GROWTH AND YIELD OF MUNGBEAN VARIETIES AS AFFECTED BY MOLYBDENUM

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CERTIFICATE

*This is to certify that the thesis entitled, "**GROWTH AND YIELD OF MUNGBEAN VARIETIES AS AFFECTED BY MOLYBDENUM**" 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 AGRONOMY,** embodies the results of a piece of bona-fide research work carried out by **KAWSAR JAHAN QURASHI**, Registration No. 15-06934 under my supervision and my 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:

Dhaka, Bangladesh

____

Prof. Dr. Parimal Kanti Biswas

Supervisor

Dedicated to my one and only Brother

List of Abbreviations

Abbreviations	**Full word**
AEZ	Agro ecological zone
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BINA	Bangladesh Institute of Nuclear Agriculture
BSMRAU	Bangabandhu Sheikh Mujibur Rahman Agricultural University
cm	Centimeter
cv.	Cultivar
CV	Coefficient of Variation
DAS	Days After Sowing
EC	Emulsifiable concentrate
et al.	And others (*et alibi*)
FAO	Food and Agriculture Organization
g	Gram
ha	Hectare
HI	Harvest Index
kg	Kilogram
L	Liter
LSD	Least Significant Difference
m^2	Square Meter
mL	milliliter
MoP	Muriate of Potash
No.	Number
NPK	Nitrogen phosphorus potassium
NS	Non Significant
%	Percent
$plant^{-1}$	per plant
Seeds pod^{-1}	Seeds per pod
t ha^{-1}	Ton (s) per hectare
TSP	Triple super phosphate

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The Author

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ABSTRACT

A field experiment was carried out at the research field of Sher-e-Bangla Agricultural University, Dhaka during the period of March to May 2016 to study the influence of molybdenum on growth and yield of mungbean varieties. The treatments were three mungbean (*Vigna radiata*) varieties viz. BARI mung-5 (V_1), BARI mung- 6 (V_2) and BU mug-4 (V_3) and five molybdenum doses viz. Control (M_0), 2g/kg seed (M_1), 4g/kg seed (M_2), 6g/kg seed (M_4) and 8g/kg seed (M_4). The experiment was laid out into Split-plot design with three replications where varieties were assigned in the main plot and molybdenum in the sub-plot. The purpose of this experiment was to evaluate variations between the mungbean varieties developed by two different institutions and to study the possibility of increasing yield by molybdenum application. Data on different yield contributing characters, growth and yield were recorded. Interaction between varieties and molybdenum showed a positive impact on growth, yield and yield attributes of mungbean. Varieties showed no significant variations on plant height, number of nodules plant^{-1}, dry weight, number of pods plant^{-1}, number of seeds pod^{-1}, first flowering, pod yield, seed yield, husk yield, stover yield, biological yield and harvest index. Pod yield, seed yield, husk yield, stover yield, biological yield and harvest index was unaffected by molybdenum application. Interaction between variety and molybdenum doses significantly influenced pod yield, seed yield, stover yield, biological yield and harvest index of mungbean. Seed yield (1210.83 kg/ha), stover yield (3338.00 kg/ha), biological yield (4.55 t/ha) was higher in V_3M_1 treatment and harvest index was higher in V_1M_1 teatment. It may be concluded that interaction between variety and molybdenum doses had a significant influence on the growth and yield of mungbean.

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CHAPTER 1
INTRODUCTION

Bangladesh is an agro based country where many crops like rice, wheat, jute, pulses, sugarcane, vegetables etc. are grown well. Among them, pulses constitute the main source of protein for the people, particularly for the poor people of Bangladesh. Pulses are considered as "the meat of the poor" because still pulses are the cheapest source of protein. These are also the best source of protein for domestic animal. These also help to overcome the malnutrition which is a serious health problem in Bangladesh that has been threatening to cripple the whole nation. Unfortunately, there is an acute shortage of grain legume production in the country. In Bangladesh, daily consumption of pulses is only 14.30g capita^{-1} (BBS, 2010), while the World Health Organization (WHO) suggested 45g capita^{-1} day^{-1} for a balanced diet. Due to shortage of production 291 thousands metric ton pulses was imported in Bangladesh in 2006-07 fiscal year (BBS, 2010).

Khesari (*Lathyrus sativus* L.), lentil (*Lens culinaris* Medic), chickpea (*Cicer arietinum* L.), blackgram (*Vigna mungo* L.), mungbean (*Vigna radiata* L.) and field pea (*Pisum sativum*) are the major pulses grown in Bangladesh. Among these khesari, lentil, chickpea and field pea are grown during winter (November-March) and contribute about 82% of total pulses. Blackgram is grown in late summer (August-December). Mungbean is grown both in early summer (March-June) and in late summer. In Bangladesh, among pulses, mungbean ranks 3rd in acreage and production and first in market price (BBS, 2013). Traditionally, mungbean was grown in the winter season due to favorable agro-ecological condition of Bangladesh although it is now cultivated in both summer and winter seasons in many countries of the world. With the technological progress, most of the growers have shifted mungbean to the Kharif-1 season instead of winter (Bose, 1982).

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

Mungbean contains 51% carbohydrate, 26% protein, 10% moisture, 4% mineral and 3% vitamin. Hence, on the nutritional point of view, mungbean is perhaps the best all other pulses (Khan, 1981 and Kaul, 1982). Among the pulse crops, mungbean has a special importance in intensive crop production system of the country for its short growing period (Ahmed *et al*., 1978). In Bangladesh it can be grown in late winter and summer season. Summer mungbean can tolerate high temperature exceeding 40^{0}C and grown well in the temperature range of $30\text{-}35^{0}$C (Singh and Yadav, 1978). This crop is reported to be drought tolerant and can also be cultivated in areas of low rainfall, but also grows well in the areas with 750-900 mm rainfall (Kay, 1979). So, cultivation of mungbean in the summer season could be an effective effort to increase pulse production in Bangladesh.

Mungbean is highly responsive to fertilizers and manures. It has a marked response to nitrogen, phosphorus and potassium. These nutrients play a key role in plant physiological process. A balanced supply of essential nutrients is indispensable for optimum plant growth. Continuous use of large amount of N, P and K are expected to influence not only the availability of other nutrients to plants because of possible interaction between them but also the buildup of some of the nutrients creating imbalances in soils and plants leading to decrease fertilizer use efficiency (Nayyar and Chibbam1992).

Molybdenum (Mo) is indispensable for a variety of species especially for legumes forming root nodules because it is directly involved in nitrogen fixing enzymes nitrogenase and nitrogen reduction enzyme, nitrate reductase. Molybdenum application can play a vital role in increasing mungbean yield through its effect on the plant itself and also on the nitrogen fixation process. On the contrary, deficiency of molybdenum resulted in decreased growth, yield and quality of mungbean as well as low nitrogen fixation. Lewis (1980) and Sharma *et al.* (1988) observed that molybdenum was responsible for the formation of nodule and increase in nitrogen fixation. He also reported that without adequate quantities of molybdenum, nitrogen fixation could not occur and microbial activity was depressed. Grewal *et al*. (1967) reported that molybdenum has a significant response to fix atmospheric nitrogen and yield of legume crops. Pulses could produce active nodule only when soils were properly supplied with molybdenum (Ahmed, 1982). Molybdenum is important for good foliage growth of higher plants.

Mo is directly involved in nitrogen fixing enzymes nitrogenase and N reduction enzyme, nitrate reductase especially for legumes forming root nodules. Its application can play a vital role in increasing mungbean yield through its effect on the plant itself and also on the nitrogen fixation process by *Rhizobium* (Westermann, 2005 and Vieira *et al.,* 1998).

Mungbean crop do not need much nutrition and usually can be grown on the marginal lands. Mungbean had played a central role in sustainable agriculture as it enhanced the soil fertility through biological nitrogen fixation in soil besides being a rich source of protein (Kannaiyan, 1999). Gupta *et al*. (1991) and Hale *et al*. (2001) stated that the molybdenum is a component of some bacterial nitrogenase and, therefore, is especially important for plants that live in symbiosis with nitrogen-fixing bacteria.

Field studies revealed that Mo is required for increasing nodulation and yield in mungbean (Paricca *et al*., 1983, and Velu and Savithri, 1982). In Bangladesh, hardly any attempt has so far been made on the application of Mo in mungbean for bringing about the improvement of nodulation and yield in relation to economic return. So it is necessary to examine the effects of different levels of this nutrient to enhance growth and productivity of mungbean. In view of these points the present study was undertaken to fulfill the following objectives:

I. To compare the growth and yield of different varieties of mungbean.
II. To know the effect of molybdenum on the performance of mungbean.
III. To determine the interaction effect of variety and different level of molybdenum on the growth and yield of mungbean.

CHAPTER 2

REVIEW OF LITERATURE

Research on mungbean is being carried out extensively in many countries including Bangladesh and the South East Asian countries specially Pakistan, India for its improvement of yield and quality. Pulse Research Centre at Iswardi, Bangladesh Agricultural Research Institute (BARI), Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) and Bangladesh Institute of Nuclear Agriculture (BINA) have been conducting research for improvement of this crop. The influence of variety and molybdenum on mungbean (*Vigna radiata* L.) have been reviewed below in this chapter.

2.1. Effects of varieties on growth and yield of mungbean

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

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 (GA_3 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 irrespective of seed treatment.

In an experiment under Bangladesh condition with four varieties of mungbean, Islam (1983) found the highest number of branches plant^{-1} from the variety Faridpur-1 followed by Mubarik, BM-7715 and BM-7704. The maximum number of pods plant^{-1} was produced by Mubarik followed by BM-7704, BM-7715 and Faridpur-1. He mentioned that pods plant^{-1} were a useful agronomic character contributing to higher yield in mungbean.

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

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

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

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

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. 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).

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 and 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). Data were recorded for days to first flowering, days to first leaf senescence, days to pod maturity, flower + pod abscission, root, stem+leaf, pod husk and seed dry matter content, pods $plant^{-1}$, seeds pod^{-1}, 100-seed weight, seed yield, biological yield and harvest index. 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.

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). Pusa 9531 showed higher yield components and grain yield than Pusa 105 and Pant mung 2.

Bhuiyan *et al.* (2003) conducted a field experiment at Regional Agricultural Research Station (RARS), Rahmatpur, Barisal. Inoculated plants gave significantly higher stover yield and seed yield copared to non-inoculated plants. Among 4 varieties, BARI mung2 produced higher yield. The variety BARI mung 2 gave the highest seed yield (1.38 t/ha) with inoculation.

Ali *et al*. (2004) conducted an experiment with munghbean varieties 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 used in this experiment. Inoculated plants gave significantly higher stover yield and seed yield compared to non inoculated plants. Among 3 varieties, BARI mung-1 produced the highest yield (1.35 t ha-1).

Sarkar *et al.* (2004) reported that in Bangladesh condition, BARI mung-2 contributed higher seed yield than BARI mung-5. Binamoog-2 had the highest number of branches plant^{-1}. The highest number of pods plant^{-1} was recorded for BARI mung-3. Pod length was greatest in BARI mung-5. **B**ARI mung-2 produced the highest seed yield and harvest index. The lowest seed yield and harvest index were recorded for BARI mung-3. The highest 1000-seed weight was obtained from BARI mung-5.

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

Mohanty *et al.* (1998) observed that among nine mungbean (*Vigna radiata*) cultivars, Kalamung was the best performing cultivar, with a potential seed yield of 793.65 kg ha^{-1}, the highest number of pods plant^{-1} (18.67) and highest number of seeds pod^{-1} (10.43).

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

2.2 Effect of Molybdenum on growth and yield of mungbean

Shil *et al.* (2007) found that boron played major role in augmenting yield. The highest mean yield (1.23 t ha^{-1}) was obtained with 2 kg ha^{-1} B and 1 kg ha $^{-1}$ Mo, which was 52% higher over control. The optimum economic dose of boron was found to be 1.76 kg ha^{-1}.

Zaman *et al.* (1996) conducted an experiment on mungbean and found that the height of 30.29 cm in plants receiving 1kg Mo ha^{-1} , which was 40.69% higher over control .They also observed that application of Mo (1 kg ha^{-1}) produced 44.6 higher root length over control. The branches plant^{-1} increased with increased level of Mo up to 2 kg ha^{-1}. They also reported that the highest branches plant^{-1} of 11.60 in mungbean due to application of Mo (2 kg ha^{-1}), which was 89% higher over control. The 1000 seed weight increased by 34.32% over control due to application of Mo (2 kg ha^{-1}) during 1990.

