RESPONSE OF MUNGBEAN VARIETIES UNDER DIFFERENT SPACING

BY

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CERTIFICATE

This is to certify that the thesis entitled, "*Response of Mungbean Varieties under Different Spacing Managements*" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE in AGRONOMY, embodies the result of a piece of *bona fide* research work carried out by MD. MASUD RANA, Registration No. 03-01191 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.

Dated: 18/10/11

Place: Dhaka, Bangladesh

Prof. Dr. Md. Fazlul Karim

Supervisor

Dedicated to

My

Beloved Parents

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RESPONSE OF MUNGBEAN VARIETIES UNDER DIFFERENT SPACING

ABSTRACT

An experiment was conducted at the Agronomy field, Sher-e-Bangla Agricultural university, Dhaka, during August to October, 2008 to study the response of mungbean varieties under different spacing management. Four mungbean varieties; (i) V_1 = BARI mung-3, (ii) V_2 = BARI mung-4, (iii) V_3 = BARI mung-5 and (iv) V_4 = BARI mung-6 with four plant spacing; (i) S_1 = 30 cm × 5 cm, (ii) S_2 = 30 cm × 10 cm, (iii) S_3 = 40 cm × 5 cm and (iv) S_4 = 40 cm × 10 cm and their combination were used under the present study. The experiment was laid out in a Randomized Complete Block Design (RCBD) (factorial) with three replications. The results showed that growth, yield and yield attrtbutes of mungbean significantly responed to the different varieties, spacings and their combined effects. At harvest, variety BARI mung-6 gave maximum branches plant^{-1} (1.83), above ground dry matter plant^{-1} (112.30 g), pod length (9.29cm), pods plant^{-1}(13.92), seeds pod^{-1} (11.97), 1000 seed weight (51.03 g), seed yield (1483 kg ha^{-1}), stover yield (2432.48 kg ha^{-1}), harvest index (37.83%) and light intensity (47.83 lux). Spacing S_4 (40 cm×10 cm) gave maximum branches plant^{-1} (1.96), above ground dry matter plant^{-1} (116.20 g), pod length (9.71 cm), pods plant^{-1}(15.36), seeds pod^{-1} (12.40), 1000 seed weight (52.40 g), light intensity (51.42 lux) but failed to gave maximum seed yield due to less plant population per unit area. where as S_2 (30 cm×10 cm) gave maximum seed yield (1520 kg ha^{-1}) and harvest index (38.17%) with higher plant establishment. The combination effect of BARI mung-6 along with spacing 30 cm×10 cm showed maximum grain yield (1645 kg ha^{-1}) with higher value of harvest index (40.16%).

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LIST OF ACRONYMS

BARI	=	Bangladesh Agricultural Research Institute
cm	=	Centimeter
^{0}C	=	Degree Centigrade
DAS	=	Days after sowing
RCBD	=	Randomized Complete Block Design
et al.	=	and others
kg	=	Kilogram
kg/ha	=	Kilogram/hectare
g	=	gram (s)
LSD	=	Least Significant Difference
m	=	Meter
P^{H}	=	Hydrogen ion conc.
kg/ha	=	ton/hectare
%	=	Percent
AEZ	=	Agro- Ecological Zone
CV%	=	Percentage of Coefficient of Variance
NS	=	Not Significant
FAO	=	Food and Agriculture Organization

Chapter I

Introduction

CHAPTER 1

INTRODUCTION

Pulses are well known as the meat of the poor people as the protein rich animal products are relatively costly and beyond the reach of many of the common people of the country. Bangladesh grows various types of pulse crops. Among them grasspea, lentil, mungbean, blackgram, chickpea, fieldpea and cowpea are important. It is an important food crops because it provides a cheap source of easily digestible dietary protein. Pulse protein is rich in amino acids like isoleucine, leucine, lysine, valine etc. According to FAO (1998) a minimum intake of pulse by a human should be 80 gm per head per day, whereas it is only 13.29 gm in Bangladesh (BBS, 2005). This is because of the fact that national production of the pulses is not adequate to meet the national demand. Thus the ideal intake of cereal: protein (10:1) is imbalanced as 30:1. Pulses as leguminous crop occupy a unique position in agriculture due its high protein content in seed and capacity of fixing atmospheric nitrogen. Legumes have been building and conserving soil fertility since the beginning of agriculture.

Mungbean (*Vigna radiata* L.) is an important pulse crop of Bangladesh. It holds the 1st position in price, 3rd in protein content and 4th in both acreage and production in Bangladesh (Sarker *et al.*, 1982). It is generally used as dhal or vegetable soup and often fed to babies. On an average, only 8-10% protein intake originates from animal sources in Bangladesh as diet, the rest can be met from plant sources by increasing the consumption of pulses. From the point of nutritional value, mungbean is perhaps the best of all other pulses (Khan *et al.*, 1982). Mungbean seed contains 51% carbohydrate, 26% protein, 3% mineral and 3% vitamins (Kaul, 1982).

The agro-ecological condition of Bangladesh is favorable for mungbean cultivation almost through out 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, maize and wheat than mungbean 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 photo-sensitive 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.

In coastal area of Noakhali and Barisal Region mungbean is sown in last week of January after T-aman rice. Mungbean is also being sown after wheat, other pulses and potato in other parts of the country.

Mungbean has a special importance in intensive crop production system of the country for its short growing period. Summer mungbean can tolerate a high temperature although not exceeding 40°C. It is reported to be drought tolerant and can be cultivated in areas of low rainfall (Kay, 1979). In India mungbean gives the highest yield under summer planting (Singh and Yadav, 1978).

Low yield of mungbean in this country is probably due to low yielding potentiality coupled with lack of appropriate agronomic practices in general and plant population per unit area in particular. In the development of appropriate management practices for mungbean, population density needs attention for maximum production of crop (Babu and Mitra, 1989). In lower plant population, individual plant performance is better than that is higher plant population but within tolerable limit higher plant population produces higher yield per hectare (Shukla and Dxit, 1996). Therefore, optimum plant population (Babu and Mitra, 1989) ensures normal plant growth because of efficient utilization of moisture, light, space and nutrients, thus increases the yield of crops. population densities can be adjusted by adjusting the spacings.

Considering the above facts, the present investigation was undertaken with following objectives:

- To compare the mungbean varieties in respect of their growth and yield performance.
- To study the yield & yield contributing characters of mungbean varieties under different spacing arrangement.
- To study the effect of interactions of varieties and different spacings on mungbean.

Chapter II
Review of Literature

CHAPTER 2

REVIEW OF LITERATURE

Many studies addressed the effect of variety and plant density on the performance of mungbean *(Vigna radiata* L.) and other crops. Bangladesh Agricultural University (BAU), Bangladesh Agricultural Research Institute (BARI) and Bangladesh Institute of Nuclear Agriculture (BINA) have started extensive research on varietal development and overall improvement of this crop. Results of such studies indicate that varietal effect and plant population density have profound influence on biomass, yield and yield attributes of crops. Review on effect of variety and plant spacing or population densities on growth, yield and yield contributing characters of mungbean and other related crops at home and abroad have been done in this chapter.

Mungbean cultivars Pusa 105 and Pusa Vishal were sown at 22.5 and 30 cm spacing and supplied with 36 - 46 and 58 - 46 kg NP/ha in a field experiment which was conducted, in Delhi, India during the kharif season of 2000. Cultivar Pusa Vishal recorded higher biological and grain yield (3.66 and 1.63 t/ha, respectively) compared to cv. Pusa 105. Row spacing at 22.5 cm resulted in higher grain yields in both crops (Tickoo *et al*., 2006).

Ahmad *et al*. (2005) conducted an experiment in Faisalabad, Punjab, Pakistan, during 2000 to study the effect of P fertilizer (0, 30, 60 and 90 kg/ha) and row spacing (30 and 45 cm) on the yield and yield components (pods per plant, seeds per pod and 1000-seed weight) of mungbean cv. NM-92. Seed yield was highest with 30 cm row spacing while pods per plant, seeds per pod and 1000-seed weight were highest with 45 cm row spacing. Phosphorus applied at 90 kg/ha gave the highest seed yield, pods per plant, seeds per pod and seed weight. Analysis of the interaction effect showed that. 30 cm row spacing combined with 90 kg P/ha gave the highest seed yield.

Miah (1988) recorded higher crop growth rate with higher planting density in cowpea and mungbean.

Muchow and Edwards (1982) reported significantly positive linear trends of dry matter production in three varieties of mungbean to increasing density.

Ahmed *et al.* (1992) found that 50 plants/m^2 of mungbean gave higher yield than 33 plants/m^2 in early kharif. Hamid (1989) found that mungbean grown at very high density failed to produce yield because of high rate of mortality. Plant density is achieved by varying the row spacing. Seed yield of soybean was significantly higher with high population in narrow rows that in the wide rows (Ethredge *et al.*, 1989).

Plant density is the most important yield contributing character, which can maximize yield (Baba and Mitra, 1989). Yield per hectare and number of seeds/pod increased with increasing plant density whereas yield per plant and number of pods/plant decreased with increasing plant density in mungbean (Panwar and Sirohi, 1987).

Khan *et al.* (2001) conducted an experiment with mungbean during the summer season of 2000, in Peshawar, Pakistan, The row spacing treatments were 25 and 50 cm, while plant spacings were 5, 7.5 and 10 cm. Emergence of seedlings/m^2, days to flowering, days to maturity, number of grains/pod, number of branches/plant, plant height (cm), 1000 grain weight (g), percent hard grain (%), biological yield (kg/ha) and grain yield (kg/ha) were significantly affected by row and plant spacings, while pods number/plant and harvest index were not significantly affected at 5% level of significance with row and plant spacings. The results revealed that a spacing of 50 cm between rows and 10 cm within rows produced the maximum number of pods/plant, grains/pod, thousand grain weight, low percent hard grain and high biological yield, harvest index and grain yield (kg/ha)

Researchers in Arkansas, Louisiana, and Texas summarized 21 field experiments conducted over 14 years to determine the effect of row spacing on seed yield in soybean (Bowers *et al.*, 2000). For all environments tested, narrow rows (< 40 cm) yielded equal to or greater than wider rows. These researchers concluded that narrow rows should be used to optimize yields in soybean in the Midsouthern USA.

Research under many conditions and locations throughout the USA has investigated adjusting plant populations and row spacing to achieve suitable vegetative growth and increase yield (Bullock and Kraljevic, 1998).

Boquot (1998) found that planting date and cultivars selection were the most important factors for increasing yields in Louisiana while row spacing was less significant. Low planting density due to wide spacing has been identified as one of the reasons responsible for low yield of garlic (Abubakar, 1998).

Bodnar *et al.* (1998) reported that widely spaced garlic plants tend to grow more vegetatively and bear more leaves/ plant. Highest bulb yield was obtained from 10 cm intra-row spacing while 20 cm intra-row spacing gave the lowest bulb yield of onions (John, 1997). The positive increase in bulb yield of garlic at closer spacing might be ascribed to increase plant population per unit land area while the decrease in bulb yield at wider intra-row spacing could be associated with decreased plant population per unit land area. It can thus be seen that, the total yield per unit area depends not only on the performance of individual plants but also on the number of plants per unit area (Babaji, 1996; Abubakar, 1997).

