PERFORMANCE OF SOME MUNGBEAN VARIETIES IN KHARIF-1 SEASON

A THESIS

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*This is to certify that thesis entitled, **"Performance of Some Mungbean Varieties in Kharif-1 Season"** submitted to the faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN AGRICULTURAL BOTANY**, embodies the result of a piece of bonafide research work carried out by **Md. Mokaddesh Hossain**, Registration No.: **08-03126** 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 been duly been acknowledged by him.

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Dedicated to my

First Teachers

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AmmaMonowara Begum

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PERFORMANCE OF SOME MUNGBEAN VARIETIES IN KHARIF-1 SEASON

ABSTRACT

The experiment was conducted at the research field of the Sher-e-Bangla Agricultural University, Dhaka during February, 2014 to June, 2014 to study the performance of different mungbean varieties in kharif-1 season. In this experiment, the treatment consisted of seven mungbean varieties viz. V_1 = BARI mung-2, V_2 = BARI mung-3, V_3 = BARI mung-4, V_4 = BARI mung-5, V_5 = BARI mung-6, V_6 = BINA moog-5 and V_7 = BINA moog-8. The experiment was laid out in a one factors Randomized Complete Block Design (RCBD) with three replications. The fertilizers were applied as basal dose at final land preparation where N, K_2O, P_2O_5 Ca and S were applied @ 20.27 kg ha^{-1}, 33 kg ha^{-1}, 48 kg ha^{-1}, 3.3 kg ha^{-1} and 1.8 kg ha^{-1} respectively in all plots. Necessary intercultural operations were done as and when necessary. Results showed that a significant variation was observed among the treatments in respect of majority of the observed parameters. The earliest of days to first flowering (32.67 DAS) was found in V_7 and the longest time (35.67 DAS) were recorded in V_5 treatment. The earliest of days to attainment of the highest length of pod (42.67 DAS) was found in V_7 and the longest time (52.67 DAS) were recorded in V_5 and V_1 treatment. The highest number of pods per plant (12.00, 18.13, 12.73, 18.33 and 11.27 at 50, 60, 70, 80 and 90 DAS, respectively) was recorded in V_7 and the lowest number of pods plant^{-1} (6.33, 6.53, 6.73, 9.33 and 7.13 at 50, 60, 70, 80 and 90 DAS, respectively) was recorded in V_2. The highest number of fertile seeds per pod (9.93) was recorded in V_7 and the lowest number of fertile seeds per pod (8.93) was observed in V_3. The highest number infertile seeds per pod (2.02) were recorded in V_3 and the lowest number of infertile seeds per pod (0.60) was observed in V_7. The longest pod length (7.96 cm) was recorded in V_7 and the shortest pod length (6.31 cm) was observed in V_3. The highest 1000-seed weight was recorded in V_7 (61.33 g). In contrast, the lowest 1000-seed weight was recorded in V_3 (36.67 g). The highest yield per 1m^2 (93.27 g) was recorded in V_7 and the lowest (64.27 g) in V_6.

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LIST OF ABBREVIATION AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
HRC	=	Horticulture Research Centre
BBS	=	Bangladesh Bureau of Statistics
FAO	=	Food and Agricultural Organization
N	=	Nitrogen
et al.	=	And others
TSP	=	Triple Super Phosphate
MOP	=	Muriate of Potash
RCBD	=	Randomized Complete Block Design
DAT	=	Days after Transplanting
ha^{-1}	=	Per hectare
g	=	gram (s)
kg	=	Kilogram
SAU	=	Sher-e-Bangla Agricultural University
SRDI	=	Soil Resources and Development Institute
wt	=	Weight
LSD	=	Least Significant Difference
^{0}C	=	Degree Celsius
NS	=	Not significant
Max	=	Maximum
Min	=	Minimum
%	=	Percent
NPK	=	Nitrogen, Phosphorus and Potassium
CV%	=	Percentage of Coefficient of Variance

CHAPTER I

INTRODUCTION

Pulses are the main source of plant protein for the people, particularly for the poor section of Bangladesh and it is called the poor men's meat as it is the cheapest source of protein. But at present pulses are beyond the reach of the poor people because of its high price due to less production. In Bangladesh per capita consumption of pulses is only 14.72g (BBS, 2012) as against 45.0g recommended by World Health Organization. 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 huge amount of foreign currency every year. So pulse production should be increased urgently to meet up the demand. Mungbean (*Vigna radiata* L.) is one of the most important pulse crop of Bangladesh. It is considered as the best of all pulses from the nutritional point of view. It contains 51% carbohydrate, 26% protein, 4% minerals and 3% vitamins (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. In Bangladesh, mungbean grows well all over the country. Among the pulses, it ranks third in area and production but first in market price. The total production of mungbean in Bangladesh in 2011-12 was 19,972 metric tons from an area of 20,117 hectares with average yield is about 0.98 tons ha^{-1} (BBS, 2012). Mungbean also improves physical, chemical and biological properties of soil by fixing nitrogen from atmosphere through symbiosis process.

The rice based cropping pattern has been found as an important cropping system in our country. Besides this, increasing area under wheat cultivation has further reduced the area under pulses. The country is also facing an acute shortage of mungbean due to low yield of approximately 590 kg ha^{-1} (MOA, 2005) and less production. The reasons for low yield are varietal and some are agronomic management. Due to the shortage of land, the scope of its extensive cultivation is very limited. Therefore, attempts must be made to increase the yield per unit area by applying improved technology and management practices. Among the cultural technologies, seed rate is one of the important components, manipulation of which is an essence for optimizing yield. Rice and wheat both are cereal crops, so the inclusion of pulse crops in rice and wheat based cropping system can create diversification. Therefore, attention should be given to increase the yield of pulses through adoption of improved cultural technology.

Bangladesh is a developing country. The land of our country is limited. But the population is very high. More people need more food. We have to produce more food in our limited land. To meet up the increased demand of food, farmers are growing more cereal crops. Due to the high population pressure, the total cultivable land is decreasing day by day along with the pulse cultivable land. So, at present the cultivation of pulse has gone to marginal land because farmers do not want to use their fertile land in pulse cultivation. Pulse cultivation is also decreasing because of its low yield and production. The long term cereal crop cultivation also effects soil fertility and productivity.

The farmers of Bangladesh generally grow mungbean by one ploughing and hardly use any fertilizer and irrigation due to its lower productivity and also to their poor socio-economic condition and lack of proper knowledge. As a result the yield becomes low. There is an ample scope for increasing the yield of mungbean with improved management practices.

The agro-ecological condition of Bangladesh is favourable for munbean cultivation almost throughout the year. The crop is usually cultivated during rabi season. But because of poor yield and marginal profit as compared to cereal crops, farmers prefer growing boro rice, maize and wheat than munbean during rabi season. Besides, the release of high yielding cultivars of cereals have pushed this crop to marginal and sub-marginal lands of less productivity and made its cultivation less remunerative. Recently, Bangladesh Agricultural Research Institute (BARI) has developed six and Bangladesh Institute of Nuclear Agriculture (BINA) has developed seven photosensitive high yielding cultivars mungbean, which are getting attention to the farmers. During kharif season the crop fits well into the existing cropping system of many areas in Bangladesh.

.The proper sowing time again depends on the varieties and prevailing environment. Selection of right varieties for sowing at optimum time is the key factor for successful mungbean production. Growers tend to manipulate sowing time in order to obtain better growth and higher quality yield. The time of sowing is also adjusted so as to synchronize the time of harvest with market demand.

The deficit situation of mungbean production in our country can be overcome either by bringing more area under mungbean cultivation or by increasing the yield through improvement of production technology, such as optimizing the dose of N, P and K fertilizers.

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

1. To find out some morphological and reproductive performances of different varieties of mungbean.

2. To compare the yield contributing characters and yield of the different varieties of mungbean.

CHAPTER II

REVIEW OF LITERATURE

A good number of research works on different aspects of mungbean production have been done by research workers in and outside of the country, especially in the South East Asia for the improvement 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 performance of different varieties of mungbean is reviewed and presented in this chapter.

2.1 Effect of variety on reproductive performance and yield attributes

Ali *et al.* (2014) investigated the effect of sowing time on yield and yield components of different mungbean varieties, 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.

