GROWTH AND YIELD OF MUNGBEAN AS AFFECTED BY MANAGEMENT PACKAGES

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CERTIFICATE

*This is to certify that the thesis entitled **"GROWTH AND YIELD OF MUNGBEAN AS AFFECTED BY MANAGEMENT PACKAGES"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (M.S.)** in **AGRONOMY,** embodies the results of a piece of bona fide research work carried out by **ANANYA BISWAS,** Registration No. **16-07530** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

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

Dated:

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DEDICATED

TO

MY BELOVED PARENTS

GROWTH AND YIELD OF MUNGBEAN AS AFFECTED BY MANAGEMENT PACKAGES

ABSTRACT

A field experiment was conducted to study the growth and yield of two mungbean varieties under different agronomic management packages at the central experimental farm, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh during March to June, 2017. Treatments consisted of three varieties: V_1= BARI Mung-6, V_2= BU mug 4, V_3=Binamoog-8; and three levels of management *i.e.* M_1= Low management (Fertilizer 0-0-0 NPK kg ha^{-1} + 40 kg seeds ha^{-1} in broadcasting + no pesticide application + no weeding), M_2= Medium management (Fertilizer 20-10-20 NPK kg ha^{-1} + 24 kg seeds ha^{-1} in line sowing (30 cm X Continuous) + pesticide application + one hand weeding), M_3= High management (Fertilizer 40-20-40 NPK kg ha^{-1} + 24 kg seeds ha^{-1} in line sowing + pesticide application + two hand weedings). Results revealed that vegetative growth and yield of mungbean was significantly influenced by different varieties and management practices where V_3 and M_3 gave the highest seed yield respectively. The highest seed yield 1190.10 kg ha^{-1} was obtained from the interaction treatment V_3M_3 due to the highest number of pods plant^{-1}, pod weight plant^{-1}, and 1000- seed weight. Medium fertilizer and one hand weeding of M_2 reduced 28.87% yield whereas no fertilizer application, no pesticide, no weeding and broadcasting sowing of M_1 reduced 87.34% yield. Therefore, it can be concluded that the application of higher management practices (high management= Fertilizer 40-20-40 NPK kg ha^{-1} + 24 kg seeds ha^{-1} in line sowing + pesticide application + two hand weedings) had a positive impact on different mungbean varieties.

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LIST OF ACRONYMS

AEZ	Agro-Ecological Zone
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
CV%	Percentage of coefficient of variance
cv.	Cultivar
DAE	Department of Agricultural Extension
DAS	Days after sowing
^0C	Degree Celsius
et al	And others
FAO	Food and Agriculture Organization
g	gram(s)
ha^{-1}	Per hectare
HI	Harvest Index
kg	Kilogram
mg	Milligram
MoP	Muriate of Potash
N	Nitrogen
No.	Number
NS	Not significant
%	Percent
SAU	Sher-e-Bangla Agricultural University
SRDI	Soil Resources and Development Institute
TSP	Triple Super Phosphate

Chapter 1
Introduction

CHAPTER I

INTRODUCTION

Bangladesh has climatic conditions favorable for growing a diverse array of crops including pulse. Many varieties of pulses are grown in different parts of Bangladesh. About 3.71 lakh hectare of land (9% of the net cropped area) of the country is devoted to pulse cultivation (BBS, 2016). Mungbean (*Vigna radiata L. Wilczek*) belongs to the family Fabaceae and it is an important pulse crop in Bangladesh covering an area of 162 thousand hectares of land with an annual production of 211 thousand metric ton. It is the second most important pulse crop in terms of area (42,559 ha) and production (36,954 t) but ranks the highest in consumer preference and total consumption (BBS, 2016). It is a crop of the tropics and sub-tropics which requires a warm temperature regime. The optimum temperature ranges from 20°- 35°C depending upon season.

Pulses are the most important protein source in the diet of majority people of Bangladesh. It contains about twice as much protein as cereals. It also contains amino acid isoleucine, leucine, lysine, valine etc. which are generally deficit in food grains (Islam *et al*., 2007). The green plants can also be used as animal feed and the residues as manure. It is the also best source of protein for domestic animals. Pluses contain a remarkable amount of minerals, vitamins, fats and carbohydrates. Generally, there is no complete dish without “dhal” in Bangladesh. Moreover, adding of legumes in cereal based cropping system can improve soil structure, nutrient exchange capacity and maintain healthy sustainable soil system. Grain legumes are believed to add 20-60 kg N ha^{-1} to the succeeding crop (Becker *et al*., 1995).

The major pulses grown in Bangladesh are: khesari (*Lathyrus sativus* L.), lentil (*Lens culinaris* Medic), chickpea (*Cicer arietinum* L.), blackgram (*Vigna mungo* L.), mungbean (*Vigna radiata* L.) and field pea (*Pisum sativum*). Among these khesari, lentil, chickpea and field pea are grown during winter season (November-March) and contribute about 82% of total pulses. Mungbean is grown both in early summer (March-June) and in late summer. In Bangladesh, among pulses, mungbean ranks 3rd in acreage and production and first in market price (BBS, 2013).

Traditionally, mungbean was grown in the winter season due to favorable agro-ecological condition of Bangladesh although it is now cultivated in both summer and winter seasons in many countries of the world. With the technological progress, most of the growers have shifted mungbean to the Kharif-1 season instead of winter (Bose, 1982).

FAO (1999) recommends a minimum pulse intake of 80 g head^{-1}day^{-1} whereas it is only 14.19 g in Bangladesh. This is because of fact that production of the pulses is not adequate to meet the national demand. The crop is potentially useful in improving cropping system as it can be grown as a cash crop due to its rapid growth and easily maturing characteristics. Moreover, pulse is considered as soil building crop as it has the remarkable quality of helping the symbiotic root *Rhizobia* to fix atmospheric nitrogen. The area under mungbean cultivation in Bangladesh in 2011-2012 was 91 thousand acres with a total production of 26 thousand tons (BBS, 2013). In Bangladesh, most of the mungbean area (~65%) is located in the southern part of the country where mungbean is fitted in T.aman rice - mungbean - fallow or Aus rice - T.aman rice – mungbean cropping system (Haque *et al*., 2002).

It is recognized that pulses offer the most practical means of solving protein malnutrition in Bangladesh but there is an acute shortage of grain legumes in relation to its requirements, because the yield of legumes in farmers' field is usually less than 1.0 t ha^{-1} against the potential yield of 2.0 to 4.0 t ha^{-1} (Ramakrishna *et al*., 2000). Low yields of grain legumes including mungbean make the crop less competitive with cereals and high value crops (Saha *et al*., 2002).

The reasons for low yield of mungbean are manifold: some are varietal and some are agronomic management especially improper fertilizer application. Among the fertilizer elements, nitrogen plays a key role in mungbean production. It affects the vegetative growth, development and yield. The important role of nitrogenous fertilizers in increasing mungbean yield has been widely recognized (Asad *et al*., 2004). Mungbean yield may be increased by 20 to 45% for proper utilization of nitrogenous fertilizers, weeding, protection from pest insects and selection of better variety. In the less developed countries, many farmers cannot afford inorganic fertilizers. This has led to interest in bio-fertilization with emphasis on biological nitrogen fixation (Wagner, 1997).

But research on “growth and yield of mungbean varieties as affected by management packages” is very limited in Bangladesh. Therefore, the present experiment was conducted for the following objectives

1. To compare the yield of three mungbean varieties .
2. To find out the role of agronomic management on the yield attributes and yield of mungbean.
3. To find out the suitable combination of variety and management packages for higher yield of mungbean.

Chapter 2
Review of literature

CHAPTER 2

REVIEW OF LITERATURE

Different types of research with a variety of treatment on mungbean is being carried out intensively and extensively in many countries including Bangladesh and the South East Asian countries specially for reducing the disease infestation and improvement of yield and quality. More recently at the Pulse Research Centre at Iswardi, Bangladesh Agricultural Research Institute (BARI), Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) and Bangladesh Institute of Nuclear Agriculture (BINA) have initiated research for improvement of this crop. Very few information was available regarding the effect of variety and management of mungbean on the growth and yield. Although this idea was not a recent one but research findings in this regard was scanty. In this chapter, an attempt has been made to review the available information in home and abroad regarding the effect of varietal and management on growth and yield of different mungbean varieties.

2.1 Effect of Variety

An experiment was conducted by Rahman *et al.* (2012) at Bangladesh Institute of Nuclear Agriculture (BINA) farm, Mymensingh to study the effect of *Rhizobial* inoculant (Biofertilizer) on the yield and yield contributing characters of mungbean cultivars. Experimental treatments included two varieties of mungbean namely Binamoog-5 and Binamoog-7 and six inoculant treatments namely control, *Bradyrhizobium* Inoculant (I), Inoculant + P, NPK, Inoculant + PK + B and Inoculant + PK + CD. Result indicated the significant performance on growth and yield among different variety was found.

Uddin *et al*. (2009) was carried out an experiment in experimental field of the Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh to investigate the interaction effect of variety and fertilizers on the growth and yield of summer Mungbean during the summer season of 2007. Five levels of fertilizer viz. control, N P K, Biofertilizer, Biofertilizer + N + P + K and Bio-fertilizer + P + K. and three varieties BARI Mung 5, BARI Mung-6 and Binamoog 5 were also used as experimental variables. Results showed that most of the growth and yield component of mungbean viz. plant height, branch plant^{-1}, number of nodules plant^{-1}, total dry matter plant^{-1}, pods plant^{-1}, seed plant^{-1}, seed pod^{-1}, weight of 1000-seeds, seed yield and straw yield were significantly influence by the bio-fertilizer (Bradyrhyzobium inoculums) treatment except number of leaves and dry weight of nodule. These are influenced by chemical fertilizer and biofertilizer also. All the parameters performed better in case of Bradyrhyzobium inoculums. BARI Mung 6 obtained highest number of nodule plant^{-1} and higher dry weight of nodule. It also obtained highest number of pod plant^{-1}, seed plant^{-1}, 1000- seed weight and seed yield. Interaction effect of variety and bio-fertilizer (Bradyrhyzobium) inoculation was significant of all the parameters. BARI Mung-6 with Bradyrhyzobium inoculums produced the highest number of nodule and pod plant^{-1}. It also showed the highest seed yield, Stover yield and 1000-seed weight.

Bhuiyan *et al.* (2008) carried out field studies with or without *Bradyrhizobium* with five mungbean varieties to observe the yield and yield attributes of mungbean. They observed that the application of *Bradyrhizobium* inoculant produced significant effect on seed and straw yields. Seed inoculation significantly increased yield and yield contributing characters. The BARI Mung-2 produced the highest seed and straw yields as well as yield attributes such as pods plant^{-1} and seeds pod^{-1}.

Ghosh (2007) conducted an experiment using BARI Mung-6 and Sona mung as planting materials and found that seed yield was higher in BARI Mung-6 with harvesting the crop at 35 days after anthesis. Weight of thousand seed and pod length was higher in BARI Mung-6 with harvesting the crop at 20 and 25 days after anthesis respectively. Shelling percentage, pods plant^{-1} and primary branches plant^{-1} was highest in Sona mung with harvesting at 15, 20 and 30 days after anthesis respectively.

Sarkar *et al.* (2004) reported that variety BARI Mung-2 contributed higher seed yield than BARI Mung-5. Binamoog-2 had the highest number of branches plant^{-1}. The highest number of pods plant^{-1} was recorded for BARI Mung-3. Pod length was greatest in BARI Mung-5.

BARI Mung-2 produced the highest seed yield and harvest index. The lowest seed yield and harvest index were recorded for BARI Mung-3. The highest 1000-seed weight was obtained from BARI Mung-5. Wang and Daun (2004) reported that, protein content was used as an indicator of environmental conditions for a study on varietal and environmental variation in proximate composition, minerals, amino acids and certain antinutrients of field peas. Four field pea varieties, each with three levels of protein content, were selected. Crude protein content overall ranged from 20.2 to 26.7%. Analysis of variance showed that both variety and environmental conditions had a significant effect on starch, acid detergent fibre (ADF), neutral detergent fibre (NDF) and fat content, but ash content was only affected by variety. Significant varietal and environmental differences in potassium (K), manganese (Mn) and phosphorus (P) were noted.

Calcium (Ca) and copper (Cu) showed significant varietal differences, while iron (Fe), magnesium (Mg) and zinc (Zn) had significant environmental differences. Environmental conditions showed significant effects on alanine, glycine, isoleucine, lysine and threonine content. Variety had a significant effect on sucrose, raffinose and phytic acid content, whereas environmental conditions had an influence on trypsin inhibitor activity (TIA). The major pea components protein and starch were inversely correlated. ADF, NDF, Fe, Mg, Zn and the amino acid arginine were positively correlated with protein content. The amino acids glycine, histidine, isoleucine, lysine and threonine were negatively correlated with protein content. It was found that tryptophan was the most deficient amino acid and the sulphur containing amino acids were the second limiting amino acids in peas. Raffinose was positively correlated with sucrose but negatively correlated with verbascose. There were significant correlations between mineral contents and some of the proximate components.

Ahmed *et al*. (2003) conducted a pot experiment on the growth and yield of mungbean cultivars Kanti, BARI Mung-4, BARI Mung-5, BU mug-1 and Binamoog-5. The seed yield of Kanti, BARI Mung-4 and BARI Mung-5 were higher than rest of the cultivars.

Mohanty *et al.* (1998) observed that among nine mungbean (*Vigna radiata*) cultivars, Kalamung was the best performing cultivar, with a potential seed yield of 793.65 kg ha^{-1}, the highest number of pods $plant^{-1}$ (18.67) and highest number of seeds pod^{-1} (10.43). Singh *et al.* (1996) conducted a field experiment in Bihar with 40 mungbean cultivars. They found that significant variation existed among the cultivars for plant height, pods $plant^{-1}$ and single plant yield.

Farrag (1995) reported from a field trial with 23 mungbean accessions the seed yield, number of pods $plant^{-1}$, number of seeds pod^{-1} and 1000-seed weight varied among the tested accessions. He also obtained that some cultivars like VC 2711 A, KPSI and UTT showed better performance under late sown condition. This indicates that all varieties have not equal potentiality to perform better under similar condition.

Islam (1983) reported that, an experiment under Bangladesh condition with four varieties of mungbean. It was found the highest number of branches $plant^{-1}$ from the variety Faridpur-1 followed by Mubarik, BM-7715 and BM-7704. The maximum number of pods $plant^{-1}$ was produced by Mubarik followed by BM-7704, BM-7715 and Faridpur-1. He mentioned that pods $plant^{-1}$ were a useful agronomic character contributing to higher yield in mungbean. Masood and Meena (1986) reported that mungbean variety 'PDM 11' gave significantly higher seed yield than the other varieties. He also found that number of pods $plant^{-1}$ varied significantly with genotypes.

2.2 Effect of Nitrogen

Hossain *et al.* (2014) conducted an experiment to investigate the comparative roles of nitrogen (50 kg ha^{-1}) and inoculums *Bradyrhizobium* (1.5 kg ha^{-1}) in improving the yield of two mungbean varieties (BARI Mung-5 and BARI Mung-6) at the Sher-e-Bangla Agricultural University (SAU) Farm, Dhaka. BARI Mung-6 performed higher seed yield than BARI Mung-5.

Malik *et al.* (2014) conducted an experiment on synergistic use of rhizobium, compost and nitrogen to improve growth and yield of mungbean (*Vigna radiata* L.) and was found that the combined application of Rhizobium, compost and 75% of the recommended mineral nitrogen (RMN) gave maximum number of nodules and dry weight.

Nursu'aidah *et al.* (2014) conducted an experiment on growth and photosynthetic responses of longbean (*Vigna unguiculata*) and mungbean (*Vigna radiata*) response to fertilization and found that mungbean grown without fertilizer produced the highest number of nodules per plant.

Khalilzadeh *et al.* (2012) conducted an experiment on growth characteristics of mungbean (*Vigna radiata* L.) affected by foliar application of urea and bio-organic fertilizers. They found that foliar application of urea and organic manure substantially improved the plant height.

