EVALUATION OF SOME ELITE MUNGBEAN VARIETIES THROUGH THEIR GROWTH AND YIELD PERFORMANCE

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CERTIFICATE

*This is to certify that thesis entitled, "**EVALUATION OF SOME ELITE MUNGBEAN VARIETIES THROUGH THEIR GROWTH AND YIELD PERFORMANCE**" submitted to the Faculty of Agricultural botany, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (MS)** IN **AGRICULTURAL BOTANY**, embodies the result of a piece of bona-fide research work carried out by **NAZMUL HAFIZUR RAHMAN**, **Registration no. 11-04239** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

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Dedicated To

My Beloved Parents

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EVALUATION OF SOME ELITE MUNGBEAN VARIETIES THROUGH THEIR GROWTH AND YIELD PERFORMANCE

Nazmul Hafizur Rahman

ABSTRACT

The experiment was carried out during late March to mid June 2017 at the Agricultural Botany experimental field of Sher-e Bangla Agricultural University (SAU), to study the yield and yield contributing characters of some elite mungbean varieties of Bangladesh. Seven mungbean varieties, *viz*. BU Mug 4, BU Mug 5, BINA moog 8, BARI Mung 4, BARI Mung 5, BARI Mung 6 and BARI Mung 7 were used for the experiment. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Results showed that, the highest plant height (21.20, 43.28 and 70.25 at 25, 45 DAS and at harvest, respectively) was obtained from the variety BARI Mung 5 whereas the highest number of leaves plant^{-1} (11.00, 16.20 and 21.60 at 25, 45 DAS and at harvest, respectively) and leaf area m^{-2} (37.12, 44.82 and 49.10 g at 25, 45 DAS and at harvest, respectively) were obtained from the variety BINA moog 8. Again, the highest number of branches plant^{-1} (1.24, 4.60 and 5.85 at 25, 45 DAS and at harvest, respectively), dry weight plant^{-1} (9.10, 17.88 and 24.72 g at 25, 45 DAS and at harvest, respectively) BARI Mung 7. Regarding yield and yield contributing parameters, number of flower plant^{-1} (32.24), number of cluster plant^{-1} (4.78), pod length (7.86 cm), number of pods plant^{-1} (25.44), number of seeds pod^{-1} (12.28), 1000 seed weight (48.88 g), seed yield (1686.70 kg ha^{-1}), stover yield (2126.70 kg ha^{-1}), biological yield (3813.40 kg ha^{-1}) and the highest harvest index (44.23%) were obtained from the variety, BARI Mung 7.

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ABBREVIATIONS AND ACRONYMS

%	=	Percentage
AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BCSRI	=	Bangladesh Council of Scientific Research Institute
Ca	=	Calcium
cm	=	Centimeter
CV %	=	Percent Coefficient of Variation
DAS	=	Days After Sowing
DMRT	=	Duncan's Multiple Range Test
e.g.	=	exempli gratia (L), for example
et al.,	=	And others
etc.	=	Etcetera
FAO	=	Food and Agricultural Organization
g	=	Gram (s)
GM	=	Geometric mean
i.e.	=	id est (L), that is
K	=	Potassium
Kg	=	Kilogram (s)
L	=	Litres
LSD	=	Least Significant Difference
M.S.	=	Master of Science
m^2	=	Meter squares
mg	=	Milligram
ml	=	Millilitres
No.	=	Number
^oC	=	Degrees Celsius
P	=	Phosphorus
SAU	=	Sher-e-Bangla Agricultural University
USA	=	United States of America
var.	=	Variety
WHO	=	World Health Organization
µg	=	Microgram

CHAPTER I

INTRODUCTION

Mungbean [*Vigna radiata*] is one of the most important pulse crops of Bangladesh and the family of mungbean is Fabaceae and sub-family Faboideae among common pulses in Bangladesh. Mungbean or greengram is one of the most important, short-season, summer growing legumes, grown widely throughout the tropics and subtropics, (Pooniya *et al.*, 2015). It is considered as the best of all pulses from the nutritional point of view. It contains carbohydrate (51%), protein (26%), minerals (4%) and vitamins (3%) (Kaul,1982). It contains almost double amount of protein as compared to cereals. It has a good digestibility and flavor. The green plants are used as animal feed and the residues as manure. Life cycle of mungbean is short; it is also drought tolerant and can grow with a minimum supply of nutrients.

The area under mungbean in Bangladesh is 2.10 lakh hectares. Mungbean is in third position according to the production and cultivable land in Bangladesh. In 2016-17 economic year, target for mungbean production was 2.4 lakh metric ton and production of mungbean in 2016-17 economic year is 2.115 lakh metric ton. (MoA, 2017)

Mungbean is produced in maximum part of Bangladesh. Among them Barisal (17617 metric ton), Rajshahi (13501 metric ton), Chittagong (2125 metric ton), Dhaka (1130 metric ton), Khulna (2206 metric ton) produce highest mungbean in Bangladesh (BBS, 2016).

The pulse crop is an important food crop because it provides a good source of easily digestible dietary protein. According to FAO (1999), per capita requirement of pulse by human should be 80 g. In Bangladesh per capita consumption of pulse is only 15.37g (BBS, 2016) as against 45.0g recommended by WHO. To maintain the supply of this level it is needed to import pulse and as a result the Government of Bangladesh has to spend a big amount of foreign currency every year. So pulse production should be increased immediately to meet up the demand. Mungbean plays an important role to supplement protein in the cereal-based low-protein diet of the people of Bangladesh, but the acreage production of mungbean is gradually declining (BBS, 2010).

In Bangladesh, mungbean grows well all over the country. This is fact that national production of the pulses is not adequate to meet the population demand. However, it is one of the least cared crops. Mungbean is cultivated with minimum tillage, local varieties with no or minimum fertilizers, pesticides and very early or very late sowing, no practicing of irrigation etc. All these factors are responsible for low yield of mungbean which is not comparable with the yields of developed countries of the world (FAO, 1999). The low yield of mungbean besides other factors may partially be due to lack of knowledge regarding the providing essential plant nutrients with following advanced production technology (Hussain *et al.*, 2008). Lack of attention on fertilizer application in proper way with appropriate amount is also managerial factors in lowering mungbean yields (Mansoor, 2007). Being leguminous in nature, mungbean needs low nitrogen but require optimum doses of other major nutrients as recommended. The management of fertilizer especially nitrogen is the important factor that greatly affects the growth, development and yield of this crop.

As the population continues to grow at this rate in Bangladesh, a huge amount of food will be required for the future generation to meet their demand of minimum food for balanced nutrition. An exponential population growth model predicts that if the production goes at a business as usual rate, pulse demand of Bangladesh may be 2.82 million ton in 2050. (Basak, 2015).

Comparative performance study of some high yielding varieties of mungbean in Sher-e-Bangla Agricultural University (Agro-ecological Zone-Modhupur Tract, AEZ-28) area is not done widely.Performance study of BARI, BINA, BSMRAU released high yielding mungbean varieties are necessary. The present study was therefore undertaken with the following objectives:

1. To find out promising varieties of mungbean.
2. To compare the yield and yield contributing characters of the different varieties of mungbean.

CHAPTER II

REVIEW OF LITERATURE

A vast number of research works on different aspects of mungbean production have been done by research workers inside and outside of the country, especially in the South East Asia for the advancement of mungbean production. Recently Bangladesh Agricultural Research Institute (BARI) and Bangladesh Institute of Nuclear Agriculture (BINA) have started research on varietal development and improvement of this crop. Research work related to the study of yield and yield contributing characters of different varieties of mungbean is reviewed and presented in this chapter.

2.1 Effect of variety on yield

Hossain *et al*. (2016) conducted an experiment at the field laboratory of the Sher-e-Bangla Agricultural University, Bangladesh during March to June, 2014. Seven mungbean varieties were laid out in a Randomized Complete Block Design (RCBD) with three replications. BARI Mung-3 showed the highest plant height whereas maximum leaves per plant found for BINA moog-8. The early flowering or days to first flowering was found in BINA moog-8 and the late flowering was recorded in BARI Mung-6. The minimum days to attainment of the highest length of pod was found in BINA moog-8 and the maximum time were recorded in BARI Mung-2 and BARI Mung-6. The highest number of fertile seeds per pod was recorded in BINA moog-8 and the lowest number of fertile seeds per pod was observed in BARI Mung-4. The highest number infertile seeds per pod were recorded in BARI Mung-4 and the lowest number of infertile seeds per pod was observed in BINA moog-8. BINA moog-8 have showed the maximum pod length and 1000-seed weight while the minimum was observed in BARI Mung-4.

The highest yield was recorded in BINA moog-8 and the lowest in BINA moog-5. Most of the morphological and yield contributing characters of BINA moog-8 was favorable for better yield in summer cultivation. So the production of mungbean can be increased by the cultivation of BINA moog-8 in summer season.

Amin *et al.* (2017) directed an experiment at research field of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh during April to July 2011 with Yield performance of 10 selected mungbean (*Vigna radiata* L. Wilczek) genotypes, viz. GK-7, GK-48, GK-65, VC-6173A, CO-3, IPSA-12, IPSA-13, IPSA-15, BARI Mug-5 and BU Mug 2. Yield and yield contributing characters of the mungbean genotypes were significantly affected by waterlogging. The longer the waterlogging period, the more was the reduction in seed yield and yield contributing characters. Among the 10 genotypes, IPSA-13 performed the best in respect of grain yield production under waterlogging condition, which was followed by VC-6173A and BU Mug 2.

Rahman *et al.* (2016) conducted an experiment at Bangladesh Agricultural University, Mymensingh during March-June, 2013 to evaluate the performance of mungbean varieties and to determine the optimum seed rate under strip tillage system. Three mungbean varieties (BARI Mung-6, Binamung-5 and Binamung-8) were tested against five seeding rates (20, 25, 30, 35 and 40 kg ha^{-1}). The experiment was laid out in split-plot design with three replications. The study revealed that variety and seed rate had significant effect on plant population, pods plant^{-1}, pod length, seeds pod^{-1}, seed yield and stover yield of mungbean. The highest seed yield was obtained from BINA mung-5 at 35 kg seed ha^{-1} while the highest stover yield was obtained from 40 kg seed ha^{-1}. For BARI Mung-6 and BINA moog-8, 35 kg seed ha^{-1} also provided higher seed yield than other seeding rates. Nevertheless, the lowest seed and stover yields were obtained from

BINAmung-8 with 20 kg seed ha^{-1}. Therefore, the study concluded that machine seeding of mungbean at 35 kg seed ha^{-1} .Yield contributing characters like number of pods $plant^{-1}$, pod length, number of seeds pod^{-1} and 1000-seed weight were significantly affected by variety and seed rate of mungbean as well as seed and stover yields .The highest number of pods plant-1 (40.73), pod length (8.08 cm), seed yield (888.17 kg ha^{-1}) and stover yield (1874.25 kg ha^{-1}) were obtained from BINA mung-5. Whilst, the highest number of seeds pod-1 (9.68) and 1000-seed weight (37.14) were obtained from BARI Mung-6. In case of seed rate, the highest number of pods $plant^{-1}$ (40.3) was counted from 20 kg seed ha^{-1} and the lowest value (33.0) from 40 kg seed ha^{-1}.