In Arkansas, Beatty and Aulakh (1982) adjusted plant population with row spacing of wheat and found that April plantings in 18-cm rows with 60 seeds/m^2 and 48-cm rows with 46 seeds/m^2 yielded more than May or June plantings at any row spacing.

High yield of good quality pod can be obtained from increased plant density and weed free environment in *vigna unguiculata* (Brathwaite, 1982). Per plant dry matter yield decreased progressively with increasing density. Grain yield/plant decreased with increasing density but the yield density function constructed based on grain yield unit area followed a quadratic relationship. Increased plant density resulted in plants bearing less, pod and seed in *vicia fava* L. (Zahab *et al.*, 1981).

One approach of elevating the seed yield of mungbean by Asian Vegetables Research and Development center (AVRDC) is to increase yield by increasing plant density (Mackenzie *et al.*, 1975).

Narrow spacing of pigeonpea increased plant height and reduced the number of branches per plant in crops (Narayanan and Narayanan, 1987). Narrow spacing significantly increased dry matter production in pigeonpea (Madhavan *et al.* 1986).

Narrow spacing was significantly affected by population density. The crop growth rate increased from 20 - 50 day after emergence and then declined in sesame (Hossain and Salauddin, 1994). The maximum crop growth rate value was recorded at 40-50 days after emergence irrespective of population densities.

Bhatti *et al.* (2005) conducted a field experiment on a sandy-clay loam soil in Faisalabad, Pakistan for two consecutive years (2001 and 2002) to evaluate the effect of intercrops and planting patterns 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 strips, while the cropping systems were sesame + mungbean, sesame + mashbean (*Vigna aconitifolia*), sesame + soybean, sesame + cowpea and sesame alone. Among the intercropping patterns, sesame intercropped with mungbean, mashbean, soybean 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.

Grain yield generally increases with raising plant population but this relationship is parabolic (Hamblin and Tennant, 1976). In general, yield of edible podded pea decreased with increase in plant spacing and vegetable pea yield decreased with increase in line to line spacing. The closer spacing was suitable for higher vegetable pod and grain yield (Anonymous, 1996). It was stated that plant density is the most important non momentary input which can be maintained through plant and row spacing to obtain higher yield per unit land area (Jain and Chauhan, 1988).

Higher grain yield was recorded with 25 cm row spacing in pea and then was significant reduction in yield when the spacing was increased to 50 cm (Yadav *et al.*, 1990).

Saimbhi *et al.* (1990) conducted an experiment with three spacings viz. 45cm × 10 cm, 30 cm × 7.5 cm and 30 cm × 10 cm to determine optimum plant spacing for green pod yield of pea. The spacing of 30 cm x 7.5 cm gave the highest pod yield, which was significantly higher than that of 30 cm x 10 cm spacing. The spacing of 45 cm × 10 cm gave the lowest pod yield in early pea, a spacing of 30 cm between the rows and 7.5 cm between the plants was the best.

Singh *et al.* (1993) reported that, pea genotypes do not respond significantly to plant density in terms of seed yield and attributes. Narrow row spacing with high plant density increased the grain yield of pea significantly (Singh and Yadav, 1978). However, Singh *et al.* (1981) obtained high grain yield of peas at 15 cm × 15 cm spacing and the grain yield decreased when the spacing was increased to 50 cm from 25 cm (Mera, 1984).

In another study, inter row spacing o f 22.5 cm produced highest grain yield of the pulses followed by 15 cm spacing (Tripurari and Yadav, 1990). Rajput *et* *al.* (1991) reported that significantly higher grain and straw yield was recorded under narrow row spacing (30 cm) than under wider row spacing (45 cm) in soybean.

Porwal *et al.* (1991) found that row spacing significantly affected seed yield and the seed index. Closer row spacing (30 cm) gave 11.9% higher seed yield over wider spacing (40 cm) in soybean. Agasimani *et al.* (1988) reported that 20 cm × 15 cm spacing gave higher yield in groundnut.

Seed yield was higher under 30 cm row spacing in dwarf pea because of more pods/plant and seeds/pod (Saharia and Thakuria, 1988).

Haque (1995) conducted a field trial in 1986 at Joydebpur, Bangladesh, *Vigna radiata* cv. BM-7703 was grown at populations of 250000, 333333, 400000 or 500000 plants/ha using 40, 30, 25 and 20 cm row spacing, respectively. Seed yield was highest with 333333 plants/ha.

Auwalu (2009) conducted a field experiment to determine the effects of N rate (0, 30, 60 or 90 kg N/ha), timing of N application (single or split applications), intra-row spacing (5, 10, 15 or 20 cm) and harvesting frequency (every 2 or 3 weeks) on the growth and yield of vegetable sesame. The experiments were conducted at Bauchi in the savanna ecological zone of Nigeria. Plant height, leaf area index and marketable yield were significantly increased by N application. Split application of N produced significantly higher total marketable yield than a single application. Decrease in intra-row spacing resulted in a significant decrease in yield per plant, however yield per hectare increased significantly. Although total marketable yield was not significantly affected by harvesting frequency, harvesting sesame at fortnightly intervals produced higher yields. A split application of 60 kg N/ha and a spacing of 20 x 10 cm was recommended for optimum production of vegetable sesame.

Raghuwanshi (2009) conducted a field trial at Tikamgarh, Madhya Pradesh in the 2008 kharif (monsoon) season, sesame cv. TKG-9, TKG-21, JLSC-8 and JT-7 produced mean seed yields of 2.53, 2.80, 2.92 and 1.86 t/ha, respectively. Yield averaged 2.05 and 3.00 t with spacings of 30 x 15 and 10 x 10 cm, and 3.99, 1.85 and 1.75 t when sown at the onset of monsoon (1 July) or 10 or 20 d after this date.

Asghar *et al.* (2009) conducted a field studies in Faisalabad, Pakistan, to determine the effect of different sowing dates and row spacings on the growth and yield of sesame cv. 92006. Four sowing dates (8, 15, 22 and 29 July) and 3 row spacings (30, 45, 60 cm) were used. Effect of sowing dates was highly significant and maximum branches/plant and seed yield was produced when the crop was sown on 8 and 15 July due to higher number of capsules per plant and more seeds per capsule. Seed yield was increased with an increase in row spacing from 30 to 45 cm. However, further increase in spacing decreased the seed yield.

Krishna *et al.* (2008) conducted a field trial during the summer at Tirupati, Andhra Pradesh, India, to assess the superiority of skip row planting of base crop of sesame over uniform row spacing at the same population level and to evaluate the feasibility of introducing green gram as intercrop under irrigated conditions. Data were recorded for plant height, leaf area index, capsules or pods per plant, test weight and seed yield per plant. Significantly higher sesame seed yield was recorded in sesame (30 × 6.6 cm) sole double row single skip treatment. Green gram yield was reduced when it was intercropped with sesame and 100% green gram population recorded higher yield than 50% green gram population. The highest net returns were obtained in sesame single row single skip + 100% green gram in skip row.

Gercek *et al.* (2007) carried out an experiment to determine the effect of irrigation method (sprinkle and drip) and row spacing (500-300, 700-300, 800-400 and 700-700 mm) on yield and several yield components of Local dark sesame in Sanliurfa (Turkey) in 2004 and 2005. The yield, plant height and number of capsules per plant were significantly affected by irrigation methods and row spacing. Means of sesame yields in two years were 1440 and 1732 kg ha-1 in sprinkle and drip irrigation, respectively. The highest yield was observed at 500-300 mm (1913 kg ha-1) treatment of plant density and the lowest yield was at 700 mm (1220 kg ha-1) row space.

Avila and Graterol (2005) studied the effects of sowing date, row spacing and fertilizer rate on the growth and yield of sesame in Turen, Portuguesa State, Venezuela, during 1996-1997 and 1997-1998. A split-split-plot design with 4 replications was used. Four fertilizer treatments were allocated to the main plot (control, 250 kg diammonium phosphate ha-1, and cowpea incorporated as green cover crops). Sowing dates (20 December and 27 December 1996, and 3 January 1997) were evaluated as subplot treatments. Row spacing was evaluated in sub-subplots (0.60, 0.30 and 0.15 m between rows). Plant height, number of pods per plant, and grain yield were evaluated. The effects of fertilizer on growth and yield were not consistent during the 2 seasons. Row spacing had no consistent effect on plant height, but the number of pods per plant increased with the increase in row spacing. The grain yields tended to decrease as the planting date was delayed in both seasons. Greater grain yields were obtained under a row spacing of 0.15 m (higher by 3.8- and 1.8-fold than the yields obtained under 0.60 and 0.30 m row spacing, respectively). The results suggest the use of a spacing 0.15 m by farmers in sesame production areas in the zone.

Sarkar and Banik (2002) conducted a field experiment during spring of 1999 and 2000 to study the effects of planting geometry (30x30, 45x15, and 45x30 cm), row orientation (east-west and north-south), and sulfur rate (0, 25, and 50 kg/ha) on the growth and productivity of sesame cv. B 67. Sowing was conducted on 12 March 1999 and 14 March 2000 after winter rice. Sesame matured in 90 days and was harvested in the first fortnight of June. A planting geometry of 45x15 cm enhanced leaf area index and net assimilation rate. Despite reductions in yield attributes (capsules per plant, seeds per capsule, and 1000-seed weight), plants grown at 45x15 cm had the highest seed yield (873 kg/ha), mainly due to high plant density. Planting in north-south direction and applying 50 kg S/ha were more effective in improving leaf area index, crop growth rate, relative growth rate, net assimilation rate, yield attributes, and crop yield than planting in east-west direction and applying 25 kg S/ha.

Cakmakc and Aydnoglu (2002) conduct a field studies during 2000-2002 in Anatolia, Turkey, to determine the influence of different row spacing (15, 30, 45 and 60 cm) and N fertilizer application rates (0, 50, 100 and 150 kg/ha) to the yield of chickling vetch (Lathyrus sativus). The treatment with 30 cm row spacing and 150 kg N ha-1 produced the highest forage and dry matter yield. The lowest forage yield was observed at 45 cm row spacing with no N fertilizer applied, while the lowest dry matter yield was observed at 30 cm row spacing and no N fertilizer application. It is concluded that chickling vetch is an alternative legume crop for rotation in terms of yield.

Chapter III

Materials and Methods

CHAPTER 3

MATERIALS AND METHODS

In this chapter, the details of different materials used and methodology followed during the experimental period are described.

3.1 Experimental site

The research work was carried out at the experimental field of Agronomy Department of Sher-e- Bangla Agricultural University, Dhaka during the period from August to October, 2008 to study the response of mungbean varieties under different spacing management. The soil of the experimental site was medium high and well drained. Chemical properties of soil, climatic condition (monthly) during the experimental period has been shown in Appendix I and Appendix II respectively. The average temperature during the experimentation was 25^0 C – 30^0 C. The soil of the experimental plots belonged to the agro ecological zone Madhupur Tract (AEZ-28).

3.2 Soil

The soil was clay loam in texture and having soil pH varied from 5.47 to 5.63. Organic matter content was very low (0.8%).