An experiment was conducted by Yaqub *et al.* (2010) to evaluate the induction of short-duration (maturity period, 55-70 days) mungbean (*Vigna radiata* L.) as a grain legume in the pre-rice niche of the rice-wheat annual double cropping system. He found that the mungbean crop (grown without mineral N fertilizer) produced 1166 kg ha^{-1} of grain in addition to 4461 kg ha^{-1} of the manure biomass (containing 52 kg N ha^{-1}) that was ploughed under before planting rice with urea-N applied in the range of 0-160 kg N ha^{-1}. Averaged across urea - N treatments, manuring significantly increased the number of tillers $plant^{-1}$ (11% increased), rice grain yield (6% increased), grain N content (4% increased) and grain N uptake (9% increased). He observed significant residual effects of manuring on the subsequent wheat crop showing higher grain yield (21% increased), grain N uptake (29% increased) and straw yield (15% increased). The results suggested the feasibility of including mungbean in the pre-rice niche to improve the productivity of the annual rice-wheat double cropping system.

Sultana *et al.* (2009) conducted an experiment at the experimental field of the Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka to evaluate the effect of nitrogen and weed managements on mungbean (*Vigna radiata* L.). They found that application of 20 kg N ha^{-1} as basal + 20 kg N ha^{-1} with one weeding at vegetative stage showed significantly higher vegetative growth, yield and dry matter production.

Perez-Fernandez *et al.* (2006) conducted an experiment on the seed germination in response to chemicals: Effect of nitrogen and pH in the media and observed that nitrogenous compounds increased germination.

A field experiment was conducted by Raman and Venkataramana (2006) in Annamalainagar, Tamil Nadu, India to investigate the effect of foliar nutrition on crop nutrient uptake and yield of greengram (*Vigna radiata*). There were 10 foliar spray treatments, consisting of water spray, 2% diammonium phosphate at 30 and 45 days after sowing, 0.01% Penshibao, 0.125% Zn chelate, 30 ppm NAA. Crop nutrient uptake, yield and its attributes (number of pods per plant and number of seeds per pod) of greengram augmented significantly due to foliar nutrition. The foliar application of 2% diammonium phosphate + NAA + Penshibao was significantly superior to other treatments in increasing the values of yield attributes. Asaduzzaman (2006) found that plant height of mungbean was significantly increased by the application of nitrogen fertilizer at 30 kg ha^{-1}.

Oad and Buriro (2005) conducted a field experiment to determine the effect of different NPK level (0-0-0, 10-20-20, 10-30-30, 10-30-40 and 10-40-40 kg ha^{-1}) on the growth and yield of mung bean cv. AEM 96 in Tandojam, Pakistan. The different NPK level significantly affected the crop parameters. The 10-30-30 kg NPK ha^{-1} was the best treatment, recording plant height of 56.25 cm.

In a pot experiment at Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, Masud (2003) observed the highest plant height with the application of 30 kg N ha^{-1} while Ghosh (2007) found the highest plant height at applying 25 kg N ha^{-1}. Agbenin *et al.* (1991) was found that applied N significantly increased growth components, dry matter yield and nutrient uptake over the control.

Mozumder (1998) conducted a field trail at the Agronomy field laboratory, Bangladesh Agricultural University, Mymensingh to study the effects of five nitrogen levels on two varieties of summer mungbean and reported that nitrogen produced negative effect on nodule production and starter dose of nitrogen (40 kg ha^{-1}) gave the maximum seed yield (1607 kg ha^{-1}).

Murakami *et al.* (1990) reported that without N fertilizer, N fixation started at 12 days after sowing (DAS), increased rapidly at 34 DAS (flowering) to reach a peak at 45 DAS had a secondary peak at 60 DAS and then decreased until the plant died (83 DAS). With N fertilizer, N fixation started at 14 DAS, increased slowly to reach a much lower peak at 50 DAS and then decreased. Nodulation was greatly decreased by applied N, but fixation per unit nodule weight was similar in both N treatments. The percentage N derived from the air of seventy-eight mungbean cultivar was 0-100% at 33 DAS and 76% in all cultivars at 60 DAS. The author suggested that these cultivars might respond more to applied N than high fixing cultivars.

2.3 Effect of Phosphorus

Sharma *et al.* (2001) conducted an experiment to study the influence of various doses of nitrogen and phosphorous on protein content, yield and its attributes of mungbean. They reported that application of 20 kg N ha^{-1} and 60 kg P_2O_5 ha^{-1} gave the average maximum test weight, biological and grain yields, harvest index and seed protein content. Singh *et al.* (2001) showed that 30 mg P_2O_5 ha^{-1} soil gave the highest plant height, nodule dry weight and yield of green gram. Yadav and Jakhar (2001) observed that grain and straw yields of mungbean increased upto 60 kg P_2O_5 ha^{-1} application ha^{-1}.

Mandal and Sikder (1999) conducted a greenhouse pot experiment to study the effect of nitrogen and phosphorous on growth and yield of mungbean grown saline soil of Khulna. They reported that growth and yield increased the setting of pods and seeds. Raj Singh *et al.* (1999) reported that application of 60 kg P_2O_5 ha^{-1} produced a maximum seed yield of 300.12 kg ha^{-1}, however, it did not differ significantly with 40 kg P_2O_5 ha^{-1}.

Singh *et al.* (1999) reported that increasing level of P significantly increased plant height, number of nodules, fresh and dry weights of nodules, number of primary branches, test weight and grain and straw yields upto 26.40 kg P ha^{-1} in mungbean. Soni and Gupta (1999) made a field experiment to study the effect of irrigation and phosphorous levels on mungbean. They found that application of 40 kg P_2O_5 ha^{-1} was significantly superior to 250 kg P_2O_5 ha^{-1}.

2.3 Effect of Potassium

Kumar *et al*. (2018) reported that the potassium application is related to mung bean plant growth, total biomass and crops yield. Different potassium level of soils is significantly affected the mung bean plants yield and yield contribution parameters.

Maximum mung bean yield was 689 kg ha^{-1} was obtained with the application of 85 Kg potash per hectare. Genotype HUM-1, and HUM-2 produced higher seed yield than JM-72. The interactive effect of three mung bean varieties and their potassium level was found significant in different parameters.

Kumar *et al*. (2014) was conducted the experiment to study the effect of different potassium levels on mungbean under custard apple based Agri-Horti system at Agricultural Research Farm of Rajiv Gandhi South Campus, Barkachha, Mirzapur. Potassium application is directly related to growth, plant biomass and yield in crops. Results showed that application of different potassium levels gave varying yield. Lowest yield (700 kg ha^{-1}) was obtained with the application of 0 kg ha^{-1} and highest yield (1096 kg ha^{-1}) was obtained with the application of 120 kg ha^{-1} potassium. It is concluded that the application of 80 kg ha^{-1} potassium gave highest Benefit/Cost ratio of mungbean and looks more remunerative in Vindhyan region.

Beg and Ahmad (2012) stated that the foliar application of Potassium on moong bean at the time of flowering at half and full basal fertilizer doses in different concentrations was applied and it was found that the treatment, 1.00 kg Potassium / ha was applied as foliar spray showed best result. It enhanced almost all the vegetative and yield characteristics of mungbean at both the basal fertilizer doses. Besides, potassium used as foliar spray at the time of flowering when the plant required maximum nutrients can enhanced the productivity and save a large amount of fertilizers.

Kabir *et al*. (2004) reported that, it is established that application of higher levels of K improves water relations as well as growth and yield of mungbean under mild level of saline conditions. So, this research review’s purpose will help readers to understand the influence of variety and management treatment on growth and yield of mungbean. A lot of research related to the present study have been conducted worldwide, but in Bangladesh there have scanty of research. So, it is important to study the influence of variety and management treatment on growth and yield of mungbean in Bangladesh. Thus, this present study was conducted.

Chapter 3
Materials and Methods

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Dhaka1207 during the Kharif-1 season of March to June, 2017 to study the effect of variety and management of mungbean on the growth and yield. The materials used and methodology followed in the investigation have been presented details in this chapter.

3.1 Description of the Experimental Site:

3.1.1 Geographical location

The experimental area was situated at 23°77′N latitude and 90°33′E longitude at an altitude of 9 meter above the sea level.

3.1.2 Agro-ecological region

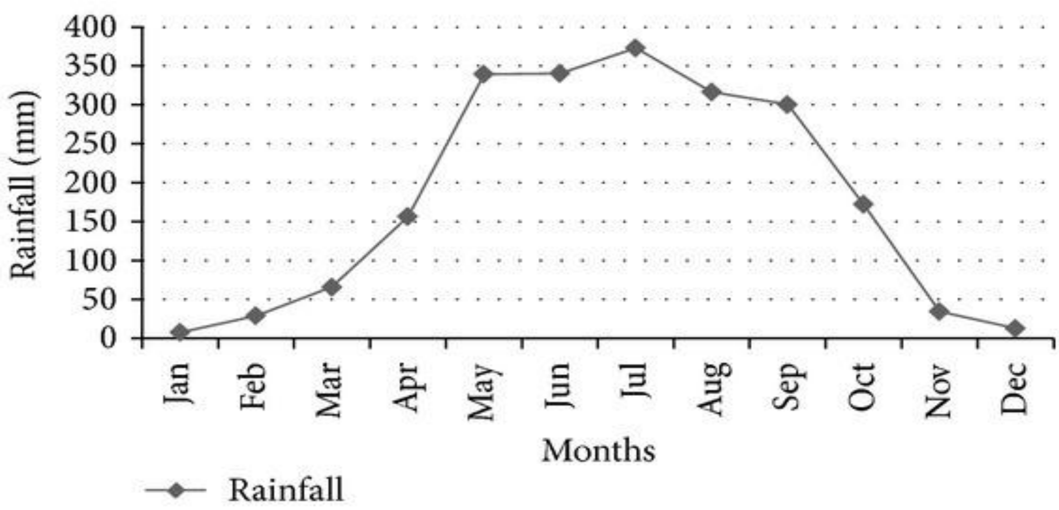
The experimental field belongs to the Agro-ecological zone of "The Modhupur Tract", AEZ-28. This was a region of complex relief and soils developed over the Modhupur clay, where floodplain sediments buried the dissected edges of the Modhupur Tract leaving small hillocks of red soils as 'islands' surrounded by floodplain. The experimental site was shown in the map of AEZ of Bangladesh in Appendix I.

3.1.3 Soil

The soil of the experimental site belongs to the general soil type, shallow red brown terrace Soils under Tejgaon Series. Top soils were clay loam in texture, olive-gray with common fine to medium distinct dark yellowish-brown mottles. Soil pH ranged from 5.6-6.5 and had organic matter 1.10-1.99%. The experimental area was flat having available irrigation and drainage system and above flood level.

3.1.4 Climate

The area has subtropical climate, characterized by high temperature, high relative humidity and heavy rainfall with occasional gusty winds in Kharif season (April-September) and scanty rainfall associated with moderately low temperature during the Rabi season (October-March). The rainfall during the experimental period of March, April and May, 2017 was recorded 60, 156 and 345 mm respectively (www.bmd.gov.bd).



3.2 Details of the experiment

3.2.1 Treatments

The treatment included in the experiment comprised of three varieties of mungbean and three treatments of management packages. The treatments were as follows:

A. Variety: 3

1. V_1= BARI Mung-6
2. V_2= BU mug 4
3. V3= Binamoog -8

B. Management package: 3

1. M_1= Low management
2. M_2=Medium management
3. M_3= High management

3.2.2 Details of management packages

Here, Low management = Fertilizer 0-0-0 NPK kg ha^{-1} + 40 kg seeds ha^{-1} in broadcast method + no pesticide application + no weeding.

Medium management = Fertilizer 20-10-20 NPK kg ha^{-1} + 24 kg seeds ha^{-1} in line sowing (30 cm X Continuous) + pesticide application + one hand weeding.

High management =Fertilizer 40-20-40 NPK kg ha^{-1} + 24 kg seeds ha^{-1} in line sowing + pesticide application + two hand weedings.

3.2.3 Experimental design and layout

The experiment was laid out into Split-plot design with three replications. Each replication had nine plots to which the treatment combinations were assigned randomly. The total numbers of unit plots were 27. The size of unit plot was 7.2 m^2 (3.0 m x 2.4 m). The distances between replication to replication and plot to plot were 1.0 m and 0.75 m, respectively.

3.2.4 Planting materials (Varietal description)

BARI Mung-6: This variety was introduced from AVRDC (NM- 94).

- Medium plant stature.
- Plant height: 40-45 cm. Resistant to YMV and CLS.
- Photo Insensitive. Bold seed size with green seed coat.
- Protein: 21.2%; CHO: 46.8%.
- Head dhal Yield: 67.2%.
- Cooking Time: 18 min.
- Synchrony in maturity and late potentiality.
- Recommended for cultivation in Jessore, Khulna, Faridpur, Pabna, Rajshahi and Dinajpur.
- 1000-seed weight: 40.0g.
- Seed yield: 1.5 –1.6 t ha^{-1}.
- Duration: 55-60 days.

BU mug 4: This variety was developed from local cross (BMX 841121).

- Plant height: 52-57 cm.
- Resistant to YMV and CLS. Photo Insensitive.
- Protein: 23.1%, CHO: 51.32%.
- Head dhal Yield: 68%.
- Cooking Time: 17 min.
- 1000-seed weight: 31.9g.
- Seed Yield: 1.1-1.3 t ha^{-1}.
- Duration: 60-65 days.

Binamoog-8: This variety was developed by BINA.

- Plant height: 41-46 cm.
- Salt tolerance variety.
- Seed yield: 1.40-1.45 t ha^{-1}.
- Duration: 58-60 days

3.2.5 Preparation of experimental land

A pre-sowing irrigation was given on 12 March, 2017. The land was opened with the help of a tractor drawn disc harrow on 14 March, 2017, and then ploughed with rotary plough twice followed by laddering to achieve a medium tilth required for the crop under consideration. All weeds and other plant residues of previous crop were removed from the field. Immediately after final land preparation, the field layout was made on March 15, 2017 according to experimental specification. Individual plots were cleaned and finally prepared the plot.

3.2.6 Fertilizer application

During final land preparation, the land was fertilized with as per treatment. The recommended fertilizer doses were 20-10-20 NPK kg ha^{-1} for medium management and 40-20-40 NPK kg ha^{-1} for high management.

3.2.7 Seed sowing

The seeds were sown by hand in 30 cm apart lines continuously at about 3 cm depth at the rate of 24 kg seed ha^{-1} and 40 kg $^{ha-1}$ in broadcasting on March 17, 2017.

3.2.8 Intercultural operations

3.2.8.1 Thinning

The plots were thinned out on 15 days after sowing to maintain a uniform plant stand.

3.2.8.2 Weeding

The crop field was infested with some weeds during the early stage of crop establishment. One hand weeding was done in medium management and two hand weedings were done in high management.

3.2.8.3 Application of irrigation water

Irrigation water was applied to the plots as a when necessary.

3.2.8.4 Drainage

There was a heavy rainfall (60, 156 and 345 mm respectively on March, April and May, 2017 during the experimental period. Drainage channels were properly prepared to easy and quick drained out of excess water.

3.2.8.5 Plant protection measures

The crops were infested by insects and diseases. The insecticide Marshall 20EC @30 mL/10L water was sprayed during the later stage of crop to control pests.

3.2.8.6 Harvesting and post-harvest operations

Maturity of crop was determined when 80-90% of the pods become blackish in color. Four harvesting was done while the first harvesting of BARI Mung-6 was done on 15 May and the others on 22 May, 27 May and 5 June. The harvesting was done by picking pods from central four lines for avoiding the boarder effects. The collected pods were sun dried, threshed and weighted to a control moisture level. The seed yield of harvesting pods plot^{-1} was added and converted into Kg ha^{-1} and dry stover yield was taken from plot^{-1} and converted to t ha^{-1}.

3.3 Recording of data

Experimental data were determined from 15 days interval of growth duration and continued until harvest. Dry weight of plants was collected by harvesting respective number of plants at different specific dates from the inner rows leaving border rows and harvest area for grain. The following data were recorded during the experimentation.

A. Crop growth characters

1. Speed of germination
2. Plant height (cm)
3. No. of leaflets plant^{-1}
4. Plant dry weight (g)
5. Number of nodules plant^{-1}
6. Nodule dry weight (g)

B. Yield and other crop characters

1. Number of branches plant^{-1}
2. Number of pods plant^{-1}
3. Length (cm) of pod
4. Number of seeds pod^{-1}
5. 1000-seed weight (g)
6. Seed yield (kg ha^{-1})
7. Shell yield (kg ha^{-1})
8. Stover yield (ton ha^{-1})

C. Weed data

1. Number of weeds plot^{-1}
2. Weed dry weight (g)

3.4 Detailed procedures of recording data

A brief outline of the data recording procedure followed during the study given below:

3.4.1. Crop growth characters

3.4.1.1 Speed of germination

Numbers of seeds germinated per m^2 from each plot were counted at 3, 4 and 5 days after sowing (DAS).