Hazra and Tripathi (1998) observed that Mo application at the rate of 1.5 kg ha^{-1} to Berseem increased forage and seed yield in calcareous soil.

Johansen *et al.* (2005) found that chickpea grown on residual soil moisture after rice harvet is a promising crop for the High Barind Tract (HBT), an uplifted, slightly undulating area in northwestern Bangladesh where the soils have an acid surface horizon (p^H 4.5-5.5 at 0-10 cm). to determine which elements could be limiting to chickpea. A subtractive design was used in which the absence of either sulfur (S), boron (B), zinc (Zn) or molybdenum (Mo) was compared to a complete nutrient control. Only Mo was found to be limiting, giving a grain yield response of 73%.

Niranjana (2005) conducted a field experiment to investigate the effect of B (1 g kg^{-1} seed), Zn (2 and 4 g kg^{-1} seed) and Mo (2 and 4 g kg^{-1} seed) as seed treatments on the growth and yield of groundnut cv. KRG-1 on Alfisol, which was deficient in Zn (0.46 mg kg^{-1}) and Mo (0.032 mg kg^{-1}). He observed that the micronutrients showed significant effect on yield, oil content and growth parameters. The Zn at 4g + Mo at 2g kg^{-1} seed treatment recorded the highest pod yield of 24.99 q kg^{-1} and growth parameters, total number of nodules (57.4) and their dry weight (100.2 mg $plant^{-1}$), number of effective nodules (27.80) and their dry weight (70 mg $plant^{-1}$) as well as root length (13.66 cm) and its dry weight (887 mg), over the control, The extent of increase was 24.11 % over the control.

Bhuiyan *et al*. (1997) conducted an experiment and observed that application of Mo and B both at the rate of 1 kg ha^{-1} along with 50 kg P_2O_5 ha^{-1} and 50 kg K_2O ha^{-1} produced significantly 347% and 440% higher nodule number and nodule weight in chickpea.

Zaman *et al.* (1996) conducted an experiment on mungbeam and observed that application of Mo (1 kg ha^{-1}) produced 97% and 150% higher nodule number and nodule weight, respectively over control.

Saha (1996) conducted a field trial in pre-kharif [pre-monsoon] seasons of 1993-94 at Pundibari, India, yellow sarson [*Brassica campestris* var. *sarson*] was given 0, 2.5 or 5.0 kg borax and 0, 1 or 2 kg sodium molybdate ha^{-1} applied as soil, 66% soil + 33% foliar or foliar applications and the residual effects were studied on summer green gram [*Vigna radiata*]. In both years green gram seed yield was highest with a combination of 5 kg borax + 2 kg sodium molybdate. Soil application gave higher yields than foliar or soil + foliar application.

Mohan and Rao (1997) observed that seed yield and number of pods/plant generally increased with increased with increasing rate of Mo (0.50 kg Mo $ha^{-1)}$ and P (90 kg P_2O_5 ha^{-1}).

Aghatise and Tayo (1994) reported that Mo application significantly increased soybean plant height compared with the control plants. At 10 weeks after emergence Mo application at the rate of 0.0, 0.2, 0.4, and 0.8kg ha^{-1} gave 23.1, 24.2 25.1, and 24.4cm height respectively.

Li and Gupta (1995) conducted an experiment in USA and observed that application of Mo (2 mg kg^{-1} soil) increased leaf N and shoot, root, and nodule dry weight, but did not significantly change mean photosynthesis, nodule nitrogense activity and chlorophyll content in soybean.

Sarkar and Banik (1991) conducted an experiment in Calcutta, India on green gram and observed that Mo application significantly increased pods per plant, seeds per pod, 100 seed weight and straw yield . They also reported that application of Mo at the rate of 0.10 and 0.25 kg ha^{-1} gave 11.45 and 11.76 kg ha^{-1} straw yield and 19.25 and 20.18 pods $plant^{-1}$, respectively.

Solaiman *et al.* (1991) carried out an experiment with two varieties of lentil, Utfala and Mymensingh local. They reported that 2 kg Mo ha^{-1} when applied with *Rhizobium* inoculants was found stimulating in respect of nodulation and dry matter production of the crop.

Paulino *et al.* (1994) showed that application of Mo favorably affected total N accumulation in soybean and benefiting N fixation, increased dry matter production.

Gupta and Narayanan (1992) reported that the pod number, seed number and weight and shoot dry weight showed significant higher values on exposure to 2 kg Mo ha^{-1} soil.

Sharma (1992) observed that application of Mo (1.5 mg ammonium molybdate/ha) increased 26.2% higher seed yield of soybean than control.

Singh *et al.* (1992) showed that protein content of cowpea grain increased significantly with increasing levels of Mo. Application of Mo at the rate of 1 or 2 kg ha^{-1} increased the protein content by 0.31 and 0.83 % respectively.

Molybdenum is required for increasing nodulation in Mungbean (Paricca *et al*, 1983; Velu and Savithri, 1982).

Molybdenum is essential for symbiotic N fixation. Pulses and legumes can have active nodules only when soils are adequately supplied with this element (Ahmed, 1982).

Mortvedt (1981) observed that Mo (2ppm) application to the soil increased the growth and N and Mo uptake of legumes.

Kalia and Sharma (1989) observed that soybean yield was increased 46% higher than control due to application of 1 kg Mo ha^{-1}.

Nayak *et al.* (1989) reported that the treatment with Mo had a significant influence on growth, yield and yield attributes like $podsplant^{-1}$, seeds pod^{-1} and seed weight.

Tiwari *et al.* (1989) reported that Mo application improved 75% higher nodule number in chickpea.

Paricca *et al. (*1983) conducted a field experiment with *Vigna radiata* L. and observed that Mo alone increased the yield by 26.4% and this effect was equivalent to 25 kg N ha^{-1}.

According to FAO (1982, 1983), application of Mo at the rate of 0.4 kg ha^{-1} is sufficient for the maximum nodulation in legumes on acid soils.

Verma *et al.* (1988) observed that application of Mo and P increase the pod number and seed yield increased with Mo application up to the highest level. Similar trends were noted for seed protein content. Mo is potentially limiting factor for chickpea yields in similar alluvial soil.

Pradhan and Sarker (1985) observed that application of Mo increased nodule by dry weight.

Significant yield responses of pulses to applied Mo in different soils have been reported from home and abroad (Kliewer and Kennedy, 1960, Ahmed, 1982).

Although pulses are usually grown in Bangladesh with minimum fertilization in the recent years inadequate soil fertility in many instances has appeared as serious limitation of their yields (Islam and Sarkar, 1993).

Gerath *et al*. (1975) reported an increase in yield of winter rape through application of boron fertilizer and recommended an application of 1 to 2 kg B ha^{-1} for increased yield.

Jakson and Chapman (1975) observed that boron stimulates germination, particularly pollen tube growth. Boron is also essential for sugar translocation, thus affecting carbon and nitrogen metabolism of plants.

Barthakur (1980) conducted a field experiment in India on soybean and observed that seed yield of soybean was increased 27% higher than control treatment with 400g Mo ha^{-1} application.

Sherrell (1984) conducted an experiment in New Zealand and observed that application of Mo by seed soaking was greater 20 times as efficient as soil application in increasing yield and N fixation.

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Dhaka-1207 during the Kharif-1 season from March to May, 2016 to study the growth and yield of mungbean varieties as affected by molybdenum application. The materials used and methodology followed in the investigation have been presented details in this chapter.

3.1 Description of the Experimental Site:

3.1.1 Geographical location

The experimental area was situated at 23°77′N latitude and 90°33′E longitude at an altitude of 9 meter above the sea level (Anon., 2004).

3.1.2 Agro-ecological region

The experimental field belongs to the Agro-ecological zone of "The Modhupur Tract", AEZ-28 (Anon., 1988a). This was a region of complex relief and soils developed over the Modhupur clay, where floodplain sediments buried the dissected edges of the Modhupur Tract leaving small hillocks of red soils as 'islands' surrounded by floodplain (Anon., 1988b). The experimental site was shown in the map of AEZ of Bangladesh in Appendix I.

3.1.3 Soil

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

3.1.4 Climate

The area has subtropical climate, characterized by high temperature, high relative humidity and heavy rainfall with occasional gusty winds in Kharif season (April-September) and scanty rainfall associated with moderately low temperature during the Rabi season (October-March).

3.2 Details of the experiment

3.2.1 Treatments

Two sets of treatment factors included in the experiment; the first set comprised of three varieties of mungbean namely BARI mung-5, BARI mung-6 and BU mug-4 and the second set consisted of five doses of Molybdenum. Two sets of treatments were as follows:

A. Main plot (Variety): 3

1. BARI mung-5 - V_1
2. BARI mung-6 - V_2
3. BU mug-4 - V_3

B. Sub-plot (Molybdenum) doses: 5

1. 0 (Control) -M_0
2. 2 g/kg seed -M_1
3. 4 g/kg seed -M_2
4. 6 g/kg seed -M_3
5. 8 g/kg seed -M_4

3.2.2 Experimental design and layout

The experiment was laid out into Split-plot design with three replications having varieties in the main plot and Molybdenum in the sub-plot. Each replication had fifteen unit plots to which the treatment combinations were assigned randomly. The total numbers of unit plots were forty-five. The size of unit plot was 7 m^2 (3.5 m x 2 m). The distances between replication to replication and plot to plot were 0.75m and 0.50 m respectively. The layout of the experiment has been shown in Appendix II.

3.2.3 Planting materials

The seeds of BARI mung-5, BARI mung-6 and BU mug-4 varieties were used as experimental material. BARI mung-5 was developed by Bangladesh Agricultural Research Institute (BARI) characterized as of 40-45 cm in height, life cycle lasts for 55-60 days and synchronous type. The plants are erect, stiff and less branched. Each plant contains 15-20 pods. Each pod is approximately 10 cm long and contains 8-10 seeds. Seeds are green in color and drum shaped. The plants of BARI mung-6 was developed by Bangladesh Agricultural Research Institute (BARI) characterized as 40-45 cm in height, life cycle lasts for 55-58 days and synchronous type. The plants are erect, stiff and less branched. On the other hand, BU mug-4 was developed by Bangabandhu Sheikh Mujibur Rahman Agricultural University characterized as life cycle lasts for 55-60 days and synchronous type. The plants are erect, stiff and less branched. Each plant contains 15-20 pods. Seeds are dark green in color. The seed yield of BARI mung-5 ranges from 1.3 to 1.5 t ha^{-1}, BARI mung-6 ranges from 1.8 t ha^{-1} and BU mug-4 ranges from 1.8 to 2.0 t ha^{-1}.

3.2.4 Preparation of experimental land

A pre-sowing irrigation was given on March 7, 2016. The land was opened with the help of a tractor drawn disc harrow on March 8, 2016, and then ploughed with rotary plough twice followed by laddering to achieve a medium tilth required for the crop under consideration. All weeds and other plant residues of previous crop were removed from the field. Immediately after final land preparation, the field layout was made on March 9, 2016 according to experimental specification. Individual plots were cleaned and finally prepared the plot.

3.2.5 Fertilizer application

During final land preparation, the land was fertilized with 55, 85 and 45 kg ha^{-1} of Urea, TSP and MoP respectively as basal dose. During seed sowing molybdenum was applied along with seeds as per treatments.

3.2.6 Seed sowing

The seeds of BARI mung-5, BARI mung-6 and BU mug-4 were sown by hand in 30 cm apart lines continuously at about 3 cm depth at the rate of 50 kg ha^{-1} on March 10, 2016.

3.2.7 Intercultural operations

3.2.7.1 Thinning

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

3.2.7.2 Weeding

The crop field was infested with some weeds during the early stage of crop establishment. Three hand weedings were done; first weeding was done at 15 days after sowing followed by second weeding at 30 days after sowing and third weeding at 45 days after sowing.

3.2.7.3 Application of irrigation water

Irrigation water was added to each plot, first irrigation was done as pre-sowing and other two were given at 25 and 40 days after sowing.

3.2.7.4 Drainage

There was a heavy rainfall during the experimental period. Drainage channels were properly prepared to easy and quick drained out of excess water.

3.2.7.5 Plant protection measures

The crops were infested by insects and diseases. The fungicide Bavistin 0.2% @25g/18L water was sprayed at 17 and 36 days after sowing and insecticide

Ripcord 10 EC @50 mL/20L water was sprayed at 20 and 47 days after sowing to control pests.