3.3 Planting material

Four varieties were used as planting materials (i) BARI-Mung-3, (ii) BARI-Mung-4, (iii) BARI-Mung-5 and (iv) BARI-Mung-6. The salient features of these varieties are described as below:

a) BARI Mung-3: Plant height was 50-55 cm and days to maturity was 60-65 days after sowing. Seed color was brownish green, 1000 seed weight was 25-29 g and finally yield was 1.0-1.1 t ha^{-1}.

b) BARI Mung-4: Plant height was 50-55 cm and days to maturity was 60-65 days after sowing. Seed color was green, 1000 seed was 28-32 and finally yield was 1.2-1.4 t ha^{-1}.

c) BARI Mung-5: Plant height was 45-50 cm and days to maturity 60-65 days after sowing. Seed color was green, 1000 seed weight was 41-42 g and finally yield was 1.2-1.5 t ha^{-1}.

d) BARI Mung-6: Plant height was 50-55 cm and days to maturity was 60-70 days after sowing. Seed color was green, 1000 seed was 40-50 g and finally yield was 1.4-1.8 t ha^{-1}.

3.4 Land preparation

The experimental land was opened with a power tiller on 12th August, 2008. Ploughing and cross ploughing were done with country plough followed by laddering. Land preparation was completed on 15th August, 2008 and was ready for sowing seeds.

3.5 Fertilizer application

The experimental plots were fertilized with 45 kg urea, 100 kg triple super phosphate (TSP) and 60 kg muriate of potash (MP) per hectare. All the fertilizers were incorporated as basal into the soil before sowing of seeds.

3.6 Treatments of the experiment

The experiment was comprised of two factors as follows

3.6.1 Factor A: Variety

The following are the mungbean varieties tested.

V_1 = BARI Mung 3

V_2 = BARI Mung 4

V_3 = BARI Mung 5

V_4 = BARI Mung 6

3.6.2 Factor B: Different plant spacing

The following are the levels of spacing used

S_1 = 30 cm × 5 cm

S_2 = 30 cm × 10 cm

S_3 = 40 cm × 5 cm

S_4 = 40 cm × 10 cm

3.6.3 Interaction of Factor A and Factor B

Combining two factors, following 16 treatment combinations were obtained---

$V_1 S_1$	$V_2 S_1$	$V_3 S_1$	$V_4 S_1$
$V_1 S_2$	$V_2 S_2$	$V_3 S_2$	$V_4 S_2$
$V_1 S_3$	$V_2 S_3$	$V_3 S_3$	$V_4 S_3$
$V_1 S_4$	$V_2 S_4$	$V_3 S_4$	$V_4 S_4$

3.7 Experimental design and layout

The experiment was laid out in a Randomized Complete Block Design (RCBD) (factorial) and each treatment was replicated three times. The size of a unit plot was 4 m × 2.5 m. The distance between two adjacent replications (block) was 1m , plot to plot distance was 0.7 5 m and the inter block and inter row spaces were used as footpath and irrigation/drainage channels.

3.8 Germination test

Germination test was performed before sowing in the laboratory . Filter papers were placed on petridishes and the papers were soaked with water. Seeds were placed at random in each petridish. Data on emergence were collected on percentage basis by using the following formula:

Germination(%) = (Number of normal seedlings/ Number of seeds set for germination ×100)

3.9 Sowing of seeds

Seeds were sown in 15 August, 2008. Line to line distance was maintained as per treatment. Seeds were sown in rows continuously at 2-3 cm depth and then rows were covered with loose soil properly.

3.10 Intercultural operations

3.10.1 Weeding

Weeding was done twice at 15 and 40 DAS (Days after sowing). Demarcation boundaries and drainage channels were also kept weed free.

3.10.2 Thinning

Thinning 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.

3.11 Harvesting and sampling

The crop was harvested on 22nd October, 2008 from prefixed 2 m^2 areas for recording yield data. Before harvesting ten plants were selected randomly from each plot and were uprooted for recording yield contributing characters data. The plants of prefixed areas were harvested plot wise and were bundled, tagged and brought to the threshing floor of Agronomy Field Laboratory.

3.12 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 the help of bamboo stick.

3.13 Drying, cleaning and weighing

The seeds were dried in the sun for reducing the moisture in the seeds to maintain the desired moisture level. The dried seeds and straw were cleaned and weighed.

3.14 Recording of data

The following data were recorded from the ten randomly selected plants for each treatment.

i. Plant height (cm)
ii. Above ground dry matter plant^{-1}(g)
iii. Pod length (cm)
iv. Branches plant^{-1} (No.)
v. Pods plant^{-1} (No.)
vi. Seeds pod^{-1} (No.)
vii. 1000 seed weight (g)
viii. Yield (kg ha^{-1})
ix. Stover yield (kg ha^{-1})
x. Harvest Index (%)
xi. Light intensity (lux)

3.15 Procedure of data collection

For growth data 10 plants were selected randomly from each plot at 15 days interval starting from 15 DAS till before harvest. For yield & yield attributes data were taken from randomly selected plants from pre selected harvest area.

3.15.1 Plant height (cm)

The heights of selected ten plants were measured with a meter scale from the ground level to the top of the plants and the mean height was expressed in cm.

3.15.2 Above ground dry matter weight plant^{-1} (g)

The plants were separated from different plant parts and then kept in the oven at 80^0 C for 2 days to reach a constant weight. Then total dry weight of plant parts were taken with an electric balance. The mean values were determined.

3.15.3 Branches plant^{-1} (No.)

Number of branches plant^{-1} was counted from total branches of ten sampled plants and then averaged.

3.15.4 Pod length (cm)

Pod length was measured from base to tip of the pod by a meter scale from randomly selected 30 pods per plot and then their mean value was recorded.

3.15.5 Pods plant^{-1} (No.)

Total pods were separated from the selected plants and counted. Then the total number of pods were averaged and expressed as plant basis.

3.15.6 Seeds pod^{-1} (No.)

Number of seeds pod^{-1} was counted from thirty randomly selected pods and then the average seed number was calculated.

3.15.7 Weight of 1000 seeds (g)

1000 seeds were counted randomly, which were taken from the seed sample of each plot separately, then weight was taken in an electrical balance and data was recorded.

3.15.8 Seed yield (kg ha^{-1})

Seeds obtained from 2 m^2 pre selected area of each unit plot were dried in sun and weighed out. The seed weight was expressed as kg ha^{-1}. The grain moisture content was measured by using a digital moisture meter. Seed yield was adjusted to 10% moisture content.

3.15.9 Stover yield (kg ha^{-1})

The plants of the harvested area were collected and dried in the sun and weighted. The weigh was converted into kg ha^{-1}.

3.15.10 Harvest Index (%)

Harvest index was collected on dry basis with the help of following formula.

Harvest index (HI %)= (Seed yield/Biological yield) x 100.

3.15.11 Light intensity (lux)

The light intensity was collected after 25 DAS from each plot. The light intensity was collected at upper, medium and base of the plant. Then light intensity (lux) were averaged and expressed as plant basis.

3.16 Analysis of data

The data collected on different parameters were statistically analyzed to obtain the level of significance using the MSTAT computer package program developed by Russel (1986). Mean difference among the treatments were tested with least significant differences (LSD) at 5% level of significance.

Chapter IV

Results and Discussion

CHAPTER 4

RESULTS AND DISCUSSION

The experiment was conducted to evaluate the effect of variety and plant density on plant characters, yield and yield attributes of mungbean. The parameters studied were plant height (cm), above ground dry matter plant^{-1}, branch plant^{-1}, pod length (cm), pod Plant^{-1}(No.), seed pod^{-1}(No.), 1000 seed weight (gram), yield (kg ha^{-1}), stover yield (kg ha^{-1}), harvest index (%) and light intensity (lux)

The results obtained from this study has been presented in Tables(1 – 5) and Figures (1 – 6). The mean square values in respect of the above parameters together with the source of variation and their corresponding degrees of freedom have been presented in the appendix III- VI. The results have been presented and discussed as below:

4.1 Growth characters

4.1.1 Plant height

4.1.1.1 Effect of variety

Significant variations on plant heights at different days were observed among varieties under different treatments (Fig.1)

At 15 DAS, BARI mung-3 produced tallest plant 17.51cm) and it was at par with BARI mung-4 (17.48 cm) and BARI mung-5 (17.33 cm).BARI mung-6 gave the shortest plant (16.98 cm).

At 30 DAS, BARI mung-3 produced tallest plant (50.29 cm) and which was closely followed by BARI mung-4 (49.39 cm) and BARI mung-6 gave the shortest plant (48.31cm) and was statistically similar with BARI mung-5 (48.67 cm).

At 45 DAS, BARI mung-3 produced tallest plant (56.31cm) and BARI mung-6 gave the shortest plant (52.78cm).

At 60 DAS, BARI mung-3 produced tallest plant (58.91cm) and it was at par with BARI mung-4 (57.15 cm) and BARI mung-6 gave the shortest plant (55.48cm).

At harvest, BARI mung-3 produced tallest plant (59.89cm) and which was closely followed by BARI mung-4 (58.17 cm) and BARI mung-6 gave the shortest plant (56.41cm) .

This variation in plant height might be attributed to the genetic characters. Similar findings of plant heights were obtained by Farghali and Hossein (1995).

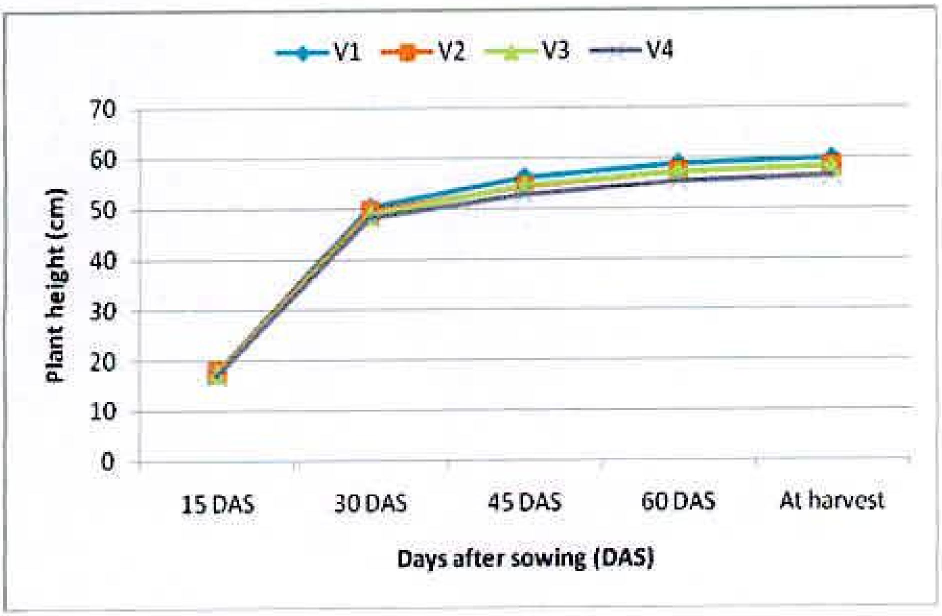

Fig. 1: Effect of varieties on plant height of mungbean at different days (LSD $_{0.05}$ = 0.2924, 0.4016, 0.4050, 0.4018 and 0.3999 at 15, 30, 45, 60 DAS and at harvest respectively)

V_1	=	BARI-mung-3	S_1	=	30 cm × 5 cm
V_2	=	BARI-mung-4	S_2	=	30 cm × 10 cm
V_3	=	BARI-mung-5	S_3	=	40 cm × 5 cm
V_4	=	BARI-mung-6	S_4	=	40 cm × 10 cm

4.1.1.2 Effect of plant spacing

Significant variations on plant heights at different days were observed among different spacing under different treatments (Fig.2).There was progressive increase in plant height with the increase in population density. It was due to increased competition for sunlight interception under dense population.

