GROWTH AND YIELD OF MUNGBEAN AS AFFECTED BY AGRONOMIC MANAGEMENTS

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This is to certify that the thesis entitled "**GROWTH AND YIELD OF MUNGBEAN AS AFFECTED BY AGRONOMIC MANAGEMENTS**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of **Master of Science** in **Agronomy**, embodies the result of a piece of bona fide research work carried out by **MD.ABU RAYHAN**, Registration number: **18-09091** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

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DEDICATED TO

MY

BELOVED PARENTS

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The Author

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ABSTRACT

A field experiment was carried out at the research field of Sher-e-Bangla Agricultural University, Dhaka during the period of March to June 2019 to study the influence of agronomic managements on the growth and yield of mungbean. The experiment comprised of two factors; Factor A: Variety (2) viz. BARI Mung-5 (V_1) and BARI Mung-6 (V_2) and Factor B: Agronomic managements (7) viz. Control- no managements (M_1), All managements except fertilizer (M_2), All managements except weeding (M_3), All managements except irrigation (M_4), All managements except insecticide (M_5), All managements except fungicide/ bactericide (M_6), Complete managements (M_7). The experiment was laid out in factorial arrangements of split-plot design with three replications. Results revealed that number of leaves plant^{-1} (9.69), number of weeds m^{-2} (123.71), dry weight of weeds (28.58), days to flowering (43.48 days) and number of seeds pod^{-1} (9.23) were significantly higher in BARI Mung-5 (V_1) but plant height (44.49 cm), number of nodules plant^{-1} (19.52), dry weight (7.55 g) plant^{-1}, SPAD value (55.98), number of pods plant^{-1} (45.71), weight of 1000-seed (43.14 g), seed yield (582.32 kg ha^{-1}), shell yield (322.80 kg ha^{-1}), shelling percentage (64.19%) and harvest index (15.41 %) were higher in BARI Mung-6 (V_2). Complete managements (M_7) showed better results in case of all growth and yield parameters than no managements (M_1). Results from interaction effect of variety and managements revealed that the highest seed yield (714.82 kg ha^{-1}) was obtained from the interaction of V_2M_6 due to the highest number of pods plant^{-1} and 1000- seed weight. Weed number (162.00) and dry weight (24.67 g) of weeds m^{-2} were found to be higher in V_1M_1 and V_2M_4 interaction, respectively. The overall result showed that BARI Mung-6 (V_2) with complete management (M_7) produced better yield in mungbean. Compared to that of complete management, the highest yield reduction was observed in no management (64.62%) that followed by no weeding (49.78%), no irrigation (13.96%) and no insecticide (10.98%).

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LIST OF ABBREVIATIONS

Abbreviations	Full word
AEZ	Agro-ecological zone
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BINA	Bangladesh Institute of Nuclear Agriculture
BSMRAU	Bangabandhu Sheikh Mujibur Rahman Agricultural University
Cm	Centimeter
CV	Coefficient of Variation
DAS	Days After Sowing
et al.	And others (*et alibi*)
FAO	Food and Agriculture Organization
G	Gram
Ha	Hectare
HI	Harvest Index
Kg	Kilogram
LSD	Least Significant Difference
m^2	Square Meter
MOP	Muriate of Potash
No.	Number
NS	Non-Significant
%	Percent
100% F	100% Flowering
$plant^{-1}$	per plant
Seeds pod^{-1}	Seeds per pod
SPAD	Soil and Plant Analyzer Development
TSP	Triple Super-phosphate
kg ha^{-1}	kilogram per hectare
viz.	Namely

CHAPTER 1

INTRODUCTION

Pulses are edible dry seeds of plants belonging to the Fabaceae family. They are consumed in the form of whole seed, split grain, dehulled split grain and flour. Many different types of pulses are grown the world over. Of these, the major ones, in terms of global production and consumption quantities, are the common bean, chickpea, dry pea, lentil, cowpea, mung bean, urd bean and pigeonpea. In addition, there are a large number of minor pulses that are grown and consumed in different parts of the world (FAO, 2016).

Mung bean (*Vigna radiata* L.) commonly known as green gram is an ancient and well-known pulse crop that belongs to family Fabaceae and originated from South East Asia. Mung beans are mainly grown for human food, in the form of boiled dry beans, stew, flour, sprouts and immature pods as a vegetable. The dry beans are sometimes used for animal food, mainly poultry, when they are either roasted or boiled while its biomass is used as fodder (Winch, 2006). Thus, it has great value as food and fodder. It is a cheap source of protein for human consumption.

According to Dainavizadeh and Mehranzadeh (2013), the nutrient composition of the seed of mung bean contains 20–24% protein, 9.4% moisture, 2.1% oil, 2.05% fats, 6.4% fiber, 343.5 kcal per100 gram energy, carbohydrates and a fair amount of vitamin A and B. In addition, the protein and carbohydrates of mung bean are more easily digestible than proteins derived from other legumes. The foliage and stems are used as fodder for livestock. It synthesizes N in Symbiosis with *Rhizobia* and enriches the soil. It fixes atmospheric N and thus improves the fertility status of soil and can fix N in soil by 63-342 kg ha^{-1} per season (Anjum *et al*., 2006).

The area under pulse crops in Bangladesh is 875 thousand acres with a production of 393 thousand million tons where mungbean is cultivated in the area of 102 thousand acres with production of 34 thousand million tons. It holds the 4^{th}

position in terms of acreage and production but ranks the highest in consumer preference and market price (BBS, 2019).

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. 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).

However it is one of the least cared crops. Moreover, lack of attention on fertilizer application in proper way with appropriate amount is also managerial factors in lowering mungbean yields (Mansoor, 2007). Being leguminous nature, mungbean needs low nitrogen with the application of suitable time and methods. Phosphorus is another important essential nutrient for the normal growth and development of plant. Potassium influences nutrient uptake by promoting root growth and nodulation. Sulphur and Boron has a great importance on yield and yield components of mungbean (Halwai *et al*., 2016). Soil fertility was improved significantly with farmyard manure used either alone or in combination with NPK over that of initial soil status (Singh *et al.*, 2001).

In Bangladesh Kharif-I Mungbean is a rainfed crop which grows on residual soil moisture. Mungbean responses favorably to added water resulting higher yields, especially when irrigation is given at the time of flowering (Lawn, 1978; Miah and Carangal, 1981). Yield performance of mungbean can be achieved by combined effect of row spacing and seed rate. Proper row spacing is one of the most important factors affecting the growth specially the weed growth in the early stage of the crop development. Farmers of this area are usually reluctant in growing mungbean in rows while row planting facilitates easy intercultural operations resulting in higher yields (BARI, 1997).

Karim (1987) estimated that weeds caused a yield loss of 28% of total food crops, 33% in cereals, 14% in pulses, 27% in oilseed and 33% in the rice crops. Although mungbean is competitive against weed control yet it is essential for pulse production (Moody, 1978). But in Bangladesh there is a general belief that mungbean does not require any weeding. So the farmers usually do not give much attention in weed control in this crop. Management of mungbean insect pests also available which also needed to be compared with other management tools.

Appropriate agronomic management practices greatly influence on the growth and yield of mungbean. Yield loss also occurred due to improper weed management, nutrient management and irrigation schedule. Therefore, these managements together is a complete package for achieving satisfactory yield production in mungbean.

From the above discussion, it is obligatory to search out suitable agronomic managements for the farmers to improve crop productivity on sustainable basis. Keeping in view the importance of mungbean and the role of agronomic managements on the growth and yield of mungbean, the present research work has been undertaken in *Kharif-1* season with the following objectives:

1. To compare the yield of two 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

Before conducting a research, it is always desirable to review the literature of the previous workers who had experienced in tackling difficulties faced by them and suggested some guidelines for solving their problems on various aspects of crops similar to what is in mind of successive investigator. Thus an attempt to be made to find and collect the relevant information available in the country and abroad from different sources to bridge knowledge gaps and to analyze the literature in our own perspective. Some of the most relevant and most recent information is reviewed in this chapter.

2.1 Effect of variety

An experiment was conducted by Hossain *et al.* (2014) 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 yield than BARI Mung-5.

Agugo *et al*. (2010) conducted an experiment in the Asian Vegetable Research and Development Centre (AVRDC) with four mungbean accessions. Results showed a significant difference in the yield of varieties with VC 6372 (45-8-1) producing the highest seed yield of 0.53 t ha^{-1} followed by NM 92, NM 94 and VC 1163 with 0.48 t ha^{-1}, 0.40 t ha^{-1} and 0.37 t ha^{-1}, respectively. The variety VC 6372 (45-8-1) also showed good agronomic characters.

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 5 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}.

A field experiment was conducted using BARI Mung-6 and Sona mung as planting materials and found that seed yield was higher in BARI Mung-6 after harvesting the crop at 35 days after anthesis. Weight of thousand seeds and pod length were 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} were highest in Sona mung with harvesting at 15, 20 and 30 days after anthesis, respectively (Ghosh, 2007).
experiment was carried out in the field of the Department of Crop Botany, Bangladesh Agricultural University (BAU), Mymensingh to evaluate the influence of seed treatment with IAA at a conc. of 50 ppm, 100 ppm and 200 ppm on the growth, yield and yield contributing characters of two modern mungbean (*Vigna radiata* L.) varieties viz. BARI Mung-4 and BARI Mung-5. Between the mungbean varieties, BARI Mung-5 performed better than that of BARI Mung-4 reported by Quaderi *et al.* (2006).

Islam *et al.* (2006) conducted an experiment at the field of the Department of Crop Botany, Bangladesh Agricultural University (BAU), Mymensingh to evaluate the effect of biofertilizer (*Bradyrhizobium*) and plant growth regulators (GA_3 and IAA) on growth of 3 cultivars of summer mungbean (*Vigna radiata* L.). Among the mungbean varieties, Binamoog-5 performed better than that of Binamoog-2 and Binamoog-4.

Tickoo *et al*. (2006) evaluated two mungbean cultivars Pusa 105 and Pusa Vishal, sown at 22.5 and 30 cm spacing and supplied with 36-46 and 58-46 kg NP ha^{-1} in a field experiment in Delhi, India during the Kharif season of 2000. Cultivar Pusa

Vishal recorded higher biological and seed yield (3.66 and 1.63 t ha^{-1}, respectively) compared to cv. Pusa 105.

Aghaalikhani *et al.* (2006) conducted a field experiment at the Seed and Plant Improvement Institute of Karaj, Iran, in the summer of 1998, to evaluate the effects of crop densities (10, 13, 20 and 40 plants m^{-2}) on yield and yield components of two cultivars (Partow and Gohar) and a line of mungbean (VC-1973A). The results indicated that VC-1973A had the highest grain yield which was superior to the other cultivars due to its early and uniform seed maturity and easy mechanized harvest.

A field experiment was conducted by Rahman *et al*. (2005) with mungbean (Feb-Jun, 1999) in Jamalpur, Bangladesh, involving planting methods, i.e. line sowing & broadcasting; mungbean cultivars (5), namely Local, BARI Mung-2, BARI Mung-3, Binamoog-2 and Binamoog-5; and sowing dates (5), i.e. 5 February, 20 February, 5 March, 20 March and 5 April. Significantly the highest dry matter production ability was found in 4 high yielding cultivars, but dry matter partitioning was highest in seeds of Binamoog-2 and lowest in local one. But the local cultivar produced the highest dry matter in leaf and stem.

A yield trial was conducted by Chaisri *et al*. (2005) involving 6 recommended cultivars (KPS 1, KPS 2, CN 60, CN 36, CN 72 and PSU 1) and 5 elite lines (C, E, F, G, H) in Lopburi Province, Thailand, during the dry (Feb-May, 2002), early rainy (Jun-Sep, 2002) and late rainy season (Oct 2002-Jan 2003). The Line C, KPS 1, CN 60, CN 36 and CN 72 gave high yields in the early rainy season, while line H, line G, line E, KPS 1 and line C gave high yields in the late rainy season.

Bhati *et al.* (2005) conducted an experiment from 2000 to 2003 to evaluate the effects of cultivars on the productivity of different kharif legumes (mungbean, mothbean and clusterbean) in the arid region of Rajasthan, India. The experiment with mungbean variety K-851 gave better yield than Asha and the local cultivar. In another experiment, mungbean cv. PDM-54 showed 56.9% higher seed yield and 13.7% higher fodder yield than the local cultivar.

Raj and Tripathi (2005) conducted a field experiment in Jodhpur, Rajasthan, India, during the kharif seasons, to evaluate the effect of cultivars (K-851 and RMG-62) as well as nitrogen (0 and 20 kg ha^{-1}) and phosphorus levels (0, 20 and 40 kg ha^{-1}) on the productivity of mungbean. The cultivars K-851 produced significantly higher values for seed and stover yields as well as yield attributes (plant height, pods $plant^{-1}$, seeds pod^{-1} and 1000-seed weight) compared with RMG-62.

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. 6 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.

Shamsuzzaman *et al*. (2004) grown two summer mungbean cultivars, i.e., Binamoog-2 and Binamoog-5, during the kharif-1 season (Feb-May, 2001) in Mymensingh, Bangladesh, under no irrigation or with irrigation one at 30 days after sowing (DAS), two at 30 and 50 DAS, and three at 20, 30 and 50 DAS. The two cultivars tested were synchronous in flowering, pod maturity and leaf senescence which were significantly delayed under different irrigated frequencies. Binamoog-2 performed slightly better than Binamoog-5 for most of the growth and yield parameters studied.

Apurv and Tewari (2004) conducted a field experiment during kharif season in Uttaranchal, India, to investigate the effect of *Rhizobium* inoculation and fertilizer on the yield and yield components of three mungbean cultivars (Pusa 105, Pusa 9531 and Pant Mung-2). Pusa 9531 showed highest yield components and grain yield than Pusa 105 and Pant Mung-2.

Madriz-Isturiz and Luciani-Marcano (2004) conducted a field trial to evaluate the performance of 20 mungbean cultivars in Venezuela, during the rainy season of 1994-95 and dry season of 1995. Among the cultivars, five like VC 1973C, Creole VC 1973A, VC 2768A, VC 1178B and Mililiter 267 were the most promising cultivars for cultivation in the area with the average yield was 1342.58 kg ha^{-1}.

Hossain and Solaiman (2004) investigated the effects of *Rhizobium* inoculation on the nodulation, plant growth, yield attributes, seed and stover yield, and seed protein content of six mungbean (*Vigna radiata*) cultivars. It was concluded that BARI Mung-4 in combination with TAL 169 strain of *Rhizobium* performed the best in terms of nodulation, plant growth, seed and stover yield and seed protein content.

Abid *et al*. (2004) conducted an experiment in Peshawar, Pakistan, during the summer season 2002, to study the effect of sowing dates (15 April, 15 May, 15 June, 15 July and 15 August) on the agronomic traits and yield of mungbean cultivars (NM-92 and M-1). Sowing on 15 April took more number of days to emergence but showed highest plant height. The highest emergence m^{-2} was recorded in 15 June-sown plants. Sowing on 15 August gave the highest number of days to 50% flowering and to physiological maturity while 15 April-sown plants gave the highest mean grain yield. NM-92 gave higher mean grain yield than M-1. The highest seed yield was found in 15 April-sown with cultivar M-1 plants.

Riaz *et al*. (2004) investigated the effect of seeding rates (15, 20 and 25 kg seed ha^{-1}) on the growth and yield of mungbean cultivars (NM-92, NARC Mung-1 and NM-98) in Faisalabad, Pakistan during 2002-03. The cultivar NM-98 produced the highest pod number (17.30), grain yield (983.75 kg ha^{-1}) and harvest index

(24.91%) where cultivar NM-92 produced the highest seed protein content (24.64%).

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.

An experiment was carried out by Taj *et al*. (2003) to find out the effects of seeding rates (10, 20, 30 and 40 kg seed ha^{-1}) on the performance of 5 mungbean cultivars (NM-92, NM 19-19, NM 121-125, N/41 and a local cultivar) in Ahmadwala, Pakistan, during the summer season, 1998. Among the cultivars, NM 121-125 recorded the highest average pods $plant^{-1}$ (18.18), seeds pod^{-1} (9.79), 1000-seed weight (28.09 g) and seed yield (1446.07 kg ha^{-1}).

Satish *et al*. (2003) conducted an experiment in Haryana, India to examine the response of mungbean cultivars (Asha, MH 97-2, MH 85-111 and K 851) to different P levels. MH 97-2 and Asha produced significantly more number of pods and branches $plant^{-1}$ compared to MH 85-111 and K 851.

Infante *et al.* (2003) conducted an experiment to evaluate the development phases and seed yield in mungbean cultivars i.e., ML 267, Acriollado and VC 1973C under the agro-ecological conditions of Maracay, Venezuela, during May-July, 1997. The earliest cultivar was ML 267 with 34.87 days to flowering and 61.83 to maturity. There were significant differences for total pod clusters $plant^{-1}$ and pods $plant^{-1}$ where ML 267 and Acriollado had the highest values. The total seeds pod^{-1} of VC 1973C and Acriollado was significantly greater than ML 267. Acriollado showed the highest yield with 1438.33 kg ha^{-1}.

Navgire *et al.* (2001) conducted a field experiment in Maharashtra, India during the kharif season including seeds of mungbean cultivars (BM-4, S-8 and BM-86) were inoculated with *Rhizobium* strains (M-11-85, M-6-84, GR-4 and M-6-65) before sowing. S-8, BM-4 and BM-86 recorded the highest mean nodulation (16.66), plant biomass (8.29 q ha^{-1}) and grain yield (4.79 q ha^{-1}) during the experimental years.

A field experiment was carried out by Nayak and Patra (2000) in which eight improved and four local mungbean cultivars were evaluated. Results of their study revealed that the yield was 0.45-0.63 t ha^{-1} in the local cultivars and 0.61-1.01 t ha^{-1} in the improved cultivars.

A field experiment was conducted by Mitra and Bhattacharya (1999) in India during the kharif (rainy) season of 1996 and 1997 to study the effect of cultivars on the growth and yield of mungbean. They observed that mungbean cv. GM-9002 had greater dry matter (at harvest), number of pods $plant^{-1}$, number of seeds pod^{-1}, 1000-seed weight, seed yield and total biomass yields than cv. UPM-12 or MH-309.

Hamed (1998) carried out two field experiments during 1995 and 1996 in Shalakan, Egypt, to evaluate mungbean cultivars (Giza 1 and Kawny 1) under 3 irrigation intervals after flowering (15, 22 and 30 days) and 4 fertilizer treatments: inoculation with *Rhizobium* (R) + *Azotobacter* (A) + 5 (N_1) or 10 kg N $feddan^{-1}$ (N_2) and inoculation with R only +5 (N_3) or 10 kg N $feddan^{-1}$ (N_4). Kawny 1 exceeded Giza 1 in pod number $plant^{-1}$ (24.3) and seed yield (0.970 t $feddan^{-1}$) while Giza 1 was superior in 1000-seed weight (7.02 g), biological and straw yields (5.53 and 4.61 t $feddan^{-1}$, respectively). The seed yield of both cultivars was positively and highly significantly correlated with all involved characters, except for 1000-seed weight of Giza 1 and branch number $plant^{-1}$ of Kawny 1.

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.

BINA (1998) reported that Binamoog-5 produced higher seed yield over Binamoog-2. Field duration of Binamoog-5 was about 78 days to mature while 82 days for Binamoog-2.

An experiment was conducted by Katial and Shah (1998) with 19 cultivars of *Vigna radiata* and found that 1000 seed weight was the highest in Gajaral-2 (39 g) and the lowest in ML 131 (24 g). Seed yield was the highest in PIMS-1 (0.89 t ha^{-1}) and the lowest in 11/99 (0.52 t ha^{-1}).

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 the highest number of seeds pod^{-1} (10.43) was found by Mohanty *et al*. (1998).

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.

Farghali and Hossain (1995) conducted an experiment with 32 accessions of mungbean with three sowing dates, concluded that V6017 had the highest seed yield. They also recorded that accessions V6017 and UTI had significantly higher plant height, number of seeds pod^{-1}, pod length and number of pods plant^{-1} than that of other accessions.

ICRISAT (1991) reported that cultivars played a key role in increasing yield. The yield of mungbean cultivars Mubarik, Kanti and Binamoog-1 were ranged from 0.8 to 1.0, 1.0 to 1.2 and 0.8 to 1.0 t ha^{-1}, respectively.

Jain *et al*. (1988) conducted an experiment with four mungbean varieties observed that 'ML 131' produced the highest seed yield compared to other varieties.

Masood and Meena (1986) reported that mungbean variety 'PDM 11' gave significantly highest seed yield than the other varieties. He also found that number of pods plant^{-1} varied significantly with genotypes.

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.

The highest seed yield from the variety Mubarik was recorded by Pahlwan and Hossain (1983) which was attributed to the highest number of pods plant^{-1} and seeds pod^{-1}.

After conducting a field experiment with five cultivars of mungbean viz. CES 87, CES 14, Pagasa, Hong-1 and local Thai variety with 32 plants m^{-2} Pookpakdi *et al*. (1980) reported that the highest yield of CES 14 was due to the highest number of seeds pod^{-1} and the lowest yield of local variety resulted from the lowest number of pods plant^{-1}. Among the varieties, Pagasa produced the lowest amount of total dry weight because the variety gave the lowest shoot dry weight.

The highest seed yield produced by 'PS 7' followed by 'PS 16' and 'PS 10'was found by Rajat *et al*. (1978). The highest yield was due to the results of highest number of pods plants^{-1} and 1000-seed weight.

2.2. Effect of Management Practices

An experiment was conducted by Hossen *et al*. (2015) at the research field of the Horticulture Research Center at Labukhali, Patuakhali during the period from January to March, 2014 to find out the most suitable BARI mungbean variety and optimum rates of N concerning higher seed yield under the regional condition of Patuakhali (AEZ–13). Two BARI mungbean varieties namely BARI Mung–5 (V_1) and BARI Mung–6 (V_2) and five levels of N fertilizer including control *viz.* 0 kg N ha$^{–1}$ (N_0), 30 kg N ha$^{–1}$ (N_{30}), 45 kg N ha$^{–1}$ (N_{45}), 60 kg N ha$^{–1}$ (N_{60}), and 75 kg N ha$^{–1}$ (N_{75}) were used for the present study as level factor A and B, respectively. They found that, the higher weight of seeds plant^{-1} (5.73 kg) was obtained from 45 kg N ha$^{–1}$ followed by 30 kg N ha$^{–1}$ (4.49 g) while it was lowest (1.78 g) in control or without N. Among the various doses of nitrogen, the seed yield had higher (1.85 t ha^{-1}) in 45 kg N ha$^{–1}$ followed by 30 kg N ha$^{–1}$ (1.55 t ha$^{–1}$) and the minimum seed yield (0.99 t ha^{-1}) was obtained from the control treatment (no nitrogen).