Parvez et al. (2013) conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from October to January 2011 to study the performance of mungbean as affected by variety and level of phosphorus. The experiment comprised four varieties viz. BARI Mung-6, Binamoog-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 $plant^{-1}$ and seed weight $plant^{-1}$ were obtained from BARI Mung-6. Binamoog-6 produced the highest seed yield which was as good as Binamoog-8. The second highest and the lowest seed yield were recorded from Binamoog-4 and BARI Mung-6, respectively. The highest stover yield was obtained from Binamoog-8 followed by Binamoog-4. The lowest stover yield was recorded from BARI Mung-6.

Rasul *et al.* (2012) conducted to establish the proper inter-row spacing and suitable variety evaluation in Faisalabad, Pakistan. Three mung bean varieties V1, V2, V3 (NM-92, NM-98, and M-1) were grown at three inter-row spacing (S1- 30 cm, S2- 60 cm and S3- 90 cm) respectively. 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 V2 at 30 cm spacing. Among varieties V2 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.

Ahamed *et al.* (2011)conducted 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 –2 season). Five Mungbean varieties namely BARI Mung-2 (M2), BARI Mung-3 (M3), BARI Mung-4 (M4), BARI Mung-5 (M5) and BARI Mung-6 (M6) were used in the experiment to observe their morpho-physiological attributes in different plant spacing viz. 20×10 cm (D1), 30X10 cm (D2) and 40×10 cm (D3). 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). Leaf area of BARI Mung-3 was the highest (147.57 cm2). The variety BARI Mung-3 produced the lowest leaf area of 110.00 cm2. In the study BARI Mung-2 took 30.44 days for flowering that is statistically atper BARI Mung-6 (30.11) and BARI Mung-4 flower earliest (at 28.88 days after sowing) as compared to all other varieties..

Salah Uddin *et al.*(2009)carried out 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 BINA moog 5 were also used as experimental variables. The experiment was laid out in Randomized Block Design with fifteen treatments where each treatment was replicated 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.

Rehman et al. (2009)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 various 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-2 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. Both mungbean varieties produced statistically similar grain yield. It is concluded from the experiment that mungbean.

Kabir and Sarkar (2008) carried out to study the effect of variety and planting density on the yield of mungbean in *Kharif*-I season (February to June) of 2003. The experiment comprised 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.

Bhuiyan *et al*. (2008) Field studies with and without *Bradyrhizobium* was carried out 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 inoculum *(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 randomly selected plants. BARI Mung-2 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 attributes, such as pods/plant and seeds/pod.

An experiment was conducted by Muhammad *et al*. (2006) 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.

Islam *et al*. (2006) carried out an experiment at the field laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh during the period from March 2002 to June 2002 to evaluate the effect of biofertilizer (*Bradyrhizobium*) and plant growth regulators (GA3 and IAA) on growth of 3 cultivars of summer mungbean (*Vigna radiata* L.). Among the mungbean varieties, BINA moog 5 performed better than that of BINA moog 2 and BINA moog 4.

Studies were conducted by Bhati *et al*. (2005) 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.

A field experiment was conducted by Raj and Tripathi (2005) 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 significantly 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 also obtained with K-851 (Rs. 6544 ha^{-1} and 1.02, respectively) than RMG-62 (Rs. 4833 ha^{-1} and 0.76, respectively).

Chaisri *et al*. (2005) conducted a yield trial 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 (February-May 2002), early rainy (June-September 2002) and late rainy season (October 2002-January 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 session.

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 by Shamsuzzaman *et al*. (2004). 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.

The performance of 20 mungbean cultivars were evaluated by Madriz-Isturiz and Luciani-Marcano (2004) in a field experiment conducted in Venezuela during the rainy season of 1994-95 and dry season of 1995. 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.

A field experiment was conducted by Apurv and Tewari (2004) during kharif season of 2003 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). The variety Pusa 9531 showed higher yield components and grain yield than Pusa 105 and Pant mung 2.

To find out the effects of *Rhizobium* inoculation on the nodulation, plant growth, yield attributes, seed and stover yields, and seed protein content of six mung bean (*Vigna radiata*) cultivars were investigated by Hossain and Solaiman (2004). The mungbean cultivars 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 concluded 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.

Ali *et al*. (2004) carried out an experiment at BARI, Joydebpur, Gazipur to find out the response of inoculation with different plant genotypes of mungbean. Three varieties of mungbean viz. BARI mung-1, BARI mung-2, BARI mung-3 and Rhizobial inoculums (BARI Rvr 405) were use in this experiment. Each variety was tested with and without inoculation. Inoculated plants gave significantly higher number of nodules.

Sadi *et al.,* (2004) observed that plant height, 1000-seed weight and harvest index were significantly influenced by variety. In an experiment with 15 genotypes in mungbean, the highest seed yield was obtained in MB 45 (Hasan, 2004).

Mondal *et al.* (2004) conducted an experiment at farmer's field of Rangpur zone during *kharif-1* season to evaluate the performance of four mungbean varieties viz. BINA moog-2, BINA moog-5, BARI mung-2 and BARI mung-5. Result revealed 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 reported in Bangladesh condition that BARI mung-2 contributed higher seed yield than BARI mung-5 due to production of higher number of pods $plant^{-1}$ (Sarker *et al.,* 2013). Ahmad *et al.,* (2003) conducted 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.

The development phases and seed yield were evaluated by Infante *et al*. (2003) 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 kg/ha.

Solaiman *et al.* (2003) studied on the response of mungbean cultivars BARI mung-2, BARI mung-3, BARI mung-4, BARI mung-5, BINA moog-2 and BU mung-1 to *Rhizobium sp.* Strains TAL 169 and TAL441. It was observed that inoculation of the seeds increased nodulation.

Bhuiyan *et al.* (2003) conducted a field Experiment at Regional Agricultural Research Station (RARS), Rahmatpur, Barisal, to study the response of inoculation with different plant genotypes. Four varieties of mungbean viz. BARI mung-2, BARI mung-3, BARI mung-4, BARI mung-5, and Rhizobial inoculum (Bradyrhizobium strain RVr-441) were used in this experiment. Each variety was tasted with/without inoculation. Inoculated plants gave significantly higher nodule number.

Vieiera *et al*. (2003) conducted an experiment to evaluate 25 mungbean genotypes during the summer season in Vicosa and Prudente de morais, Minas Gerais, Brazil. The yield varied from 1200 to 2000 kg ha^{-1} in Prudente de morais.

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 in a field experiment conducted by Navgire *et al*. (2001) in Maharashtra, 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 (4.79 q/ha) during the experimental years. S-8, BM-4 and BM-86 recorded the highest nodulation, plant biomass and grain yield when their seeds were inoculated with *Rhizobium* strains M-6-84, M-6-65 and M-11-85, respectively.

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 (N_2), and inoculation with R only +5 (N_3) or 10 kg N/feddan (N_4). Kawny 1 surpassed Giza 1 in pod number per plant (24.3) and seed yield (0.970 t/feddan), while Giza 1 was superior in 100-seed weight (7.02 g), biological and straw yields (5.53 and 4.61 t/feddan, respectively). While Kawny 1 surpassed Giza 1 in oil yield (35.78 kg/feddan), the latter cultivar recorded higher values of protein percentage and yield (28.22% and 264.6 kg/feddan). The seed yield of both cultivars was positively and highly significantly correlated with all involved characters, except for 100-seed weight of Giza 1 and branch number per plant of Kawny 1.

BINA (1998) reported that MC-18 BINA mung-5 produced higher seed yield over BINA mung-2. Field duration of BINA mung-5 was about 78 days as against 82 days for BINA mung-2. Mohanty *et al.* (1998) observed that among nine summer mungbean (*Vigna radiata* L.) cultivars, kalamung was the best performing cultivar with a potential grain yield of 793.65 kg ha^{-1} and the highest number of pods plant-1(18.66) and high number of seeds pod^{-1}.

BARI (1980) conducted a field trial with three mungbean strains to know the optimum seed rate and observed that optimum seed rate depend on seed size of a genotype and said that bold seeded plants required more seed rate than the small seeded ones. BARI (1991) found that small seeded entries had greater germination percentage than bold seeded ones which required less seed rate compared to bold seeded plants and even with same seed rate, small seeded entries accommodated more plants per unit area which contributed towards higher yield than the bold seeded ones.

BINA (1997) reported that genotypic effect in relation to seed rate was significant on grain yield and got the similar results to BARI (1991).

Thakuria and Shaharia (1990) reported that different varieties of mungbean differed significantly in seed yield and other yield related traits. Rana and Singh (1992) in Kanpur, Uttar Pradesh of India reported that the yield was generally higher in *Vigna radiata* than *Vigna mango* and was the highest in cultivar PDM-11 than Sona.