Dong Kwan *et al.* (2017) experimented with a mungbean cultivar 'Sanpo' (*Vigna radiata* (L.) Wilczek) was derived from the cross between SM9710-3B-7 and Jangannogdu at the Jeollanamdo Agricultural Research and Extension Services (JARES) in 2012. 'Sanpo' has erect growth habit, green hypocotyls, heart leaflet, dull green seed surface, and black and straight pod when matured. The stem length of 'Sanpo' were 71 cm, which was 5 cm longer than check cultivar 'Owool'. The pods number per plant, the seeds number per pod, and the seed weight of 'Sanpo' are similar to check cultivar. It has field resistance to *Cercospora* leaf spot, mungbean mottle virus, and powdery mildew. In addition, 'Sanpo' has high lodging resistance. The hard seed rate of 'Sanpo' was 2.4%, which was 0.8% point lower than check cultivar. The sprout yield ratio of 'Sanpo' was 8.26 times, which was 10% (77% point) more than check cultivar. The average yield of 'Sanpo' was 1.62 ton/ha, which was 14% more than the check cultivar 'Owool'.

Indu *et al*. (2017) directed a experiment at Junagadh Agricultural University, India with fifty diverse genotypes of mung bean were evaluated in a randomized block design with three replication for the study of selection indices during kharif 2014.

Thirty-one selection indices involving seed yield per plant (X_1) and four yield components viz., biological yield per plant (X_2), number of primary branches per plant (X_3), length of pod (X_4) and plant height (X_5) were constructed using the discriminated function analysis. Discriminate function analysis indicated that selection efficiency of the function was improved by increasing the number of characters in the index. Among the single character indices, biological yield per plant exhibited higher genetic advance and relative efficiency over straight selection for seed yield per plant. The index based on five characters viz., seed yield per plant, biological yield per plant, number of primary branches per plant, length of pod and plant height recorded the highest genetic advance as well as relative efficiency and selection efficiency. These characters chosen on the basis of their positive correlation with seed yield per plant and have positives direct effects. The superiority of selection based on index increases with an increase in the number of characters under selection.

Islam *et al*. (2013) conducted in three mungbean growing coastal districts, namely Barisal, Patuakhali, and Noakhali of Bangladesh during 2010-2011 to assess the extent of technology adoption and constraints to BARI-mungbean production. The study focused the level of technology adoption in terms of variety use, input use and agronomic practices. The study revealed that farmers followed the recommended practices which were very encouraging. All the farmers adopted improved mungben varieties of which 51% farmers adopted BARI Mung-5 variety. The level of adoption of seed rate, use of urea, and MoP was found to be high. The level of adoption of agronomic practices like ploughing, sowing time, weeding and insecticides use were also found to be high. The farmers were mostly influenced by DAE personnel and neighboring farmers in adopting improved mungbean technology. Multiple regression revealed that experience, training, organizational membership, relation with different media, and mungbean suitable area had positive and significant influence in increasing the area under mungbean cultivation. Most farmers showed positive attitude towards improved mungbean cultivation of which 67% farmers wanted to increase its cultivation in the next year. The major constraints to improved mungbean production were high price of insecticides, lack of labour and disease and insect infestation. Farmers required improved mungbean seeds and production technology which may increase the yield and income of the farmers. The scientists of BARI have developed and disseminated 6 mungbean varieties to the farmers since 1982. BINA-mung and BAU-mung were also developed by BINA and BSMRAU. All the farmers adopted improved mungbean varieties, such as BARI-Mung-2 (27%), BARI-Mung-5 (45%) and BARI-Mung-6 (22%). The farmers of Noakhali district mostly adopted BARI-Mung-5 and BARI-Mung-2. On the other hand, the highest 74% of the farmers of Patuakhali adopted BARI-Mung-5. It was observed that BINA-mung and BAU-mung cultivating farmers were not found within the sample farmers. Adopted farmers opined that they preferred BARI-mung varieties mainly due to higher yield along with their seed availability compared to BINA-mung and BAU-mung varieties.

Rasul *et al*. (2012) has conducted the proper inter-row spacing and suitable variety evaluation in Faisalabad, Pakistan. Three mungbean varieties V_1, V_2, V_3 (NM-92, NM-98, and M-1) were grown at three inter-row spacing (S1- 30 cm, S2- 60 cm and S3- 90 cm). Experiment was laid out in Randomized Complete Block Design (RCBD) with split plot arrangement randomizing varieties in the main and inter-row spacing in the sub-plots. The data recorded were analyzed statistically using Fisher's analysis of variance technique and Least Significant Difference (LSD) test at 5% probability level. Highest seed yield was obtained for variety V_2 at 30 cm spacing. Among varieties V_2 exhibited the highest yield 727.02 kg ha^{-1} while the lowest seed yield 484.79 kg ha^{-1} was obtained with V_3. The spacing 30 cm showed highest seed yield 675.84 kg ha^{-1} as compared to other spacing treatments. Low potential varieties and improper agronomic practices may be a serious cause of low productivity in pulses. The interaction of V_2S_1 exhibited significantly higher yield than other treatments. The lowest seed yield was obtained at V_3S_1 (462.8 kg ha^{-1}). The higher yield in V_2S_1 was characterized by more number of plants in narrow spacing of 30 cm (37 plants m^{-2}), plant height of 51.4 cm, higher number of fruit bearing branches (7 per plant), the highest number of pods per plant (18.86), number of seeds per pod (10.06), 1000 grain weight (4.8 g), the highest biological yield (4894.2 kg ha^{-1}) with a harvest index of (17.75) and the highest number of nodules per plant (15) were the components of high yield formation for mungbean variety V_2 under the inter-row spacing of 30cm. So it can be concluded that mungbean variety Nm-98 should be grown at inter row spacing of 30 cm under the agro-climatic conditions of Faisalabad.

Noorzai *et al*. (2017) conducted a field experiment was carried out at The Experimental Farm of Afghanistan National Agricultural Sciences and Technology University (ANASTU), Kandahar, Afghanistan during April to June, 2015 to assess the performance of promising mungbean varieties viz. Mai-2008, Mash-2008, NM-94, NM-98 and 'Kunduzy' under semi-arid conditions of Kandahar. It was revealed that different varieties showed significant differences for growth, morpho-physiological and yield parameters. Mai-2008 exhibited highest plant height (41.5 cm). Maximum number of primary branches (3.8) was observed in NM-94 followed by Mash-2008 while 'Kunduzy' exhibited minimum number of primary branches $plant^{-1}$. The NM-98 produced highest pod length (10.7 cm) while Mash-2008 produced maximum number of pods $plant^{-1}$ (25.8), 1000-grains weight and seed yield $plant^{-1}$ (9.5 g). The trend of seed yield was Mash-2008>Mai-2008>NM-98>NM-94>Kunduzy, respectively. However, maximum straw yield (5.93 t ha^{-1}) was recorded in NM-94. Mash-2008 resulted in higher gross (AFN 151,100 ha^{-1}) and net returns (AFN 1,24,680ha^{-1}) followed by Mai-2008 while 'Kunduzy' resulted in lowest gross and net returns.

Significantly higher B: C ratio was observed in Mash-2008 followed by Mai-2008, NM-94, NM-98, and 'Kunduzy', respectively. Overall, it may be inferred that the Mash-2008 was the best performer w.r.t. growth and yield attributes, seed yield and profitability followed by Mai-2008 in semi-arid conditions of Afghanistan.

Ahamed *et al.* (2011) experimented at the experimental field of Agricultural Botany Department, Sher-e- Bangla Agricultural University, Dhaka, Bangladesh from the period of August, 2009 to April, 2010 (Kharif –II). Five Mungbean varieties namely BARI Mung-2 (M_2), BARI Mung-3 (M_3), BARI Mung-4 (M_4), BARI Mung-5 (M_5) and BARI Mung-6 (M_6) were used in the experiment to evaluate their morpho-physiological attributes in various plant spacing viz. 20×10 cm (D_1), 30X10 cm (D_2) and 40×10 cm (D_3). The highest plant height of BARI Mung-4 is 49.38 cm that is statistically at per with the height of BARI Mung-3 (i.e. 48.38 cm). BARI Mung-3 showed the highest leaf area (147.57 cm^2). The variety BARI Mung-3 produced the lowest leaf area of 110.00 cm^2. In the study BARI Mung-2 took 30.44 days for flowering that is statistically at per BARI Mung-6 (30.11) and BARI Mung-4 flower earliest (at 28.88 days after sowing) as compared to all other varieties.

Kabir and Sarkar (2008) conducted a study about the effect of variety and planting density on the yield of mungbean in Kharif-I season (February to June) of 2003. For this experiment they used five varieties viz. BARIMung-2, BARIMung-3, BARIMung-4, BARIMung-5 and BINAMung-2. The experiment was laid out in a Randomized Complete Block Design with three replications. It was observed that BARI mung-2 produced the highest seed yield and BINA moog-2 did the lowest.

Muhammad *et al.* (2006) conducted an experiment to study the nature of association between *Rhizobium phaseoli* and mungbean. Inocula of two *Rhizobium* strains, Tal-169 and Tal-420 were applied to four mungbean genotypes viz., NM-92, NMC-209, NM-98 and Chakwal Mung-97. A control treatment was also included for comparison. The experiment was carried out at the University of Arid Agriculture, Rawalpindi, Pakistan, during kharif, 2003. Both the strains in association with NM-92 had higher nodule dry weight, which was 13% greater than other strains x mungbean genotypes combinations. Strain Tal-169 was specifically more effective on genotype NCM-209 and NM-98 compared with NM-92 and Chakwal Mung-97. Strain Tal-420 increased branches plant^{-1} of all the genotypes. Strain Tal-169 in association with NCM- 209 produced the highest yield of 670 kg ha^{-1} which was similar (590 kg ha^{-1}) in case of NCM-209 either inoculated with strain Tal-420 or uninoculated. Variety NM-92 produced the lowest grain yield (330 kg ha^{-1}) either inoculated with strain Tal-420 or uninoculated.

Gul *et al.* (2008) was conducted an experiment to determine correlation among different yield contributing traits of mungbean, at Agricultural Research Farm of the NWFP Agricultural University, Peshawar, during the growing season 2004. Correlation was worked out among plant height, days to flowering, days to maturity, total dry weight plot^{-1}, yield plant^{-1}, 100-grain weight, harvest index and yield ha^{-1}. Significant differences were observed among different populations for all the parameters. Correlation analysis revealed that earliness had negative correlation with plant height and dry weight per plot while 100-seed weight and harvest index were recorded to be positively correlated. Dry weight per plot was found to have positive correlation with days to maturity, seeds pod^{-1} and plant height while negatively correlated with yield per hectare and harvest index. 100-grain weight showed positive correlation with pods plant^{-1} and harvest index while it had negative correlation with days to maturity, seeds pods^{-1} and plant height.

