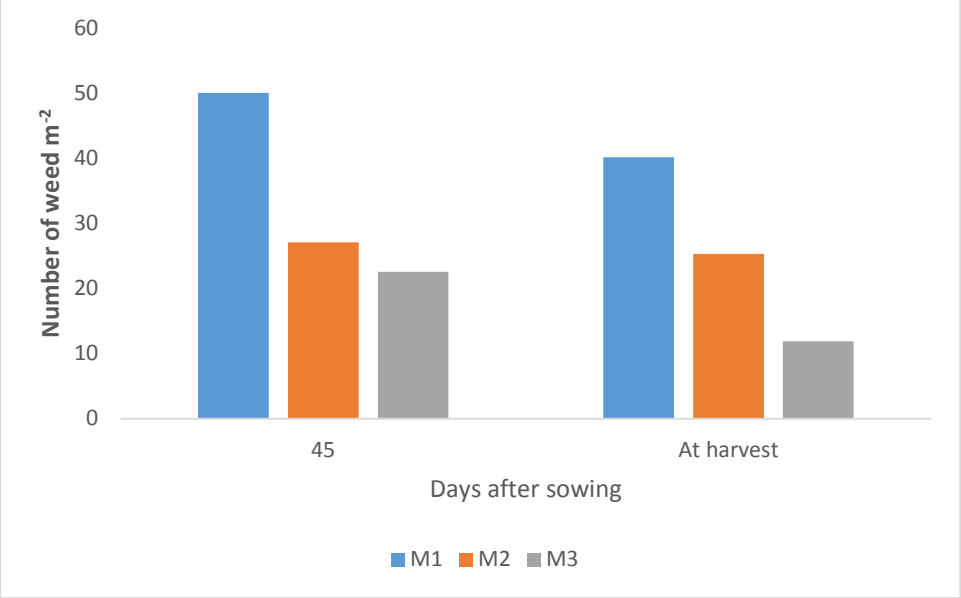


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 10: Effect of variety on the number of weeds m^{-2} of blackgram at different days after sowing.

4.5.2 Effect of management packages

Different management packages that applied as urea, TSP, MOP, seed rate, irrigation and weeding had significant effect on the number of weeds m^{-2} at 45 DAS and at harvest (Appendix X and Figure 11). At 45 DAS, the highest number of weed m^{-2} (50.11) was recorded from M_1 (low management), while the lowest number (22.55) was found from M_3 (high management). At harvest, the highest number of weeds m^{-2} (40.22) was recorded from M_1 (low management), while the lowest number (11.89) was found from M_3 (high management).



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 11: Effect of management packages on the number of weeds m^{-2} of blackgram at different days after sowing ($LSD_{(0.05)}$ = 10.02 and 16.35 at 45 DAS and harvest, respectively).

4.5.3 Interaction effect of variety and management packages

Interaction effect between variety and management packages was found significant in respect of the number of weeds m^{-2} at 45 DAS and at harvest (Appendix X and Table 5). At 45 DAS, the highest number of weeds m^{-2} (56.33) was produced by the V_2M_1 (BARI mash-2 with low management) combination which was statistically similar to the interactions of V_1M_1 (BARI mash-3 with low management) & V_3M_1 (BINA mash-1with low management) and the lowest number of weeds m^{-2} (19.67) was produced by the interaction of V_3M_3 (BINA mash-1 with high management) which was statistically similar to the interaction of V_2M_3 (BARI mash-2 with high management) , V_1M_3 (BARI mash-3 with high management), V_3M_2 (BINA mash-1 with medium management), V_2M_1 (BARI Mash-2 with no fertilizer), V_2M_2 (BARI mash-2 with medium management). At harvest, the highest total number of weeds m^{-2} (48.00) was produced by the V_1M_1 (BARI Mash-3 with low management) interaction which shown similarity with the combinations of V_2M_1 (BARI mash-2 with low management) ,V_3M_2 (BINA mash-1 with medium management) & V_3M_1 (BINA mash-1 with low management), while the lowest number of weeds m^{-2} (9.33) was produced by V_3M_3 (BINA mash-1 with high management) which shown similarity with the combination of V_1M_3 (BARI Mash-3 with high management), V_2M_3

(BARI mash-2 with high management), V_2M_2 (BARI mash-2 with medium management), V_1M_2 (BARI mash-3 with medium management),V_3M_1 (BINA mash-1 with low management) and V_3M_2 (BINA mash-1 with medium management).

Table 5: Interaction effect of variety and management packages on number of weeds m^{-2} of blackgram at different growth stages

Treatment combination	Number of weeds m^{-2} at	
	45 DAS	At harvest
V1M1	52.00 a	48.00 a
V1M2	27.00 bc	22.00 a-c
V1M3	25.67 bc	13.00 bc
V2M1	56.33 a	40.33 ab
V2M2	28.33 bc	21.00 a-c
V2M3	22.33 c	13.33 bc
V3M1	42.00 ab	32.33 a-c
V3M2	26.00 bc	33.00 a-c
V3M3	19.67 c	9.33 c
$LSD_{(0.05)}$	17.35	28.32
CV (%)	29.32	61.67

In a column means having similar letter(s) are statistically similar

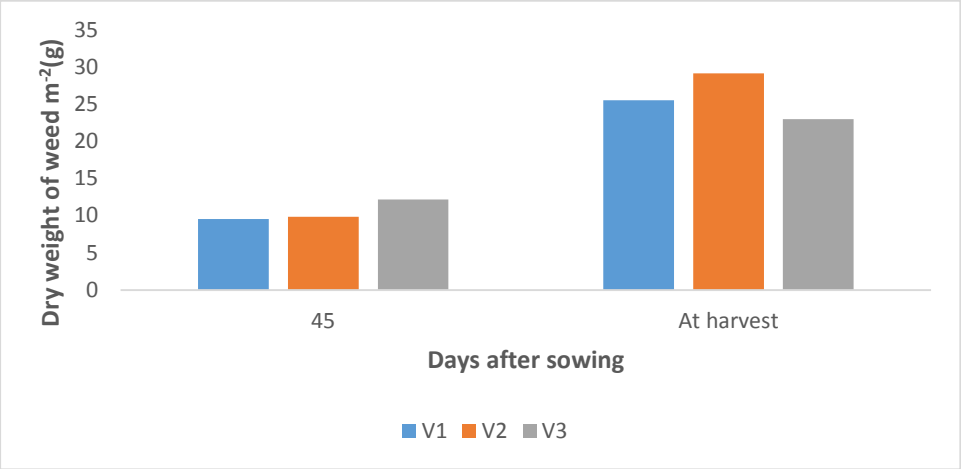
NS = Not significant, CV = Coefficient of variation, $LSD_{(0.05)}$ = Least significant difference at 5% level, DAS = Days after sowing, V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

M_1 = Low management, M_2 = Medium management and M_3 = High management

4.6 Dry weight of weeds m^{-2}

4.6.1 Effect of variety

The dry weight of weeds m^{-2} showed non-significant effect by the variety of blackgram at 45 DAS and at harvest (Appendix X and Figure 12). At 45 DAS, weed dry weight was found maximum (12.18 g $plant^{-1}$) in BINA mash-1. The weed dry weight was found minimum (9.53 g $plant^{-1}$) in BARI mash-3. At harvest, weed dry weight was found maximum (29.18 g $plant^{-1}$) in BARI mash-2. The weed dry weight was found minimum (22.99 g $plant^{-1}$) in BINA mash-1.

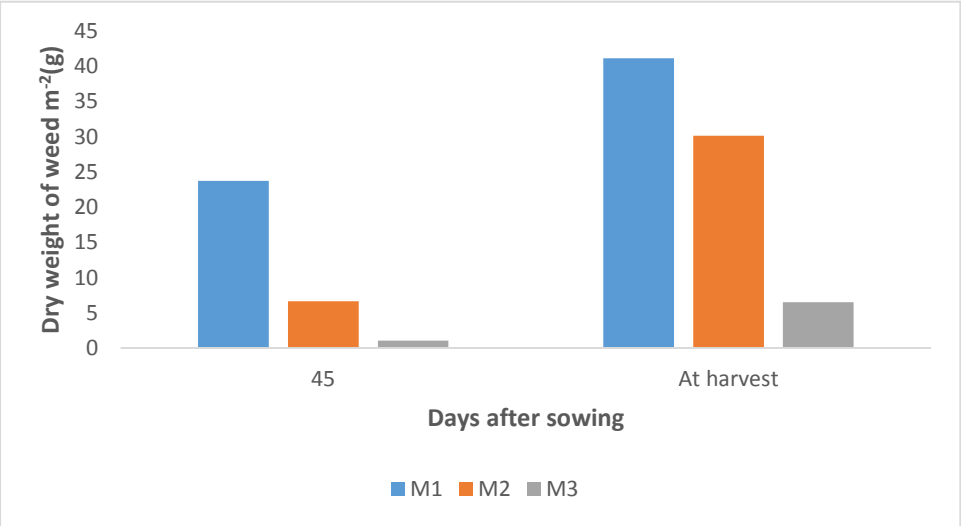


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 12: Dry weight of weeds m^{-2} of blackgram as influenced by variety

4.6.2 Effect of management packages

Management packages had significant effect on dry weight of weeds $m^{-2}$of blackgram at 45 DAS and at harvest (Appendix X and Figure 13). At 45 DAS, dry weight of weed was highest (23.7 g $plant^{-1}$) in M_1 (low management) and lowest (1.06 g $plant^{-1}$) in M_3 (high management) which was statistically similar with M_2 (medium management) (6.63 g $plant^{-1}$).



M_1 = Low management, M_2 =Medium management and M_3=High management

Figure 13: Dry weight of weed m^{-2} of blackgram as influenced by management packages (LSD $_{(0.05)}$ at 45 DAS and at harvest 11.6 and 18.72 respectively).

At harvest, dry weight of weed was highest (41.13 g plant^{-1}) in M_1 (low management) and lowest (6.48 g plant^{-1}) in M_3 (high management).

4.6.3 Interaction effect of variety and management packages

Interaction effect between variety and management packages was found significant in respect of dry weight of weeds m^{-2} of blackgram at 45 DAS and at harvest (Appendix X and Table 6). At 45 DAS, weed dry weight m^{-2} was highest in V_3M_1 treatment (BINA mash-1withlow management) but the results were statistically similar in V_1M_1 (BARI mash-3 with low management), V_2M_1 (BARI mash-2with low management) V_3M_2 (BINA mash-1 with medium management) and V_2M_2 (BARI mash-2 with medium management) treatment. Weed dry weight m^{-2} was lowest in V_2M_3 treatment (BARI mash-2 with high management) which was statistically similar with V_3M_3 (BINA mash-1 with high management).

Table 6: Interaction effect of variety and management packages on dry weight of weed m^{-2} of blackgram at different growth stages

Treatment combination	**Dry weight of weed m^{-2}(g)**	
	45 DAS	At harvest
V1M1	22.50 ab	44.75 ab
V1M2	3.88 b-d	26.99 bc
V1M3	1.68 cd	4.90 c
V2M1	20.98 a-c	49.25 a
V2M2	7.97 a-d	31.47 bc
V2M3	0.62 d	6.81 c
V3M1	27.63 a	29.40 bc
V3M2	8.03 a-d	31.88 bc
V3M3	0.87 d	7.71 c
LSD $_{(0.05)}$	20.09	32.41
CV (%)	107.96	70.35

In a column means having similar letter(s) are statistically similar

NS = Not significant, CV = Coefficient of variation, LSD $_{(0.05)}$ = Least significant difference at 5% level, DAS = Days after sowing, V_1 = BARI mash-3, V_2 = BARI mash-2 , V_3 = BINA mash-1

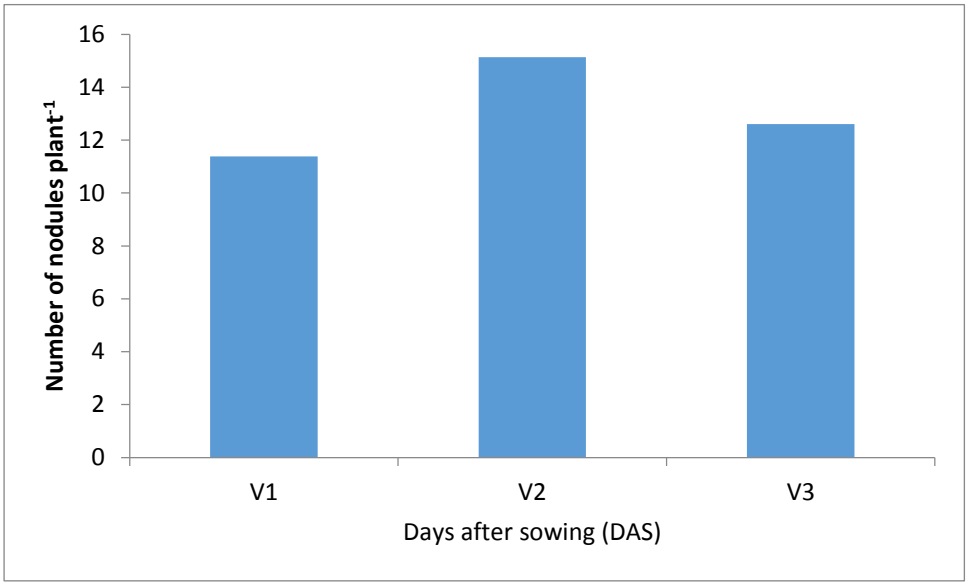
M_1 = Low management, M_2 = Medium management and M_3 = High management

At harvest, weeds dry weight m^{-2} was highest in V_2M_1 treatment (BARI mash-2with low management) and lowest in V_1M_3 treatment (BARI mash-3 with high management).

4.7 Number of nodules plant^{-1}

4.7.1 Effect of variety

The number of nodules plant^{-1} was not significantly influenced by variety of blackgram (Appendix IX and Figure 14). The V_2 produced maximum number of nodules plant^{-1} (15.13) and the V_1 gave the minimum number of nodules plant^{-1} (11.38) which was statistically similar with V_3.

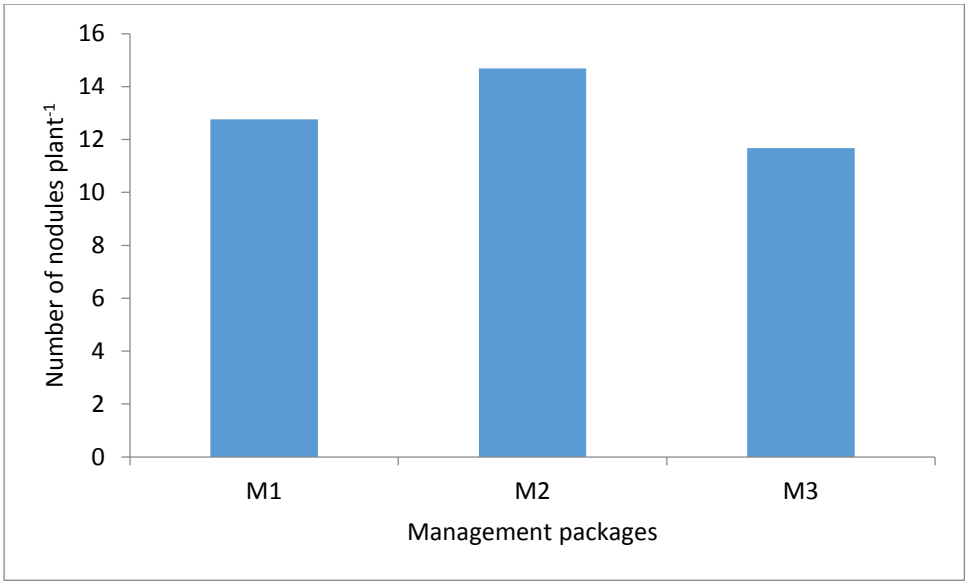


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 14: Effect of variety on the number of nodules plant^{-1} of blackgram

4.7.2 Effect of management packages

The management packages have no significant effect in formation of nodules plant^{-1} (Appendix IX and Figure 15). The maximum number of nodules plant^{-1} (14.69) was produced by M_2 and the minimum number of nodules plant^{-1} was produced by M_3 (11.67) which was statistically similar to the treatments M_1.



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 15: Effect of management packages on the number of nodules plant^{-1} of blackgram

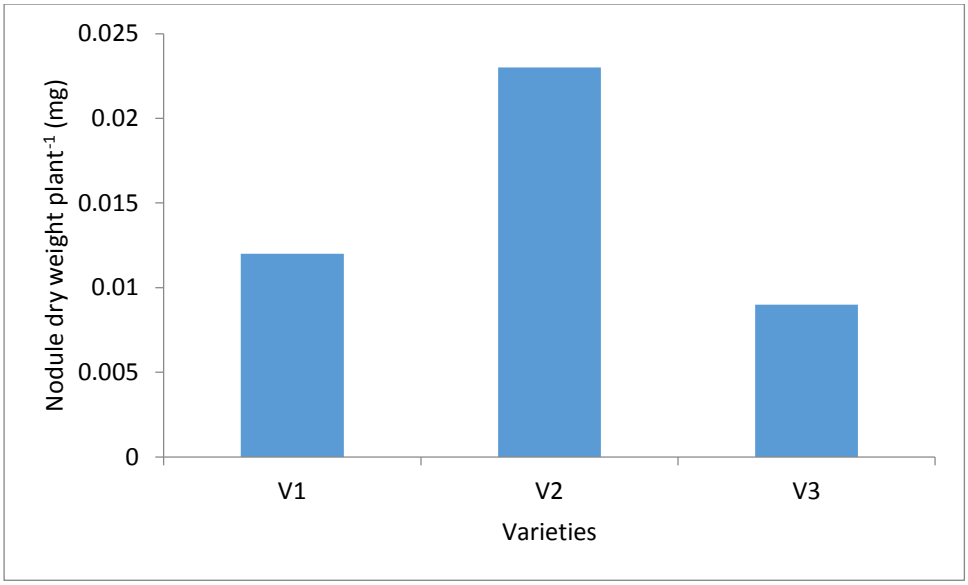
4.7.3 Interaction effect of variety and management packages

No Significant interaction effect between the variety and management packages was observed on total number of nodules produced plant^{-1} (Appendix IX and Table 7). The numerically maximum number of nodules was produced from the V_2M_2 (18.33 plant^{-1}) and the minimum number of nodules was produced in V_1M_3 (9.73 plant^{-1}).

4.8 Dry weight of nodules plant^{-1}

4.8.1 Effect of variety

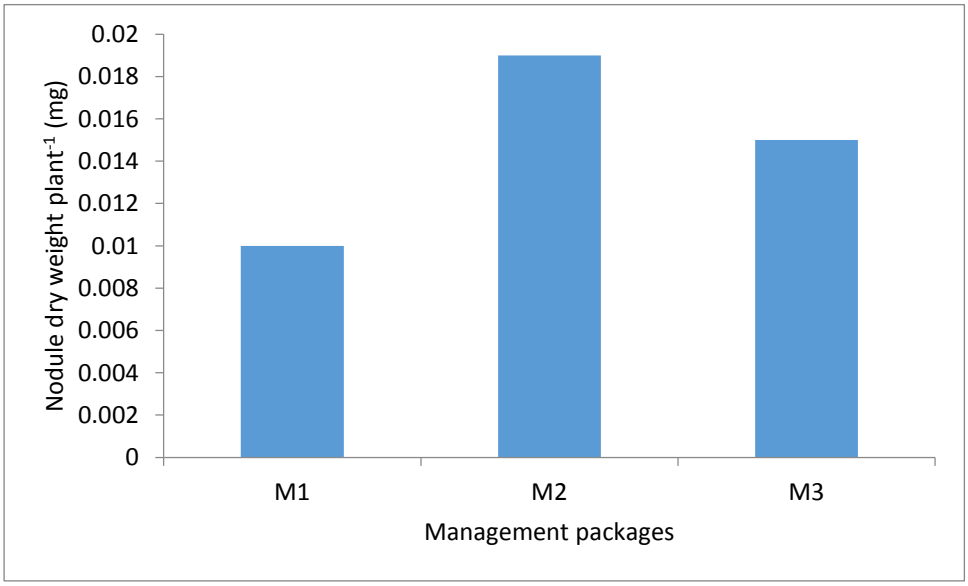
The dry weight of nodules plant^{-1} had no significant effect for variety (Appendix IX and Figure 16). The V_2 produced the maximum dry weight of nodules (0.023 mg plant^{-1}) and the V_3 gave the minimum weight (0.009 mg plant^{-1}).



V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 16: Effect of variety on nodules dry weight plant^{-1} of blackgram

4.8.2 Effect of management packages



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 17: Effect of management packages on nodules dry weight plant^{-1} of blackgram

Management packages had no significant effect on dry weight of nodules plant^{-1} (Appendix IX and Figure 17). The maximum dry weight of nodules (0.019 mg plant^{-1}) was produced by M_2 and the minimum dry weight of nodules (0.01 mg plant^{-1}) was produced by M_1. Rest of the treatment gave the intermediate result.

4.8.3 Interaction effect of variety and management packages

Significant interaction effect between the variety and management packages was observed for dry weight of nodules produced plant^{-1} (Appendix IX and Table 7). The highest dry weight of nodules (0.034 mg plant^{-1}) was obtained from the V_2M_2 interaction which was statistically similar with the interaction of V_2M_3. The lowest dry weight of nodules was produced from V_3M_2 (0.007 mg plant^{-1}) that similar to all other interaction except V_2M_2 & V_2M_3.