Chaudhury *et al.* (1989) reported that mungbean cultivars had significant variation in dry matter accumulation in stem, leaf, seed and husk.

However, BARI (2006) and BINA (2007) released several mungbean varieties and instructed that seed rate depend on seed size of a variety. BARI (2005) and

BINA (2005) further reported that optimum seed rate required 30-35 kg ha^{-1} for BARI mung-2, BARI mung-3, BARI mung-4, BINA moog-2, BINA moog-3, BINA moog-4 and BINA moog-7 while optimum seed rate required 35-40 kg ha^{-1} for BARI mung-5, BARI mung-6, BINA moog-5 and BINA moog-6.

2.2 Effect of sowing time on reproductive performance and yield attributes

Inderjit *et al.* (2005) conducted a field experiment on sandy-loam soil of Gurdaspur, Punjab, India, during the 1998-2000 winter season (rabi) to study the effect of different sowing dates, row spacings and seed rates on the productivity of lentil *(Lens culinaris* cv. LG 308) and reported significant effect for emergence of seedling for different sowing date. Turk *et al.* (2003) reported significant effect regarding seedling emergence for different sowing time. The sowing time and rate optimum for the growth and yield of the large-seeded lentil cv. Diskiai and the small-seeded cv. Smelinukai were investigated by Kazemekas (2001) on a light loamy soil in Lithuania from 1998 to 2000 and reported that sowing time significantly influenced seedling germination. Gurung *et al.* (1996) carried out a field experiment in 1991-94 at Dhankuta, Nepal to determine the appropriate sowing date for lentils and reported that October sowings were associated with early good crop vigor with highest percentage of seedling germination.

Sowing date effects on plant height of pulse crop that were reported by the different researcher. Hanlan *et al.* (2006) reported that sowing date influenced overall plant height. Hossain *et al.* (2006) reported that lentil sown in November received less aphid infestation with tallest plant. Turk *et al.* (2003) reported tallest plant for early sowing (1 January). Allam (2002) reported that sowing on

1 November gave taller plants. The sowing time and rate optimum for the growth and yield of the large-seeded lentil were investigated by Kazenw-kas-(2001) and found that the earliest sowing date were optimum for plant height. Andrews *et al*. (2001) reported that maximum plant height was closely positively related to monthly mean values for mean daily air temperature. Gurung *et al*. (1996) observed that longest plant from October sowings were associated with early good crop VU[1]01.11- which was mainly due to warmer air temperatures during the early vegetative growth. Bukhtiar *et al*. (1991) reported that the last week of October proved the better sowing date at which AARIL344 produced the tallest plant and the Dist week of October was found better with an optimum range from the end of September to 2nd week of November.

Number of branches per plant of pulse crop varied significantly for different sowing time. Hanlan *et al*. (2006) observed that highest canopy traits such as rapid growth, light interception. Lal *et al.* (2006) also reported similar observation. Turk *et al.* (2003) recorded high yields were obtained for early sowing (1 January), high plant density (120 plants m^{-2}) for highest number of branches per plant. Al-Hussien *et al.* (2002) reported that different sowing dates (early and late) significantly affect number of branches per plant of lentil. Allam (2002) found under various sowing dates (1 November, 15 November, and 1 December) that the sowing on 1 November gave taller plants with higher number of branches. Siddique *et al*. (1998) observed sowing in late April or early May allowed a longer period for vegetative and reproductive growth, rapid canopy development, more water use, and, hence, greater vegetative growth and number of branches. Gurung *et al.* (1996) reported reduced number of branches per plant from November and December sowings were mainly due to the adverse effect of low air temperatures at the early vegetative growth period and shorter total crop growth period. Mishra *et al.* (1996) also reported similar findings. Brand *et al.* (2003) reported that the optimum sowing dates for all cultivars in 2000 were mid June to early July and in 2001 mid May to mid June. Rahman and Sarker (1997) reported that high-yielding cultivars also had more leaves and petioles at both vegetative and reproductive phases, and number of branches per plant. Bukhtiar *et al.* (1991) reported that the last week of October was found -better with an optimum range from the end of September to 2nd week of November.

Kazemekas (2001) reported dry matter content increased in the earliest sowing date were optimum for the growth and yield of both lentil cultivars. Andrews *et al.* (2001) in Canterbury, New Zealand were used to assess the potential of lentil and found 1 October sowing get maximum total dry matter. Siddique *et al.* (1998) reported that sowing in late April or early May allowed a longer period for vegetative and reproductive growth, rapid canopy development, more water use, and, hence, greater dry matter production. Early-sown lentils began flowering and filling seeds earlier in the growing season, at a time when vapour pressure deficits and air were lower. The values of water use efficiency for dry matter production, and transpiration efficiency, for early-sown lentil were comparable to those reported for cereal and other grain legume crops in similar environments.

Inderjit *et al.* (2005) reported that lentil sown on 10 November produced flowering and attain maturity the crop sown on 25 November and 10 December by a margin of 8.85 and 11.5%, respectively. Kazemekas (2001) found that the earliest sowing date were optimum for the optimum flowering and maturity. Andrews *et al*. (2001) in Canterbury, New Zealand was used to assess the potential of lentil as a grain legume crop in the UK. The model was validated using five sowing dates (21 April, 28 April, 5 May, 12 May and 26 May) at Durham, UK, in 1999. Predicted time to flowering was within 7 days of actual time to flowering and predicted seed yields were within 9% of actual yields. Time to flowering generally decreased along the transect from North West to South East UK ranging from 28 June to 9 July and from 20 May to 14 June with the May and October sowings, respectively. Siddique *et al*. (1998) reported that sowing in late April or early May allowed a longer--period for vegetative and reproductive growth. Early-sown lentils began flowering earlier in the growing season, at a time when vapor pressure deficits and air temperatures were lower, and used more water in the post-flowering period when compared with those treatments where sowing was delayed. E1-Nagar and Galal (1997) in Egypt, lentils were sown 1 or 15 November, or 1 December and were harvested at physiological maturity or one or two weeks later and reported that delaying harvesting by one or two weeks after physiological maturity decreased seed yield by 19.7% and 33.6%, respectively.

Brand *et al.* (2003) found that the optimum sowing dates for all cultivars in 2000 were mid June to early July and in 2001 mid May to mid June. Turk *et al.* (2003) reported that early sowing (1 January) ensured high plant density (120 plants m-

2). The performance of lentil cv. Giza 9 were investigated by Allam (2002) under various sowing dates (1 November, 15 November, and 1 December and reported that sowing on 1 November gave higher number of pods per plant, number of seeds per pod and seed yield per plant. Harvest index was higher when sowing was conducted on 1 and 15 November. Rahman and Sarker (1997) reported that higher seed yields were achieved through the contribution of more pods per plant and bigger seeds. Gurung *et al.* (1996) reported that warmer air temperatures during vegetative growth period and longer total growth period, seed yield from September sowing was low. This was mainly due to excess rainfall during early vegetative growth stage which had adverse effects on crop establishment. Bukhtiar *et al.* (1991) observed that the higher harvest index (HI) of 42.3% in AARIL344 and 41.4% in AARIL337 was obtained from 23 November sowing. The lower HI (25.1%) was recorded in AARIL355 sown on 26 September. The last week of October was found better with an optimum range from the end of September to 2nd week of November.

Lal *et al.* (2006) found maximum disease intensity (51%) was recorded in 15 October-sown crop, while maximum grain yield (730 kg/ha) was obtained in crop sown on 5 November. Hossain *et al.* (2006) reported that lentil aphid appeared in the field in the first week of January. The crop sown in November received less aphid infestation and consequently produced higher yield than the crop sown in December. Inderjit *et al.* (2005) found that lentil sown oil 10 November (14.6 q/ha) out yielded the crop sown on 25 November and 10 December by a margin of 12.8 and 90.1%, respectively. Significantly higher mean seed yield was obtained in lentil sown on 10 November at 20 cm row spacing (15.7 q/ha) and that sown on 10 November using 37.5 kg seed/ha (15.9 q/ha). Brand *et al.* (2003) reported that the optimum sowing dates for all cultivars in 2000 were mid June to early July and in 2001 mid May to mid June. The effects of sowing date (1 January, 15 January and 2 February), plant density phosphorus level and ethephon application were investigated in the semiarid region in the north of Jordan by Turk *et al.* (2003) and observed that high yields were obtained for early sowing (1 January). Field experiments were conducted by Ahmed *et al.* (2002) found that the control options were sowing dates (mid-November, mid-December and mid-January), host plant resistance (cultivars ILL 5883 (highly resistant), ILL 5722 (moderately resistant) and ILL 2130 (highly susceptible) and fungicide seed treatment.