3.4.1.2 Plant height

Plant heights of five randomly selected plants from each plot were measured at 15, 30, 45 and 60 days after sowing (DAS) and at harvest. The heights of the plants were determined by measuring the distance from the soil surface to the tip of the leaf or pod of main shoot.

3.4.1.3 Number of leaflets plant^{-1}

Numbers of leaflets of five randomly selected plants from each plot were recorded at 15, 30, 45 and 60 days after sowing and the means were determined.

3.4.1.4 Plant dry weight

Five plants from each plot were collected for each recording data. The plant parts were separated and packed in separate paper packets then kept in the oven at 80^0 C for two days to reach a constant weight. Then dry weight of different plant parts was taken separately with an electric balance. The mean values were determined.

3.4.1.5 Number of nodules plant^{-1} and dry weight

The five plants plot^{-1} from second line was uprooted and total number of nodules were counted only at 40 DAS and the mean values were determined. Finally, dry weight of nodule also determined.

3.4.2 Yield and other crop characters

3.4.2.1 Number of branches plant^{-1}

The number of branches plant^{-1} from five randomly selected pods of each plot were counted and mean values were taken.

3.4.2.2 Number of pods plant^{-1}

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

3.4.2.3 Pod length

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

3.4.2.4 Number of seeds pod^{-1}

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.

3.4.2.5 1000-seed weight

A sub sample of seeds was taken from each plot from which 1000 seeds were counted manually. One thousand seeds thus counted were weighed at 12% moisture level in a digital balance to obtain 1000-seed weight (g).

3.4.2.6 Seed yield

The pods from harvested area (central four lines, 3.6 m^2) 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 and converted into kg ha^{-1}.

3.4.2.7 Shell yield

Shell yield was calculated and recorded as Kg ha^{-1}.

3.4.2.8 Stover yield

The pods from harvested area (central four lines, 3.6 m^2) were harvested as per experimental treatments and were threshed. Seeds were cleaned and properly dried under sun. Then Stover yield plot^{-1} was recorded and converted into ton ha^{-1}.

3.4.3 Weed data

Number of weeds plot-1 were counted and then dry weight was also recorded

3.5 Analysis of data

The data collected on different parameters were statistically analyzed to obtain the level of significance using the CropStat computer package program. Mean difference among the treatments were tested with Duncan's Multiple Range test (DMRT) at 5% level of significance.

Chapter 4

Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

This chapter represents the result and discussions of the present study entitled the effect of variety and management of mungbean on the growth and yield. Summary of mean square values at different parameters are also given in the appendices. Tables and figures have been presented on where required.

4.1 Speed of germination

Effect of varieties

The seeds were sowing at 17th March 2017. The first emergence was started at 20th March. Significant effect was not found in 1st germination (after 3 DAS) but significant difference was recorded significant in 2nd germination when maximum speed of germination from V_3 followed by V_2 and lowest germination for V_1. In 3rd germination varietal difference was not found. The maximum numbers of seedlings (36.89, 37.33 and 49.55) were counted in V_3 at 3rd, 4th and 5th DAS, respectively (Figure 1, Appendix II, III and IV) while the minimum numbers of seedling (21.66, 25.22 and 32.55) were counted in V_1 at 3rd, 4th and 5th DAS, respectively. Rahman *et al.* (2012), Uddin *et al.* (2009), Bhuiyan *et al.* (2008), Ghosh (2007) and Sarkar *et al.* (2004) reported the similar finding.

Effect of management

All management packages showed significant difference in three times of germination. The maximum numbers of seedlings (36.33, 40.55 and 46.33) were counted in M_3 treatment at 3rd, 4th and 5th DAS, respectively (Figure 1, Appendix II, III, IV) due to line sowing of seeds, pesticide application, two hand weedings and fertilizer application at the rate of 40-20-40 NPK kg ha^{-1} while the minimum numbers of seedling (20.44, 23.77 and 36.00) were counted in M_1 treatment at 3rd, 4th and 5th DAS, respectively due to broadcasting sowing of seeds, no pesticide application, no weeding and no fertilizer application.

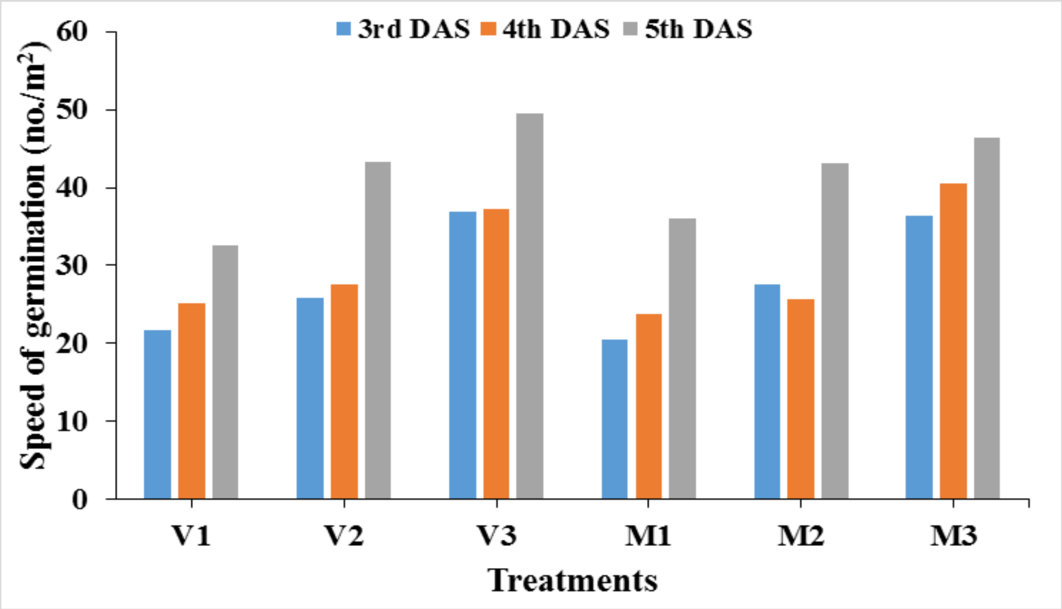


Figure 1. Effect of variety and management on speed of germination
DAS= Days after sowing; V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.

Combined effect of variety and management

The combined effect of variety and management produced statistically non significant effect on speed of germination (Table 1, Appendix II, III, IV). But maximum number of seedlings (46.66, 55.33 and 54.66) was counted in V_3M_3 at the same time whereas minimum number of seedlings (15.33, 23.00 and 29.66) was counted in V_1M_1 at 3rd, 4th and 5th DAS, respectively.

Table 1. Combined effect of variety and management on speed of germination

Treatments	Speed of germination (no. m^{-2}) at		
	3rd Days	4th Days	5th Days
V_1M_1	15.33a	23.00a	29.66a
V_1M_2	20.00a	25.00a	32.33a
V_1M_3	29.66a	34.67a	35.66a
V_2M_1	19.00a	21.33a	36.00a
V_2M_2	26.00a	22.67a	45.33a
V_2M_3	32.66a	31.66a	48.66a
V_3M_1	27.00a	27.00a	42.33a
V_3M_2	37.00a	29.77a	51.66a
V_3M_3	46.66a	55.33a	54.66a
CV (%)	26.75	19.37	28.53

V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.
Common letters do not differ significantly by DMRT test at 5% level of probability.

4.2 Plant height

Effect of varieties

Plant height of mungbean is positively affected by the varieties and showed statistically significant variation except at 30 DAS (Figure 2 and Appendix V, VI, VII, VIII). The tallest mungbean plant (10.00 cm, 31.32 cm, 53.37 cm and 70.48 cm at 15, 30, 45 and 60 DAS, respectively) was found in V_3 and the shortest plant (9.20 cm, 27.71 cm, 47.10 cm and 56.77 cm at 15, 30, 45 and 60 DAS, respectively) was recorded in V_1. The plant height of mungbean is directly associated with the varieties.

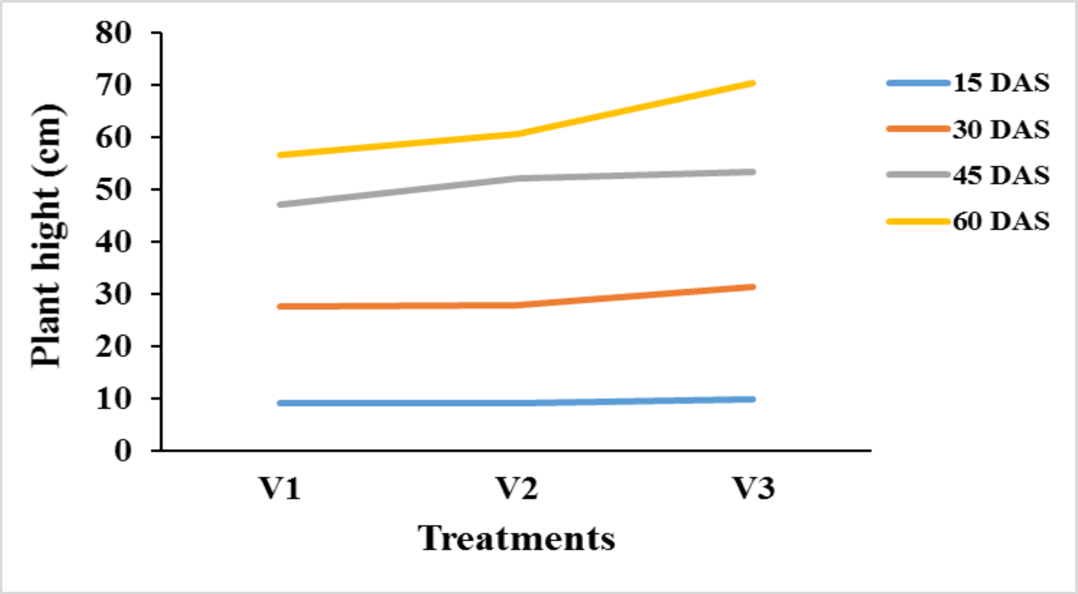


Figure 2. Effect of varieties on plant height

DAS= Days after sowing; V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8

Effect of management

Management had significant impact on plant height of mungbean only at 45 and 60 DAS (Figure2 and Appendix V, VI, VII, VIII). The plant height was ranges from 9.05 cm to 9.78 cm, 27.66 cm to 30.88 cm, 46.74 cm to 55.50 cm and 57.15 cm to 63.51 cm at 15, 30, 45 and 60 DAS, respectively. The maximum plant (9.78 cm, 30.88 cm, 55.50 cm and 67.25 cm at 15, 30, 45 and 60 DAS, respectively) was recorded in M_3 and shortest plant (9.05 cm, 27.66 cm, 46.74 cm and 57.15 cm 15, 30, 45 and 60 DAS, respectively) was found in M_1. The present result conformity with the findings of Asaduzzaman (2006).

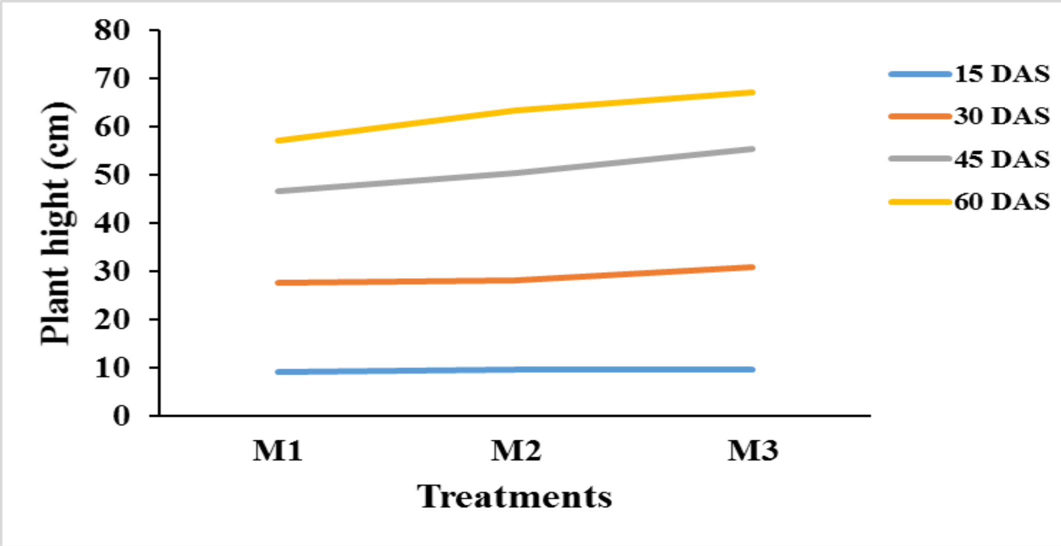


Figure 3. Effect of management on plant height
DAS= Days after sowing; M_1= Low management, M_2= Medium management, M_3= High management

Combined effect of varieties and management

Combined effect of varieties and management produced statistically significant plant height at 30, 45 and 60 DAS but not significant only at 15 DAS (Table 2 and appendix V, VI, VII, VIII). The maximum plant (10.26 cm, 34.30 cm, 59.43 cm and 75.00 cm at 15, 30, 45 and 60 DAS, respectively) was found in V_3M_3 compared to other combinations. The shortest plant was produced by V_1M_1 (8.69 cm, 26.61 cm, 44.54 cm and 53.86 cm 15, 30, 45 and 60 DAS, respectively). There was trend to increase plant height with the advancement of days of sowing.

Table 2. Combined effect of variety and management on plant height

Treatments	Plant height (cm) at			
	15 DAS	30 DAS	45 DAS	60 DAS
V_1M_1	8.69a	26.61b	44.54c	53.86b
V_1M_2	9.32a	27.74b	46.16c	55.36b
V_1M_3	9.58a	29.11b	50.60b	61.10ab
V_2M_1	8.92a	26.76b	46.09c	53.46b
V_2M_2	9.23a	27.13b	54.30ab	62.83ab
V_2M_3	9.50a	29.25b	56.46a	65.66ab
V_3M_1	9.54a	29.62b	49.59b	64.13ab
V_3M_2	10.21a	30.03ab	51.08b	72.33a
V_3M_3	10.26a	34.30a	59.43a	75.00a
CV (%)	11.95	9.92	5.83	8.44

DAS= Days after sowing; V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.
Common letters do not differ significantly by DMRT test at 5% level of probability.

4.3 Number of leaflets plant^{-1}

Effect of varieties

Mungbean varieties produced significant values of number of leaflets plant^{-1}only at 45 and 60 DAS however significant only 30 DAS (Figure 4 and Appendix IX, X, XI, XII). The leaflets number showed increasing trend up to 60 DAS. The maximum number of leaflets was found in variety V_3 and minimum number of leaflets was recorded in V_1. The values of leaflets number in V_3 was 5.13, 13.73, 19.73 and 24.92 at 15, 30, 45 and 60 DAS, respectively. The values of leaflets number in V_1 was 5.06, 12.60, 16.26 and 19.56 15, 30, 45 and 60 DAS, respectively. The present finding is agreed with the findings of Rahman *et al.* (2012).

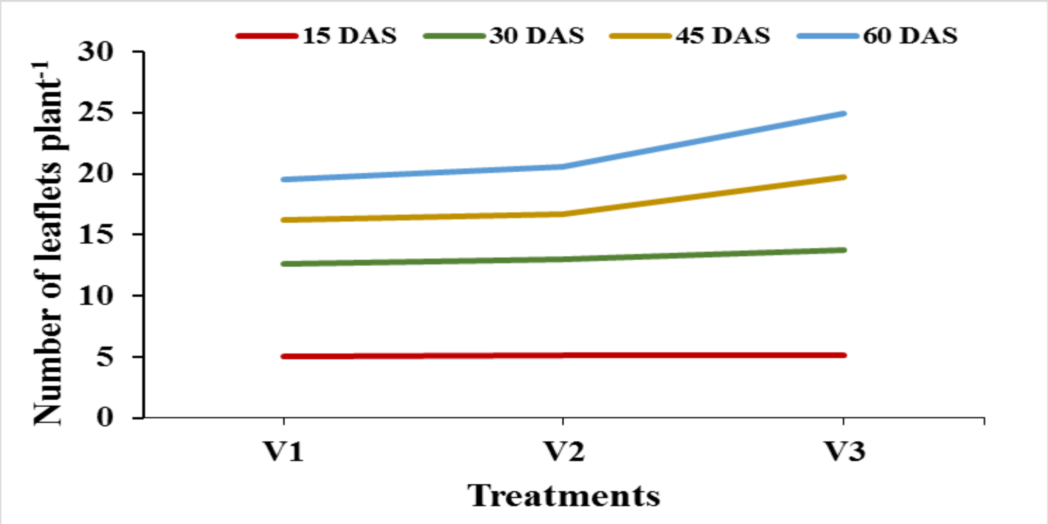


Figure 4. Effect of varieties on number of leaflets

DAS= Days after sowing; V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8

Effect of management

Application of management showed significant effect on number of leafletsplant^{-1} of mungbean except at 15 DAS (Figure 5 and Appendix IX, X, XI, XII).The maximum number of leaflets plant^{-1} (5.13, 13.73, 18.68, 23.43 at 15, 30, 45 and 60 DAS, respectively) was recorded in M_3 treatment while minimum number of leaflets plant^{-1} (5.06, 12.53, 16.33 and 19.85 15, 30, 45 and 60 DAS, respectively) was found in M_1 treatment. The present finding is agreed with the finding of Perez-Fernandez *et al.* (2006).