At 15 DAS, BARI mung-6 produced tallest plant (17.92 cm) and which was statistically similar with BARI mung-5 (17.66 cm) and BARI mung-3 (17.22 cm). BARI mung-4 gave the shortest plant (16.61 cm).

At 30 DAS, BARI mung-5 produced tallest plant (51.32cm). BARI mung-6 gave the shortest plant (46.16 cm).

At 45 DAS, BARI mung-3 produced tallest plant (57.37 cm) and BARI mung-6 gave the shortest plant (50.96 cm).

At 60 DAS, BARI mung-3 produced tallest plant (59.81cm) and which was closely followed by BARI mung-4 (58.15 cm) and BARI mung-6 gave the shortest plant (53.61 cm) .

At harvest, BARI mung-3 produced tallest plant (60.81 cm) and it was at par with BARI mung-4 (59.16 cm) and BARI mung-6 gave the shortest plant (54.61 cm) .

The present results were in agreement with the result of El-habbasha *et al.*(1996).

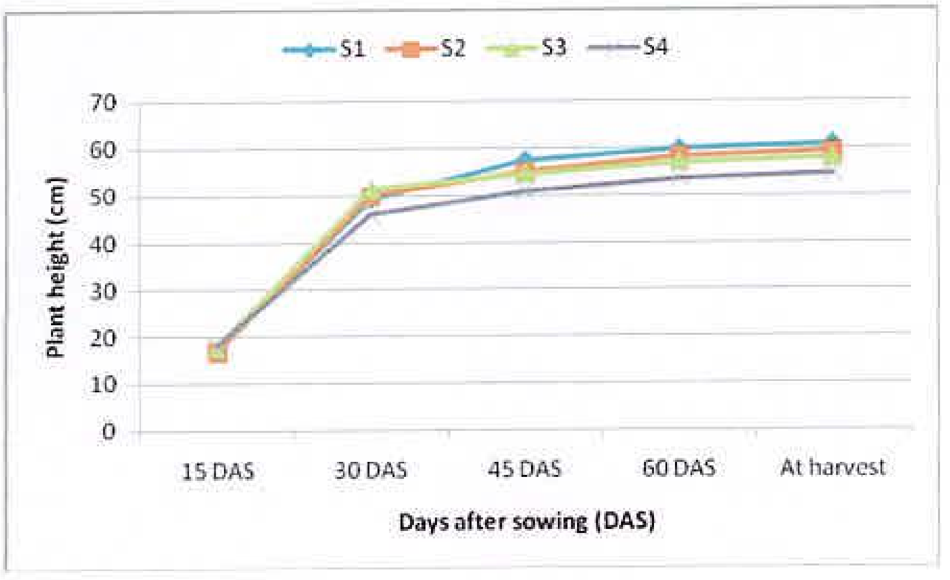

Fig. 2: Effect of spacing on plant height of mungbean at different days(LSD $_{0.05}$ = 0.4025, 0.4042, 0.3928, 0.3989 and 0.3946 at 15, 30, 45, 60 DAS and at harvest respectively)

V_1	=	BARI-Mung-3	S_1	=	30cm × 5 cm
V_2	=	BARI-Mung-4	S_2	=	30 cm × 10 cm
V_3	=	BARI-Mung-5	S_3	=	40 cm × 5 cm
V_4	=	BARI-Mung-6	S_4	=	40 cm × 10 cm

4.1.1.3 Interaction effect of variety and spacing

Plant height was increased progressively with time. Plant height differed significantly with interaction effect at all growth stages (Table-1).

At 15 DAS, the tallest plant(18.67 cm) was observed in V_2S_4 (BARI mung-4 and 40 cm×10 cm) and at par with V_1S_4 (BARI mung-3 and 40 cm×10 cm) (18.42 cm). Treatment V_3S_2 (BARI mung-5 and 30 cm×10 cm) (16.38 cm) gave smallest plant height and statistically similar with V_2S_2 (BARI mung-4 and 30 cm×10 cm) (16.54 cm), V_1S_2 (BARI mung-3 and 30 cm×10 cm) (16.73 cm), V_4S_1 (BARI mung-6 and 30cm×5cm) (16.77 cm) and V_4S_2 (BARI mung-6 and 30 cm×10 cm) (16.79 cm). The other treatment combinedly gave intermediate values.

At 30 DAS, the tallest plant (52.40 cm) was observed in V_1S_3 (BARI mung-3 and 40 cm×5 cm) and it was par with V_1S_2 (BARI mung-3 and 30 cm×10 cm) (51.96 cm).Treatment V_4S_4 (BARI mung-6 and 40 cm×10 cm) (43.43 cm) gave smallest plant height. The other treatment combinedly gave intermediate values.

At 45 DAS, the tallest plant (60.32 cm) was observed in V_1S_2 (BARI mung-3 and 30 cm×10 cm). Treatment V_4S_4 (BARI mung-6 and 40 cm×10 cm) (48.26 cm) gave smallest plant height. The other treatment combinedly gave intermediate values.

At 60 DAS, the tallest plant (63.50 cm) was observed in V_1S_2 (BARI mung-3 and 30 cm×10 cm). Treatment V_4S_4 (BARI mung-6 and 40 cm×10 cm) (51.12 cm) gave smallest plant height. The other treatment combinedly gave intermediate values.

At harvest, the tallest plant (64.51 cm) was observed in V_1S_2 (BARI mung-3 and 30 cm×10 cm). Treatment V_4S_4 (BARI mung-6 and 40 cm×10 cm) (52.10 cm) gave smallest plant height. The other treatment combinedly gave intermediate values.

The difference of plant heights of varieties were due to the influence of different plant spacing that varies the light interception of plants coupled with other growing environments.

Table 1: Interaction effect of variety and spacing on plant height of mungbean at different days

Treatment	Plant height (cm)				
	15 DAS	**30 DAS**	**45 DAS**	**60 DAS**	**At harvest**
V_1S_1	17.11	49.60	58.85	61.73	62.70
V_1S_2	16.73	51.96	60.32	63.50	64.51
V_1S_3	17.76	52.40	54.60	56.84	57.81
V_1S_4	18.42	47.20	51.45	53.55	54.54
V_2S_1	17.35	51.60	59.18	61.61	62.64
V_2S_2	16.54	48.97	52.52	56.73	57.75
V_2S_3	17.82	49.52	50.42	53.08	54.12
V_2S_4	18.67	47.47	54.97	57.19	58.17
V_3S_1	17.63	49.27	58.90	61.06	62.11
V_3S_2	16.38	47.70	53.80	56.01	57.05
V_3S_3	17.45	51.16	56.27	58.55	59.59
V_3S_4	17.85	46.54	49.14	52.60	53.61
V_4S_1	16.77	46.27	52.53	54.84	55.80
V_4S_2	16.79	51.34	53.21	56.36	57.33
V_4S_3	17.60	52.20	57.11	59.61	60.40
V_4S_4	16.74	43.43	48.26	51.121	52.10
$LSD_{0.05}$	**0.580**	**0.6149**	**0.8632**	**0.6058**	**0.8824**
CV(%)	**7.91**	**8.56**	**9.66**	**8.44**	**7.98**

V_1= BARI Mung-3,V_2= BARI Mung-4,V_3= BARI Mung-5,V_4= BARI Mung-6,

S_1= 30 cm × 10 cm,S_2=30 cm × 10 cm,S_3=30 cm × 10 cm,S_4=30 cm × 10 cm

4.1.2 Branches plant^{-1}

4.1.2.1 Effect of variety

Significant variations on number of branches plant^{-1} at different days were observed among varieties under different treatments (Fig.3)

At 30 DAS, there was no significant difference was observed among the different varieties.

At 60 DAS, BARI mung-6 produced highest number of branches plant^{-1} (1.69) and which was similar with BARI mung-5 (1.67) and .BARI mung-3 gave the lowest number of branches plant^{-1} (1.49) and which was statically similar with BARI mung-4 (1.51).

At harvest, BARI mung-6 produced highest number of branches plant^{-1}(1.83) and it was at par with BARI mung-5 (1.81) and .BARI mung-3 gave the lowest number of branches plant^{-1}(1.69) and which was closely followed by BARI mung-4 (1.51)

This variation in number of branches plant^{-1} might be attributed to the genetic characters. .

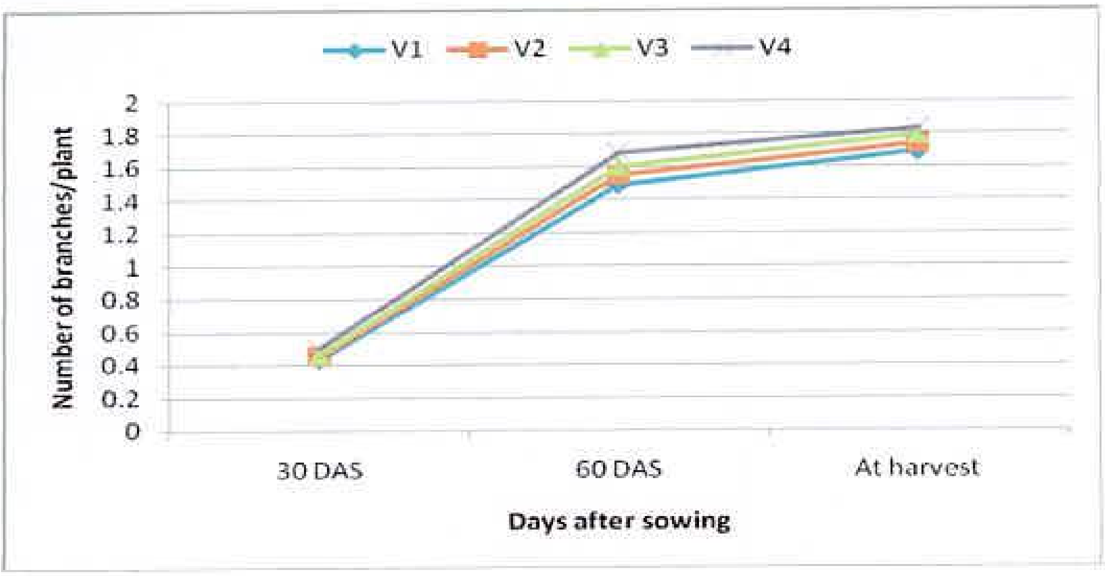

Fig. 3: Effect of varieties on branches plant^{-1} of mungbean at different days (LSD $_{0.05}$ = 0.3925, 0.4010 and 0.3950, at 30, 60 DAS and at harvest respectively)

V_1	=	BARI-Mung-3	S_1	=	30 cm × 5 cm
V_2	=	BARI-Mung-4	S_2	=	30 cm × 10 cm
V_3	=	BARI-Mung-5	S_3	=	40 cm × 5 cm
V_4	=	BARI-Mung-6	S_4	=	40 cm × 10 cm

4.1.2.2 Effect of spacing

Significant variations on number of branches plant^{-1} at different days were observed among different spacing under different treatments (Fig.4).Spacing had a great significant effect on number of branches plant^{-1} at different days after sowing . Higher spacing resulted higher number of branches plant^{-1}.