Seed yield plot^{-1} was found to be non-significantly correlated with 100-grain weight. Harvest index had significant positive correlation with seed yield plant^{-1} while it had significant negative correlation with days to maturity, seed pod^{-1}, plant height and dry weight per plot. Similarly, seed yield per plant was positively correlated with pods plant^{-1}, yield ha^{-1} and harvest index. On the other hand, its correlation with plant height was significantly negative.

Bhuiyan *et al.* (2008) studied with and without *Bradyrhizobium* were driven with five mungbean varieties to observe the yield and yield attributes of mungbean. Five mungbean varieties viz. BARI Mung-2, BARI Mung-4, BARI Mung-5, BINA moog-2 and Barisal local, and the rhizobial inoculums (*Bradyrhizobium* strain BAUR-604) were used. The seeds and stover were dried and weighed adjusting at 14% moisture content and yields were converted to t/ha. The yield attributing data were recorded from 10 plants which were randomly selected. BARI Mung-2 has produced the highest seed yield (1.03 t/ha in 2001 and 0.78 t/ha in 2002) and stover yield (2.24 t/ha in 2001 and 2.01 t/ha in 2002). Higher number of pods/plant was also recorded in BARI Mung-2, while BARI Mung-5 produced the highest 1000-seed weight. Application of *Bradyrhizobium* inoculant produced significant effect on seed and stover yields in both trials conducted in two consecutive years. Seed inoculation significantly increased seed (0.98 t/ha in 2001, 27% increase over control and 0.75 t/ha in 2002, 29% increase over control) and stover (2.31 t/ha in 2001 and 2.04 t/ha in 2002) yields of mungbean. *Bradyrhizobium* inoculation also significantly increased pods/plant, seeds/pod and 1000-seed weight. Inoculated BARI Mung-2 produced the highest seed and stover yields as well as yield of attribute, such as pods/plant and seeds/pod.

Shamsuzzaman *et al.* (2004) operated an experiment with two summer mungbean cultivars, i.e. BINA moog 2 and BINA moog 5, were grown during the kharif-1 season (February-May) of 2001, in Mymensingh, Bangladesh, under no irrigation or with irrigation once at 30 days after sowing (DAS), twice at 30 and 50 DAS, and thrice 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. BINA moog 2 performed slightly better than BINA moog 5 for most of the growth and yield parameters studied.

Madriz-Isturiz and Luciani-Marcano (2004) conducted a field experiment in Venezuela during the rainy season of 1994-95 and dry season of 1995 in the performance of 20 mungbean cultivars were evaluated by in Significant differences in the values of the parameters measured due to cultivar were recorded. The cultivars 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}.

An experiment was conducted by Apurv and Tewari (2004) during kharif I season of 2003 in Uttaranchal, India, to find out 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). The variety Pusa 9531 showed higher yield components and showed higher grain yield than Pusa 105 and Pant mung 2.To investigate the effects of *Rhizobium* inoculation on the nodulation, plant growth, yield attributes, seed and stover yields, and seed protein content of six mungbean (*Vigna radiata*) varieties were superintend by Hossain and Solaiman (2004). The mungbean varieties were BARI Mung-2, BARI Mung-3, BARI Mung-4, BARI Mung-5, BINA mung-2 and BU mung-1. *Rhizobium* strains TAL169 and TAL441 were used for inoculation of the seeds. Two-thirds of seeds of each cultivar were inoculated with *Rhizobium* inoculant and the remaining one-third of seeds were kept uninoculated. Among the cultivars, BARI Mung-4 performed the best in all aspects showing the highest seed yield of 1135 kg/ha. *Rhizobium* strain TAL169 did better than TAL441 in most of the studied parameters. It was finalized that BARI Mung-4 in combination with TAL169 performed the best in terms of nodulation, plant growth, seed and stover yields, and seed protein content.

Mondal *et al.* (2004) guided an experiment at farmer's field of Rangpur zone during kharif-1 season to value the performance of four mungbean varieties viz. BINA moog-2, BINA moog-5, BARI mung-2 and BARI mung-5. Result claimed that BINA moog-5 had the highest seed yield (1091 kg ha^{-1}) than the other tested varieties because it produced the greater number of pods $plant^{-1}$ and 1000 seed weight. Moreover, BINA moog-5 matured 5 days earlier than the others.

It was found that, in Bangladesh condition that BARI mung-2 contributed higher seed yield than BARI mung-5 due to production of higher number of pods $plant^{-1}$, suggested by Sarker *et al*. (2013).

Ahmad *et al*., (2003) directed a pot experiment in Bangladesh on the growth and yield of mungbean cultivars viz., BARI mung-2, BARI mung-3, BARI mung-4, BARI mung-5, BU mung-1, BU mung-2 and BINA mung-5 and found that BARI mung-2 produced the highest seed yield while BARI mung-3 produced the lowest.

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

Rahman *et al*. (2005) directed an experiment with mungbean in Jamalpur, Bangladesh, from February to June 1999, involving 2 planting methods, i.e. line sowing and broadcasting; 5 mungbean cultivars, namely Local, BARI moog 2, BARI moog 3, BINA moog 2 and BINA moog 5; and 5 sowing dates. The highest dry matter production ability was found in 4 modern mungbean cultivars, and dry matter partitioning was found highest in seeds of BINA moog 2 and lowest in Local. The local cultivar produced the highest portion of dry matter in leaf and stem.

Infante *et al.* (2003) driven a research in mungbean cultivars ML 267, Acriollado and VC 1973C under the agro-ecological conditions of Maracay, Venezuela, during May-July 1997. The differentiation of the development phases and stages, and the morphological changes of plants were studied. The variable totals of pod clusters, pods per plant, seeds per pods and pod length were also studied. 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 per plant and pods per plant, where ML 267 and Acriollado had the highest values. The total seeds per pod of VC 1973C and Acriollado were significantly greater than ML 267. Acriollado showed the highest yield with 1438.33 $kgha^{-1}$.

Tickoo *et al.* (2006) were driven an experiment on mungbean using cultivars Pusa 105 and Pusa Vishal, which were sown in furrow and broadcast method with 36-46 and 58-46 kg NP ha^{-1} in Delhi, India during the kharif season of 2000. Cultivar Pusa Vishal recorded higher biological and grain yield (3.66 and 1.63 tha^{-1}, respectively) compared to cv. Pusa 105 with furrow sowing. Row spacing at 22.5 cm resulted in higher grain yields in furrow sowing.

Bhatti *et al.* (2005) directed a field experiment on a sandy-clay loam soil in Faisalabad, Pakistan for two consecutive years (2001 - 2002) to evaluate the effect of intercrops and planting patters on the agronomic traits of sesame. The planting patterns comprised 40 cm spaced single rows, 60 cm spaced 2- row strips and 100 cm spaced 4-row stripes, while the cropping systems were sesame + mungbean, sesame + mashbean (*Vigna aconitifolia*), sesame + soyabean, sesame + cowpea and sesame alone. Among the intercropping patterns , sesame intercropped with mungbean, mashbean, soyabean and cowpea in the pattern of 100 cm spaced 4-row strips (mungbean 25 cm apart) proved to be feasible, easily workable and more productive than sesame monocropping.

Hussain *et al*. (2011) suggested that differences between mungbean genotypes for number of fruit bearing branches plant-^{1}, number of pods plant^{-1}, number of seeds pod^{-1} and 1000 seed weight.

Differences between mungbean varieties for number of days to flowering, plant height, number of pods plant^{-1}, pod length, number of seeds plant^{-1}, 1000 seeds weight, seed yield kg ha^{-1} and biological yield showed by Aslam *et al.,* (2004).

2.2 Effect of micro-nutrients on yield

Parvez *et al*. (2013) conducted during the period from October to January 2011 at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to study the performance of mungbean as affected by variety and level of phosphorus. The experiment included four varieties viz. BARI Mung-6, BINA moog-4, BINAmoog-6 and Binamoog-8 and four levels of phosphorus viz. 0,20, 40 and 60 kg P_2O_5 ha^{-1} , and laid out in a Randomized Complete Block Design with three replications. Results revealed that the longest plant, highest number of branches plant $^{-1}$, number of total pods plant-^{1}, seeds plant and seed weight plant^{-1} were obtained from BARI Mung-6. Binamoog-6 produced the highest seed yield which was as good as BINA moog-8. The second highest and the lowest seed yield were recorded from BINA moog-4 and BARI Mung-6, respectively. The highest yield was obtained from BINAmoog-8 followed by BINA moog-4. The lowest yield was recorded from BARI Mung-6.

Ali *et al*. (2014) conducted an experiment to find out the effect of foliar application of iron sulfate ($FeSO_4$) on growth, yield and quality of mungbean. The experiment was consisted of foliar applications of 0.5%, 1% and 1.5% of $FeSO_4$both at branching and flowering stages. The results showed that various $FeSO_4$ treatments increased growth and yield components like plant height, number of pod bearing branches per plant, number of pods per plant, number of seeds per pod, 1000-grain weight and seed yield. Moreover, application of $FeSO_4$ also improved the quality of mungbean by increasing protein and iron contents in grains. Application of 1.5% foliar $FeSO_4$ both at branching and flowering stages gave higher number of pods per plant (44.64%).

Romel *et al*. (2014) was conducted the experiment from February to April, 2013 at the experimental field of the farm of Sher-e-Bangla Agricultural University to study the effect of potassium fertilizer and vermicompost on growth, yield and nutrient contents of mungbean (BARI Mung 5). The two-factorial experiment was conducted by using RCBD (Randomized Completely Block Design) with three replications. During the experiment, following treatments were included: K_0 -Control, K_1-K_2O @ 10 kg ha^{-1}, K_2- K_2O @15 kg ha^{-1}, K_3 - K_2O @ 20 kg ha^{-1} and V_0- No Vermicompost, V_1- Vermicompost @ 4 tha^{-1}, V_2-Vermicompost @ 6 tha^{-1}, V_3 – Vermicompost @ 8 t ha^{-1}. Potassium and vermicompost doses as well as their interactions showed significant effect on growth and yield parameters. At harvest highest plant height, number of leaves and branches $plant^{-1}$, average dry weight $plant^{-1}$, number of pods $plant^{-1}$, number of seeds pod^{-1}, number of seeds $plant^{-1}$, 1000-seed weight, seed yield and stover yield were recorded in K_3 (K_2O @ 20 kg ha^{-1}) and it was either closely followed by or statistically similar with the application of K_2O @15 kg ha^{-1} (K_2) and subsequently followed by K_1 (K_2O @ 10 kg ha^{-1}). N, P and K content in seed were recorded in K_3 (K_2O @ 20 kg ha^{-1}) and it was followed by the application of K_2O @15 kg ha^{-1} (K_2) and then K_1 (K_2O @ 10 kg ha^{-1}). Lowest results for above parameters were found from the treatment using no potassium fertilizer (K_0). Similarly, the highest values for highest plant height, number of leaves and branches $plant^{-1}$, average dry weight $plant^{-1}$, number of pods $plant^{-1}$, number of seeds pod^{-1}, number of seeds $plant^{-1}$, 1000-seed weight, seed yield and stover yield were recorded in V_3 (vermicompost @ 8 tha^{-1}) which was either closely followed by or statistically similar with Vermicompost @ 6 t ha^{-1} and then followed by Vermicompost @ 4 t ha^{-1}. Lowest results were found from the treatment using no vermicompost (V_0).