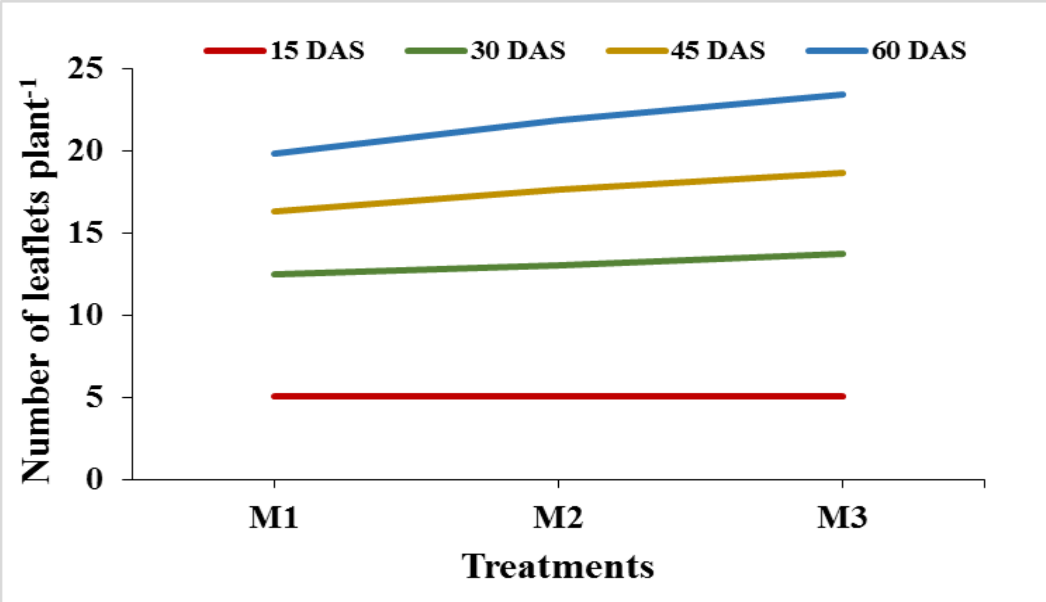


Figure 5. Effect of management on number of leaflets
DAS= Days after sowing; M_1= Low management, M_2= Medium management, M_3= High management

Combined effect of varieties and management

Combined effect of mungbean varieties and management produced non-significant effect on number of leaflets plant^{-1} at 15 DAS but difference at 30 & 45 DAS (Table 3 and Appendix IX, X, XI, XII). Although having non-significant effect, the maximum number of leaflets was recorded in V_3M_3 treatment combination (14.60, 20.86 and 26.50 at 30, 45 and 60 DAS, respectively) and minimum number of leaflets was found in V_1M_1 (11.80, 15.60 and 17.90 at 30, 45 and 60 DAS, respectively).

Table 3. Combined effect of variety and management on number of leaflets

Treatments	Number of leaflets plant^{-1} at			
	15 DAS	30 DAS	45 DAS	60 DAS
V_1M_1	5.20a	11.80b	15.60cd	17.90d
V_1M_2	5.00a	12.60ab	16.40bcd	19.70cd
V_1M_3	5.20a	13.40ab	16.80bcd	21.10bcd
V_2M_1	5.13a	12.80ab	15.00d	18.30d
V_2M_2	5.00a	13.00ab	16.60bcd	20.90cd
V_2M_3	5.20a	13.20ab	18.40abc	22.70abc
V_3M_1	5.00a	13.00ab	18.40abcd	23.36abc
V_3M_2	5.20a	13.60ab	19.93ab	24.90ab
V_3M_3	5.00a	14.60a	20.86a	26.50a
CV (%)	3.77	5.36	5.53	5.16

DAS= Days after sowing; V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management. Common letters do not differ significantly by DMRT test at 5% level of probability.

4.4 Number of branches plant^{-1}

Effect of varieties

Number of branches plant^{-1} of mungbean was significantly affected by the varietal treatments (Figure 6 and Appendix XIII, XIV). The maximum number of branches of mungbean plant was found in V_3 (1.04 and 2.31 at 45 and 60 DAS, respectively). The minimum number of branches of mungbean was recorded in V_1 (0.84 and 2.02 at 45 and 60 DAS, respectively). The present result has conformity with findings of Uddin *et al*. (2009).

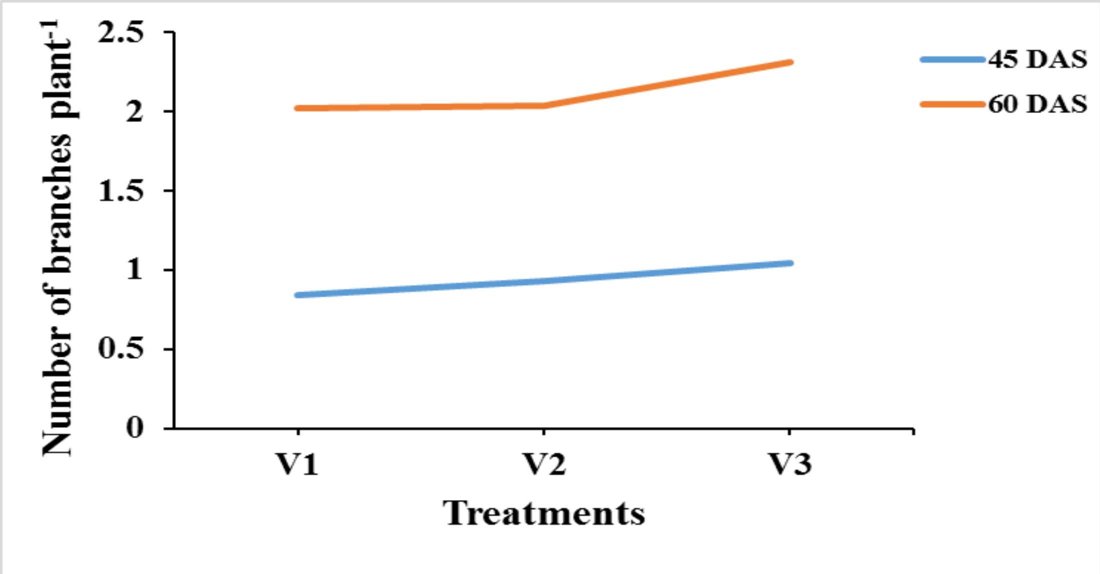


Figure 6. Effect of varieties on number of branches plant^{-1}
DAS= Days after sowing; V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8

Effect of management

Different management had significant impact on number of branches pant^{-1}of mungbean (Figure 7 and Appendix XIII, XIV). The number of branches plant^{-1} of mungbean range was from 0.15 to 1.71 and 1.37 to 2.77 at 45 and 60 DAS, respectively. The maximum number of branches was recorded in M_3 and minimum number of branches was found in M_1. Hossain *et al.* (2014), Malik *et al.* (2014) and Khalilzadeh *et al.* (2012) reported the similar finding.

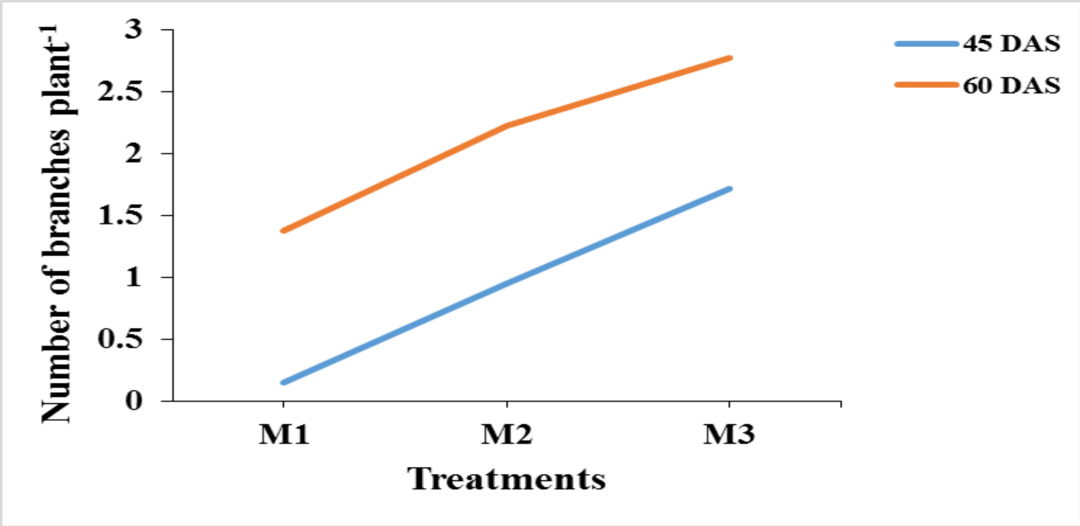


Figure 7. Effect of management on number of branches plant^{-1}
DAS= Days after sowing; M_1= Low management, M_2= Medium management, M_3= High management

Combined effect of varieties and management

Combined effect of varieties and management had significant effect on number of branches plant^{-1} of mungbean at 45 and 60 DAS (Table 4 and appendix XIII, XIV). Although having non-significant impact, the maximum number of branches (1.40 and 2.53 at 45 and 60 DAS, respectively) was found in V_3M_3compared to other combinations. The minimum number of branches was produced by V_1M_1 (0.26 and 1.33 at 45 and 60 DAS, respectively).

Table 4. Combined effect of variety and management on number of branches

Treatments	Number of branches at	
	45 DAS	60 DAS
V_1M_1	0.26c	1.33d
V_1M_2	1.00abc	2.00bcd
V_1M_3	1.86a	2.73ab
V_2M_1	0.06c	1.53cd
V_2M_2	0.60bc	2.33abc
V_2M_3	1.86a	3.06a
V_3M_1	0.13c	1.26d
V_3M_2	1.26ab	2.33abc
V_3M_3	1.40ab	2.53ab
CV (%)	34.11	13.85

DAS= Days after sowing; V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management. Common letters do not differ significantly by DMRT test at 5% level of probability.

4.5 Plant dry weight

Effect of varieties

Mungbean varieties produced non-significant values of plant dry weight at 30, 45 and 60 DAS (Figure 8 and Appendix XV, XVI, XVII). Though having the non-significant effect, the maximum values of plant dry weight were found in V_3variety and lowest value of plant dry weight was recorded in V_1variety. The plant dry weight ranges from 0.183 g to 0.213 g, 1.58 g to 3.03 g and 6.84 g to 13.00 g at 30, 45 and 60 DAS, respectively. The present finding is agreed with the finding of Rahman *et al.* (2012).

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

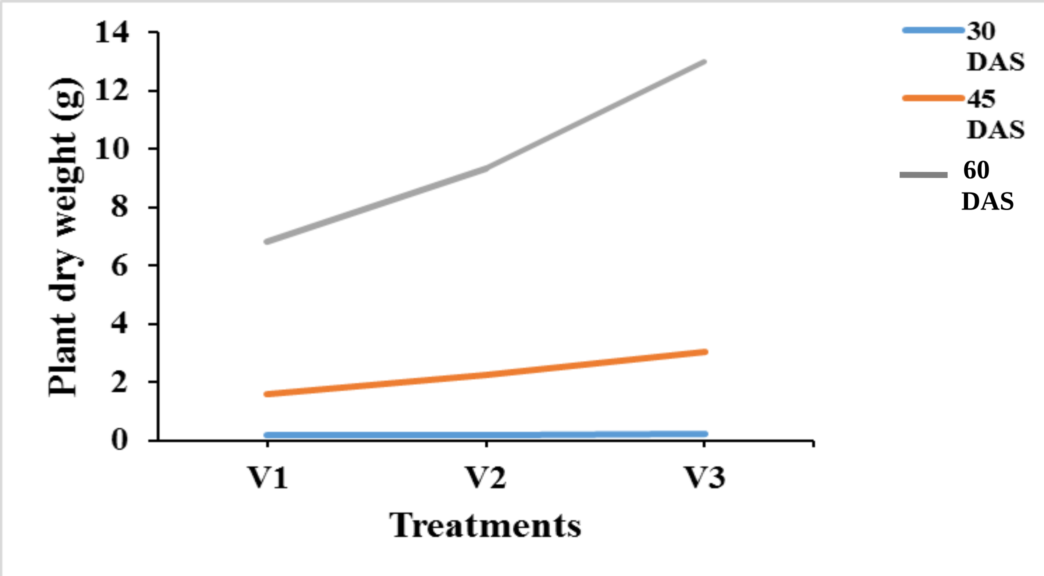


Figure 8. Effect of varieties on plant dry weight

DAS= Days after sowing; V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8

Effect of management

Management did not show any significant effect on plant dry weight of mungbean (Figure 9 and Appendix XV, XVI, XVII). The highest plant dry weight (0.203 g, 2.73 g and 11.63 g at 30, 45 and 60 DAS, respectively) was recorded in M_3 treatment while lowest plant dry weight (0.186 g, 2.01 g and 8.42 g at 30, 45 and 60 DAS, respectively) was found in M_1 treatments. Khalilzadeh *et al.* (2012) also reported the similar finding.

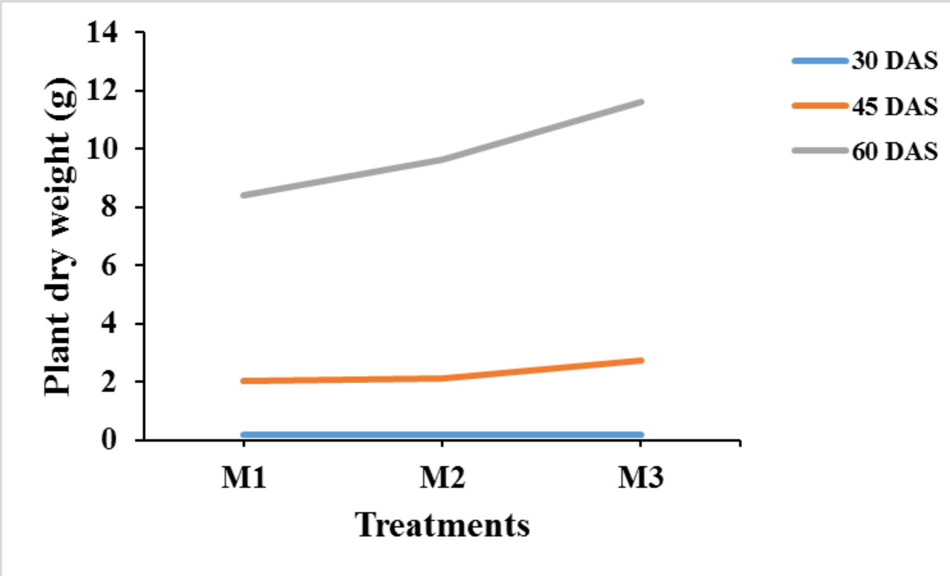


Figure 9. Effect of management on plant dry weight

DAS= Days after sowing; M_1= Low management, M_2= Medium management, M_3= High management

Combined effect of varieties and management

Combined effect varieties and management showed non-significant effect on plant dry weight of mungbean at all sampling dates (Table 5 and Appendix XV, XVI, XVII). The maximum plant dry weight was recorded in V_3M_3 (0.234 g, 3.89 g and 15.47 g at 30, 45 and 60 DAS, respectively) treatments and minimum number of plant dry weight was found in V_1M_1 (0.181 g, 1.54 g and 5.04 g at 30, 45 and 60 DAS, respectively).