At 30 DAS, highest number of branches plant^{-1} were (0.65) with S_4 (40 cm×10 cm) And which was statistically similar with S_2(30 cm×10 cm) (0.62) . Treatment S_1 (30 cm×5 cm) gave the lowest number of branches plant^{-1} (0.29).

At 60 DAS, highest number of branches plant^{-1} were (1.90) with S_4 (40 cm×10 cm) And it was at par with S_2 (30 cm×10 cm) (1.88) . Treatment S_1 (30 cm×5 cm) gave the lowest number of branches plant^{-1} (1.23).

At harvest, highest number of branches plant^{-1} were (1.96) with S_4 (40 cm×10 cm) And which was statistically similar with S_2 (30 cm×10 cm) (1.90) . Treatment S_1 (30 cm×5 cm) gave the lowest number of branches plant^{-1} (1.52).

The present results were in agreement with the result of Madhavan *et al.*(1986), Khan *et al.* (2001) and Asgar *et al.* (2009).

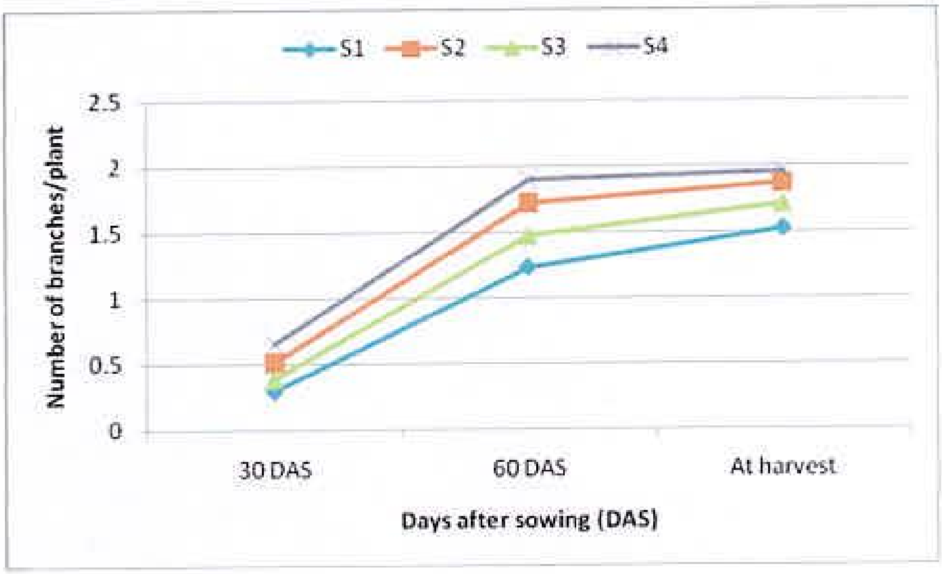

Fig 4: Effect of spacing on branches plant^{-1} of mungbean at different days(LSD $_{0.05}$ = 0.3915, 0.4026 and 0.3890 at 30, 60 DAS and at harvest respectively)

V_1	=	BARI-Mung-3	S_1	=	30 cm × 5 cm
V_2	=	BARI-Mung-4	S_2	=	30 cm × 10 cm
V_3	=	BARI-Mung-5	S_3	=	40 cm × 5 cm
V_4	=	BARI-Mung-6	S_4	=	40 cm × 10 cm

4.1.2.3 Interaction effect of variety and spacing

Branches plant^{-1} was increased progressively with time. No. of branches plant^{-1} differed significantly with interaction effect at all growth stages (table-2).

At 30 DAS, the highest number of branches plant^{-1}(0.71)was observed in $V_4 S_4$ (BARI mung-6 and 40 cm×10 cm) and which was closely followed by with V_3S_4 (BARI mung-5 and 40 cm×10 cm) (0.66) and V_2S_4 (BARI mung-4 and 40 cm×10 cm) (0.64). Treatment V_1S_1 (BARI mung-3 and 30 cm×5 cm) (0.26) gave lowest number of branches plant^{-1} and statistically similar with V_2S_1 (BARI Mung-4 and 30 cm×5 cm) (0.28) and V_3S_1 (BARI Mung-5 and 30 cm×5 cm) (0.29). The other treatment combinedly gave intermediate values.

At 60 DAS, the highest number of branches plant^{-1}(1.98) was observed in $V_4 S_4$ (BARI mung-6 and 40 cm×10 cm) and which it was at par with V_3S_4 (BARI mung-5 and 40 cm×10 cm) (1.91) and V_2S_4 (BARI mung-4 and 40 cm×10 cm) (1.88). Treatment V_1S_1 (BARI mung-3 and 30 cm×5 cm) (1.12) gave lowest number of branches plant^{-1} and statistically similar with V_2S_1 (BARI mung-4 and 30 cm×5 cm) (1.18). The other treatment combinedly gave intermediate values.

At harvest, the highest number of branches plant^{-1}(2.02) was observed in $V_4 S_4$ (BARI mung-6 and 40 cm×10 cm) and which was similar value with V_3S_4 (BARI mung-5 and 40 cm×10 cm) (1.97) and V_2S_4 (BARI mung-4 and 40 cm×10 cm) (1.94). Treatment V_1S_1 (BARI Mung-3 and 30 cm×5 cm) (1.42) gave lowest number of branches plant^{-1} and statistically similar with V_2S_1 (BARI Mung-4 and 30 cm×5 cm) (1.49). The other treatment combinedly gave intermediate values.

The difference of number of branches plant^{-1} of varieties were due to the influence of different plant spacing that varies the light interception of plants coupled with other growing environments.

Table 2: Interaction effect of variety and spacing on branches plant^{-1} of Mungbean at different days

Treatment	Number of branches plant^{-1}		
	30 DAS	**60 DAS**	**At harvest**
V_1S_1	0.26	1.12	1.42
V_1S_2	0.48	1.61	1.81
V_1S_3	0.36	1.42	1.63
V_1S_4	0.61	1.83	1.90
V_2S_1	0.28	1.18	1.49
V_2S_2	0.49	1.68	1.86
V_2S_3	0.37	1.45	1.68
V_2S_4	0.64	1.88	1.94
V_3S_1	0.29	1.26	1.55
V_3S_2	0.51	1.75	1.89
V_3S_3	0.39	1.47	1.74
V_3S_4	0.66	1.91	1.97
V_4S_1	0.33	1.37	1.60
V_4S_2	0.54	1.85	1.92
V_4S_3	0.44	1.54	1.79
V_4S_4	0.71	1.98	2.02
LSD $_{0.05}$	**0.0747**	**0.1055**	**0.07457**
CV(%)	**6.59**	**7.88**	**8.19**

V_1=BARI -mung-3, V_2=BARI mung-4, V_3=BARI mung-5, V_4=BARI mung-6

S_1=30 cm × 5 cm, S_2=30 cm × 10 cm, S_3=30 cm × 5 cm, S_4=30 cm × 10 cm

4.1.3 Above ground dry matter plant^{-1}

4.1.3.1 Effect of variety

Significant variations on dry weight plant^{-1}at different days were observed among varieties under different treatments (Fig.5)

At 15 DAS, there was no significant variation was observed among the different varieties.

At 30 DAS, BARI mung-4 produced highest dry weight plant^{-1} (31.6 g) and BARI mung-5 gave the lowest dry weight plant^{-1} (26.77 g) which was similar value with BARI mung-3 (28.07 g).

At 45 DAS, BARI mung-5 produced highest dry weight plant^{-1} (53.07 g)and BARI mung-4 gave the lowest dry weight plant^{-1} (46.73 g).

At 60 DAS, BARI mung-6 produced highest dry weight plant^{-1} (76.5 g) and BARI mung-3 gave the lowest dry weight plant^{-1} (68.49 g) and which was closely followed by BARI mung-4 (70.79).

At harvest, BARI mung-6 produced highest dry weight plant^{-1} (112.3 g) and BARI mung-3 gave the lowest dry weight plant^{-1} (88.48 g) .

This variation in dry weight plant^{-1} might be attributed to the genetic characters, availability of plant nutrients or other factors for nutrients uptake during growth stages.

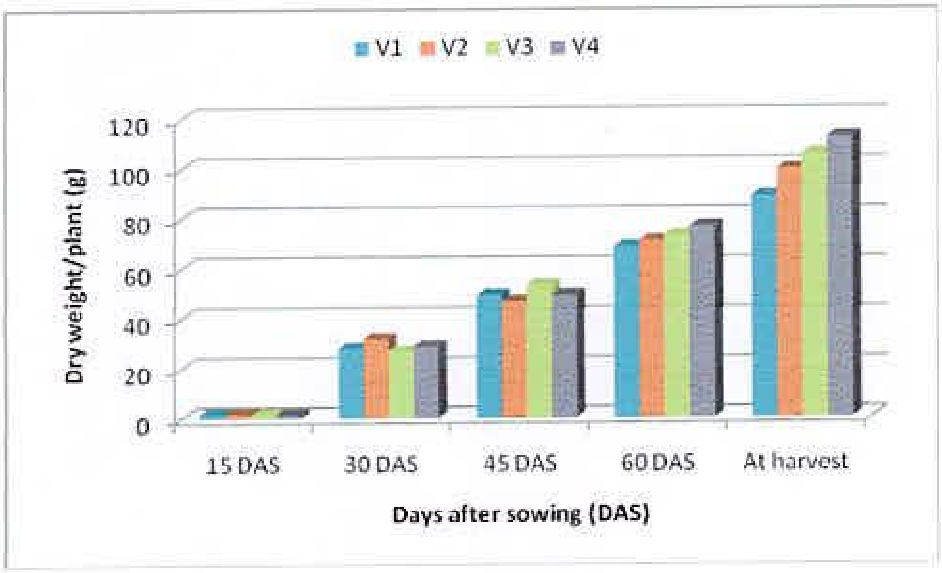

Fig. 5: Effect of varieties on above ground dry matter plant^{-1} of mungbean at different days(LSD $_{0.05}$ = NS, 0.476, 0.479, 0.4746 and 0.4716 at 15, 30, 45, 60 DAS and at harvest respectively)

V_1=BARI Mung-3,V_2= BARI Mung-4,V_3= BARI Mung-5,V_4= BARI Mung-6

4.1.3.2 Effect of plant spacing

Significant variations on dry weight at different days were observed among different spacing under different treatments (Fig.6). The positive relationship of dry weight with population density might be due to competition for sunlight and related factors. Higher plant density produced higher dry weight plant^{-1}.

At 15 DAS, there was no significant variation was observed among the different treatments.

At 30 DAS, highest dry weight plant^{-1} (37.61 g) was observed in S_4 (40 cm×10 cm). Treatment S_1 (30 cm×5 cm) gave the lowest dry weight plant^{-1} (22.75 g). The other treatment combinedly gave intermediate values.