Uddin *et al.* (2009) conducted an experiment including five levels of fertilizer viz. control, N + P +K, Biofertilizer, Biofertilizer + N + P + K and Bio-fertilizer + P + K. and three varieties viz. BARI mung 5, BARI mung 6 and BINA mung 5 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 gained highest number of nodule $plant^{-1}$ and higher dry weight of nodule. It also gained highest number of pod $plant^{-1}$, seed $plant^{-1}$, 1000 seed weight and seed yield.

Quaderi *et al*. (2006) conducted an experiment in the Field Laboratory of the Department of Crop Botany, Bangladesh Agricultural University during the period from October 2000 to February 2001 to evaluate the influence of seed treatment with Indole Acetic Acid (IAA) at a concentration of 50 ppm, 100 ppm and 200 ppm on the growth, yield and yield contributing characters of two mungbean (*Vigna radiata* L.) varieties viz. BARI moog 4 and BARI moog 5. The two-factor experiment was laid out in Randomized Complete Block Design (RCBD) (factorial) with 3 replications. Among these mungbean varieties, BARI mung 5 performed better than BARI mung 4.

Salah Uddin *et al*. (2009) conducted 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 (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 BINA moog 5 were also used. The experiment was laid out in Randomized Block Design with fifteen treatments where each treatment was replicated for three times. 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.

Bhati *et al.* (2005) directed an experiment from 2000 to 2003 to evaluate the effects of cultivars and nutrient management strategies 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 effects of cultivar (K-851 and RMG-62) as well as nitrogen (0 and 20 kg/ha) and phosphorus levels (0,20 and 40 kg ha^{-1})

on the productivity of mungbean. The cultivars K-851 produced higher values for seed and straw yields as well as yield attributes (plant height, pods plant^{-1}, seeds pod^{-1} and 1000-seed weight) compared with RMG-62. Higher net return and benefit cost (B:C) ratio were obtained with K-851 (Rs. 6544 ha^{-1} and 1.02, respectively) than RMG-62 (Rs.4833 ha^{-1} and 0.76, respectively).

Azadi *et al.* (2013) found that various nitrogen doses influence 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}).

Achakzai *et al.* (2012) reported that different influence of nitrogen show most of the growth attributes of the mungbean. Maximum days to flowering, number of branches plant^{-1}, number of leaves plant^{-1}, plant height, number of branches plant^{-1}, leaf area and grain yield recorded for plants subjected to highest dose of applied N fertilizer at 100 kg ha^{-1}.

Sultana *et al.* (2009) suggested that application of 20 kg N ha^{-1} and 20 kg N ha^{-1} at vegetative stage showed significantly higher values of all growth parameters like shoot dry weight, number of branches, leaf area, pods plant^{-}1 and seed yield.

Plant height of mungbean showed superiority at 30 kg N ha-1 followed by 40 kg N ha^{-1}. Nitrogen based fertilizer significantly influenced plant height at all growth stages of mungbean. At 20, 35, 50, 65 DAS and harvest the maximum heights were observed in the plants treated with 30 kg N ha^{-1} suggested by Sultana (2006). Malik *et al.* (2003) lead an experiment to determine the effect of varying levels of phosphorus (0, 50, 75 and 100 kg ha^{-1}) and nitrogen (0, 25, and 50 kg ha^{-1}) on the yield and quality of mungbean cv. NM-98 in 2001. They found that number of flowers per plant was found to be significantly higher by 25 kg N ha^{-1}. Number of seeds per pod was significantly affected by varying levels of nitrogen and phosphorus. Growth and yield components were significantly affected by varying levels of nitrogen and phosphorus. A fertilizer combination 25 kg N + 75kg ha^{-1} resulted with maximum seed yield (1112.96 kg ha^{-1}).

Rajender *et al*. (2003) supervised the effects of N (0, 10, 20 and 30 kg ha-1) and P (0, 20, 40 and 60 kg ha^{-1}) fertilizer rates on mungbean genotypes MH 85-111 and T44. Plant growth and grain yield increased with increasing N rates up to 20 kg ha^{-1}. Further increase in N did not affect the yield.

Abd-El-Latif *et al*. (1998) organized an experiment with the foliar application of nutrients on the growth and yield of mungbean cv. Kowmy-1. Urea increase the number of branches $plant^{-1}$ on mungbean plant.

Srinivas *et al.* (2002) driven an experiment on the performance of mungbean at different levels of nitrogen and phosphorus. Different rates of N (0, 25 and 60 kg ha^{-1}) and P (0, 25, 50 and 60 kg ha^{-1}) were tested. They found that the number of pods per plant was increased with the increasing rates of N up to 40 kg ha^{-1} followed by a decrease with further increase in N. They also found that 1000-seed weight was increased with increasing rates of N up to 40 kg ha^{-1}.

A greenhouse pot experiment where BARI Mung-5 grown on saline soil and given 0, 50 or 100 kg N ha^{-1} and 0, 75 or 150 kg P ha^{-1}. Growth and yield increased significantly with N application while P significantly increased the setting of pods and seeds. Root growth was significantly improved by both individual and combined application of these two fertilizers reported by Mandal and Sikdar (1999).

2.3 Effect of cultural operations on yield

Akter *et al.* (2013), An experiment was conducted at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh to assess the effect of weeding on growth, yield and yield contributing characters of mungbean (*Vigna radiata* L.) cv. BINA moog- 4 during October 2011 to February 2012. The experiment was laid out in a randomized complete block design with four replications. The trial comprised seven treatments namely, T_1 = no weeding, T_2 = one-stage weeding (Emergence-Flowering), T_3 = one-stage weeding (Flowering-Pod setting), T_4 = one-stage weeding (Pod setting-Maturity), T_5 = two-stage weeding (Emergence-Flowering and Flowering-Pod setting), T_6 = two-stage weeding (Flowering-Pod setting and Pod setting-Maturity) and T_7 = three-stage weeding (Emergence-Flowering and Flowering-Pod setting and Pod setting-Maturity). The growth parameters such as relative growth rate (0.075 g g^{-1} day^{-1}) and net assimilation rate (0.075 g $m^{-2}day^{-1}$) showed the best performance with T2 at one-stage weeding condition (Emergence-Flowering). Three-stage weeding ensured the highest plant height (58.62 cm) as well as the highest number of branches (4.45) and leaves (10.34) $plant^{-1}$. Dry weight $plant^{-1}$ (12.38g) was highest from three stage weeding and the lowest from no weeding treatment. The highest number of pods (22.03) $plant^{-1}$, the longest pod (5.95 cm), the highest number of seeds (17.07) pod^{-1} and the highest seed yield (1.38 t ha^{-1}) were obtained from three-stage weeding (Emergence-Flowering and Flowering-Pod setting and Pod setting-Maturity) in mungbean. On the other hand, the lowest seed yield was obtained under no weeding condition. The highest seed yield resulted in higher biological yield (4.70 t ha^{-1}) and the highest harvest index (37.15%) in three-stage weeding and the lowest from no weeding. Number of pods $plant^{-1}$, length of pod, number of seeds pod^{-1} and 1000-seed weight showed highly significant positive correlations with seed yield. These parameters strongly influenced the growth, yield and yield contributing characters of mungbean (*Vigna radiata* L.).

Hossain *et al.* (2012) conducted a study at Sheikh Mujibur Rahman Agricultural University, Gazipur. The objectives of the study were to examine the allelopathic effect of different concentrations of root aqueous extract on the growth and yield of BU Mung 4 in pot condition at open field. There were six treatments having different concentrations of extracts (2.5, 5.0, 7.5, 10.0, 12.5 and 15.0%) of these plant parts and one control treatment (distilled water). Growth and yield performances experiment were conducted with root extract only having four different concentrations (2.5, 5.0, 7.5 and 10.0%) and one control treatment. The experiments were conducted in completely randomized design (CRD) with four replications. Different concentrations of root extracts showed negative effect on the performance of mungbean. Shorter plant was observed when treated with 7.5 and 10.0% aqueous extracts, while number of leaves per plant decreased irrespective conc. 5.0, 7.5 and 10.0% root aqueous extract, respectively. Number of weed found in 2.5, 5.0, 7.5 and 10.0% root extracts treated pots were 68, 72, 73 and 62% lower than control pot. Therefore, the study revealed that allelochemicals released from different plant parts of *M. oleifera* impeded the rate of germination in laboratory condition, and similarly root extract impeded the growth and yield of mungbean in pot condition. Similarly, *M. oleifera* showed sharp weed growth inhibitory/ suppression effect. Growth and yield performance of BU Mung 4 grown in pot revealed that rate of germination, plant h eight, number of leaves per plant, plant dry weight and seed yield were suppressed in treatments having concentrations of *M. oleifer* a root extract, irrespective of concentrations. Growth and yield parameters suffered more in higher.

Hutami and Achlan (1992) organized an experiment with different water stress condition in mungbean field and reported that plant height of mungbean reduced significantly due to water stress condition but the application of irrigation ensure highest plant height compare to stress condition.

Swaraj *et al.* (1995) conducted a field experiment with applying water stress condition in mungbean and reported that with increasing severity and duration of water stress, the number of branches decreased. Murari and Pandey (1985) studied the influence of soil moisture levels on yield attributing characters of lentil and observed that irrigation increased number of branches. They also reported that straw yields were also increased significantly from non-irrigation to irrigation.

Collinson *et al.* (1996) reported that decreased water application resulted in reduced total dry matter production and that resulted from declines in conservation of the intercepting radiation and thereby photo assimilation. In adequate soil moisture condition plant produced higher photosynthesis and dry matter in mungbean (Miah *et al.*, 1996).

Growth, canopy structure and seed yield of mungbean was evaluated under water stress conditions. Water logging, optimum moisture and drought conditions had constituted the treatments. The distribution patter of the dry matter was more or less similar in all the treatments. They also observed that drought conditions reduced total dry matter of plants. (Islam *et al.*, 1994)

Hamid *et al.* (1990) suggested that in dry soil condition lower shoot dry weight could result from the higher partitioning of dry matter to roots at the expense of shoots. The maximum reduction in yield due to moisture occurs during grain filling stage drastic yield reduction was also reported in mungbean due to water stress. The yield loss was primarily caused by the reduction of canopy development, inhibition of photosynthetic rate and lower dry matter production.