Al-Hussien *et al.* (2002) reported that delaying the sowing date and applying imazapic and imazethapyr resulted in the most promising results, recording 97-98% weed control in Idleb and Tel Hadya and producing 221 and 40% more seed yield in Idleb and Tel Hadya, respectively. Muhammad *et al.* (2002) reported sowing in November significantly enhanced seed yield by 113.2% in 1993-94 and 102.1% in 1994-95 compared to sowing in December. This positive response to early sowing, higher density or fully Irrigated crop was the direct consequence of improvement in all the yield components. The sowing time and rate optimum for the growth and yield of the large-seeded lentil were investigated by Kazemekas (2001) and found that based on the different parameters evaluated, i.e. seed yield, the earliest sowing date were optimum for the growth and yield of both lentil cultivars.

Andrews *et al.* (2001) predicted time to flowering was within 7 days of actual time to flowering and predicted seed yields were within 9% of actual yields. Actual yields ranged from 1.40 to 1.65 tha^{-1}. El-Nagar and Galal (1997) reported that delaying sowing decreased seed yield. Rahman and Sarker (1997) reported the highest (1.85 t/ha) and the lowest (0.75 t/ha) seed yields were obtained from cultivars 1LX 87052 and Utfala, respectively. Higher seed yields were achieved through the contribution of higher total dry matter, more pods per plant and bigger seeds. Gurung *et al.* (1996) found that average seed yields of crops sown on 10 and 25 October were 1274 and 1591 kg/ha, respectively, which were significantly higher than other sowing dates. Seed yield was greatly reduced if sowing was advanced from 10 October to 25 September (533) kg/ha) or delayed from 25 October to 9 November (597 kg/ha). The straw yields of lentil were also higher from October sowings. Mishra *et al.* (1996) reported that seed yield decreased with delay in sowing date after 23 October and the weed-free control gave the highest seed yield. Sekhon *et al.* (1994) reported that sowing rates had no significant effect on seed yields and seed yields ranged from 1.04 t at the lowest rate to 1.20 t at 60 kg seed/ha. Bukhtiar *et al.* (1991) found that the last week of October proved the better sowing date at which AARIL344 produced the highest yield of 1686 kg/ha followed by 9-6 and AARIL496 (1649 and 1625 kg/ha, respectively). With sowing in the 2nd week of November AARIL496 yielded better (1446 kg/ha) followed by 9-6 and AARIL344 (1427 and 1365 kg/ha, respectively). The overall mean seed yield for cultivars was higher

(1236.5) 6.5 kg/ha) in 9-6 followed by AARIL496 (1225.4 kg/ha) and AARIL344 (1222.4 kg/ha). Tile lowest mean yield (493.2 kg/ha) was recorded in AARIL355.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at the research field of the department of Agricultural Botany of Sher-e-Bangla Agricultural University, Dhaka during the period from February, 2014 to June, 2014 to find out the morphological, reproductive performances and yield of different varieties of mungbean. Materials used and methodologies followed in the present investigation have been described in this chapter.

3.1 Description of the experimental site

3.1.1 Site and soil

Geographically the experimental field was located at 23^0 77´ latitude and 88^0 33´ Elongitudes at an altitude of 9 m above the mean sea level. The soil is belonged to the Agro-ecological Zone – Modhupur Tract (AEZ 28). The land topography was medium high and soil texture was silt clay with pH 8.0. The morphological, physical and chemical characteristics of the experimental soil have been presented in Appendix-1.

3.1.2 Climate and weather

The climate of the locality is subtropical which is characterized by high temperature and heavy rainfall during *Kharif* season (April-September) and scanty rainfall during *Rabi* season (October-March) associated with moderately low temperature.

3.2 Plant materials

BARI mung-2:

BARI mung-2 was used as planting material. BARI mung-2 was released and developed by BARI in 1987. Plant height of the cultivar ranges from 60 to 55 cm. It is resistant to cercospora leaf spot and tolerant to yellow mosaic virus. Its life cycle is about 60 to 65 days after emergence. One of the main characteristics of this cultivar is synchronization of pod ripening. Average yield of this cultivar is about 1200 kg ha^{-1}. The seeds of BARI mung-2 for the experiment were collected from BARI, Joydepur Gazipur. The seeds were drum-shaped, dull and greenish and free from mixture of other seeds, weed seeds and extraneous materials.

BARI mung-3:

BARI mung-3 was used as planting material. BARI mung-3 was released and developed by BARI in 1996. Plant height of the cultivar ranges from 50 to 55 cm. It is resistant to *Cercospora* leaf spot and tolerant to yellow mosaic virus. Its life cycle is about 50 to 55 days after emergence. One of the main characteristics of this cultivar is synchronization of pod ripening. Average yield of this cultivar is about 1300 kg ha^{-1}. The seeds of BARI mung-3 for the experiment were collected from BARI, Joydepur Gazipur. The seeds were drum-shaped, dull and greenish and free from mixture of other seeds, weed seeds and extraneous materials.

BARI mung-4:

BARI mung-4 was used as planting material. BARI mung-4 was released and developed by BARI in 1996. Plant height of the cultivar ranges from 52 to 57 cm. It is resistant to *Cercospora* leaf spot and tolerant to yellow mosaic virus. Its life cycle is about 60 to 65 days after emergence. One of the main characteristics of this cultivar is synchronization of pod ripening. Average yield of this cultivar is about 1400 kg ha^{-1}. The seeds of BARI mung-4 for the experiment were collected from BARI, Joydepur Gazipur. The 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 was used as planting material. BARI mung-5 was released and developed by BARI in 1997. Plant height of the cultivar ranges from 40 to 45 cm. It is resistant to *Cercospora* leaf spot and tolerant to yellow mosaic virus. Its life cycle is about 55 to 60 days after emergence. One of the main characteristics of this cultivar is synchronization of pod ripening. Average yield of this cultivar is about 1700 kg ha^{-1}. The seeds of BARI mung-5 for the experiment were collected from BARI, Joydepur Gazipur. The seeds were large shaped, deep green and free from mixture of other seeds, weed seeds and extraneous materials.

BARI mung-6:

BARI mung-6 was used as planting material. BARI mung-6 was released and developed by BARI in 2003. Plant height of the cultivar ranges from 40 to 45 cm. It is resistant to *Cercospora* leaf spot and tolerant to yellow mosaic virus. Its life cycle is about 55 to 58 days after emergence. One of the main characteristics of this cultivar is synchronization of pod ripening. Average yield of this cultivar is about 1800 kg ha^{-1}. The seeds of BARI mung-6 for the experiment were collected from BARI, Joydepur, Gazipur. The seeds were large shaped, deep green and free from mixture of other seeds, weed seeds and extraneous materials.

BINA moog-5:

A late winter-cum-summer mungbean variety, released in 1998. It matures between 70-80 days. Seed is green shiny and bigger than BINA moog-1. Almost all the pods mature at a time. Plants are short and tolerant to *Cercospora* leaf spot and yellow mosaic virus diseases. Maximum seed yield potential is 2.0 t/ha (av. 1.5 t/ha).

BINA moog-8:

BINA moog-8 is a summer mungbean variety released in 2010. It is obtained from seeds of MB-149 which were irradiated with 400 Gy dose of gamma ray. Maturity period ranges from 64-67 days. Maximum grain yield is about 2.0 t/ha (av. 1.8 t/ha). Seed is medium size with green shiny color. Seed contains higher 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.

3.3 Treatments under investigation

There was one factor in the experiment namely variety levels as mentioned below:

Factor-A: Varieties-7

V_1 = BARI mung-2

V_2 = BARI mung-3

V_3 = BARI mung-4

V_4 = BARI mung-5

V_5 = BARI mung-6

V_6 = BINA moog-5

V_7 = BINA moog-8

3.4 Experimental design and layout

The experiment was laid out in a one factors randomized complete block design (RCBD) design having three replications. Each replication had 7 unit plots to which the treatment combinations were assigned randomly. The unit plot size was 3 m^2 (1m ×3m). The blocks and unit plots were separated by 1.0 m and 0.50 m spacing respectively.