Table 5. Combined effect of variety and management on plant dry weight

Treatments	Plant dry weight (g/plant) at		
	30 DAS	45 DAS	60 DAS
V_1M_1	0.181a	1.54a	5.04a
V_1M_2	0.183a	1.56a	6.47a
V_1M_3	0.185a	1.65a	9.02a
V_2M_1	0.183a	2.04a	8.39a
V_2M_2	0.188a	2.01a	9.23a
V_2M_3	0.191a	2.66a	10.41a
V_3M_1	0.195a	2.45a	11.81a
V_3M_2	0.208a	2.75a	13.20a
V_3M_3	0.234a	3.89a	15.47a
CV (%)	13.53	37.33	30.79

DAS= Days after sowing; V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.
Common letters do not differ significantly by DMRT test at 5% level of probability.

4.6 Number of nodules plant^{-1}

Effect of varieties

Mungbean varieties produced non-significant values of number of nodules plant^{-1}(Figure10 and Appendix XVIII). The maximum number of nodules was found in V_3variety and minimum number of nodules was recorded in V_2variety. The values of nodules number in V_3 treatment was 7.80 while the values of nodules number in V_1 treatment was 5.73. The present result consisted with the report of Uddin *et al*. (2009).

Effect of management

The management showed non-significant effect on number of nodules mungbean (Figure 10 and Appendix XVIII). The maximum number of nodules plant^{-1} (8.37) was recorded in M_1 treatment while minimum number of nodules plant^{-1} (4.93) was found in M_3 treatments. This might be due to minimum amount of nitrogen fertilizer in M_1 treatment facilitated to produce maximum number of nodules. The present finding is agreed with the finding of Perez-Fernandez *et al.* (2006).

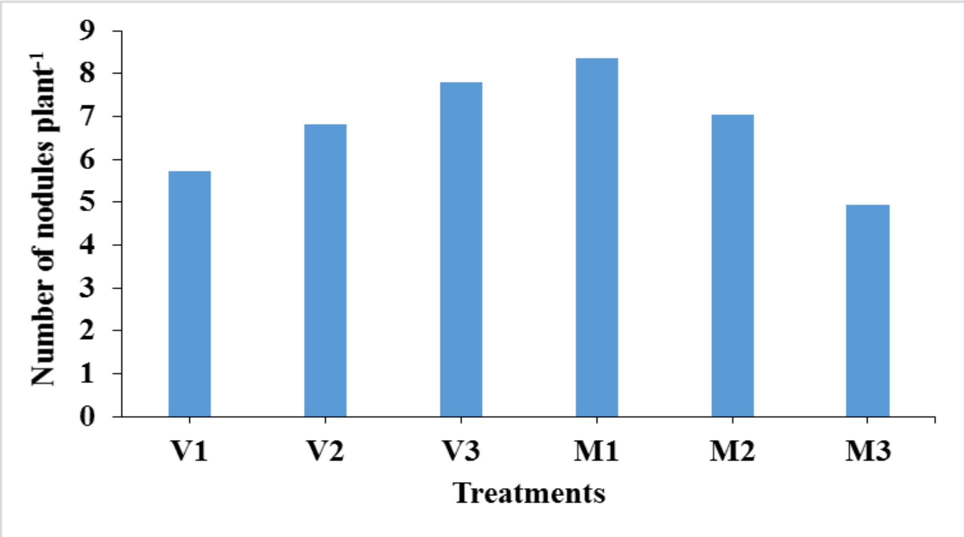


Figure 10. Effect of varieties and management on number of nodules plant^{-1}
V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.

Combined effect of varieties and management

Combined effect varieties and management showed non-significant effect on number of nodule plant^{-1}of mungbean (Table 6 and Appendix XVIII). Although having non-significant effect, the maximum number of nodules was recorded in V_3M_1 (10.26) treatments and minimum number of nodules was found in V_2M_3 (4.86).

4.7 Dry weight of nodules

Effect of varieties

Nodules dry weight of mungbean was positively affected by the varieties and showed statistically non-significant variation (Figure 11 and Appendix XIX). The highest nodules dry weight (0.056 g) was found in V_3 and lowest nodules dry weight (0.047 g) was recorded in V_1. The nodules dry weight is directly associated with the varieties of mungbean.

Effect of management

Different management did not have any significant impact on nodules dry weight of mungbean (Figure 11 and Appendix XIX). The nodules dry weight range was from 0.049 g to 0.052 g. The maximum nodules dry weight was recorded in M_1 and lowest nodules dry weight was found in M_3. This might be due to highest amount of nitrogen was applied in M_3 treatment and as a result less amount of nodule was produced by plant. The present result consisted with the report of Asaduzzaman (2006).

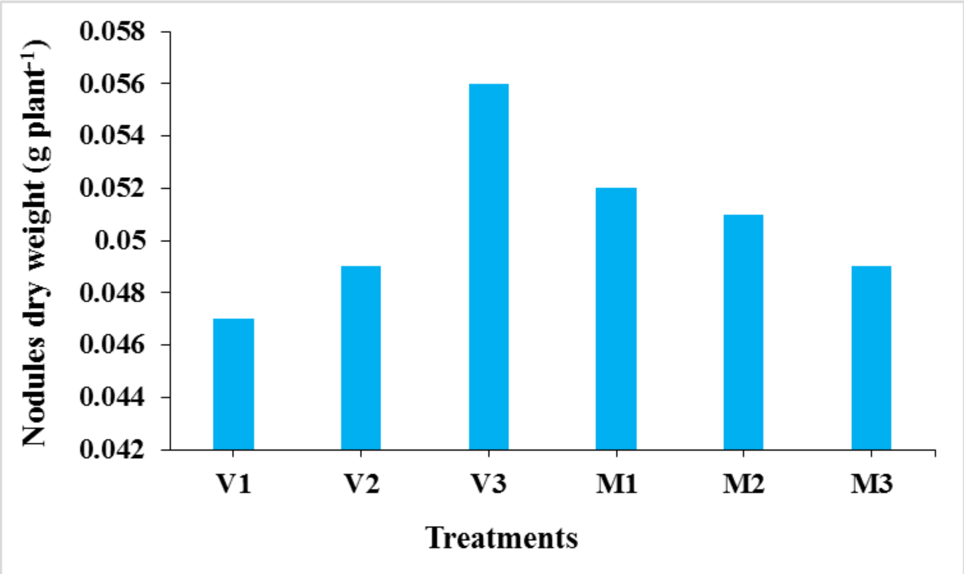


Figure 11. Effect of varieties and management on nodule dry weight
V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.

Combined effect of varieties and management

Combined effect of varieties and fertilizer management did not produce significant nodules dry weight (Table 6 and appendix XIX). The maximum nodules dry weight (0.058 g) was found in V_3M_1 compared to others combinations. The lowest nodules dry weight was produced by $V_1M_1$and V_2M_3 (0.042 g).

Table 6. Combined effect of variety and management on number of nodules and dry weight of nodules

Treatments	Number of nodules(plant^{-1})	Dry weight of nodule (g plant^{-1})
V_1M_1	8.00a	0.042a
V_1M_2	7.20b	0.048a
V_1M_3	5.26b	0.052a
V_2M_1	6.86b	0.056a
V_2M_2	5.66b	0.049a
V_2M_3	4.66c	0.042a
V_3M_1	10.26c	0.058a
V_3M_2	8.26c	0.057a
V_3M_3	4.86c	0.055a
CV (%)	49.38	27.43

V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.
Common letters do not differ significantly by DMRT test at 5% level of probability.

4.8 Number of pods plant^{-1}

Effect of varieties

Mungbean varieties produced statistically significant values of number of pods plant^{-1} (Figure 12 and Appendix XX). The maximum number of pods was found in V_3 and minimum number of pods was recorded in V_1. The values of pods number in V_3 and V_1 was 12.33 and 6.56, respectively. Rahman *et al.* (2012) and Ghosh (2007) also reported the similar finding.

Effect of management

Different types of management showed significant effect on number of pods of mungbean (Figure 12 and Appendix XX). The maximum number of pods plant^{-1} (12.11) was recorded in M_3 treatment while the minimum number of pods plant^{-1} (6.00) was found in M_1 treatments. The similar finding also reported by the Yaqub *et al.* (2010) and Sultana *et al.* (2009) reported the similar finding.

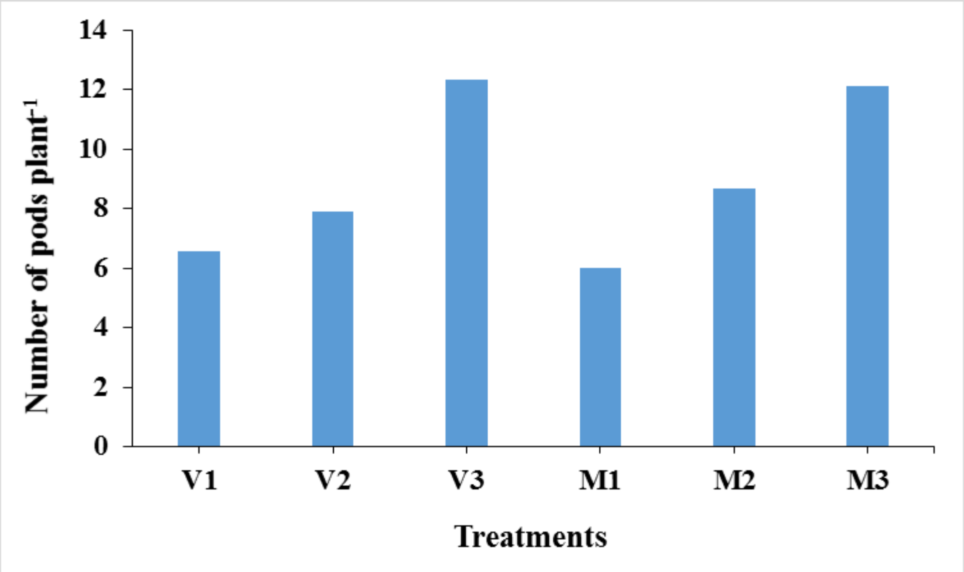


Figure 12. Effect of varieties and management on number of pods plant^{-1}
V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.

Combined effect of varieties and management

Combined effect of mungbean varieties and management showed non-significant effect on number of pods plant^{-1} (Table 7 and Appendix XX). The maximum number of pods was recorded in V_3M_3 (14.00) and the minimum number of pods was found in V_1M_1 (3.66).

4.9 Pod length

Effect of varieties

Pod length of mungbean did not show significant value due to the varietal difference (Figure 13, Appendix XXI). From the figure it can be demonstrated that the highest value of pod length (9.41 cm) was recorded from the variety V_3 while the lowest value (8.55 cm) of the same trait was found in variety V_1. This might be due the genetic variations among the variety. The similar finding also reported by the Uddin *et al.* (2009) and Sarkar *et al.* (2004) reported the similar finding.

Effect of management

Different types of management in mungbean showed statistically significant variations on pod length (Figure 13, Appendix XXI). Result revealed that, the longest pod (9.55 cm) was produced by M_3 treatment while the shortest pod (10.44 cm) was produced by the treatment M_1. The similar finding also reported by the Yaqub *et al.* (2010) and Sultana *et al.* (2009) reported the similar finding.

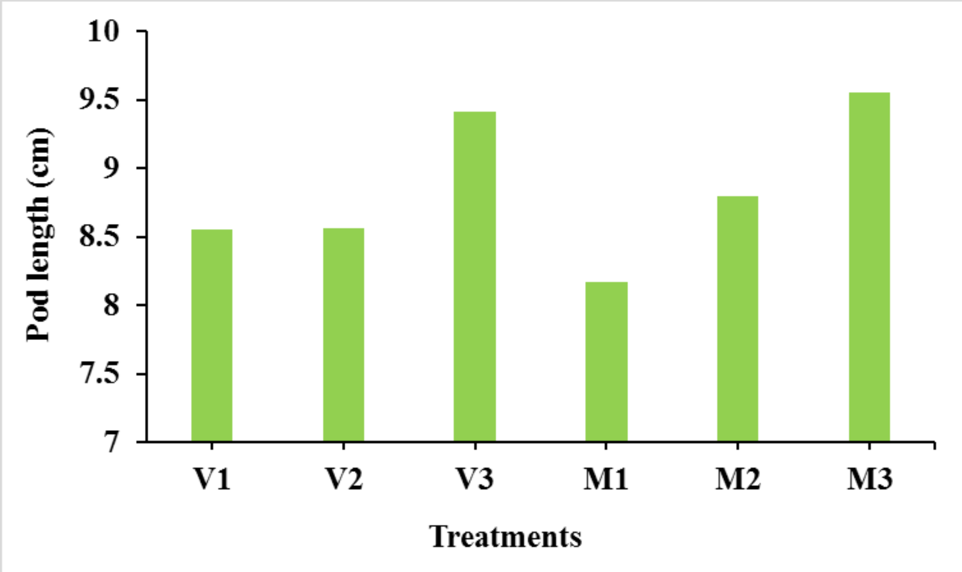


Figure 13. Effect of variety and management on pod length
V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.

Combined effect of varieties and management

The combined effect of varieties and management did not produce statistically significant pod length (Table 7, Appendix XXI). From the table it can be represented that the combination of V_3M_3 produced maximum value of pod length (10.50 cm) and the lowest value (8.07 cm) of the same trait was recorded in V_1M_1.

4.10 Number of seeds pod^{-1}

Effect of varieties

Mungbean varieties produced significant values of number of seedspod^{-1} (Figure 14 and Appendix XXII). The maximum number of seeds pod^{-1}was found in V_3variety and minimum number of seeds pod^{-1}was recorded in V_1variety. The number of seeds pod^{-1} were ranges from 10.11 to 12.22. The present finding is agreed with the finding of Rahman *et al.* (2012).

Effects of management

The management showed non-significant effect on number of seeds pod^{-1}(Figure10 and Appendix XXII). The maximum number of seeds pod^{-1}(12.00) was recorded in M_3 treatment while minimum number of seeds pod^{-1}(10.44) was found in M_1 treatments. Hossain *et al.* (2014), Malik *et al.* (2014) and Khalilzadeh *et al.* (2012) reported the similar finding.

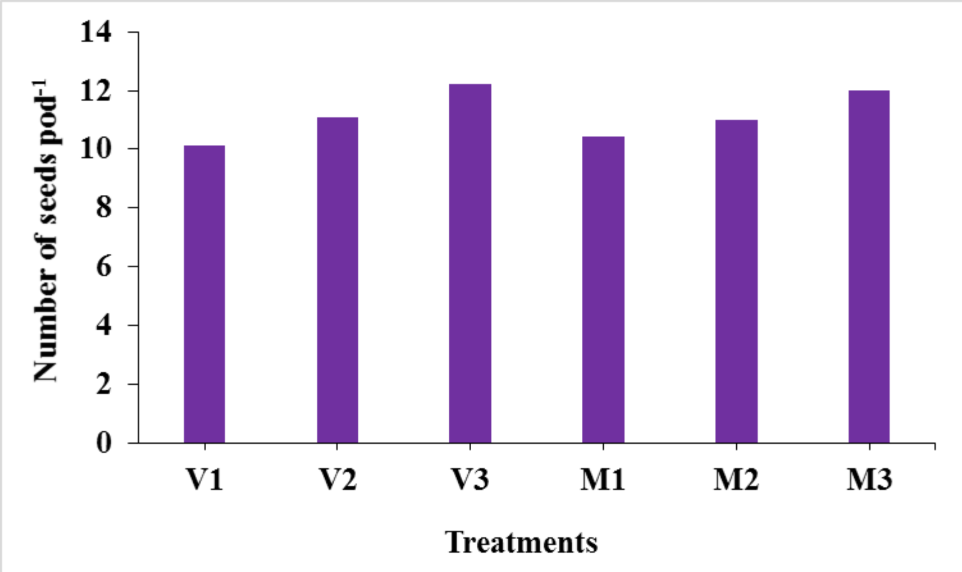


Figure 14. Effect of varieties and management on number of seeds pod^{-1}
V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.

Combined effect of varieties and management

The combined effect of mungbean varieties and management showed non-significant effect on number of seeds pod^{-1}(Table 6 and Appendix XXII). Although having non-significant effect, the maximum number of seeds pod^{-1} was recorded in V_3M_3 (13.00) treatments and minimum number of seeds pod^{-1} was found in V_1M_1 (9.00).