At 45 DAS, highest dry weight plant^{-1} (59.84 g) was observed in S_4 (40 cm×10 cm). Treatment S_1 (30 cm×5 cm) gave the lowest dry weight plant^{-1} (39.95 g). The other treatment combinedly gave intermediate values.

At 60 DAS, highest dry weight plant^{-1} (85.06 g) was observed in S_4 (40 cm×10 cm). Treatment S_1 (30 cm×5 cm) gave the lowest dry weight plant^{-1} (57.89 g). The other treatment combinedly gave intermediate values.

At harvest, highest dry weight plant^{-1} (116.2 g) was observed in S_4 (40 cm×10 cm). Treatment S_1 (30 cm×5 cm) gave the lowest dry weight plant^{-1} (88.11 g). The other treatment combinedly gave intermediate values.

The achievement of this result might be due to the competition for nutrients uptake during growth stages. Higher plant spacing indicated less population density and nutrition competition.

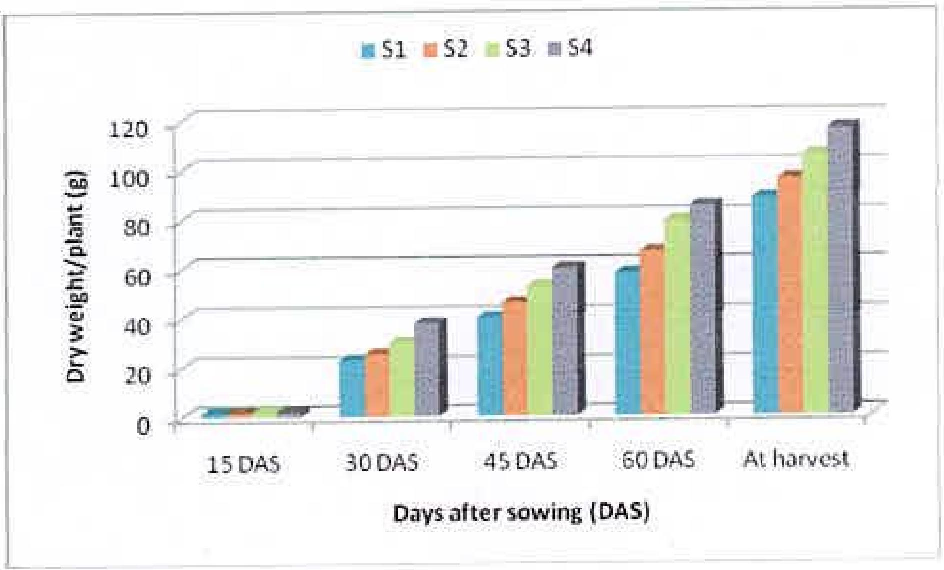

Fig. 6: Effect of plant spacing on above ground dry matter plant-1 of mungbean at different days (LSD $_{0.05}$ = NS, 0.383, 0.3812, 0.3875 and 0.3911 at 15, 30, 45, 60 DAS and at harvest respectively)

S_1=30 cm×5 cm, S_2=30 cm×10 cm, S_3=40 cm×5 cm, S_4=40 cm×10 cm

4.1.3.3 Interaction effect of variety and spacing

Dry weight plant^{-1}was increased progressively with time.Dry weight plant^{-1}differed significantly with interaction effect at all growth stages(Table-3).

At 15 DAS, there was no significant variation was observed. Dry weight plant^{-1} at different growth stages of mungbean varied remarkably.

At 30 DAS, the highest dry weight (45.81 g) was observed in V_2S_4 (BARI mung-4 and 40 cm×10 cm). Treatment V_3S_1 (BARI mung-5 and 30 cm×5 cm) (20.41 g) gave lowest dry weight. The other treatment combinedly gave intermediate values.

At 45 DAS, the highest dry weight (68.76 g) was observed in V_4S_4 (BARI mung-6 and 40 cm×10 cm). Treatment V_1S_1 (BARI mung-3 and 30 cm×5 cm) (31.37 g) gave lowest dry weight and statistically similar with V_4S_1 (BARI mung-6 and 30 cm×5 cm) (31.91 g) . The other treatment combinedly gave intermediate values.

At 60 DAS, the highest dry weight (96.21 g) was observed in V_4S_4 (BARI mung-6 and 40 cm×10 cm). Treatment V_1S_1 (BARI mung-3 and 30 cm×5 cm) (54.64 g) gave lowest dry weight and statistically similar with V_4S_1 (BARI mung-6 and 30 cm×5 cm) (54.71 g) . The other treatment combinedly gave intermediate values.

At harvest, the highest dry weight (125.7 g) was observed in V_4S_4 (BARI mung-6 and 40 cm×10 cm) and it was at par with V_2S_4 (BARI mung-4 and 40 cm×10 cm) (125.4 g) and V_4S_3 (BARI mung-6 and 40 cm×5 cm) (124.6g) Treatment V_1S_1 (BARI mung-3 with 30 cm×5 cm) (77.29 g) gave lowest dry weight and . The other treatment combinedly gave intermediate values.

The difference of dry weight plant^{-1} of varieties were due to the influence of different plant spacing that varies the light interception of plants coupled with other growing environments.

Table 3: Interaction effect of variety and spacing on above ground dry matter plant^{-1} of mungbean at different days

Treatment	Dry weight/plant (g)				
	15 DAS	**30 DAS**	**45 DAS**	**60 DAS**	**At harvest**
V_1S_1	1.443	24.71	31.37	54.71	77.29
V_1S_2	1.507	25.46	44.88	62.86	88.74
V_1S_3	1.990	30.70	52.01	75.08	89.91
V_1S_4	2.000	31.41	68.76	81.31	98.00
V_2S_1	1.507	24.34	45.14	66.25	85.37
V_2S_2	1.523	24.61	46.18	69.69	89.07
V_2S_3	1.800	31.63	47.36	72.13	97.69
V_2S_4	1.820	45.81	48.22	75.11	125.4
V_3S_1	1.343	20.41	51.37	55.94	98.32
V_3S_2	1.250	22.48	47.40	64.78	98.76
V_3S_3	1.470	27.92	55.38	83.25	108.8
V_3S_4	1.670	36.28	58.14	87.60	115.8
V_4S_1	1.327	21.54	31.91	54.64	91.45
V_4S_2	1.423	27.95	45.37	69.39	107.4
V_4S_3	1.460	28.61	55.09	85.76	124.6
V_4S_4	1.627	36.93	64.25	96.21	125.7
LSD $_{0.05}$	**NS**	**1.082**	**1.221**	**2.593**	**2.507**
CV(%)	**4.22**	**7.49**	**6.34**	**8.22**	**8.78**

V_1=BARI -Mung-3, V_2=BARI Mung-4, V_3=BARI Mung-5, V_4=BARI Mung-6

S_1=30 cm × 5 cm, S_2=30 cm × 10 cm, S_3=30 cm × 5 cm, S_4=30 cm × 10 cm

4.2 Yield and yield contributing characters

4.2.1 Pod length

4.2.1.1 Effect of variety

Variety showed highly significant difference in pod length (Table 4). Longer pod length (9.29 cm) was observed in BARI-mung-6 (V_4) and shorter was in (88.48 cm) BARI-Mung-3 (V_1). This result is in agreement with the result of Sarkar *et al.* (2004) who reported that pod length differed from variety to variety. The probable reason of this difference could be the genetic make-up of the variety .

4.2.1.2 Effect of plant spacing

The difference in pod length due to plant spacing was statistically significant (Table 4). The longest pod (9.71 cm) was produced by S_4 (40 cm × 10 cm) and the shortest pod (7.26 cm) was in S_1 (30 cm × 5 cm). The result was similar with the result documented by Miranda *et al.* (1997) who noticed that pod length decreased with increasing population density. Production of shorter pods at the highest population density was probably due to hard competition for nutrient, water, and light in closer spacing.

4.2.1.3 Interaction effect of variety and spacing

Interaction effect of variety and plant spacing was significant on pod length (Table 4). The highest pod length (9.91 cm) was recorded in V_4S_4 which was statistically similar with V_4S_2 (BARI mung-6 and 30 cm×10 cm) and similar with V_3S_4 (BARI mung-5 and 40 cm×10 cm) and V_2S_4 (BARI Mung-4 and 40 cm×10 cm). On the other hand the lowest pod length (6.81 cm) was recorded in V_2S_1 (BARI Mung-4 and 30 cm×5 cm) which was statistically similar with V_1S_1 (BARI Mung-3 and 30 cm×5 cm) (6.82 cm). The other values from different treatments were as intermediate results.

4.2.2 Pods plant^{-1}

4.2.2.1 Effect of variety

Significant variation was remarked on number of pods/plant under the present study (Table 4). Results showed that highest pods plant^{-1} (13.92) was observed in BARI-Mung-6 (V_4). The lowest number of pods plant^{-1} (12.46) was in BARI-Mung-3 (V_1) which was closely followed by V_2. The probable reason of this difference might be due to spacing, genetical character, availability of light intensity for proper photosynthesis etc.

4.2.2.2 Effect of spacing

Plant spacing showed a highly significant influence on number of pods plant^{-1} (Table 4). Number of pods plant^{-1} increased with increased plant spacing. The maximum number of pods plant^{-1} (15.36) was achieved with S_4 (40 cm × 10 cm) and the lowest (9.94) was with S_1 (30 cm × 5 cm). Number of pods plant^{-1} decreased with increased population density. It could be probably by the availability of more space, water, light and nutrient in the thinly populated crop resulted in the production of more pods plant^{-1}. A similar result was found by Ahmed *et al.* (2005).

4.2.2.3 Interaction effect of variety and plant spacing

Significant variation was obtained due to combination of variety and plant spacing (Table 4). Varietal effect with higher spacing showed higher number of pods/plant and the highest (16.13) number of pods/plant was recorded with V_4S_4 which was closely followed by V_3S_4 (15.26). Higher performance also obtained with V_1S_4 and V_2S_4 but significantly different from V_4S_4. The lowest number of pods plant^{-1} (8.93) was obtained with V_1S_1.

4.2.3 Seeds pod^{-1}

4.2.3.1 Effect of variety

Different varieties were not significantly influenced by number of seeds pod^{-1} (Table 4). But the results showed that the maximum number of seeds pod^{-1} (11.97) was obtained in BARI-Mung-6 (V_4) while the minimum (11.52) was in BARI-Mung-3 (V_1). A result was found by Infante *et al.* (2003) which was not similar with this study. They found significant difference on number of seeds/pod among the varieties.

4.2.3.2 Effect of plant spacing

Plant spacing showed a significant effect on number of seeds pod^{-1} (Table 4). The highest number of seeds pod^{-1} (12.40) was recorded in S_4 (40 cm × 10 cm) which was statistically similar with S_3 (30 cm × 10 cm) and the lowest (10.25) was recorded in S_1 (30 cm × 5 cm). Number of seeds pod^{-1} decreased gradually with the increasing population density probably due to intense competition for the above and below ground resources. Similar result was reported by Miranda *et al.* (1997).