3.5 Land preparation

The experimental land was opened with a power tiller on 27 February, 2014. Ploughing and cross ploughing were done with country plough followed by laddering. Land preparation was completed on 8^{th} March, 2014 and was ready for sowing of seeds.

3.6 Fertilizer application

The fertilizers were applied as basal dose at final land preparation where N, K_2O, P_2O_5 Ca and S were applied @ 20.27 kg ha^{-1}, 33 kg ha^{-1}, 48 kg ha^{-1}, 3.3 kg ha^{-1} and 1.8 kg ha^{-1} respectively in all plots. All fertilizers were applied by broadcasting and mixed thoroughly with soil.

3.7 Sowing of seeds

Seeds were sown at the rate of 45 kg ha^{-1} in the furrow on March 08, 2014 and the furrows were covered with the soils soon after seeding.

3.8 Intercultural operations

3.8.1 Weed control

Weeding was done once in all the unit plots with care so as to maintain a uniform plant population as per treatment in each plot at 15 DAS.

3.8.2 Thinning

Thinning was done at 20 days after sowing (DAS) and 35 DAS. Plant to plant distance was maintained at 10 cm.

3.8.3 Irrigation and drainage

Presowing irrigation was given to ensure the maximum germination percentage. During the whole experimental period, there was a shortage of rainfall in earlier part; however, it was heavier in later one. So it was essential to remove the excess water from the field at later period.

3.8.4 Insect and pest control

Hairy caterpillar was successfully controlled by the application of Malathion 57 EC @ 1.5 L ha^{-1} on the time of 50% pod formation stage (55 DAS).

3.9 Determination of maturity

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

3.10 Harvesting and sampling

The crop was harvested at 70 DAS from prefixed 1.0 m^2 areas. Before harvesting 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.

3.11 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.

3.12 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.

3.13 Recording of data on different characters

I. Plant height (cm)

The height of the selected plant was measured from the ground level to the tip of the plant at 10, 20, 30, 40, 50, 60, 70 and 80 days after sowing (DAS). Usually harvesting of fruits are done when the maximum fruits are ripen at the first time. But if the plants are kept in the field for longer period the life span of the plants are extended further giving new flowers and fruits. This is the nature of mungbean plants.

II. Number of leaves per plant

Number of leaves per plant was counted from each selected plant sample and then averaged at 10, 20, 30, 40, 50, 60, 70, 80 and 90 days after sowing. Usually harvesting of fruits are done when the maximum fruits are ripen at the first time. But if the plants are kept in the field for longer period the life span of the plants are extended further giving new flowers and fruits. This is the nature of mungbean plants.

III. Days to first flowering

Dates of first flowering were recorded treatment wise and the period of time for first flowering in days was calculated from the date of sowing.

IV. Days to attain the highest length of fruits

Dates of attaining the highest length of fruits were recorded treatment wise and the period of time for attaining the highest length of fruits in days was calculated from the date of sowing.

V. Number of fruits per plant

Number of fruits per plant was counted from each selected plant sample and then averaged at 50, 60, 70, 80 and 90 days after sowing. Usually harvesting of fruits are done when the maximum fruits are ripen at the first time. But if the plants are kept in the field for longer period the life span of the plants are extended further giving new flowers and fruits. This is the nature of mungbean plants.

VI. Number of fertile seeds per pod

Average number of fertile seed pod^{-1} was calculated by counting the number of fertile seed pod^{-1} of 5 pod plant^{-1}.

VII. Number of infertile seeds per pod

Average number of infertile seeds pod^{-1} was calculated by counting the number of infertile seed pod^{-1} of 5 pod plant^{-1}.

VIII. Pod length (cm)

Pod length was measured in centimeter (cm) scale from randomly selected ten pods. Mean value of them was recorded as treatment wise.

IX. 1000 seed weight (g)

A composite sample was taken from the yield of ten plants. The 1000-seeds of each plot were counted and weighed with a digital electric balance. The 1000-seed weight was recorded in (g).

X. Seed yield per m^2 (g)

Seed yield was recorded on the basis of total harvested seeds per 1m^2 and was expressed in terms of yield (g). Seed yield was adjusted to 12% moisture content.

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

Seed yield was recorded on the basis of total harvested seeds per 1m^2 and was expressed in terms of yield (kg ha^{-1}). Seed yield was adjusted to 12% moisture content.

3.14 Data analysis technique

The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique with the help of a computer package program

MSTAT-C and the mean differences were adjusted by Least Significance Difference (LSD) test (Gomez & Gomez, 1986).

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted at the research field of the Department of Agricultural Botany of Sher-e-Bangla Agricultural University, Dhaka to study the performance of different varieties of mungbean in Kharif-1 season. Results obtained from the present study have been presented and discussed in this chapter. The data have been presented in different tables and figures . The results have been presented and discussed, and possible interpretations are given under the following headings**.**

4.1 Plant height

Data on plant height were recorded periodically at 10, 20, 30, 40, 50, 60, 70 and 80 days after sowing (DAS). The plant height was significantly affected due to the different varieties at different days after sowing. The tallest plant height (9.20, 16.56, 31.35, 42.50, 50.75, 49.27, 51.17 and 52.43 cm at 10, 20, 30, 40, 50, 60, 70 and 80 DAS, respectively) was obtained from V_2 (BARI mung-3) and the shortest plant height (6.89, 13.26, 26.89, 37.79, 40.23, 37.46, 38.57 and 38.77 cm at 10, 20, 30, 40, 50, 60, 70 and 80 DAS, respectively) was obtained in V_5 (BARI mung-6) (Fig. 1 and Appendix II and IX). This variation in plant height might be attributed to the genetic characters. Usually harvesting of fruits are done when the maximum fruits are ripen at the first time. But if the plants are kept in the field for longer period the life span of plants are extended further giving new flowers and fruits. Similar findings of plant heights were obtained by Farghali and Hossein (1995).

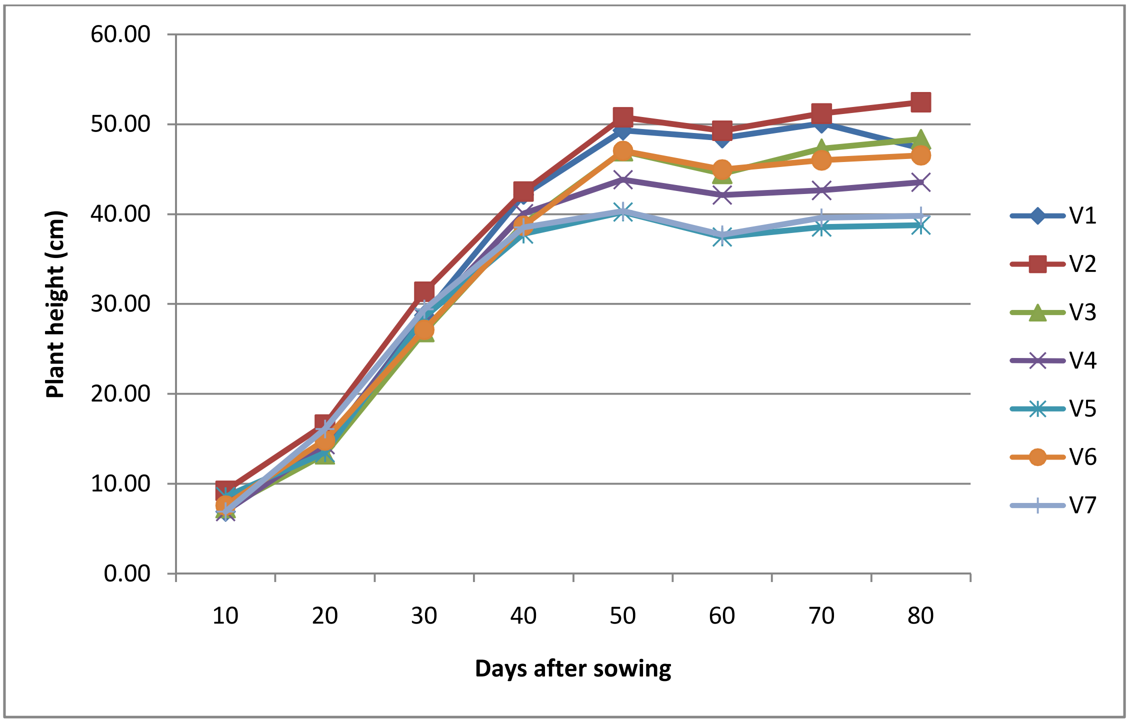

Figure 1. Effect of varieties on the plant height of mungbean at different days after sowing

4.2 Number of leaves per plant

The number of leaves per plant counted at different days was significantly influenced by varieties. Treatment V_7 (BINA moog-8) produced maximum number of leaves (1.64, 3.74, 6.31, 9.93, 10.33, 10.87, 8.20, 8.67 and 7.53 at 10, 20, 30, 40, 50, 60, 70, 80 and 90 DAS, respectively) and the minimum (1.24, 3.61, 5.74, 6.87, 6.67, 6.13, 5.07, 3.43 and 2.40 at 10, 20, 30, 40, 50, 60, 70, 80 and 90 DAS, respectively) number of leaves were recorded in V_5 treatment (Fig. 2 and Appendix III and X).