Ludlow and Muchow (1990) reported that reduced shoot dry weight under moisture stress partitioned more biomass to roots at the expense of shoot growth. The results revealed that increase in moisture tension caused reduction in shoot weight.

Islam *et al*. (1994) conducted an experiment on mungbean with different water stress condition in Japan and reported that plants produced lower leaf number under drought conditions. Arjunan *et al*. (1988) observed higher number of functional leaves in tolerant genotypes of groundnut under moisture deficit condition at harvest, which ensured plants a continued supply of photosynthesis to the sink until maturity. This means stress susceptible plants lost functioning of leaves that unable them to continue photo-assimilation and grain filling. In another experiment reduced leaf numbers were recorded for moisture stressed conditions in groundnut.

Hutami *et al.* (1991) have conducted an experiment on the water stress of mungbean. They observed that leaf area reduced in water stress conditions. Leaf growth is extremely sensitive to water stress condition and the reduction in leaf area due to moisture stress has been reported by many workers in many different crops. The total number of leaf of a plant may be changed due to either in leaf numbers or leaf sizes (Turk and Hall, 1980; Babu *et al.,* 1984; Pandey *et al.,* 1984, Patel *et al.,* 1983).

2.4 Effect of sowing date on yield

Ali *et al.* (2014) reported that sowing time had the effect on different mungbean varieties for yield and yield components. A field experiment was conducted during 2012 at agronomic research area (University of Agriculture, Faisalabad, Pakistan). The experiment was designed according to randomized complete block design under split plot arrangement in triplicate. Different sowing times (15th June, 25th June, 5th July and 15th July) were assigned to main plots and varieties (NM-2011, NM-2006, AZRI-2006 and NM-98) were allocated to subplots. Different mungbean varieties also responded significantly towards yield and yield components and NM-2011 variety outperformed in terms of maximum seed yield (1282.87 kg ha^{-1}) than rest of varieties.

Rehman *et al.* (2009) driven a field experiment to study the effect of five planting dates viz. 30th March, 15th April, 15th May, 15th June and 15th July on two mungbean varieties i.e. NM-92 and M-1 were evaluated at NWFP Agricultural University, Peshawar during summer 2004. Significant differences were observed among different planting dates for all the parameters except days to 50% flowering and grains pod^{-1}. Sowing date of 30th March took more days to emergence, flowering and physiological maturity. Maximum emergence M-1 was recorded for 15th April sowing. The crop attained maximum plant height under 15th May sowing. Highest grain yield was recorded for early planting of 30th March. These mungbean varieties produced statistically similar grain yield. It is concluded from the experiment that mungbean.

Jahan and Adam (2012), lead a field experiment was carried out at University of Dhaka from March to July, 2011 to study the effect of time of sowing on the growth and yield of BARI mung-5. The treatments consisted of three dates of sowing viz. March 15, April 15 and May 15. The crop responded significantly to sowing time and 15 April sowing seeds produced plants having maximum plant height (68.4 cm), leaves/plant (29.33), total dry matter/plant (17.99), branches/plant (8.17), pods/plant (11.33), pod length (8.78 cm), seeds/pod (11.17), 1000 seed weight (46.52 g), seed yield/plant (5.33 g), yield/ha (1.77 t) and harvest index (29.58 %) at harvest. The seed yield decreased by 36.8 and 49.9% when seed sown early (15 March) or late (15 May) due to production of lower yield components.

Abid *et al*. (2004) conducted an experiment in Peshawar, Pakistan, during the summer season of 2002 to study the effect of sowing dates on the agronomictraits and yield of two mungbean cultivars namely, NM-92 and M-1. Data were recorded for days to emergence, emergence/m^2, days to 50% flowering, plant height at maturity, days to physiological maturity and grain yield. Sowing on 15 April took more number of days to emergence but showed maximum plant height. The highest emergence/m^2 and higher mean grain yield was recorded in NM-92 than M-1.

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 in a field experiment conducted by Navgire *et al*. (2001) in India during the kharif season of 1993-94 and 1995-96. S-8, BM-4 and BM-86 recorded the highest mean nodulation (16.66), plant biomass (8.29 q/ha) and grain yield (4.79q/ha) during the experimental years. S-8, BM-4 and BM-86 recorded the highest nodulation, plant biomass and grain yield.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted in the farm of Sher-e-Bangla Agricultural University during the period from late March, 2017 to mid June 2017 study to the yield performances of seven varieties of mungbean in *kharif I* season. This chapter includes materials and methods that were used in conducting the experiment. The details materials and methods of this experiment are presented below under the following headings:

3.1. Experimental site

The experiment was conducted at the Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207. The experimental site is situated between $23^{0}74^{/}$N latitude and $90^{0}35^{/}$E longitude (Anon., 1989).

3.2. Soil

The soil of the experimental field belongs to the Tejgaon series under the Agro-ecological Zone, Madhupur Tract (AEZ- 28) and the General Soil Type is shallow Red Brown Terrace Soils. A composite sample was made by collecting soil from several spots of the field at a depth of 0-15 cm before the initiation of the experiment. The collected soil was air-dried, ground and passed through 2 mm sieve and analyzed for some important physical and chemical properties. The physical and chemical properties of soil was sandy loam in texture and having soil pH varied from 5.60. Organic matter content was very low (0.78). The physical composition such as sand, silt, clay content were 27%, 43% and 30%, respectively. The analytical data of the soil sample collected from the experimental area were determined in the SRDI, Soil Testing Laboratory, Khamarbari, Dhaka .

3.3 Climate

The experimental area has sub-tropical climate characterized by high temperature, heavy rainfall during May to September and scanty rainfall during rest of the year.

3.4 Plant materials:

BU Mug-4:

BU Mug-4 used as planting material. BU mug-4was released and developed by BSMRAU in 2006, short growth duration, synchronous maturity, fewer branching, bolder seed size (50-55mg) and resistance to yellow mosaic virus and leaf spot disease; excess moisture and soil flooding tolerant. Das to maturity is 40-50 days. Seed yield 1600-1700 Kg/ha.

BU Mug-5:

BU Mug-5 was used as planting material. BU mug-5was released and developed by BSMRAU in 2015. Almost all the pods mature at a time. Plants are short and tolerant to *Cercospora* leaf spot and yellow mosaic virus diseases.

BINA moog-8:

BINA moog-8 is a summer mungbean variety released in 2010. Maturity period ranges from 64-67 days. Maximum grain yield is about 2.0 t ha^{-1} (avg.1.8 tha^{-1}). Seed is medium size with green shiny color. Seed contains high protein (23%). Plants are short and tolerant to yellow mosaic virus (YMV) disease. This variety is suitable for cultivation in pulse growing areas of Bangladesh.

BARI Mung-4:

BARI Mung-4 used as planting material. BARI mung-4 was released by BARI in 1996. Plant height of the cultivar ranges from 50-55cm. It is very resistant to *Cercospora* leaf spot and tolerant to yellow mosaic virus. Its life cycle is 60 to 65 days after emergence. One of the main characteristics of this cultivar is synchronization of pod ripening. The seeds of BARI mung-4 for the experiment were collected from BARI, Gazipur. Seeds were drum-shaped, dull and greenish and free from mixture of other seeds, weed seeds and extraneous materials.

BARI Mung-5:

BARI Mung-5 used as planting material. BARI mung-5 was released and developed by BARI in 1997. Plant height ranges from 40-45 cm. High yielding variety, leaf, pod and seed are large. Photo insensative and can be grown in *Kharif-I, kharif-II* and rabi. Seed color deep green, large shaped with smooth seed coat, pods matured at a same stage, 1000 seed weight 40-42 g, crop duration 60-65 days.

BARI Mung-6:

BARI Mung-6 used as planting material. BARI mung-6 was released and developed by BARI in 2003. Plant height 40-45 cm, photo insensitive and can be grown in *Kharif-I, Kharif-II* and late Rabi, after flowering stage plant growth become stunted, leaf and seed color green and leaf broad, seed large shaped with smooth seed coat, pods matured at a same stage. Grain large, 1000 seed weight 51-52 g, after wheat harvest sowing up to April first week, It is sowing also Kharif-2 and Rabi season , crop duration about 55-58 days.

BARI Mung-7:

BARI mung-7 was used as planting material. BARI mung-7 was released and developed by BARI in 2015. Plant height of the cultivar ranges from 55-60cm.Its life cycle is about 60-62 days after emergence. One of the main characteristics of this cultivar is synchronization of pod ripening. Average yield of this cultivar is about 1700-1900 kg ha^{-1}. The seeds of BARI mung-5 for the experiment were collected from BARI, Joydevpur, Gazipur.

3.5. Land preparation

The field was irrigated before ploughing. After getting ‘zoe’ condition the land was first opened with tractor drawn disc plough. Ploughed soil was brought into desirable fine tilth by 4 ploughing and cross-ploughing, harrowing and laddering. The stubbles and weeds were removed. Experimental land was divided into unit plots following the design of experiment.

3.6. Fertilizer application

Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MP) were used as a source of nitrogen, phosphorous, and potassium respectively. The total amount of TSP, cowdung and MP was applied as basal dose at the time of land preparation. The total amount of Urea was applied in two installments at 15 and 30 day after seed sowing.

Fertilizers	Dose (Kg/ha)
Urea	40-45
TSP	80-90
MP	3-40
Gypsum	50-55

3.7. Treatment

The experiment consisted of one factor:

Factor A: Varieties

V_1: BU Mug- 4

V_2: BU Mug- 5

V_3: BINA moog-8

V_4: BARI Mung-4

V_5: BARI Mung-5

V_6: BARI Mung-6

V_7: BARI Mung-7

3.8. Sowing of seeds in the field

The seeds of mungbean were sown on 27 March, 2017.

3.9. Experimental design

The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. The experimental area was divided into four equal blocks. Each block was divided into 7 plots. Row to row was 60 cm and plot to plot distance was 60 cm.

3.10. Intercultural operations

3.10.1 Weed control

Weeding was done once in all the unit plots with care so as to maintain a uniform plant population.

3.10.2 Thinning

Thinning was done at 20 days after sowing (DAS) and 30 DAS.

3.10.3 Irrigation and drainage

Irrigation was given to get the maximum germination percentage. During the whole experimental period, there was a heavier of rainfall in earlier part. So it was essential to remove the excess water from the field at later period.

3.11. Determination of maturity

At the time when 80% of the pods turned brown color, the crop was considered to attain maturity.

3.12 Harvesting and sampling

Ten plants were selected randomly from each plot and were uprooted for data recording. The rest of the plants of prefixed 1 m^2 area were harvested plot wise and were bundled separately, tagged and brought to the threshing floor.

3.13 Threshing

The crop was sun dried for three days by placing them on the open threshing floor. Seeds were separated from the plants by beating the bundles with bamboo sticks.