3.2.7.6 Harvesting and post-harvest operations

Maturity of crop was determined when 80-90% of the pods become blackish in color. Two harvesting was done while the first harvesting was done on 7 May and the second on 27 May. The harvesting was done by picking pods from central six lines for avoiding the boarder effects. The collected pods were sun dried, threshed and weighted to a control moisture level. The seed weight of harvesting pods plot^{-1} was added and converted into t ha^{-1}.

3.3 Recording of data

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

A. Crop Growth Parameters:

1. Plant height (cm) at 15 days interval upto harvest.
2. Number of leaves per plant at 15 days interval upto harvest.
3. Dry matter weight per plant at 15 days interval upto harvest.
4. Number of nodules per plant at 30 & 45 DAS.

B. Yield and Other Contributing Parameters:

5. Number of branches per plant at 30, 45 & 60 DAS.
6. Number of pods per plant.
7. Length of the pod.
8. Number of seeds per pod.
9. Weight of thousand seeds (g).
10. Shelling percentage
10. Pod yield (kg/ha).

11. Seed yield (kg/ha).
12. Husk yield (kg/ha).
13. Stover yield (kg/ha)
14. Biological yield (t/ha).
15. Harvest index (%).

3.4 Detailed procedures of recording data

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

3.4.1. Crop growth characters

3.4.1.1 Emergence

Numbers of seeds germinated per m^2 from each plot were counted at 4, 5, 6, 7, 8, 9, 10 and 11days after sowing (DAS) when maximum seeds are germinated.

3.4.1.2 Plant height (cm)

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

3.4.1.3 Number of leaves plant^{-1}

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

3.4.1.4 Number of nodules plant^{-1}

The five plants plot^{-1} from second line were uprooted carefully and total number of nodules were counted at 30 and at 45 DAS and the mean values were determined.

3.4.1.5 Dry weight plant^{-1} (g)

Five plants from each plot were collected for each recording data. The plant parts were packed in paper packets then kept in the oven at 80^0 C for 72hrs to reach a constant weight. Then the dry weights were taken with an electric balance. The mean values were determined.

3.4.2 Yield and other crop characters

3.4.2.1 Number of branches plant^{-1}

The number of branches plant^{-1} from five randomly selected plants of each plot were counted at 30, 45, 60 days after sowing (DAS) and at harvest and mean values were taken.

3.4.2.2 First flowering

The date of first flowering of each plot was recorded.

3.4.2.3 Number of pods plant^{-1}

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

3.4.2.4 Pod length (cm)

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

3.4.2.5 Number of seeds pod^{-1}

Pods from each of five randomly selected plants plot^{-1} were separated from which ten pods were selected randomly. The number of seeds pod^{-1} was counted and average values were recorded.

3.4.2.6 1000-seed weight (g)

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

3.4.2.7 Shelling percentage (%)

Pods from each of five randomly selected plants $plot^{-1}$ were separated and dried under sun. After that the weight of the shells and seeds were recorded from which shelling percentage was calculated as per following formula:

$$\text{Shelling percentage} = \frac{\text{Weight shelled}}{\text{Weight unshelled}} \times 100$$

3.4.2.8 Pod yield (kg ha^{-1})

The pods from harvested area (central six lines, 4 m^2) were harvested as per experimental treatments and properly dried under sun. Then pod yield $plot^{-1}$ was recorded and converted into kg ha^{-1}.

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

The pods from harvested area (central six lines, 4 m^2) were harvested as per experimental treatments and were threshed. Seeds were cleaned and properly dried under sun. Then seed yield $plot^{-1}$ was recorded at 12% moisture level and converted into kg ha^{-1}.

3.4.2.10 Husk yield (kg ha^{-1})

The pods from harvested area (central six lines, 4 m^2) were harvested as per experimental treatments and were threshed. Husks were properly dried under sun. Then Husk yield $plot^{-1}$ was recorded and converted into kg ha^{-1}.

3.4.2.11 Stover yield (t/ha)

After separation of pod, the plants were sun-dried for several days to a constant weight to record the stover yield $plot^{-1}$. The stover yield m^{-2} was then converted to t ha^{-1}.

3.4.2.12 Biological yield (t ha^{-1})

Seed yield and straw yield were all together regarded as biological yield. Biological yield was calculated with the following formula:

Biological yield (t ha^{-1}) = Seed yield (t ha^{-1}) + Straw yield (t ha^{-1})

3.4.2.13 Harvest index (%)

Harvest index denotes the ratio of seed yield to biological yield and was calculated with following formula (Gardner *et al.*, 1985).

$$\text{Harvest index (\%)} = \frac{\text{Seed yield (t ha}^{-1})}{\text{Biological yield (t ha}^{-1})} \times 100$$

3.5 Analysis of data

The data collected on different parameters were statistically analyzed to obtain the level of significance using the CROPSTAT computer package program. Mean difference among the treatments were tested with Least Significant Difference Test (LSD) at 5% level of significance.

CHAPTER 4

RESULTS AND DISCUSSION

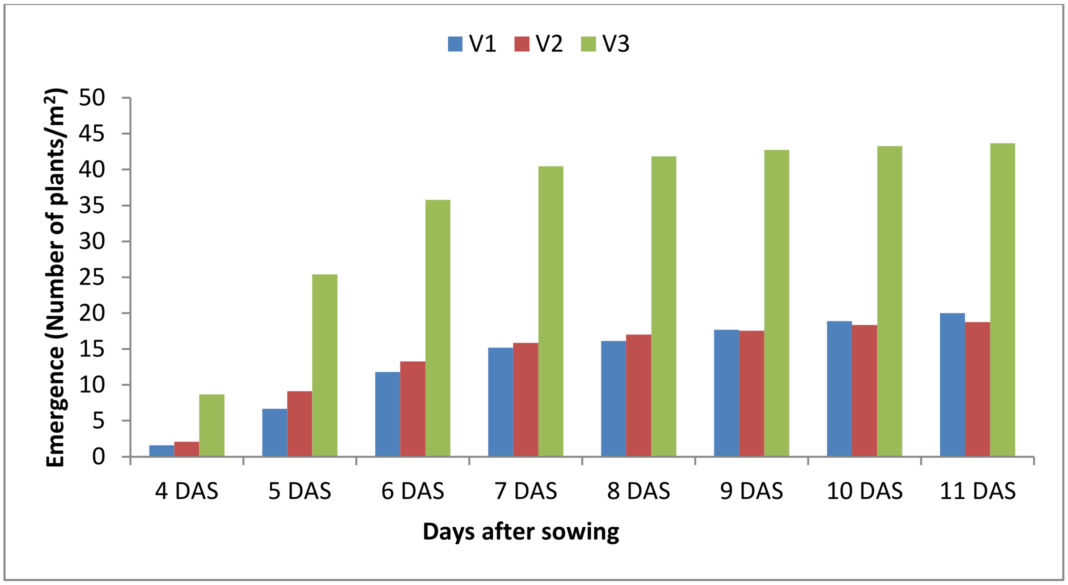
The experiment was conducted to investigate the effect of various levels of molybdenum on the growth and yield of three mungbean varieties, BARI mung-5, BARI mung-6 and BU mug-4. The findings have been presented and discussed and possible interpretations are given under the following headings:

4.1 Crop growth characters

4.1.1 Emergence (Number of plant/m^2)

4.1.1.1 Effect of variety

Emergence of mungbean was significantly influenced by varieties at 5, 6, 7, 8, 9, 10 and 11 days after sowing (DAS) but effect was not significant at 4 DAS (Appendix III and Figure 1). At 4 DAS, number of plant/m^2 emerged of BARI mung-5, BARI mung-6 and BU mug-4 was statistically similar. But at 5 DAS, emergence was higher in V_3 (BU mug-4) but the result was statistically similar with V_2 (BARI mung-6). The lowest emergence was found in V_1 (BARI mung-5) but the result was statistically similar with V_2 (BARI mung-6). At 6, 7 and 8 DAS the highest emergence was found in V_3 (BU mug-4) and the lowest emergence was found in V_1 (BARI mung-5) and it was statistically similar with V_2 (BARI mung-6). At 9, 10, 11 DAS, number of plant emerged/m^2 was higher in V_3 (BU mug-4). Emergence was lower in V_2 (BARI mung-6) but the result was statistically similar with V_1 (BARI mung-5). These results were compared with the findings of Ghosh (2007) who found that emergence was significantly influenced by varieties. He also found the highest emergence in Sona mung and the lowest in BARI mung-6.

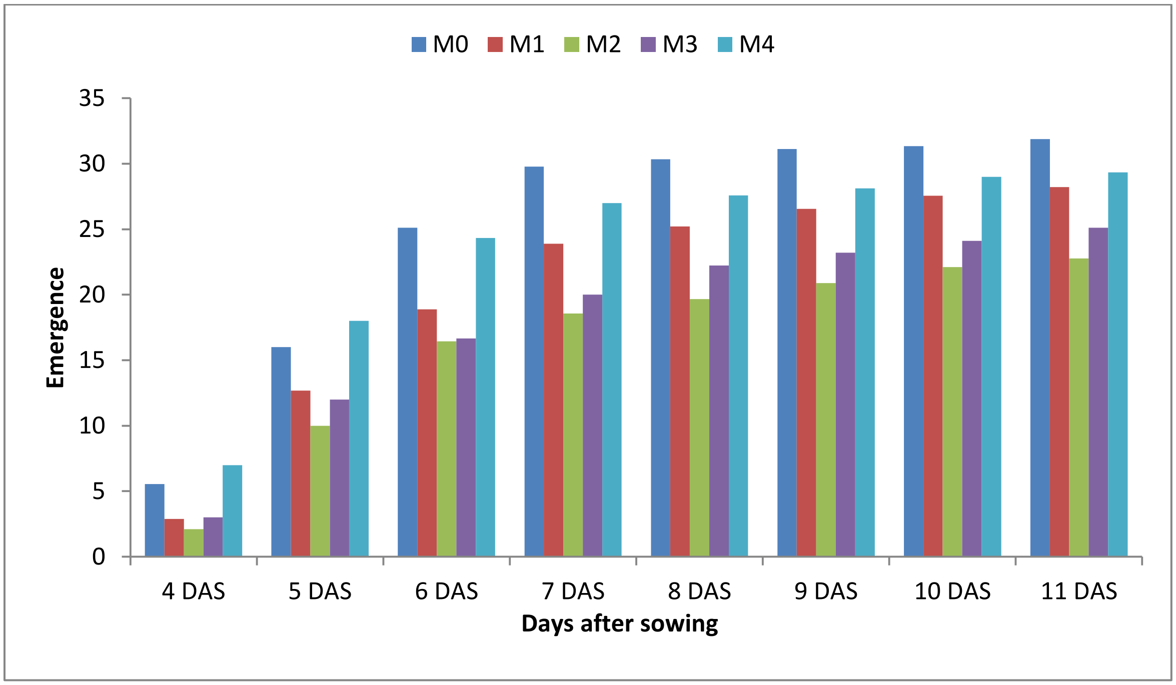


V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4

Figure 1. Emergence of mungbean as influenced by variety ($LSD_{0.05}$=18.632, 18.533, 19.729, 18.604, 18.366, 17.593 and 15.838 at 5, 6, 7, 8, 9, 10 and 11 DAS, respectively).

4.1.1.2 Effect of molybdenum

Emergence of mungbean was significantly influenced by molybdenum at 4, 5, 7, 8 and 9 DAS but effect was not significant at 6, 10 and 11 DAS (Appendix III and Figure 2). At 4 DAS emergence was higher in M_4 (8g/kg seed) but it was statistically similar with M_0 (control). The lowest emergence was found in M_2 (4g/kg seed) but it was statistically similar with M_1 (2g/kg seed), M_3 (6g/kg seed) and M_0 (control). At 5 DAS the highest emergence was observed in M_4 (8g/kg seed) which was statistically similar with M_0 (control), M_1 (2g/kg seed) and M_3 (6g/kg seed). Emergence was lowest at M_2 (4g/kg seed) but it was statistically similar with M_3 (6g/kg seed), M_1 (2g/kg seed) and M_0 (control). At 7 DAS the highest emergence was observed in M_0 (control) but it was statistically similar with M_4 (8g/kg seed) and M_1 (2g/kg seed). The lowest emergence was found in M_2 (4g/kg seed) but it was statistically similar with M_3 (6g/kg seed), M_1 (2g/kg seed) and M_4 (8g/kg seed). At 8 and 9 DAS the highest emergence was in M_0 (control) but it was statistically similar with M_4 (8g/kg seed), M_1 (2g/kg seed) and M_3 (6g/kg seed). Emergence was lower in M_2 (4g/kg seed) but it was statistically similar with M_3 (6g/kg seed), M_1 (2g/kg seed) and M_4 (8g/kg seed). At 10 and 11 DAS maximum emergence was found inM_4 (8g/kg seed) but it was statistically similar with others.