4.2.3.3 Interaction effect of variety and spacing

Interaction effect of variety and plant spacing was significant on number of seeds pod^{-1} (Table 4). The highest number of seeds pod^{-1} (12.65) was recorded in V_4S_4 which was statistically similar with V_4S_2 and V_2S_4 and similar with V_3S_4. On the other hand the lowest number of seeds/pod (9.59) was recorded in V_1S_1 which was statistically similar with V_2S_1. Significantly different results were obtained from all other treatments compared to highest and lowest number of seeds/pod.

4.2.4 Weight of 1000 seeds

4.2.4.1 Effect of variety

Variety showed highly significant difference in 1000 seed weight (Table 4). The highest 1000 seed weight (51.03 g) was observed in BARI-Mung-6 (V_4) and lowest (47.87 g) was in BARI-Mung-3 (V_1). This result was in agreement with the result of Sarkar et al. (2004).

4.2.4.2 Effect of plant spacing

The difference in 1000 seed weight due to plant spacing was statistically significant (Table 4). The highest 1000 seed weight (52.40 g) was produced by S_4 (40 cm × 10 cm) which was statistically similar with S_2 (30 cm × 10 cm) and the lowest 1000 seed weight (45.95 g) was in S_1 (30 cm × 5 cm). Higher 1000 seed weight was obtained with lower plant population. This might be due to availability of more nutrition, water and light to the plant at lower density which provided scope for increased photosynthetic activities and translocation of more metabolites to the seed sink.

4.2.4.3 Interaction effect of variety and spacing

Interaction effect of variety and plant spacing was significant on 1000 seed weight (Table 4). The highest 1000 seed weight (54.43 g) was recorded in V_4S_4 which was statistically similar with V_4S_2 (54.41 g). On the other hand the lowest 1000 seed weight (44.31 g) was recorded in V_1S_1 which was statistically similar with V_2S_1. Significantly different results were obtained from all other treatments compared to highest and lowest 1000 seed weight.

4.2.5 Yield

4.2.5.1 Effect of variety

Variety had remarkable influence on seed yield (Table 4). The highest seed yield (1483 kg ha^{-1}) was observed in BARI mung-6 (V_4) and lowest (1338kg ha^{-1}) was in BARI-mung-3 (V_1). The probable reason of this difference might be due to higher number of pod length, seeds/pod and 1000 seed weight. The performance of other varieties were as intermediate yielder.

4.2.5.2 Effect of plant spacing

Plant spacing showed significant impact on seed yield (Table 4). The highest seed yield (1520 kg ha^{-1}) was obtained by S_2 (30 cm × 10 cm) and the lowest (1334 kg ha^{-1}) was in S_4 (40 cm × 10 cm). Increase in seed yield with increasing the population density up to a certain limit and here after the response was negative, this result was in agreement with the findings of Mimber (1993)

4.2.5.3 Interaction effect of variety and spacing

Interaction effect of variety and plant spacing was significant on seed yield (Table 4). The highest seed yield (1645 kg ha^{-1}) was recorded in V_4S_2 and the lowest seed yield (1275 kg ha^{-1}) was recorded in V_1S_4.

4.2.6 Stover yield

4.2.6.1 Effect of variety

Significant difference was found on stover yield as influenced by different mungbean variety (Table 4). Stover yield differed according to variety and it might be due to its genetical character of producing higher branches, leaves etc. The variety V_4 (BARI-Mung-6) showed the highest stover yield (2432.48 kgha^{-1}) and the lowest (2391.97 kg ha^{-1}) was with V_1 (BARI-Mung-3).

4.2.6.2 Effect of spacing

Stover yield was significantly affected by different spacing of mungbean (Table 4). Results showed that the highest stover yield (2481.22 kg ha^{-1})was with S_1 (30 cm × 5 cm) and the lowest (2344.07 kg ha^{-1}) was with S_4 (40 cm × 10 cm). The results obtained under the present study were similar with Rajput *et al.* (1991).

4.2.6.3 Interaction effect of variety and spacing

Stover yield of mungbean under the present study was significantly influenced by the interaction effect of variety and spacing (Table 4). Result showed that the highest stover yield (2502.13 kg ha^{-1}) was with V_4S_1 (BARI-Mung-6 with 30 cm ×5 cm). The lowest stover yield (2312.00 kg ha^{-1}) was with V_1S_4 (BARI-Mung-3 with 40 cm × 10 cm). All other combined treatments showed significantly different results in respect of highest and lowest stover yield under the present study.

4.3 Harvest index

4.3.1 Effect of variety

Significant variation as influenced by different variety of mungbean at different days after sowing was found on harvest index of mungbean. The highest harvest index (37.83%) was found with V_4 (BARI-mung-6) which was closely followed by V_3 (BARI-mung-5). The lowest harvest index (35.60%) was observed with V_1 (BARI-mung-3). The results obtained from all other treatments showed intermediate value compared to highest and lowest harvest index under the present study.

4.3.2 Effect of spacing

Spacing had a great influence on harvest index of mungbean. The highest harvest index (38.17%) was with S_2 (30 cm × 10 cm). On the other hand, the lowest harvest index (36.26%) was recorded with S_4 (40 cm × 5 cm) which was statistically similar with S_1 and S_3. These results were in conformity with the findings of Khan *et al.* (2001).

4.3.3 Interaction effect of variety and spacing

Significantly different results were found on harvest index as influenced by variety and spacing combination of mungbean (Table 4). It was observed that the highest harvest index (40.16%) was with V_4S_2 (BARI-mung-6 and 30 cm × 10 cm). The lowest harvest index (35.22%) was with V_1S_1 (BARI-mung-3 and 30 cm × 5 cm) which was statistically similar with V_1S_3 (BARI-mung-3 and 40 cm × 5 cm) and closely followed by V_1S_4 (BARI-mung-3 and 40 cm × 10 cm) at 30, 60 DAS and at harvest. All other combined treatments showed significantly different results in respect of highest and lowest harvest index of mungbean under the present study.

Table 4: Response of yield and yield contributing characters of mungbean varieties under different spacing management

Treatment	Pod length (cm)	pod plant^{-1}	seed pod^{-1}	1000 seed weight (g)	Yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index(%)
Effect of variety							
V_1	8.66	12.46	11.52	47.87	1338	2391.97	35.60
V_2	8.72	12.88	11.59	49.39	1391	2405.69	36.63
V_3	8.88	13.26	11.82	50.09	1436	2419.17	37.24
V_4	9.29	13.95	11.97	51.03	1483	2432.48	37.83
$LSD_{0.05}$	0.09133	0.4443	NS	0.8910	3.145	6.124	0.8816
Effect of spacing							
S_1	7.256	9.942	10.25	45.95	1429	2481.22	36.53
S_2	9.571	14.43	12.31	51.78	1520	2433.58	38.17
S_3	9.017	12.83	11.93	48.25	1365	2390.45	36.34
S_4	9.711	15.36	12.40	52.40	1334	2344.07	36.26
$LSD_{0.05}$	0.1292	0.5167	0.1149	0.8902	3.145	8.289	0.8437
Interaction effect of variety and spacing							
V_1S_1	6.82	8.927	9.587	44.31	1340	2464.35	35.22
V_1S_2	9.43	13.87	12.25	49.32	1435	2416.34	36.26
V_1S_3	8.80	12.12	11.87	46.84	1300	2375.21	35.37
V_1S_4	9.51	14.94	12.36	51.00	1275	2312.00	35.55
V_2S_1	6.81	9.467	9.737	45.07	1420	2472.26	36.48
V_2S_2	9.50	14.17	12.14	51.63	1480	2428.16	37.87
V_2S_3	8.87	12.79	11.86	48.06	1350	2382.14	36.17
V_2S_4	9.72	15.11	12.63	52.94	1315	2340.22	35.98
V_3S_1	7.61	10.15	10.51	46.68	1460	2486.15	37.00
V_3S_2	9.44	14.58	12.26	51.76	1520	2438.59	38.40
V_3S_3	8.71	13.05	12.04	49.08	1400	2396.33	36.88
V_3S_4	9.74	15.26	12.47	52.80	1365	2355.60	36.69
V_4S_1	7.78	11.22	11.19	47.76	1495	2502.13	37.40
V_4S_2	9.87	15.09	12.61	54.41	1645	2451.23	40.16
V_4S_3	9.61	13.36	11.94	49.01	1410	2408.12	36.93
V_4S_4	9.91	16.13	12.65	54.43	1380	2368.45	36.82
$LSD_{0.05}$	**0.1973**	**0.8918**	**0.2689**	**1.689**	**6.289**	**5.394**	**0.5326**
CV(%)	**8.12**	**6.29**	**5.48**	**7.88**	**9.14**	**8.86**	**9.42**

V_1=BARI Mung-3, V_2= BARI Mung-4, V_3= BARI Mung-5, V_4= BARI Mung-6
S_1=30cm×5cm, S_2=30cm×10cm, S_3=40cm×5cm, S_4=40cm×10cm

4.4 Light intensity

4.4.1 Effect of variety

Significant variations on light intensity at different days were observed among varieties under different treatments (Table.5)

At 25 DAS, the highest light intensity (36.50 lux) was observed in V_4 (BARI Mung-6) and V_1 (BARI Mung-3) gave the lowest light intensity (29.06 lux) which was closely followed by V_3 (BARI Mung-5) (29.31 lux).

At 50 DAS, the highest light intensity (43.92 lux) was observed in V_4 (BARI Mung-6) and V_1 (BARI Mung-3) gave the lowest light intensity (32.04 lux).

At harvest, the highest light intensity (47.83 lux) was observed in V_4 (BARI Mung-6) and V_1 (BARI Mung-3) gave the lowest light intensity (39.33 lux).

The probable reason of this difference could be the genetic make up of the variety which was influenced primarily by heredity to produce higher branches, leaves to intercept more light.

4.4.2 Effect of plant spacing

Significant variations on light intensity at different days were observed among varieties under different treatments.Plant spacing had the most significant influence on light intensity (Table.5).

At 25 DAS, the highest light intensity (33.43 lux) was observed in S_4 (40 cm×10 cm) and S_1 (30 cm×5 cm) gave the lowest light intensity (29.08 lux).

At 50 DAS, the highest light intensity (43.26 lux) was observed in S_4 (40 cm×10 cm) and S_1 (30 cm×5 cm) gave the lowest light intensity (35.40 lux).

At harvest, the highest light intensity (51.42 lux) was observed in S_4 (40 cm×10 cm)and S_1 (30 cm×5 cm) gave the lowest light intensity (38.73 lux) and which was statistically similar with S_3 (40 cm×5 cm) (38.33 lux).

Capacity of higher light intensity in crop field probably depends on due to higher space of crops for uniform dissemination of its branches, leaves etc.

4.4.3 Interaction effect of variety and spacing

Interaction effect of variety and spacing was significant on light intensity (Table.5)

At 25 DAS, the highest light intensity (49.11 lux) was observed in V_4S_4 (BARI Mung-6 with 40 cm×10 cm) and V_1S_1 (BARI Mung-3 with 30 cm×5 cm) gave the lowest light intensity (22.11 lux) which was closely followed by V_2S_1 (BARI Mung-4 with 30 cm×5 cm) (22.69 lux).