Table 7. Interaction effect of variety and management packages on the number of nodules plant^{-1} and nodule dry weight plant^{-1} of blackgram

Treatment combination	Number of nodules plant^{-1}	Nodule dry weight plant^{-1} (mg)
V1M1	13.33	0.009 b
V1M2	11.07	0.014 b
V1M3	9.73	0.013 b
V2M1	13.53	0.014 b
V2M2	18.33	0.034 a
V2M3	13.53	0.021 ab
V3M1	11.40	0.009 b
V3M2	14.67	0.007 b
V3M3	11.73	0.01 b
$LSD_{(0.05)}$	12.69 (NS)	0.016
CV (%)	54.75	59.63

In a column means having similar letter(s) are statistically similar

NS = Not significant, CV = Coefficient of variation, $LSD_{(0.05)}$ = Least significant difference at 5% level,

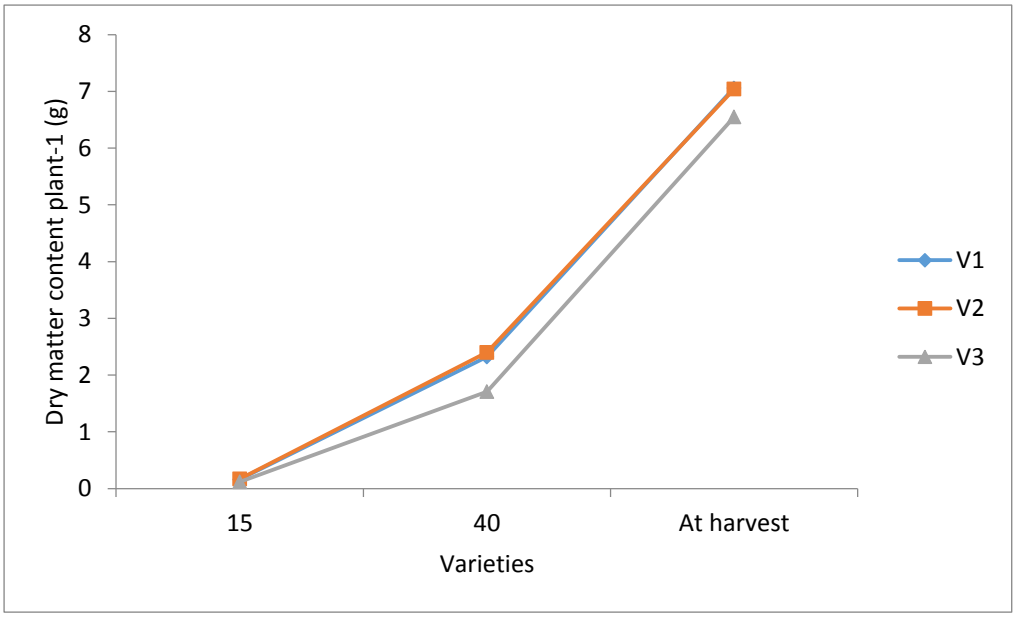
DAS = Days after sowing, V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

M_1 = Low management, M_2 = Medium management and M_3 = High management

4.9 Dry matter content plant^{-1}

4.9.1 Effect of variety

The total dry matter weight of plant was significantly influenced by varieties at 15 DAS but insignificant at 40 DAS and at harvest (Appendix VIII and Figure 18). At 15 DAS, the higher dry matter weight plant^{-1} (0.17 g) was recorded in BARI Mash-2 (V_2) and the lower dry matter weight plant^{-1} (0.12 g) was recorded in BINA Mash-1 (V_3). But at 40 DAs and at harvest, varieties had no significant effect though the higher dry matter weight plant^{-1} observed in BARI Mash-2 (V_2) and BARI Mash-3 (V_3) respectively and the lower dry matter weight plant^{-1} observed in BINA Mash-1 (V_3). These findings agreed with Pookpakdi *et al*. (1980) who stated that total dry weight and dry matter production varied according to variety.



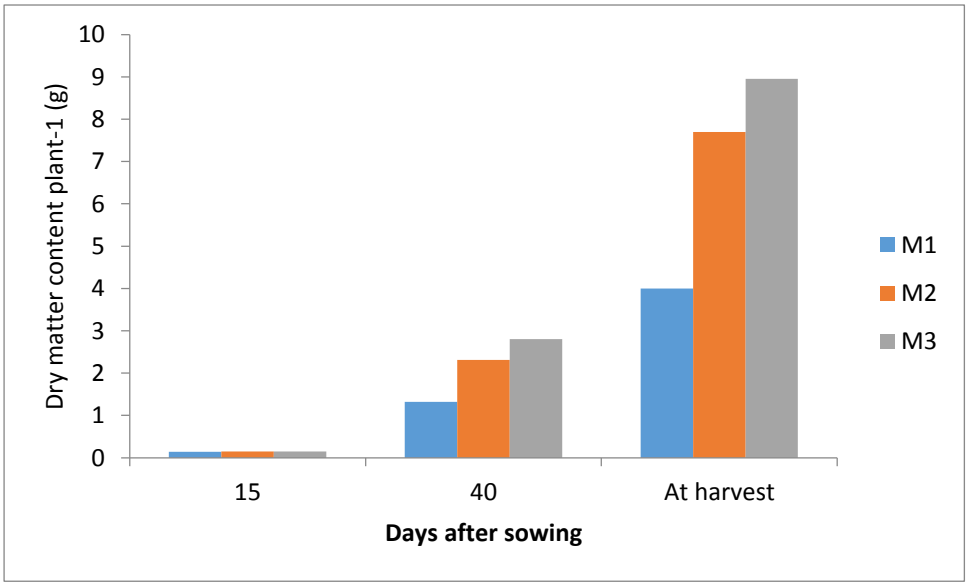
V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 18: Effect of variety on above ground dry weight plant^{-1} of blackgram at different days after sowing (LSD $_{(0.05)}$ = 0.04, 0.94 and 4.36at 15, 40 DAS and at harvest, respectively)

4.9.2 Effect of management packages

The total dry matter weight of plant was significantly influenced by different management packages that applied as supplementary urea, MOP, NPK , irrigation and weeding at 40 DAS but insignificant at 15 DAS and at harvest (Appendix VIII and Figure 19). At 40

DAS, the highest dry matter weight plant^{-1} (2.8 g) was recorded in M_3 treatment which was statistically similar with M_2 (2.31 g) and the lowest dry matter weight plant^{-1}(1.32 g) was recorded in M_1 treatment. At harvest, the treatment M_3 produced the maximum dry matter weight plant^{-1} (8.95 g) and the minimum (4.0 g) was obtained from the M_1 treatment. At 15 DAS, the maximum dry matter weight plant^{-1} (0.15 g) was recorded in both M_2 and M_3 treatment, while the minimum (0.14 g) was recorded in M_1 treatment. Tenebe *et al*. (1995) and Singh and Jain (1996) noticed significant increase in plant growth of cowpea by increased levels of phosphorus application.



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 19: Effect of management packages on above ground dry weight plant^{-1} of blackgram at different days after sowing (LSD $_{(0.05)}$ = 0.55 at 40 DAS)

4.9.3 Interaction effect of variety and management packages

Interaction effect of variety and management packages significantly influenced by the total dry matter weight plant^{-1} of blackgram at 40 DAS and at harvest but insignificantly influenced by the total dry matter weight plant^{-1} at 15 DAS (Appendix VIII and Table 8). At 15 DAS, the maximum dry matter weight plant^{-1} (0.17 g) was observed between the V_1M_2, V_2M_2 and V_2M_3 interaction and the minimum dry matter weight plant^{-1} (0.11 g) was observed in the V_3 with the interaction of M_1. At 40 DAS, the highest dry matter weight plant^{-1} (3.19 g) was obtained from the V_1M_3 interaction which was statistically similar to the interactions of V_2M_3 and V_2M_2 while the lowest (1.14 g) was observed in the V_3M_1 interaction which shown similarity to the combinations of V_1M_1,V_2M_1 & V_3M_2.

Again at harvest, the highest dry matter weight plant^{-1} (10.40 g) was produced by the V_1M_3 which was statistically similar to all treatment except V_1M_1 & V_2M_1 and the lowest dry matter weight plant^{-1} (3.11 g) was observed in the V_1M_1 interaction which shown similarity with V_2M_1, V_3M_1, V_3M_3, V_3M_2, V_1M_2 & V_2M_2 treatment combination.

Table 8. Interaction effect of variety and management packages on dry matter content plant^{-1} of blackgram

Treatment combination	Dry matter content plant^{-1} (g) at		
	15 DAS	40 DAS	At harvest
V1M1	0.14	1.34 ef	3.11 c
V1M2	0.17	2.41 a-d	7.68 a-c
V1M3	0.16	3.19 a	10.40 a
V2M1	0.16	1.47 d-f	3.56 bc
V2M2	0.17	2.69 a-c	8.01 a-c
V2M3	0.17	3.02 ab	9.53 ab
V3M1	0.11	1.14 f	5.32 a-c
V3M2	0.13	1.80 c-f	7.40 a-c
V3M3	0.12	2.19 b-e	6.92 a-c
LSD $_{(0.05)}$	0.37 (NS)	0.96	6.22
CV (%)	13.33	25.16	50.8

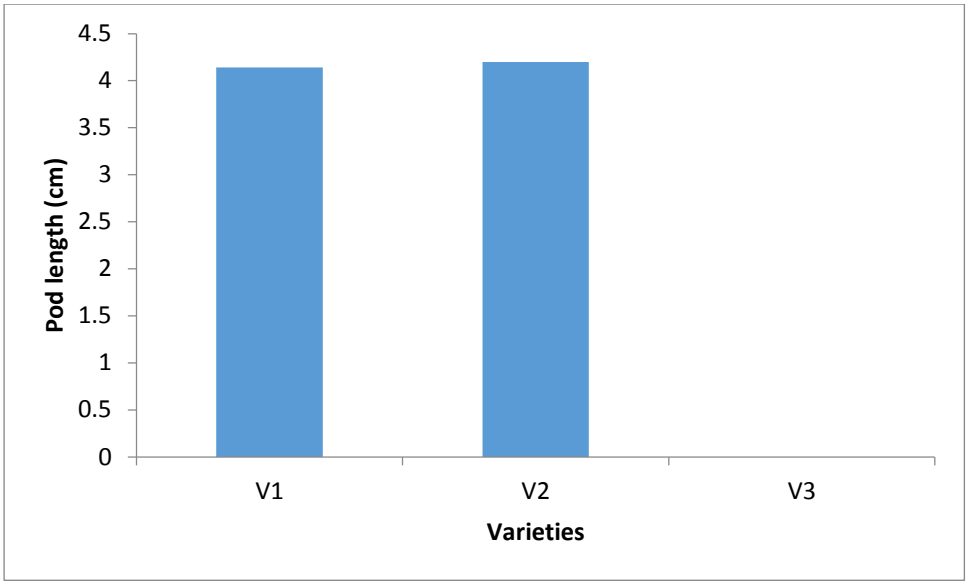
In a column means having similar letter(s) are statistically similar

NS = Not significant, CV = Coefficient of variation, LSD $_{(0.05)}$= Least significant difference at 5% level, DAS = Days after sowing, V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1, M_1 = Low management, M_2 = Medium management and M_3 = High management

4.10 Pod length at 1st harvest

4.10.1 Effect of variety

The pods length that 1st harvest were significantly influenced by variety (Appendix XIII and Figure 20). Results showed that, the V_2 produced longer pod length at 1stharvest (4.2 cm) whereas the shorter pod length that 1st harvest was obtained from V_1 (4.14 cm). As there was no flower in V_3, pod length data for V_3 was not available.

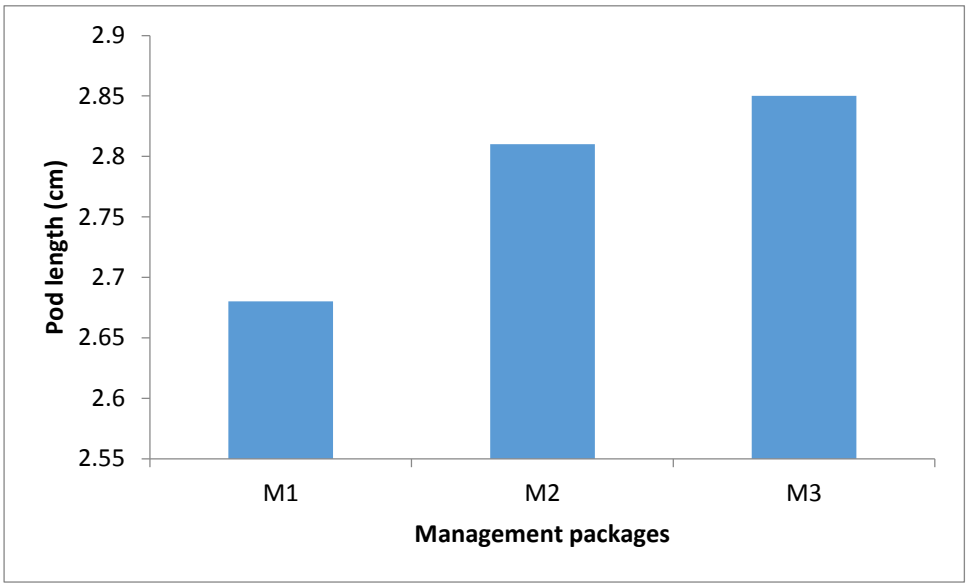


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 20: Effect of variety on pod length at 1st harvest of blackgram (LSD $_{(0.05)}$ = 0.29)

4.10.2 Effect of management packages

Significant variation was recorded in terms of pod length of blackgram for different managements (Appendix XIII and Figure 21). The longest pod (2.85 cm) was found from M_3. On the other hand, the shortest pod (2.68 cm) was recorded from M_1.



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 21: Effect of management packages on pod length at 1st harvest of blackgram (LSD $_{(0.05)}$ = 0.165).

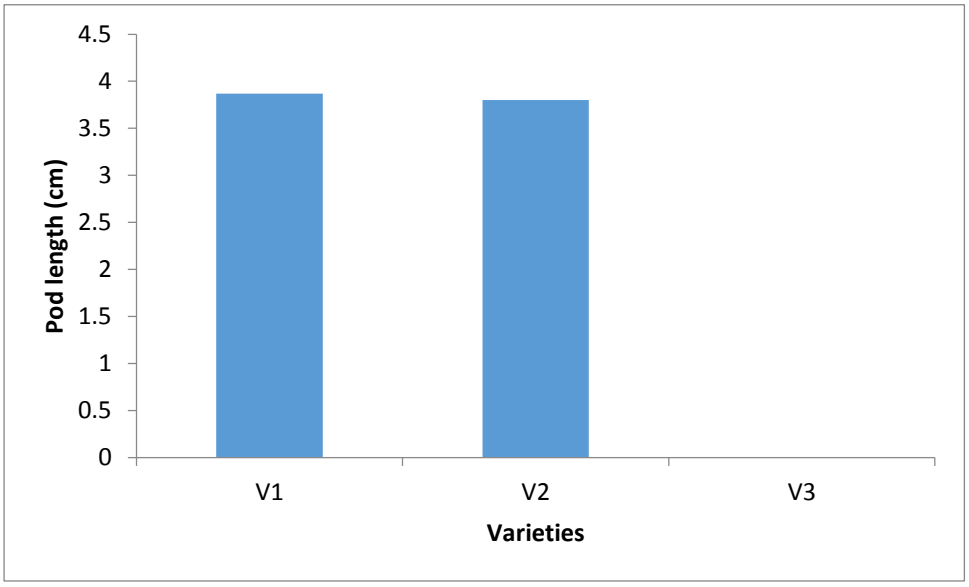
4.10.3 Interaction effect of variety and management packages

The pod length at 1st harvest was significantly influenced by the interaction effect of variety and management packages (Appendix XIII and Table 9). The longest pod length at 1^{st} harvest (4.31 cm) was obtained from the V_1M_2 which shown similarity with all treatment except V_1M_1. The shortest pod length at 1^{st} harvest (3.85 cm) was obtained from V_1M_1 which shown similarity with the interaction of V_2M_2. As there was no flower in V_3 treatment, there was no pod length data found from V_3M_1, V_3M_2 and V_3M_3 interactions.

4.11 Pods length (cm) at last harvest

4.11.1 Effect of variety

The pods length at last harvest was significantly influenced by variety (Appendix XIII and Figure 22). Results showed that, the V_1 produced longest pod length at last harvest (3.87 cm) whereas the shortest pod length that last harvest was obtained from V_2 (3.8 cm). As there was no flower in V_3, pod length data for V_3 was not available.

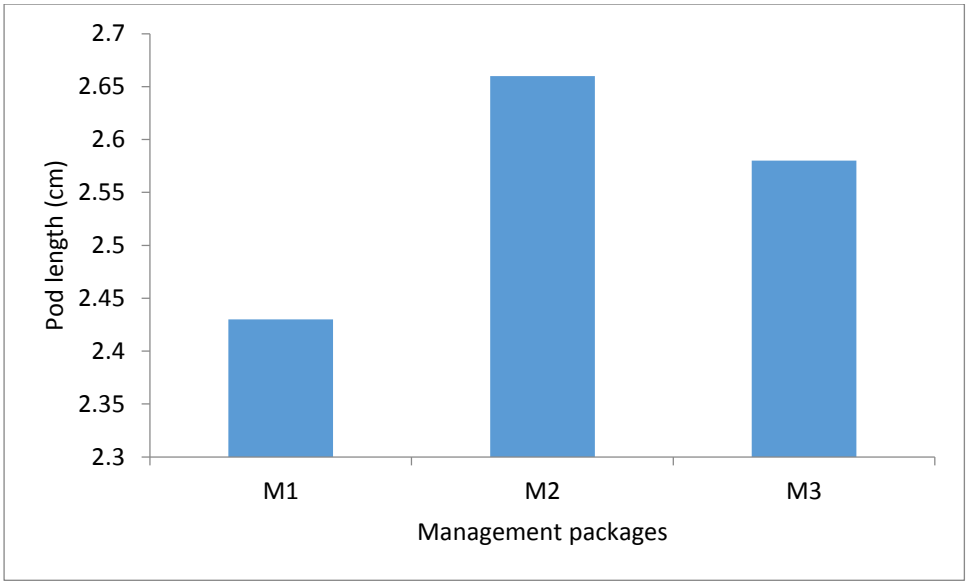


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 22: Effect of variety on pod length at last harvest of blackgram ($LSD_{(0.05)}$ = 0.36)

4.11.2 Effect of management packages

Management packages showed significant effect on the pod length at last harvest (Appendix XIII and Figure 23). Results revealed that, treatment M_2 produced longest pods length at last harvest (2.66 cm) and the shortest was obtained from M_1 (2.43 cm).



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 23: Effect of management packages on pod length at last harvest of blackgram ($LSD_{(0.05)}$ = 0.17)

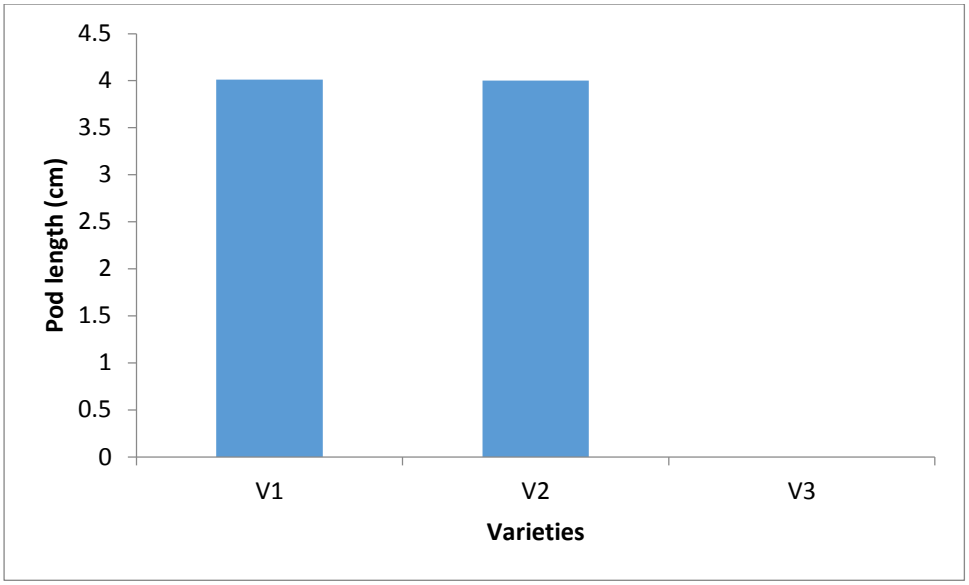
4.11.3 Interaction effect of variety and management packages

The pod length at last harvest was significantly influenced by the interaction effect of variety and management packages (Appendix XIII and Table 9). The longest pod length at last harvest (4.06 cm) was obtained from the V_1M_3 which shown similarity with V_2M_2 and V_1M_2. The shortest pod length at last harvest (3.59 cm) was obtained from V_1M_1 which shown similarity with the interaction of V_2M_3 and V_2M_1. As there was no flower in V_3 treatment, there was no pod length data found from V_3M_1, V_3M_2 and V_3M_3 interactions.