M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 2. Emergence of mungbean as influenced by molybdenum ($LSD_{0.05}$= 3.839, 7.706, 9.755, 10.258 and 10.331 at 4, 5, 7, 8 and 9 DAS, respectively).

4.1.1.3 Interaction effect of variety and Molybdenum

Interaction of variety and molybdenum showed significant effect on emergence of mungbean (Table 1). At 4 DAS, the highest emergence was recorded at V_3M_4treatment (BU mug-4 with 8g/kg seed) which was statistically similar with V_3M_0 treatment (BU mug-4 with no molybdenum treatment). The lowest emergence was found in V_1M_2 treatment (BARI mung-5 with 4g/kg seed) but it was statistically similar with V_1M_3, V_1M_4, V_2M_0, V_2M_3, V_2M_2, V_1M_1, V_2M_1, V_2M_4, V_3M_1, V_3M_2 and V_1M_0. At 5 DAS the highest emergence was observed in

V_3M_4 treatment which was statistically similar with V_3M_0 treatment. The lowest emergence was found in V_1M_2 treatment that was statistically similar with V_1M_3, V_1M_4, V_2M_0, V_2M_2, V_1M_1, V_2M_3, V_2M_1, V_2M_4 and V_1M_0. At 6 DAS the highest emergence was found in V_3M_4 treatment which was statistically similar with V_3M_0 treatment. The lowest emergence was recorded in V_1M_3but it was statistically similar with V_1M_4, V_1M_2, V_2M_0, V_2M_2, V_2M_3, V_1M_1, V_2M_1, V_2M_4 and V_1M_0. At 7 DAS the highest emergence was found in V_3M_0 treatment which was statistically similar with V_3M_4 and V_3M_3 treatment. The lowest emergence was recorded in V_1M_3 but it was statistically similar with V_1M_4, V_2M_2, V_1M_2, V_2M_0, V_2M_3, V_2M_1, V_1M_1, V_2M_4 and V_1M_0. At 8 DAS the highest emergence was found in V_3M_0 treatment which was statistically similar with V_3M_4, V_3M_3 and V_3M_1 treatment. The lowest emergence was recorded in V_1M_4 but it was statistically similar with V_1M_3, V_2M_2, V_1M_2, V_2M_0, V_2M_3, V_1M_1, V_2M_1, V_2M_4 and V_1M_0. At 9 DAS the highest emergence was found in V_3M_0 treatment which was statistically similar with V_3M_4, V_3M_3 and V_3M_1treatment. The lowest emergence was recorded in V_1M_4 but it was statistically similar with V_1M_3, V_2M_2, V_2M_0, V_1M_2, V_2M_3, V_2M_1, V_1M_1 and V_1M_0. At 10 DAS the highest emergence was recorded in V_3M_0 treatment which was statistically similar with V_3M_4, V_3M_3 and V_3M_1 treatment. The lowest emergence was recorded in V_1M_4 but it was statistically similar with V_1M_3, V_2M_0, V_2M_2, V_2M_3, V_1M_2, V_2M_1, V_1M_1, V_2M_4 and V_1M_0. At 11 DAS the highest emergence was recorded in V_3M_4 treatment which was statistically similar with V_3M_1, V_3M_3 and V_3M_1 treatment. The lowest emergence was found in V_1M_4 but it was statistically similar with V_2M_0, V_2M_2, V_1M_3, V_2M_3, V_1M_2, V_2M_1, V_2M_4, V_1M_1 and V_1M_0.

Table 1. Interaction effect of variety and molybdenum on emergence of mungbean at different days after sowing

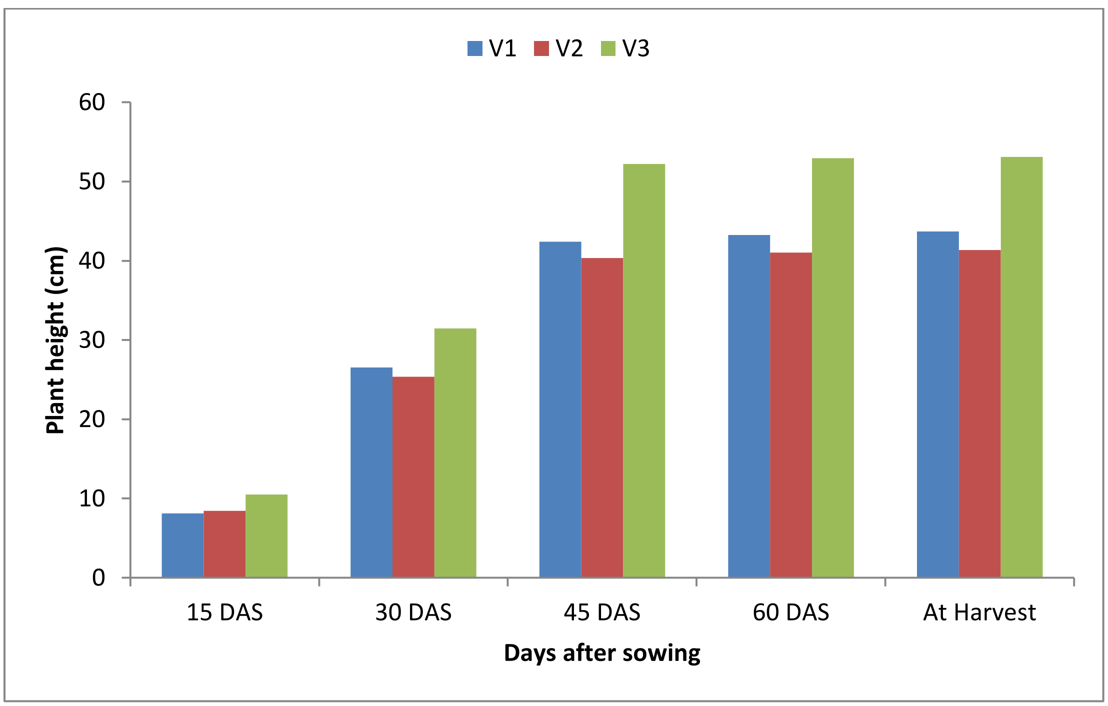
Treat-ments	Emergence (Number of plants /m^2) at							
	4 DAS	5 DAS	6 DAS	7 DAS	8 DAS	9 DAS	10 DAS	11 DAS
V_1M_0	5.67b-d	12 c-e	19.67c-f	24.33c-f	25 b-d	26.33b-e	26.67b-d	27.67b-d
V_1M_1	1.67 cd	8.67 de	13.33d-f	19 c-f	20 cd	21 c-e	22.33b-d	24.33b-d
V_1M_2	0.00 d	4 e	10.33 f	13 f	14.33 d	15.67de	18 d	19.67 d
V_1M_3	0.33 d	4.33 e	7 f	9.67 f	11 d	13.67 e	15 d	16 d
V_1M_4	0.33 d	4.33 e	8.67 f	10 f	10.33 d	11.67 e	12.33d	12.33 d
V_2M_0	1d	7 e	10.67 f	13.33ef	14.33 d	14.67 e	15 d	15.67 d
V_2M_1	2.33 cd	10 c-e	15.67c-f	18.33d-f	20 cd	20.33 de	21.33cd	21.33cd
V_2M_2	1.33 cd	7.33 de	10.67 f	12.67 f	13 d	14.33 e	16.67d	16 d
V_2M_3	1 d	9.33c-e	12 ef	15 ef	16.67 d	17 de	17 d	18 d
V_2M_4	4.67b-d	12 c-e	17.33c-f	20 c-f	21 cd	21.33b-d	22.67b-d	22.67cd
V_3M_0	10 ab	29 ab	45 ab	51.67 a	51.67 a	52.33 a	52.33a	52.33 a
V_3M_1	4.67b-d	19.33b-d	27.67c-e	34.33b-d	35.67a-c	38.33a-c	39 a-c	39 a-c
V_3M_2	5 b-d	18.67b-d	28.33 cd	30c-e	31.67 b	32.67b-d	32.67b	32.67 b
V_3M_3	7.67bc	22.23 bc	31 bc	35.33a-c	39 ab	39 ab	40.33ab	41.33ab
V_3M_4	16 a	37.67 a	47 a	51 ab	51.33 a	51.33 a	52 a	53 a
LSD (0.05)	6.649	13.348	15.974	16.897	17.768	17.893	18.23	17.911
CV(%)	96.01	57.68	46.72	42.05	63.08	64.32	66.19	66.05

In a column, the means having the same letter (s) do not differ significantly,
CV = Coefficient of variation, $LSD_{(0.05)}$= Least significant difference at 5% level, DAS = Days after sowing
V_1= BARI mung-5, V_2= BARI mung-6, V_3= BU mug-4,M_0=0(Control),M_1= 2g/kg seed, M_2= 4g/kg seed, M_3= 6g/kg seed, M_4= 8g/kg seed,

4.1.2 Plant height (cm) at different growth stages

4.1.2.1 Effect of variety

The plant height of mungbean was not significantly influenced by varieties at 15, 30, 45, 60 days after sowing (DAS) and at harvest (Appendix IV and Figure 3).At 15 DAS numerically maximum plant height was observed in V_3 (BU mug-4). At 30, 45, 60 DAS and at harvest the maximum plant height was recorded in V_3 (BU mug-4). The result revealed that varieties had no significant effect because plant height of BARI mung-5, BARI mung-6 and BU mug-4 were statistically similar at 15, 30, 45, 60 DAS and at harvest. These results were dissimilar with the findings of Aguilar and Villarea (1989) and Thakuria and Saharia (1990) who reported that varieties differ significantly in respect of plant height of mungbean.

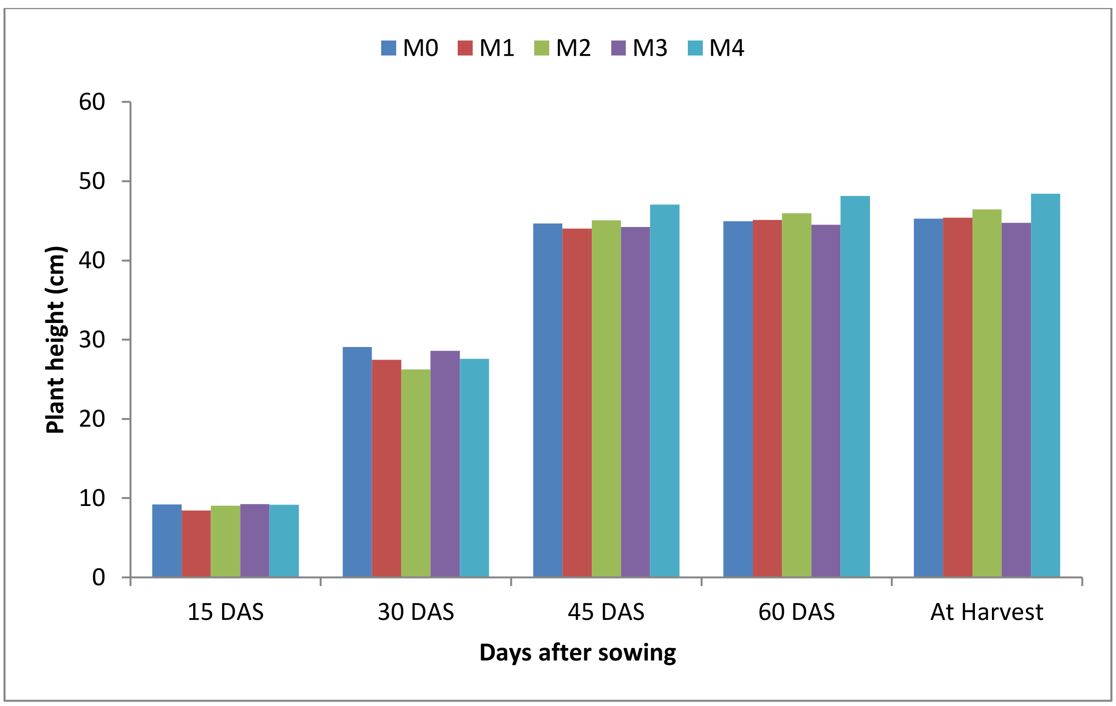


V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4

Figure 3. Plant height of mungbean as influenced by variety.