Azadi *et al*. (2013) observed that different nitrogen levels influenced different growth and yield attributes of mungbean such as plant height, seed yield, stem diameter, number of node and 75 kg N ha^{-1} showed higher values than the other N doses (50, 100 and 150 kg N ha^{-1}).

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.

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}.

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. 11 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.

An experiment was conducted with four row spacing (S_1=15 cm, S_2=20 cm, S_3=25 cm and S_4=30 cm) and four weeding treatments (W_0=No weeding, W_1=Weeding at 15 days after sowing (DAS), W_2 =Weeding at 15 and 30 days after sowing (DAS) and W_3 =Weeding at 15, 30 and 45 days after sowing (DAS) and Zaher *et al.* (2014) observed that the highest number of pods $plant^{-1}$ (43.29), pod length (6.69 cm), number of seeds pod^{-1} (9.43), 1000-seed weight (30.49 g), seed yield (1591 kg ha^{-1}), biological yield (3964 kg ha^{-1}) and harvest index (44.26%) were produced from 30 cm row spacing with three times of weeding.

An experiment was conducted by Akter *et al*. (2013) at the Agronomy field of Bangladesh Agricultural University (BAU), Mymensingh to assess the effect of weeding on growth, yield and yield contributing characters of mungbean cv. Binamoog-4 during (Oct 2011-Feb 2012). Three-stage weeding (Emergence-Flowering, Flowering-Pod setting and Pod setting- Maturity) ensured the highest plant height (58.62 cm), branches (4.45) and leaflets (10.34) plant^{-1}, dry weight plant^{-1} (12.38 g), number of pods (22.03) plant^{-1}, pod length (5.95 cm), number of seeds (17.07) pod^{-1}, seed yield (1.38 t ha^{-1}), biological yield (4.70 t ha^{-1}) and harvest index (37.15%).

Khot *et al*. (2012) reported that dry matter production plant^{-1} at harvest (18.95 g) and dry weight plant^{-1} (12.38 g) was highest from two hand-weeding (at 20 DAS & 40 DAS) and the lowest from no weeding treatment while conducting an experiment on mungbean with weed management.

Sultana *et al.* (2007) conducted an experiment at the field of the Department of Agronomy, Sher-e-Bangla Agricultural University (SAU), Dhaka to evaluate the effect of nitrogen and weed managements on mungbean (*Vigna radiata* L.) during the period from March 2007 to June 2007. Different managements of nitrogen (0, 20 kg N ha^{-1} at vegetative, 20 kg N ha^{-1} at vegetative & flowering) and weeding (No weeding, one weeding at vegetative, two weeding at vegetative & flowering stage) were integrated. Results showed that application of 20 kg N ha^{-1} as basal + 20 kg N ha^{-1} with one weeding at vegetative stage showed significantly higher values of all growth and yield contributing parameters.

Rehman and Ullah (2009) reported that pulses have been grown with poor management practices for long time resulting in poor yields. Proper seed bed, land preparation and weeding are important for adequate germination of seed, crop establishment and good yields, because weed infestation is one of the major factors lowering yield in pulses in Pakistan.

BARI (2005) reported that all crops have a vulnerable stage during their life cycle when they are particularly sensitive to weed competition. In general, it ranges up to first 25 to 50% of the life time of crops. Weed control is essential during the early growth stage of mungbean. One hand weeding is absolutely essential 20 days after planting and two weeding are economical for successful mungbean production.

Baloch (2012) reported that the seed yield per unit area is function of the individual yield components which are influenced by crop management and the environment. The grain yield was significantly affected by different irrigation levels applied at different time intervals to mungbean crop. The highest seed yield (1634 kg ha^{-1}) was recorded in T_2 with 5 irrigations. It was statistically similar to T_3 and T_4 with 1412 and 1339 kg ha^{-1}. The lowest seed yield (588 kg ha^{-1}) was obtained in control.

Assaduzaman *et al*. (2008) reported that most of the important pulses have marked moisture sensitive stage of growth in relation to seed yield. The stage that is less sensitive to moisture deficiency is the period from emergence up to flowering. The greatest sensitivity to indicate water supply is during period when irrigation is reported to give maximum increase in yield. A favorable moisture supply is very important during pod and seed development. The main component of yield which is affected is the number of pods which is increased by irrigation at flowering and 1,000 seed weight which is increased by irrigation during pod growth.

Field experiments were conducted (Dubey, 2010) during the rainy seasons of 2006 and 2007 at the Indian Agricultural Research Institute, New Delhi for the management of yellow mosaic (Mungbean Yellow Mosaic Virus) and cercospora leaf spots (*Cercospora canescens* and *Pseudocercospora cruenta*) of mungbean. Insecticides and fungicides as seed dressings, with or without foliar sprays, were evaluated. Amongst the treatments, a combination of seed treatment with thiamethoxam (Cruiser™) at 4 g kg^{-1} and carbendazim (Bavistin™) + TMTD (Thiram™) at 2.5 g kg^{-1} (1:1 ratio) followed by foliar applications of thiamethoxam (Actara™) 0.02% and carbendazim 0.05% at 21 and 35 d, respectively after sowing produced the highest seedling establishment, shoot and root lengths, number of pods, plant biomass, 1000-seed weight, and grain yield in mungbean with the lowest intensity of cercospora leaf spots and mungbean yellow mosaic. Vector (whitefly) populations were also the lowest in this treatment during all stages of the crop. This treatment was cost-effective, as it provided the highest return per Rupee of input. It was second best for the number of *Rhizobium* root nodules per plant.

Ali *et al.* (2011) conducted an experiment at Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh during March to June 2008 to evaluate the efficacy of fungicides as foliar spray in producing healthy seeds of mungbean. The treatments were Application of Bavistin (Carbendazim) @ 2.0 g $liter^{-1}$, Rovral 50 WP (Iprodione) @ 2.0 g $liter^{-1}$, Dithane M-45 (Mancozeb) @ 2.5 g $liter^{-1}$, Tilt 250 EC (Propiconazole) @ 2.0 ml $liter^{-1}$, Ridomil (Metalexil + Mancozeb) @ 2.0 g $liter^{-1}$, Cumulax- DF (Sulphar) @ 2.0 g $liter^{-1}$, Vitavax-200 (Carboxin) @ 2.5 g $liter^{-1}$ plus seed treatment @ 2.5 g kg^{-1} seed and Untreated (control). All the fungicides were sprayed at 15, 30, 45 and 60 days after sowing. Results showed that the fungicides reduced the incidence and percent disease index of Cercospora leaf spot. But foliar application of Bavistin 50 WP performed better than others. Highest seed yield (1324 kg ha^{-1}) was obtained in Bavistin 50 WP treated plots. Vitavax-200 also performed better in respect of improving seed purity and germination.

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, 2019 to study the effect of growth and yield of mungbean as affected by agronomic managements. 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 silty clay in texture, olive-gray with common fine to medium distinct dark yellowish-brown mottles. Soil pH 5.6 and had organic matter 0.78%. The experimental area was flat having available irrigation and drainage system and above flood level. The physical and chemical properties of the soil was shown in Appendix III.

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).

3.2 Details of the experiment

3.2.1 Treatments

The treatment included in the experiment comprised of two varieties of mungbean and seven treatments of agronomic managements. The treatments were as follows:

A. Variety: 2
   1. BARI Mung-5
   2. BARI Mung-6

B. Agronomic Managements: 7
   1. M_1= Control (no management)
   2. M_2= All managements except fertilizer
   3. M_3= All managements except weeding
   4. M_4= All managements except irrigation
   5. M_5=All managements except insecticides
   6. M_6= All managements except fungicide or bactericide
   7. M_7= Complete management (recommended)

3.2.2 Experimental design and layout

The experiment was laid out into Split-plot design with three replications. Each replication had fourteen plots to which the treatment combinations were assigned randomly following design. The total numbers of unit plots were 42. 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. The experimental layout was shown in Appendix II.

3.2.3 Planting materials (Varietal description)

BARI Mung-5:

- This variety was introduced from AVRDC
- Plant height: 40-45 cm. Resistant to YMV and CLS.
- Photo insensitive. Seed color deep green with smooth seed coat.
- Protein: 20-22%
- Cooking Time: 17-20 min.
- Synchrony in maturity and late potentiality.
- Recommended for cultivation in Jessore, Jhalkati, Khulna, Faridpur, Meherpur, Pabna, Rajshahi and Dinajpur.
- 1000-seed weight: 40-42 g.
- Seed yield: 1.2 –1.5 t ha^{-1}
- Duration: 60-65 days.

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: 51-52 g
- Seed yield: 1.5 –1.6 t ha^{-1}
- Duration: 55-58 days.

3.2.4 Preparation of experimental land

A pre-sowing irrigation was given on 12 March, 2019. The land was opened with the help of a tractor drawn disc harrow on 13 March, 2019, 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 14, 2019 according to experimental specification. Individual plots were cleaned and finally prepared the plot.

3.2.5 Fertilizer application

During final land preparation, the land was fertilized with as per treatment. The recommended fertilizer doses were:

Urea= 45 kg ha^{-1}

TSP= 90 kg ha^{-1}

MoP= 40 kg ha^{-1}

Gypsum= 55 kg ha^{-1}

Boron= 10 kg ha^{-1}

3.2.6 Seed sowing

The seeds were sown by hand in 30 cm apart lines and maintaining 7cm row distance continuously at about 3 cm depth at the rate of 30 kg seed ha^{-1} in line sowing on March 15, 2019.

3.2.7 Intercultural operations

3.2.7.1 Thinning

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

3.2.7.2 Weeding

The crop field was infested with some weeds during the early stage of crop establishment. Two hand weeding were done in every treatment except M_1 and M_3 at 25 and 45 DAS.

3.2.7.3 Application of irrigation water

Irrigation water was applied to all plots except M_1 and M_4 at 10, 30 and 45 DAS respectfully.

3.2.7.4 Drainage

Drainage channels were properly prepared to easy and quick drained out of excess water of irrigation and rainfall from the experimental plots.

3.2.7.5 Plant protection measures

The crops were infested by insects and diseases. The insecticide Ripcord 10EC @10 mL/10L water was sprayed during the later stage of crop to control pests except M_1 and M_5. The fungicide Autostin 50WP was sprayed @2g/1L water to all plots except M_1 and M_6

3.2.7.6 Harvesting and post-harvest operations

Maturity of crop was determined when 80-90% of the pods become blackish in color. Harvesting of BARI Mung-6 was done on 14 May and BARI Mung-5 on 24 May. The harvesting was done by picking pods from central three 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 weighted and converted into kg 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. Plant height (cm) at 15, 30, 45 DAS and harvest
2. No. of leaves plant^{-1} at 15, 30 and 45 DAS
3. Dry weight plant^{-1} (g)
4. Number of nodules plant^{-1}
5. SPAD value at 40 DAS
6. Days to 1st flowering, 50% flowering and 100% flowering

B. Yield and other crop characters

1. Number of pods plant^{-1}
2. Length (cm) of pod
3. Number of seeds pod^{-1}

4. Weight of 1000 seeds (g)

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

6. Shell yield (kg ha^{-1})

7. Shelling percentage

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

9. Biological yield

10. Harvest index

C. Weed data

1.Number of weeds m^{-2}

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 Plant height

Plant heights of five randomly selected plants from each plot were measured at 15, 30, 45 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.

3.4.1.2 Number of leaves $plant^{-1}$

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

3.4.1.3 Plant dry weight

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

3.4.1.4 Number of nodules plant^{-1}

The five plants plot^{-1} was uprooted leaving boarder lines and harvest area and then total number of nodules were counted at 20 and 40 DAS and the mean values were determined.

3.4.1.5 SPAD value

SPAD value of chlorophyll were recorded on 40 DAS with the Soil and Plant Analyzer Development (SPAD) meter. However SPAD meters only provide with a measure of relative chlorophyll or nitrogen content.

3.4.2 Yield and other crop characters

3.4.2.1 Number of pods plant^{-1}

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

3.4.2.2 Pod length

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

3.4.2.3 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.

3.4.2.4 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).

3.4.2.5 Seed yield

The pods from harvested area (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}.

3.4.2.6 Shell yield

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

3.4.2.7 Stover yield

The pods from harvested area (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 kg 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 least significant difference test (LSD) at 5% level of significance.

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to determine the growth and yield of mungbean as affected by agronomic managements. The analyses of variance (ANOVA) of the data on different growth, yield contributing characters and yield of mungbean are presented in Appendix IV-XIII. The results have been offered with the help of table and graphs and possible interpretations given under the following headings:

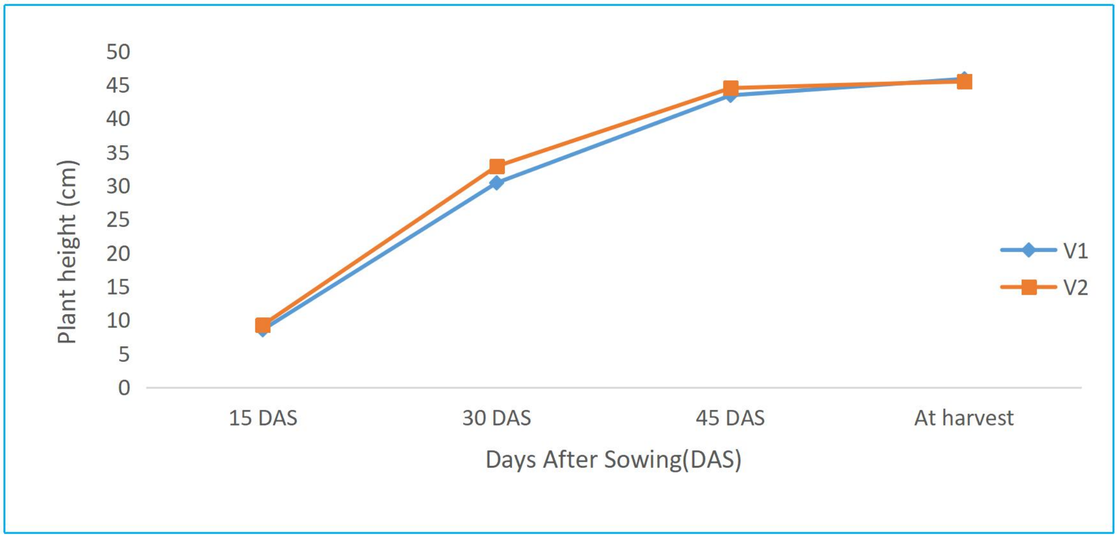
4.1 Crop Growth Characters

4.1.1 Plant height

4.1.1.1 Effect of variety

The plant height of mungbean was significantly influenced by varieties at 15, 30, 45 DAS and at harvest (Appendix IV and Figure 1).

The result revealed that at 15 DAS, the taller plant (9.26 cm) was obtained from BARI Mung-6 (V_2) and the shorter plant (8.57 cm) was at BARI Mung-5 (V_1). The taller plant (32.86 cm) was recorded at 30 DAS from BARI Mung-6 (V_2) and the shorter plant (30.40 cm) at BARI Mung-5 (V_1). Similar trend of plant height was observed at 45 DAS at BARI Mung-6 (44.49 cm) & BARI Mung-5 (43.41 cm). But at 60 DAS, the higher plant height (45.86 cm) was obtained from BARI Mung-5 (V_1) and the lower plant height (45.48 cm) was from BARI Mung-6 (V_2). These results were in agreement with the findings of Ghosh (2004) and Thakuria and Saharia (1990) who reported that varieties differ significantly in respect of plant height of mungbean.



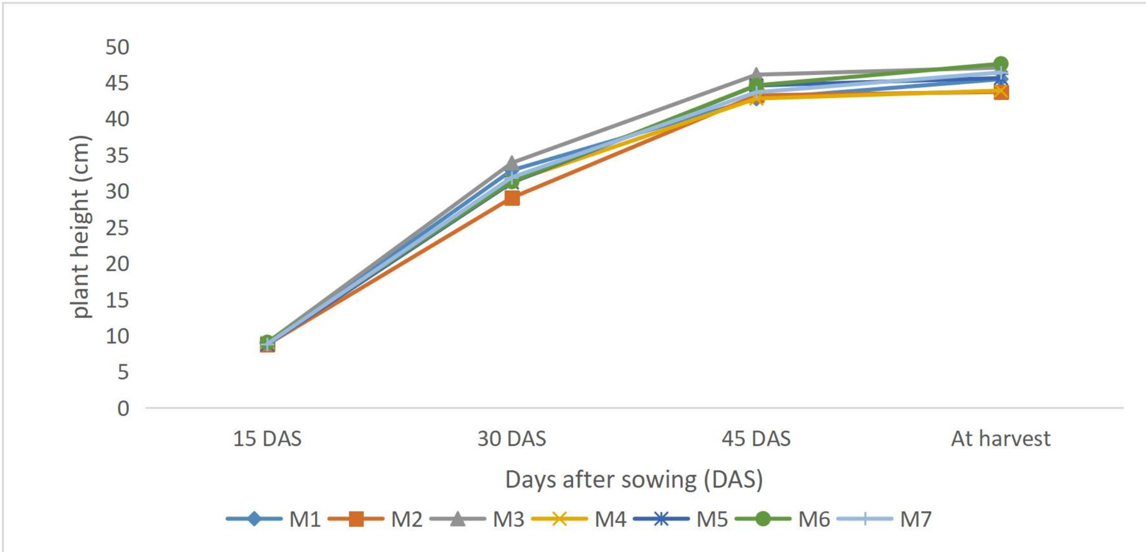
V_1 = BARI Mung-5 and V_2 = BARI Mung-6

Figure 1. Effect of variety on plant height of mungbean at different days after sowing (LSD $_{(0.05)}$ = 1.27, 4.27, 3.13 and 4.72 at 15, 30, 45 and 60 DAS, respectively).

4.1.1.2 Effect of agronomic managements

There were significant differences observed among the treatments of management practices at 30 DAS but insignificant difference observed at 15, 45 DAS and at harvest for plant height of mungbean (Appendix IV and Figure 2).

At 15 DAS, the maximum plant height (9.07 cm) was observed with M_6 which was statistically similar with all managements. At 30 DAS the highest plant height (33.89 cm) was found with M_3 which was statistically similar to M_1, M_4, M_5, M_6, M_7 and the smallest (29.06 cm) was observed at M_2. At 45 DAS, the maximum plant height (46.08 cm) was observed with M_3 which was statistically similar with all managements. At 60 DAS, the highest plant height (47.59 cm) was observed with M_6 which was statistically similar with all managements. The present result conformity with the findings of Asaduzzaman (2006).



M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 2. Effect of different managements on plant height of mungbean at different days after sowing ($LSD_{(0.05)}$ = NS, 4.10, NS and NS at 15, 30, 45 DAS and at harvest, respectively).

4.1.1.3 Interaction effect of variety and agronomic managements

There was non-significant effect observed in plant height due to interaction between variety and managements at 15, 45 and 60 DAS but significant effect observed at 30 DAS. (Appendix Ⅳ and Table 1).

At 30 DAS, the longest plant (35.05 cm) was obtained from the interaction of V_2M_3 followed by V_1M_1, V_1M_3, V_1M_5, V_1M_6, V_1M_7, V_2M_1, V_2M_2, V_2M_4, V_2M_5, V_2M_6 & V_2M_7 treatment combinations which were statistically similar, while the lowest plant height (27.86 cm) was recorded in the treatment combination of V_1M_2 which was statistically similar with the interactions of V_1M_4.

Table 1. Interaction effect of variety and agronomic managements on plant height of mungbean

Treatment combinations	Plant height (cm) at			
	15 DAS	30 DAS	45 DAS	60 DAS
V_1M_1	8.93	32.40 ab	40.43	45.74
V_1M_2	8.59	27.86 b	44.07	44.41
V_1M_3	8.67	32.73 ab	46.23	46.54
V_1M_4	8.42	28.23 b	40.40	41.76
V_1M_5	8.25	31.99 ab	46.50	46.89
V_1M_6	4.69	30.25 ab	44.00	49.23
V_1M_7	8.47	29.27 ab	42.25	46.47
V_2M_1	8.88	33.31 ab	45.07	45.19
V_2M_2	8.94	30.26 ab	42.37	42.99
V_2M_3	9.41	35.05 a	45.92	47.58
V_2M_4	9.58	34.35 a	45.17	46.00
V_2M_5	9.32	30.35 ab	42.67	44.35
V_2M_6	9.45	32.33 ab	45.20	45.94
V_2M_7	9.21	34.40 a	45.07	46.31
$LSD_{(0.05)}$	**NS**	**5.80**	**NS**	**NS**
CV (%)	**9.93**	**10.88**	**10.15**	**11.42**

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

V_1 = BARI Mung-5 and V_2 = BARI Mung-6

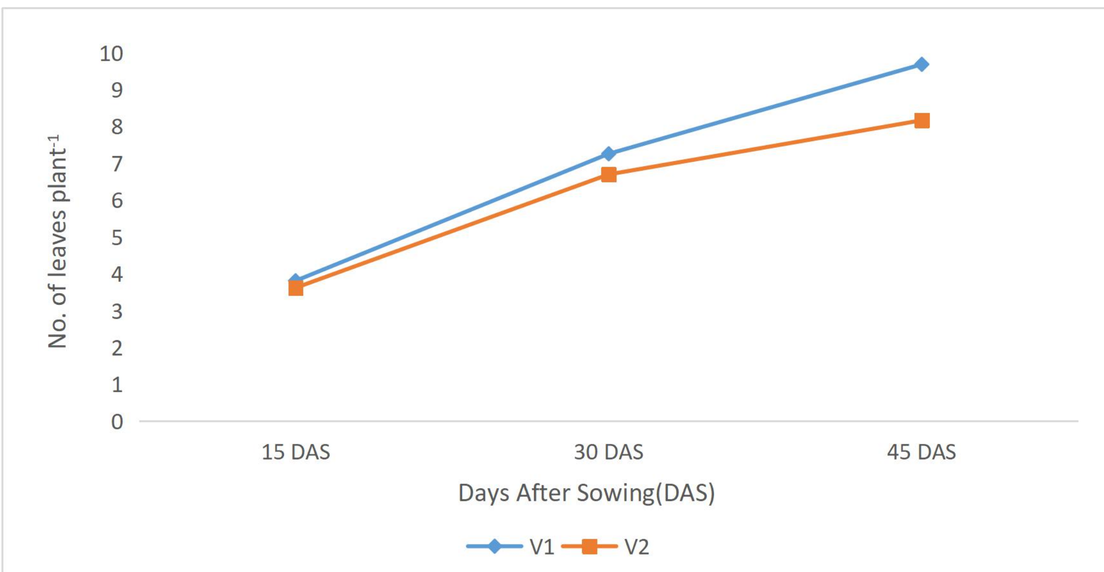
M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

4.1.2 Number of leaves plant^{-1} at different days after sowing

4.1.2.1 Effect of variety

The number of leaves plant^{-1} of mungbean was significantly influenced by varieties at 15, 30 and 45 DAS (Appendix V and Figure 3).