4.12 Average pod length

4.12.1 Effect of variety

The average pod length differed significantly due to varietal variation (Appendix XIII and Figure 24). The longest pod length (4.01 cm) was recorded in BARI mash-3 and the shortest pod length (4.0 cm) was recorded in BARI mash-2. As there was no flower in V_3, pod length data for V_3 was not found. No pod was found in treatment BINA mash-1only vegetative growth data found in this treatment. The result agreed with the findings of Farghali and Hossain (1995) who observed that varieties differ significantly in respect of pod length.

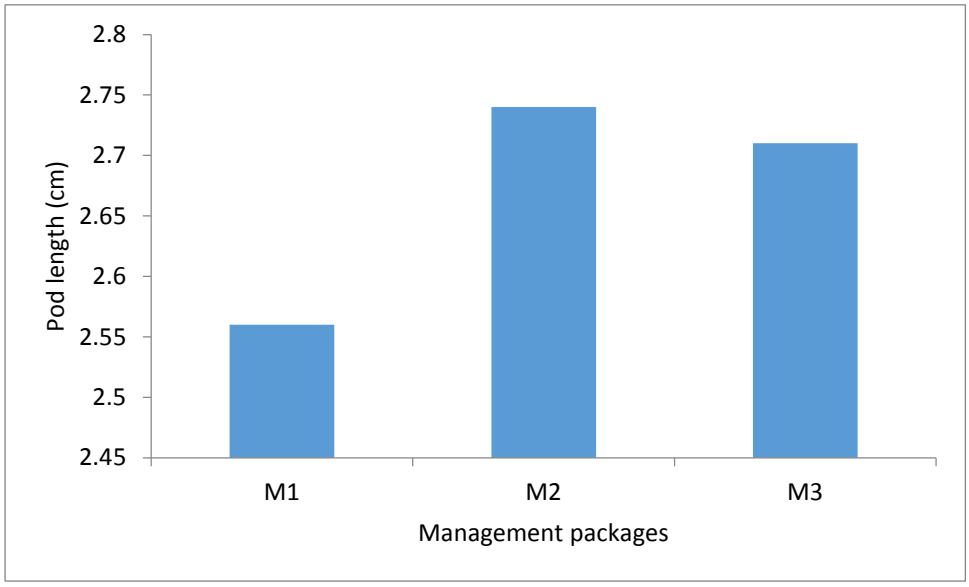


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 24: Effect of variety on average pod length of blackgram (LSD $_{(0.05)}$ = 0.15)

4.12.2 Effect of management packages

Management packages showed significant effect on the average pod length (Appendix XIII and Figure 25). Results revealed that, treatment M_2 produced longer pod length (2.74 cm) and the shorter was obtained from M_1 (2.56 cm).



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 25: Effect of management packages on average pods length of blackgram

(LSD $_{(0.05)}$ = 0.15)

4.12.3 Interaction effect of variety and management packages

Table 9: Interaction effect of variety and management packages on average pod length of blackgram

Treatment combination	Pod length (cm) at		
	1st harvest	Last harvest	Average
V1M1	3.85 b	3.59 c	3.72 b
V1M2	4.31 a	3.96 ab	4.14 a
V1M3	4.27 a	4.06 a	4.16 a
V2M1	4.20 a	3.71 bc	3.96 ab
V2M2	4.11 ab	4.02 a	4.07 a
V2M3	4.28 a	3.67 bc	3.97 ab
V3M1	0.00 c	0.00 d	0.00 c
V3M2	0.00 c	0.00 d	0.00 c
V3M3	0.00 c	0.00 d	0.00 c
LSD $_{(0.05)}$	0.29	0.3	0.26
CV (%)	5.69	6.65	5.43

In a column means having similar letter(s) are statistically similar

NS = Not significant, CV = Coefficient of variation, $LSD_{(0.05)}$ = Least significant difference at 5% level,

DAS = Days after sowing, V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

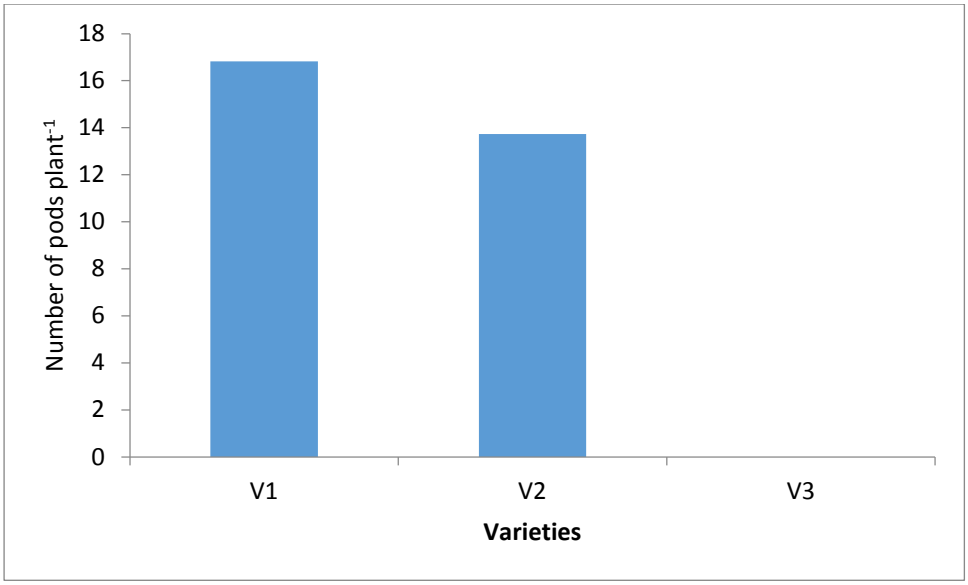
M_1 = Low management, M_2 = Medium management and M_3 = High management

The average pod length was significantly influenced by the interaction effect of variety and management packages (Appendix XIII and Table 9). The longer pod length (4.16 cm) was obtained from the V_1M_3 which shown similarity with all treatments except V_1M_1. The shorter pod length (3.72 cm) was obtained from V_1M_1 which shown similarity with the interaction of V_2M_1 and V_2M_3. As there was no flower in V_3 treatment, there was no pod length data found from V_3M_1, V_3M_2 and V_3M_3 interactions.

4.13 Number of pods plant^{-1} at 1st harvest

4.13.1 Effect of variety

The number of pods plant^{-1} at 1st harvest was significantly influenced by variety (Appendix XI and Figure 26). Results showed that, the V_1 produced highest number of pods plant^{-1} at 1st harvest (16.82) whereas the lowest number of pods plant^{-1} at 1st harvest was obtained from V_2 (13.73). As there was no flower in V_3, pod data for V_3 was not available.

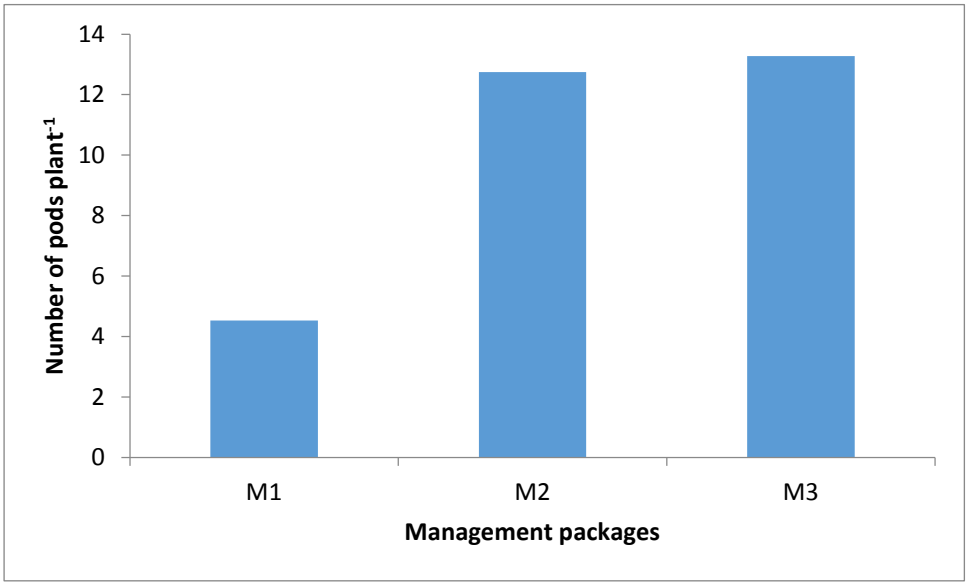


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 26: Effect of variety on pods plant^{-1} at 1st harvest of blackgram (LSD $_{(0.05)}$ = 3.69)

4.13.2 Effect of management packages

Management packages showed significant effect on the number of pods plant^{-1} at 1st harvest (Appendix XI and Figure 27). Results revealed that, treatment M_3 produced highest number of pods plant^{-1} at 1st harvest (13.27) and the lowest was obtained from M_1 (4.53).



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 27: Effect of management packages on pods plant^{-1} at 1st harvest of blackgram (LSD $_{(0.05)}$ = 5.41).

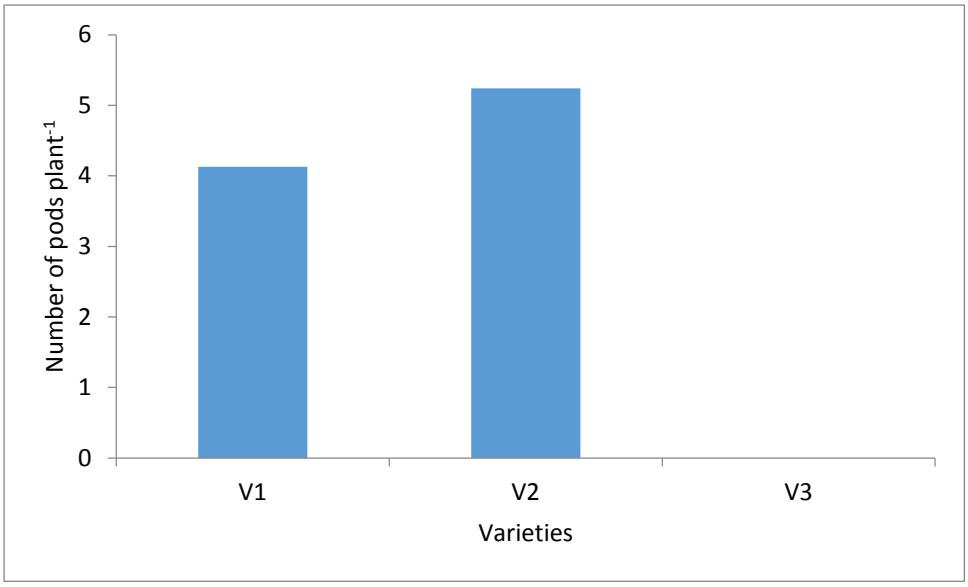
4.13.3 Interaction effect of variety and management packages

The number of pods plant^{-1} at 1st harvest was significantly influenced by the interaction effect of variety and management packages (Appendix XI and Table 10). The highest number of pods plant^{-1} at 1st harvest (22.47) was obtained from the V_1M_2 which shown similarity with V_1M_3, V_2M_3 and V_2M_2. The lowest number of pods plant^{-1} at 1st harvest (6.73) was obtained from V_1M_1 which shown similarity with the interaction of V_2M_1. As there was no flower in V_3 treatment, no pod data was found from V_3 interactions.

4.14 Number of pods plant^{-1} at last harvest

4.14.1 Effect of variety

The number of pods plant^{-1} at last harvest was significantly influenced by variety (Appendix XI and Figure 28). Results showed that, the V_2 produced highest number of pods plant^{-1} at last harvest (5.24) whereas the lowest number of pods plant^{-1} at last harvest was obtained from V_1 (4.13). As there was no flower in V_3, pod data for V_3 was not available.

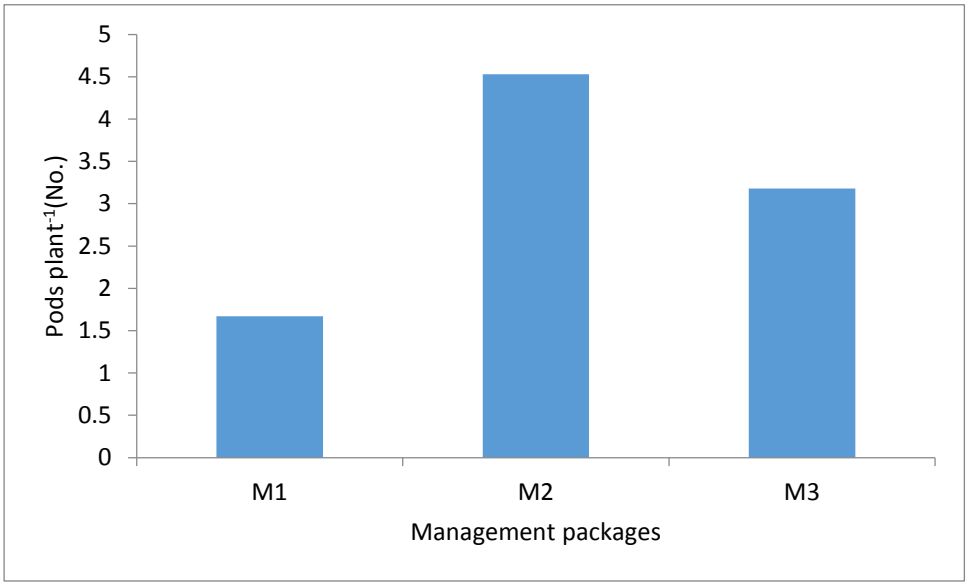


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 28: Effect of variety on pods plant^{-1} at last harvest of blackgram at different days after sowing (LSD $_{(0.05)}$ = 2.78).

4.14.2 Effect of management packages

Management packages showed significant effect on the number of pods plant^{-1} at last harvest (Appendix XI and Figure 29). Results revealed that, treatment M_2 produced highest number of pods plant^{-1} at last harvest (4.53) and the lowest was obtained from M_1 (1.67) .



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 29: Effect of management packages on pods plant^{-1} at last harvest of blackgram (LSD $_{(0.05)}$ = 2.46)

4.11.3 Interaction effect of variety and management packages

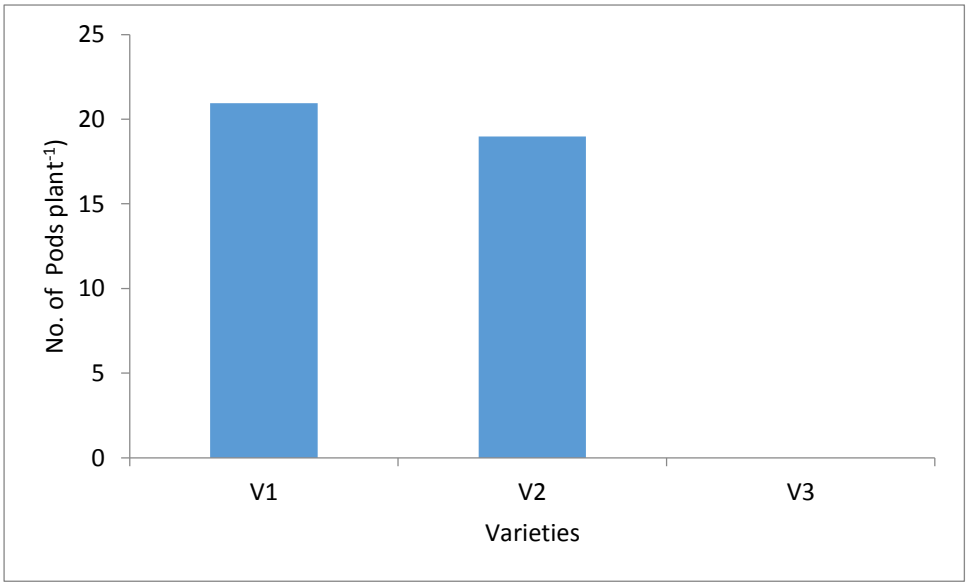
The number of pods plant^{-1} at last harvest was significantly influenced by the interaction effect of variety and management packages (Appendix XI and Table 10). The highest number of pods plant^{-1} at last harvest (9.87) was obtained from the V_2M_2 which shown similarity with V_1M_3. The lowest number of pods plant^{-1} at last harvest (2.47) was obtained from V_1M_1 which shown similarity with the interaction of V_2M_1, V_2M_3, V_1M_2 and V_1M_3. As there was no flower in V_3 treatment, no pod data was found from V_3 interactions.

4.15 Number of total pods plant^{-1}

4.15.1 Effect of variety

The total number of pods plant^{-1} differed significantly due to varietal variation (Appendix XI and Figure 30). The highest number of pods plant^{-1} (20.95) was recorded in BARI

mash-3 and the lowest number of pods plnat^{-1} (18.98) was recorded in BARI mash-2. As there was no flower in V_3, pod data for V_3 was not available. The result agreed with Pahlwan and Hossain (1983) who observed the highest number of pods plant^{-1} from variety Mubarik but the result disagreed with Pookpadi *et al*. (1980) who observed the lowest number of pods plant^{-1} in local variety. Masood and Meena (1986) reported that number of pods plant^{-1} varied significantly with genotypes. Islam (1983), Haque *et al*. (2002) also opined that pods plant^{-1} as a useful agronomic character contributing to higher yield of mungbean and there was a significant positive correlation between the number of pods plant^{-1} and yield plant^{-1}.

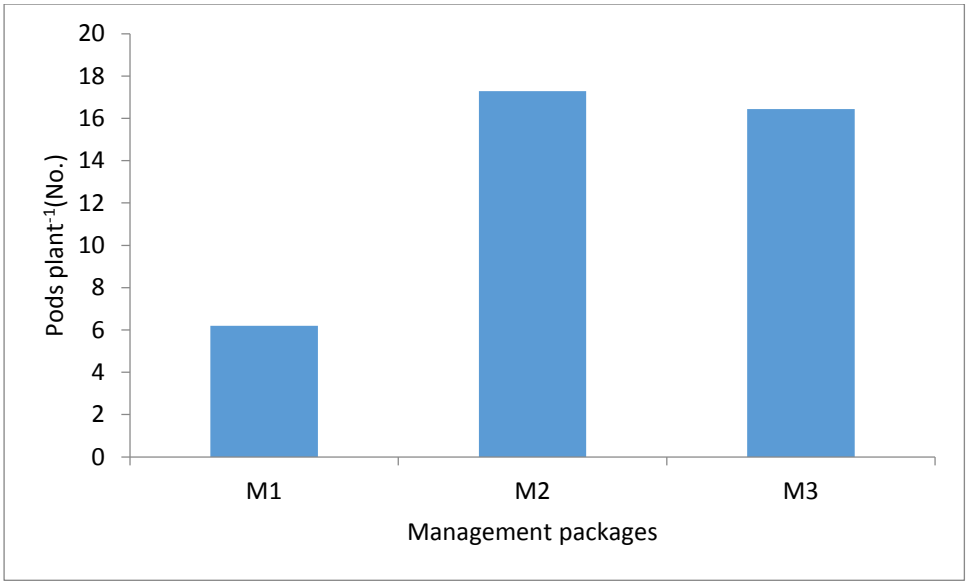


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 30: Effect of variety on total number of pods plant^{-1} of blackgram (LSD $_{(0.05)}$ = 4.03).

4.15.2 Effect of management packages

Management packages showed significant effect on the total number of pods plant^{-1} (Appendix XI and Figure 31). Results revealed that, treatment M_2 produced maximum number of pods plant^{-1} (17.28) and the minimum was obtained from M_1 (6.2).



M_1 = Low management M_2 = Medium management and M_3 = High management

Figure 31: Effect of management packages on total number of pods plant^{-1} of blackgram (LSD $_{(0.05)}$ = 5.22).

4.15.3 Interaction effect of variety and management packages

The total number of pods plant^{-1} was significantly influenced by the interaction effect of variety and management packages (Appendix XI and Table 10). The highest number of pods plant^{-1} (27.46) was obtained from the V_1M_3 which shown similarity with all treatment except V_1M_1 and V_2M_1. The lowest number of pods plant^{-1}(9.20) was obtained from V_1M_1 which shown similarity with the interaction of V_2M_1. As there was no flower in V_3 treatment, there was no pod data found from V_3 interactions. But Kudikeri *et al*. (1973) revealed that phosphorus has also been reported to increase the number of leaves and fruits per plant as well as earliness in flowering and yield. Patel (1979) also noted that application of P_2O_5 @ 60 kg/ha gave significantly higher pod yield over 20 and 40 kg/ha in summer vegetable cowpea.