4.3 Days to first flowering

There was a marked difference among the varieties in the days to first flowering. The earliest of days to first flowering (32.67 DAS) was found in V_7 and the longest time (35.67 DAS) were recorded in V_5 treatment (Table 1 and Appendix V).

4.4 Days to attain the highest length of fruits

There was a marked difference among the varieties in the days to attain the highest length of fruits. The earliest of days to attainment the highest length of fruit (42.67 DAS) was found in V_7 and the longest time (52.67 DAS) were recorded in V_5 and V_1 treatment (Table 1 and Appendix V).

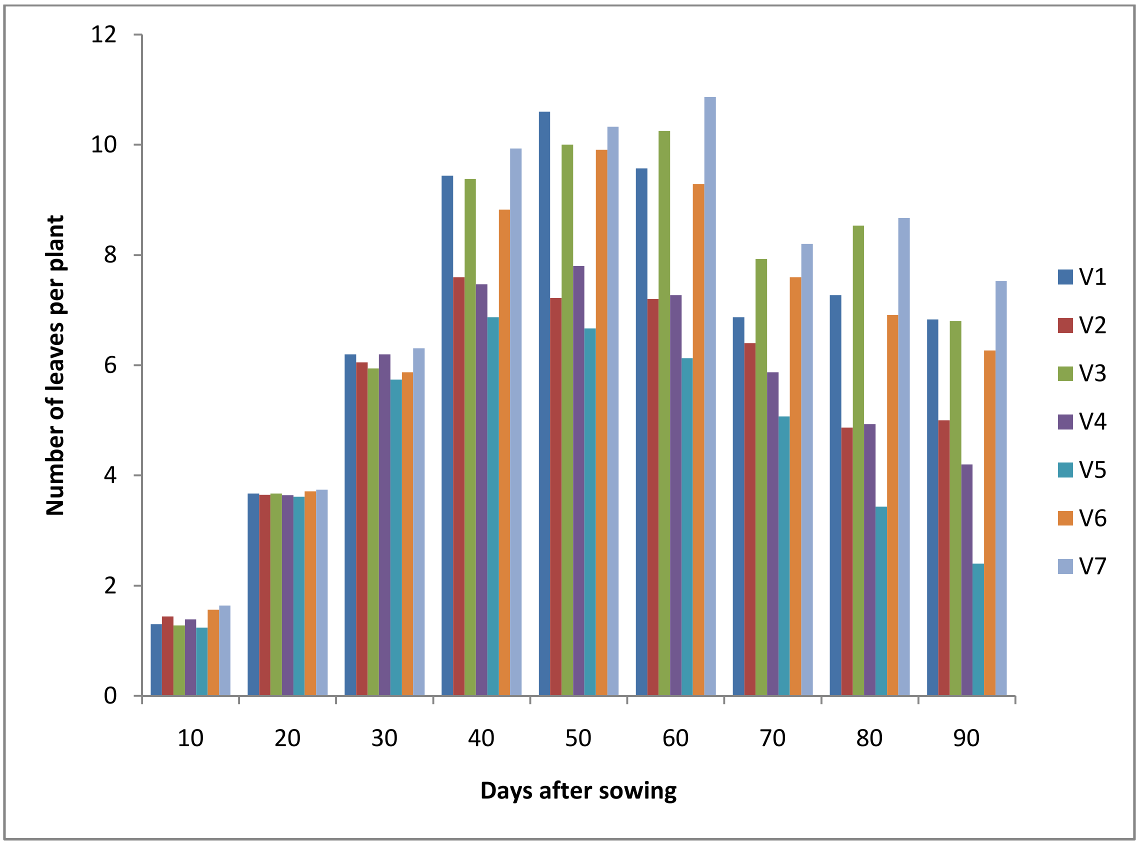

Figure 2. Effect of varieties on the number of leaves of mungbean at different days after sowing

Table 1. Effect of varieties on Days to first flowering and Days to attain the highest length of fruits of mungbean plant

Treatment	Days to first flowering	Days to attain the highest length of fruits
V_1 (BARI mung 2)	33.67 bc	52.67 a
V_2 (BARI mung 3)	34.00 bc	50.33 b
V_3 (BARI mung 4)	34.67 ab	49.00 bc
V_4 (BARI mung 5)	33.67 bc	47.67 cd
V_5 (BARI mung 6)	35.67 a	52.67 a
V_6 (BINA moog 5)	35.00 ab	46.33 d
V_7 (BINA moog 8)	32.67 c	42.67 e
$LSD_{(0.5)}$	1.38	2.14

In a column same letter(s) do not significantly differ at 0.05 level of probability.

4.5 Number of pods per plant

Data on number of pods per plant were recorded periodically at 50, 60, 70, 80 and 90 days after sowing (DAS) (Fig. 3 and Appendix IV and XI). The number of pods per plant was significantly affected due to the different varieties at different days after sowing. The highest number of pods per plant (12.00, 18.13, 12.73, 18.33 and 11.27 at 50, 60, 70, 80 and 90 DAS, respectively) was recorded in V_7 (BINA moog-8). The lowest number of pods plant^{-1} (6.33, 6.53, 6.73, 9.33 and 7.13 at 50, 60, 70, 80 and 90 DAS, respectively) was recorded in V_3 (BARI mung-4). Genotypic variations in effective pods plant^{-1} was observed by Mondal *et al.,* (2004) and Debnath (2006) in mungbean.

4.6 Number of fertile seeds per pod

The number of fertile seeds per pod was significantly affected by varieties. The highest number of fertile seeds per pod (9.93) was recorded in V_7 (BINA moog-8). The minimum number of fertile seeds per pod (8.93) was observed in V_3 (Table 2 and Appendix VI). A result was found by Infante *et al.* (2003) which was similar with this study. They found significant difference on number of seeds per pod among the varieties. Genotypic variations in seeds pod^{-1} was also observed by Thakuria and Saharia (1990) and Tomar and Tiwari (1996) in mungbean.