4.1.2.2 Effect of molybdenum

Molybdenum had no significant effect on plant height at 15, 30, 45, 60 DAS and at harvest (Appendix IV and Figure 4). At 15 DAS higher plant height was observed in M_3 (6g/kg seed). At 30 DAS the maximum plant height was recorded in M_0 (Control). At 45, 60 DAS and at harvest M_4 (8g/kg seed) shows higher plant height. It indicated that plant height at 15, 30, 45, 60 DAS and at harvest with different molybdenum dose showed statistically similar result. Aghatise and Tayo (1994) reported that Mo application significantly increased soybean plant height compared with the control plants. At 10 weeks after emergence Mo application at the rate of 0.0, 0.2, 0.4, and 0.8kg ha^{-1} gave 23.1, 24.2, 25.1, and 24.4cm height respectively. Zaman *et al.* (1996) conducted an experiment on mungbean and found that the height of 30.29 cm in plants receiving 1kg ha^{-1}, which was 40.69% higher over control.



M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 4. Plant height of mungbean as influenced by molybdenum.

4.1.2.3 Interaction effect of variety and molybdenum

The plant height of mungbean was significantly influenced by interaction between variety and molybdenum at 15, 30, 45, 60 days after sowing (DAS) and at harvest (Table 2).At 15 DAS, V_3M_4 treatment shows higher plant height (10.95 cm). But it was statistically similar with V_3M_3, V_3M_2, V_3M_0, V_3M_1, V_2M_0, V_1M_3, V_2M_3, V_1M_4, V_2M_2 and V_1M_2. The lowest plant height (7.31 cm) was recorded in V_1M_1 treatment which was statistically similar with V_2M_1, V_2M_4, V_1M_0, V_1M_2, V_1M_4, V_2M_2, V_2M_3, V_1M_3, V_2M_0, V_3M_1 and V_3M_0. At 30 DAS, the highest plant height (33.71 cm) was recorded in V_3M_3 treatment but this was statistically similar with V_3M_4, V_1M_0, V_3M_1, V_3M_0 and V_3M_2. The lowest plant height (23.93 cm) was found in V_2M_2 treatment which was statistically similar with V_1M_1, V_1M_2, V_2M_4, V_2M_3, V_2M_0, V_1M_4, V_1M_3 and V_2M_1. At 45 DAS, V_3M_4 treatment shows higher plant height (54.65 cm) but it was statistically similar with V_3M_2, V_3M_1, V_3M_3, V_3M_0 and V_1M_0. The lowest plant height (36.90 cm) was found in V_2M_o treatment which was statistically similar with V_1M_1, V_2M_3, V_1M_2, V_2M_2, V_2M_1, V_1M_4, V_1M_3, V_2M_4 and V_1M_0. At 60 DAS, the highest plant height (55.25 cm) was recorded in V_3M_4 treatment but this was statistically similar with V_3M_2, V_3M_1, V_3M_3, V_3M_0, V_1M_0 and V_1M_4. The lowest plant height (37.12 cm) was found in V_2M_o treatment which was statistically similar with V_2M_3, V_1M_1, V_2M_2, V_1M_2, V_1M_3, V_2M_1, V_2M_4, V_1M_4 and V_1M_0. At harvest, highest plant height (55.65 cm) was recorded in V_3M_4 treatment but this was statistically similar with V_3M_2, V_3M_1, V_3M_3, V_3M_0, V_1M_0 and V_1M_4. The lowest plant height (37.76 cm) was found in V_2M_o treatment which was statistically similar with V_2M_3, V_1M_1, V_2M_2, V_1M_2, V_1M_3, V_2M_1, V_2M_4, V_1M_4 and V_1M_0.

Table 2. Interaction effect of variety and fertilizer materials on plant height of mungbean at different growth stages

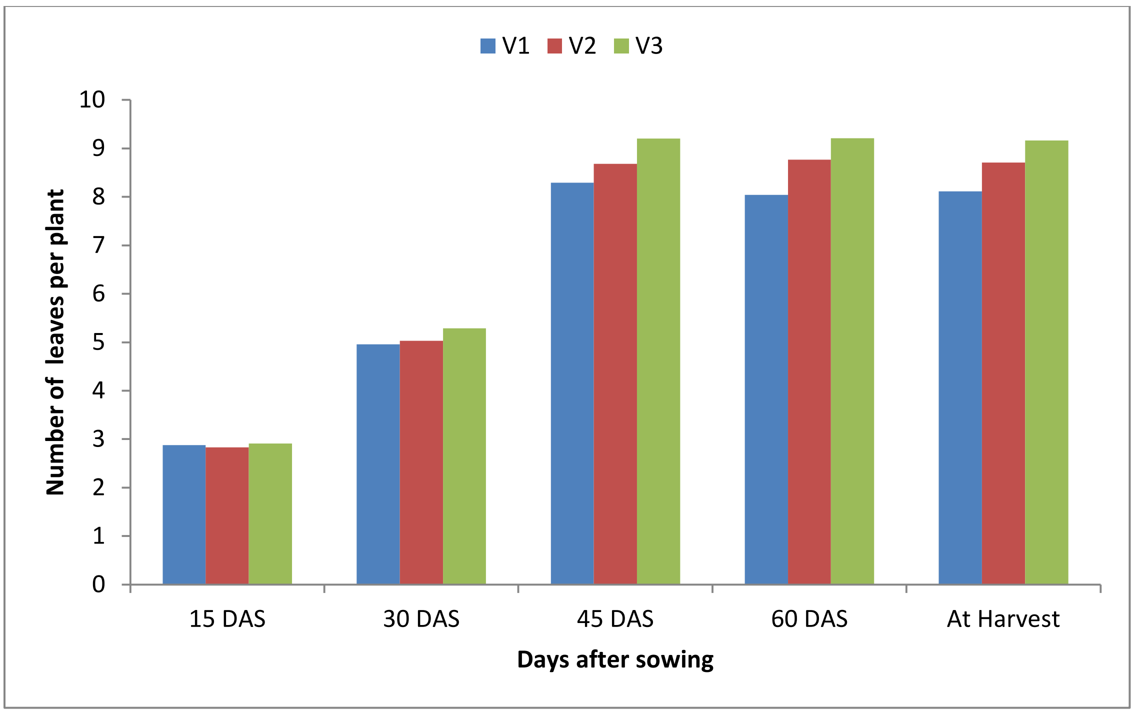
Treatments	Plant height (cm) at				
	15 DAS	30 DAS	45 DAS	60 DAS	At harvest
V_1M_0	8.22 b-d	31.25 a-c	46.61 a-d	46.81 a-e	47.19 a-d
V_1M_1	7.31 d	24.17 d	38.07 d	39.59 e	39.73 d
V_1M_2	8.27 a-d	24.52 d	40.91 cd	41.71 de	42.34 cd
V_1M_3	8.51 a-d	26.78 b-d	43.19 b-d	43.31 c-e	44.15 cd
V_1M_4	8.39 a-d	25.90 b-d	43.30 b-d	44.87 a-e	45.09 a-d
V_2M_0	9.13 a-d	25.45 b-d	36.90 d	37.12 e	37.76 d
V_2M_1	8.01 cd	27.05 b-d	42.25 cd	43.48 c-e	44.36 cd
V_2M_2	8.39 a-d	23.93 d	40.99 cd	41.25 de	41.49 cd
V_2M_3	8.43 a-d	25.24 cd	38.47 d	38.89 e	38.63 d
V_2M_4	8.18 b-d	25.21 cd	43.17 b-d	44.34 b-e	44.52 b-d
V_3M_0	10.28 a-d	30.51 a-c	50.49 a-c	50.97 a-d	50.79 a-c
V_3M_1	10.01 a-d	31.21 a-c	51.68 a-c	52.21 a-c	52.13 a-c
V_3M_2	10.43 a-c	30.35 a-c	53.27 ab	54.95 ab	55.52 ab
V_3M_3	10.79 ab	33.71 a	51.05 a-c	51.37 a-d	51.45 a-c
V_3M_4	10.95 a	31.59 ab	54.65 a	55.25 a	55.65 a
$LSD_{(0.05)}$	2.674	6.137	10.981	10.634	11.029
CV (%)	17.60	13.10	14.48	13.80	14.21

In a column, the means having the same letter (s) do not differ significantly
CV = Coefficient of variation, $LSD_{(0.05)}$= Least significant difference at 5% level, DAS = Days after sowing
V_1= BARI mung-5, V_2= BARI mung-6, V_3= BU mug-4, M_0=0 (Control),M_1=2g/kg seed, M_2=4g/kg seed
M_3=6g/kg seed, M_4=8g/kg seed

4.1.3 Number of leaves plant^{-1} at different growth stages

4.1.3.1 Effect of variety

Varieties showed no significant influence on leaf number at 15, 30, 45 and 60 DAS i.e. the number of leaves/plant were statistically similar among the varieties but the number of leaves/plant of mungbean was significantly influenced by varieties at harvest (Appendix V and Figure 5). At 15, 30, 45 and 60 DAS V_3 (BU mug-4) resulted the maximum leaf number. At harvest, higher leaf number (9.16) was reported in V_3 (BU mug-4) which was statistically similar with V_2 (BARI mung-6). The lowest number of leaves (8.11) was found in V_1 (BARI mung-5) but it was statistically similar with V_2 (BARI mung-6).Ansary (2007) reported that varieties differ significantly in respect of number of leaflets plant^{-1}. He found two varieties BARI mung-6 and BU mung-2 had significant effect on number of leaflets plant^{-1} at 30 and 45 DAS.

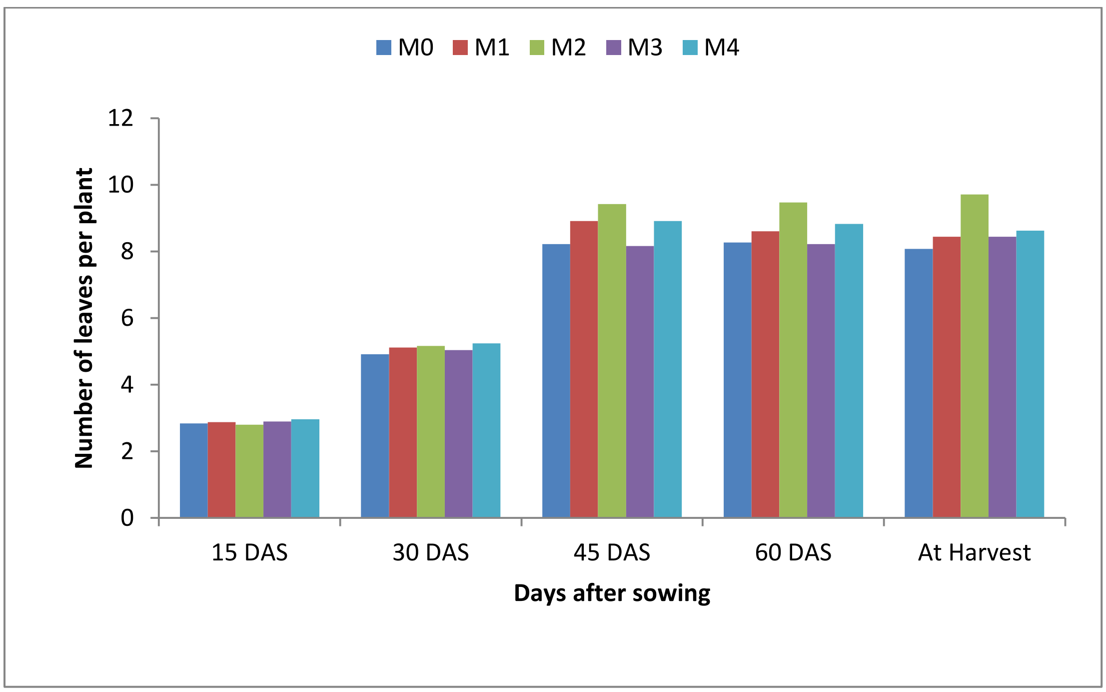


V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4

Figure 5. Number of leaves plant^{-1} of mungbean as influenced by variety ($LSD_{0.05}$= 7.268 at harvest).