The result revealed that at 15 DAS, the number of leaves plant^{-1} was higher (3.81) in BARI Mung-5 (V_1) compared to BARI Mung-6 (V_2). Similar trend of number of leaves plant^{-1} in BARI Mung-5 (7.26 and 9.69) and BARI Mung-6 (6.70 and 8.17) was observed at 30 and 45 DAS respectively. Ansary (2007) reported that varieties differ significantly in respect of number of leaves plant^{-1}. He also observed two varieties of mungbean BARI Mung-6 and BU mug-2 had significant effect on number of leaves plant^{-1} at 30 and 45 DAS.



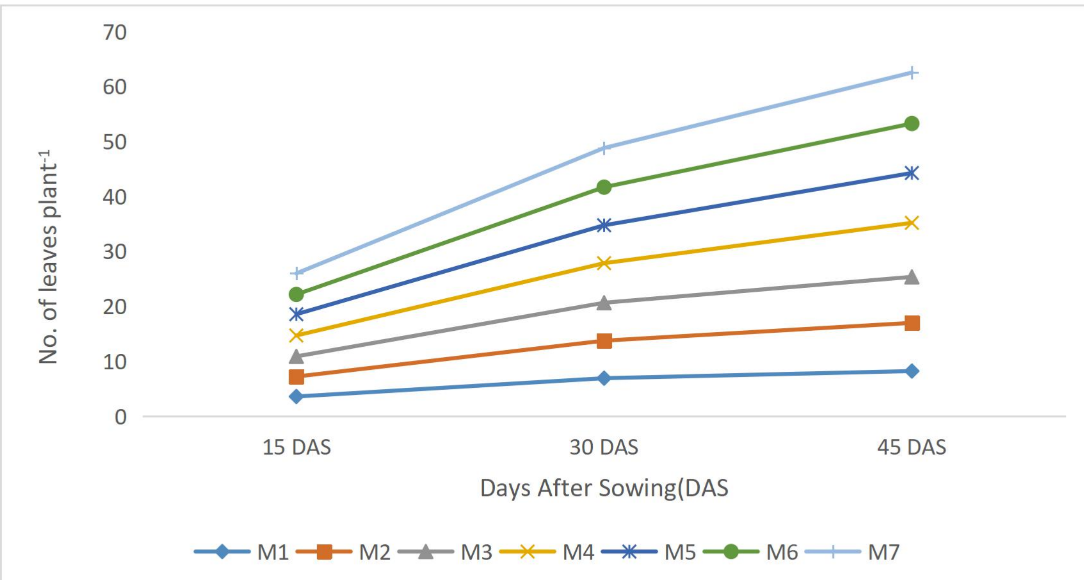
V_1 = BARI Mung-5 and V_2 = BARI Mung-6

Figure 3. Effect of variety on the number of leaves plant^{-1} of mungbean at different days after sowing ($LSD_{(0.05)}$ = 1.31, 0.32 and 0.79 at 15, 30 and 45 DAS, respectively).

4.1.2.2 Effect of agronomic managements

The number of leaves plant^{-1} of mungbean had significantly influenced by different managements at 15 and 45 DAS but insignificant at 30 DAS (Appendix V and Figure 4).

At 15 and 30 DAS the highest number of leaves plant^{-1} found in M_5 (3.87) and M_4 (7.20) managements which was statistically similar followed by other managements. At 45 DAS, the highest number of leaves plant^{-1} (9.83) was found in M_4 treatment and the lowest number of leaves plant^{-1} (8.23) was recorded from M_1 treatment.



M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 4. Effect of managements on the number of leaves plant^{-1} of mungbean at different days after sowing ($LSD_{(0.05)}$ = 0.32, 0.49 and 0.77 at 15, 30 and 45 DAS, respectively).

4.1.2.3 Interaction effect of variety and agronomic managements

Interaction effect of variety and agronomic managements had significant influence on the number of leaves plant^{-1} at 45 DAS but there was no significant variation observed on the number of leaves plant^{-1} at 15 and 30 DAS (Appendix V and Table 2).

At 45 DAS, the interaction of V_1M_4 produced the highest number of leaves plant^{-1} (11.20) which was statistically similar with V_1M_7 and the lowest number of leaves plant^{-1} (7.73) produced by V_2M_3 interaction which showed similarity with V_2M_1. At 15 DAS, the V_1M_4 interaction produced the maximum number of leaves plant^{-1} (4.00), while the minimum number of leaves plant^{-1} (3.40) produced by V_2M_6 interaction. At 30 DAS, the V_1M_4 produced the maximum number of leaves plant^{-1} (7.67) and the minimum number of leaves plant^{-1} (6.73) produced by V_2M_6 interaction.

Table 2. Interaction effect of variety and agronomic managements on the number of leaves plant-1 of mungbean

Treatment combinations	Number of Leaves plant-1 at		
	15 DAS	30 DAS	45 DAS
V_1M_1	3.60	7.20	8.53 d-f
V_1M_2	3.73	6.93	9.33 b-d
V_1M_3	3.73	7.00	9.00 c-e
V_1M_4	4.00	7.67	11.20 a
V_1M_5	4.00	7.33	9.87 bc
V_1M_6	3.80	7.13	9.73 bc
V_1M_7	3.80	7.53	10.20 ab
V_2M_1	3.60	6.67	7.93 ef
V_2M_2	3.53	6.73	8.20 ef
V_2M_3	3.60	6.80	7.73 f
V_2M_4	3.60	6.73	8.47 d-f
V_2M_5	3.73	6.47	8.27 d-f
V_2M_6	3.40	6.73	8.27 d-f
V_2M_7	3.87	6.73	8.33 d-f
$LSD_{(0.05)}$	**NS**	**NS**	**1.09**
CV (%)	**7.17**	**5.86**	**7.23**

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

V_1 = BARI Mung-5 and V_2 = BARI Mung-6

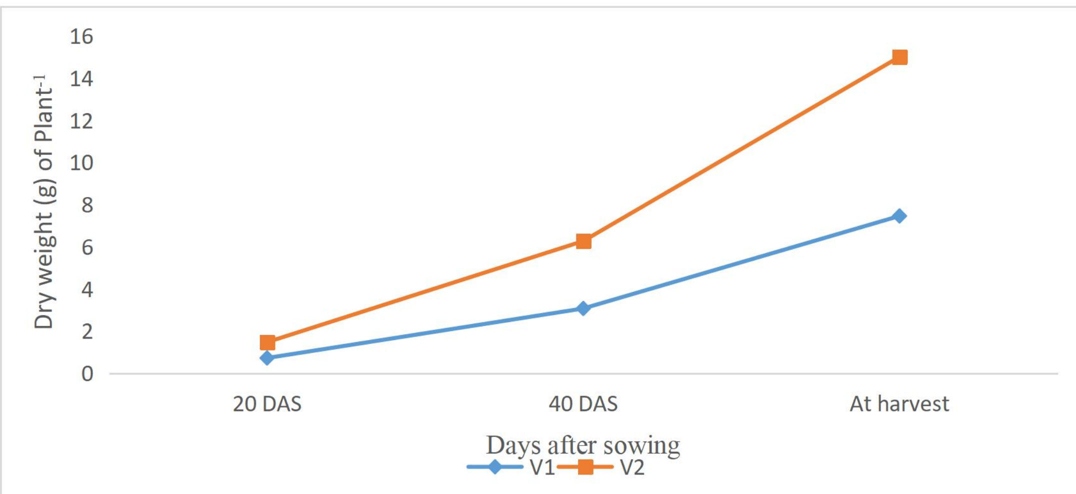
M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

4.1.3 Dry matter weight plant^{-1} at different days after sowing

4.1.3.1 Effect of variety

The total dry matter weight of plant was significantly influenced by varieties at 20 DAS but insignificant at 40 DAS and at harvest (Appendix VI and Figure 5).

At 20 DAS, the higher dry matter weight plant^{-1}(0.75 g) was recorded in BARI Mung-6 (V_2) and the lower dry matter weight plant^{-1} (0.72 g) was recorded in BARI Mung-5 (V_1). But at 40 DAS and harvest, varieties had no significant effect though the higher dry matter weight plant^{-1} observed in BARI Mung-6 (V_2) compared to that of BARI Mung-5 (V_1). These findings agreed with Pookpakdi *et al*. (1980) who stated that total dry weight and dry matter production varied according to variety.



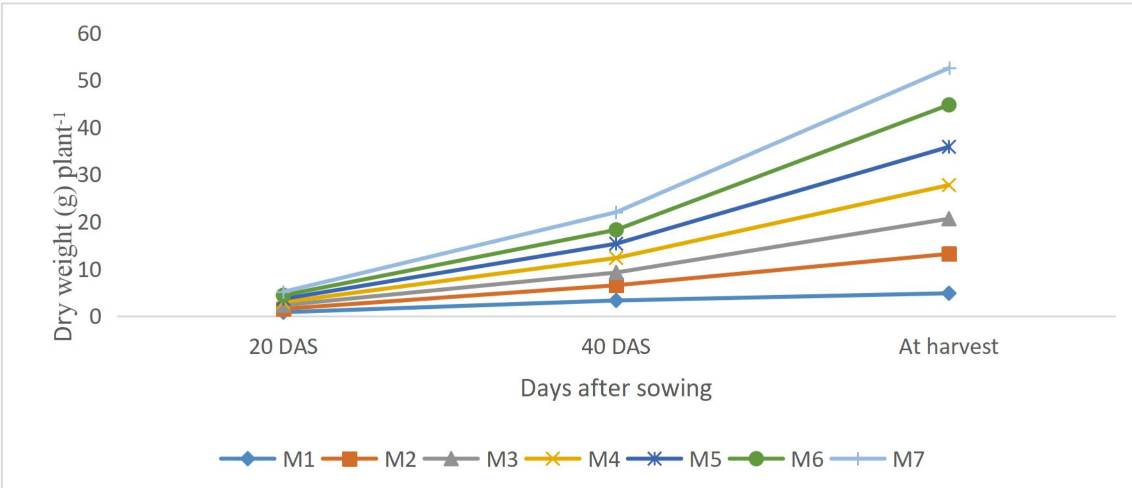
V_1 = BARI Mung-5 and V_2 = BARI Mung-6

Figure 5. Effect of variety on the dry matter weight of mungbean at different days after sowing (LSD$_{(0.05)}$ = 0.16, NS, NS at 20, 40 DAS at harvest, respectively).

4.1.3.2 Effect of agronomic managements

The total dry matter weight of plant was significantly influenced by agronomic managements at 20 DAS and at harvest but insignificant at 40 DAS (Appendix VI and Figure 6). At 20 DAS, the maximum dry matter weight plant^{-1} (0.80 g) was recorded in M_1 treatment and the minimum (0.63 g) was recorded in M_4 treatment.

At 40 DAS numerically the maximum dry matter weight plant^{-1} (3.73 g) was recorded in M_7 treatment, while the minimum (2.70 g) was recorded in M_3 treatment. At harvest, the M_6 produced the maximum dry matter weight plant^{-1} (8.89 g) which was statistically similar with M_2, M_5 and the minimum dry matter weight plant^{-1} (4.82 g) was obtained from the M_1 treatment.



V_1 = BARI Mung-5 and V_2 = BARI Mung-6

M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 6. Effect of different managements on the dry matter weight of mungbean at different days after sowing (LSD$_{(0.05)}$ = 0.16, NS and 3.02 at 20, 40 DAS and harvest, respectively).

4.1.3.3 Interaction effect of variety and agronomic managements

Interaction effect of variety and agronomic managements significantly influenced the total dry matter weight plant^{-1} of mungbean at harvest but insignificant at 20 and 40 DAS (Appendix VI and Table 3).

At 20 DAS, numerically the maximum dry matter weight plant^{-1} (0.83 g) was observed in the V_1M_1 and V_2M_6 interaction and the minimum dry matter weight plant^{-1} (0.63 g) was observed in the V_1M_4, V_2M_4 and V_2M_5 interaction. At 40 DAS, numerically the maximum dry matter weight plant^{-1} (3.88 g) was obtained from the V_2M_7 while the minimum (2.46 g) was observed in the V_1M_3 interaction. At harvest, the V_2 with the interaction of M_6 produced the highest dry matter weight plant^{-1} (10.45 g) which was statistically similar to all other interactions, except no management of both varieties whereas the minimum dry matter weight plant^{-1} (4.37 g) was produced by the interaction of V_2M_1 that similar to V_1M_1 interaction (5.27 g plant^{-1}).

Table 3. Interaction effect of variety and agronomic managements on the dry matter weight plant^{-1} of mungbean

Treatment combinations	Dry matter weight plant^{-1} at		
	20 DAS	40 DAS	At harvest
V_1M_1	0.83	3.06	5.27 bc
V_1M_2	0.67	3.05	9.80 a
V_1M_3	0.77	2.46	7.91 a-c
V_1M_4	0.63	2.62	6.72 a-c
V_1M_5	0.77	3.44	7.18 a-c
V_1M_6	0.70	3.29	7.33 a-c
V_1M_7	0.67	3.59	7.99 a-c
V_2M_1	0.77	3.51	4.37 c
V_2M_2	0.77	3.38	6.88 a-c
V_2M_3	0.80	2.93	6.99 a-c
V_2M_4	0.63	3.55	7.53 a-c
V_2M_5	0.63	2.56	9.02 ab
V_2M_6	0.83	2.61	10.45 a
V_2M_7	0.80	3.88	7.60 a-c
$LSD_{(0.05)}$	**NS**	**NS**	**4.27**
CV (%)	**56.85**	**30.31**	**33.80**

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

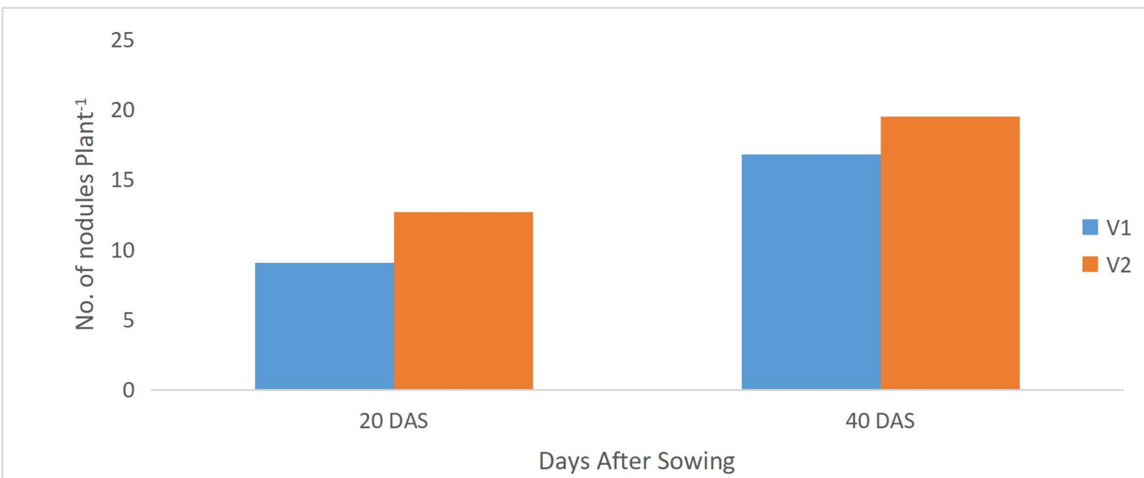
V_1 = BARI Mung-5 and V_2 = BARI Mung-6

M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

4.1.4 Number of nodules plant^{-1} at different days after sowing

4.1.4.1 Effect of variety

The total number of nodules plant^{-1} was significantly influenced by varieties of mungbean throughout the growing season (Appendix VII and Figure 7). The BARI Mung-6 (V_2) produced the higher total number of nodules plant^{-1} (12.67 and 19.52 at 20 and 40 DAS, respectively) and the BARI Mung-5 (V_1) gave the lower total number of nodules plant^{-1} (9.70 and 16.82 at 20 and 40 DAS, respectively). It appeared that the peak nodulation in mungbean occurred between pre-flowering and pod filling stage. Patel and Patel (1994) reported significantly higher number of nodules plant^{-1} in mungbean at 30 DAS followed by 45 DAS.



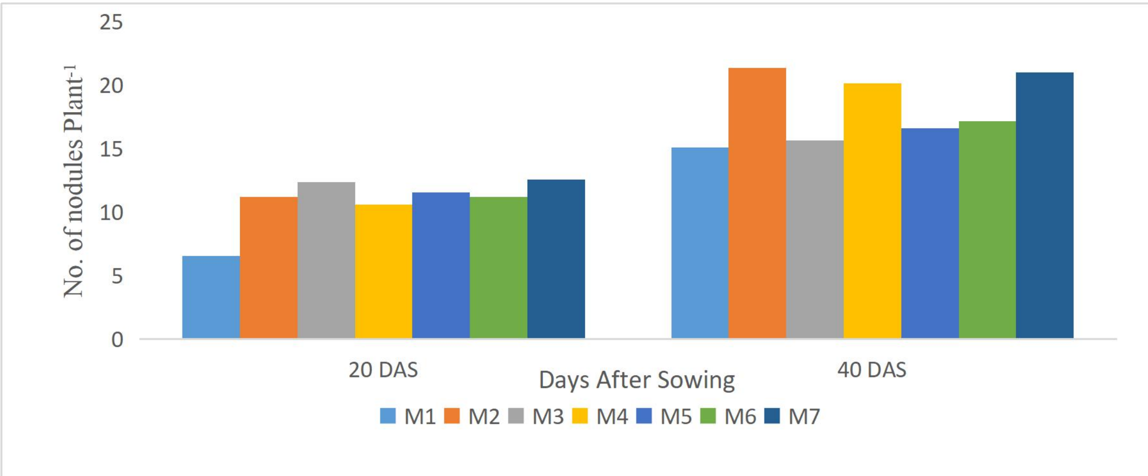
V_1 = BARI Mung-5 and V_2 = BARI Mung-6

Figure 7. Effect of variety on the number of nodules plant^{-1} of mungbean at different days after sowing(LSD$_{(0.05)}$ = 4.30 and 1.80 at 20 and 40 DAS, respectively).

4.1.4.2 Effect of agronomic managements

The different managements had significant effect on the total number of nodules plant^{-1} recorded at 20 and 40 DAS (Appendix VII and Figure 8).

At 20 DAS, the highest number of nodules plant^{-1} (12.55) was produced by the M_7 treatment which was statistically similar to M_3 and the lowest number of nodules plant^{-1} (6.55) was produced by M_1. At 40 DAS, the highest number of nodules plant^{-1} (21.40) was produced by M_2 and the lowest number of nodules plant^{-1} (15.10) was produced by M_1 treatment.



M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 8. Effect of agronomic managements on the number of nodules plant^{-1} of mungbean at different days after sowing ($LSD_{(0.05)}$ = 5.64 and 6.28 at 20 and 40 DAS, respectively).

4.1.4.3 Interaction effect of variety and agronomic managements

Significant interaction effect between the variety and agronomic managements was observed at 20 and 40 DAS on the total number of nodules produced plant^{-1} (Appendix VII and Table 4). At 20 DAS, the highest number of nodules plant^{-1} (16.50) was produced from the V_2M_7 and the lowest number of nodules plant^{-1} (6.30) was produced in interaction of V_2M_1. At 40 DAS, the highest number of nodules plant^{-1} (24.47) was produced from the V_2M_7 and the lowest number of nodules plant^{-1} (13.73) was produced in interaction of V_1M_1.

Table 4. Interaction effect of variety and agronomic managements on the number of nodules plant^{-1} of mungbean

Treatment combinations	Number of nodules plant^{-1} at	
	20 DAS	40 DAS
V_1M_1	6.80 bc	13.73 c
V_1M_2	8.20 bc	19.67 a-c
V_1M_3	10.90 a-c	16.07 a-c
V_1M_4	6.87 bc	16.73 a-c
V_1M_5	8.80 a-c	16.20 a-c
V_1M_6	13.30 a-c	17.73 a-c
V_1M_7	8.60 a-c	17.60 a-c
V_2M_1	6.30 c	16.47 a-c
V_2M_2	14.23 a-c	23.13 ab
V_2M_3	13.87 a-c	15.27 bc
V_2M_4	14.37 ab	23.60 ab
V_2M_5	14.30 ab	17.07 a-c
V_2M_6	9.13 ab	16.67 a-c
V_2M_7	16.50 a	24.47 a
LSD $_{(0.05)}$	**7.97**	**8.88**
CV (%)	**43.53**	**29.00**

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

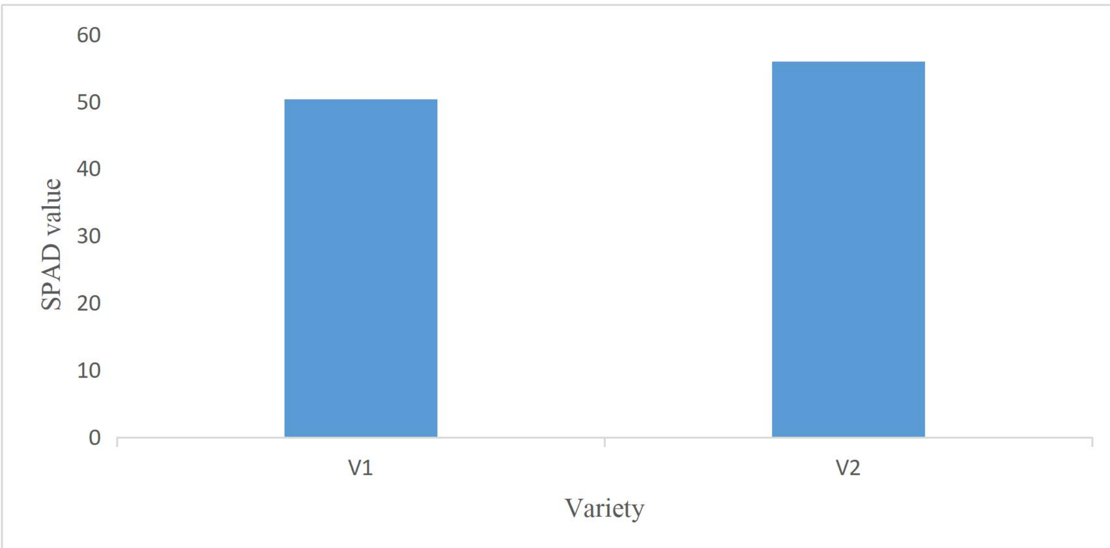
V_1 = BARI Mung-5 and V_2 = BARI Mung-6

M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

4.1.5 SPAD value

4.1.5.1 Effect of variety

SPAD value was significantly influenced by varieties of mungbean (Appendix VIII and Figure 9). The BARI Mung-6 (V_2) produced the higher SPAD value (55.98) and the BARI Mung-5 (V_1) gave the lower value of 50.39 at 40 DAS.