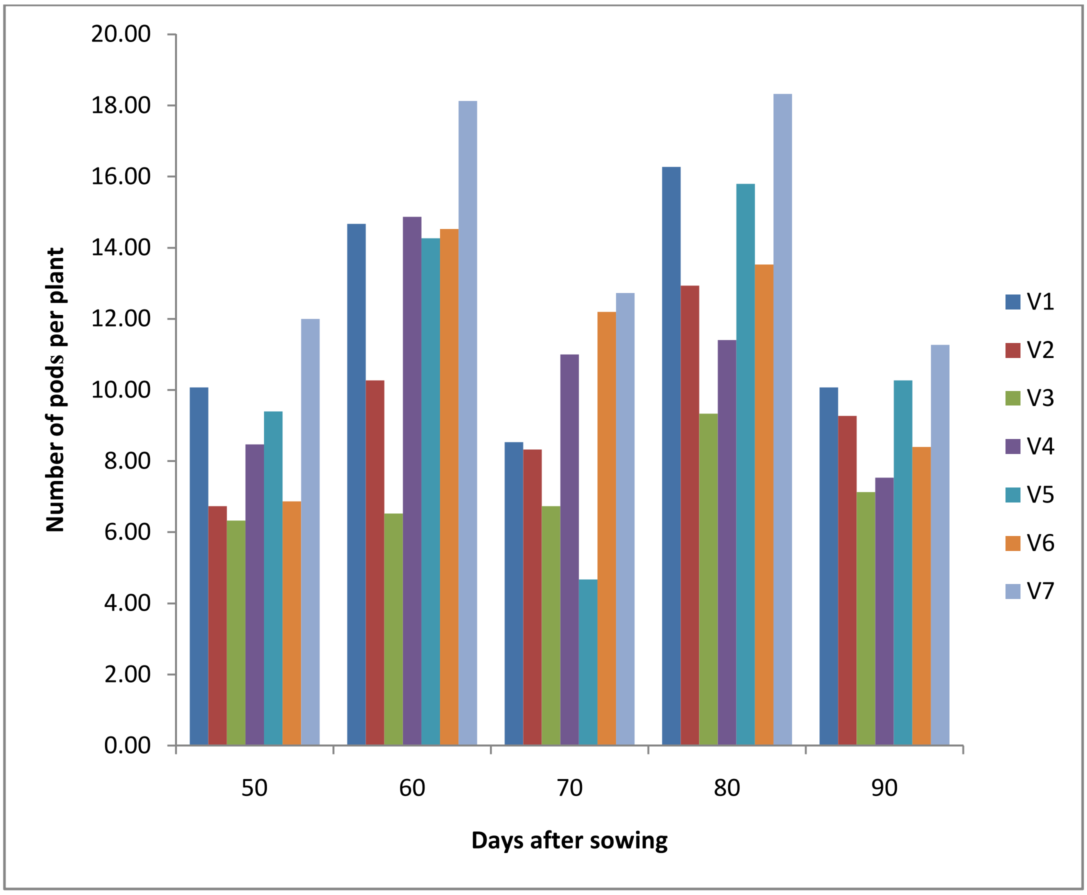

Figure 3. Effect of varieties on the number of pods per plant of mungbean at different days after sowing

Table 2. Effect of varieties on number of fertile seeds per pod and Number of infertile seeds per pod of mungbean plant

Treatment	Number of fertile seed per pod	Number of infertile seed per pod
V_1 (BARI mung 2)	9.67 ab	1.80 ab
V_2 (BARI mung 3)	9.70 ab	1.40 ab
V_3 (BARI mung 4)	8.93 c	2.02 a
V_4 (BARI mung 5)	9.20 bc	1.40 ab
V_5 (BARI mung 6)	9.07 bc	2.00 a
V_6 (BINA moog 5)	9.65 ab	0.62 b
V_7 (BINA moog 8)	9.93 a	0.60 b
$LSD_{(0.5)}$	0.64	1.24

In a column same letter(s) do not significantly differ at 0.05 level of probability.

4.7 Number of infertile seeds per pod

The number of infertile seeds per pod was significantly affected by varieties. The highest number infertile seeds per pod (2.02) were recorded in V_3 (BARI mung4). The minimum number infertile seeds per pod (0.60) were observed in V_7 (Table 2 and Appendix VI). A result was found by Infante *et al.* (2003) which was similar with this study. They found significant difference on number of infertile seeds per pod among the varieties. Genotypic variations in seeds pod^{-1} was also observed by Thakuria and Saharia (1990) and Tomar and Tiwari (1996) in mungbean.

4.8 Pod Length

Pod length is one of the most important yield contributing characters in mungbean. Varieties showed significant difference in pod length (Table 3 and Appendix VII). The longest pod length (7.96 cm) was recorded in V_7 (BINA moog-8). The shortest pod length (6.31 cm) was observed in V_3. These results have the agreement with the results of Sarkar *et al.* (2004) who reported that pod length differed from varieties to varieties. The probable reason of this difference could be the genetic make-up of the varieties.

Table 3. Effect of varieties on the yield contributing characters of mungbean plant

Treatment	Pod length (cm)	Thousand seed weight (g)
V_1 (BARI mung 2)	6.34 c	42.00 c
V_2 (BARI mung 3)	6.32 c	41.33 c
V_3 (BARI mung 4)	6.31 c	36.67 d
V_4 (BARI mung 5)	7.55 b	51.33 b
V_5 (BARI mung 6)	7.20 b	58.67 a
V_6 (BINA moog 5)	7.18 b	50.67 b
V_7 (BINA moog 8)	7.96 a	61.33 a
$LSD_{(0.5)}$	0.37	4.11

In a column same letter(s) do not significantly differ at 0.05 level of probability.

4.9 1000 seed weight

Variety had a significant effect in 1000-seed weight and it was also observed in studied varieties of mungbean (Table 3 and Appendix VII). The highest 1000-seed weight was recorded in BINA moog-8 (61.33 g). In contrast, the lowest

1000-seed weight was recorded in BARI mung-4 (36.67 g). Genotypic variation in 1000-seed weight was also observed by Tomar *et al.* (1995) in mungbean that also supported the present experimental results.

4.10 Yield per m^2(g)

The yield was significantly affected by varieties. Yield per $1m^2$ is a function of various yield components such as number of pods per plant, seeds per pod and 1000-grain weight. The highest yield per $1m^2$ (93.27 g) was recorded in V_7 and the minimum (64.27 g) in V_6 (Table 4 and appendix VIII). The probable reason of this difference might be due to higher number of pod length, seeds per pod. The performance of other varieties was as intermediate yielder. Genotypic variation in seed yield was also observed by Borah (1994).

Table 4. Effect of varieties on the yield of mungbean plant

Treatment	Weight of seed in $1m^{-2}$ (g)	Yield (Kg/ha)
V_1 (BARI mung 2)	75.95 c	759.50 c
V_2 (BARI mung 3)	86.10 ab	861.00 ab
V_3 (BARI mung 4)	74.27 c	742.70 c
V_4 (BARI mung 5)	80.77 bc	807.70 bc
V_5 (BARI mung 6)	77.77 bc	777.70 bc
V_6 (BINA moog 5)	64.27 d	642.70 d
V_7 (BINA moog 8)	93.27 a	932.70 a
$LSD_{(0.5)}$	8.74	87.37

In a column same letter(s) do not significantly differ at 0.05 level of probability.

4.11 Yield (kg/ha)

The yield was significantly affected by varieties. Yield is a function of various yield components such as number of pod per plant, seed per pod and 1000-grain weight. The highest yield (932.70 kg/ha) was recorded in BINA moog-8. In contrast, the lowest yield was recorded in BINA moog-5 (642.70 kg/ha) (Table 4 and appendix VIII). The probable reason of this difference might be due to higher number of pod length, seeds per pod. The performance of other varieties was as intermediate yielder. Genotypic variation in seed yield was also observed by Borah (1994).

CHAPTER IV

SUMMARY AND CONCLUSION

The experiment was conducted at the research field of the Department of Agricultural Botany of Sher-e-Bangla Agricultural University, Dhaka during the period from February, 2014 to June, 2014 to study the morphological, reproductive performances and yield of different varieties of mungbean.. In this experiment, the treatment consisted of seven mungbean varieties viz. V_1 = BARI mung-2, V_2 = BARI mung-3, V_3 = BARI mung-4, V_4 = BARI mung-5, V_5 = BARI mung-6, V_6 = BINA moog-5 and V_7 =BINA moog-8. The experiment was laid out in a one factors Randomized Complete Block Design (RCBD) with three replications. The fertilizers were applied as basal dose at final land preparation where N, K_2O, P_2O_5 Ca and S were applied @ 20.27 kg ha^{-1}, 33 kg ha^{-1}, 48 kg ha^{-1}, 3.3 kg ha^{-1} and 1.8 kg ha^{-1} respectively in all plots. Necessary intercultural operations were done as and when necessary.

Results showed that a significant variation was observed among the treatments in respect of majority of the observed parameters. The collected data were statistically analyzed for evaluation of the treatment effect.

The plant height was significantly affected due to the different varieties at different days after sowing. The tallest plant height (9.20, 16.56, 31.35, 42.50, 50.75, 49.27, and 51.17, 52.43 cm at 10, 20, 30, 40, 50, 60, 70 and 80 DAS, respectively) was obtained from V_2 (BARI mung-3). Treatment V_7 (BINA moog-8) produced maximum number of leaves (1.64, 3.74, 6.31, 9.93, 10.33, 10.87, 8.20, 8.20 and 7.53 at 10, 20, 30, 40, 50, 60, 70, 80 and 90 DAS, respectively). The earliest of days to first flowering (32.67 DAS) was found in V_7 (BINA moog-8).