4.1.3.2 Effect of molybdenum

Number of leaves plant^{-1} of mungbean was significantly influenced by molybdenum application at 60 days after sowing (DAS) and at harvest but at 15, 30 and 45 DAS, molybdenum had no significant effect because number of leavesplant^{-1} of BARI mung-5, BARI mung-6 and BU mug-4 were statistically similar at 15, 30 and 45 DAS (Appendix V and Figure 6). At 15 and 30DASthe maximum leaf number was recorded in M_4 (8g/kg seed) whereas at 45 DAS the maximum leaf number was observed in M_2 (4g/kg seed). At 60 DAS, M_2 (4g/kg seed) showed highest leaf number (9.47) but it was statistically similar with M_4 (8g/kg seed), M_2 (4g/kg seed) and M_0 (Control). The lowest leaf number (8.22) was found in M_3 (6g/kg seed) which was statistically similar with M_0 (Control), M_1 (2g/kg seed) and M_4 (8g/kg seed). At harvest, the highest leaf number (9.71) was recorded in M_2 (4g/kg seed). The lowest number of leaf (8.07) was found in M_0 (Control) but it was statistically similar with M_1 (2g/kg seed), M_3 (6g/kg seed) and M_4 (8g/kg seed).



M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 6. Number of leaves plant^{-1} of mungbean as influenced by molybdenum ($LSD_{0.05}$= 14.396 and 11.688 at 60 DAS and at harvest, respectively).

4.1.3.3 Interaction effect of variety and molybdenum

Interaction effect of variety and molybdenum had no significant influence on leaf number of mungbean at 15 DAS but significant variation observed at 30, 45, 60 DAS and at harvest (Table 3).At 30 DAS, the highest leaf number (5.67) was recorded in V_3M_2 treatment which was statistically similar with V_3M_1, V_2M_4, V_3M_4, V_1M_4, V_2M_1, V_1M_0, V_1M_3, V_3M_3, V_3M_0, V_2M_3, V_2M_2 and V_1M_2. The lowest leaf number (4.67) was found in V_1M_1 and V_2M_0 but it was statistically similar with V_1M_2, V_2M_2, V_2M_3, V_3M_0, V_3M_3, V_1M_3, V_1M_0, V_2M_1, V_1M_4, V_3M_4 and V_2M_4. At 45 DAS, the highest leaf number (10.60) was observed in V_3M_2 treatment which was statistically similar with V_2M_1, V_3M_4, V_2M_2, V_1M_4, V_3M_1, V_3M_3, V_1M_2, V_2M_4, V_1M_0 and V_3M_0. The lowest leaf number (7.80) was found in V_1M_1, V_1M_3 and V_2M_3 treatment which was statistically similar with V_1M_4, V_3M_0, V_1M_0, V_1M_2, V_2M_4, V_1M_4, V_3M_1, V_3M_3, V_2M_2, V_3M_4 and V_2M_1. At 60 DAS, the highest leaf number (10.33) was observed in V_3M_2 treatment which was statistically similar with V_2M_1, V_3M_4, V_2M_2, V_3M_3, V_1M_4, V_1M_2, V_3M_0, V_2M_4, V_3M_1 and V_2M_3. The lowest leaf number (7.33) was found in V_1M_3 treatment which was statistically similar with V_1M_1, V_2M_0, V_1M_0, V_2M_3, V_3M_1, V_2M_4, V_3M_0, V_1M_2, V_1M_4, V_3M_3 and V_2M_2. At harvest, the highest leaf number (10.87) was observed in V_3M_2 treatment which was statistically similar with V_2M_1 and V_2M_2. The lowest leaf number (7.67) was recorded in V_1M_1, V_1M_3 and V_2M_0 treatment which was statistically similar with V_1M_0, V_1M_4, V_3M_0, V_3M_1, V_2M_4, V_2M_3, V_3M_3, V_1M_2, V_3M_4, V_2M_1 and V_2M_2.

Table 3. Interaction effect of variety and molybdenum on number of leaves plant^{-1} of mungbean at different growth stages

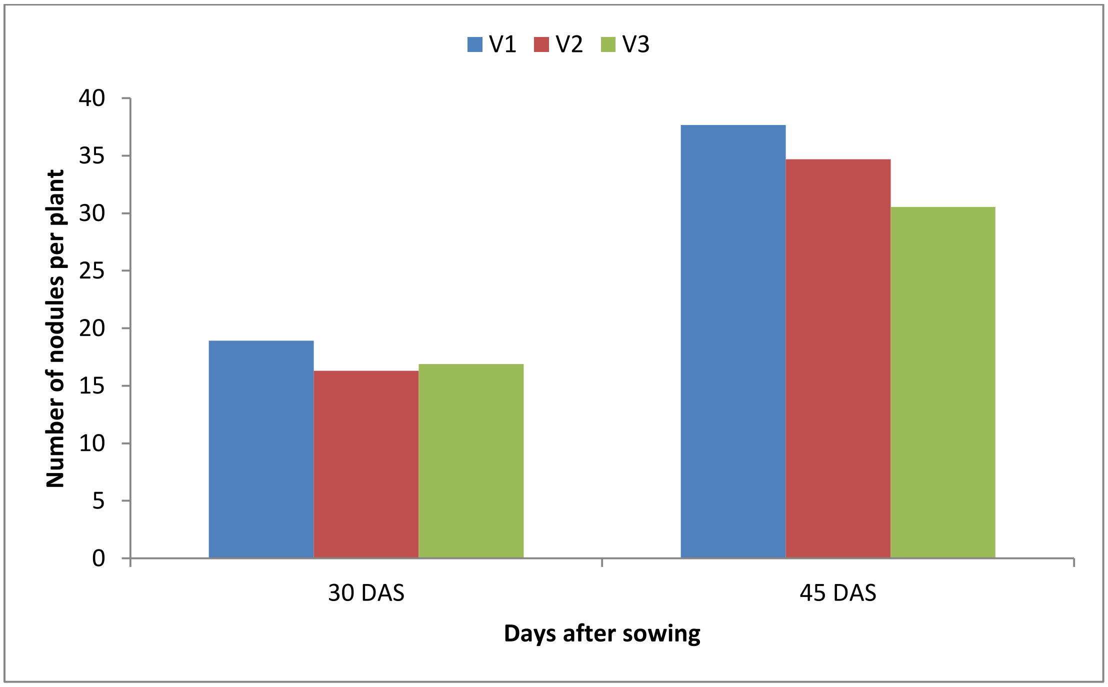
Treatments	Number of leaves plant^{-1}				
	15 DAS	30 DAS	45 DAS	60 DAS	At harvest
V_1M_0	2.73	5.07 ab	8.47 ab	8.20 b-d	8.07 b
V_1M_1	2.87	4.67 b	7.80 b	7.53 cd	7.67 b
V_1M_2	2.93	4.87 ab	8.53 ab	8.80 a-d	9.00 b
V_1M_3	3.00	5.07 ab	7.80 b	7.33 d	7.67 b
V_1M_4	2.87	5.13 ab	8.87 ab	8.83 a-d	8.13 b
V_2M_0	2.87	4.67 b	7.87 b	7.87 b-d	7.67 b
V_2M_1	2.73	5.13 ab	10.07 ab	9.80 ab	9.20 ab
V_2M_2	2.73	4.93 ab	9.13 ab	9.26 a-d	9.27 ab
V_2M_3	2.80	5.00 ab	7.80 b	8.40 a-d	8.80 b
V_2M_4	3.00	5.40 ab	8.53 ab	8.53 a-d	8.60 b
V_3M_0	2.93	5.00 ab	8.33 ab	8.73 a-d	8.47 b
V_3M_1	3.00	5.53 a	8.87 ab	8.47 a-d	8.47 b
V_3M_2	2.73	5.67 a	10.60 a	10.33 a	10.87 a
V_3M_3	2.87	5.07 ab	8.87 ab	8.93 a-d	8.87 b
V_3M_4	3.00	5.20 ab	9.33 ab	9.60 a-c	9.13 ab
$LSD_{(0.05)}$	NS	0.824	2.332	2.105	1.705
CV (%)	6.79	9.60	15.86	14.40	11.69

In a column, the means having the same letter (s) do not differ significantly
NS= Not Significant, CV = Coefficient of variation, $LSD_{(0.05)}$= Least significant difference at 5% level, DAS = Days after sowing
V_1= BARI mung-5, V_2= BARI mung-6, V_3= BU mug-4, M_0=0 (Control), M_1=2g/kg seed, M_2=4g/kg seed M_3=6g/kg seed, M_4=8g/kg seed

4.1.4Number of nodules plant^{-1} at different growth stages

4.1.4.1 Effect of variety

Varieties had no significant influence on number of nodules plant^{-1} at 30 and 45 DAS (Appendix VI and Figure 7). At 30 and 45 DAS, V_1 (BARI mung-5), V_2 (BARI mung-6) and V_3 (BU mug-4) showed statistically similar result (Figure 7). The varietyV_1(BARI mung-5) had the maximum number of nodules plant^{-1} at 30 and 45 DAS. Patel and Patel (1994)reported that significantly higher number of nodules plant^{-1} in mungbean was observed at 30 DAS followed by 45 and 15 DAS. Pal and Lal (1993) also reported that nodules were higher at 45 DAS than 60 DAS in mungbean.



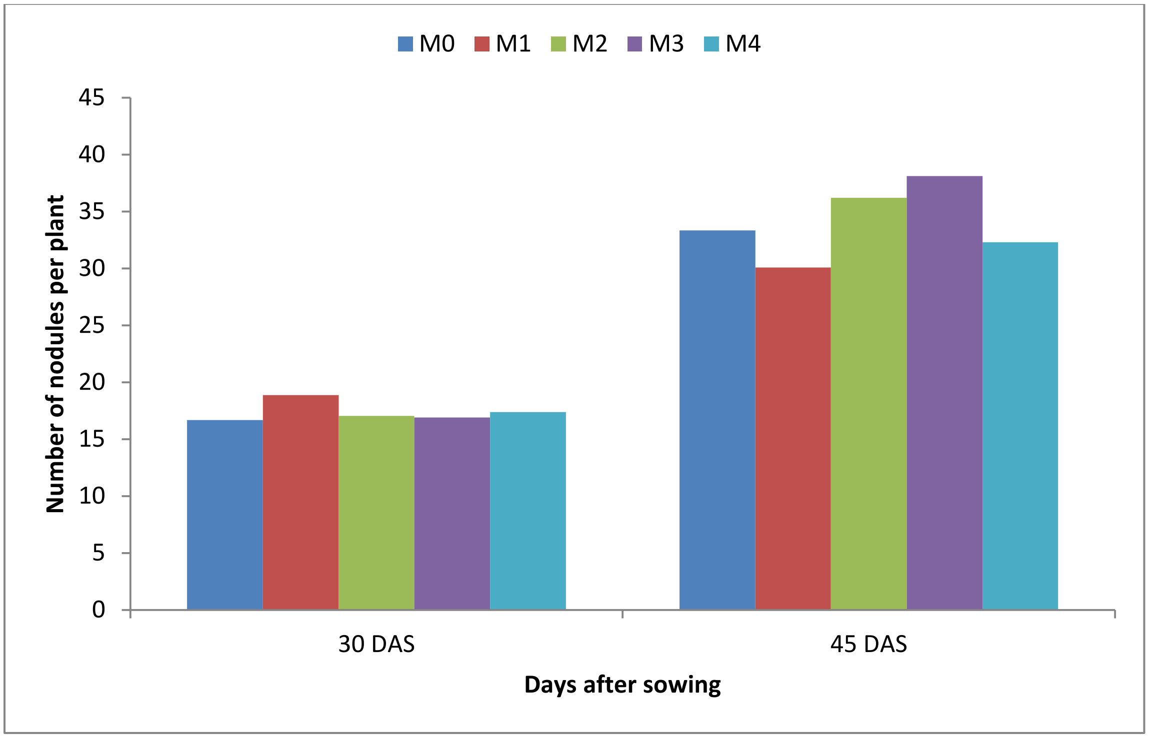
V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4

Figure 7. Number of nodules plant^{-1} of mungbean as influenced by variety.

4.1.4.2 Effect of molybdenum

Molybdenum had no significant effect on number of nodules plant^{-1} at 30 DAS and it had significant effect on number of nodules plant^{-1} at 45 DAS (Appendix VI and Figure 8). At 30 DAS, M_1 (2g/kg seed) showed the maximum number of nodules plant^{-1}. At 45 DAS, the highest number of nodules plant^{-1}(38.13) was recorded in M_3 which was statistically similar to M_2, M_1 and M_4. The lowest number of nodules plant^{-1} (30.09) was found in M_1 and it was statistically similar to M_4, M_0 and M_2. Bhuiyan*et al*. (1997) conducted an experiment and observed that application of Mo and B both at the rate of 1 kg ha^{-1} along with 50 kg P_2O_5

ha^{-1} and 50 kg k_2O ha^{-1} produced significantly 347% and 440% higher nodule number and nodule weight in chickpea over uninoculated control treatment.