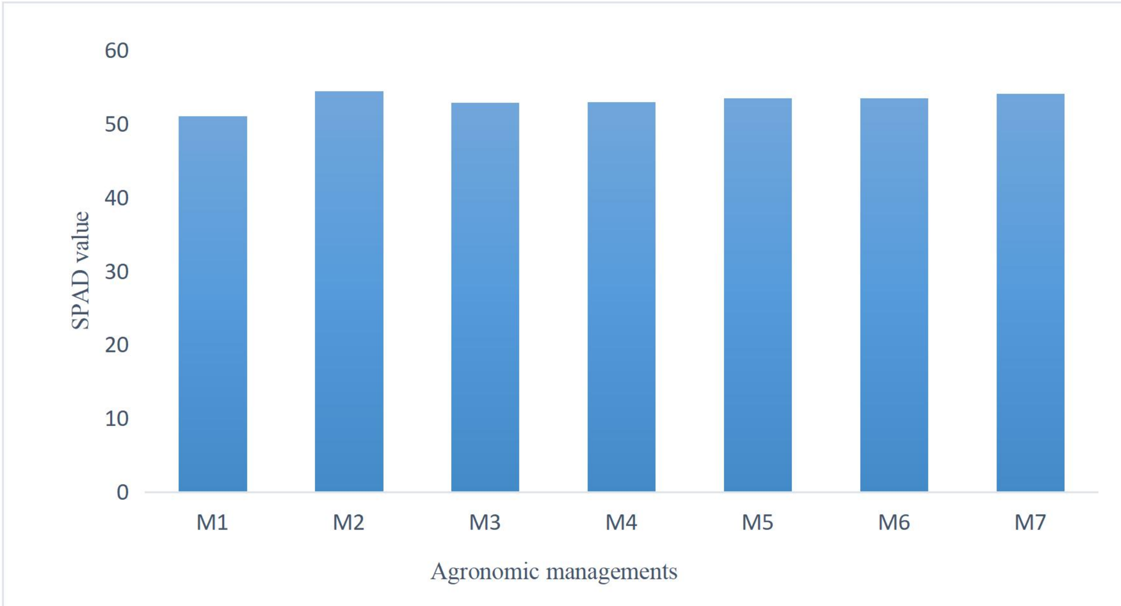
V_1 = BARI Mung-5 and V_2 = BARI Mung-6

Figure 9. Effect of variety on the SPAD value of mungbean at 40 days after sowing($LSD_{(0.05)}$=2.63).

4.1.5.2 Effect of agronomic managements

The different agronomic managements had insignificant effect on the SPAD value recorded at 40 DAS (Appendix VIII and Figure 10).

At 40 DAS, the highest SPAD value (54.44) was produced by the M_2 treatment which was statistically similar to M_7, M_6, M_5, M_4, M_4 and the lowest SPAD value (51.00) was produced by M_1 (no management).



M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 10. Effect of different agronomic managements on the SPAD value of mungbean at 40 days after sowing ($LSD_{(0.05)}$ = 3.41).

4.1.5.3 Interaction effect of variety and agronomic managements

Significant interaction effect between the variety and managements for SPAD value was observed at 40 DAS (Appendix VIII and Table 5) where the highest SPAD value (57.82) was produced from the V_2M_7 which was statistically similar to all other interactions of BARI Mung-6 in respect of agronomic managements. The lowest SPAD value (48.18) was produced in interaction of V_1M_1 which was statistically similar to all agronomic managements of variety BARI Mung-5.

Table 5. Interaction effect of variety and agronomic managements on SPAD value of mungbean

Treatment combinations	SPAD value
V_1M_1	48.18 e
V_1M_2	51.54 b-e
V_1M_3	50.33 de
V_1M_4	51.74 b-e
V_1M_5	50.83 c-e
V_1M_6	49.89 de
V_1M_7	50.29 de
V_2M_1	53.81 a-d
V_2M_2	57.35 a
V_2M_3	55.39 a-c
V_2M_4	54.21 a-d
V_2M_5	56.09 ab
V_2M_6	57.15 a
V_2M_7	57.82 a
$LSD_{(0.05)}$	**4.82**
CV (%)	**5.38**

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

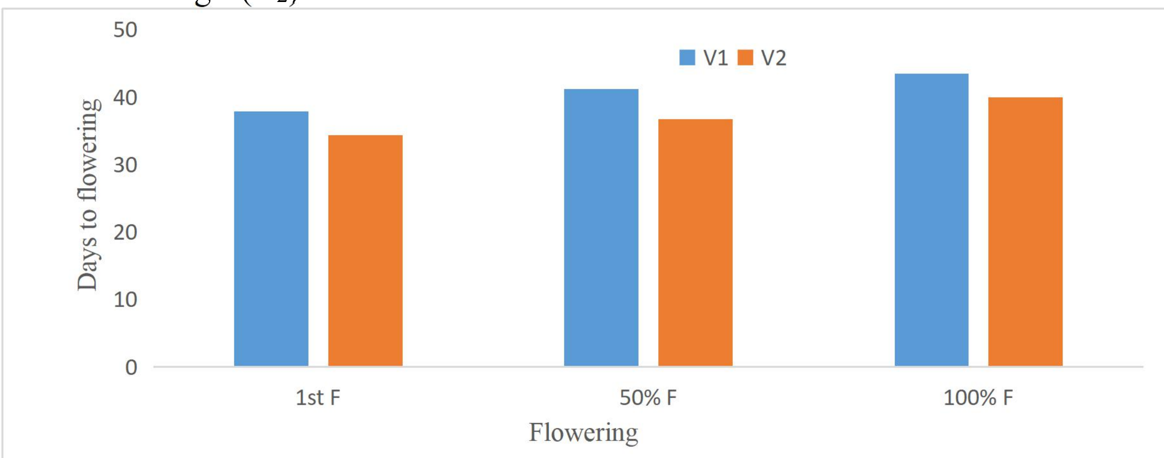
V_1 = BARI Mung-5 and V_2 = BARI Mung-6

M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

4.1.6 Days to flowering

4.1.6.1 Effect of variety

Days to flowering was significantly influenced by varieties of mungbean (Appendix Ⅸ and Figure 11). The result revealed that the highest duration required for 1st, 50% and 100% flowering was (37.86 days, 41.24 days and 43.48 days respectively) in BARI Mung-5 (V_1). The lowest duration required for 1st, 50% and 100% flowering was (34.33 days, 36.71 days and 40 days respectively) in BARI Mung-6(V_2).



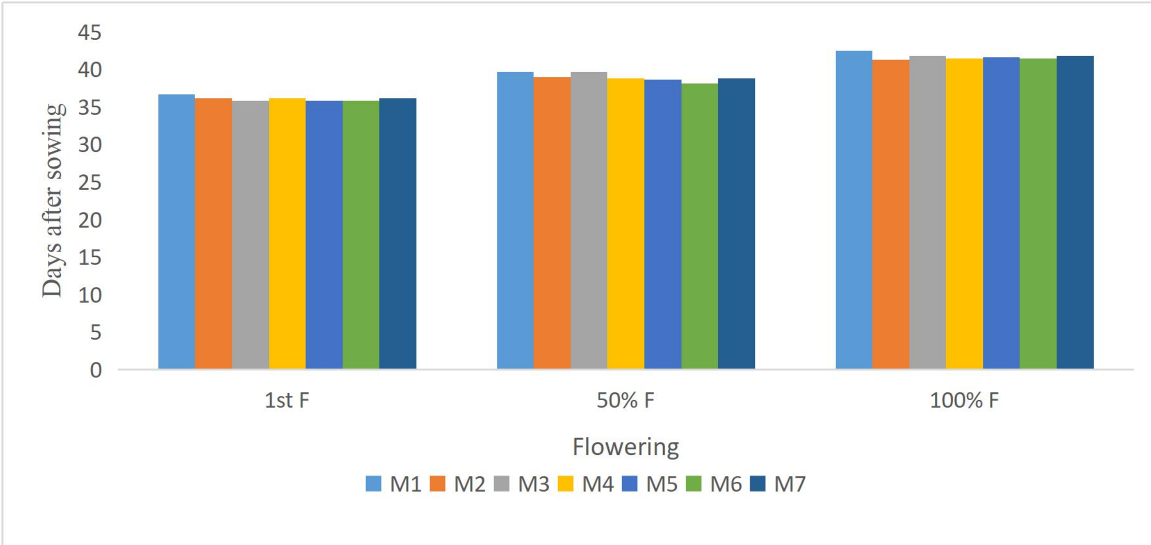
V_1 = BARI mung 5, V_2 = BARI mung 6

1st F= 1st Flowering, 50% F= 50% flowering, 100% F=100% Flowering

Figure 11. Effect of variety on the flowering duration of mungbean ($LSD_{(0.05)}$ = 1.34 , 1.25 and 0.89 at 1st flowering, 50% flowering and 100% flowering respectively).

4.1.6.2 Effect of agronomic managements

The highest duration for 1st flowering (36.67 days) was recorded in M_1 (no managements) that was similar to M_2, M_4 and M_7 treatment and the lowest duration for 1st flowering (35.83 days) was found in M_3 (no weeding). For 50% flowering, the highest duration (39.67 days) needed for no management (M_1) and the lowest duration (38.17 days) for M_6 (no fungicide/bactericide). The highest duration (42.50 days) for 100% flowering needed in M_1 and the lowest duration (41.33 days) in M_2 (no fertilizer) treatment.



1st F= 1st Flowering, 50% F= 50% flowering, 100% F=100% Flowering

M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 12. Effect of managements on the flowering duration of mungbean($LSD_{(0.05)}$=0.94, 1.20 and 0.80 at 1st flowering, 50% flowering and 100% flowering respectively).

4.1.6.3 Effect of interaction of variety and agronomic managements

Flowering was significantly influenced by different interaction of variety and managements of mungbean (Appendix IX and Table 6). The highest duration of 1st flowering (38 days) needed for V_1M_1,V_1M_2,V_1M_5,V_1M_6 and V_1M_7 that similar to V_1M_4 and V_1M_3. The lowest duration of 1st flowering (33.67 days) needed for V_2M_6 that indicated to V_2M_5 and similar to other managements of the variety BARI Mung-6.The highest duration of 50% flowering (42.67 days) needed for V_1M_3 and the lowest duration of 50% flowering (36.33 days) needed for V_2M_5 that indicated to V_2M_6 and similar to other managements of the variety BARI Mung-6.The higher duration of 100% flowering(45 days) needed for V_1M_1 and the lowest duration of 100% flowering (40 days) needed for V_2M_1 and similar to other managements of the variety BARI Mung-6.

Table 6. Interaction effect of variety and agronomic managements on the flowering duration of mungbean

Treatment combinations	1st flowering	50% flowering	100% flowering
V_1M_1	38.00 a	42.00 ab	45.00 a
V_1M_2	38.00 a	41.33 a-c	42.67 b
V_1M_3	37.33 a	42.67 a	43.67 b
V_1M_4	37.67 a	40.67 bc	43.00 b
V_1M_5	38.00 a	41.00 a-c	43.33 b
V_1M_6	38.00 a	40.00 c	43.00 b
V_1M_7	38.00 a	41.00 a-c	43.67 b
V_2M_1	35.33 b	37.33 d	40.00 c
V_2M_2	34.33 bc	36.67 d	40.00 c
V_2M_3	34.33 bc	36.67 d	40.00 c
V_2M_4	34.67 bc	37.00 d	40.00 c
V_2M_5	33.67 c	36.33 d	40.00 c
V_2M_6	33.67 c	36.33 d	40.00 c
V_2M_7	34.33 bc	36.67 d	40.00 c
$LSD_{(0.05)}$	**1.33**	**1.69**	**1.13**
CV (%)	**2.19**	**2.58**	**1.61**

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

V_1 = BARI Mung-5 and V_2 = BARI Mung-6

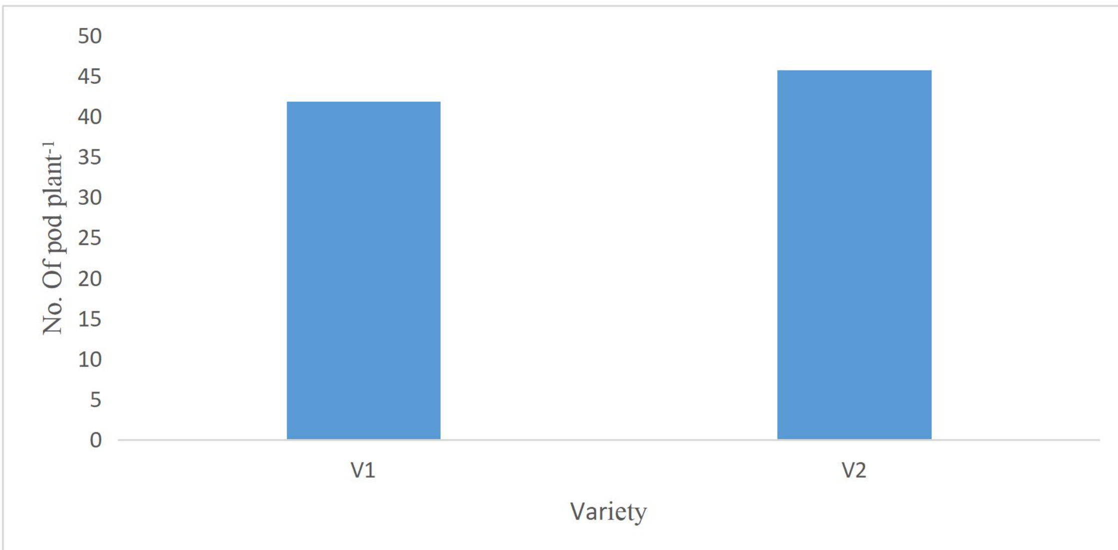
M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

4.2 Yield and other crop characters

4.2.1 Number of pods plant^{-1}

4.2.1.1 Effect of variety

The number of pods plant^{-1} was significantly influenced by variety (Appendix X and Figure 13). Results showed that, the V_2 produced higher number of pods plant^{-1} (45.71) whereas the lower number of pods plant^{-1} was obtained from V_1 (41.86).

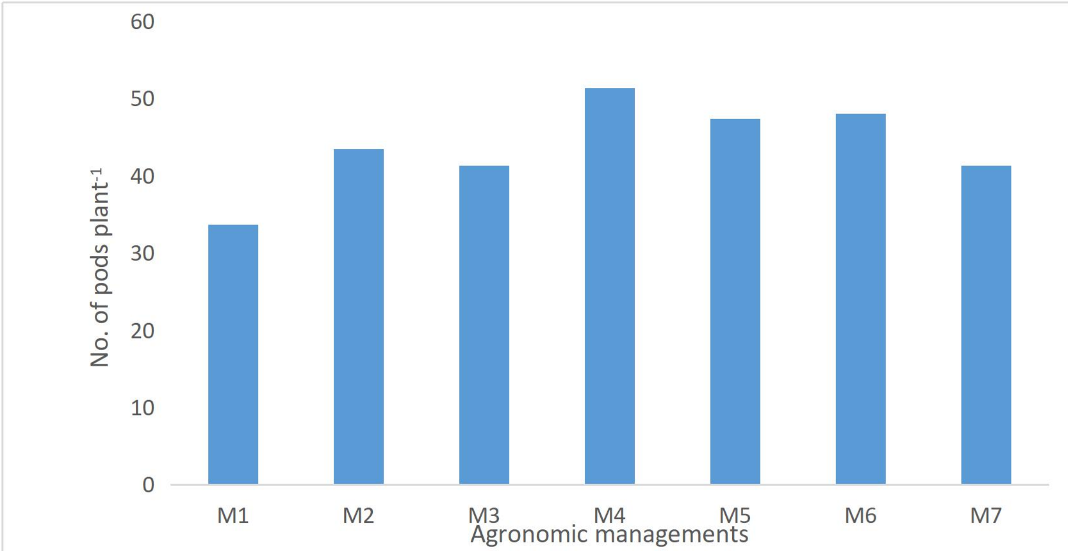


V_1 = BARI Mung-5, V_2 = BARI Mung-6

Figure 13: Effect of variety on pods plant^{-1} mungbrean (LSD$_{(0.05)}$ = 1.22).

4.2.1.2 Effect of agronomic managements

The number of pods plant^{-1} significantly varied for different agronomic managements (Appendix X and figure 14). The highest number of pods plant^{-1} (51.33) was found from the M_4 treatment which was statistically similar with all managements while the lowest number of pods plant^{-1} (33.67) was obtained from the M_1 treatment (no managements).



M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 14: Effect of agronomic managements on pods plant^{-1} of mungbean ($LSD_{(0.05)}$ = 1.09).

4.2.1.3 Interaction effect of variety and managements

The number of pods plant^{-1} was not significantly influenced by the interaction effect of variety and management packages (Appendix X and Table 7). The maximum number of pods plant^{-1} (54.33) was obtained from the V_1M_4 which showed similarity with all managements. The minimum number of pods plant^{-1} (29.67) was obtained from V_1M_1.

Table 7. Interaction effect of variety and agronomic managements on no. of pods plant1, pod length and no. of seeds pod^{-1} of mungbean

Treatment combinations	Pods plant^{-1}(No.)	Pod length (cm)	Seeds pod^{-1} (No.)
V_1M_1	29.67	6.97 c	9.18 ab
V_1M_2	43.67	7.77 a-c	9.16 ab
V_1M_3	36.67	7.68 a-c	9.18 ab
V_1M_4	54.33	7.73 a-c	9.43 ab
V_1M_5	43.67	7.67 a-c	9.33 ab
V_1M_6	43.00	7.85 a	9.14 ab
V_1M_7	42.00	7.89a	9.17 ab
V_2M_1	37.67	7.88 a	8.95 bc
V_2M_2	43.33	7.74 a-c	8.87 bc
V_2M_3	46.00	7.80 ab	9.23 ab
V_2M_4	48.33	7.89 a	8.96 bc
V_2M_5	51.00	7.45 a-c	9.20 ab
V_2M_6	53.00	7.05 bc	8.36 c
V_2M_7	40.67	7.74 a-c	9.59 a
$LSD_{(0.05)}$	**NS**	**0.78**	**0.60**
CV (%)	**34.28**	**8.21**	**5.13**

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

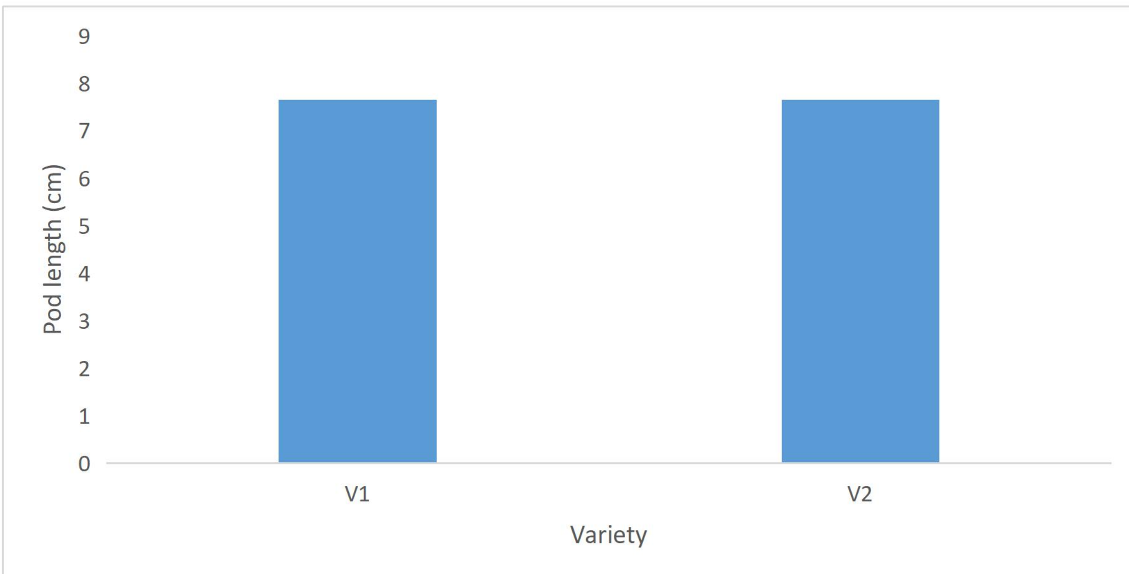
V_1 = BARI Mung-5 and V_2 = BARI Mung-6

M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

4.2.2 Length of pod

4.2.2.1 Effect of variety

The pod length was insignificantly influenced by the variety (Appendix X and figure 15). The maximum (7.652) and minimum (7.651) pod length was obtained from the V_1 (BARI Mung-5) and V_2 (BARI Mung-5), respectively. The result disagreed with the findings of Farghali and Hossain (1995) who observed that varieties differed significantly in respect of pod length.