Table 7. Combined effect of variety and fertilizer management on yield contributing characters

Treatments	Number of pods plant^{-1}	Pod length (cm)	Seeds pod^{-1}
V_1M_1	3.66c	8.070a	9.000a
V_1M_2	5.33c	8.470a	10.000a
V_1M_3	10.66b	9.120a	11.333a
V_2M_1	4.00c	7.887a	10.667a
V_2M_2	8.00d	8.773a	11.000a
V_2M_3	11.66b	9.023a	11.667a
V_3M_1	10.33b	8.553a	11.667a
V_3M_2	12.66b	9.170a	12.000a
V_3M_3	14.00a	10.507a	13.000a
CV (%)	22.15	8.04	12.86

V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.
Common letters do not differ significantly by DMRT test at 5% level of probability.

4.11Weight of 1000 seeds

Effect of varieties

Weight of 1000 seeds of mungbean is positively affected by the varieties and showed significant variations among the varieties (Figure 15 and Appendix XXIII). The highest weight of 1000 seeds (40.46 g) was found in V_3 and lowest 1000 seeds weight (36.56 g) was recorded in V_1. The 1000 seeds weight is directly associated with the varieties of mungbean. The variety Binamoog-8 showed bolder seed then the other two varieties.

Effect of management

Application of different management had significant impact on 1000 seeds weight of mungbean (Figure 15 and Appendix XXIII). The 1000 seeds weight was range from36.24 g to 39.95 g. The maximum 1000 seeds weight was recorded in M_3 and lowest 1000 seeds weight was found in M_1treatment. The similar finding also reported by the Yaqub *et al.* (2010) and Sultana *et al.* (2009) reported the similar finding.

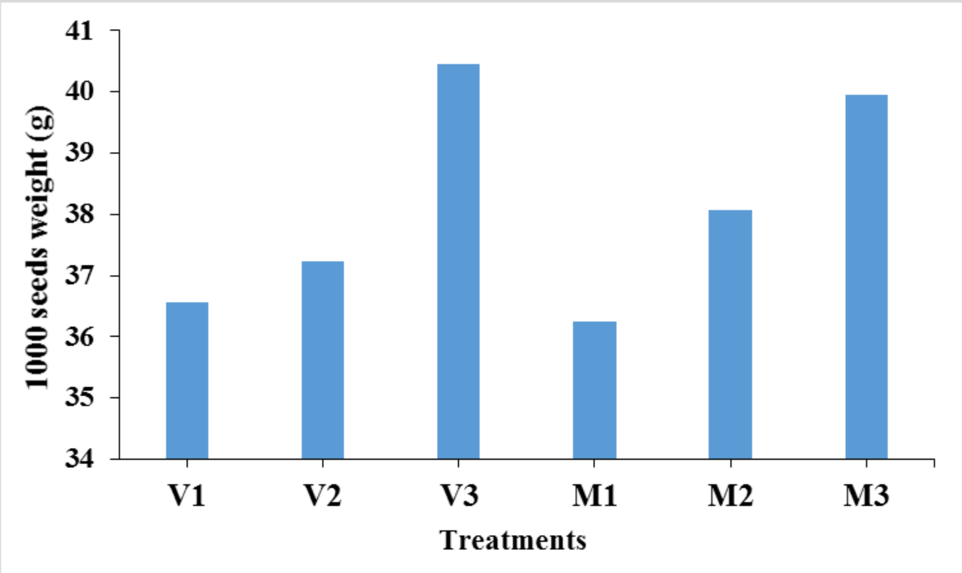


Figure 15. Effect of varieties and fertilizer management on 1000 seeds weight
V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.

Combined effect of varieties and management

Combined effect of varieties and management produced significant effect on 1000 seeds weight of mungbean (Table 8 and appendix XXIII). The highest 1000 seeds weight (42.46 g) was found in V_3M_3 combined compared to others combinations. The lowest value of 1000 seed weight was produced by V_1M_1 (34.53 g).

4.12 Seeds yield

Effect of varieties

Mungbean varieties produced non-significant values of seed yield (Figure 16 and Appendix XXIV). Although having non-significant among the varieties, the maximum seed yield was found in V_3 and lowest seed yield was recorded in V_1. The seed yield ranges from 547.03 kg ha^{-1} to 746.04 kg ha^{-1}.The present result consisted with the report of Uddin *et al*. (2009).

Effect of management

The management showed significant effect on seed yield of mungbean (Figure 16 and Appendix XXIV). The maximum seed yield was recorded in M_3 treatment (1032.10 kg ha^{-1}) while lowest seed yield was found in M_1 treatments (130.70 kg ha^{-1}). The present result consisted with the report of Asaduzzaman (2006). The lower fertilizer and one lower hand weeding of M_2 reduced 28.87% yield whereas no fertilizer application, no pesticide, no weeding and broadcasting sowing of M_1 reduced 87.34% yield.

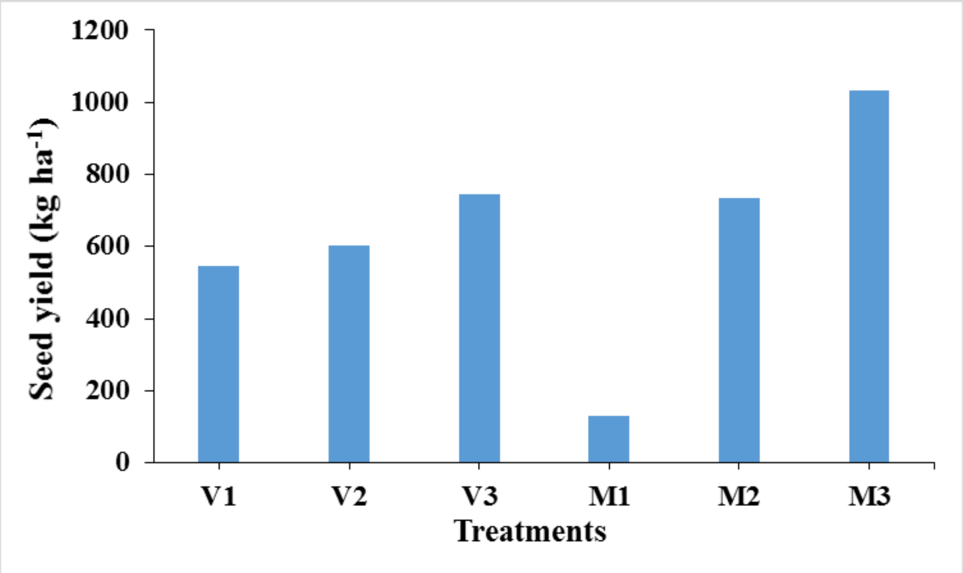


Figure 16. Effect of varieties and management on pods yield
V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.

Combined effect of varieties and management

Combined effect of mungbean varieties and management showed significant effect on seed yield (Table 8 and Appendix XXIV). The highest seed yield was recorded in V_3M_3treatment (1198.10 kg ha^{-1}) and lowest seed yield was found in V_1M_1 (78.30 kg ha^{-1}) on an average seed yeild was not potential due to heavy rain fall (345 mm) before harvesting pods.

4.13 Shell yield

Effect of varieties

Shell yield of mungbean did not show the statistically significant variation (Figure 17 and Appendix XXV). The maximum shell yield (294.30 kg ha^{-1}) was found in V_3variety and lowest shell yield (243.04 kg ha^{-1}) was recorded in V_1 variety. The present result consisted with the report of Uddin *et al*. (2009) and Ghosh (2007).

Effect of fertilizer management

The different fertilizer management had significant effect on shell yield of mungbean (Figure 17 and Appendix XXV). The shell yield was range from142.19 kg ha^{-1} to 411.69 kg ha^{-1}. The maximum shell yield was recorded in M_3 and the lowest shell yield was found in M_1. The present finding is agreed with the finding of Perez-Fernandez *et al.* (2006).

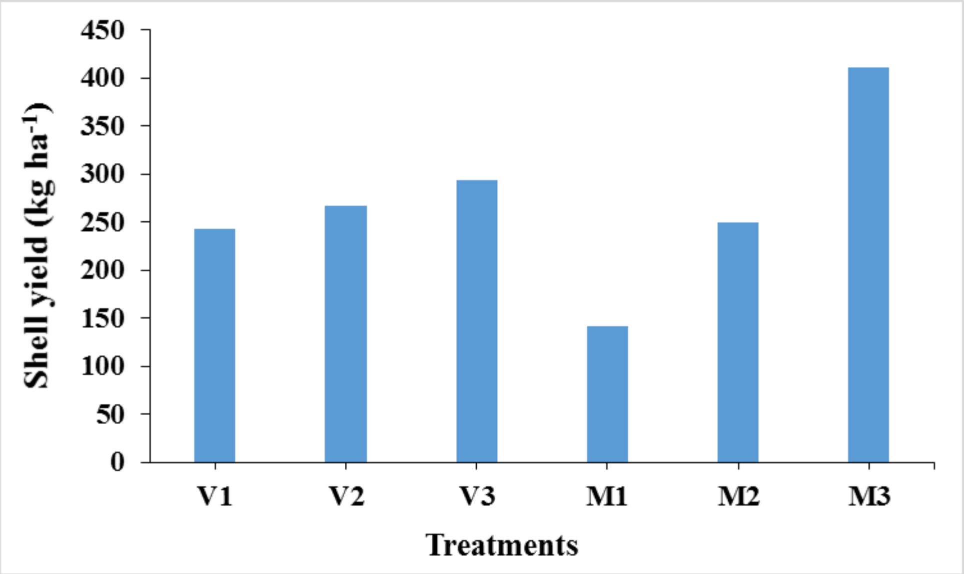


Figure 17. Effect of varieties and management on seeds yield (kg ha^{-1})
V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.

Combined effect of varieties and fertilizer management

The combined effect of varieties and fertilizer management produced non-significant shell yield (Table 8 and appendix XXV). The maximum shell yield (479.36 kg ha^{-1}) was found in V_3M_3 combined compared to others combinations. The lowest shell yield was produced by V_1M_1 (133.91 kg ha^{-1}).

4.14 Stover yield

Effect of varieties

Mungbean varieties produced insignificant values of stover yield (Figure 18). Although having insignificant impact among the varieties, the maximum stover yield was found 2.02 ton ha^{-1} in V_3 treatment and the lowest stover yield was recorded 1.76 ton ha^{-1} in V_1.

Effect of management

The management showed significant effect on stover yield of mungbean (Figure 18). The highest stover yield was recorded in M_3 (2.87 ton ha^{-1}) while the lowest stover yield was recorded in M_1 (0.70 ton ha^{-1}).

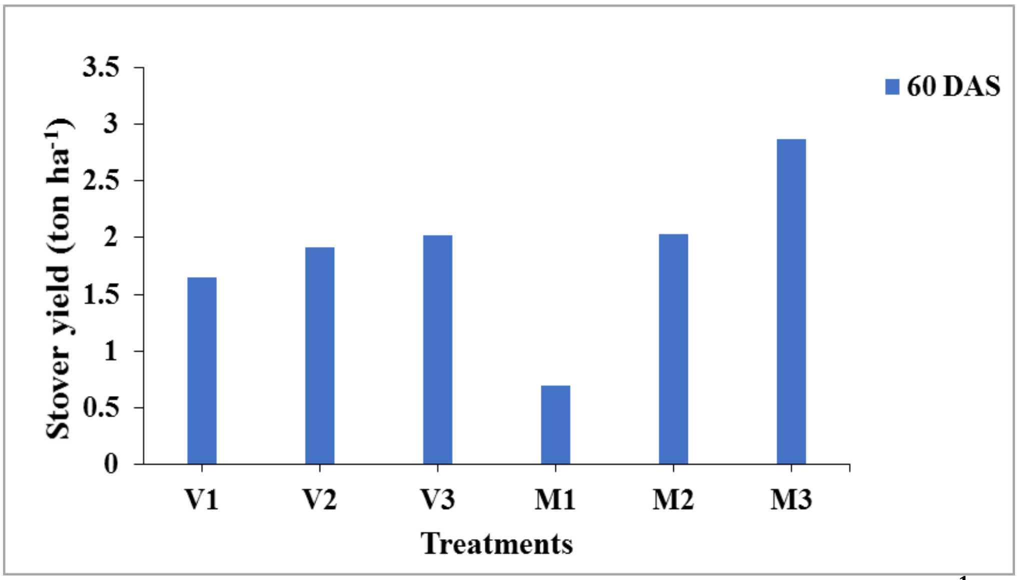


Figure 18. Effect of varieties and management on Stover yield (ton ha^{-1})
DAS= Days after sowing; V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8; M_1= Low management, M_2= Medium management, M_3= High management.

Combined effect of varieties and management

Combined effect of mungbean varieties and management showed non-significant effect on stover yield (Table 8). The maximum stover yield was recorded in V_3M_3 treatment (2.45 ton ha^{-1}) and the lowest stover yield was found in V_1M_1 (0.25 ton ha^{-1}).

Table 8. Combined Effect of variety and management on yield parameters

Treatments	Yield parameters			
	1000 seeds weight (g)	Yield (kg ha^{-1})	Shell yield (kg ha^{-1})	Stover dry yield (ton ha^{-1})
V_1M_1	34.53b	78.30d	133.91d	0.25a
V_1M_2	36.83ab	643.90c	244.20d	1.84a
V_1M_3	38.33ab	918.90b	351.01b	2.26a
V_2M_1	35.23b	96.80d	144.18d	0.35a
V_2M_2	37.43ab	735.60c	251.36c	1.98a
V_2M_3	39.06ab	979.20b	404.69a	2.40a
V_3M_1	38.96ab	217.20d	148.49c	0.45a
V_3M_2	39.96ab	822.80b	255.06c	2.03a
V_3M_3	42.46a	1198.10a	479.36a	2.45a
CV (%)	3.92	14.80	22.83	18.79

V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.
Common letters do not differ significantly by DMRT test at 5% level of probability.

4.15 Number of weeds m^{-2}

Effect of varieties

Variety had significant effect on numbers of weeds m^{-2}. The highest number of weeds (1512.00 and 1384.00 at 45 DAS and 60 DAS, respectively) was found around the V_3 and the lowest number of weeds (1221.30 and 1117.30 m^{-2} at 45 DAS and 60 DAS, respectively) was recorded around the V_1 (Figure 19 and Appendix XXVI, XXVII). This might be due to that V_1 had allelopathic effect to control the weeds.

Effect of management

The management showed significant effect on number of weeds in mungbean field (Figure 19 and Appendix XXVI, XXVII). The highest number of weeds (1768.00 and 1680.00 at 45 DAS and 60 DAS, respectively) was recorded in M_1 while the lowest number of weeds (568.00 and 266.70 m^{-2} at 45 DAS and 60 DAS, respectively) was found in M_3. This might be due to that M_3 produced densely populated plant that helped to reduce the weed.

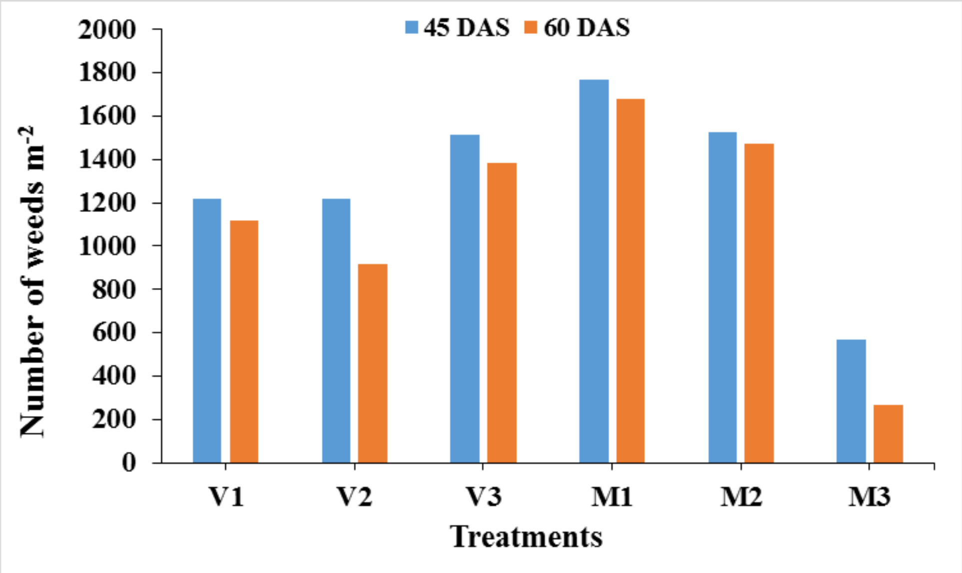


Figure 19. Effect of varieties and management on number of weeds m^{-2}

DAS= Days after sowing; V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8; M_1= Low management, M_2= Medium management, M_3= High management.