M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 8. Number of nodules plant^{-1} of mungbean as influenced by molybdenum ($LSD_{0.05}$= 20.009 at 45 DAS).

4.1.4.3 Interaction Effect of variety and molybdenum

Interaction between varities and molybdenum had significant influence on number of nodules plant^{-1} at 30 and 45 DAS (Table 4). At 30 DAS, the highest number of nodules plant^{-1} (22.00) was recorded in V_1M_2 treatment which was statistically similar with V_3M_1, V_1M_0, V_1M_1,V_1M_4, V_2M_2, V_3M_3, V_3M_4, V_1M_3, V_2M_1, V_2M_4, V_2M_3, V_3M_0 and V_2M_0. The lowest number of nodules plant^{-1} (11.40) was found in V_3M_2 treatment but it was statistically similar with V_2M_0, V_3M_0, V_2M_3, V_2M_4, V_2M_1, V_1M_3, V_3M_4, V_3M_3, V_2M_2, V_1M_4, V_1M_1 and V_1M_0. At 45 DAS, the highest number of nodules plant^{-1} (46.60) was observed in V_1M_3 which was statistically similar with V_2M_0, V_1M_4, V_3M_2, V_3M_3, V_2M_2 and V_1M_2. The lowest number of nodules plant^{-1}(24.67) was recorded in V_3M_1 treatment but it was statistically similar with V_3M_0, V_2M_4, V_3M_4, V_2M_3, V_2M_1, V_1M_0, V_1M_1, V_1M_2 and V_2M_2.

Table 4. Interaction effect of variety and molybdenum on number of nodules plant^{-1} of mungbean at different growth stages

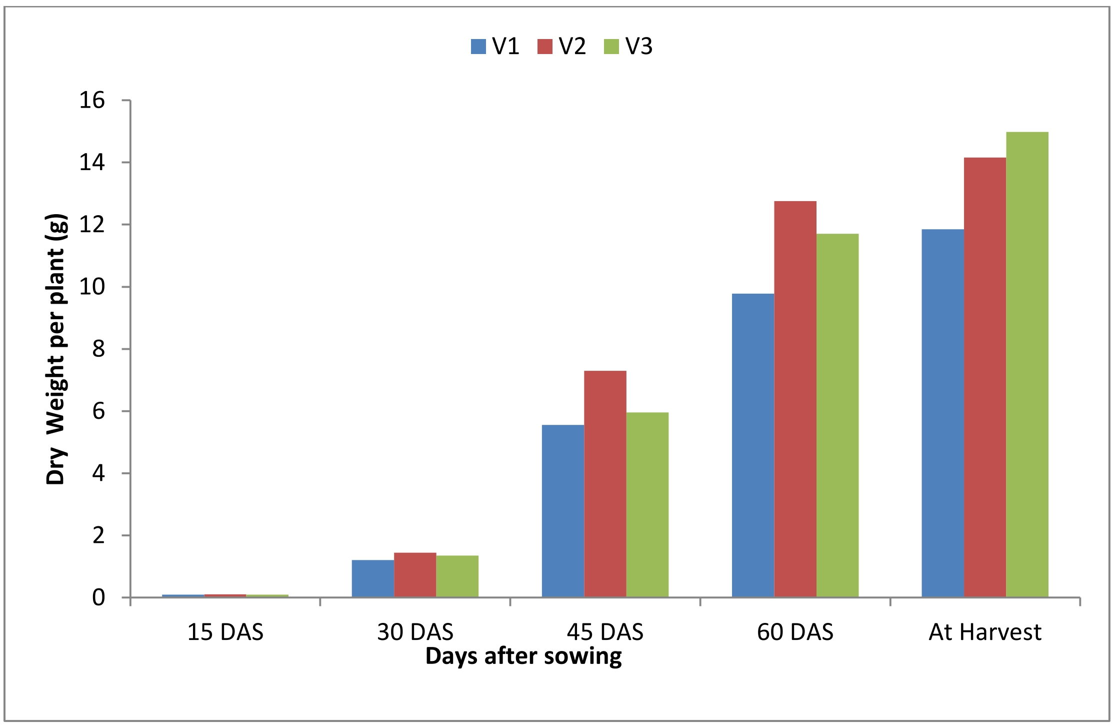
Treatments	Number of nodules plant^{-1}	
	30 DAS	45 DAS
V_1M_0	19.60 ab	33.67 b-e
V_1M_1	18.20 ab	33.87 b-e
V_1M_2	22.00 a	35.47 a-e
V_1M_3	16.93 ab	46.60 a
V_1M_4	17.93 ab	38.80 a-c
V_2M_0	14.67 ab	40.80 ab
V_2M_1	16.60 ab	31.73 b-e
V_2M_2	17.73 ab	35.87 a-e
V_2M_3	16.07 ab	30.80 b-e
V_2M_4	16.47 ab	29.00 c-e
V_3M_0	15.80 ab	25.53 de
V_3M_1	21.80 a	24.67 e
V_3M_2	11.40 b	37.33 a-c
V_3M_3	17.73 ab	37.00 a-d
V_3M_4	17.73 ab	29.13 c-e
$LSD_{(0.05)}$	9.718	11.469
CV (%)	33.19	20.01

In a column, the means having the same letter (s) do not differ significantly
CV = Coefficient of variation, $LSD_{(0.05)}$= Least significant difference at 5% level, DAS = Days after sowing
V_1= BARI mung-5, V_2= BARI mung-6, V_3= BU mug-4,M_0=0 (Control), M_1=2g/kg seed, M_2=4g/kg seed
M_3=6g/kg seed, M_4=8g/kg seed

4.1.5 Dry weight plant^{-1} at different growth stages

4.1.5.1 Effect of variety

Varieties had no significant influence on dry weight plant^{-1} of mungbean at 15, 30, 45, 60 DAS and at harvest (Appendix VII and Figure 9). At 15, 30, 45 and 60 DAS, the maximum dry weight was recorded in V_2 (BARI mung-6) but the result was statistically similar with other varieties V_1 (BARI mung-5) and V_3 (BU mug-4). At harvest maximum dry weight plant^{-1} was observed in V_3 (BU mug-4).

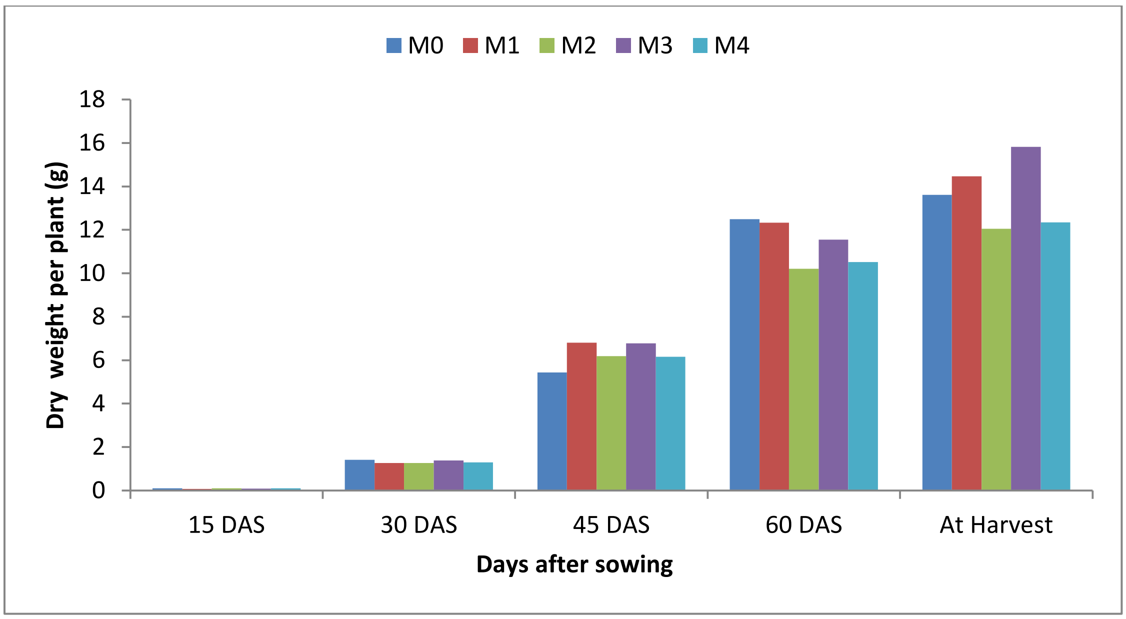


V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4

Figure 9. Dry weight plant^{-1} of mungbean as influenced by variety.

4.1.5.2 Effect of molybdenum

Molybdenum had no significant effect on dry weight plant^{-1} at 15, 30, 45 and 60 DAS but at harvest molybdenum showed significant effect on dry weight plant^{-1} (Appendix VII and Figure 10). At 15 DAS, the maximum dry weight plant^{-1} observed in M_0 (Control), M_2 (4g/kg seed) and M_4 (8g/kg seed). At 30 and 60 DAS, the maximum dry weight plant^{-1} was recorded in M_0 (Control). At 45 DAS, maximum dry weight plant^{-1} was found in M_1 (2g/kg seed). At harvest, the highest dry weight plant^{-1} (15.82 g) was obtained in M_3 (6g/kg seed) and the result was statistically similar with M_1 (2g/kg seed), M_0 (Control) and M_4 (8g/kg seed). The minimum dry weight plant^{-1} (12.05 g) was recorded in M_2 (4g/kg seed) but it was statistically similar withM_4 (8g/kg seed), M_0 (Control) and M_1 (2g/kg seed). Mandal *et al.* (1998) observed that dry matter yield of lentil was increased by the application of lime, P and Mo. Plant dry matter/pot was highest with 100% lime + 50 mg P + 1 mg Mo.



M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 10. Dry weight plant^{-1} of mungbean as influenced by molybdenum ($LSD_{0.05}$= 3.704 at harvest).

4.1.5.3 Interaction effect of variety and molybdenum

Interaction between variety and molybdenum had no significant effect on dry weight plant^{-1} at 15 DAS but it had significant effect on dry weight plant^{-1} at 30, 45, 60 DAS and at harvest (Table 5). At 15 DAS, the maximum dry weight plant^{-1} was observed in V_2M_0 treatment but this result was statistically similar to others. At 30 DAS, the highest dry weight plant^{-1} (1.66 g) obtained in V_3M_3 treatment which was statistically similar to V_2M_0, V_2M_3, V_1M_2, V_2M_4, V_3M_1, V_1M_0, V_3M_0, V_2M_1, V_3M_4, V_2M_2, V_1M_4, V_1M_1 and V_3M_2. The lowest dry weight plant^{-1} (0.93 g) was observed in V_1M_3 treatment but it is statistically similar with V_3M_2, V_1M_1, V_1M_4, V_2M_2, V_3M_4, V_2M_1, V_3M_0, V_1M_0, V_3M_1, V_2M_4, V_1M_2 and V_2M_3. At 45 DAS, the highest dry weight plant^{-1} (8.15 g) was recorded in V_2M_4 treatment which is statistically similar to V_3M_3, V_2M_0, V_2M_3, V_2M_1, V_3M_1, V_3M_2, V_1M_1, V_2M_2, V_1M_2, V_1M_4, V_1M_3 and V_3M_4. The lowest dry weight plant^{-1} (4.31 g) was observed in V_3M_0 treatment but it was statistically similar with V_1M_0, V_3M_4, V_1M_3, V_1M_4, V_1M_2, V_2M_2, V_1M_1, V_3M_2, V_3M_1, V_2M_1, V_2M_3, V_2M_0 and V_3M_3. At 60 DAS, the highest dry weight plant^{-1} (16.59 g) was recorded in V_2M_0 treatment which was statistically similar toV_2M_3, V_3M_0, V_3M_1, V_1M_1, V_2M_4, V_3M_3, V_2M_2, V_1M_4 and V_3M_2. The lowest dry weight plant^{-1} (6.90 g) was recorded in V_1M_0 treatment which was statistically similar to V_3M_4, V_1M_3, V_1M_2, V_2M_1, V_3M_2, V_1M_4, V_2M_2, V_3M_3 and V_2M_4. At harvest, the highest dry weight plant^{-1} (18.38 g) was observed in V_2M_3 treatment which was statistically similar to V_3M_1, V_3M_3, V_2M_0, V_1M_1, V_3M_0, V_3M_2, V_2M_4, V_3M_4, V_2M_2 and V_1M_3. The lowest dry weight plant^{-1} (9.53 g) was recorded in V_1M_0 treatment but it was statistically similar to V_1M_2, V_2M_1, V_1M_4, V_1M_3, V_2M_2, V_3M_4, V_2M_4, V_3M_2 and V_3M_0.