At 50 DAS, the highest light intensity (57.71 lux) was observed in V_4S_4 (BARI Mung-6 with 40 cm×10 cm) and V_1S_1 (BARI Mung-3 with 30 cm×5 cm) gave the lowest light intensity (27.46 lux) which was closely followed by V_3S_4 (BARI Mung-5 with 40 cm×10 cm) (29.86 lux).

At 25 DAS, the highest light intensity (66.74 lux) was observed in V_4S_4 (BARI Mung-6 with 40 cm×10 cm) and V_1S_1 (BARI Mung-3 with 30 cm×5 cm) gave the lowest light intensity (26.40 lux).

The probable reason of this difference could be the genetic make up of the variety which was influenced primarily by heredity to produce higher branches, leaves etc.

Table 5: Response of mungbean varieties to interception of light intensity (lux) under different spacing management at different days

Treatment	Light intensity (lux)		
	25 DAS	50 DAS	At harvest
Effect of variety			
V_1	29.06	32.04	39.33
V_2	30.67	39.54	45.26
V_3	29.31	37.50	41.40
V_4	36.50	43.92	47.83
$LSD_{0.05}$	0.8828	0.8486	0.9224
Effect of spacing			
S_1	29.08	35.40	38.73
S_2	31.84	36.96	45.32
S_3	31.19	37.38	38.33
S_4	33.43	43.26	51.42
$LSD_{0.05}$	0.8824	0.8482	0.8918
Interaction effect of variety and spacing			
V_1S_1	22.11	27.46	26.40
V_1S_2	30.91	39.33	38.42
V_1S_3	32.31	48.04	40.79
V_1S_4	30.90	38.91	48.43
V_2S_1	22.69	30.59	29.66
V_2S_2	28.90	35.75	39.90
V_2S_3	32.55	42.56	45.34
V_2S_4	37.21	46.57	47.19
V_3S_1	24.81	33.26	34.09
V_3S_2	37.22	31.35	48.26
V_3S_3	31.68	39.48	42.56
V_3S_4	24.89	29.86	43.34
V_4S_1	43.14	38.26	40.04
V_4S_2	25.52	41.39	52.06
V_4S_3	28.24	31.44	52.04
V_4S_4	49.11	57.71	66.74
$LSD_{0.05}$	**1.766**	**2.493**	**1.784**
CV(%)	**6.34**	**7.12**	**8.54**

V_1=BARI Mung-3, V_2= BARI Mung-4, V_3= BARI Mung-5, V_4= BARI Mung-6
S_1=30 cm×5 cm, S_2=30 cm×10 cm, S_3=40 cm×5 cm, S_4=40 cm×10 cm

Chapter V

Summary and Conclusion

CHAPTER 5

SUMMARY AND CONCLUSION

The experiment was conducted at the Agronomy field, Sher-e-Bangla Agricultural university, Dhaka, during August to October, 2008 to study the response of mungbean variety under different spacing management. Four mungbean variety; (i) V_1 = BARI-Mung-3, (ii) V_2 = BARI-Mung-4, (iii) V_3 = BARI-Mung-5 and (iv) V_4 = BARI-Mung-6 and four plant spacing; (i) S_1 = 30 cm × 5 cm, (ii) S_2 = 30 cm × 10 cm, (iii) S_3 = 40 cm × 5 cm and (iv) S_4 = 40 cm × 10 cm were used under the present study. The experiment was laid out in a Randomized Complete Block Design (RCBD) (factorial) with three replications. The size of unit plot was 4 m × 2.5 m. Intercultural operations were done as when necessary. Data on growth and yield parameters were recorded from vegetative growth to maturity. All the collected data were statistically analyzed and the mean differences among the treatments were compared by least significance difference (LSD) at 5% or 1% level of significance.

The results revealed that all the growth, yield character and yield were significantly influenced by variety, spacing and their interaction.

Results exposed that BARI-Mung-3 (V_1) showed highest plant height (59.89 cm) where the lowest (56.41 cm) was with BARI-Mung-6 (V_4). But incase of highest branches plant^{-1} (1.83), dry matter/plant (112.3 g), pod length (9.29

cm), number of pods plant^{-1} (13.95), number of seeds pod^{-1} (11.97), 1000 seed weight (51.03 g), grain yield (1483.00 kg ha^{-1}), stover yield (2432.48 kg ha^{-1}), harvest index (37.83%) and l ight intensity (47.83%) were observed at maturity stage with BARI-Mung-6 (V_4) where the lowest; 1.69, 88.48 g, 8.66 cm, 12.46, 11.52, 47.87 g, 1338.00 kg ha^{-1}, 2491.97 kg ha^{-1}, 35.60% and 39.33% respectively at maturity stage were obtained with BARI-Mung-3 (V_1).

Plant spacing had also great influence on growth parameters, yield and yield attributes of mungbean. The highest plant height (60.81 cm) was with S_1 (30 cm × 5 cm) where the lowest (54.61 cm) was with S_4 (40 cm × 10 cm). Again, the highest branches/plant (1.96), dry matter plant^{-1} (116.20 g), pod length (9.711 cm), number of pods plant^{-1} (15.36), number of seeds pod^{-1} (12.40), 1000 seed weight (52.40 g) and light intensity (51.42%) were observed at maturity stage with S_4 (40 cm × 10 cm) where the lowest; 1.52, 88.11 g, 7.256 cm, 9.94, 10.25, 45.95 and 38.33% respectively at maturity stage were obtained with S_1 (30 cm × 5 cm). But the highest grain yield (1520 kg ha^{-1}) and the lowest (1334 kg ha^{-1}) were obtained with S_2 (30 cm × 10 cm) and S_4 (40 cm × 10 cm) respectively. The highest stover yield (2481.22 kg ha^{-1}) and harvest index (38.17%) respectively was achieved with S_1 (30 cm × 5 cm) and S_2 (30 cm × 10 cm) respectively but the lowest stover yield (2344.07 kg ha^{-1}) and harvest index (36.26%) was obtained with S_4 (40 cm × 10 cm).

Interaction effect of variety and plant spacing were found statistically significant on almost all the growth and yield parameters. The highest and lowest plant height (64.51 and 52.10 cm respectively) were obtained from V_1S_2

and V_4S_4 respectively. Again, the highest number of branches/plant (2.02), dry matter plant^{-1} (125.7 g), pod length (9.91 cm), number of pods/plant (16.13), number of seeds/pod (12.65), 1000 seed weight (54.43 g) and light intensity (66.74%) were observed at maturity stage with V_4S_4 where the lowest; 1.42, 77.29 g, 6.823 cm, 8.93, 9.587, 44.31 g and 26.40% respectively at maturity stage were obtained with V_1S_1. But the highest grain yield (1645 kg/ha) was found in V_4S_2 where the lowest (1275 kg ha^{-1}) was with V_1S_4. The highest stover yield (2502.13 kg ha^{-1}) and harvest index (40.16%) respectively were obtained by V_4S_1 and V_4S_2 respectively where the lowest stover yield (2312 kg ha^{-1}) and harvest index (35.22%) were obtained by V_1S_4 and V_1S_1 respectively.

From the results of the experiment, it could be concluded that variety BARI mung -6 coupled with spacing 30 cm×10 cm gave maximum seed yield which was attributed to maximum pod length, seeds pod^{-1} and 1000 seed weight.

This type of experiment could be retested in different agro-ecological zone of Bangladesh for validation of present result.

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Appendices

APPENDICES

Appendix I. Monthly average air temperature, relative humidity and total rainfall of the experimental site during the period from September 2010 to December 2010

Month	Max. Temp. (°C)	Min. Temp. (°C)	RH (%)	Rain fall (mm)
August	29.30	20.20	72.12	25
September	28.00	15.40	75.12	Terrace
October	27.50	14.00	50.31	Terace
November	26.98	14.88	71.15	Terrace

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

Appendix II. Chemical composition of soil of the experimental plot

Soil Characteristics	Analytical results
Agrological Zone	Madhupur Tract
P^H	5.47 – 5.63
Total N (%)	0.43
Available phosphorous	22 ppm
Exchangeable K	0.42 meq / 100 g soil

Appendix III: Response of plant height of mungbean varieties under different spacing management at different days

Source of variations	Degrees of freedom	Plant height at different days after sowing Mean square				
		15 DAS	30 DAS	45 DAS	60 DAS	At harvest
Replication	2	0.024	0.011	0.004	0.012	0.018
Factor A	3	0.895*	9.212*	25.118*	23.499*	23.499*
Factor B	3	3.939*	57.437*	83.933*	82.396*	82.396*
AB	9	0.632*	10.977*	32.907*	30.915*	30.915*
Error	30	0.234	0.236	0.64	0.228	0.246

Appendix IV: Response of above ground dry matter plant^{-1} of mungbean varieties under different spacing management at different days

Source of variations	Degrees of freedom	Dry weight/plant at different days after sowing Mean square				
		15 DAS	30 DAS	45 DAS	60 DAS	At harvest
Replication	2	0.122	0.226	0.332	0.026	0.058
Factor A	3	NS	49.789*	82.472*	13.790*	122.694*
Factor B	3	NS	513.928*	878.122*	17.646*	176.075*
AB	9	NS	31.934*	165.131*	12.141*	14.285*
Error	30	0.238	0.230	0.335	0.268	0.189

Appendix V: Response of branches plant^{-1}of mungbean varieties under different spacing management at different days

Sources of variance	Degrees of freedom	Mean square		
		30 DAS	60 DAS	At harvest
Replication	2	0.026	0.004	0.314
Factor A	3	0.013**	1.082**	3.046*
Factor B	3	0.291**	3.025*	8.454*
AB	9	2.024*	6.003*	10.001*
Error	30	0.014	1.001	1.024

Appendix VI: Response of yield and yield contributing characters of mungbean varieties under different spacing management

Source of variations	Degrees of freedom	Pod length (cm)	Number of pods plant^{-1}	Number of seeds pod^{-1}	1000 seed weight (g)	Yield (kg ha^{-1})
Replication	2	0.016	0.000	0.014	0.002	156.250
Factor A	3	0.973*	4.769*	0.526*	21.293*	46156.25*
Factor B	3	15.295*	67.66*	12.037*	110.689*	81106.25*
AB	9	0.178*	0.225 *	0.461*	1.611*	2077.083*
Error	30	0.226	0.000	0.128	1.142	12.917

Appendix VII: Response of mungbean variety under different spacing management on Stover yield and Harvest Index of mungbean

Sources of variance	Degrees of freedom	Mean square		
		Yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index
Replication	2	156.250	3.428	1.272
Factor A	3	46156.25*	6.114*	10.88*
Factor B	3	81106.25*	9.314*	9.851*
AB	9	2077.083*	14.127*	7.753*
Error	30	12.917	4.286	3.250

Appendix VIII: Response of mungbean varieties to interception of light intensity (lux) under different spacing management at different days

Source of variations	Degrees of freedom	Mean square		
		25 DAS	50 DAS	At harvest
Replication	2	0.458	1.112	0.689
Factor A	3	145.616*	291.702*	174.700*
Factor B	3	38.855*	142.766*	462.242*
AB	9	212.024*	170.445*	248.158*
Error	30	2.266	2.014	3.586