Table 10: Interaction effect of variety and management packages on number of pods plant^{-1} of blackgram

Treatment combination	Number of pods plant^{-1}		
	1st harvest	Last harvest	Total
V1M1	6.73 b	2.47 b	9.20 b
V1M2	22.47 a	3.73 b	26.20 a
V1M3	21.27 a	6.20 ab	27.47 a
V2M1	6.87 b	2.53 b	9.40 b
V2M2	15.8 ab	9.87 a	25.67 a
V2M3	18.53 a	3.33 b	21.86 a
V3M1	0.00 c	0.00 c	0.00 c
V3M2	0.00 c	0.00 c	0.00 c
V3M3	0.00 c	0.00 c	0.00 c
LSD $_{(0.05)}$	9.37	4.26	9.05
CV (%)	51.75	76.79	38.21

In a column means having similar letter(s) are statistically similar

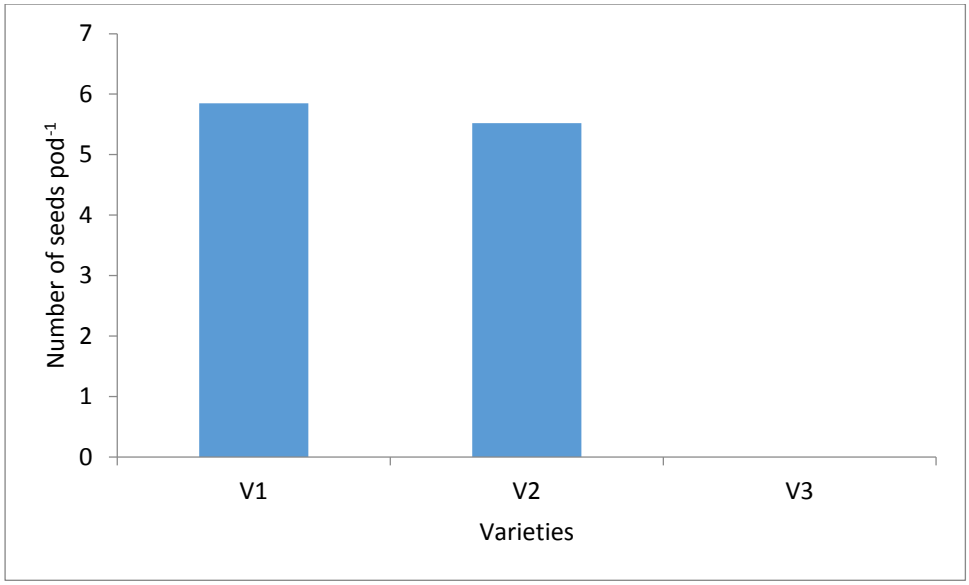
NS = Not significant, CV = Coefficient of variation, $LSD_{(0.05)}$ = Least significant difference at 5% level, DAS = Days after sowing, V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

M_1 = Low management, M_2 = Medium management and M_3 = High management

4.16 Number of seeds pod^{-1} at 1st harvest

4.16.1 Effect of variety

The number of seeds pod^{-1} at 1st harvest was significantly influenced by the Variety (Appendix XII and Figure 32). The V_1 produced higher number of seeds pod^{-1} at 1st harvest (5.85) and the V_2 produced lower number of seeds pod^{-1} at 1st harvest (5.52). As there was no flower in V_3, no seed data for V_3 was available.

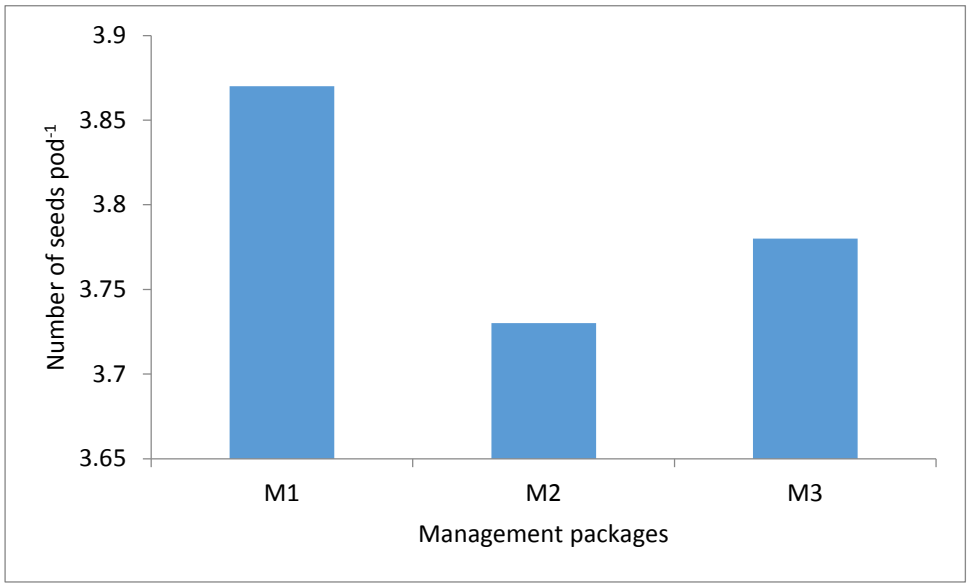


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 32: Effect of variety on seeds pod^{-1} at 1st harvest of blackgram (LSD $_{(0.05)}$ = 0.41).

4.16.2 Effect of management packages

Management packages showed non-significant effect on the number of seeds pod^{-1} at 1st harvest (Appendix XII and Figure 33). The maximum number of seeds pod^{-1} at 1st harvest was recorded from the M_1 (3.87) and the minimum number of seeds pod^{-1} at 1st harvest was recorded from M_2 (3.73).



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 33: Effect of management packages on seeds pod^{-1} at 1st harvest of blackgram (LSD $_{(0.05)}$ = 0.42)

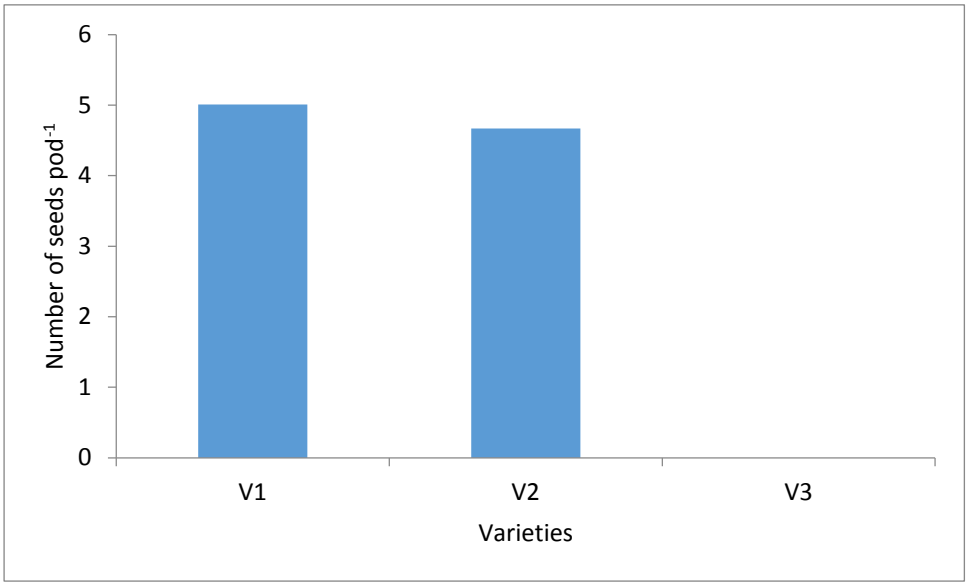
4.16.3 Interaction effect of variety and management packages

The number of seeds pod^{-1} at 1st harvest was significantly influenced by the interaction effect of variety and management packages (Appendix XII and Table 11). The highest number of seeds pod^{-1} at 1st harvest (6.23) was obtained from V_1 with the interaction of M_3, which was similar with all the interactions except V_2M_3. The lowest number of seeds pod^{-1} at 1st harvest (5.10) was obtained from V_2 with the interaction of M_3 which was similar with all the interaction except V_1M_3. As there was no flower in V_3 treatment, no seed data was found from V_3 interactions.

4.17 Number of seeds pod^{-1} at last harvest

4.17.1 Effect of variety

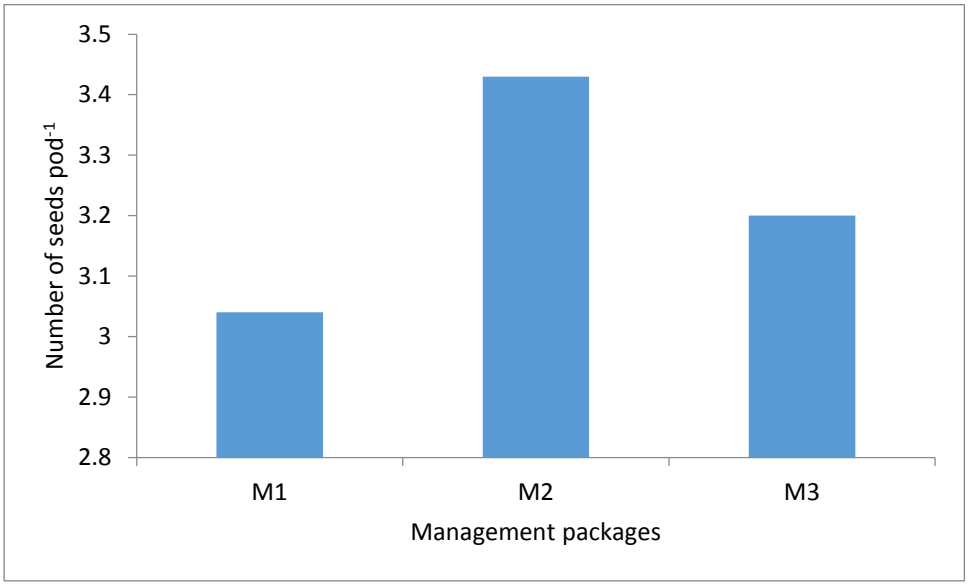
The number of seeds pod^{-1} at last harvest was not significantly influenced by the variety (Appendix XII and Figure 34). The V_1 produced maximum number of seeds pod^{-1} at last harvest (5.01) and the V_2 produced minimum number of seeds pod^{-1} at last harvest (4.67). As there was no flower in V_3, seed data for V_3 was not available.



V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 34: Effect of variety on the number of seeds pod^{-1} at last harvest of blackgram (LSD $_{(0.05)}$ = 0.75).

4.17.2 Effect of management packages



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 35: Effect of management packages on the number of seeds pod^{-1} at last harvest of blackgram (LSD $_{(0.05)}$ = 0.58).

Management packages showed non-significant effect on the number of seeds pod^{-1} at last harvest (Appendix XII and Figure 35). The maximum number of seeds pod^{-1} at last harvest was recorded from the M_2 (3.43) and the minimum number of seeds pod^{-1} at last harvest was recorded from M_1 (3.04).

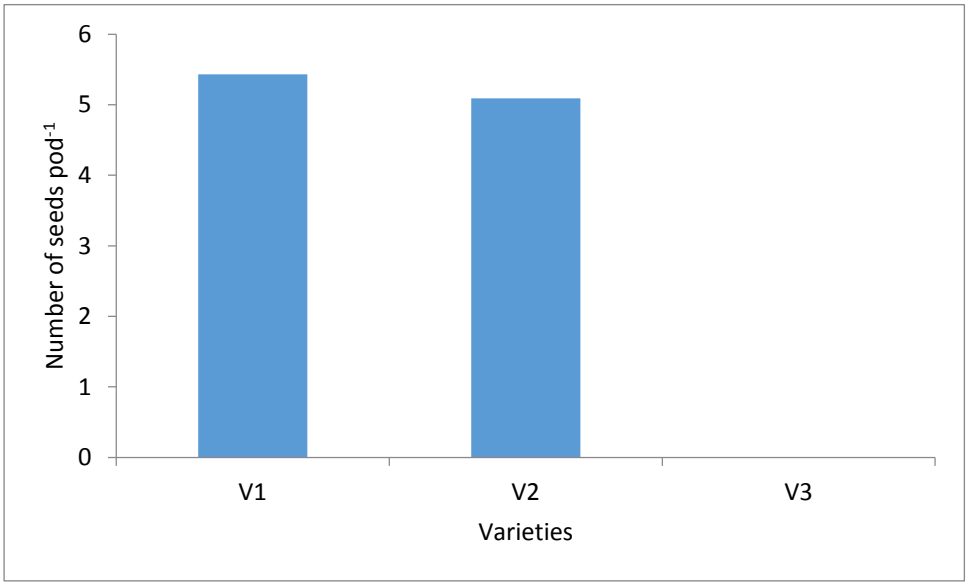
4.17.3 Interaction effect of variety and management packages

The number of seeds pod^{-1} at last harvest was significantly influenced by the interaction effect of variety and management packages (Appendix XII and Table 11). The highest number of seeds pod^{-1} at last harvest (5.47) was obtained from V_1 with the interaction of M_3, which was similar with the interactions V_2M_2, V_1M_2, V_1M_1 and V_2M_1. The lowest number of seeds pod^{-1} at last harvest (4.13) was obtained from V_2 with the interaction of M_3 which was similar with the interaction of V_1M_1, V_2M_1 and V_1M_2. As there was no flower in V_3 treatment, there was no seed data found from V_3 interactions.

4.18 Number of average seeds pod^{-1}

4.18.1 Effect of variety

The average number of seeds pod^{-1} showed significant variations between the varieties of blackgram (Appendix XII and Figure 36). The highest number of seeds pod^{-1} (5.43) was recorded in BARI mash-3 and the lowest number of seeds pod^{-1} (5.09) was recorded in BARI mash-2. As there was no flower in V_3, seed data for V_3 was not available. The result support the findings of Pahlwan and Hossain (1983) and Pookpakdi *et al*. (1980) who found the highest yield from two mungbean cultivars Mubarik and CES 14 with the highest number of seeds pod^{-1}. But the result did not support the findings of Ghosh (2007) who found that number of seeds pod^{-1} did not differ significantly between BARI mung-6 and Sona mung.

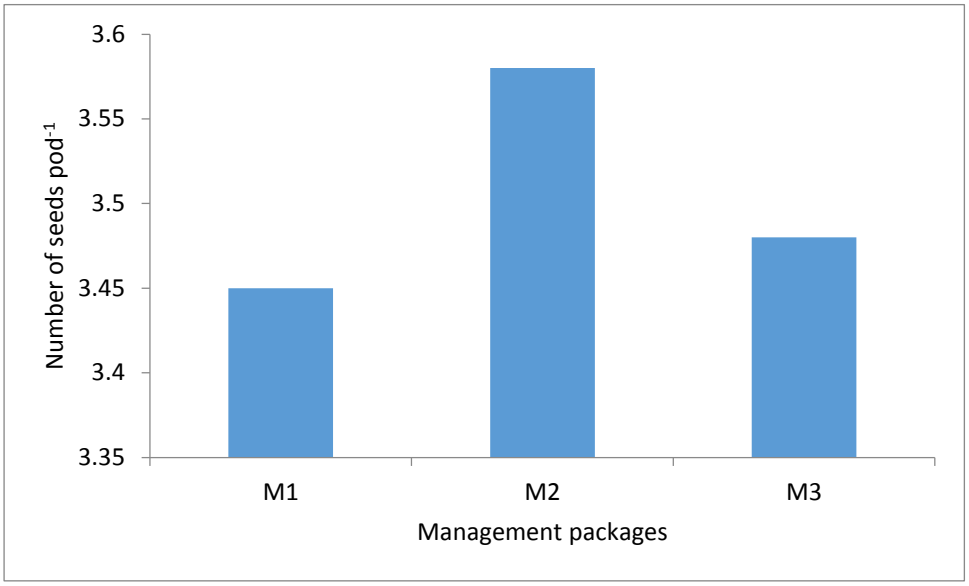


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 36: Effect of variety on theaverage number seeds pod^{-1} of blackgram

(LSD $_{(0.05)}$ = 0.26)

4.18.2 Effect of management packages



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 37: Effect of management packages on the average number of seeds pod^{-1} of blackgram

Management packages showed non-significant effect on the average number of seeds pod^{-1} (Appendix XII and Figure 37). The maximum number of seeds pod^{-1} was recorded from the M_2 (3.58) and the minimum number of seeds pod^{-1} was recorded from M_1 (3.45). Jain *et al*. (1986) noted that the number of seeds per pod was significant only up to 40 kg P_2O_5/ha.

4.18.3 Interaction effect of variety and management packages

The average number of seeds pod^{-1} was significantly influenced by the interaction effect of variety and management packages (Appendix XII and Table 11). The highest number of seeds pod^{-1} (5.85) was obtained from the V_3M_3 which shown similarity with all treatment except V_2M_3. The lowest number of seeds pod^{-1} (4.62) was obtained from V_2M_3 which shown similarity with the interaction ofV_1M_1 and V_2M_1 and other treatments except V_3M_3. As there was no flower in V_3 treatment, there was no seed data found from V_3 interactions.

Table 11: Interaction effect of variety and management packages on average number of seeds pod^{-1} of blackgram

Treatment combination	Number of seeds pod^{-1}		
	1st harvest	Last harvest	Average
V1M1	5.80 ab	4.47 ab	5.13 ab
V1M2	5.53 ab	5.10 ab	5.32 ab
V1M3	6.23 a	5.47 a	5.85 a
V2M1	5.80 ab	4.67 ab	5.23 ab
V2M2	5.67 ab	5.20 a	5.43 ab
V2M3	5.10 b	4.13 b	4.62 b
V3M1	0.00 c	0.00 c	0.00 c
V3M2	0.00 c	0.00 c	0.00 c
V3M3	0.00 c	0.00 c	0.00 c
LSD $_{(0.05)}$	0.72	1.00	0.83
CV (%)	10.55	17.57	13.36

In a column means having similar letter(s) are statistically similar

NS = Not significant, CV = Coefficient of variation, $LSD_{(0.05)}$ = Least significant difference at 5% level,

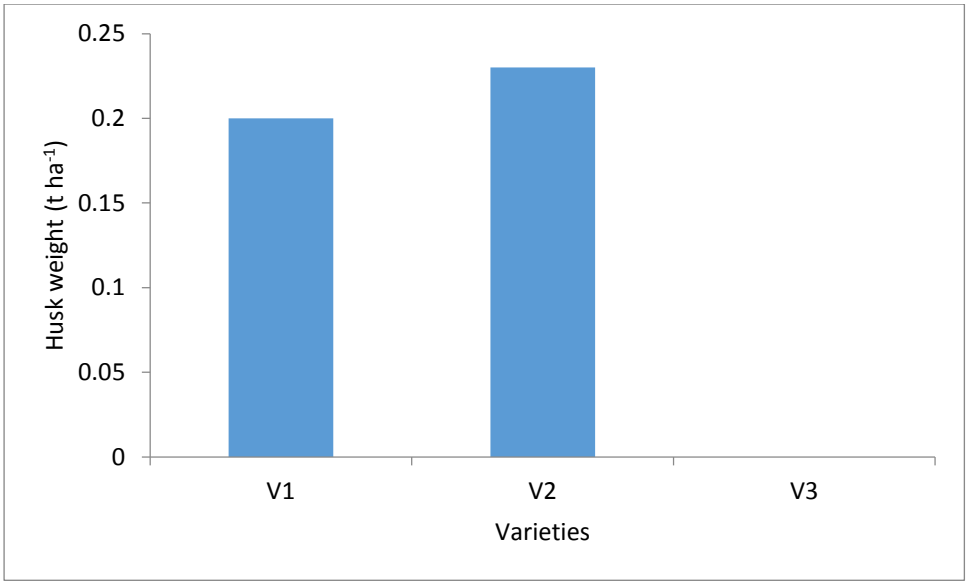
DAS = Days after sowing, V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

M_1 = Low management, M_2 = Medium management and M_3 = High management

4.19 Husk weight at 1st harvest

4.19.1 Effect of variety

The husk weight at 1st harvest was significantly influenced by the variety (Appendix XV and Figure 38). The V_2 produced highest husk weight at 1st harvest (0.23 t ha^{-1}) and the V_1 produced lowest husk weight at 1st harvest (0.20 t ha^{-1}). As there was no flower in V_3, husk data for V_3 was available.

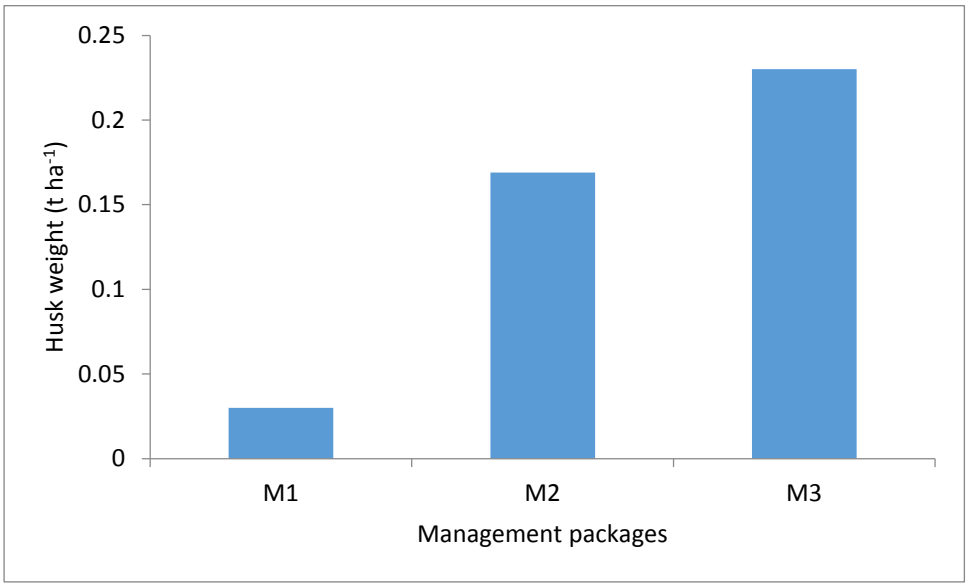


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 38: Effect of variety on husk weight at 1st harvest of blackgram (LSD $_{(0.05)}$ = 0.13).