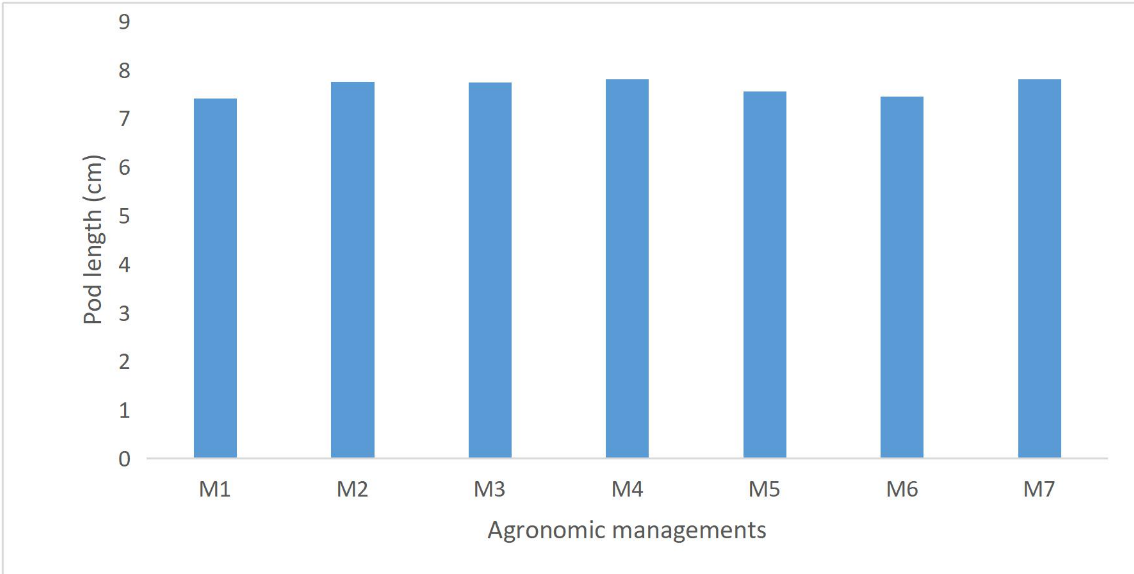


V_1 = BARI Mung-5 and V_2 = BARI Mung-6

Figure 15: Effect of variety on pod length of mungbean ($LSD_{(0.05)}$ = 0.295).

4.2.2.2 Effect of agronomic managements

There was insignificant difference observed in pod length due to different agronomic managements (Appendix X and figure 16). Numerically maximum pod length (7.81 cm) was observed in the M_7 treatment and the minimum pod length (7.42 cm) was observed in M_1 treatment.



M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 16: Effect of agronomic management on pod length of mungbean ($LSD_{(0.05)}$ = NS).

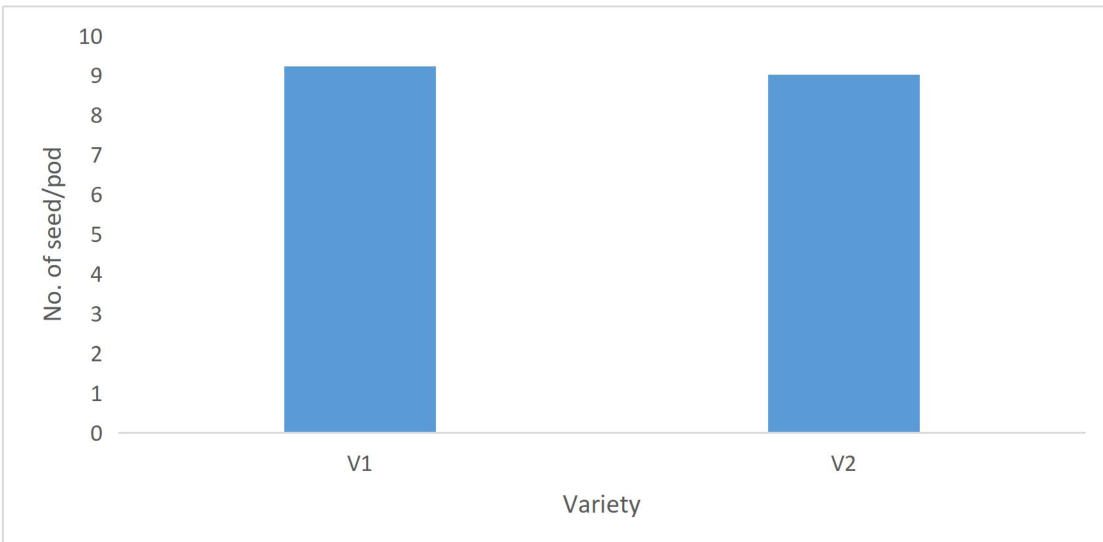
4.2.2.3 Interaction effect of variety and agronomic managements

Interaction effect of variety and agronomic managements showed significant differences on pod length (Appendix X and Table 7). The longest pod (7.89 cm) was attained from the V_2M_4 interaction which was statistically similar with V_1M_7, V_2M_1, while the shortest pod (6.97 cm) was obtained from the V_1M_1 interaction which showed similarity with the V_2M_6 interaction.

4.2.3 Number of seeds pod^{-1}

4.2.3.1 Effect of variety

The number of seeds pod^{-1} was significantly influenced by the variety (Appendix X and Figure 17). The BARI Mung-5 (V_1) produced the higher number of seeds pod^{-1} (9.23) and the BARI Mung-6 (V_2) produced the lower number of seeds pod^{-1} (9.02). The result agreed with Pahlwan and Hossain (1983) and Pookpakdi *et al.* (1980) who found the higher yield from two mungbean cultivars Mubarik and CES 14 with the higher number of seeds pod^{-1}.

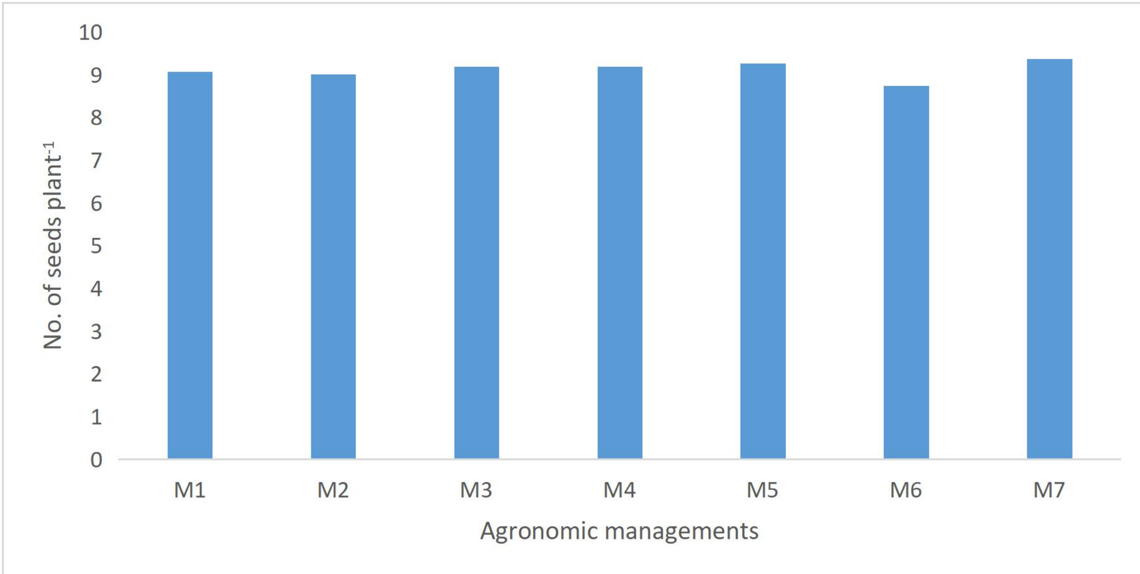


V_1 = BARI Mung-5 and V_2 = BARI Mung-6

Figure 17. Effect of variety on the number of seeds pod^{-1} of mungbean (LSD$_{(0.05)}$ =0.23).

4.2.3.2 Effect of agronomic managements

Different managements had significant effect on the number of seeds pod^{-1} (Appendix X and Figure 18). The highest number of seeds pod^{-1} (9.38) was recorded from the M_7 treatment and the lowest number of seeds pod^{-1} (8.75) was recorded from the M_6 treatment.



M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 18. Effect of agronomic managements on the number of seeds pod^{-1} of mungbean ($LSD_{(0.05)}$ = 0.42).

4.2.3.3 Interaction effect of variety and agronomic managements

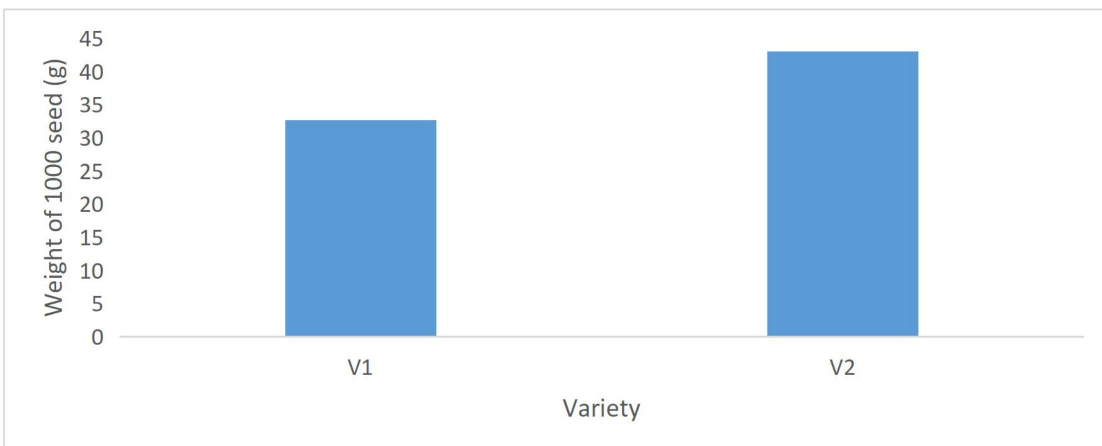
The number of seeds pod^{-1} was significantly influenced by the interaction effect of variety and agronomic managements (Appendix X and Table 7).

The highest number of seeds pod^{-1} (9.59) was obtained from the V_2 with the interaction of M_7 while the lowest number of seeds pod^{-1} (8.36) was obtained from the V_2 with the interaction of M_6.

4.2.4 Weight of 1000 seeds (g)

4.2.4.1 Effect of variety

The weight of 1000-seed was significantly influenced by the variety (Appendix XI and Figure 19). The higher weight of 1000-seed (43.14 g) was obtained from BARI Mung-6 (V_2) and the lower weight of 1000-seed (32.74 g) was obtained from BARI Mung-5 (V_1). The variation in 1000-seed weight between two varieties might be due to genetic constituents of the crop. The result of the present investigation was similar with the studies conducted by Thakuria and Shaharia (1990); Trung and Yoshida (1983); Sarkar and Banik (1991); Sardana and Verma (1987); Raj and Tripathi (2005); Katial and Shah (1998); Ghosh (2007). They opined that 1000-seed weight was differed significantly among the mungbean varieties.

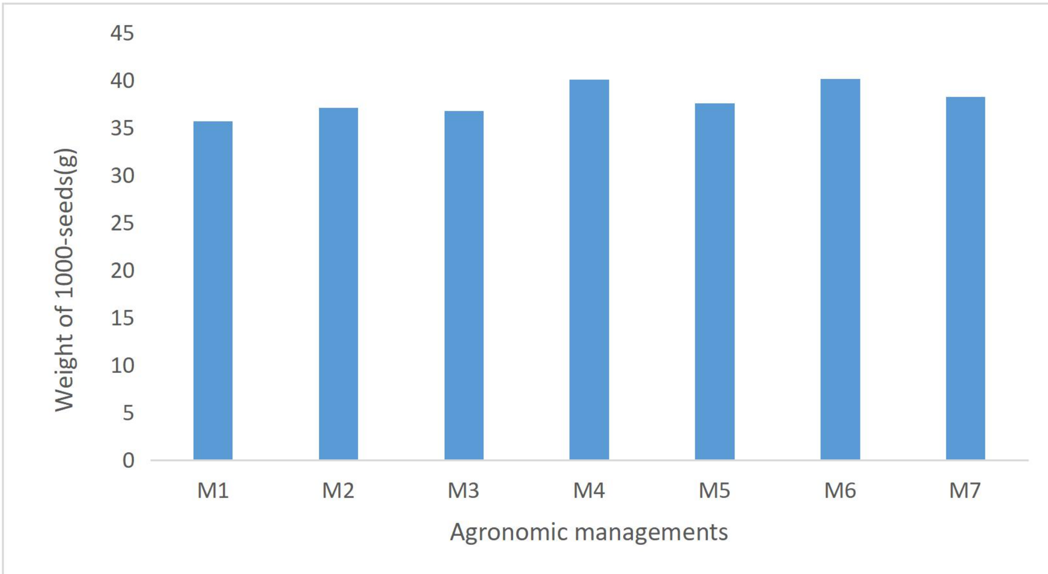


V_1 = BARI Mung-5 and V_2 = BARI Mung-6

Figure 19. Effect of variety on the weight of 1000-seed of mungbean ($LSD_{(0.05)}$ = 0.10).

4.2.4.2 Effect of agronomic managements

Statistically significant variation was observed on the weight of 1000-seed due to different managements (Appendix XI and Figure 20). The highest weight of 1000-seed (40.17 g) was recorded from the M_6 treatment which was statistically similar with M_4 and the lowest weight of 1000-seed (32.74 g) from the M_1. Muhammad *et* *al*. (2004) reported that weeding at 10 and 35 days after sowing significantly affected 1000-seeds weight.



M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 20. Effect of agronomic managements on the weight of 1000-seed of mungbean ($LSD_{(0.05)}$=3.22).

4.2.4.3 Interaction effect of variety and agronomic managements

Interaction effect between variety and agronomic managements was found significant in respect of weight of 1000-seed (Appendix XI and Table 8). The highest weight of 1000-seed (47.56 g) was obtained from the V_2M_4 interaction which shown similarity with the interactions of V_2M_5, V_2M_6 & V_2M_7. The lowest weight of 1000-seed (31.32 g) was obtained from the V_1M_5 which was similar with all other interactions of BARI Mung-5 irrespective of agronomic managements. The result was in conformity with the findings of Saha *et al.* (2002) who reported that irrespective of cultivars, seed growth was better in Kharif-1 than in Kharif-2 season due to more sunny hours prevailed during the reproductive phases as well as low rainfall in the Kharif-1 season. Lassim *et al*. (1984) also observed that field weathering caused reduction in seed yield and quality.

Table 8. Interaction effect of variety and agronomic managements on the wt. of 1000-seeds, seed yield, shell yield, shelling percentage of mungbean

Treatment combinations	Wt. of 1000-seeds (g)	Seed yield (kg ha^{-1})	Shell yield (kg ha^{-1})	Shelling percentage
V_1M_1	33.63 de	136.86 g	93.91 d	57.34 cd
V_1M_2	32.09 e	508.04 b-d	329.80 ab	60.97 bc
V_1M_3	32.14 e	234.52 fg	149.33 cd	60.90 bc
V_1M_4	32.65 e	368.73 d-f	197.15 c	65.27 ab
V_1M_5	31.32 e	356.33 ef	304.30 b	54.06 d
V_1M_6	34.71 de	487.12 c-e	319.17 b	60.57 bc
V_1M_7	32.65 e	509.20 bc	307.57 b	62.33 a-c
V_2M_1	37.74 cd	280.94 f	169.99 cd	62.49 ab
V_2M_2	42.09 bc	708.02 a	386.02 ab	64.72 ab
V_2M_3	41.40 bc	358.43 ef	207.27 c	63.79 ab
V_2M_4	47.56 a	647.70 ab	359.66 ab	64.18 ab
V_2M_5	43.76 ab	694.79 a	373.93 ab	65.04 ab
V_2M_6	45.64 ab	714.82 a	419.40 a	63.03 ab
V_2M_7	43.79 ab	671.54 a	345.33 ab	66.07 a
LSD (0.05)	**4.56**	**140.31**	**94.85**	**5.01**
CV (%)	**7.13**	**17.46**	**19.89**	**4.78**

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

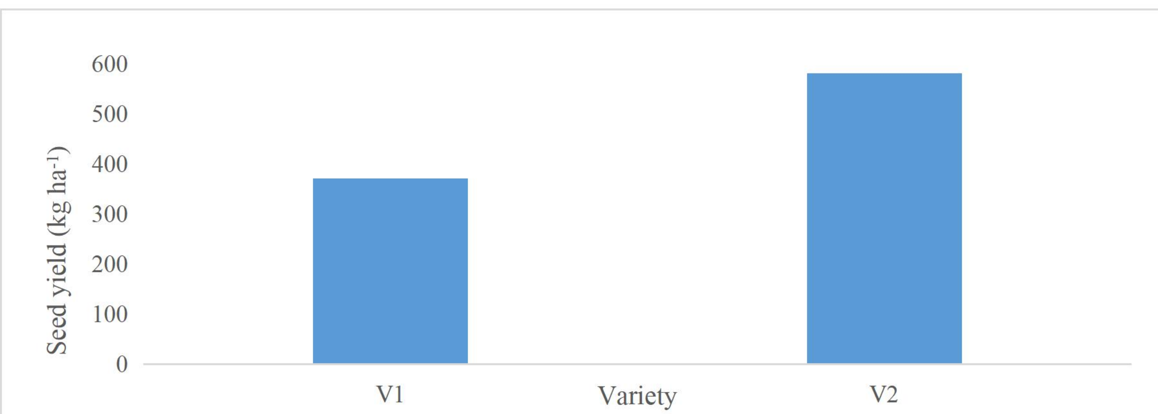
V_1 = BARI Mung-5 and V_2 = BARI Mung-6

M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

4.2.5 Seed yield

4.2.5.1 Effect of variety

The seed yield of mungbean was significantly influenced by the variety (Appendix XII and Figure 21). The maximum seed yield (582.32 kg ha^{-1}) was obtained from BARI Mung-6 which was higher than BARI Mung-5 (371.54 kg ha^{-1}). The higher seed yield in BARI Mung-6 might be due to the contribution of individual seed weight. The finding was in agreement with BARI (1982), ICRISAT (1991) and Singh and Singh (1988) who reported that cultivars played a key role in increasing yield. These results also have agreement with the reports of Ashraf and Warrick (2003); Prasad and Ram (1982); Thakuria and Shaharia (1990). They noted that different varieties of mungbean differed significantly in case of seed yield. Pahlwan and Hossain (1983) reported that the highest yield from the variety Mubarik was attributed to the highest number of pods plant^{-1} and seeds plant^{-1}. Quaderi *et al.* (2006) reported that mungbean varieties, Binamoog-5 performed better than that of Binamoog-4 in context of yield. Tickoo *et al.* (2006) recorded that the cultivar Pusa Vishal recorded higher grain yield (1.63 t ha^{-1}) compared to cv. Pusa 105. Bhati *et al*. (2005) showed that K-851 gave better yield than Asha and the local cultivar.

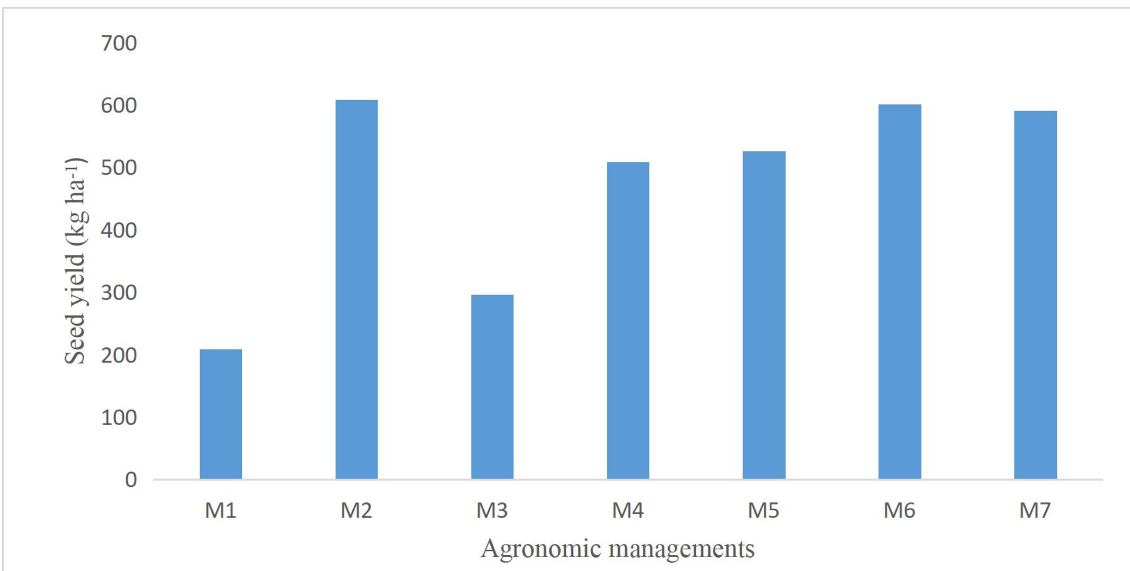


V_1 = BARI Mung-5 and V_2 = BARI Mung-6

Figure 21. Effect of variety on the seed yield of mungbean ($LSD_{(0.05)}$=42.34).

4.2.5.2 Effect of agronomic managements

Managements had significant effect on the seed yield of mungbean (Appendix XII and Figure 22). The M_2 produced significantly the highest seed yield (608.03 kg ha^{-1}) which was similar with M_5. M_6 and M_7 and the lowest seed yield (208.90 kg ha^{-1}) was obtained from the M_1 treatment which was similarly followed by M_3. Yield losses due to uncontrolled weed growth in mungbean ranged from 27 to 100% (AVRDC, 1976). Muhammad *et al*. (2004) reported that weeding at 10 and 35 days after sowing significantly affected grain yield. Sarker and Mondal (1993) reported that seed yield was reduced by 49 to 55% when weeds were not removed at all. Mungbean should be kept weed free during the first 45 days of sowing to increase yield was reported by Jha *et al.* (1997).



M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 22. Effect of different agronomic managements on the seed yield of mungbean ($LSD_{(0.05)}$=99.21).

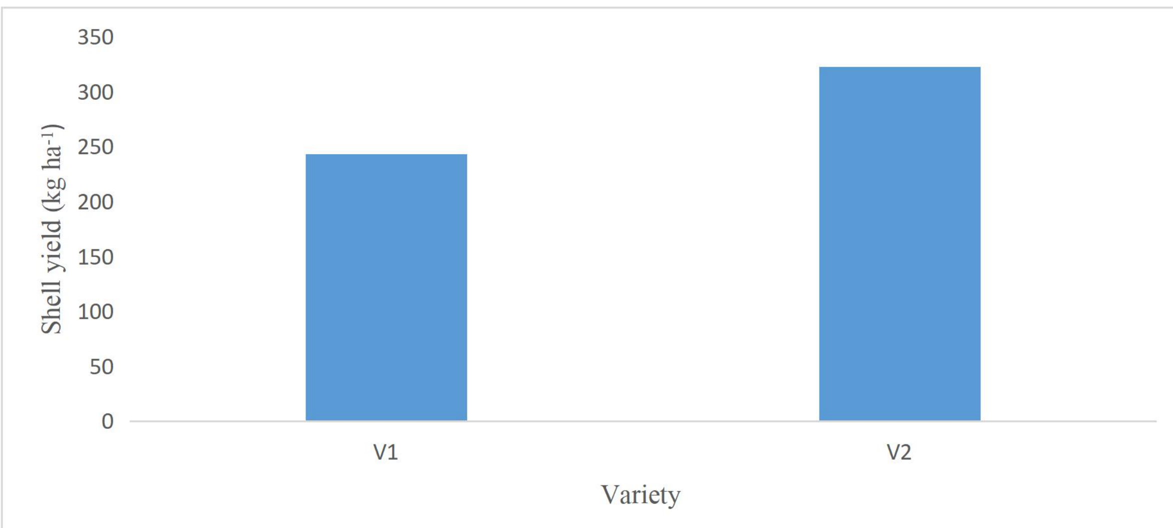
4.2.5.3 Interaction effect of variety and agronomic managements

Interaction effect between variety and agronomic managements was found significant in respect of seed yield (Appendix XII and Table 8). The highest seed yield (714.82 kg ha^{-1}) was obtained from the V_2M_6 interaction which was similar with the interaction of V_2M_2, V_2M_5, V_2M_7 and the lowest seed yield (136.86 kg ha^{-1}) was obtained from the V_1M_1 interaction.