The earliest of days to attainment of the highest length of pod (42.67 DAS) was found in V_7. The number of pods per plant was significantly affected due to the different varieties at different days after sowing. The highest number of pods per plant (12.00, 18.13, 12.73, 18.33 and 11.27 at 50, 60, 70, 80 and 90 DAS, respectively) was recorded in V_7 (BINA moog 8). The longest pod length (7.96 cm) was recorded in V_7 (BINA moog-8). The highest number fertile seeds per pod (9.93) were recorded in V_7 (BINA moog-8). The minimum number infertile seeds per pod (0.60) were observed in V_7 (BINA moog-8). Variety had a significant effect in 1000-seed weight and it was also observed in studied varieties of mungbean. The highest 1000-seed weight was recorded in BINA moog-8 (61.33 g) and the lowest 1000 seed weight was recorded in BARI mung -4 (36.67g). The highest yield (932.70 kg/ha) was recorded in BINA moog-8. In contrast, the lowest yield was recorded in BINA moog-5 (642.70 kg/h).

From the results of the study, it may be concluded as follows:

- ❖ There are significant differences in the morphological and reproductive performances of different varieties of mungbean.
- ❖ The performance of mungbean variety named BINA moog-8 was better in respect of growth, yield and yield components during the whole life cycle of the plant. BINA moog-5 provided the lowest yield.

- ❖ Further detailed study is needed to observe the reproductive behaviour of mungbean for better understanding. This kind of study has to be performed in different agro ecological zones of Bangladesh to have a concrete direction.

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APPENDICES

Appendix I: Soil characteristics of the research field of the department of Agricultural Botany of Sher-e-Bangla Agricultural University are analyzed by Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Research 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	**N/A**

Source: SRDI

B. Physical and chemical properties of the initial soil

Characteristics	Value
Practical size analysis	
Sand (%)	16
Silt (%)	56
Clay (%)	28
Silt + Clay (%)	84
Textural class	Silt clay loam
pH	5.56
Organic matter (%)	0.25
Total N (%)	0.02
Available P (µgm/gm soil)	53.64
Available K (me/100g soil)	0.13
Available S (µgm/gm soil)	9.40
Available B (µgm/gm soil)	0.13
Available Zn (µgm/gm soil)	0.94
Available Cu (µgm/gm soil)	1.93
Available Fe (µgm/gm soil)	240.9
Available Mn (µgm/gm soil)	50.6

Source: SRDI

Appendix II: Analysis of variance of the data on plant height of different varieties of mungbean at different days after sowing

Source	Degrees of Freedom	Means square							
		Plant Height							
		10 DAS	20DAS	30DAS	40 DAS	50DAS	60DAS	70DAS	80DAS
Replication	2	0.133	4.648	1.625	4.173	51.668	44.768	32.048	45.01
Factor A	6	2.523	4.718	6.679	10.28	51.897	66.466	72.955	70.82
Error	12	0.592	1.714	8.617	3.472	17.747	18.384	16.87	20.108

Appendix III: Analysis of variance of the data on Number of leaves per plant of different varieties of mungbean at different days after sowing

Source	Degrees of Freedom	Means square								
		Number of leaves								
		10DAS	20DAS	30DAS	40DAS	50DAS	60DAS	70DAS	80DAS	90DAS
Replication	2	0.01	0.00	0.28	2.26	0.05	2.36	0.05	0.83	0.01
Factor A	6	0.07	0.01	0.13	4.18	8.09	9.54	3.95	12.00	9.85
Error	12	0.02	0.03	0.33	1.42	0.87	2.13	0.51	1.78	0.72

Appendix IV: Analysis of variance of the data on Number of pods per plant of different varieties of mungbean at different days after sowing

Source	Degrees of Freedom	Means square				
		Number of pods per plant				
		50DAS	60DAS	70DAS	80DAS	90DAS
Replication	2	1.099	0.836	0.274	0.16	0.47
Factor A	6	12.99	42.562	26.275	28.513	6.911
Error	12	0.775	0.343	0.839	1.484	1.848

Appendix V: Analysis of variance of the data on Days to first flowering and Days to attain the highest length of fruits of different varieties of mungbean

Source	Degrees of Freedom	Means square	
		Days to first flowering	**Days to attain the highest length of fruits**
Replication	2	0.048	0.333
Factor A	6	2.984	38.635
Error	12	0.603	1.444

Appendix VI: Analysis of variance of the data on Number of fertile seeds per pod and Number of infertile seed per pod of different varieties of mungbean

Source	Degrees of Freedom	**Means square**	
		Number of fertile seed per pod	**Number of infertile seed per pod**
Replication	2	2.09	0.547
Factor A	6	0.43	1.077
Error	12	2.372	0.487

Appendix VII: Analysis of variance of the data on Pod length and Thousand seed weight of different varieties of mungbean

Source	Degrees of Freedom	**Means square**	
		Pod length (cm)	Thousand seed weight (g)
Replication	2	0.134	4
Factor A	6	1.337	256.762
Error	12	0.044	5.333

Appendix VIII: Analysis of variance of the data on Weight of seed per m^2 and Yield of different varieties of mungbean

Source	Degrees of Freedom	Means square	
		Weight of seed in 1m^{-2}	Yield (kg/ha)
Replication	2	8.042	804.245
Factor A	6	253.667	25366.67
Error	12	24.122	2412.246

Appendix IX: Effect of varieties on the plant height of mungbean at different days after sowing

	Plant height							
Treatment	10 DAS	20DAS	30DAS	40 DAS	50DAS	60DAS	70DAS	80DAS
V_1	6.91 c	14.19 ab	28.73ab	42.14 ab	49.30 a	48.43 a	50.07 ab	47.30 abc
V_2	9.20 a	16.56 a	31.35 a	42.50 a	50.75 a	49.27 a	51.17 a	52.43 a
V_3	7.30 bc	13.26 b	26.89 b	38.89 bc	46.98ab	44.47ab	47.27 abc	48.33 ab
V_4	6.90 c	14.34 ab	28.35ab	40.05abc	43.82ab	42.11ab	42.63 bcd	43.53 bc
V_5	6.89 ab	13.26 b	26.89 ab	37.79 c	40.23 b	37.46 b	38.57d	38.77 c
V_6	7.59 bc	14.82 ab	27.13 b	38.69 bc	47.02ab	44.95ab	45.97abcd	46.53 abc
V_7	6.89 c	16.08 a	29.42 ab	38.53 bc	40.34 b	37.69 b	39.60 cd	39.80 bc
$Lsd_{(0.5)}$)	1.37	2.33	3.38	3.32	7.49	7.63	7.31	7.98

Appendix X : Effect of varieties on the number of leaves of mungbean at different days after sowing

	No. of leaves per plant								
Treatment	10DAS	20DAS	30DAS	40DAS	50DAS	60DAS	70DAS	80DAS	90DAS
V_1	1.30 bc	3.61 c	6.20 ab	9.44 ab	10.60 a	9.57ab	6.87abc	7.27 ab	6.83 a
V_2	1.44abc	3.65 c	6.05 bc	7.60 bc	7.22 b	7.20bc	6.40 bc	4.87 bc	5.00 bc
V_3	1.28 bc	3.67 bc	5.94 d	9.38 ab	10.00 a	10.25a	7.93 a	8.53 a	6.80 a
V_4	1.39abc	3.64 c	6.20 ab	7.47 bc	7.80 b	7.27bc	5.87 cd	4.93 bc	4.20 c
V_5	1.24 ab	3.67 bc	5.74 cd	6.87 c	6.67 b	6.13c	5.07 d	3.43 c	2.40 d
V_6	1.24 c	3.71 ab	5.87 cd	8.82abc	9.91 a	9.29ab	7.60 ab	6.91 ab	6.27 ab
V_7	1.64 a	3.74 a	6.31 a	9.93 a	10.33 a	10.87a	8.20 a	8.67 a	7.53 a
$Lsd_{(0.5)}$)	0.27	0.06	0.20	2.12	1.66	2.59	1.27	2.38	1.51

Appendix XI : Effect of varieties on number of pods per plant of mungbean at different days after sowing

Treatment	No. of pods per plant									
	50DAS		60DAS		70DAS		80DAS		90DAS	
V_1	10.07	b	14.67	b	8.53	c	16.27	b	10.07	abc
V_2	6.83	c	10.27	c	8.33	cd	12.93	cd	9.27	abcd
V_3	6.33	c	6.53	d	6.73	d	9.33	e	7.13	d
V_4	8.47	b	14.87	b	11.00	b	11.40	d	7.53	cd
V_5	9.40	b	14.27	b	4.67	ab	15.80	b	10.27	ab
V_6	6.87	c	14.53	b	12.20	e	13.53	c	8.40	bcd
V_7	12.00	a	18.13	a	12.73	a	18.33	a	11.27	a
$Lsd_{(0.5)}$	1.57		1.04		1.63		1.63		2.42	