Combined effect of varieties and management

Combined effect of mungbean varieties and management showed significant on number of weeds (Table 9 and Appendix XXVI, XXVII). The highest number of weeds recorded in V_3M_1 (2048.00 and 2048.00 at 45 DAS and 60 DAS, respectively) and the lowest number of weeds was found in V_2M_3 (480.00 and 216.00 at 45 DAS and 60 DAS, respectively).

4.16 Dry weight of Weeds

Effect of varieties

Variety had significant effect on 45 DAS and not significant at 60 DAS. In case of varietal treatment, the maximum weeds weight (410.24 g and 375.73 g at 45 DAS and 60 DAS, respectively) was found in V_3 and the lowest weeds weight (331.47 g and 303.52 g at 45 DAS and 60 DAS, respectively) was recorded in V_1 (Figure 20 and Appendix XXIV). This might be due to allelopathic effect of V_1.

Effect of management

Different management had significant effect on weeds weight at 45 and 60 DAS (Figure 20 and Appendix XXIV). The weeds weight was ranges from 154.13 g to 476.81 g and 72.43 g to 456.29 g at 45 DAS and 60 DAS, respectively. The maximum weeds weight was recorded in M_1 and the lowest weeds weight was found in M_3. This might be due to positive impact of management while M_3 produced densely plant helped to control weeds.

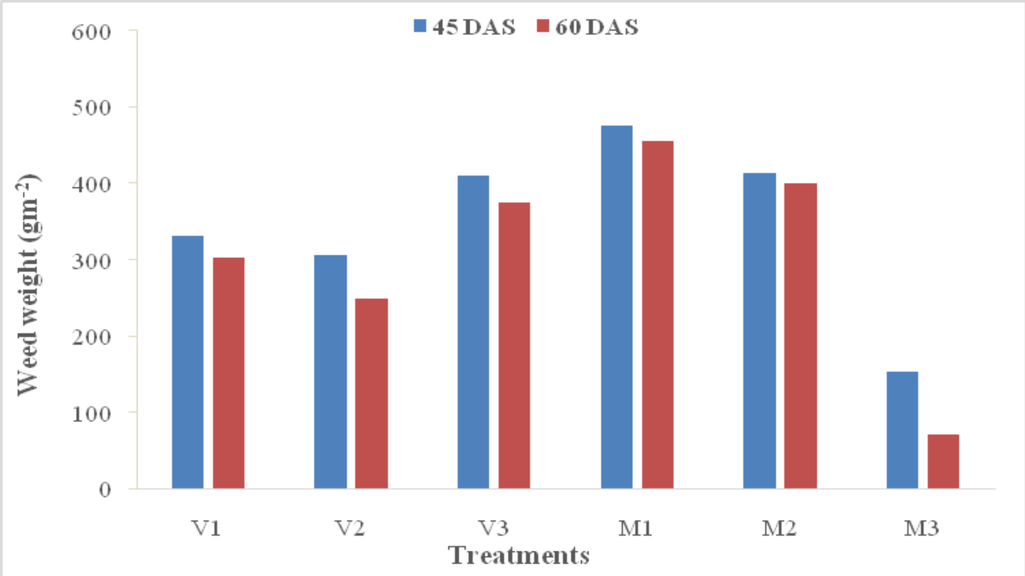


Figure 20. Effect of varieties and management on weeds weight
DAS= Days after sowing; V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.

Combined effect of varieties and management

Combined effect of varieties and management produced significant on dry weight of weeds (Table 9 and appendix XXIV) due to different management practices. The highest weight of dry weeds (555.68 g and 556.00 g at 45 DAS and 60 DAS, respectively) was found in V_3M_1 combined compared to others combinations. The lowest weeds weight was produced by V_1M_3 (147.68 g at 45 DAS) and V_3M_3 (52.56 g at 60 DAS).

Table 9. Combined effect of variety and management on weeds parameters

Treatments	Number of weeds m^{-2} at		Weed weight (g m^{-2}) at	
	45 DAS	60 DAS	45 DAS	60 DAS
V_1M_1	1688.0ab	1616.0a	458.08ab	438.96a
V_1M_2	1432.0ab	1456.0b	388.64ab	395.52a
V_1M_3	544.0c	280.0c	147.68c	76.08b
V_2M_1	1568.0ab	1376.0b	425.68ab	373.92a
V_2M_2	1344.0b	1160.0b	364.88b	31520ab
V_2M_3	480.0c	216.0c	130.24c	58.64b
V_3M_1	2048.0a	2048.0a	555.68a	556.00a
V_3M_2	1808.0ab	1800.0a	490.56ab	488.64a
V_3M_3	680.0c	304.0c	184.48c	82.56b
CV (%)	13.74	28.55	13.74	28.58

DAS= Days after sowing; V_1= BARI Mung-6, V_2= BU mug-4, V_3=Binamoog-8;
M_1= Low management, M_2= Medium management, M_3= High management.
Common letters do not differ significantly by DMRT test at 5% level of probability.

Chapter 5
Summary and conclusion

CHAPTER V

SUMMARY AND CONCLUSION

The investigation was conducted at the Agronomy field, Sher-e-Bangla Agricultural University to effect of variety and management on the growth and yield of mungbean. This chapter represents the summery and conclusion of the research. Here V1= BARI Mung-6, V2= BU mug-4, V3=Binamoog-8; M1= Low management, M2= Medium management, M3= High management.The maximum numbers of seedlings (36.89, 37.33 and 49.55) were counted in V3 variety at 3rd, 4th and 5th DAS, respectively. While the minimum numbers of seedling (21.66, 25.22 and 32.55) were counted in V1 variety at 3rd, 4th and 5th DAS, respectively. The maximum numbers of seedlings (36.33, 40.55 and 46.33) were counted in M3 treatment at 3rd, 4th and 5th DAS, respectively. While the minimum numbers of seedling (20.44, 23.77 and 36.00) were counted in M_1 treatment at 3^{rd}, 4^{th} and 5^{th} DAS, respectively. The interaction effect showed non-significant but maximum number of seedlings (46.66, 55.33 and 54.66) were counted in V_3M_3 at 3^{rd}, 4^{th} and 5^{th} DAS, respectively.

The maximum mungbean plant height (10.00 cm, 31.32 cm, 53.37 cm and 70.48 cm at 15, 30, 45 and 60 DAS, respectively) was found in V_3 and the minimum plant height (9.20 cm, 27.71 cm, 47.10 cm and 56.77 cm at 15, 30, 45 and 60 DAS, respectively) was recorded in V_1. The plant height was ranges from 9.05 cm to 9.78 cm, 27.66 cm to 30.88 cm, 46.74 cm to 55.50 cm and 57.15 cm to 63.51 cm at 15, 30, 45 and 60 DAS, respectively. The maximum plant (9.78 cm, 30.88 cm, 55.50 cm and 67.25 cm at 15, 30, 45 and 60 DAS, respectively) was recorded in M_3 and shortest plant (9.05 cm, 27.66 cm, 46.74 cm and 57.15 cm 15, 30, 45 and 60 DAS, respectively) in M_1. The tallest plant (10.26 cm, 34.30 cm, 59.43 cm and 75.00 cm at 15, 30, 45 and 60 DAS, respectively) was found in V_3M_3 compared to other combinations. The shortest plant was produced by V_1M_1 (8.69 cm, 26.61 cm, 44.54 cm and 53.86 cm 15, 30, 45 and 60 DAS, respectively).

The leaflets number showed increasing trend up to 60 DAS. The maximum number of leaflets was found in variety V_3 and minimum was recorded in V_1 variety. The values of leaflets number in V_3 variety was 5.13, 13.73, 19.73 and 24.92 at 15, 30, 45 and 60 DAS, respectively. The values of leaflets number in V_1 variety was 5.06, 12.60, 16.26 and 19.56 15, 30, 45 and 60 DAS, respectively. The maximum number of leaflets plant^{-1} (5.13, 13.73, 18.68, 23.43 at 15, 30, 45 and 60 DAS, respectively) was recorded in M_3 treatment while minimum number of leaflets plant^{-1} (5.06, 12.53, 16.33 and 19.85 15, 30, 45 and 60 DAS, respectively) was found in M_1 treatment. The maximum number of leaflets was recorded in V_3M_3 treatment combination (14.60, 20.86 and 26.50 at 30, 45 and 60 DAS, respectively) and minimum number of leaflets was found in V_1M_1 (11.80, 15.60 and 17.90 at 30, 45 and 60 DAS, respectively).

The maximum number of branches of mungbean plant^{-1} was found in V_3 (1.04 and 2.31 at 45 and 60 DAS, respectively) while minimum number of branches of mungbean in V_1 (0.84 and 2.02 at 45 and 60 DAS, respectively). The number of branches plant^{-1} of mungbean range was from 0.15 to 1.71 and 1.37 to 2.77 at 45 and 60 DAS, respectively. The maximum number of branches was recorded in M_3 and minimum number of branches was found in M_1. The maximum number of branches (1.40 and 2.53 at 45 and 60 DAS, respectively) was found in V_3M_3 compared to other combinations. The minimum number of branches was produced by V_1M_1 (0.26 and 1.33 at 45 and 60 DAS, respectively).

The highest values of plant dry weight were found in V_3 variety and lowest value of plant dry weight was recorded in V_1 variety. The plant dry weight ranges from 0.183 g to 0.213 g, 1.58 g to 3.03 g and 6.84 g to 13.00 g at 30, 45 and 60 DAS, respectively. The highest plant dry weight (0.203 g, 2.73 g and 11.63 g at 30, 45 and 60 DAS, respectively) was recorded in M_3 treatment while lowest plant dry weight (0.186 g, 2.01 g and 8.42 g at 30, 45 and 60 DAS, respectively) was found in M_1 treatments. The highest plant dry weight was recorded in V_3M_3 (0.234 g, 3.89 g and 15.47 g at 30, 45 and 60 DAS, respectively) treatments and minimum number of plant dry weight was found in V_1M_1 (0.181 g, 1.54 g and 5.04 g at 30, 45 and 60 DAS, respectively).

The maximum number of nodules plant^{-1} was found in V_3 variety and minimum number of nodules was recorded in V_1 variety. The values of nodules number in V_3 treatment was 7.80 while the values of nodules number in V_1 treatment was 5.73. The maximum number of nodules plant^{-1} (8.37) was recorded in M_1 treatment while minimum number of nodules plant^{-1} (4.93) was found in M_3 treatments. This might be due to minimum management in M_1 treatment facilitated to produce maximum number of nodules. The maximum number of nodules was recorded in V_3M_1 (10.26) treatments and minimum number of nodules was found in V_3M_3 (4.86).

The highest nodules dry weight (0.056 g) was found in V_3 and lowest nodules dry weight (0.047 g) was recorded in V_1. The nodules dry weight is directly associated with the varieties of mungbean. The nodules dry weight range was from 0.049 g to 0.052 g. The highest nodules dry weight was recorded in M_1 and lowest nodules dry weight in M_3. The highest nodules dry weight (0.058 g) was found in V_3M_1 compared to others combinations. The lowest nodules dry weight was produced by V_1M_1 and V_2M_3 (0.042 g).

The maximum number of pods was found in V_3 variety and minimum number of pods was recorded in V_1 variety. The values of pods number in V_3 and V_1 variety was 12.33 and 6.56, respectively. The maximum number of pods plant^{-1} (12.11) was recorded in M_3 treatment while the minimum number of pods plant^{-1} (6.00) in M_1 treatments. The maximum number of pods was recorded in V_3M_3 (14.00) and the minimum number of pods in V_1M_1 (3.66).

The highest value of pod length (9.41 cm) was recorded from the variety V_3 while the lowest value (8.55 cm) of the same trait was found in variety V_1. This might be due the genetic variations among the variety.

The longest pod (9.55 cm) was produced by M_3 treatment while the shortest pod (10.44 cm) was produced by the treatment M_1. The combination of V_3M_3 produced highest value of pod length (10.50 cm) and the lowest value (8.07 cm) of the same trait was recorded in V_1M_1.

The maximum number of seeds pod^{-1} was found in V_3 variety and minimum number of seeds pod^{-1} was recorded in V_1 variety. The number of seeds pod^{-1} were ranges from 10.11 to 12.22. The maximum number of seeds pod^{-1} (12.00) was recorded in M_3 treatment while minimum number of seeds pod^{-1} (10.44) in M_1 treatments. The maximum number of seeds pod^{-1} was recorded in V_3M_3 (13.00) treatments and minimum number of seeds pod^{-1} in V_1M_1 (9.00).

The highest weight of 1000 seeds (40.46 g) was found in V_3 and lowest 1000 seeds weight (36.56 g) was recorded in V_1. The 1000 seeds weight is directly associated with the varieties of mungbean. The 1000 seeds weight was range from 36.24 g to 39.95 g. The highest 1000 seeds weight was recorded in M_3 and lowest 1000 seeds weight was found in M_1 treatment. The highest 1000 seeds weight (42.46 g) was found in V_3M_1 combined compared to others combinations. The lowest value of 1000 seed weight was produced by V_1M_1 (34.53 g).

The highest seed yield was found in V_3 treatment and lowest seed yield was recorded in V_3 treatment. The seed yield ranges from 547.03 kg ha^{-1} to 746.04 kg ha^{-1}. The highest seed yield was recorded in M_3 treatment (1032.10 kg ha^{-1}) while lowest seed yield was found in M_1 treatments (130.70 kg ha^{-1}). The highest seed yield was recorded in V_3M_3 treatment (1198.10 kg ha^{-1}) and lowest seed yield was found in V_1M_1 (78.30 kg ha^{-1}).

The highest shell yield (294.30 kg ha^{-1}) was found in V_3 variety and lowest shell yield (243.04 kg ha^{-1}) in V_1 variety. The shell yield was range from 142.19 kg ha^{-1} to 411.69 kg ha^{-1}. The highest shell yield was recorded in M_3 and the lowest shell yield in M_1.

The highest shell yield (479.36 kg ha^{-1}) was found in V_3M_3 combined compared to others combinations. The lowest shell yield was produced by V_1M_1 (133.91 kg ha^{-1}).

The highest stover yield (2.02 ton ha^{-1}) was found in V_3 variety and lowest stover yield (1.63 ton ha^{-1}) was recorded in V_1 variety. The stover yield was range from 1.29 ton ha^{-1} to 2.37 ton ha^{-1}. The highest stover yield was recorded in M_3 and the lowest stover yield was found in M_1. The highest stover yield (2.45 ton ha^{-1}) was found in V_3M_3 combined compared to others combinations. The lowest stover yield was produced by V_1M_1 (1.18 ton ha^{-1}).

In case of varietal treatment, the highest number of weeds (1512.00 and 1384.00 at 45 DAS and 60 DAS, respectively) was found around the V_3 variety and the lowest number of weeds (1221.30 and 1117.30 at 45 DAS and 60 DAS, respectively) was recorded around the V_1 variety. The highest number of weeds (1768.00 and 1680.00 at 45 DAS and 60 DAS, respectively) was recorded in M_1 treatment while the lowest number of weeds (568.00 and 266.70 at 45 DAS and 60 DAS, respectively) was found in M_3 treatments. The highest number of weeds recorded in V_3M_1 (2048.00 and 2048.00 at 45 DAS and 60 DAS, respectively) treatments and the lowest number of weeds was found in V_2M_3 (480.00 and 216.00 at 45 DAS and 60 DAS, respectively).

In case of varietal treatment, the highest weeds dry weight (410.24 g and 375.73 g at 45 DAS and 60 DAS, respectively) was found in V_3 variety and the lowest weeds weight (331.47 g and 303.52 g at 45 DAS and 60 DAS, respectively) was recorded in $V_{1.}$ The weeds weight was ranges from 154.13 g to 476.81 g and 72.43 g to 456.29 g at 45 DAS and 60 DAS, respectively.

The highest weeds weight was recorded in M_1 and the lowest weeds weight in M_3. The highest weeds weight (555.68 g and 556.00 g at 45 DAS and 60 DAS, respectively) was found in V_3M_1 combined compared to others combinations. The lowest weeds weight was produced by V_1M_3 (147.68 g at 45 DAS) and V_3M_3 (52.56 g at 60 DAS).

Combined effect of mungbean varieties and management showed non-significant effect on stover yield. The maximum stover yield was recorded in V_3M_3 treatment (2.45 ton ha^{-1}) and the lowest stover yield was found in V_1M_1 (0.25 ton ha^{-1}). The highest values of yield and yield contributing character i.e. number of pods $plant^{-1}$, number of seeds per pod, pod length, 1000 seeds weight andseed yield were highest in V_3M_3 combination. Therefore, the combine effect V_3M_3 could be used to cultivate mungbean for increasing production.