4.19.2 Effect of management packages

Management packages showed insignificant effect on the husk weight at 1st harvest (Appendix XV and Figure 39). The maximum husk weight was recorded from the M_3 (0.23 t ha^{-1}) and the minimum husk weight was recorded from M_1 (0.03 t ha^{-1}) at 1st harvest.



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 39: Effect of management packages husk weight at 1st harvest of blackgram.

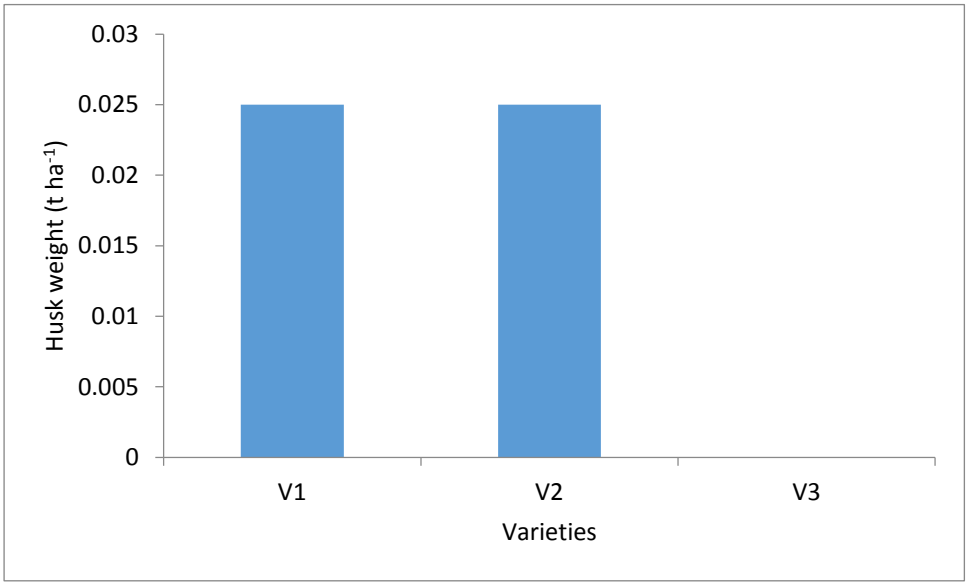
4.19.3 Interaction effect of variety and management packages

The husk weight was significantly influenced by the interaction effect of variety and management packages (Appendix XV and Table 12). The highest husk weight at 1st harvest (0.56 t ha^{-1}) was obtained from the V_2M_1 which was similar with V_2M_3 treatment. The lowest husk weight at 1st harvest (0.23 t ha^{-1}) was obtained from V_2M_2 which shown similarity with all the interaction except V_2M_1 andV_2M_3. As there was no flower in V_3 treatment, there was no husk data found from V_3M_1, V_3M_2 and V_3M_3 interactions.

4.20 Husk weight at last harvest

4.20.1 Effect of variety

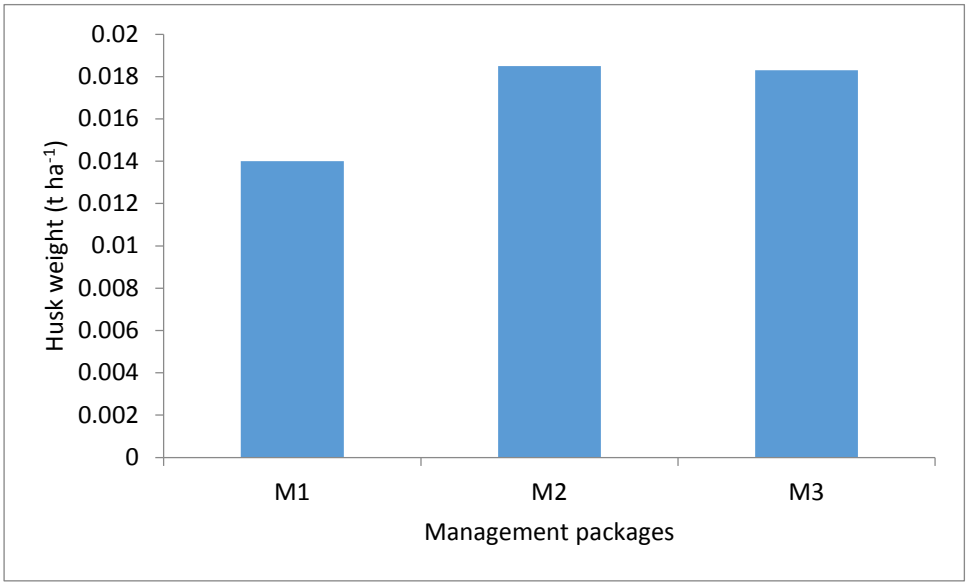
The husk weight at last harvest was not significantly influenced by the variety (Appendix XV and Figure 40). The V_1 and V_2 both produced identical husk weight at last harvest (0.025 t ha^{-1}). As there was no flower in V_3, husk data for V_3 was not available.



V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 40: Effect of variety on husk weight at last harvest of blackgram.

4.20.2 Effect of management packages



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 41: Effect of management packages on husk weight at last harvest of blackgram.

Management packages showed insignificant effect on the husk weight at last harvest (Appendix XV and Figure 41). The maximum husk weight was recorded from M_2 (0.0185 t ha^{-1}) at last harvest. But M_1 treatment was showed minimum husk weight was recorded from (0.014 t ha^{-1}) at last harvest.

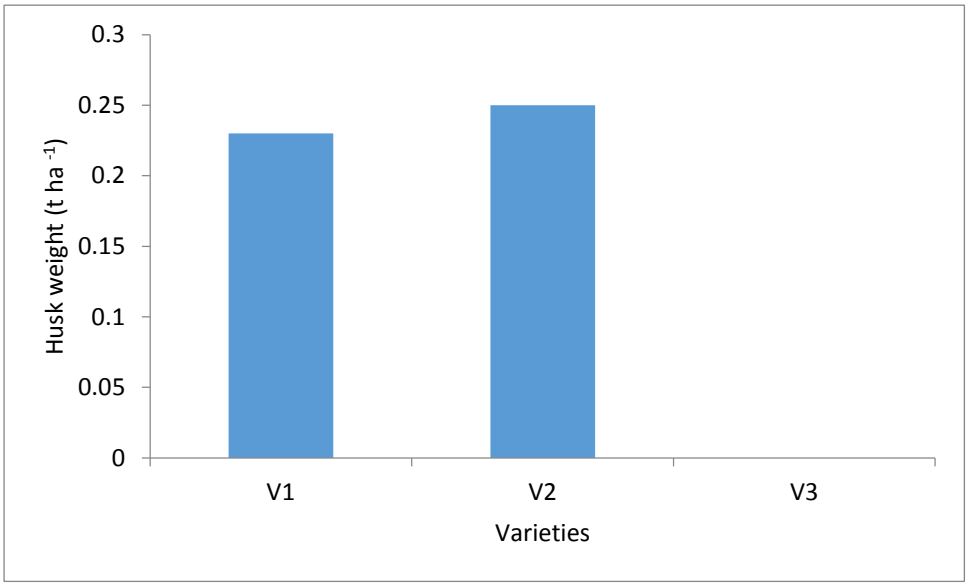
4.20.3 Interaction effect of variety and management packages

The husk weight was showed non-significantly influenced by the interaction effect of variety and management packages (Table 12). The maximum husk weight at last harvest (0.037 t ha^{-1}) was obtained from the V_2M_2 treatment. The minimum husk weight at last harvest (0.018 t ha^{-1}) was obtained from both V_1M_2 and V_2M_1 interaction. As there was no flower in V_3 treatment, there was no husk data found from V_3M_1, V_3M_2 and V_3M_3 interactions.

4.21 Total husk weight

4.21.1 Effect of variety

The total husk weight was significantly influenced by the variety (Appendix XV and Figure 42). The V_2 produced highest husk weight (0.25 t ha^{-1}) and the V_1 produced lowest husk weight (0.23 t ha^{-1}). As there was no flower in V_3, husk data for V_3 was not available.

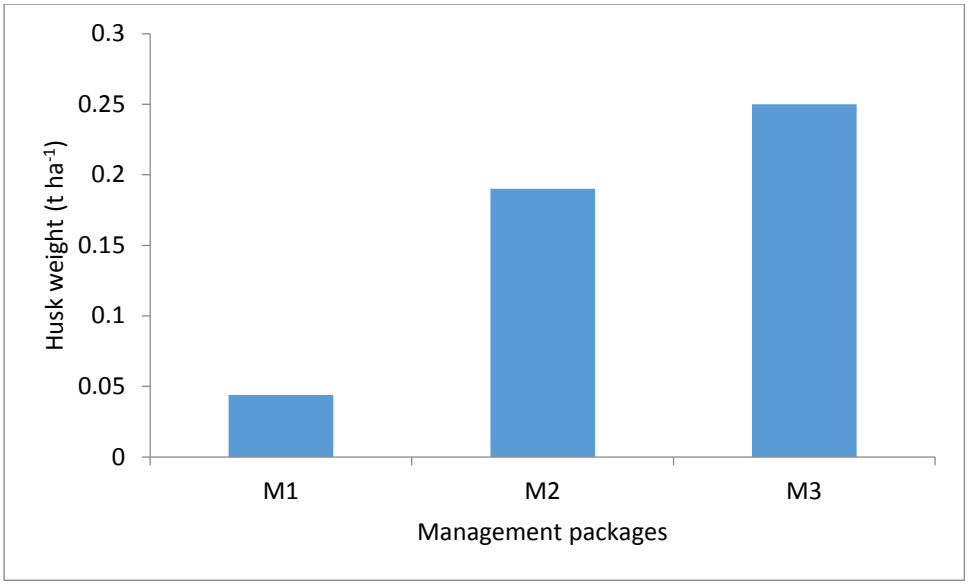


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 42: Effect of variety on total husk weight of blackgram ($LSD_{(0.05)}$ = 0.13).

4.21.2 Effect of management packages

Management packages showed non-significant effect on the total husk weight (Appendix XV and Figure 43). The maximum husk weight was recorded from the M_3 (0.25 t ha^{-1}) and the minimum number of husk weight was recorded from M_1 (0.044 t ha^{-1}).



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 43: Effect of management packages on total husk weight of blackgram

4.21.3 Interaction effect of variety and management packages

The total husk weight was significantly influenced by the interaction effect of variety and management packages (Appendix XV and Table 12). The highest husk weight (0.74 t ha^{-1}) was obtained from the V_2M_1 treatment. The lowest husk weight (0.06 t ha^{-1}) was obtained from V_1M_1 which was similarity with V_2M_2. As there was no flower in V_3 treatment, no husk data was found from V_3M_1, V_3M_2 and V_3M_3 interactions.

Table 12: Interaction effect of variety and management packages on husk weight of blackgram

Treatment combination	Husk weight (t ha^{-1}) at		
	1st harvest	Last harvest	Total
V1M1	0.36 bc	0.024	0.06 c
V1M2	0.27 bc	0.018	0.29 b
V1M3	0.31 bc	0.034	0.35 b
V2M1	0.56 a	0.018	0.74 a
V2M2	0.23 c	0.037	0.27 bc
V2M3	0.40 ab	0.02	0.41 b
V3M1	0.00 d	0.00	0.00 d
V3M2	0.00 d	0.00	0.00 d
V3M3	0.00 d	0.00	0.00 d
$LSD_{(0.05)}$	0.16	0.20 (NS)	0.17
CV (%)	63.88	6.71	59.29

In a column means having similar letter(s) are statistically similar

NS = Not significant, CV = Coefficient of variation, $LSD_{(0.05)}$ = Least significant difference at 5% level,

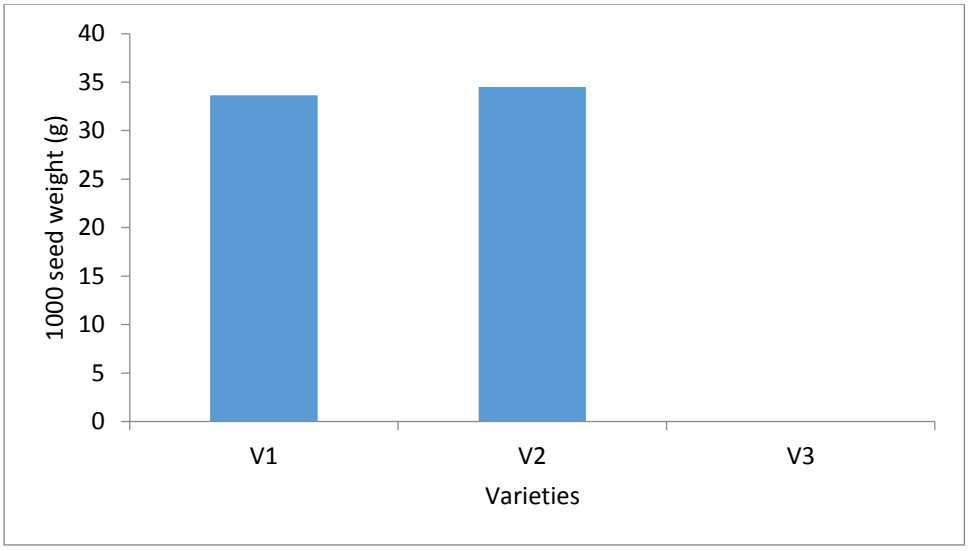
DAS = Days after sowing, V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

M_1 = Low management, M_2 = Medium management and M_3 = High management

4.22 1000 seed weight at 1st harvest

4.22.1 Effect of variety

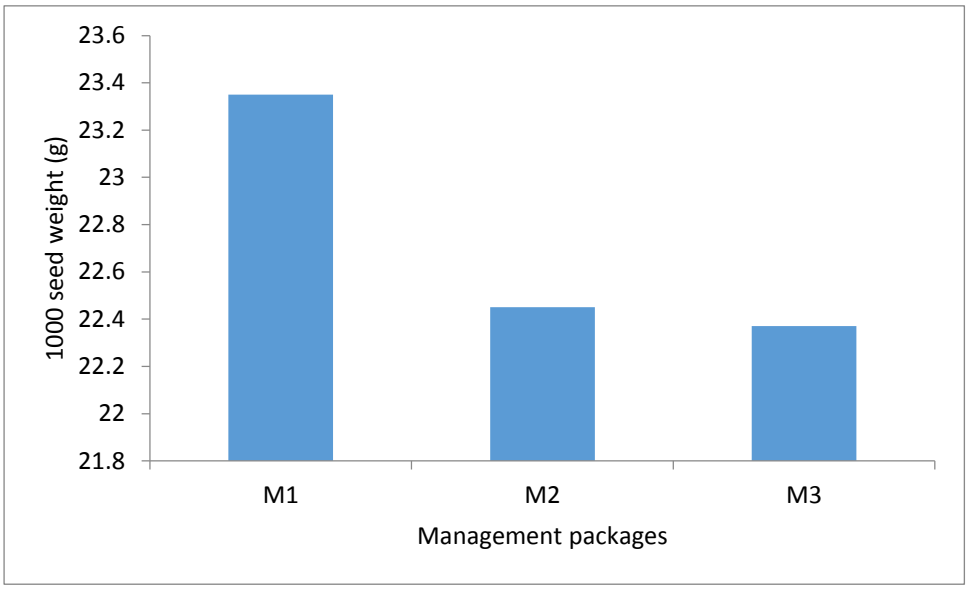
The 1000-seed weight at 1st harvest was significantly influenced by the variety (Appendix XVI and Figure 44). The numerically maximum 1000-seed weight at 1st harvest (34.5 g) was obtained from V_2 and the minimum 1000-seed weight at 1st harvest (33.65 g) was obtained from V_1. As there was no flower in V_3, seed weight data for V_3 was not available.



V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 44: Effect of variety on 1000-seed weight at 1st harvest of blackgram (LSD $_{(0.05)}$ = 0.99).

4.22.2 Effect of management packages



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 45: Effect of management packages on 1000-seed weight at 1st harvest of blackgram

There was not significant variation observed among the management package in respect of 1000 seed weight of 1st harvest (Appendix XVI and Figure 45). The maximum 1000-seed

weight at 1st harvest (23.35 g) was obtained from the M_1 and the minimum 1000-seed weight at 1st harvest (22.37 g) was obtained from the M_3.

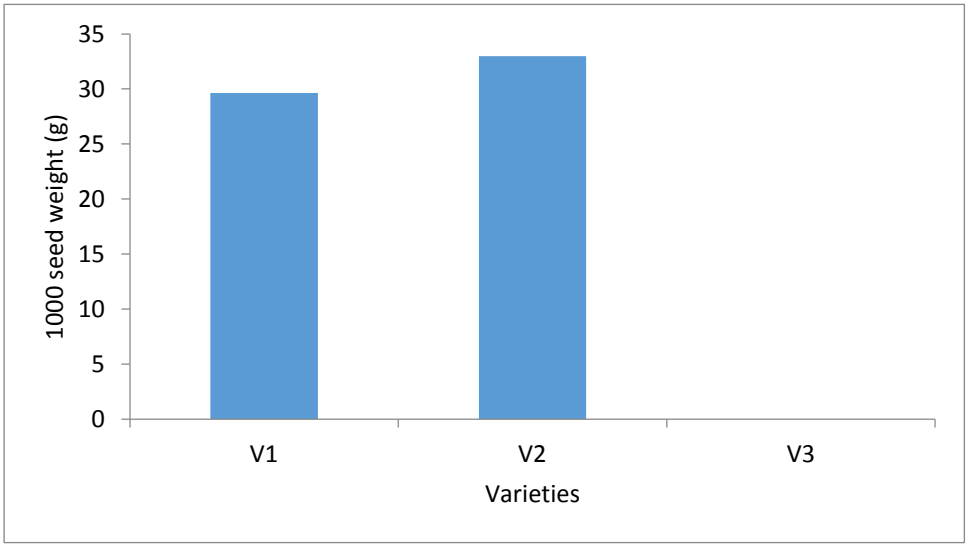
4.22.3 Interaction effect of variety and management packages

Interaction effect between variety and management packages was found significant in respect of 1000-seed weight at 1st harvest (Appendix XVI and Table 13). The maximum 1000-seed weight at 1st harvest (35.48 g) was obtained from V_2M_1. As there was no flower in V_3 treatment, there was no seed weight data found from V_3M_1, V_3M_2 and V_3M_3 interactions.

4.23 1000 seed weight at last harvest

4.23.1 Effect of variety

The 1000-seed weight at last harvest was not significantly influenced by the variety (Appendix XVI and Figure 46). The numerically maximum 1000-seed weight at last harvest (32.97 g) was obtained from V_2 and the minimum 1000-seed weight at last harvest (29.64 g) was obtained from V_1. As there was no flower in V_3, seed weight data for V_3 was not available.

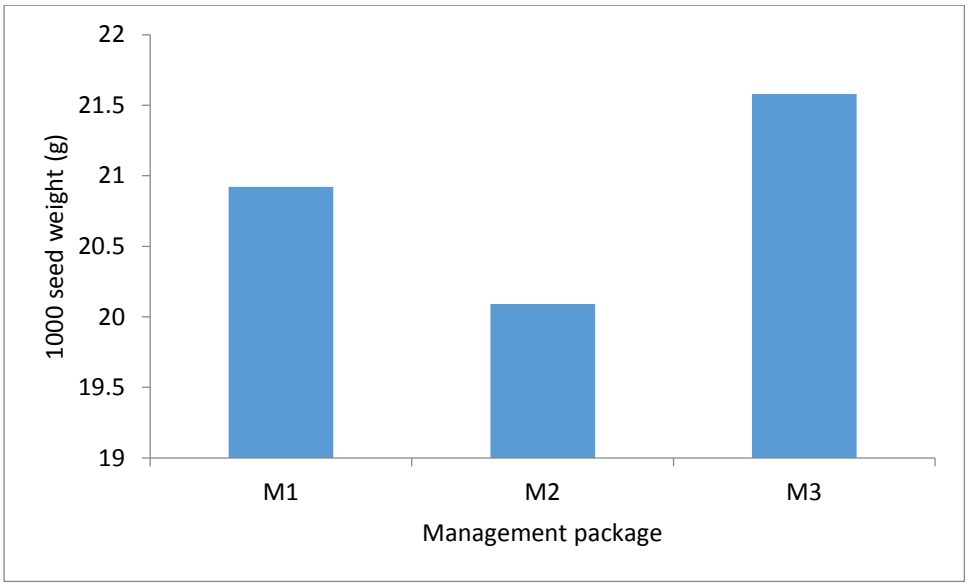


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 46: Effect of variety on 1000 seed weight at last harvest of blackgram.

4.23.2 Effect of management packages

There was non-significant variation observed among the management package in respect of 1000 seed weight of last harvest (Appendix XVI and Figure 47). The maximum 1000-seed weight at last harvest (21.58 g) was obtained from the M_3 and the minimum 1000-seed weight at last harvest (20.09 g) was obtained from the M_2.