4.2.6 Shell yield

4.2.6.1 Effect of variety

Statistically significant variation was recorded for shell yield by the variety (Appendix XI and Figure 23). The higher shell yield (322.80 kg ha^{-1}) was recorded from BARI Mung-6 (V_2) and the lower shell yield (243.04 kg ha^{-1}) from BARI Mung-5 (V_1).

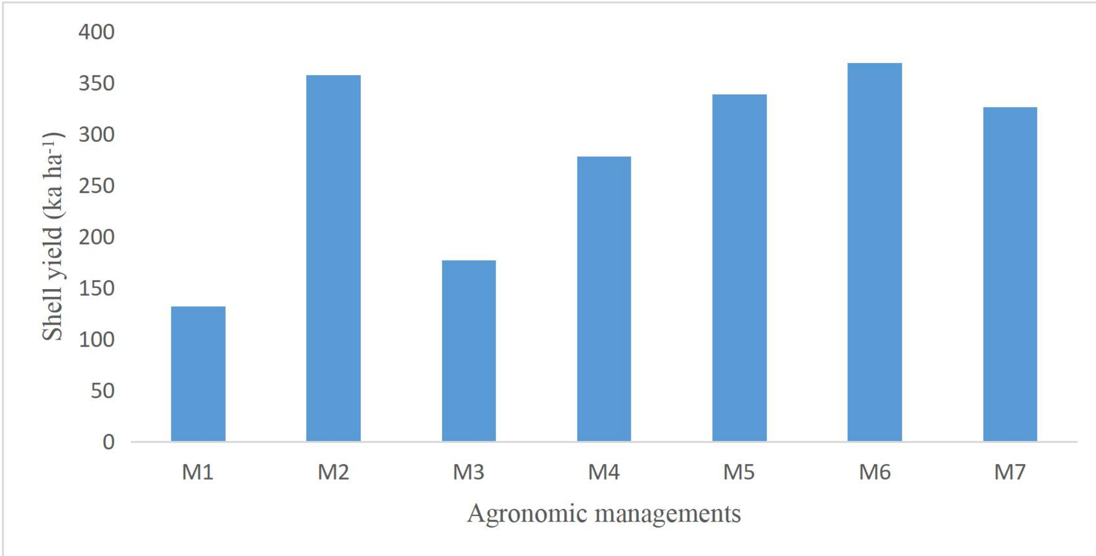


V_1 = BARI Mung-5 and V_2 = BARI Mung-6

Figure 23. Effect of variety on the shell yield of mungbean ($LSD_{(0.05)}$= 20.52).

4.2.6.2 Effect of agronomic managements

The different managements had significant effect on shell yield (Appendix XI and Figure 24). The M_6 produced significantly the highest shell yield (369.28 kg ha^{-1}) which was statistically similar with M_2 managements and the lowest shell yield (131.95 kg ha^{-1}) was obtained from the M_1 which was similar to M_3 treatment.



M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 24. Effect of agronomic managements on the shell yield of mungbean ($LSD_{(0.05)}$= 67.07).

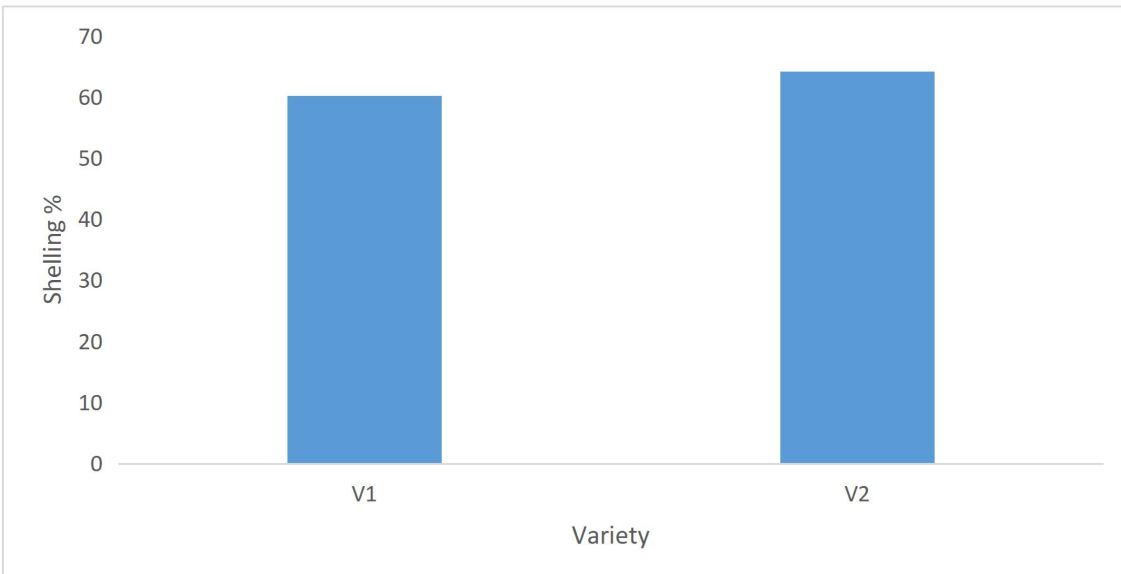
4.2.6.3 Interaction effect of variety and agronomic managements

Interaction effect between variety and agronomic managements was found significant in respect of shell yield (Appendix XI and Table 12). The highest shell yield (419.40 kg ha^{-1}) was obtained from the V_2M_6 which was similar to V_1M_2, V_2M_2, V_2M_4, V_2M_5 and V_2M_7 interaction. The lowest shell yield (93.91 kg ha^{-1}) was obtained from the V_1M_1 interaction that similar to V_1M_3 and V_2M_1.

4.2.7 Shelling percentage

4.2.7.1 Effect of variety

Statistically significant variation was recorded for shelling percentage by the variety (Appendix XI and Figure 25). The higher shelling percentage (64.19%) was recorded from BARI Mung-6 (V_2) and the lower shelling percentage (60.20%) from BARI Mung-5 (V_1).

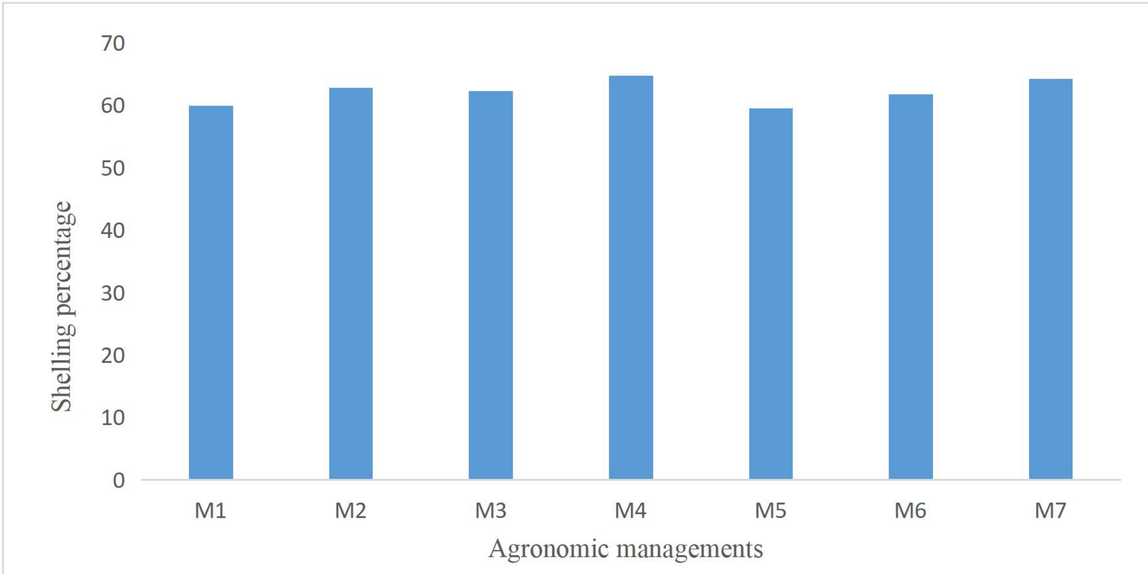


V_1 = BARI Mung-5 and V_2 = BARI Mung-6

Figure 25. Effect of variety on the shelling percentage of mungbean ($LSD_{(0.05)}$= 3.83).

4.2.7.2 Effect of managements

The different managements had significant effect on shelling percentage (Appendix XI and Figure 26). The M_6 produced significantly the highest shell yield (64.73%) which was statistically similar with M_7 managements and the lowest shelling percentage (59.55%) was obtained from the M_5 which was similar to M_1 treatment.



M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 26. Effect of agronomic managements on the shelling percentage of mungbean ($LSD_{(0.05)}$= 3.83).

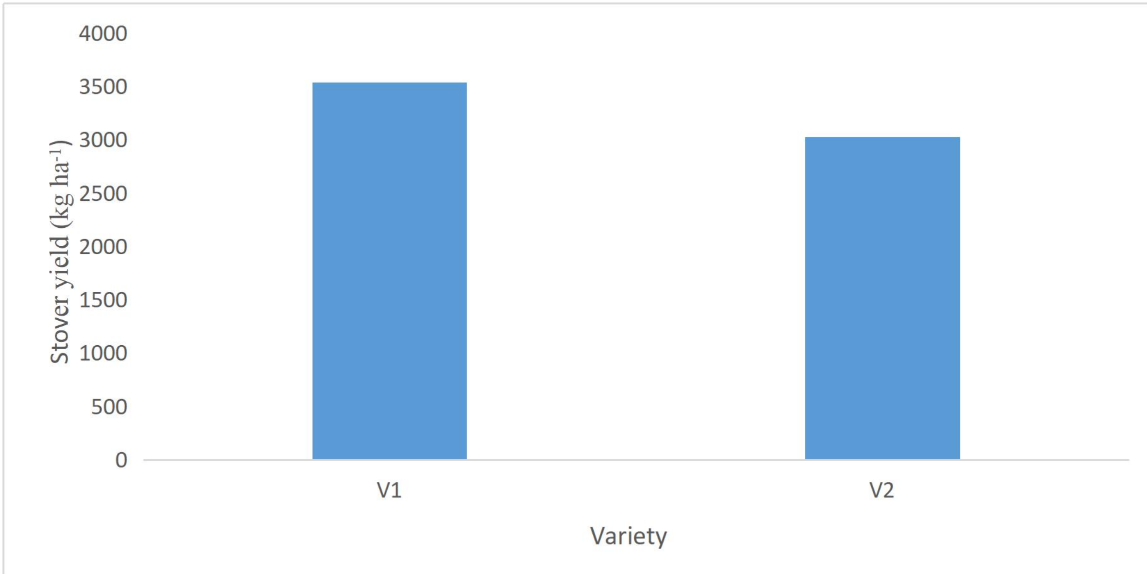
4.2.7.3 Interaction effect of variety and agronomic managements

Interaction effect between variety and agronomic managements was found significant in respect of shelling percentage (Appendix XI and Table 8). The highest shelling percentage (66.07) was obtained from the V_2M_7.The lowest shelling percentage (54.06) was obtained from the V_1M_5 which was followed by V_1M_1 interaction.

4.2.8 Stover yield

4.2.8.1 Effect of variety

Statistically significant variation was recorded for stover yield by the variety (Appendix XII and Figure 27). The higher stover yield (3539.20 kg ha^{-1}) was recorded from BARI Mung-5 (V_1) and the lower stover yield (3023.55 kg ha^{-1}) from BARI Mung-6 (V_2). Bhati *et al*. (2005) reported that mungbean cv. PDM-54 showed 13.7% higher fodder yield than the local cultivar.

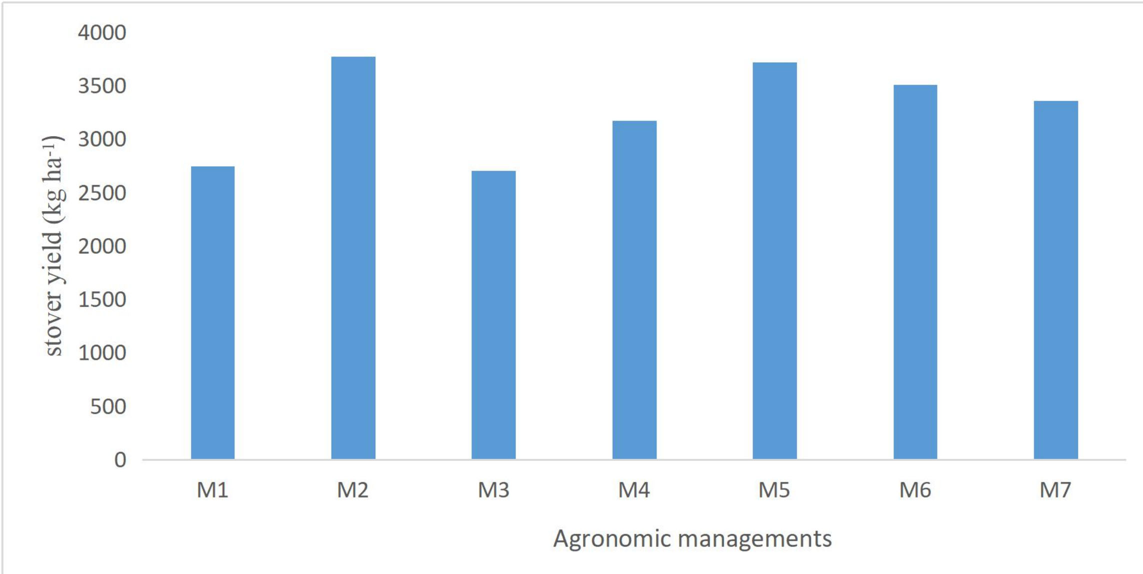


V_1 = BARI Mung-5 and V_2 = BARI Mung-6

Figure 27. Effect of variety on the stover yield of mungbean ($LSD_{(0.05)}$=1832.85).

4.2.8.2 Effect of agronomic managements

The different managements had insignificant effect on stover yield (Appendix XII and Figure 28). The M_2 produced the highest stover yield (3770.89 kg ha^{-1}) which was statistically similar all managements and the lowest stover yield (2704.76 kg ha^{-1}) was obtained from the M_3 treatment.



M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 28. Effect of managements on the stover yield of mungbean ($LSD_{(0.05)}$= 1441.44).

4.2.8.3 Interaction effect of variety and agronomic managements

Interaction effect between variety and agronomic managements was found significant in respect of stover yield (Appendix XII and Table 9). The highest stover yield (5470.93 kg ha^{-1}) was obtained from the V_1M_5 which was similar to V_1M_2, V_1M_7 and V_2M_6 interaction. The lowest stover yield (1959.30 kg ha^{-1}) was obtained from the V_2M_5 interaction that was similar to all other interactions except V_1M_7, V_1M_2 and V_1M_5.

Table 9. Interaction effect of variety and managements on the stover yield, biological yield and harvest index of mungbean

Treatment combinations	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
V_1M_1	2430.94 bc	2661.71 d	5.28 f
V_1M_2	4344.28 ab	5182.12 ab	9.85 d-f
V_1M_3	2540.84 bc	2924.70 cd	8.34 ef
V_1M_4	3098.04 bc	3663.93 b-d	10.46 de
V_1M_5	5470.93 a	6131.57 a	6.19 ef
V_1M_6	3152.91 bc	3959.20 b-d	13.61 b-d
V_1M_7	3736.42 ab	4553.20 a-d	11.37 cd
V_2M_1	3060.21 bc	3511.14 b-d	10.20 de
V_2M_2	3197.51 bc	4291.56 a-d	16.81 b
V_2M_3	2868.68 bc	3432.38 b-d	10.46 de
V_2M_4	3246.05 bc	4253.42 a-d	15.19 bc
V_2M_5	1959.30 c	3028.01 cd	23.02 a
V_2M_6	3860.80 a-c	4995.03 a-c	15.46 bc
V_2M_7	2972.27 bc	3989.14 b-d	16.71 b
LSD $_{(0.05)}$	**2038.50**	**2129.95**	**4.63**
CV (%)	**36.87**	**31.28**	**22.22**

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

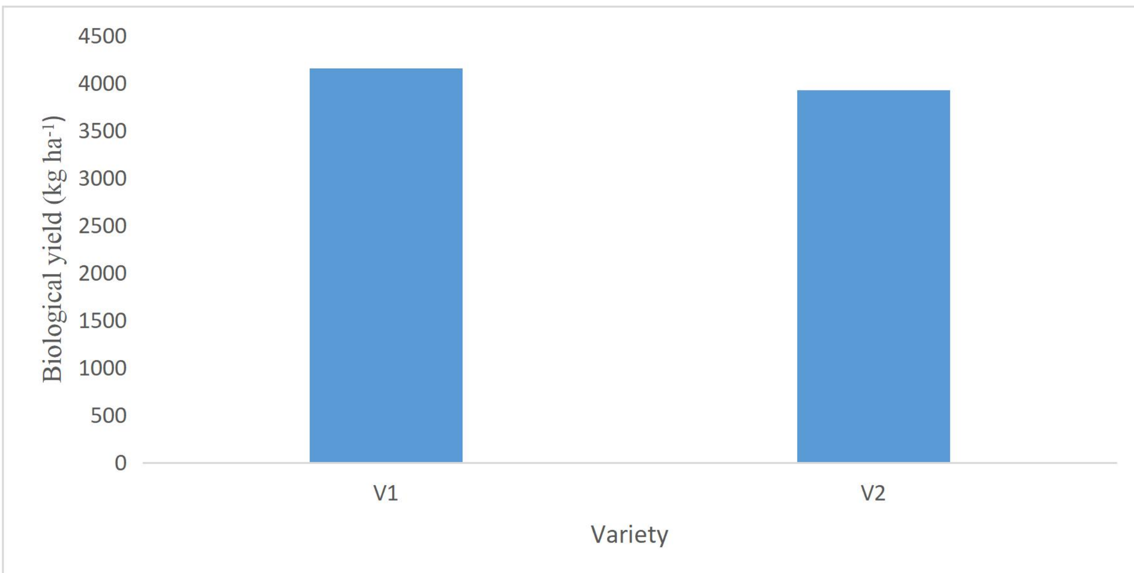
V_1 = BARI Mung-5 and V_2 = BARI Mung-6

M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

4.2.9 Biological yield

4.2.9.1 Effect of variety

The biological yield of mungbean was insignificantly influenced by the variety (Appendix XII and Figure 29). The higher biological yield (4153.77 kg ha^{-1}) was obtained from BARI Mung-5 (V_1) and the lower biological yield (3928.67 $kgha^{-1}$) was obtained from BARI Mung-6 (V_2). The higher biological yield in BARI Mung-5 might be due to the contribution of higher stover yield.

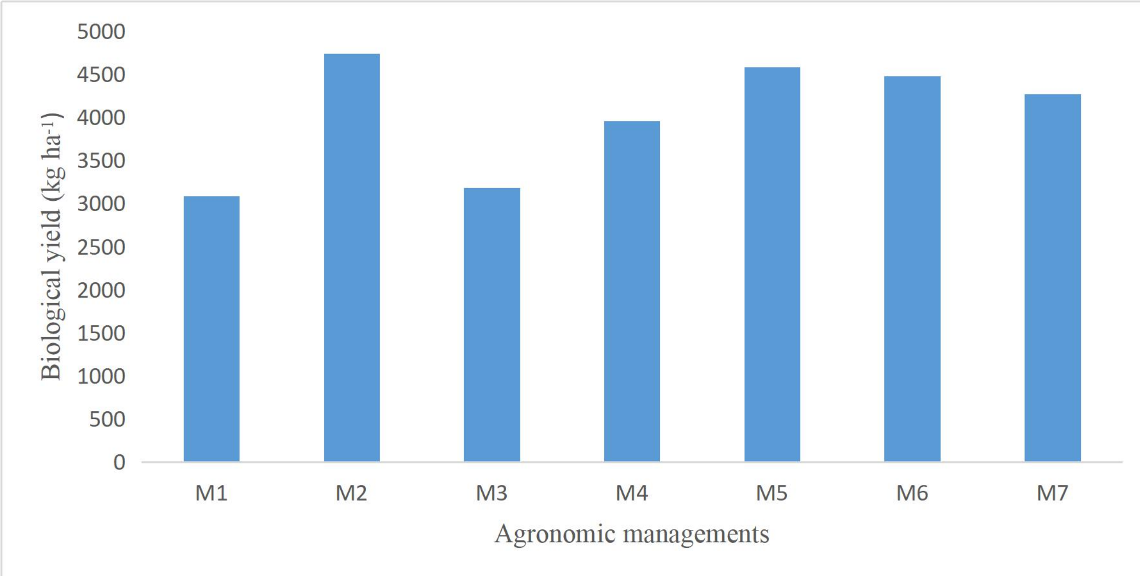


V_1 = BARI Mung-5 and V_2 = BARI Mung-6

Figure 29. Effect of variety on the biological yield of mungbean ($LSD_{(0.05)}$=1851.69).

4.2.9.2 Effect of agronomic managements

The managements had significant effect on biological yield (Appendix XII and Figure 30). The M_2 produced significantly the highest biological yield (4736.84 kg ha^{-1}) which was similar to the M_5 and M_6 treatment and the lowest biological yield (3086.43 kg ha^{-1}) was obtained from the M_1 treatment which was similar to M_3.



M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 30. Effect of agronomic managements on the biological yield of mungbean ($LSD_{(0.05)}$= 1506.10).