3.14 Drying, cleaning and weighing

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

3.15 Data collection

The following data were recorded

1. Plant height
2. Leaves plant^{-1}
3. Branches plant^{-1}
4. Flower plant^{-1}
5. Leaf area m^{-2}
6. Dry weight plant^{-1}
7. Cluster plant^{-1}
8. Pods plant^{-1}
9. Seeds pod^{-1}
10. Pod length
11. 1000 seeds weight
12. Seed yield
13. Stover yield
14. Biological yield
15. Harvest index (%)

3.16 Recording of data on different characters

I. Plant height

The height of the selected plant was measured from the ground level to the tip of the plant.

II. Leaves plant^{-1}

Number of leaves per plant was counted from each selected plant.

III. Branches plant^{-1}

From each selected plant number of branches per plant was counted.

IV. Dry weight plant^{-1}

Ten plants are selected from each plot at 25 DAS and 45 DAS. The selected plants were dried in over at 70°C for 72 hours. Formula for the determination of dry weight is:

Dry weight plant^{-1} =Dry weight/ Plants number

V. Leaf area m^{-2}

Leaf area was measured by leaf area meter.

VI. Flower plant^{-1}

From each selected plant sample number of flower per plant was counted.

VII. Cluster plant^{-1}

Cluster per selected plant was recorded.

VIII. Pod length

Ten randomly selected pods were from selected ten plants was counted and the average length was expressed on per pod basis.

IX. Pods plant^{-1}

From randomly selected 10 plants of each plot and then mean of pods per plant was calculated.

X. Seeds pod^{-1}

Number of seeds pod^{-1} was counted from selected 10 plants randomly and mean was calculated.

XI.1000 seeds Weight

Cleaned dried one thousand seeds were counted randomly from each harvest sample and that was weighed by using a digital electric balance.

XII. Seed yield

The grains were threshed from the plants, dried, cleaned and then weighed. The yield of seed in kg plot^{-1} was adjusted at optimum moisture content.

XIII. Stover yield ha^{-1}

Harvested crop in each plot was sun dried to get a constant weight. After that the stovers were weighted and from that the stover yield plot^{-1} was measured.

XIV. Biological yield ha^{-1}

Biological yield was measured from stover yield and grain yield. The biological yield was determined with the following formula:

Biological yield = Stover yield + Grain yield.

XV. Harvest index (%)

From the ratio of grain yield to biological yield the harvest index was measured and expressed it in percentage. It was determined with the following formula.

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

XVII. Data analysis

The data obtained for different parameters were statistically analyzed to notice significant difference among the treatment by using computer based software like MSTAT-C. The average values of all parameters were calculated and analysis of variance was performed. The significance of the difference among the treatments means was measured by the latest significant different test at 5% level of probability.

CHAPTER IV

RESULTS AND DISCUSSION

The study was conducted to evaluation of yield and yield contributing characters of some elite mungbean varieties of Bangladesh. The experimental findings regarding morpho-physiological attributes and yield of mungbean have been presented under the following headings:

4.1 Growth parameters

4.1.1 Plant height

Different varieties of mungbean had significant influence on plant height at different growth stages (Table 1 and Appendix V). Results revealed that the highest plant height (21.20, 43.28 and 70.25 at 25, 45 DAS and at harvest respectively) was obtained from the variety, V_5 (BARI Mung 5) which was statistically identical with V_2 (BU Mug 5) at 45 DAS and at harvest but statistically similar at 25 DAS followed by V_6 (BARI Mung 6). The lowest plant height (14.40, 31.55 and 51.75 at 25, 45 DAS and at harvest respectively) was found from the variety, V_4 (BARI Mung 4) which was statistically similar with V_1 (BU Mug 4) at the time of harvest. Ali *et al.*, (2002) suggested that mungbean cultivars differ significantly from each others in plant height. Significant differences between mungbean genotypes for plant height by Aslam *et al.* (2004)

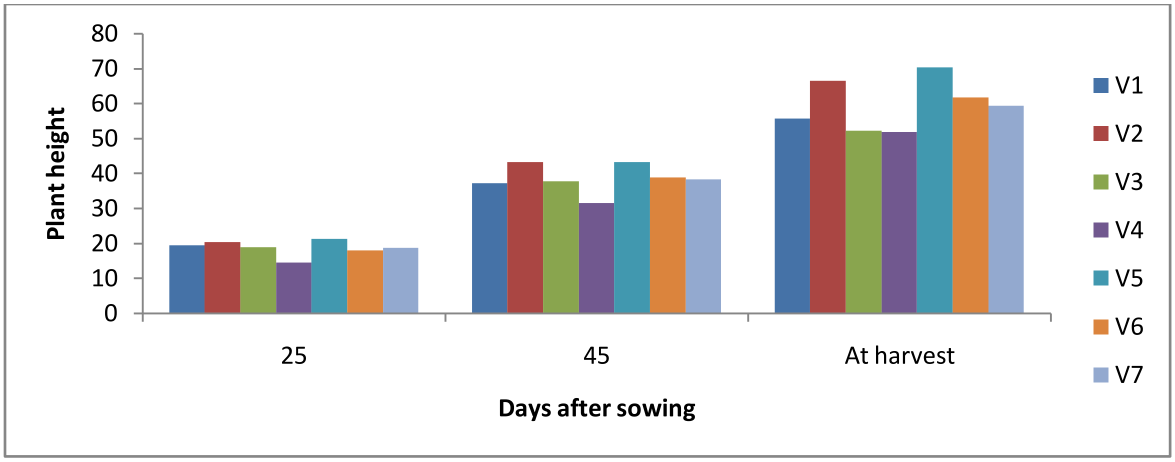

Figure 1. Plant height of mungbean influenced by different varieties

4.1.2 Leaves plant^{-1}

There was a significant variation on number of leaves plant^{-1} influenced by different variety at different growth stages (Table 2 and Appendix VI). It was found that the highest number of leaves plant^{-1} (11.00, 16.20 and 21.60 at 25, 45 DAS and at harvest respectively) was obtained from the variety, V_3 (BINA moog 8) which was statistically identical with V_2 (BU Mug 5) and V_5 (BARI Mung 5) at 25 and 45 DAS but significantly different at the time of harvest. At 25 DAS the variety, V6 (BARI Mung 6) also showed similar results with V3 (BINA moog 8). The lowest number of leaves plant-1 (8.60, 11.00 and 14.20 at 25, 45 DAS and at harvest respectively) was found from the variety, V4 (BARI Mung 4) which was statistically identical with V1 (BU Mug 4) and V7 (BARI Mung 7) at the time of harvest. Hossain *et al.*, (2017) higher number of leaves of BINA moog-8 than BU Mug-4

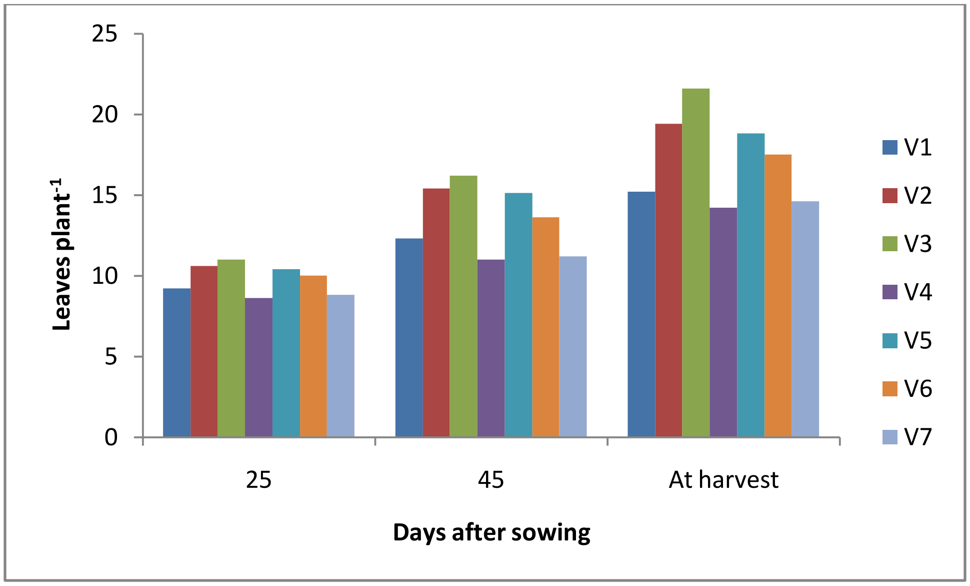

Figure 2. Leaves plant^{-1}influenced by different varieties

4.1.3 Branches plant^{-1}

Number of branches plant^{-1} was significantly influenced by different varieties at different growth stages (Table 3 and Appendix VII). That the highest number of branches plant^{-1} (1.24, 4.60 and 5.85 at 25, 45 DAS and at harvest respectively) was obtained from the variety, V_7 (BARI Mung 7) closely followed by V_3 (BINA Moog 8) at 25 and 45 DAS .The lowest number of branches plant^{-1} (0.70, 3.12 and 3.20 at 25, 45 DAS and at harvest respectively) was found from the variety, V_4 (BARI Mung 4) which was statistically similar with V_1 (BU Mug 4) at 45 DAS and at harvest.

Table 1. Number of branches $plant^{-1}$ of mungbean influenced by some elite varieties

Treatments	Number of branches $plant^{-1}$		
	25 DAS	45 DAS	At harvest
V_1	0.86 c	3.30 de	5.012
V_2	1.00 b	3.85 c	4.00 c
V_3	1.20 a	4.48 a	4.58 b
V_4	0.70 d	3.12 e	3.20 e
V_5	0.90 bc	3.40 d	3.60 d
V_6	1.00 b	4.10 b	4.36 b
V_7	1.24 a	4.60 a	5.85 a
$LSD_{0.05}$	0.1074	0.206	0.273
CV (%)	3.371	5.246	5.012

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly

V_1 = BU Mug-4, V_2 = BU Mug-5, V_3 = BINA moog-8, V_4 = BARI Mung-4, V_5 = BARI Mung-5, V_6 = BARI Mung-6, V_7 = BARI Mung-7

DAS- Days After Sowing

4.1.4 Dry weight $plant^{-1}$

Significant variation was observed on dry weight $plant^{-1}$ at different growth stages influenced by different variety (Table 4 and Appendix VIII). It was noted that the highest dry weight $plant^{-1}$ (9.10, 17.88 and 24.72 g at 25, 45 DAS and at harvest respectively) was obtained from the variety, V_7 (BARI Mung 7) which was statistically identical with V_3 (BINA moog 8) at 25 and 45 DAS but significantly different at harvest. At all growth stages, the lowest dry weight $plant^{-1}$ (5.86, 11.64 and 15.76 g at 25, 45 DAS and at harvest respectively) was found from the variety, V_4 (BARI Mung 4) which was close to the variety, V_1 (BU Mug 4) and V_5 (BARI Mung 5).