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 47: Effect of management packages on 1000-seed weight at last harvest of blackgram.

4.23.3 Interaction effect of variety and management packages

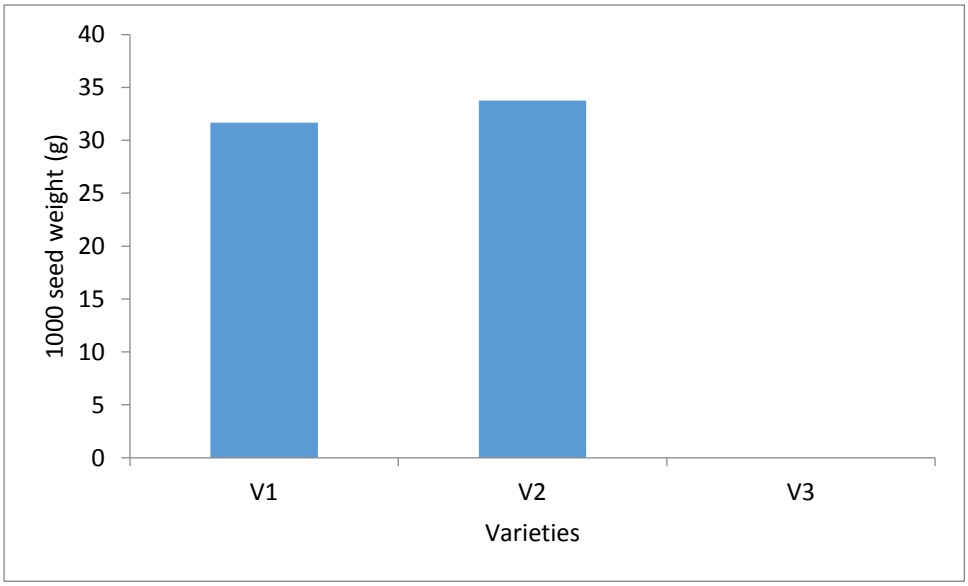
Interaction effect between variety and management packages was found significant in respect of 1000-seed weight at last harvest (Appendix XVI and Table 13). The maximum 1000-seed weight at last harvest (34.59 g) was obtained from V_2M_3 which was statistically similar with V_2M_1 and V_2M_2 interactions. The minimum 1000-seed weight at last harvest (28.46 g) was obtained from V_1M_2. As there was no flower in V_3 treatment, there was no seed weight data found from V_3M_1, V_3M_2 and V_3M_3 interactions.

4.24 Average 1000 seed weight

4.24.1 Effect of variety

The average 1000-seed weight was not significantly influenced by the variety (Figure 48). The numerically maximum 1000-seed weight (33.74 g) was obtained from V_2 and the

minimum 1000-seed weight (31.65 g) was obtained from V_1. As there was no flower in V_3, seed weight data for V_3 was not available. The variation in 1000-seed weight between the varieties might be due to genetic constituents of the crop. The result of the present investigation was similar with the studies conducted by Thakuria and Shaharia (1990); Trung and Yoshida (1983); Sarkar and Banik (1991); Sardana and Verma (1987); Raj and Tripathi (2005); Katial and Shah (1998) and Ghosh (2007). They opined that 1000-seed weight was differed significantly among the mungbean varieties.

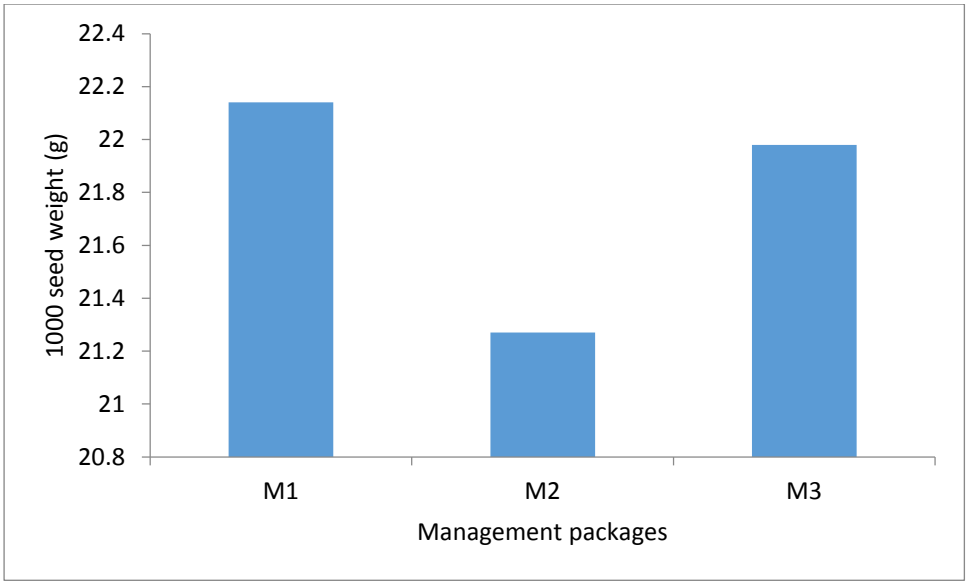


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 48: Effect of variety on average 1000 seed weight of blackgram.

4.24.2 Effect of management packages

There was not significant variation observed among the management package in respect of average 1000 seed weight (Appendix XVI and Figure 49). The maximum 1000-seed weight (22.14 g) was obtained from the M_1 and the minimum 1000-seed weight (21.27 g) was obtained from the M_2.



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 49: Effect of management packages on average 1000-seed weight of blackgram.

4.24.3 Interaction effect of variety and management packages

Interaction effect between variety and management packages was found significant in respect of average 1000-seed weight (Appendix XVI and Table 13). The highest 1000-seed weight (34.65 g) was obtained from V_2M_3 which was statistically similar with V_2M_1 treatment. The lowest 1000-seed weight (31.23 g) was obtained from V_1M_2 that similar to V_1M_3, V_1M_1 andV_2M_2. As there was no flower in V_3 treatment, there was no seed weight data available from V_3M_1, V_3M_2 and V_3M_3 interactions.

Table 13: Interaction effect of variety and management packages on 1000-seed weight of blackgram

Treatment combination	1000-seed weight (g)		
	1st harvest	Last harvest	Average
V1M1	34.56 a	30.29 bc	32.42 b
V1M2	34.01 a	28.46 c	31.23 b
V1M3	32.38 a	30.17 bc	31.28 b
V2M1	35.48 a	32.48 ab	33.98 a
V2M2	33.33 a	31.82 a-c	32.57 b
V2M3	34.72 a	34.59 a	34.65 a
V3M1	0.00 b	0.00 d	0.00 c
V3M2	0.00 b	0.00 d	0.00 c
V3M3	0.00 b	0.00 d	0.00 c
LSD (0.05)	3.23	3.48	1.99
CV (%)	7.98	9.37	5.15

In a column means having similar letter(s) are statistically similar

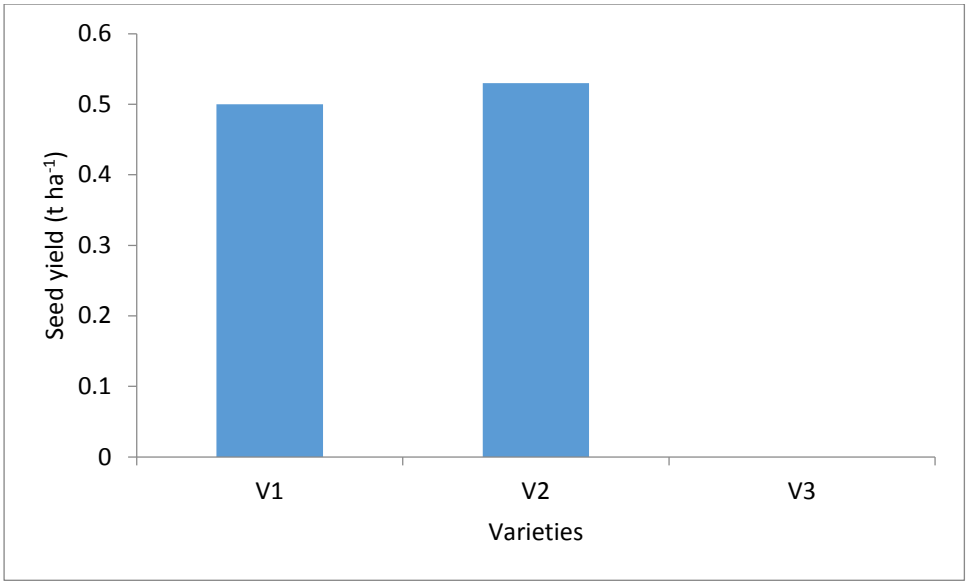
NS = Not significant, CV = Coefficient of variation, LSD $_{(0.05)}$ = Least significant difference at 5% level, DAS = Days after sowing, V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

M_1 = Low management, M_2 = Medium management and M_3 = High management

4.25 Seed yield at 1st harvest

4.25.1 Effect of variety

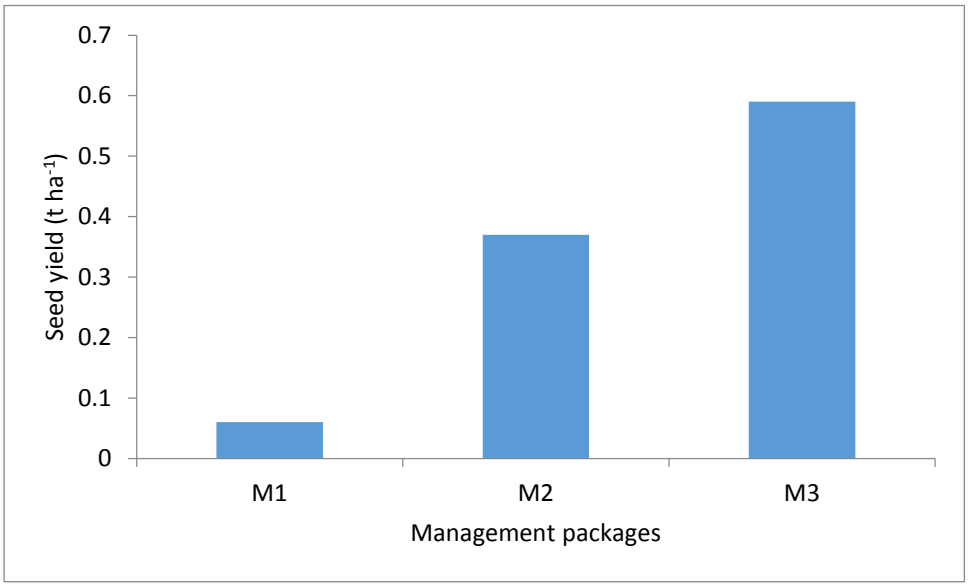
The seed yield at 1st harvest was significantly influenced by the variety (Appendix XIV and Figure 50). The V_2 produced highest seed yield at 1st harvest (0.53 t ha^{-1}) and the V_1 produced lowest seed yield at 1st harvest (0.5t ha^{-1}). As there was no flower in V_3, yield data for V_3 was not available.



V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 50: Effect of variety on seed yield at 1st harvest of blackgram (LSD $_{(0.05)}$ = 0.28).

4.25.2 Effect of management packages



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 51: Effect of management packages on seed yield at 1st harvest of blackgram (LSD $_{(0.05)}$ = 0.23).

Management packages showed significant effect on the seed yield at 1st harvest (Appendix XIV and Figure 51). The highest seed yield was recorded from the M_3 (0.59 t ha^{-1}) and the lowest seed yield was recorded from M_1 (0.06t ha^{-1}) at 1st harvest.

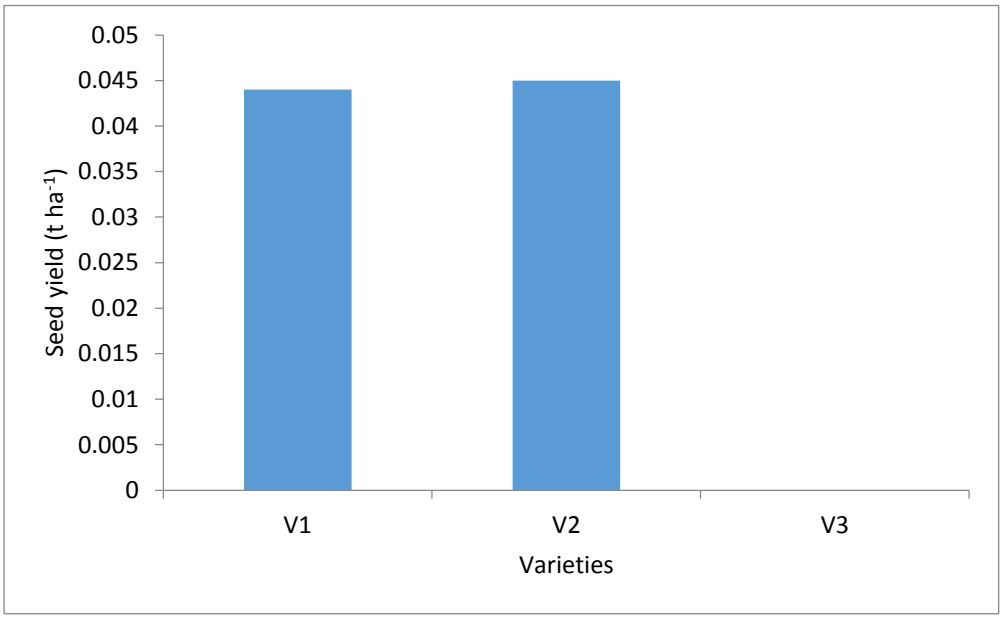
4.25.3 Interaction effect of variety and management packages

The seed yield was significantly influenced by the interaction effect of variety and management packages (Appendix XIV and Table 14). The highest seed yield at 1st harvest (1.01t ha^{-1}) was obtained from the V_2M_3 which was similar with V_1M_3 and V_1M_2 treatment. The lowest seed yield at 1st harvest (0.07t ha^{-1}) was obtained from V_1M_1 which shown similarity with the interaction of V_2M_1. As there was no flower in V_3 treatment, there was no yield data available from V_3M_1, V_3M_2 and V_3M_3 interactions.

4.26 Seed yield at last harvest

4.26.1 Effect of variety

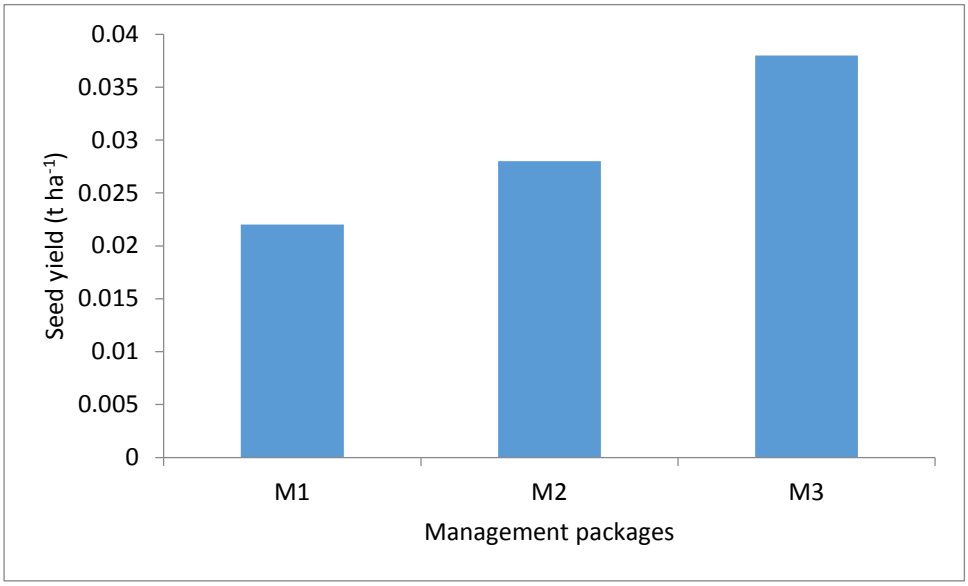
The seed yield at last harvest was significantly influenced by the variety (Appendix XIV Figure 52). The V_2 produced highest seed yield at last harvest (0.045 t ha^{-1}) and the V_1 produced lowest seed yield at last harvest (0.044t ha^{-1}). As there was no flower in V_3, yield data for V_3 was not available.



V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 52: Effect of variety on seed yield at last harvest of blackgram (LSD $_{(0.05)}$ = 0.02).

4.26.2 Effect of management packages



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 53: . Effect of management packages on seed yield at last harvest of blackgram ($LSD_{(0.05)}$ = 0.021)

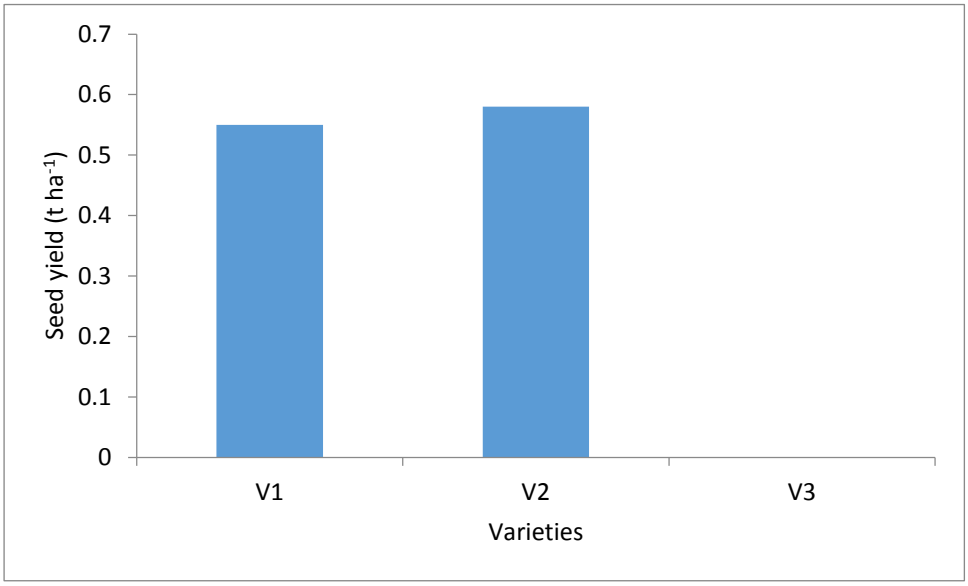
Management packages showed non-significant effect on the seed yield at last harvest (Appendix XIV and Figure 53). The maximum seed yield was recorded from the M_3 (0.038t ha^{-1}) and the minimum seed yield was recorded from M_1 (0.022 t ha^{-1}) at last harvest.

4.26.3 Interaction effect of variety and management packages

The seed yield was significantly influenced by the interaction effect of variety and management packages (Appendix XIV and Table 14). The highest seed yield data last harvest (0.07t ha^{-1}) was obtained from the V_1M_3 which was similar with V_2M_2, V_2M_3 and V_2M_1 treatment. The lowest seed yield at last harvest (0.029t ha^{-1}) was obtained from V_1M_2 which shown similarity with all the interaction except V_1M_3.As there was no flower in V_3 treatment, there was no yield data found from V_3M_1,V_3M_2 and V_3M_3 interactions.

4.27 Total seed yield

4.27.1 Effect of variety



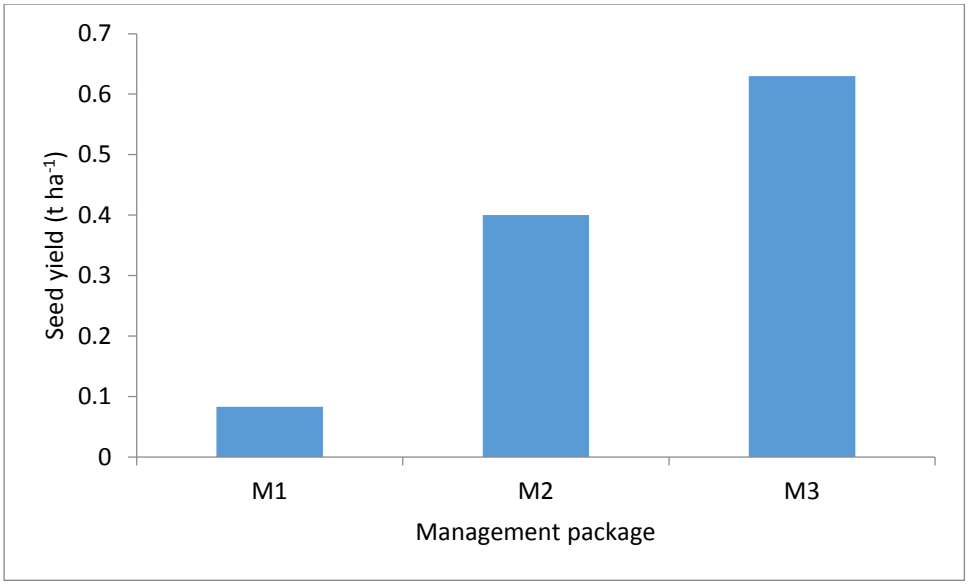
V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 54: Effect of variety on total seed yield of blackgram (LSD $_{(0.05)}$ = 0.29)

The total seed yield was significantly influenced by the variety (Appendix XIV and Figure 54). The V_2 produced highest seed yield (0.58t ha^{-1}) and the V_1 produced lowest seed yield (0.55 t ha^{-1}). As there was no flower in V_3, yield data for V_3 was not available.