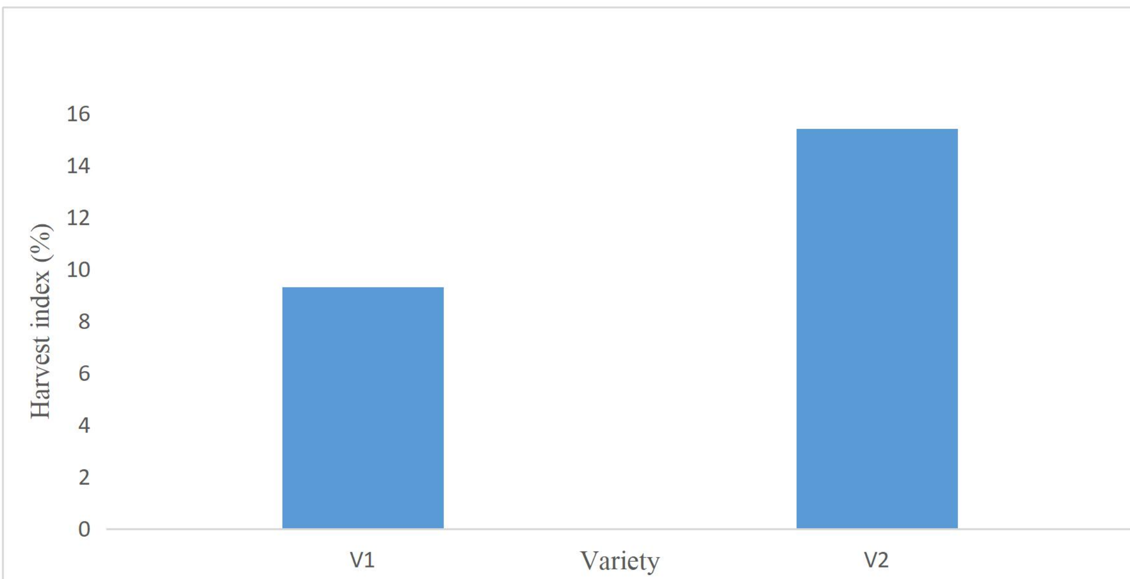
4.2.9.3 Interaction effect of variety and agronomic managements

Interaction effect between variety and agronomic managements was found significant in respect of biological yield (Appendix XII and Table 9). The highest biological yield (6131.57 kg ha^{-1}) was obtained from the V_1M_5 interaction which was similar to the interactions of V_1M_2, V_1M_7, V_2M_4 and V_2M_6 and the lowest biological yield (2661.71 kg ha^{-1}) was obtained from the V_1M_1 interaction that was similar to all other interactions except V_2M_6, V_1M_2 and V_1M_5.

4.2.10 Harvest index

4.2.10.1 Effect of variety

The harvest index was significantly influenced by the variety (Appendix XII and Figure 31). The higher harvest index (15.41%) was found in BARI Mung-6 (V_2) and the lower harvest index (9.30%) was in BARI Mung-5 (V_1). The result was agreed with the findings of Aguliar and Villarea (1989) and Ghosh (2007) who reported that the harvest index of mungbean was significantly influenced by the variety.

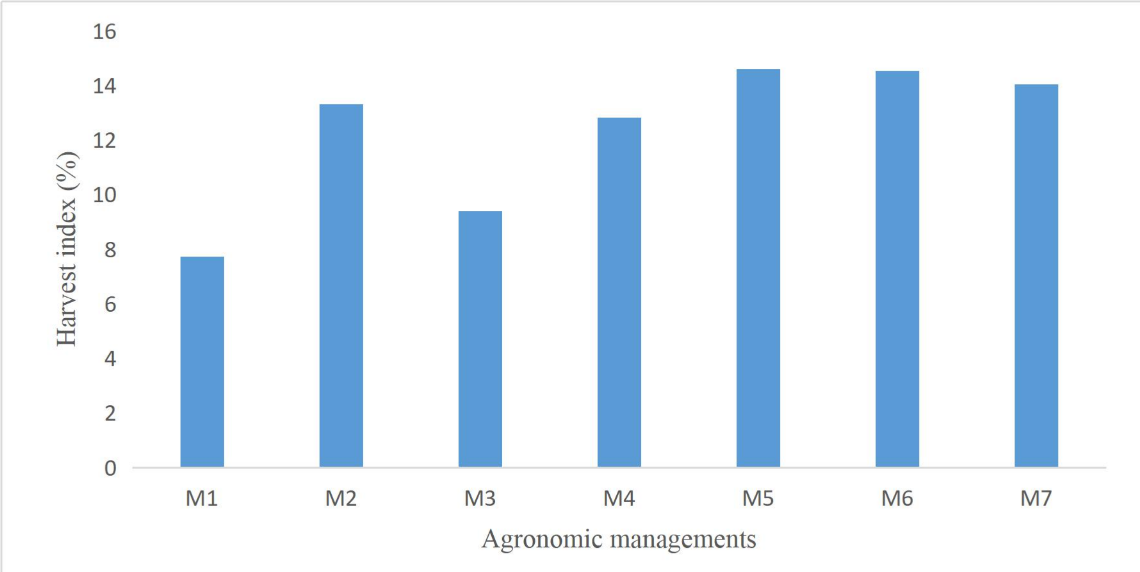


V_1 = BARI Mung-5 and V_2 = BARI Mung-6

Figure 31. Effect of variety on the harvest index of mungbean ($LSD_{(0.05)}$= 3.70).

4.2.10.2 Effect of agronomic managements

The agronomic managements had significant effect on harvest index of mungbean (Appendix XII and Figure 32). The M_5 produced significantly the highest harvest index (14.61%) which was statistically similar with M_2, M_4, M_6 and M_7 and the lowest harvest index (7.74%) was obtained from the M_1 treatment which was similar with M_3.



M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 32. Effect of agronomic managements on the harvest index of mungbean ($LSD_{(0.05)}$= 3.27).

4.2.10.3 Interaction effect of variety and agronomic managements

Interaction effect between variety and agronomic managements was found significant in respect of harvest index (Appendix XII and Table 9). The highest harvest index (23.02%) was obtained from the V_2M_5 interaction and the lowest harvest index (6.19%) was obtained from the V_1 with the interaction of M_5 which was similar to the interactions of V_1M_2 and V_1M_3.

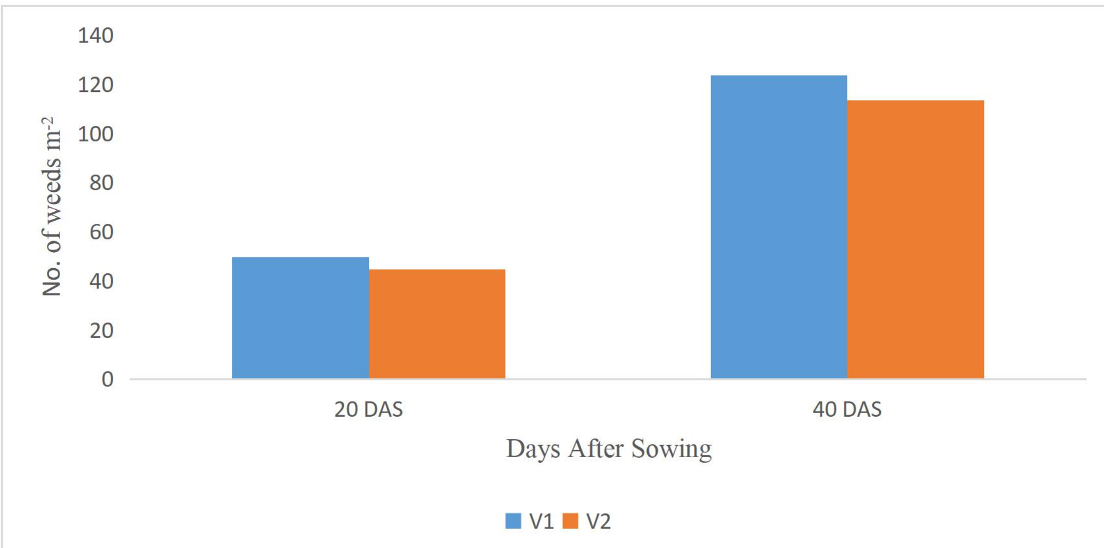
4.3 Weed data

4.3.1 Number of weeds m^{-2}

4.3.1.1 Effect of variety

The number of weeds m^{-2} was significantly influenced by the variety at 20 and 40 DAS (Appendix XIII and Figure 33).

The higher number of weeds m^{-2} (49.62 and 123.71) was found in BARI Mung-5 (V_1) and the lower number of weeds m^{-2} (44.76 and 113.43) was observed in BARI Mung-6 (V_2) at 20 and 40 DAS respectively.

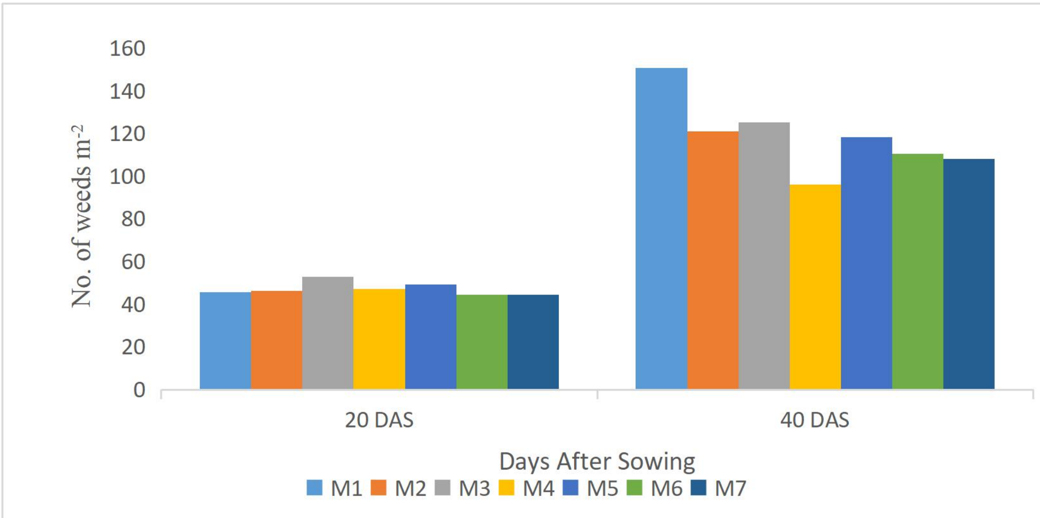


V_1 = BARI Mung-5 and V_2 = BARI Mung-6

Figure 33. Effect of variety on the number of weeds m^{-2} of mungbean at different days after sowing (LSD $_{(0.05)}$ = 14.87 and 26.09 at 20 and 40 DAS respectively).

4.3.1.2 Effect of agronomic managements

The different managements had significant effect on the number of weeds m^{-2} at 20 and 40 DAS (Appendix XIII and Figure 34). The results revealed that at 20 DAS, the highest number of weeds m^{-2} (53) was produced by M_3 which was statistically similar to M_2, M_4 and M_5 treatments and the lowest number of weeds m^{-2} (44.33) was produced by the M_6 and M_7 treatment which was statistically similar. At 40 DAS, the highest total number of weeds m^{-2} (150.67) was produced by the M_1 treatment which was statistically similar to M_2, M_3, M_5 and M_6 treatments and the lowest number of weeds m^{-2} (96.00) was produced by the M_4 treatment which was statistically similar to M_7.



M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 34. Effect of different managements on the number of weeds m^{-2} of mungbean at different days after sowing ($LSD_{(0.05)}$ = 7.24, 41.34 at 20 and 40 DAS respectively).

4.3.1.3 Interaction effect of variety and agronomic managements

Interaction effect between variety and agronomic managements was found significant in respect of the number of weeds m^{-2} at 20 and 40 DAS (Appendix XIII and Table 10).

At 20 DAS, the highest number of weeds m^{-2} (57.33) was produced by the V_1M_3 combination which was statistically similar to the interactions of V_1M_2, V_1M_5, V_1M_6, V_2M_1, V_2M_2, V_2M_3, V_2M_5 and V_2M_7 and the lowest number of weeds m^{-2} (36) was produced by the interaction of V_2M_7 which was statistically similar to the interaction of V_1M_2, V_2M_1 and V_2M_6. At 40 DAS, the highest total number of weeds m^{-2} (162.00) was produced by the V_1M_1 interaction while the lowest number of weeds m^{-2} (94.00) was produced by V_1M_4 which shown similarity with the combination of V_2M_4 and V_2M_6.

Table 10. Interaction effect of variety and agronomic managements on number of weeds m^{-2} of mungbean

Treatment combinations	Number of weeds m^{-2} at	
	20 DAS	40 DAS
V_1M_1	46.67 bc	162.00 a
V_1M_2	44.67 b-d	112.00 ab
V_1M_3	57.33 a	138.67 ab
V_1M_4	49.33 a-c	94.00 b
V_1M_5	49.33 a-c	131.33 ab
V_1M_6	47.33 a-c	120.00 ab
V_1M_7	52.67 ab	108.00 ab
V_2M_1	44.67 b-d	139.33 ab
V_2M_2	48.00 a-c	130.00 ab
V_2M_3	48.67 ab	112.00 ab
V_2M_4	45.33 b-d	98.00 b
V_2M_5	49.33 a-c	105.33 ab
V_2M_6	41.33 cd	101.33 b
V_2M_7	36.00 d	108.00 ab
$LSD_{(0.05)}$	**10.25**	**58.46**
CV (%)	**12.88**	**29.26**

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

V_1 = BARI Mung-5 and V_2 = BARI Mung-6

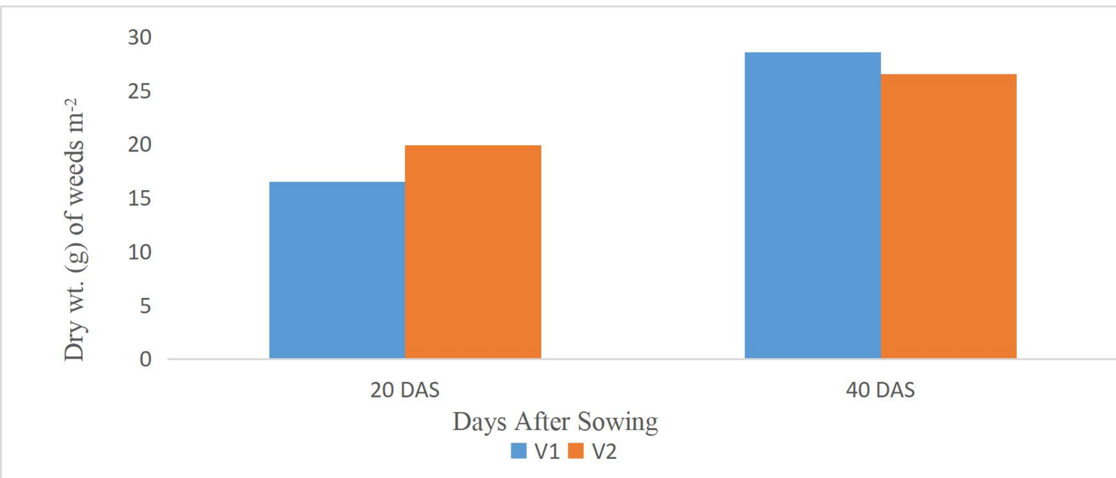
M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

4.3.2 Dry weight of weeds m^{-2}

4.3.2.1 Effect of variety

The dry weight of weeds m^{-2} was significantly influenced by the variety at 20 DAS but insignificant at 40 DAS (Appendix XIII and Figure 35).

At 20 DAS, the higher dry weight of weeds m^{-2} (19.90 g) was found in BARI Mung-6 (V_2) and the lower dry weight of weeds m^{-2} (16.52 g) was observed in BARI Mung-5 (V_2). At 40 DAS the higher dry weight of weeds m^{-2} (28.58 g) was found in BARI Mung-5 (V_1) and the lower dry weight of weeds m^{-2} (26.54 g) was observed in BARI Mung-6 (V_2).

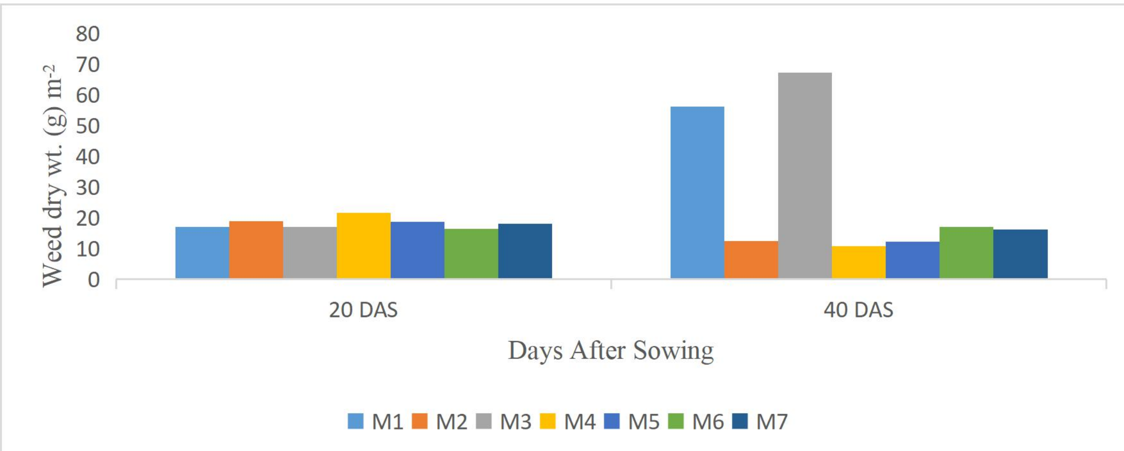


V_1 = BARI Mung-5 and V_2 = BARI Mung-6

Figure 35. Effect of variety on the dry weight of weeds m^{-2} of mungbean at different days after sowing ($LSD_{(0.05)}$ = 6.39 and NS at 20 and 40 DAS, respectively).

4.3.2.2 Effect of agronomic managements

The different agronomic managements had insignificant effect on the dry weight of weeds m^{-2} at 20 DAS but significant effect at 40 DAS (Appendix XIII and Figure 36). The results revealed that at 20 DAS, the maximum dry weight of weeds m^{-2} (21.67 g) was produced by M_4 and the minimum dry weight of weeds m^{-2} (16.33 g) was produced by the M_6 treatment which was statistically similar to all managements. At 40 DAS, the maximum dry weight of weeds m^{-2} (67.29 g) was produced by M_3 treatment which was similar to M_1. The minimum dry weight of weeds m^{-2} (12.18 g) was produced by M_5 which shown similarity to the M_2, M_4, M_6 and M_7 treatments. Das and Yaduraju (1996) observed that the weed growth rate (WGR) increased up to 35 DAS in mungbean which was assumed to be the most critical period of weed competition.



M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Figure 36. Effect of different managements on the dry weight of weeds m^{-2} of mungbean at different days after sowing ($LSD_{(0.05)}$ = NS and 15.49 at 20 and 40 DAS respectively).

4.3.2.3 Interaction effect of variety and agronomic managements

Interaction effect between variety and agronomic managements was found insignificant in respect of the dry weight of weeds m^{-2} at 20 and 40 DAS (Appendix XIII and Table 11). At 20 DAS, the highest dry weight of weeds m^{-2} (24.67 g) was produced by the V_2M_4 which was similar to V_2M_2 combination and the lowest (13.67 g) was produced by the interaction of V_1M_2. At 40 DAS, the highest dry weight of weeds m^{-2} (71.73 g) was produced by the V_2M_3 interaction and the lowest (7.49 g) was produced by V_2M_4.

Table 11. Interaction effect of variety and managements on dry weight of weeds m^{-2} of mungbean

Treatment combinations	Dry weight of weeds m^{-2} at	
	20 DAS	40 DAS
V_1M_1	16.00 ab	67.28 ab
V_1M_2	13.67 b	13.25 c
V_1M_3	16.67 ab	62.84 ab
V_1M_4	18.67 ab	14.06 c
V_1M_5	16.67 ab	9.36 c
V_1M_6	14.67 ab	17.42 c
V_1M_7	19.33 ab	15.86 c
V_2M_1	18.00 ab	45.45 b
V_2M_2	24.00a	11.77 c
V_2M_3	17.33 ab	71.73 a
V_2M_4	24.67 a	7.49 c
V_2M_5	20.67 ab	14.99 c
V_2M_6	18.00 ab	16.80 c
V_2M_7	16.67 ab	17.59 c
$LSD_{(0.05)}$	**10.08**	**21.91**
CV (%)	**32.83**	**47.18**

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

V_1 = BARI Mung-5 and V_2 = BARI Mung-6

M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

CHAPTER V

SUMMARY AND CONCLUSION

The field experiment was conducted at the Agronomy farm of Sher-e-Bangla Agricultural University (SAU), Dhaka, during the period from March to June 2019 to study the influence of management packages on growth and yield of two mungbean varieties in Kharif-1 season under the Modhupur Tract (AEZ-28). The treatment of the experiment consists of two varieties viz. BARI mung-5, BARI mung-6 and seven agronomic managements viz. M_1 = Control (No managements), M_2 = All managements except fertilizer, M_3 = All managements except weeding, M_4 = All managements except irrigation, M_5 = All managements except insecticide, M_6 = All managements except fungicide/ bactericide, M_7 =Complete managements. The experiment was laid out in Split-plot design following the principles of randomization with three replications. Variety was placed in the main plot and management packages were placed in the sub plot. Data on different growth stage, yield contributing characters and yield were recorded and statistically significant variation was observed for different treatment. The sowing date was on March 15, 2019.