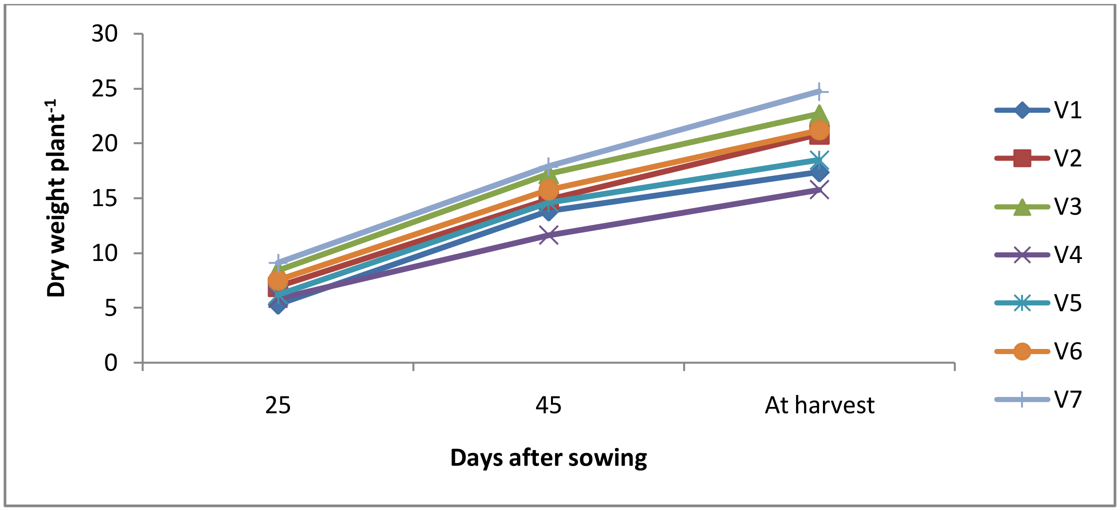

Figure 3. Dry weight plant^{-1} of mungbean influenced by different varieties

Table 2. Dry weight plant^{-1} of mungbean influenced by some elite varieties

Treatments	Dry weight plant^{-1}		
	25 DAS	45 DAS	At harvest
V_1	5.30 d	13.80 d	17.36 d
V_2	6.94 bc	14.88 bc	20.80 c
V_3	8.42 a	17.20 a	22.67 b
V_4	5.86 d	11.64 e	15.76 e
V_5	6.20 cd	14.60 cd	18.48 d
V_6	7.50 b	15.75 b	21.20 c
V_7	9.10 a	17.88 a	24.72 a
$LSD_{0.05}$	0.869	0.981	1.391
CV (%)	4.763	8.594	9.248

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly

V_1 = BU Mug-4, V_2 = BU Mug-5, V_3 = BINA moog-8, V_4 = BARI Mung-4, V_5 = BARI Mung-5, V_6 = BARI Mung-6, V_7 = BARI Mung-7

DAS- Days After Sowing

4.1.5 Leaf area m^{-2}

Leaf area m^{-2} was significantly varied due to different variety at different growth stages (Table 5 and Appendix IX). It was observed that the highest leaf area m^{-2} (37.12, 44.82 and 49.10 g at 25, 45 DAS and at harvest, respectively) was obtained from the variety, V_3 (BINA moog-8) where the lowest leaf area m^{-2} (27.48, 33.78 and 36.57 at 25, 45 DAS and at harvest, respectively) was found from the variety, V_4 (BARI Mung 4). At the time of harvest the variety, V_7 (BARI Mung 7) was statistically identical with V_3 (BINA moog-8) but statistically similar at 45 DAS (BARI, 2015).

Table 3. Leaf area m^{-2} of mungbean influenced by some elite varieties

Treatments	Leaf area m^{-2}		
	25 DAS	45 DAS	At harvest
V_1	28.73 cd	35.33 e	38.85 d
V_2	34.83 b	40.71 c	43.38 c
V_3	37.12 a	44.82 a	49.10 a
V_4	27.48 d	33.78 f	36.57 e
V_5	35.72 ab	42.72 b	46.56 b
V_6	29.56 c	38.16 d	42.37 c
V_7	35.30 b	43.40 ab	48.06 a
$LSD_{0.05}$	1.425	1.431	1.435
CV (%)	10.53	11.61	12.42

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly

V_1 = BU Mug-4, V_2 = BU Mug-5, V_3 = BINA moog-8, V_4 = BARI Mung-4, V_5 = BARI Mung-5, V_6 = BARI Mung-6, V_7 = BARI Mung-7

DAS- Days After Sowing

4.2 Yield contributing characters

4.2.1 Flower plant^{-1}

Remarkable variation was observed on number of flower plant^{-1} influenced by different variety (Table 6 and Appendix X). It was observed that the highest number of flower plant^{-1} (32.24) was obtained from the variety, V_7 (BARI Mung

7) which was significantly different from others but close to the variety, V_1 (BU Mug 4) and V_3 (BINA Moog 8) where the lowest number of flower plant^{-1}(18.80) was found from the variety, V_4 (BARI Mung 4) which was nearest to V_2 (BU Mug 5).

4.2.2 Cluster plant^{-1}

Significant influence was noted on number of cluster plant^{-1} affected by different variety (Table 6 and Appendix X). Results verified that the highest number of cluster plant^{-1} (4.78) was obtained from the variety, V_7 (BARI Mung 7) followed by V_1 (BU Mug 4) where the lowest number of cluster plant^{-1}(3.42) was found from the variety, V_4 (BARI Mung 4) which was statistically identical with V_2 (BU Mug 5).

4.2.3 Pod length

Pod length of mungbean varied significantly due to varietal difference (Table 6 and Appendix X). Results indicated that the highest pod length (7.86 cm) was obtained from the variety, V_7 (BARI Mung 7) which was significantly different from all other varieties followed by V_1 (BU Mug 4). The lowest pod length (5.21 cm) was found from the variety, V_4 (BARI Mung 4) which was close to the variety, V_2 (BU Mug 5) and V_5 (BARI Mung 5) but significantly different.

4.2.4 Pods plant^{-1}

Significant variation was remarked for number of pods plant^{-1} as influenced by different varieties of mungbean (Table 6 and Appendix X). The highest number of pods plant^{-1} (25.44) was obtained from the variety, V_7 (BARI Mung 7) which was statistically similar with the variety, V_1 (BU Mug 4) where the lowest number of pods plant^{-1} (13.80) was found from the variety, V_4 (BARI Mung 4) which was close to the variety, V_2 (BU Mug 5) and V_5 (BARI Mung 5).

4.2.5 Seeds pod^{-1}

Number of seeds pod^{-1} was found significant with different varieties of mungbean (Table 6 and Appendix X). Results exposed that the highest number of seeds pod^{-1} (12.28) was obtained from the variety, V_7 (BARI Mung 7) which was statistically identical with V_1 (BU Mug 4) and V_3 (BINA moog 8) and statistically similar with V_6 (BARI Mung 6). The lowest number of seeds pod^{-1} (9.66) was found from the variety, V_4 (BARI Mung 4) which was statistically identical with V_2 (BU Mug 5) and statistically similar with V_5 (BARI Mung 5).

4.2.6 1000 seeds Weight

Significant influence was noted on 1000 seed weight affected by different variety of mungbean (Table 6 and Appendix X). It was observed that the highest 1000 seed weight (48.88 g) was obtained from the variety, V_7 (BARI Mung 7) which was statistically identical with V_6 (BARI Mung 6) followed by V_1 (BU Mug 4). The lowest 1000 seed weight (31.74 g) was found from the variety, V_4 (BARI Mung 4) which was close to the variety, V_3 (BINA moog 8).

Table 4. Yield contributing parameters of mungbean influenced by some elite varieties

Treatments	Yield contributing parameters					
	Number of flower plant^{-1}	Number of cluster plant^{-1}	Pod length (cm)	Number of pods plant^{-1}	Number of seeds pod^{-1}	1000 seed weight (g)
V_1	29.64 b	4.52 b	7.18 b	23.78 ab	12.06 a	44.62 b
V_2	21.70 e	3.60 e	6.07 d	16.36 d	10.16 c	40.44 c
V_3	28.84 b	4.28 bc	6.87 bc	22.48 b	11.84 a	38.56 d
V_4	18.80 f	3.42 e	5.21 e	13.80 e	9.660 c	31.74 e
V_5	23.40 d	3.85 d	6.20 d	17.40 d	10.52 bc	41.20 c
V_6	25.38 c	4.04 cd	6.67 c	19.50 c	11.48 ab	49.76 a
V_7	32.24 a	4.78 a	7.86 a	25.44 a	12.28 a	48.88 a
$LSD_{0.05}$	1.124	0.244	0.312	1.785	1.036	1.821
CV (%)	8.341	4.568	6.314	9.337	7.286	8.586

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly

V_1 = BU Mug-4, V_2 = BU Mug-5, V_3 = BINA moog-8, V_4 = BARI Mung-4, V_5 = BARI Mung-5, V_6 = BARI Mung-6, V_7 = BARI Mung-7

DAS- Days After Sowing

4.3 Yield parameters

4.3.1 Seed yield

Variation on seed yield was noted that was significantly varied influenced by different variety of mungbean (Table 7 and Appendix XI). Results revealed that the highest seed yield (1686.70 kg ha^{-1}) was obtained from the variety, V_7 (BARI Mung 7) which was significantly different from others where the second and third highest seed yield (1591.50 and 1507.40 kg ha^{-1}, respectively) was observed from V_3 (BINA Moog 8) and V_1 (BU Mug 4) respectively. Again, the lowest seed yield (1372.80 kg ha^{-1}) was found from the variety, V_4 (BARI Mung 4) which was closer to V_2 (BU Mug 5) and V_5 (BARI Mung 5).

4.3.2 Stover yield

Stover yield of mungbean affected by different variety showed significant variation (Table 7 and Appendix XI). Results signified that the highest stover yield (2126.70 kg ha^{-1}) was obtained from the variety, V_7 (BARI Mung 7) followed by the variety, V_1 (BU Mug 4) and V_3 (BINA Moog 8). Again, the lowest stover yield (1941.30 kg ha^{-1}) was found from the variety, V_4 (BARI Mung 4) which was significantly different from all other test variety but closer to the variety, V_2 (BU Mug 5) and V_5 (BARI Mung 5).

4.3.3 Biological yield

The recorded data on biological yield was significantly different with the consideration of different varietal performance (Table 7 and Appendix XI). The highest biological yield (3813.40 kg ha^{-1}) was obtained from the variety, V_7 (BARI Mung 7) which was significantly different from others. The variety, V_3 (BINA moog 8), V_1 (BU Mug 4) and V_6 (BARI Mung 6) also gave comparatively higher biological yield compared to highest results but significantly different. The lowest biological yield (3314.10 kg ha^{-1}) was found from the variety, V_4 (BARI Mung 4) which was also significantly different from others but close to the variety, V_2 (BU Mug 5) and V_5 (BARI Mung 5).