4.27.2 Effect of management packages

Management packages showed significant effect on the total seed yield (Appendix XIV and Figure 55). The highest seed yield was recorded from the M_3 (0.63t ha^{-1}) and the lowest seed yield was recorded from M_1 (0.083 t ha^{-1}). Lower management reduced 86.83% yield of blackgram as compared to higher management.



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 55: Effect of management packages on total seed yield of blackgram (LSD $_{(0.05)}$ = 0.24).

4.27.3 Interaction effect of variety and management packages

The total seed yield was significantly influenced by the interaction effect of variety and management packages (Appendix XIV and Table 14). The highest seed yield (1.06t ha^{-1}) was obtained from the V_2M_3 which was similar with V_1M_3 and V_1M_2 treatment. The lowest number of seed yield (0.10t ha^{-1}) was obtained from V_1M_1 which was similarity with V_2M_1. As there was no flower in V_3 treatment, there was no yield data found from V_3M_1, V_3M_2 and V_3M_3 interactions.

Table 14: Interaction effect of variety and management packages on seed yield of blackgram

Treatment combination	Seed yield (t ha^{-1}) at		
	1st harvest	Last harvest	Total
V1M1	0.07 d	0.032 b	0.10 d
V1M2	0.65 ab	0.029 b	0.69 ab
V1M3	0.78 ab	0.07 a	0.85 ab
V2M1	0.11 cd	0.035 ab	0.15 cd
V2M2	0.47 bc	0.056 ab	0.53 bc
V2M3	1.01 a	0.046 ab	1.06 a
V3M1	0.00 d	0.00 c	0.00 d
V3M2	0.00 d	0.00 c	0.00 d
V3M3	0.00 d	0.00 c	0.00 d
$LSD_{(0.05)}$	0.39	0.036	0.42
CV (%)	65.76	66.66	63.1

In a column means having similar letter(s) are statistically similar

NS = Not significant, CV = Coefficient of variation, $LSD_{(0.05)}$ = Least significant difference at 5% level,

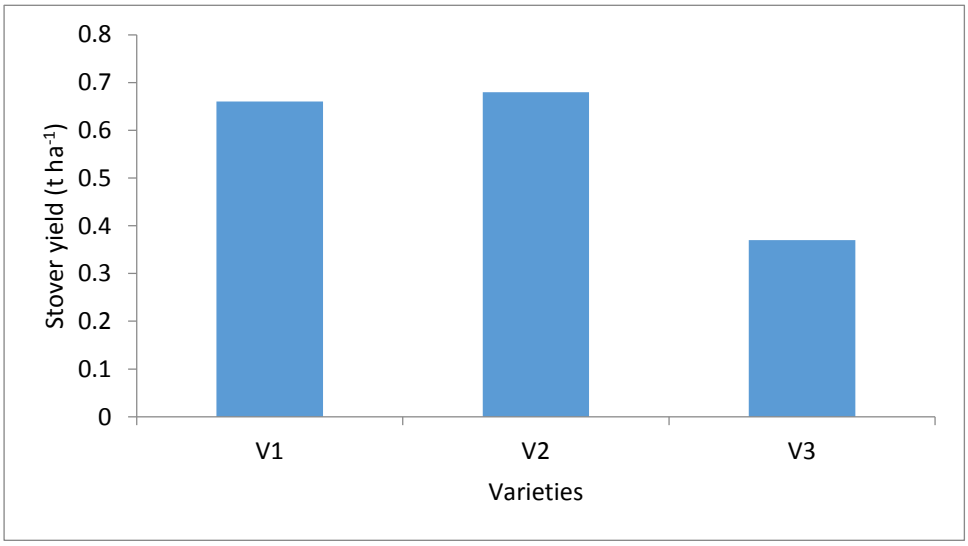
DAS = Days after sowing, V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

M_1 = Low management, M_2 = Medium management and M_3 = High management

4.28 Stover yield

4.28.1 Effect of Variety

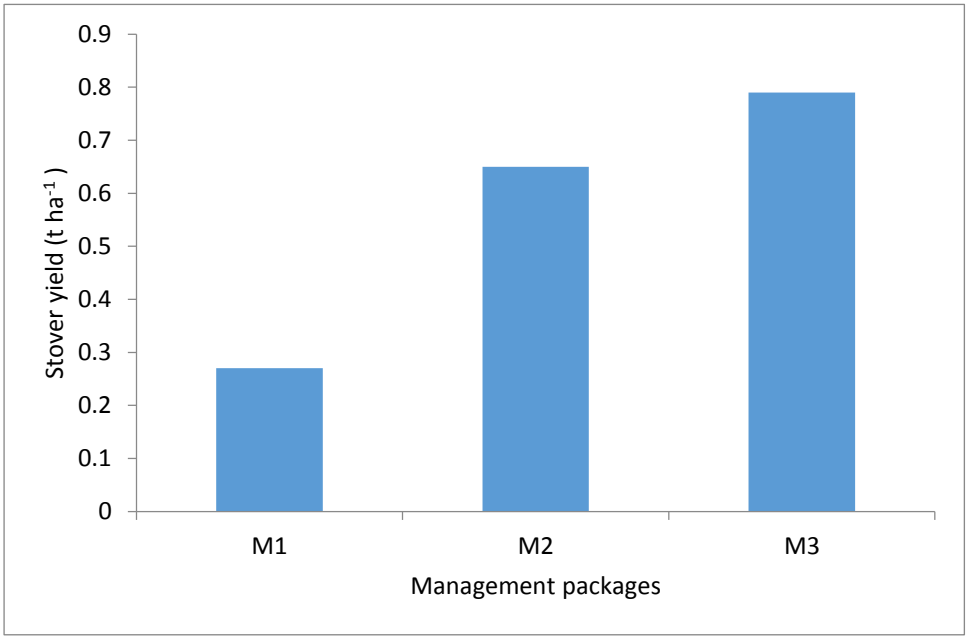
Stover yield was not significantly influenced by the variety (Appendix XVII and Figure 56). The numerically maximum stover yield (0.68 t ha^{-1}) was obtained from the V_2 which showed similarity with V_1 compared to the yield (0.37 t ha^{-1}) of V_3. The V_2 gave 9.02 % higher yield than the V_3. Bhati *et al*. (2005) reported that mungbean cv. PDM-54 showed 13.7% higher fodder yield than the local cultivar.



V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 56: Effect of variety on stover yield of blackgram.

4.28.2 Effect of management packages



M_1 = Low management, M_2 = Medium management and M_3 = High management

Figure 57: Effect of management packages on stover yield of blackgram(LSD $_{(0.05)}$ = 0.20).

Management packages had significant effect on stover yield (Appendix XVII and Figure 57). The M_3 produced significantly the highest stover yield (0.79 t ha^{-1}) which was similar to M_3. The lowest stover yield (0.27 t ha^{-1}) was obtained from M_1.

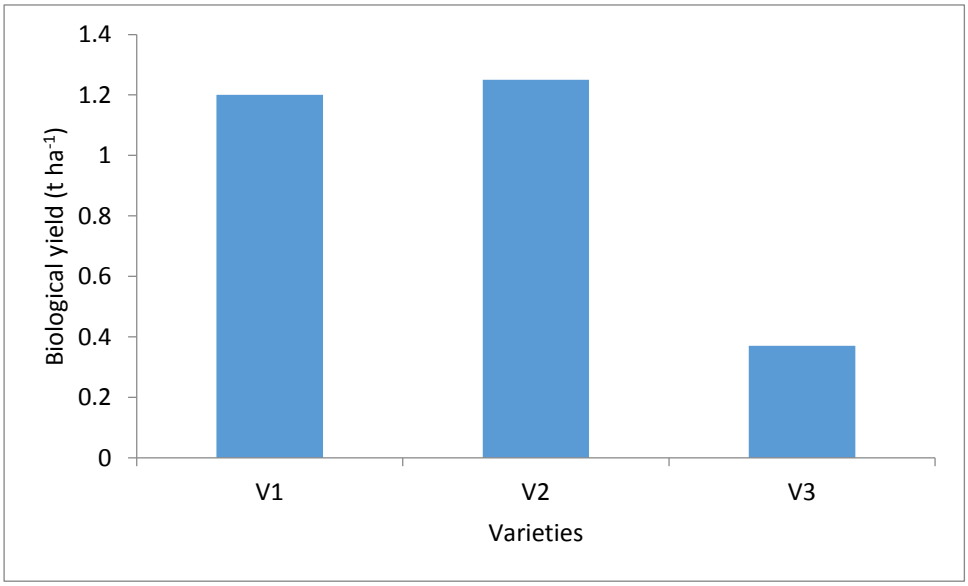
4.28.3 Interaction effect of variety and management packages

Interaction effect between variety and management packages was found significant in respect of stover yield (Appendix XVII and Table 15). The highest stover yield (0.98 t ha^{-1}) was obtained from V_2M_3. The lowest stover yield (0.26 t ha^{-1}) was obtained from V_3M_1 interaction.

4.29 Biological yield

4.29.1 Effect of Variety

The biological yield was significantly influenced by the variety (Figure 58). The highest biological yield (1.25 t ha^{-1}) was obtained from the V_2 which similar with V_1 whereas the lowest biological yield (0.37 t ha^{-1}) was obtained from V_3.

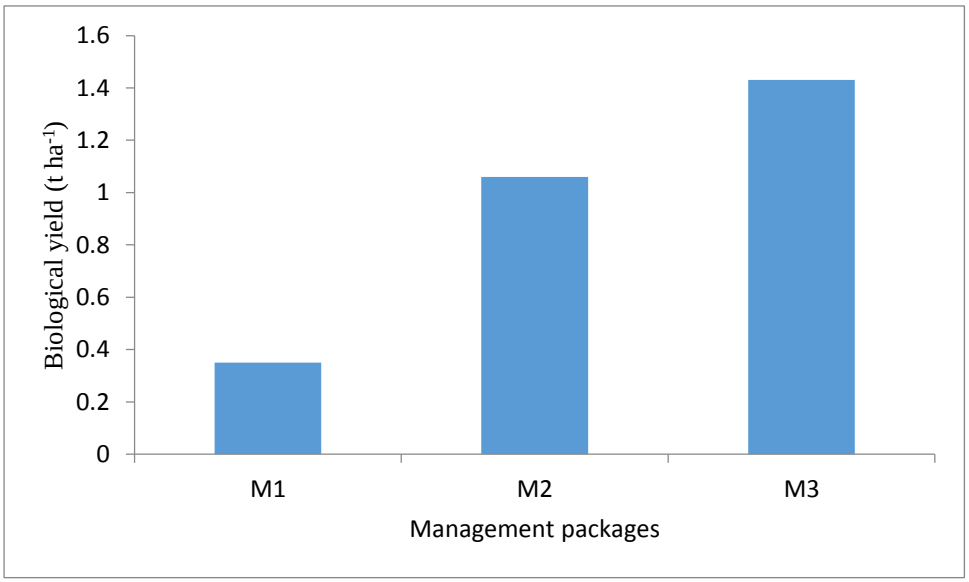


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 58: Effect of variety on biological yield of blackgram ($LSD_{(0.05)}$ = 0.52)

4.29.2 Effect of management packages

Management packages had significant effect on biological yield (Appendix XVII and Figure 59). The M_3 produced significantly the highest biological yield (1.43 t ha^{-1}) over the treatment M_1 (0.35 t ha^{-1}).



M_1 =Low management, M_2 = Medium management and M_3 = High management

Figure 59: Effect of management packages on biological yield of blackgram **(**LSD $_{(0.05)}$ = 0.30).

4.29.3 Interaction effect of variety and management packages

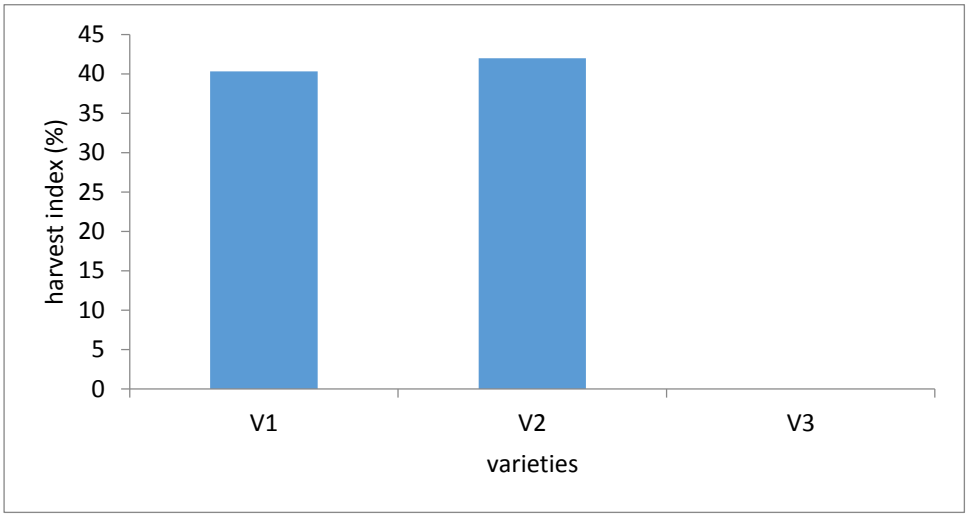
Interaction effect between variety and management packages was found significant in respect of biological yield (Appendix XVII and Table 15). The highest biological yield (2.04 t ha^{-1}) was obtained from V_2M_3, which was similar to the interaction of V_1M_3. The lowest biological yield (0.26 t ha^{-1}) was obtained from V_3M_1 which was similar to the interactions with V_1M_1, V_3M_3, V_3M_2, V_2M_1 and V_3M_2.

4.30 Harvest index

4.30.1 Effect of variety

Harvest index was significantly influenced by variety (Figure 60). The highest harvest index (41.98%) was found from the V_2 and the lowest harvest index (40.31%) was found from the V_1. As there was no flower in V_3, harvest index data for V_3 was not available. The result was agreed with the findings of Aguliar and Villarea (1989) and Ghosh

(2007) who reported that the harvest index of mungbean was significantly influenced by the variety.

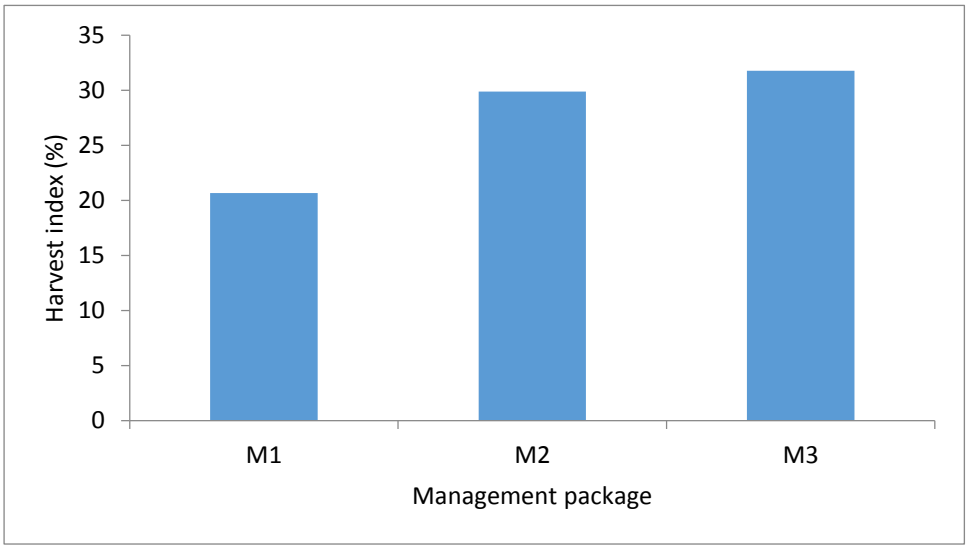


V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

Figure 60: Effect of variety on harvest index of blackgram (LSD $_{(0.05)}$ = 11.74)

4.30.2 Effect of management packages

Management packages had significant effect on harvest index (Appendix XVII and Figure 61). The highest harvest index (31.75%) was obtained from M_3. The lowest harvest index (20.65%) was obtained from M_1 treatment.



M_1 = Low management, M_2 =Medium management and M_3=High management

Figure 61: Effect of management packages on harvest index of blackgram(LSD $_{(0.05)}$ = 10.41).

4.30.3 Interaction effect of variety and management packages

Interaction effect between variety and management packages was found significant in respect of harvest index (Appendix XVII and Table 15). The highest harvest index (49.75%) was obtained from V_2M_3 which was similar to all the interactions except V_1M_1. The lowest harvest index (28.84%) was obtained from the V_1 with the interaction of M_1. As there was no flower in V_3 treatment, there was no harvest index available for V_3M_1, V_3M_2 and V_3M_3 interactions.

Table 15: Interaction effect of variety and management packages on yield characters of blackgram

Treatment combination	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
V1M1	0.27 c	0.35 c	28.84 b
V1M2	0.75 ab	1.44 b	46.57 ab
V1M3	0.97 a	1.82 ab	45.51 ab
V2M1	0.28 c	0.43 c	33.10 ab
V2M2	0.76 ab	1.29 b	43.07 ab
V2M3	0.98 a	2.04 a	49.75 a
V3M1	0.26 c	0.26 c	0.00 c
V3M2	0.44 bc	0.44 c	0.00 c
V3M3	0.42 bc	0.42 c	0.00 c
LSD $_{(0.05)}$	0.35	0.53	18.02
CV (%)	34.19	31.38	36.93

In a column means having similar letter(s) are statistically similar

NS = Not significant, CV = Coefficient of variation, LSD $_{(0.05)}$ = Least significant difference at 5% level,

DAS = Days after sowing, V_1 = BARI mash-3, V_2 = BARI mash-2, V_3 = BINA mash-1

M_1 = Low management, M_2 =Medium management and M_3 = High management

CHAPTER V

SUMMARY AND CONCLUSION

The field experiment was conducted at the Agronomy farm of Sher-e-Bangla Agricultural University (SAU), Dhaka, during the period from March 2017 to June 2017 to study the influence of management packages on growth and yield of three blackgram varieties in Kharif-1 season under the Modhupur Tract (AEZ-28). The treatment of the experiment consists of three varieties viz. BARI mash-3, BARI mash-2 and BINA mash-1 and three management packages viz. Low management (M_1), Medium management (M_2) and High management (M_3). The experiment was laid out in Split-plot design following the principles of randomization with three replications. Variety was placed in the main plot and management packages were placed in the sub plot. Data on different growth stage, yield contributing characters and yield were recorded and statistically significant variation was observed for different treatment. The sowing date was on March 17, 2017.

The data on growth parameters viz. plant emergence was recorded at 4-7 DAS where Plant height, number of leaves plant^{-1}, dry matter plant^{-1} were recorded during the period from 15 DAS to harvest. Number of nodules plant^{-1} and dry weight of nodules plant^{-1} were recorded once at maximum vegetative stage. Yield contributing characters and yield parameters like number of branches plant^{-1}, number of pods plant^{-1} at 1st harvest, number of pods plant^{-1} at last harvest, number of total pods plant^{-1}, number of seeds pod^{-1} at 1st harvest, number of seeds pod^{-1} at last harvest, pod length at 1st harvest, pod length at last harvest, 1000-seed weight at 1st harvest and 1000-seed weight at last harvest were recorded. Germination percentage was recorded upto hundred percent germination from 1m^2 area. Five plants were randomly selected from each unit plot for taking observations on plant height, number of leaflets plant^{-1} and number of branches plant^{-1} with 15 days interval at 15, 30, 45 days after sowing and at harvest. Pods plant^{-1}, pod length and number of seeds pod^{-1} were recorded from the selected plants. Number of nodules plant^{-1}, dry weight of nodules and dry weight of plants were taken from 30 DAS upto harvest. Central four lines from each plot were harvested for economic yield, biological yield and harvest index (%). Thousand seed weight was measured from sampled seed. Data were analyzed using cropstat package. The mean differences among the treatments were compared by least significant difference (LSD) test at 5% level of significance. Data on different growth parameters, yield attributes and yield were significantly varied for different treatments. In

case of variety, at 4, 5, 6 and 7 DAS, maximum seedling emergence (33.44, 47.00, 21.44 and 6.44 %,respectively) was recorded from V_2,V_3,$V_2$and V_1 respectively and the lowest (30.56, 40.89, 15.44 and 4.33 %, respectively) was found from V_1 ,V_2,V_3 and V_2. Plant height of BARI mash-2 was higher (11.01, 31.74 and 53.54 cm respectively) at 15, 30 and 45 DAS, but at harvest plant height was higher (87.06 cm) in BINA mash-1. At 15, 45 DAS and harvest maximum number of leaflets plant^{-1} (5.00, 30.95 and 45.66 respectively) was recorded from V_1 (BARI mash-3) but at 30 DAS maximum number of leaflets plant^{-1} (19.89) and minimum number of leaflets plant^{-1} (4.07, 16.89, 29.68 and 38.73 respectively) was recorded from BINA mash-1. At 45 DAS and harvest, the maximum number of branches plant^{-1} (1.89 and 2.22 respectively) was found from V_1 (BARI mash-3).At 17, 40 DAS and harvest, the higher dry matter content plant^{-1} (0.17, 2.40 and 7.06g respectively) was found from V_2 (BARI mash-2) and the lower dry weight plant^{-1} (0.12, 1.71 and 6.55g respectively) was found from V_3 (BINA mash-1). At 45 DAS and harvest, the higher number of weeds (35.67 and 27.67 m^{-2} respectively) was found from V_2 (BARI mash-2) and V_1 and the lower number of weeds (29.22 and 24.89 respectively) was found from V_3 (BINA mash-1). Maximum number of nodules plant^{-1} (15.13) was produced by V_2 (BARI mash-2) and minimum number of nodules plant^{-1} (11.38) was produced by V_1 (BARI mash-3). Same trend was observed for nodule dry weight plant^{-1}. Here, maximum nodule weight (0.023 mg) was recorded from V_2 (BARI mash-2) and the minimum one (0.009 mg) was given by V_3 (BINA mash-1). At 45 DAS and harvest, the higher dry weight of weeds (12.18 and 29.18 respectively) was found from V_3 and V_2. At 45 DAS and harvest the lower dry weight of weeds (9.53 and 22.99 respectively) was found from $V_1$and V_3. The highest total pods plant^{-1} (20.95) was recorded in V_1whereas the lowest total pods plant^{-1} (18.98) was recorded in V_1 but as there was no flower in V_3, yield data was not available. The longest pod length (4.01) was found from V_1 and shortest pod length (4.00) was found from V_2. The maximum seed yield (0.58 t ha^{-1}) was obtained from treatment V_2 and the minimum seed yield (0.55 t ha^{-1}) was obtained from treatment V_1. The maximum 1000-seed weight (33.74 g) was recorded from $V_2$and the minimum 1000-seed weight (31.65 g) was recorded from V_1. The highest harvest index (41.98) was obtained from V_2.