The data on growth parameters viz. plant height, number of leaves plant^{-1}, dry matter plant^{-1} were recorded during the period of days after sowing. Number of nodules plant^{-1} were recorded at 20 and 40 DAS. SPAD value was recorded at 45 DAS and flowering data was recorded as 1st flowering, 50% flowering and 100% flowering. Yield contributing characters and yield parameters like number of pods plant^{-1}, pod length, number of seeds pod^{-1}, 1000-seed weight were recorded. Five plants were randomly selected from each unit plot for taking observations on plant height, number of leaves plant^{-1} with 15 days interval at 15, 30, 45 DAS and at harvest. Pods plant^{-1}, pod length and number of seeds pod^{-1} were recorded from the selected plants. Number of nodules plant^{-1} 20 and 40 DAS and dry weight of plants were taken from 20, 40 DAS and at harvest. Central 7.2 m^2 from each plot were harvested for seed yield, biological yield and harvest index. Thousand seed weight was measured from sampled seed. Data were analyzed using CropStat package. The mean differences among the treatments were compared by least significant difference (LSD) test at 5% level of significance. Data on different growth parameters, yield attributes and yield were significantly varied for different treatments. Plant height of BARI mung was higher (9.26, 32.86 and 44.49 cm respectively) at 15, 30 and 45 DAS, but at harvest plant height was higher (45.86 cm) in BARI mung-5. At 15, 30 and 45 DAS maximum number of leaves plant^{-1} (3.81, 7.26 and 9.69 respectively) was recorded from V_1 (BARI mung-5) and minimum number of leaves plant^{-1} (3.62, 6.70 and 8.70 respectively) was recorded from BARI mung-6. At 20, 40 and harvest the higher dry matter content plant^{-1} (0.75, 3.20 and 7.55 g respectively) was found from V_2 (BARI Mung-6) and the lower dry weight plant^{-1} (0.72, 3.07 and7.46 g respectively) was found from V_1 (BARI Mung-5). At 20 and 40 DAS, the higher number of weeds (49.62 and 123.51 m^{-2} respectively) was found from V_1 (BARI Mung-5) and the lower number of weeds (44.76 and 113.46 respectively) was found from V_2 (BARI Mung-6). At 20 and 40 DAS maximum number of nodules plant^{-1} (12.67 and 19.52) was produced by V_2 (BARI Mung-6) and minimum number of nodules plant^{-1} (9.07 and 16.82) was produced by V_1 (BARI Mung-5). At 20 DAS, the higher dry weight of weeds (19.90 g) was found from V_2 and lower dry weight of weeds (16.52 g) was found from V_1. At 40 DAS, the higher dry weight of weeds (28.58 g) was found from V_1 and lower dry weight of weeds (26.54 g) was found from V_2. The highest total pods plant^{-1} (45.71) was recorded in V_2 whereas the lowest total pods plant^{-1} (41.86) was recorded in V_1. The longest pod length (7.652) was found from V_1 and shortest pod length (7.651) was found from V_2. The maximum seed yield (582.32 kg ha^{-1}) was obtained from treatment V_2 and the minimum seed yield (371.54 kg ha^{-1}) was obtained from treatment V_1. The maximum 1000-seed weight (43.14 g) was recorded from V_2 and the minimum

1000-seed weight (32.74 g) was recorded from V_1. The highest harvest index (15.41) was obtained from V_2.

At 15 DAS and harvest, plant height was highest (9.07 and 47.59 cm, respectively) in M_6 and lowest (8.77 and 43.70 cm respectively) in M_2. But at 30 and 45 DAS, plant height was highest (33.89 and 46.08 cm) in M_3 and lower (29.06 and 42.75 cm respectively) in M_2 and M_1. At 15, 30 and 45 DAS, maximum number of leaves plant^{-1} (3.87, 7.20 and 9.83 respectively) was recorded from M_5 and M_4 respectively. At 15, 30 and 45 DAS, the minimum number of leaves plant^{-1} (3.60, 6.83 and 8.23 respectively) was recorded from M_1 and M_2 respectively. At 20 and 40 DAS, the highest dry weight of weeds (21.67 g and 67.29 g respectively) was found from M_4 and M_3 respectively. At 20 and 40 DAS, the highest number of weeds m^{-2} (53.00 and 150.67 respectively) was found from M_3 and M_1 respectively. At 40 DAS maximum number of nodules plant^{-1} (21.40) was produced from M_2 and minimum number of nodules plant^{-1} (15.10) was produced by M_1. At 20, 40 DAS and harvest the highest dry weight plant^{-1} (0.80 g, 3.73 g and 8.89 g respectively) was found from M_1, M_3 and M_6 respectively while the lowest dry weight plant^{-1} (0.63 g, 2.70 g and 4.82 g) was found from M_4, M_3 and M_1 respectively. The highest pods plant^{-1} (51.33) was recorded in M_4 whereas the lowest total pods plant^{-1} (33.67) was recorded in M_1. The longest pod length (7.81 cm) was found from M_7 and shortest pod length (7.42) was found from M_1. The maximum seed yield (608.03 kg ha^{-1}) was obtained from M_2 and the minimum seed yield (208.90 kg ha^{-1}) was obtained from M_1. The maximum shell weight (369.28 kg ha^{-1}) was obtained from M_6 and the minimum (131.95 kg ha^{-1}) was obtained from treatment M_1. The maximum 1000-seed weight (40.17 g) was recorded by M_6 and the minimum 1000-seed weight (35.68 g) was recorded from M_1. The maximum harvest index (14.61%) was recorded from M_5 and the minimum harvest index (7.74%) was recorded from M_1.

Due to interaction effect of variety and management, plant height of V_2M_4, V_2M_3, V_1M_5 and V_1M_6 was highest (9.58, 35.05,46.50 and 49.23 cm respectively) at 15, 30, 45 DAS and harvest. At 45 DAS, maximum number of leaves plant^{-1} (11.20) was recorded from V_1M_4 and minimum number of leaves plant^{-1} (7.73) was recorded from V_2M_3. At 20 and 40 DAS, the highest dry weight of weeds (24.67 g and 71.73 g) was found from V_2M_4 and V_2M_3 respectively and the lowest dry weight of weeds (13.67 g and 7.49 g) was found from V_1M_2 and V_2M_4 respectively. At 20 and 40 DAS, the highest number of weeds m^{-2} (57.33 and 162.00 respectively) was found from V_1M_3 and V_1M_1 and the lowest number of weeds m^{-2} (36.00 and 94.00, respectively) was found from V_2M_7 and V_1M_4. At 40 maximum number of nodules plant^{-1} (24.47) was produced by V_2M_7 and minimum number of nodules plant^{-1} (15.27) was produced by V_2M_3. At 20 and harvest, the highest dry weight plant^{-1} (0.83 g and 10.45 g respectively) was found from V_2M_6 while at 40 DAS, the highest dry weight plant^{-1} (3.88 g) was found from both V_2M_7 and at 20, 40 DAS and harvest, the lowest dry weight plant^{-1} (0.63 g, 2.46 g and 4.37 g, respectively) was found from V_1M_4, V_1M_3 and V_2M_1. The highest pods plant^{-1} (54.33) was recorded in V_1M_4 whereas the lowest total pods plant^{-1} (29.67) was recorded in V_1M_1. The longest pod length (7.89 cm) was found from V_2M_4 and shortest pod length (6.97 cm) was found from V_1M_1. The maximum seeds pod^{-1} (9.59) was obtained from treatment V_2M_7 and the minimum seeds pod^{-1} (8.36) was obtained from treatment V_2M_6. The maximum seed yield (714.82 kg ha^{-1}) was obtained from treatment V_2M_6 and the minimum (136.86 kg ha^{-1}) was obtained from treatment V_1M_1. The maximum shell yield (419.40 kg ha^{-1}) was obtained from treatment V_2M_6 and the minimum (93.91 kg ha^{-1}) was obtained from treatment V_1M_1. The maximum 1000-seed weight (47.56 g) was recorded from V_2M_4 and the minimum 1000-seed weight (31.32 g) was recorded by V_1M_5. The maximum harvest index (23.02%) was recorded from V_2M_5 and the minimum harvest index (6.19%) was recorded from V_1M_5. Considering the findings of the present experiment, following conclusions may be drawn:

- The mungbean variety, BARI mung-6 showed higher seed yield due to higher yield attributes.
- The complete management showed maximum growth and yield in mungbean. No management reduced 64.62% yield of mungbean that followed by no weeding (49.78%), no irrigation (13.96%) and no insecticide (10.98%).
- BARI Mung-6 along with complete management could be the better production package for maximum growth and yield of mungbean. More emphasis have to be given on weed management of mungbean cultivation.

Before recommendation of variety and management packages to optimize mungbean production further study is needed in different agro-ecological zones of Bangladesh at farmer's field for valid conclusion.

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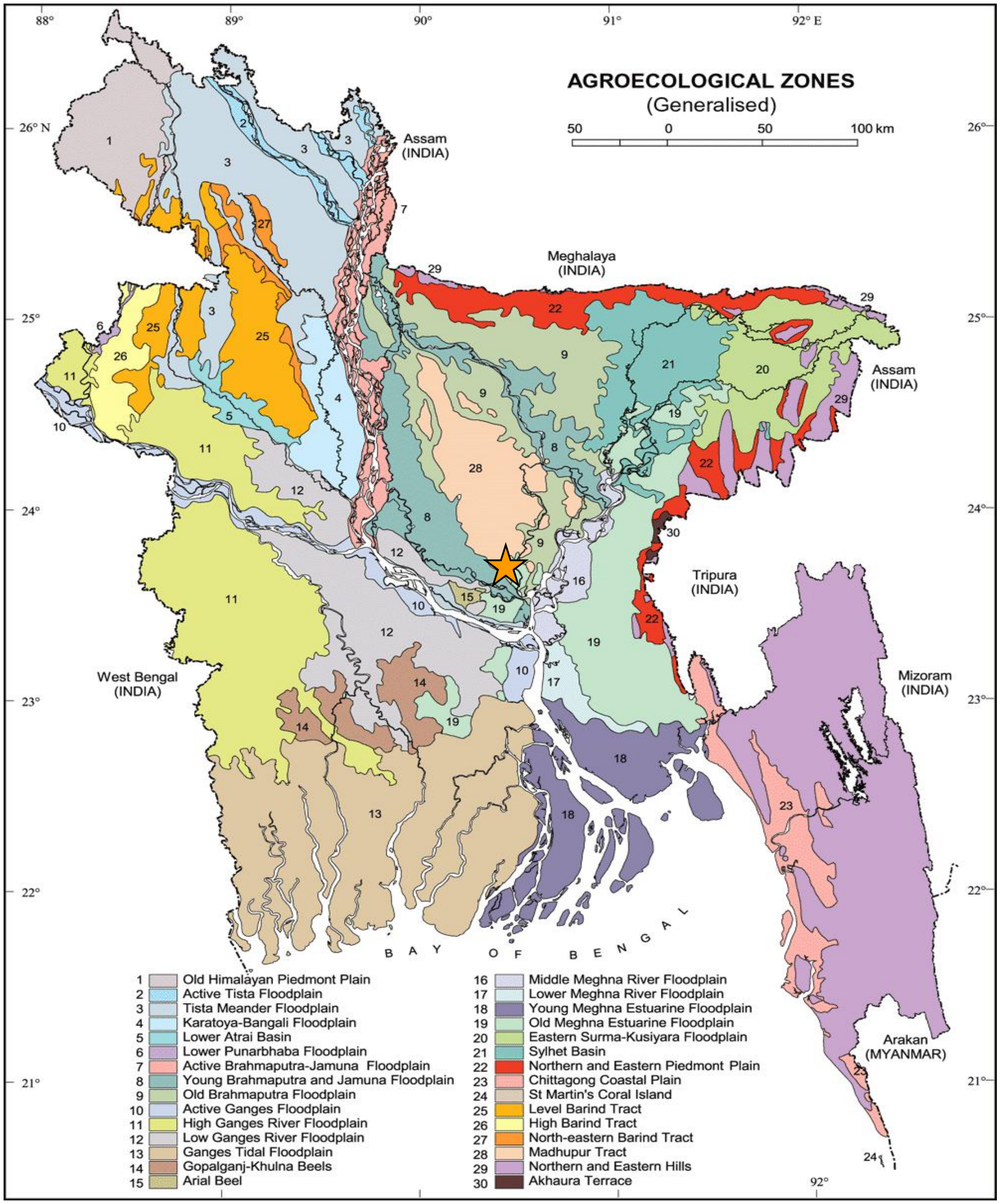
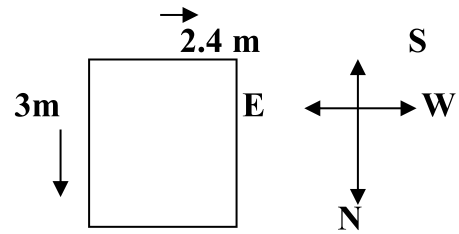
APPENDICES

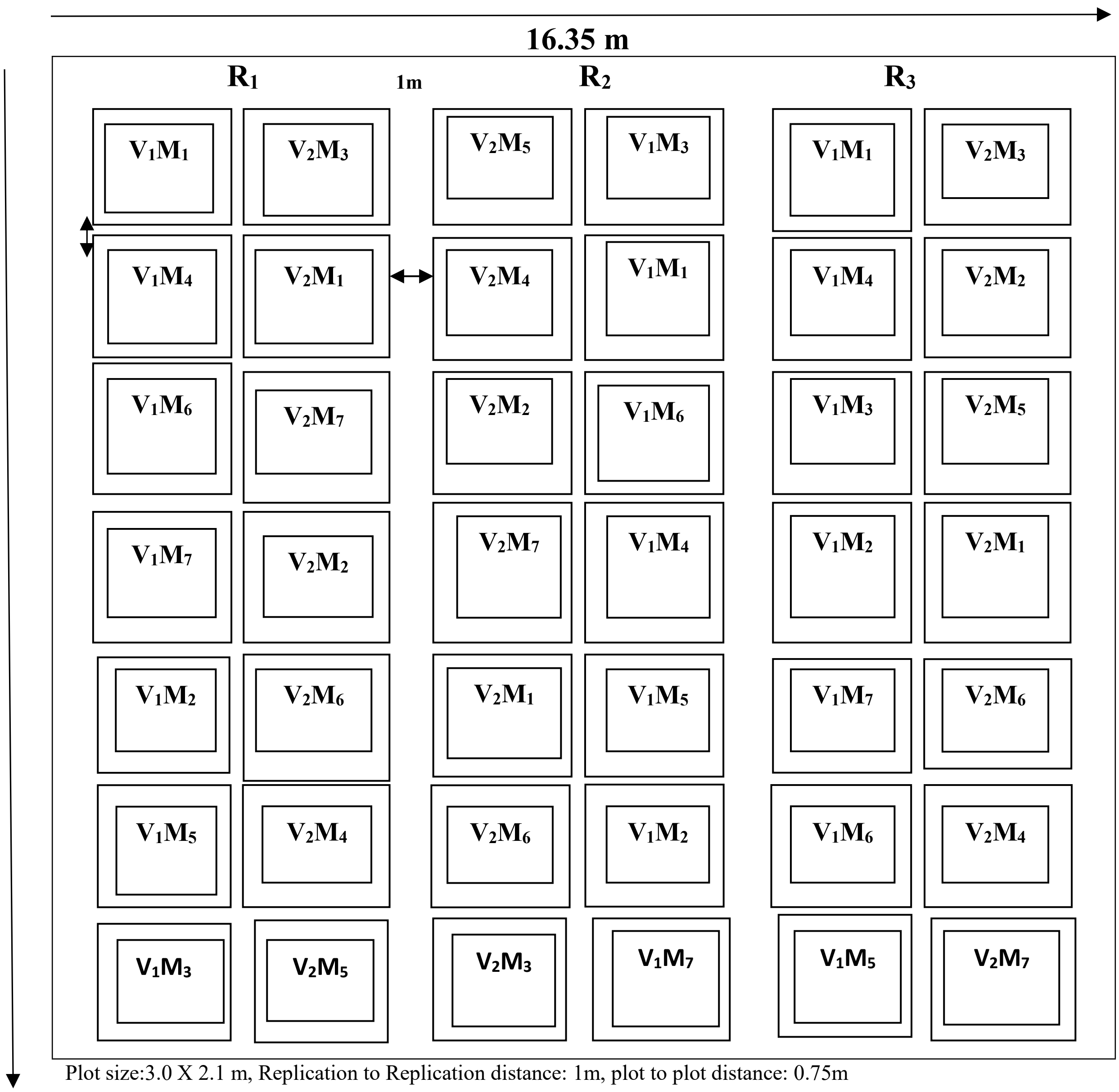
Appendix I. Map showing the experimental sites under study



★ **The experimental site under study**

Appendix II. Field layout of the experiment





Plot size:3.0 X 2.1 m, Replication to Replication distance: 1m, plot to plot distance: 0.75m

Factor A: Variety, V_1= BARI mung 5, V_2= BARI mung 6

Factor B: Agronomic managements

M_1 = Control (No managements)
M_2 = All managements except fertilizer
M_3 = All managements except weeding
M_4 = All managements except irrigation
M_5 = All managements except insecticide
M_6 = All managements except fungicide/ bactericide
M_7 =Complete managements

Appendix III. Characteristics of soil of experimental field

A. Morphological characteristics of the experimental field

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

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

Physical characteristics	
Constituents	**Percent**
Sand	26
Silt	45
Clay	29
Textural class	Silty clay

Chemical characteristics	
Soil characters	**Value**
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total nitrogen (%)	0.03
Available P (ppm)	20.54
Exchangeable K (me/100 g soil)	0.10

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

Appendix IV. Mean square values of plant height of mungbean as influenced by variety and managements

Source of variation	Degrees of freedom	Mean square			
		Plant height at			
		15 DAS	30 DAS	45 DAS	At harvest
Replication	2	1.47098	44.2447	34.5608	13.3187
Variety (A)	1	4.88244**	63.5467**	12.2688*	1.53833*
Error I	2	0.908924	10.3333	5.55706	12.6384
Managements (B)	6	0.0914856	13.7489*	8.76925	13.2531*
Interaction (A×B)	6	0.259416	9.83853	15.7618	9.41705*
Error II	24	0.784441	11.8442	19.8995	27.2037

*Significant at 5% level

** Significant at 1% level

Appendix V. Mean square values of number of leaves plant^{-1} of mungbean as influenced by variety and managements

Source of variation	Degrees of freedom	Mean square		
		No. of leaves at		
		15 DAS	30 DAS	45 DAS
Replication	2	0.422857	0.000952383	0.0866667
Variety (A)	1	0.380952**	3.31524**	24.3810**
Error I	2	0.0723810	0.0580953	0.355238
Managements (B)	6	0.0796825*	0.110476	1.78222**
Interaction (A ×B)	6	0.0498413	0.144127	0.665397*
Error II	24	0.0709524	0.167302	0.417619

* Significant at 5% level

** Significant at 1% level

Appendix VI. Mean square values of dry matter content plant^{-1} of mungbean as affected by variety and managements

Source of variation	Degrees of freedom	Mean square		
		Dry matter content plant^{-1} at		
		20 DAS	40 DAS	At harvest
Replication	2	0.0830952	0.387707	12.7772
Variety (A)	1	0.00857143*	0.180059	0.0877714
Error I	2	0.0150000	3.02552	5.50886
Managements (B)	6	0.0194444*	0.631493	10.4218*
Interaction (A×B)	6	0.0157937	0.645015	6.02385*
Error II	24	0.0173809	0.904765	6.43056

* Significant at 5% level

Appendix VII. Mean square values of no. of nodules plant^{-1} of mungbean as affected by variety and managements

Source of variation	Degrees of freedom	Mean square	
		No. of nodules plant^{-1}	
		20 DAS	**40 DAS**
Replication	2	4.98952	13.9457
Variety (A)	1	136.440**	76.8152*
Error I	2	10.4724	1.84095
Managements (B)	6	24.5419*	41.6121*
Interaction (A×B)	6	30.1908*	16.2775
Error II	24	22.3812	27.7633

* Significant at 5% level
** Significant at 1% level

Appendix VIII. Mean square values of SPAD value of mungbean as affected by variety and managements

Source of variation	Degrees of freedom	SPAD value
Replication	2	11.9653
Variety (A)	1	328.206**
Error I	2	3.91603
Managements (B)	6	7.43891
Interaction (A×B)	6	4.26215
Error II	24	8.17451

** Significant at 1% level

Appendix IX. Mean square values of days to 1st flowering, 50% flowering and 100%

flowering of mungbean as affected by variety and managements

Source of variation	Degrees of freedom	Mean square		
		Days to flowering		
		1st Flowering	50% flowering	100% flowering
Replication	2	1.45238	0.0238095	0.452381
Variety (A)	1	130.381**	214.881**	126.881**
Error I	2	1.02381	0.880956	0.452379
Managements (B)	6	0.547619	1.74603*	0.880952*
Interaction (A×B)	6	0.658730*	0.936508*	0.880952*
Error II	24	0.626984	1.00794	0.452381

* Significant at 5% level
** Significant at 1% level

Appendix X. Mean square values of no. pods plant^{-1} , pod length, seeds pod^{-1} of mungbean as affected by variety and managements

Source of variation	Degrees of freedom	Mean square		
		No. of pods plant^{-1}	Pod length	Seeds pod^{-1}
Replication	2	76.5714	0.148544	1.8452
Variety (A)	1	156.214*	3.07052	3.392075**
Error I	2	5.42857	0.424515	0.105605
Managements (B)	6	201.817	0.76008	3.77047*
Interaction (A×B)	6	59.6587	1.385745*	1.69342*
Error II	24	225.333	0.4214075	1.00291

* Significant at 5% level
** Significant at 1% level

Appendix XI. Mean square values of 1000 seed weight, shell yield, shelling percentage of mungbean as affected by variety and managements

Source of variation	Degrees of freedom	Mean square		
		1000-seed wt.	Shell yield	Shelling percentage
Replication	2	7.59805	8371.21	6.57284
Variety (A)	1	1135.84**	66807.0**	166.563**
Error I	2	0.564596	238.831	8.31144
Managements (B)	6	17.1022**	52102.1**	23.2013**
Interaction (A×B)	6	16.5874**	2567.11	19.8937**
Error II	24	7.31212	3167.96	8.85179

** Significant at 1% level

Appendix XII. Mean square values of seed yield, stover yield, biological yield and harvest index of mungbean as influenced by variety and managements

Source of variation	Degrees of freedom	Mean square value			
		Seed yield	Stover yield	Biological yield	Harvest index
Replication	2	19832.6	1246840.0	1175680.0	30.0913
Variety (A)	1	466490.00**	2791900.0*	532060.0	391.315**
Error I	2	1016.56	1905020.0	1944380.0	7.77975
Managements (B)	6	153191.00**	1115450.0	2679470.0*	43.8693**
Interaction (A×B)	6	8923.23*	3348940.0**	3197080.0*	38.4444**
Error II	24	6932.70	1463380.0	1597620.0	7.53315

* Significant at 5% level
** Significant at 1% level

Appendix XIII. Mean square values of no. of weed and weeds dry weight of mungbean as affected by variety and managements

Source of variation	Degrees of freedom	Mean square			
		Number of weeds m^{-2} at		Oven dry weight of weed at	
		20 DAS	40 DAS	20 DAS	40 DAS
Replication	2	62.9524	2646.00	56.2143	58.1611
Variety(A)	1	247.714**	1110.86*	120.024**	43.5948
Error I	2	125.429	386.00	23.1667	167.275
Managements (B)	6	57.7460*	1765.49*	19.0397	3379.38**
Interaction (A×B)	6	63.7143*	462.190	25.3571	151.808
Error II	24	36.9683	1203.56	35.7460	169.099

*Significant at 5% level of significance
** Significant at 1% level of significance