CONCLUSION

- The variety Binamoog 8 showed highest seed yield due to higher yield attributes.
- High management level (Fertilizer 40-20-40 NPK kg ha^{-1} + 24 kg seeds ha^{-1} in line sowing + pesticide application + two hand weedings) gave higher seed yield as compared to other management packages.
- In combined effect, the variety Binamoog 8 along with high management level showed high seed yield and yield attributes.
- More research should be done in different agro-ecological zone at farmer's field for valid conclusion.

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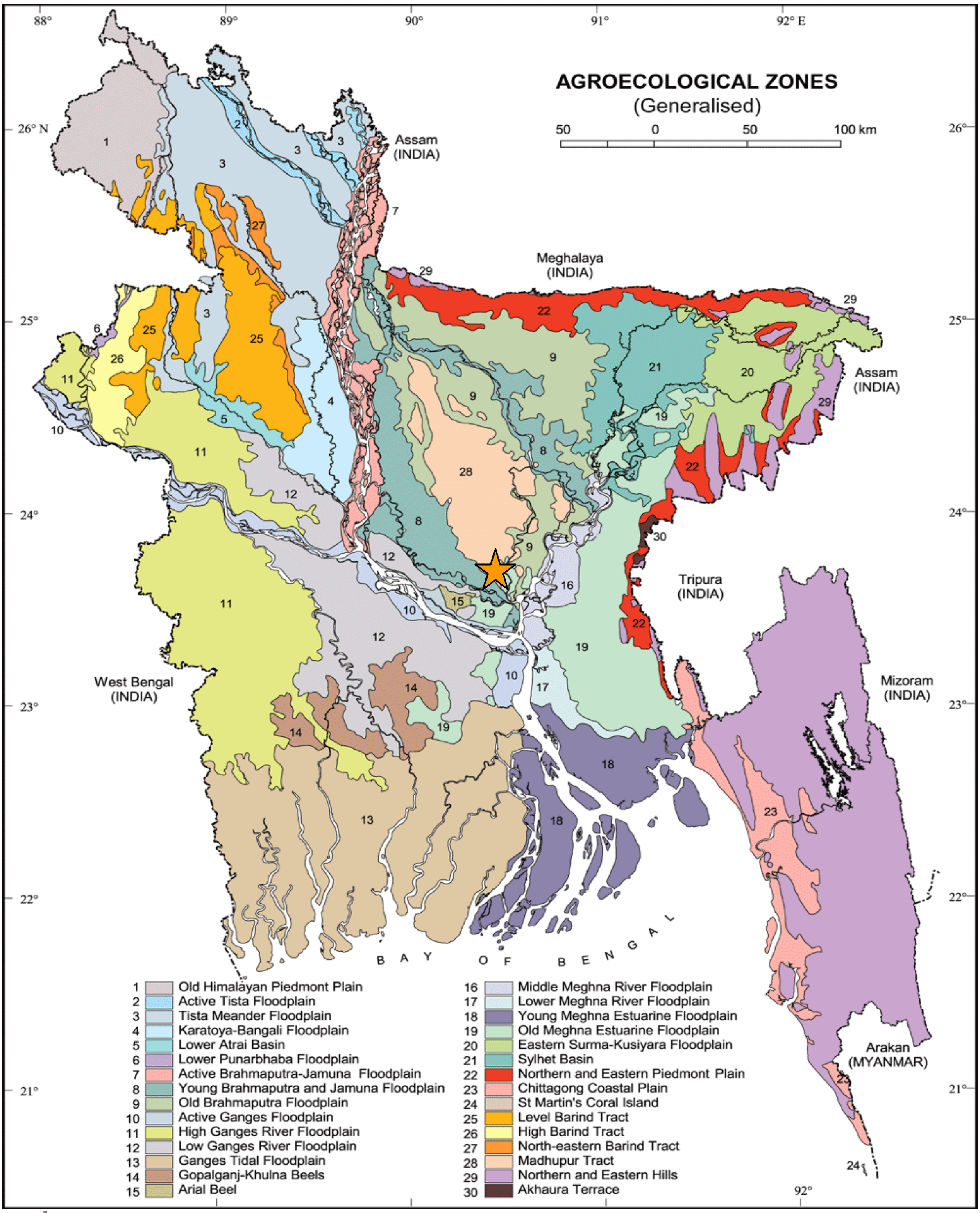
Appendices

APPENDICES

Appendix I. Map showing the experimental sites under study



★ **The experimental site under study**

Appendix II. Anova for the germination of 3rd day

Source	DF	SS	MS	F	P
Replication	2	1607.41	803.704		
Variety	2	1111.63	555.815	2.86	0.1693
Error I	4	777.04	194.259		
Management	2	1139.19	569.593	10.05	0.0027
Variety X Management	4	41.93	10.481	0.18	0.9418
Error II	12	680.22	56.685		
Total	26	5357.41			

Appendix III. Anova for the germination of 4th day

Source	DF	SS	MS	F	P
Replication	2	587.19	293.593		
Variety	2	1331.63	665.815	16.86	0.0112
Error I	4	157.93	39.481		
Management	2	503.19	251.593	1.77	0.2124
Variety X Management	4	57.93	14.481	0.10	0.9798
Error II	12	1708.22	142.352		
Total	26	4346.07			

Appendix IV. Anova for the germination of 5th day

Source	DF	SS	MS	F	P
Replication	2	543.19	271.593		
Variety	2	743.19	371.593	2.24	0.2229
Error I	4	664.59	166.148		
Management	2	1511.63	755.815	22.33	0.0001
Variety X Management	4	380.15	95.037	2.81	0.0741
Error II	12	406.22	33.852		
Total	26	4248.96			

Appendix V. Anova for the plant height at 15 DAS

Source	DF	SS	MS	F	P
Replication	2	1.7859	0.89293		
Variety	2	3.8099	1.90493	15.79	0.0126
Error I	4	0.4827	0.12067		
Management	2	2.5420	1.27098	0.99	0.3997
Variety X Management	4	0.1588	0.03971	0.03	0.9979
Error II	12	15.3931	1.28276		
Total	26	24.1723			

Appendix VI. Anova for the plant height at 30 DAS

Source	DF	SS	MS	F	P
Replication	2	46.251	23.1255		
Variety	2	75.664	37.8320	4.97	0.0822
Error I	4	30.420	7.6050		
Management	2	52.381	26.1905	3.17	0.0783
Variety X Management	4	8.047	2.0116	0.24	0.9079
Error II	12	99.021	8.2518		
Total	26	311.784			

Appendix VII. Anova for the plant height at 45 DAS

Source	DF	SS	MS	F	P
Replication	2	35.515	17.757		
Variety	2	201.908	100.954	6.77	0.0520
Error I	4	59.653	14.913		
Management	2	347.161	173.581	19.69	0.0002
Variety X Management	4	60.133	15.033	1.71	0.2132
Error II	12	105.783	8.815		
Total	26	810.152			

Appendix VIII. Anova for the plant height at 60 DAS

Source	DF	SS	MS	F	P
Replication	2	9.91	4.953		
Variety	2	899.18	449.589	25.23	0.0054
Error I	4	71.28	17.820		
Management	2	469.27	234.636	8.40	0.0052
Variety X Management	4	55.21	13.802	0.49	0.7406
Error II	12	335.32	27.943		
Total	26	1840.17			

Appendix IX. Anova for the leaflet at 15 DAS

Source	DF	SS	MS	F	P
Replication	2	0.02074	0.01037		
Variety	2	0.02074	0.01037	0.07	0.9344
Error I	4	0.60148	0.15037		
Management	2	0.02074	0.01037	0.28	0.7606
Variety X Management	4	0.20148	0.05037	1.36	0.3047
Error II	12	0.44444	0.03704		
Total	26	1.30963			

Appendix X. Anova for the leaflet at 30 DAS

Source	DF	SS	MS	F	P
Replication	2	0.1067	0.05333		
Variety	2	5.9467	2.97333	5.57	0.0697
Error I	4	2.1333	0.53333		
Management	2	6.5067	3.25333	6.59	0.0117
Variety X Management	4	1.4933	0.37333	0.76	0.5728
Error II	12	5.9200	0.49333		
Total	26	22.1067			

Appendix XI. Anova for the leaflet at 45 DAS

Source	DF	SS	MS	F	P
Replication	2	0.702	0.3511		
Variety	2	64.747	32.3733	20.09	0.0082
Error I	4	6.444	1.6111		
Management	2	25.076	12.5378	13.31	0.0009
Variety X Management	4	3.831	0.9578	1.02	0.4373
Error II	12	11.307	0.9422		
Total	26	112.107			

Appendix XII. Anova for the leaflet at 60 DAS

Source	DF	SS	MS	F	P
Replication	2	3.399	1.6993		
Variety	2	144.643	72.3215	54.54	0.0013
Error I	4	5.304	1.3259		
Management	2	57.816	28.9081	23.00	0.0001
Variety X Management	4	1.713	0.4281	0.34	0.8454
Error II	12	15.084	1.2570		
Total	26	227.959			

Appendix XIII. Anova for the branches plant^{-1} at 45 DAS

Source	DF	SS	MS	F	P
Replication	2	0.8030	0.40148		
Variety	2	0.1807	0.09037	1.79	0.2779
Error I	4	0.2015	0.05037		
Management	2	10.8919	5.44593	52.89	0.0000
Variety X Management	4	0.9926	0.24815	2.41	0.1068
Error II	12	1.2356	0.10296		
Total	26	14.3052			

Appendix XIV. Anova for the branches plant^{-1} at 60 DAS

Source	DF	SS	MS	F	P
Replication	2	0.8207	0.41037		
Variety	2	0.4652	0.23259	4.83	0.0857
Error I	4	0.1926	0.04815		
Management	2	8.9452	4.47259	51.61	0.0000
Variety X Management	4	0.3081	0.07704	0.89	0.4998
Error II	12	1.0400	0.08667		
Total	26	11.7719			

Appendix XV. Anova for the plant dry weight at 30 DAS

Source	DF	SS	MS	F	P
Replication	2	0.00664	$3.319E^{-03}$		
Variety	2	0.00460	$2.299E^{-03}$	3.13	0.1522
Error I	4	0.00294	$7.352E^{-04}$		
Management	2	0.00129	$6.473E^{-04}$	1.28	0.3123
Variety X Management	4	0.00114	$2.840E^{-04}$	0.56	0.6939
Error II	12	0.00605	$5.040E^{-04}$		
Total	26	0.02266			

Appendix XVI. Anova for the plant dry weight at 45 DAS

Source	DF	SS	MS	F	P
Replication	2	4.8798	2.43990		
Variety	2	9.4466	4.72332	2.29	0.2177
Error I	4	8.2627	2.06566		
Management	2	2.7831	1.39153	1.91	0.1908
Variety X Management	4	1.5195	0.37986	0.52	0.7224
Error II	12	8.7532	0.72943		
Total	26	35.6448			

Appendix XVII. Anova for the plant dry weight at 60 DAS

Source	DF	SS	MS	F	P
Replication	2	23.317	11.659		
Variety	2	203.260	101.630	6.43	0.0563
Error I	4	63.204	15.801		
Management	2	47.492	23.746	2.56	0.1189
Variety X Management	4	3.499	0.875	0.09	0.9824
Error II	12	111.470	9.289		
Total	26	452.242			

Appendix XVIII. Anova for the number of nodules plant^{-1}

Source	DF	SS	MS	F	P
Replication	2	0.590	0.2948		
Variety	2	19.239	9.6193	0.66	0.5672
Error I	4	58.699	14.6748		
Management	2	54.296	27.1481	2.42	0.1311
Variety X Management	4	9.553	2.3881	0.21	0.9264
Error II	12	134.738	11.2281		
Total	26	277.114			

Appendix XIX. Anova for the nodule dry weight

Source	DF	SS	MS	F	P
Replication	2	$1.163E^{-03}$	$5.815E^{-04}$		
Variety	2	$4.501E^{-04}$	$2.250E^{-04}$	3.60	0.1278
Error I	4	$2.504E^{-04}$	$6.259E^{-05}$		
Management	2	$2.696E^{-05}$	$1.348E^{-05}$	0.07	0.9343
Variety X Management	4	$4.344E^{-04}$	$1.086E^{-04}$	0.55	0.7022
Error II	12	$2.365E^{-03}$	$1.971E^{-04}$		
Total	26	$4.690E^{-03}$			

Appendix XX. Anova for the number of pods plant^{-1}

Source	DF	SS	MS	F	P
Replication	2	107.185	53.5926		
Variety	2	164.741	82.3704	10.32	0.0264
Error I	4	31.926	7.9815		
Management	2	168.963	84.4815	21.62	0.0001
Variety X Management	4	20.148	5.0370	1.29	0.3282
Error II	12	46.889	3.9074		
Total	26	539.852			

Appendix XXI. Anova for the pod length

Source	DF	SS	MS	F	P
Replication	2	1.0320	0.51600		
Variety	2	4.3637	2.18183	1.53	0.3214
Error I	4	5.7115	1.42787		
Management	2	8.5883	4.29416	8.50	0.0050
Variety X Management	4	1.2198	0.30496	0.60	0.6674
Error II	12	6.0622	0.50519		
Total	26	26.9775			

Appendix XXII. Anova for the number seeds pod^{-1}

Source	DF	SS	MS	F	P
Replication	2	10.2963	5.1481		
Variety	2	20.0741	10.0370	7.04	0.0490
Error I	4	5.7037	1.4259		
Management	2	11.1852	5.5926	2.72	0.1061
Variety X Management	4	1.4815	0.3704	0.18	0.9443
Error II	12	24.6667	2.0556		
Total	26	73.4074			

Appendix XXIII. Anova for the 1000 seed weight

Source	DF	SS	MS	F	P
Replication	2	1.425	0.7126		
Variety	2	78.156	39.0781	8.38	0.0372
Error I	4	18.664	4.6659		
Management	2	61.979	30.9893	13.87	0.0008
Variety X Management	4	1.704	0.4259	0.19	0.9387
Error II	12	26.811	2.2343		
Total	26	188.739			

XXIV. Anova for the seed yield

Source	DF	SS	MS	F	P
Replication	2	45182	22591		
Variety	2	189144	94572	1.05	0.4308
Error I	4	361240	90310		
Management	2	3795677	1897838	216.57	0.0000
Variety X Management	4	22555	5639	0.64	0.6419
Error II	12	105159	8763		
Total	26	4518956			

Appendix XXV. Anova for the shell yield

Source	DF	SS	MS	F	P
Replication	2	14023	7012		
Variety	2	11848	5924	0.81	0.5073
Error I	4	29323	7331		
Management	2	331110	165555	44.22	0.0000
Variety X Management	4	13603	3401	0.91	0.4898
Error II	12	44926	3744		
Total	26	444832			

Appendix XXVI. Anova for the number of weeds at 45 DAS

Source	DF	SS	MS	F	P
Replication	2	1149824	574912		
Variety	2	714368	357184	9.63	0.0296
Error I	4	148352	37088		
Management	2	7257600	3628800	115.79	0.0000
Variety X Management	4	87040	21760	0.69	0.6101
Error II	12	376064	31339		
Total	26	9733248			

Appendix XXVII. Anova for the number of weeds at 60 DAS

Source	DF	SS	MS	F	P
Replication	2	1575595	787797		
Variety	2	986667	493333	1.82	0.2747
Error I	4	1086549	271637		
Management	2	$1.048E^{+07}$	5240405	49.52	0.0000
Variety X Management	4	337109	84277	0.80	0.5500
Error II	12	1270016	105835		
Total	26	$1.574E^{+07}$			

Appendix XXVIII. Anova for the weed weight at 45 DAS

Source	DF	SS	MS	F	P
Replication	2	84490	42245		
Variety	2	52438	26219	9.57	0.0299
Error I	4	10958	2740		
Management	2	534599	267299	115.94	0.0000
Variety X Management	4	6385	1596	0.69	0.6113
Error II	12	27665	2305		
Total	26	716536			

Appendix XXVIV. Anova for the weed weight at 60 DAS

Source	DF	SS	MS	F	P
Replication	2	116184	58092		
Variety	2	72470	36235	1.80	0.2770
Error I	4	80532	20133		
Management	2	773134	386567	49.40	0.0000
Variety X Management	4	24734	6183	0.79	0.5535
Error II	12	93897	7825		
Total	26	1160951			