4.3.4 Harvest index

Considerable influence was observed on harvest index persuaded by different variety (Table 7 and Appendix XI). It was observed that the highest harvest index (44.23%) was obtained from the variety, V_7 (BARI Mung 7) which was significantly different from other varieties but closer to the variety, V_3 (BINA moog 8). The lowest harvest index (41.42%) was found from the variety, V_4 (BARI Mung 4) which was also significantly different from which was at par the variety V_5 (BARI Mung 5).

Table 5. Yield parameters of mungbean influenced by some elite varieties

Treatments	Yield parameters			
	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
V_1	1507.40 c	2058.40 b	3565.80 c	42.27 c
V_2	1416.50 e	1956.90 e	3373.40 f	41.99 de
V_3	1591.50 b	2066.60 b	3658.10 b	43.51 b
V_4	1372.80 f	1941.30 f	3314.10 g	41.42 g
V_5	1421.70 e	1986.50 d	3408.20 e	41.71 f
V_6	1482.90 d	2012.60 c	3495.50 d	42.42 c
V_7	1686.70 a	2126.70 a	3813.40 a	44.23 a
$LSD_{0.05}$	10.539	11.637	13.241	0.0.262
CV (%)	11.68	13.66	12.76	8.254

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly

V_1 = BU Mug-4, V_2 = BU Mug-5, V_3 = BINA moog-8, V_4 = BARI Mung-4, V_5 = BARI Mung-5, V_6 = BARI Mung-6, V_7 = BARI Mung-7

DAS- Days After Sowing

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the Agricultural Botany experimental field of Sher-e Bangla Agricultural University (SAU), to study the yield and yield contributing characters of some elite mungbean varieties of Bangladesh. Seven mungbean varieties, *viz*. V_1 (BU Mug 4), V_2 (BU Mug 5), V_3 (BINA moog 8), V_4 (BARI Mung 4), V_5 (BARI Mung 5), V_6 (BARI Mung 6) and V_7 (BARI Mung 7) were used for the experiment. Data were recorded on different growth, yield and yield contributing parameters and analyzed statistically. Significantly influence was observed on different growth, yield and yield contributing parameters affected by different varieties.

Considering growth performance, the highest plant height (21.20, 43.28 and 70.25 at 25, 45 DAS and at harvest, respectively) was obtained from the variety, V_5 (BARI Mung 5) where the highest number of leaves plant^{-1} (11.00, 16.20 and 21.60 at 25, 45 DAS and at harvest, respectively) and leaf area m^{-2} (37.12, 44.82 and 49.10 g at 25, 45 DAS and at harvest, respectively) were obtained from the variety, V_3 (BINA moog 8). Again, the highest number of branches plant^{-1} (1.24, 4.60 and 5.85 at 25, 45 DAS and at harvest, respectively), dry weight plant^{-1} (9.10, 17.88 and 24.72 g at 25, 45 DAS and at harvest, respectively). On the other hand, the lowest plant height (14.40, 31.55 and 51.75 at 25, 45 DAS and at harvest, respectively), number of leaves plant^{-1} (8.60, 11.00 and 14.20 at 25, 45 DAS and at harvest, respectively), number of branches plant^{-1} (0.70, 3.12 and 3.20 at 25, 45 DAS and at harvest, respectively), dry weight plant^{-1} (5.86, 11.64 and 15.76 g at 25, 45 DAS and at harvest, respectively), leaf area m^{-2} (27.48, 33.78 and 36.57 at 25, 45 DAS and at harvest, respectively).

Regarding yield and yield contributing parameters, number of flower plant^{-1} (32.24), number of cluster plant^{-1} (4.78), pod length (7.86 cm), number of pods plant^{-1} (25.44), number of seeds pod^{-1} (12.28), 1000 seed weight (48.88 g), seed yield (1686.70 kg ha^{-1}), stover yield (2126.70 kg ha^{-1}), biological yield (3813.40 kg ha^{-1}) and the highest harvest index (44.23%) were obtained from the variety, V_7 (BARI Mung 7). Similarly, the lowest number of flower plant^{-1}(18.80), number of cluster plant^{-1}(3.42), pod length (5.21 cm), number of pods plant^{-1} (13.80), number of seeds pod^{-1} (9.66), 1000 seed weight (31.74 g), seed yield (1372.80 kg ha^{-1}), stover yield (1941.30 kg ha^{-1}), biological yield (3314.10 kg ha^{-1}) and harvest index (41.42%) were recorded from the variety, V_4 (BARI Mung 4).

From the above findings it can be concluded that among some elite mungbean varieties of Bangladesh, the variety V_7 (BARI Mung 7) showed maximum result on number of branches plant^{-1}, dry weight plant^{-1}, number of flower plant^{-1}, number of cluster plant^{-1}, pod length, number of pods plant^{-1}, number of seeds pod^{-1}, 1000 seed weight, seed yield (kg ha^{-1}), stover yield (kg ha^{-1}), biological yield (kg ha^{-1}), harvest index (%) compared to other varieties

Variety V_3 (BINA moog 8) showed better performance only on leaf area m^{-2} considering yield compared to other varieties.

CHAPTER VI

RECOMMENDATION

1) Among the varieties, BARI Mung-7 showed the highest seed yield. It may be used for cultivation for higher yield.

2) Further research may be needed for ensuring higher yield performance in mungbean in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability.

CHAPTER VII

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APPENDICES

Appendix I. Agro-Ecological Zone of Bangladesh showing the experimental location

Figure 4. Experimental site

Appendix II. Monthly records of air temperature, relative humidity, rainfall and sunshine hours during the period from March to June, 2017

Month	RH (%)	Air temperature (C)			Rainfall (mm)
		Max.	Min.	Mean	
March	52.44	35.20	21.00	28.10	0
April	65.40	34.70	24.60	29.65	165
May	68.30	32.64	23.85	28.25	182
June	71.28	27.40	23.44	25.42	190

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix III. Characteristics of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

A. Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Agronomy Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	Not Applicable

Source: Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of the initial soil

Characteristics	Value
Particle size analysis % Sand	27
%Silt	43
% Clay	30
Textural class	Silty Clay Loam (ISSS)
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	45

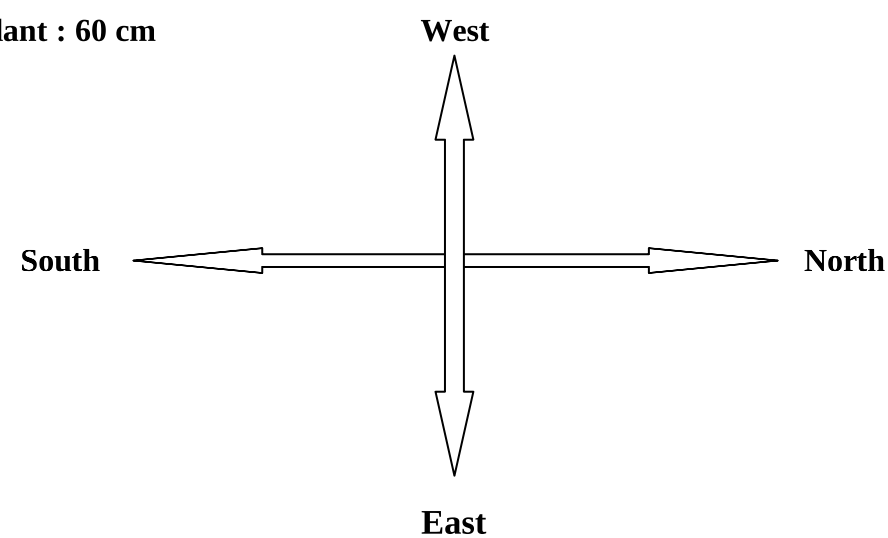
Source: Soil Resource Development Institute (SRDI)

Appendix IV. Layout of the experiment field

V_5R_1	V_4R_1	V_3R_3	V_2R_4
V_3R_1	V_1R_2	V_7R_3	V_6R_4
V_6R_1	V_5R_2	V_4R_3	V_3R_4
V_7R_1	V_3R_2	V_2R_3	V_5R_4
V_2R_1	V_6R_2	V_5R_3	V_1R_4
V_4R_1	V_2R_2	V_1R_3	V_7R_4
V_1R_1	V_7R_2	V_6R_3	V_4R_4

Row to Row : 60 cm

Plant to Plant : 60 cm



Appendix V. Plant height of mungbean as influenced by some elite varieties

Sources of variation	Degrees of freedom	Plant height (cm)		
		25 DAS	45 DAS	At harvest
Replication	3	0.233	1.084	1.312
Factor A	6	14.311	20.381*	23.48*
Error	18	2.052	2.316	3.529

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

Appendix VI. Number of leaves plant^{-1} of mungbean as influenced by some elite varieties

Sources of variation	Degrees of freedom	Number of leaves plant^{-1}		
		25 DAS	45 DAS	At harvest
Replication	3	0.217	0.526	0.617
Factor A	6	11.362	16.114*	18.507*
Error	18	1.514	1.326	1.148

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

Appendix VII. Number of branches plant^{-1} of mungbean as influenced by some elite varieties

Sources of variation	Degrees of freedom	Number of branches plant^{-1}		
		25 DAS	45 DAS	At harvest
Replication	3	0.007	0.032	0.018
Factor A	6	1.315**	2.354*	2.378**
Error	18	0.036	0.078	0.106

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

Appendix VIII. Dry weight plant^{-1} of mungbean as influenced by some elite varieties

Sources of variation	Degrees of freedom	Dry weight plant^{-1}		
		25 DAS	45 DAS	At harvest
Replication	3	0.084	0.207	0.322
Factor A	6	4.352**	10.319**	12.611*
Error	18	0.215	0.416	1.536

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

Appendix IX. Leaf area m^{-2} of mungbean as influenced by some elite varieties

Sources of variation	Degrees of freedom	Leaf area m^{-2}		
		25 DAS	45 DAS	At harvest
Replication	3	2.312	2.056	2.117
Factor A	6	14.314**	17.518**	21.208*
Error	18	1.326	2.319	3.514

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

Appendix X. Yield contributing parameters of mungbean as influenced by some elite varieties

Sources of variation	Degrees of freedom	Yield contributing parameters					
		Number of flowers $plant^{-1}$	Number of clusters $plant^{-1}$	Pod length (cm)	Number of pods $plant^{-1}$	Number of seeds pod^{-1}	1000 seed weight (g)
Replication	3	1.038	0.112	0.064	1.052	0.044	0.238
Factor A	6	18.367	8.314**	5.26**	12.68*	5.94**	16.58*
Error	18	1.529	0.346	0.614	1.302	0.348	1.314

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

Appendix XI. Yield parameters of mungbean influenced by some elite varieties

Sources of variation	Degrees of freedom	Yield parameters			
		Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Replication	3	4.883	5.376	5.107	0.231
Factor A	6	166.47	188.34	180.94	8.539
Error	18	12.349	14.388	13.641	0.236

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