For management package, at 6 and 7 DAS, maximum emergence percentage (35.11 and 9.67%, respectively) was recorded from M_1 and the lowest (9.56 and 2.67 %, respectively) was found from M_2. At 30 and 45 DAS, plant height was highest (30.05 and 52.41 cm,

respectively) in M_1 and lowest (28.66 and 50.38 cm, respectively) in M_3. But at harvest, plant height was highest (79.39 cm) in M_3 and lower (69.90 cm) in M_2. At 15, 30, 45 DAS and at harvest, maximum number of leaflets plant^{-1} (4.82, 22.22, 32.40 and 52.13 respectively) was recorded from M_3 and minimum number of leaflets plant^{-1} (4.38, 14.55, 28.13 and 26.73 respectively) was recorded from M_1. At 30, 45 DAS and harvest, the maximum number of branches plant^{-1} (1.89, 2.44 and 3.00 respectively) was found from M_3 and the minimum number of branches plant^{-1} (0, 0.11 and 1.11) was found from M_1. At 45 DAS and harvest, the highest dry weight of weeds (23.7g and 24.13g respectively) was found from M_1. At 45 DAS and harvest, the highest number of weeds (50.11 and 40.22 respectively) was found from M_1. Maximum number of nodules plant^{-1} (14.69) was produced from M_2 and minimum number of nodules plant^{-1} (11.67) was produced by M_3. Same trend was observed for nodule dry weight plant^{-1}. Here, maximum nodule weight (0.019 mg) was recorded from M_2 and the minimum one (0.01 mg) was given by M_1. At 17, 40 DAS and harvest, the highest dry weight plant^{-1} (0.15g, 2.80g and 8.95g respectively) was found from M_3 while the lowest dry weight plant^{-1} (0.14g, 1.32g and 4.00g) was found from M_1. The highest pods plant^{-1} (17.28) was recorded in M_2 whereas the lowest total pods plant^{-1} (6.20) was recorded in M_1. The longest pod length (5.47 cm) was found from M_2 and shortest pod length (5.12) was found from M_1. The maximum seed yield (0.63 t ha^{-1}) was obtained from M_3 and the minimum seed yield (0.083 t ha^{-1}) was obtained from M_1. The maximum husk weight (0.25 g) was obtained from M_3 and the minimum (0.044 g) was obtained from treatment M_1. The maximum 1000-seed weight (22.24 g) was recorded by M_1 and the minimum 1000-seed weight (21.27 g) was recorded from M_2. The maximum harvest index (31.75) was recorded from M_3 and the minimum harvest index (20.65) was recorded from M_1.

Due to interaction effect of variety and management, at 6 and 7 DAS, maximum seedling emergence (43. 33 and 12.67 %, respectively) was recorded from V_2M_1 & V_1M_1 and the lowest (7.00 and 1.33 %, respectively) was found from V_3M_2 & V_2M_2. Plant height of V_2M_2 was highest (11.88 and 34.54 cm respectively) at 15 and 30 DAS, but at 45 DAS plant height was highest in V_2M_1 and V_3M_3. At harvest, maximum number of leaflets plant^{-1} (56.8) was recorded from V_2M_3 and minimum number of leaflets plant^{-1} (24.6) was recorded from V_3M_1. At 30, 45 DAS and harvest, the maximum number of branches plant^{-1} (2.33, 2.66 and 3.33 respectively) was found from V_3M_3 and the minimum number of branches plant^{-1} (0, 1.00 and 1.00 respectively) was found from both V_1M_1 and V_1M_3.

At 45 DAS and harvest, the highest dry weight of weeds (27.63g and 49.24g) was found from V_3M_1 and V_2M_1 respectively and the lowest dry weight of weeds (0.62 and 4.90) was found from V_2M_3 and V_1M_3 respectively. At 45 DAS and harvest, the highest number of weeds (56.33 and 48.00 respectively) was found from V_2M_1 and V_1M_1 and the lowest number of weeds (19.66 and 9.33 respectively) was found from V_3M_3. Maximum number of nodules plant^{-1} (18.33) was produced by V_2M_2 and minimum number of nodules plant^{-1} (9.73) was produced by V_1M_3. Same trend was observed for nodules dry weight plant^{-1}. Here, maximum nodule weight (0.034 mg) was recorded from V_2M_2 and the minimum one (0.007 mg) was given by V_3M_2. At 40 DAS and harvest, the highest dry weight plant^{-1} (3.19 g and 10.40 g respectively) was found from V_1M_3 while at 15 DAS, the highest dry weight plant^{-1} (0.17g) was found from both V_2M_3 and V_2M_2 and at 15 and 40 DAS, the lowest dry weight plant^{-1} (0.11g and 1.14 g respectively) was found from V_3M_1 while at harvest, the lowest (3.11 g) in V_1M_1. The highest pods plant^{-1} (27.47) was recorded in V_1M_3 whereas the lowest total pods plant^{-1} (0.00) was recorded in V_3M_1, V_3M_2 and V_3M_3. The longest pod length (8.32 cm) was found from V_1M_3 and shortest pod length (0.00) was found from V_3M_1, V_3M_1 and V_3M_3 due to no flowering of V_3 variety. The maximum seeds pod^{-1} (5.85) was obtained from treatment V_1M_3 and the minimum seedspod^{-1} (0.00) was obtained from treatment V_3M_1, V_3M_2 and V_3M_3. The maximum seed weight (1.06 t ha^{-1}) was obtained from treatment V_2M_3 and the minimum (0.00 t ha^{-1}) was obtained from treatment V_3M_1, V_3M_2 and V_3M_3. The maximum husk weight (0.74 g) was obtained from treatment V_2M_1 and the minimum (0.00 g) was obtained from treatment V_3M_1, V_3M_2 and V_3M_3. The maximum 1000-seed weight (34.65 g) was recorded from V_2M_3 and the minimum 1000-seed weight (0.00 g) was recorded by V_3M_1, V_3M_2 and V_3M_3. The maximum harvest index (49.75) was recorded from V_2M_3 and the minimum harvest index (0) was recorded from V_3M_1, V_3M_2 and V_3M_3.

Considering the findings of the present experiment, following conclusions may be drawn:

- The blackgram variety, BARI mash-2 showed higher yield than other variety.
- The high management showed maximum growth and yield in blackgram. Lower management reduced 86.83% yield of blackgram.
- BARI mash-2 along with high management could be the better production package for maximum growth and yield of blackgram.

Before recommendation of variety and management packages to optimize blackgram production further study is needed in different agro-ecological zones of Bangladesh for regional adaptability.

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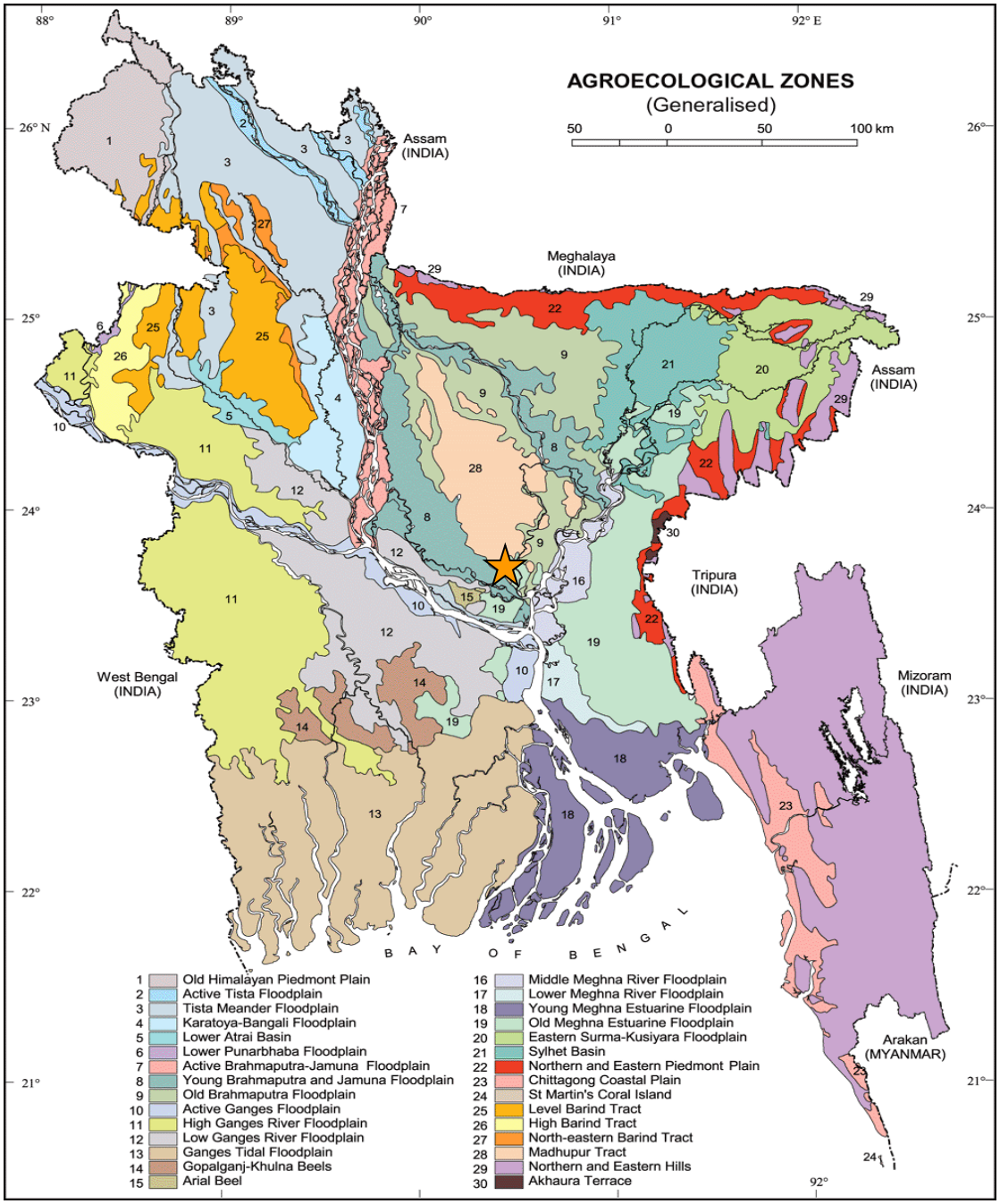
APPENDICES

Appendix I. Map showing the experimental sites under study



★ **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 Research Farm, Dhaka
AEZ	AEZ-28, Modhupur Tract
General Soil Type	Deep 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 characters	**Value**
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total nitrogen (%)	0.03
Available P (ppm)	20.54
Exchangeable K (me/100 g soil)	0.10

Source: Soil Resource and Development Institute (SRDI), Farmgate, Dhaka

Appendix III. Monthly average air temperature, relative humidity andtotal rainfall of the experimental site during the period from March to June, 2017

Month (2017)	*Air temperature (^{o}C)		*Relative humidity (%)	*Rainfall (mm)(total)
	Maximum	Minimum		
March	32	17	64	00
April	35.5	20.5	72	78
May	36.6	21.1	71	185
June	39.4	24.4	78	277

* Monthly average

Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka-1212

Appendix IV. Mean square values of emergence percentage of blackgram as influenced by variety and management packages

Source of variation	Degrees of freedom	Mean square			
		Emergence percentage at			
		4 DAS	5 DAS	6 DAS	7 DAS
Replication	2	676.778	323.148	29.3704	0.037037
Variety (A)	2	19.1111*	87.3704*	91.7037	10.4815
Error I	4	13.8889	12.4815	21.9259	6.03704
Management packages (B)	2	1099	700.704*	1756.26*	132.481*
Interaction (A×B)	4	60.7778*	206.537*	63.4815*	9.64815*
Error II	12	83.0175	114.759	63.6296	7.03704

* Significant at 5% level

Appendix V. Mean square values of plant height of blackgram as influenced by variety and management packages

Source of variation	Degrees of freedom	Mean square			
		Plant height at			
		15 DAS	30 DAS	45 DAS	Harvest
Replication	2	4.01219	68.8422	21.8717	104.634
Variety (A)	2	4.34908*	33.4416	38.7478*	1398.54*
Error I	4	0.726704	13.8653	8.33008	101.963
Management packages (B)	2	4.10366*	5.31498	9.72197	257.619
Interaction (A×B)	4	0.36617*	11.9779	14.2811*	248.851*
Error II	12	0.810889	19.283	9.48325	131.618

* Significant at 5% level

Appendix VI. Mean square values of number of leaflets plant^{-1} of blackgram as influenced by variety and management packages

Source of variation	Degrees of freedom	Mean square			
		Number of leaflets plant^{-1} at			
		15 DAS	30 DAS	45 DAS	Harvest
Replication	2	0.0844	2.7037	4.138	122.013
Variety (A)	2	2.44*	23.5926*	3.613	127.413
Error I	4	0.211	1.148	3.964	34.75
Management packages (B)	2	0.564	135.593*	41.013*	1803.69*
Interaction (A×B)	4	0.324*	8.537*	1.607*	30.973*
Error II	12	0.23	5.56	2.71	168.32

* Significant at 5% level

Appendix VII. Mean square values of number of branches plant^{-1} of blackgram as influenced by variety and management packages

Source of variation	Degrees of freedom	Mean square		
		Number of branches plant^{-1} at		
		30 DAS	45 DAS	Harvest
Replication	2	0.4815	0.259	0.7037
Variety (A)	2	1.148*	0.259	0.148
Error I	4	0.259	0.426	0.4259
Management packages (B)	2	8.037*	4.148*	8.259*
Interaction (A×B)	4	0.48148*	0.3148*	0.148*
Error II	12	0.222	0.259	0.241

* Significant at 5% level

Appendix VIII. Mean square values of dry matter content plant^{-1}of blackgram as influenced by variety and management packages

Source of variation	Degrees of freedom	Mean square		
		Dry matter content plant^{-1} at		
		15 DAS	40 DAS	Harvest
Replication	2	0.000267	0.468	16.64
Variety (A)	2	0.005258*	1.25	0.784
Error I	4	0.001027	0.520	11.125
Management packages (B)	2	0.000821	5.096*	59.64*
Interaction (A×B)	4	0.00004	0.154*	6.724*
Error II	12	0.00044	0.289	12.224

* Significant at 5% level

Appendix IX. Mean square values of no. of nodules plant^{-1} and nodule dry weight of blackgram as influenced by variety and management packages

Source of variation	Degrees of freedom	Mean square	
		At 40 DAS	
		No. of nodules plant^{-1}	**Nodule dry weight plant^{-1}**
Replication	2	53.2326	0.000207
Variety (A)	2	33.0237	0.000487
Error I	4	23.1259	0.000161
Management packages (B)	2	21.0859	0.000137
Interaction (A×B)	4	10.7926	0.0000978*
Error II	12	50.9037	0.0000802

* Significant at 5% level

Appendix X. Mean square values of no. of weed and weeds dry weight of blackgram as influenced by variety and management packages

Source of variation	Degrees of freedom	Mean square			
		Number of weed at		Dry weight of weed	
		45 DAS	Harvest	45 DAS	Harvest
Replication	2	945.593	127.37	115.63	296.236
Variety(A)	2	111.37	23.148	20.4215	86.7969
Error I	4	100.648	150.259	116.026	64.3137
Management packages (B)	2	1963.59*	1807.82*	1253.58*	2821.84*
Interaction (A×B)	4	40.9815*	154.37*	16.9928*	133.131*
Error II	12	95.1296	253.407	127.517	332.042

*Significant at 5% level of significance

Appendix XI. Mean square values of number of pods plant^{-1} of blackgram as influenced by variety and management packages

Source of variation	Degrees of freedom	Mean square		
		Number of pods plant^{-1} at		
		1st harvest	Last harvest	Total
Replication	2	0.4548	14.71	19.41
Variety(A)	2	721.699*	68.73*	1204.8*
Error I	4	7.98	4.525	9.47
Management packages (B)	2	216.206*	18.51*	342.938*
Interaction (A×B)	4	62.79*	20.43*	93.22*
Error II	12	27.75	5.74	25.86

*Significant at 5% level of significance

Appendix XII. Mean square values of number of seeds pod^{-1} of blackgram as influenced by variety and management packages

Source of variation	Degrees of freedom	Mean square		
		Number of seeds pod^{-1} at		
		1st harvest	Last harvest	Average
Replication	2	0.0459	0.6114	0.117
Variety(A)	2	97.34*	70.51*	83.38*
Error I	4	0.1048	0.3298	0.038
Management packages (B)	2	0.04148	0.3448	0.039
Interaction (A×B)	4	0.3737*	0.638*	0.46*
Error II	12	0.1657	0.317	0.218

*Significant at 5% level of significance

Appendix XIII. Mean square values of pod length of blackgram as influenced by variety and management packages

Source of variation	Degrees of freedom	Mean square		
		Pod length at		
		1st harvest	Last harvest	Average
Replication	2	0.052	0.133	0.045
Variety(A)	2	52.23*	44.18*	48.11*
Error I	4	0.0513	0.077	0.014
Management packages (B)	2	0.0664*	0.1179*	0.082*
Interaction (A×B)	4	0.0743*	0.089*	0.057*
Error II	12	0.0258	0.029	0.021

*Significant at 5% level of significance

Appendix XIV. Mean square values of seed weight of blackgram as influenced by variety and management packages

Source of variation	Degrees of freedom	Mean square		
		Seed weight at		
		1st harvest	Last harvest	Total
Replication	2	0.133	0.0047	0.145
Variety(A)	2	0.806*	0.006*	0.952*
Error I	4	0.046	0.00016	0.047
Management packages (B)	2	0.654*	0.00059	0.693*
Interaction (A×B)	4	0.195*	0.00064*	0.197*
Error II	12	0.05	0.00042	0.056

*Significant at 5% level of significance

Appendix XV. Mean square values of husk weight of blackgram as influenced by variety and management packages

Source of variation	Degrees of freedom	Mean square		
		Husk weight at		
		1st harvest	Last harvest	Total
Replication	2	0.0195	0.00028	0.022
Variety(A)	2	0.144*	0.0019*	0.179*
Error I	4	0.0098	0.000079	0.0098
Management packages (B)	2	0.098	0.000057	0.1034
Interaction (A×B)	4	0.027*	0.00023	0.027*
Error II	12	0.0082	0.00013	0.009

*Significant at 5% level of significance

Appendix XVI. Mean square values of weight of 1000-seeds of blackgram as influenced by variety and management packages

Source of variation	Degrees of freedom	Mean square		
		Weight of 1000-seeds at		
		1st harvest	Last harvest	Average
Replication	2	1.746	2.147	0.57
Variety(A)	2	3486.21*	2964.71*	3216.25*
Error I	4	0.577	6.39	1.877
Management packages (B)	2	2.658	5.042	1.909
Interaction (A×B)	4	2.369*	2.186*	1.411*
Error II	12	3.29	3.83	1.257

*Significant at 5% level of significance

Appendix XVII. Mean square values of stover yield, biological yield and harvest index of blackgram as influenced by variety and management packages

Source of variation	Degrees of freedom	Mean square		
		Stover yield	Biological yield	Harvest index
Replication	2	0.01186	0.091	103.545
Variety (A)	2	0.256	2.196*	5084.1*
Error I	4	0.068	0.157	80.53
Management packages (B)	2	0.664*	2.695*	318.24*
Interaction (A×B)	4	0.079*	0.512*	94.59*
Error II	12	0.038	0.087	102.64

*Significant at 5% level of significance