Table 5. Interaction effect of variety and molybdenum on dry weight plant^{-1} of mungbean at different growth stages

Treatments	Dry weight plant^{-1}				
	15 DAS	30 DAS	45 DAS	60 DAS	At harvest
V_1M_0	0.09	1.31 ab	4.52 b	6.90 c	9.53 d
V_1M_1	0.08	1.08 ab	6.54 ab	13.55 ab	16.06 a-c
V_1M_2	0.11	1.55 ab	5.84 ab	8.75 bc	10.18 cd
V_1M_3	0.08	0.93 b	5.19 ab	8.72 bc	12.34 a-d
V_1M_4	0.09	1.15 ab	5.68 ab	10.97 a-c	11.16 b-d
V_2M_0	0.13	1.62 a	7.50 ab	16.59 a	16.35 a-c
V_2M_1	0.11	1.27 ab	7.18 ab	9.69 bc	10.25 cd
V_2M_2	0.09	1.24 ab	6.19 ab	11.17 a-c	12.78 a-d
V_2M_3	0.13	1.59 ab	7.48 ab	14.35 ab	18.38 a
V_2M_4	0.10	1.47 ab	8.15 a	11.99 a-c	13.04 a-d
V_3M_0	0.09	1.31 ab	4.31 b	13.97 ab	14.99 a-d
V_3M_1	0.06	1.47 ab	6.69 ab	13.73 ab	17.11 ab
V_3M_2	0.09	1.02 ab	6.55 ab	10.70 a-c	13.19 a-d
V_3M_3	0.09	1.66 a	7.64 ab	11.57 a-c	16.76 ab
V_3M_4	0.12	1.27 ab	4.64 ab	8.60 bc	12.84 a-d
$LSD_{(0.05)}$	NS	0.676	3.503	5.985	6.416
CV (%)	32.76	30.17	33.14	31.11	27.87

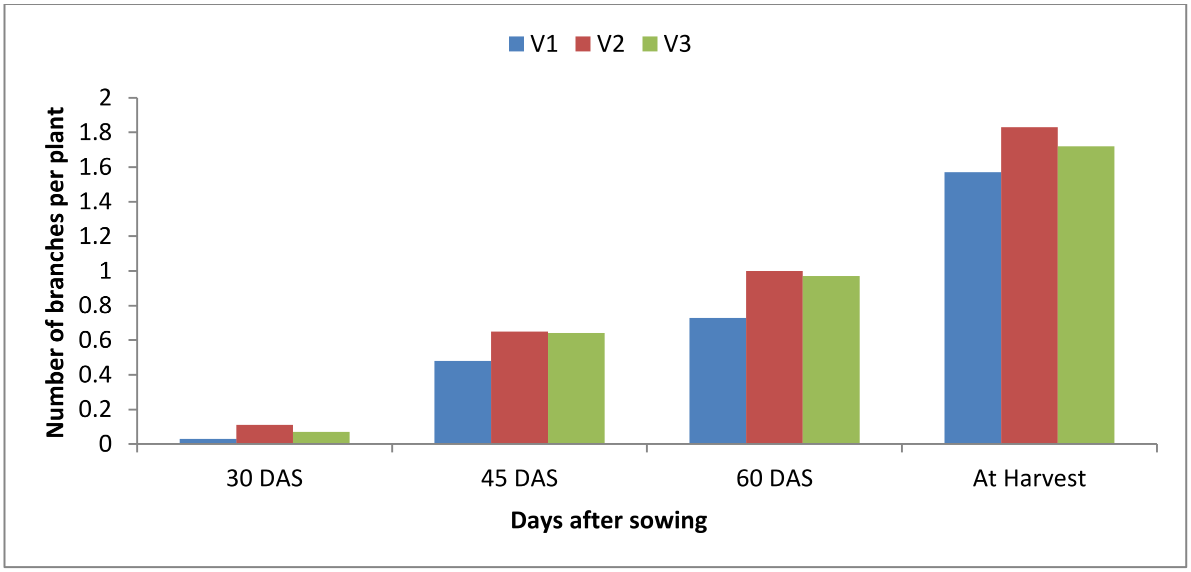
In a column, the means having the same letter (s) do not differ significantly
NS= Not Significant, CV = Coefficient of variation, $LSD_{(0.05)}$= Least significant difference at 5% level, DAS = Days after sowing
V_1= BARI mung-5, V_2= BARI mung-6, V_3= BU mug-4, M_0=0 (Control), M_1=2g/kg seed, M_2=4g/kg seed M_3=6g/kg seed, M_4=8g/kg seed

4.2 Yield and other crop characters

4.2.1 Number of branches plant $^{-1}$

4.2.1.1 Effect of variety

The number of branches plant^{-1} was not significantly influenced by variety at 45 DAS, 60 DAS and at harvest but at 30 DAS the number of branches plant^{-1} varied significantly for the three varieties (Appendix VIII and Figure 11). At 30 DAS, the highest number of branches plant^{-1} (0.11) was observed in V_2 (BARI mung-6) that statistically similar to V_3 (BU mug-4). The lowest number of branches plant^{-1} (0.03) was found in V_1 (BARI mung-5) but it was statistically similar toV_3 (BU mug-4). At 45, 60 DAS and at harvest maximum number of branches plant^{-1} was observed in V_2 (BARI mung-6) that statistically similar to other varieties. Islam (1983) who observed significant variation of branch number plant^{-1} in different studied varieties of mungbean and the highest number of branches plant^{-1} was in the variety Faridpur 1 followed by Mubarik, BM-7715 and BM-7704. Ghosh (2007) observed varieties differ significantly in respect of number of branches plant^{-1}. He found the highest number of branches plant^{-1} in Sona mung and the lowest number of branches plant^{-1} in BARI mung-6.

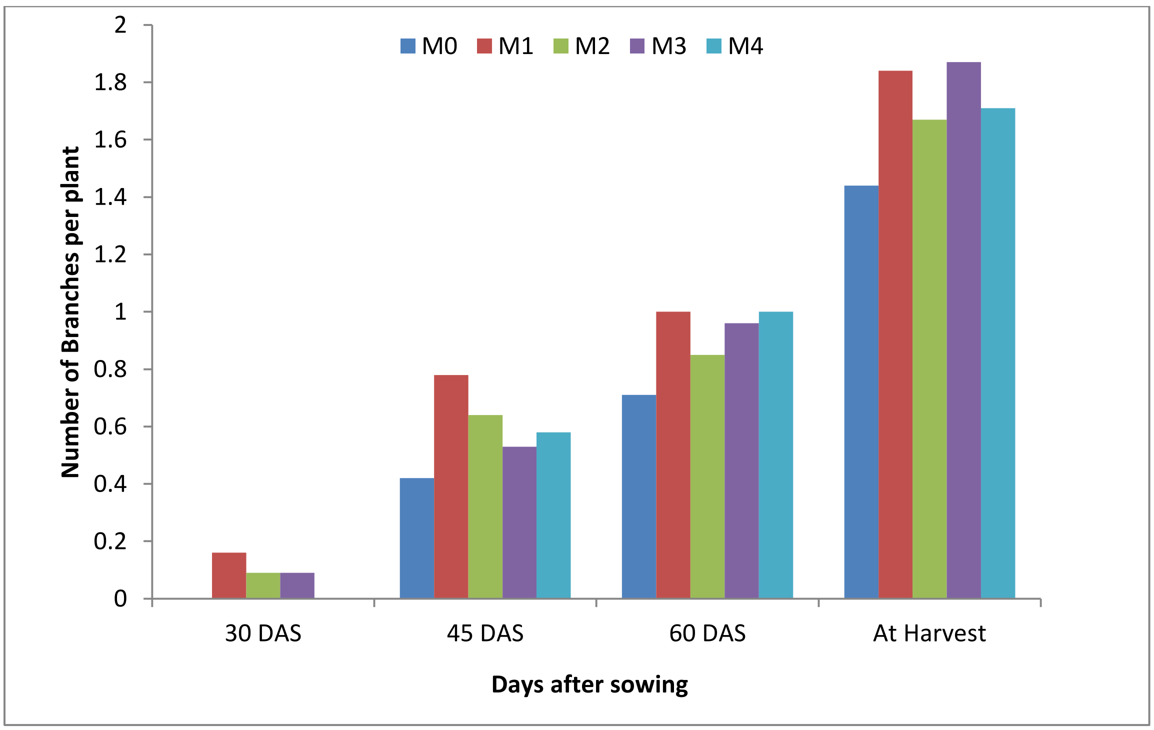


V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4

Figure 11. Number of branches plant^{-1} of mungbean as influenced by variety ($LSD_{0.05}$= 0.06 at 30 DAS).

4.2.1.2 Effect of molybdenum

The number of branches plant^{-1} was not significantly influenced by variety at30, 45, 60 DAS and at harvest (Appendix VIII and Figure 12). At 30 DAS and 45 DAS maximum number of branches plant^{-1} was found in M_1 (2g/kg seed) but this result was statistically similar to others. At 60 DAS higher branch number plant^{-1} was recorded in M_1 (2g/kg seed) and M_4 (8g/kg seed). At harvest maximum number of branches plant^{-1} was obtained in M_3 (6g/kg seed). Zaman *et al.* (1996) branches plant^{-1} increased with increased level of Mo up to 2 kg ha^{-1}. They also reported that the highest branches plant^{-1} of 11.60 in mungbean due to application of Mo (2 kg ha^{-1}), which was 89% higher over control.



M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 12. Number of branches plant^{-1} of mungbean as influenced by molybdenum.

4.2.1.3 Interaction effect of variety and molybdenum

Interaction between variety and molybdenum had significant influence on number of branches plant^{-1} at 30, 45, 60 DAS and at harvest (Table 6). At 30 DAS, the highest number of branches plant^{-1} (0.40) was found in V_2M_1 treatment, that statistically similar with V_1M_2, V_2M_3, V_3M_2 and V_3M_3. The lowest number of branches plant^{-1} (0.00) was recorded in V_1M_0, V_1M_1, V_1M_3, V_1M_4, V_2M_0, V_2M_2, V_2M_4, V_3M_0 and V_3M_4 treatment that was statistically similar with V_3M_1, V_1M_2, V_2M_3, V_3M_2 and V_3M_3. At 45 DAS, higher number of branches plant^{-1} (1.07) was observed in V_2M_1 treatment, this was statistically similar with V_3M_1, V_3M_2, V_1M_4, V_2M_3, V_1M_2, V_3M_3, V_2M_0, V_2M_2, V_3M_4, V_1M_1, V_2M_4, V_3M_0 and V_1M_3.The lowest number of branches plant^{-1} (0.27) was recorded in V_1M_0 treatment that statistically similar with V_1M_3, V_1M_1, V_2M_4, V_3M_0, V_2M_0, V_2M_2, V_3M_4, V_1M_2, V_3M_3, V_2M_3, V_1M_4, V_3M_1 and V_3M_2. At 60 DAS, the highest number of branches plant^{-1} (1.40) was observed in V_2M_1 treatment which was statistically similar withV_2M_3, V_3M_4, V_3M_2, V_1M_4, V_3M_1, V_2M_4, V_3M_0, V_3M_3, V_1M_3, V_2M_2, V_2M_0, V_1M_1 and V_1M_2. The lowest number of branches plant^{-1} (0.53) was recorded in V_1M_0 treatment but this result was statistically similar with V_1M_1, V_1M_2, V_2M_0, V_1M_3, V_2M_2, V_2M_4, V_3M_0, V_3M_3, V_3M_1, V_1M_4, V_3M_2, V_3M_4 and V_2M_3. At harvest, higher number of branches plant^{-1} (2.33) was observed in V_2M_3 treatment, that statistically similar with V_2M_1, V_3M_2, V_1M_4, V_1M_1, V_3M_3, V_2M_4, V_3M_1, V_2M_2 and V_3M_4. The lowest number of branches plant^{-1} (1.33) was recorded in V_1M_2 treatment which was statistically similar with V_1M_0, V_2M_0, V_1M_3, V_3M_0, V_2M_2, V_3M_4, V_2M_4, V_3M_1, V_1M_1, V_3M_3, V_1M_4 and V_3M_2.

Table 6. Interaction effect of variety and molybdenum on number of branches plant^{-1} of mungbean at different growth stages

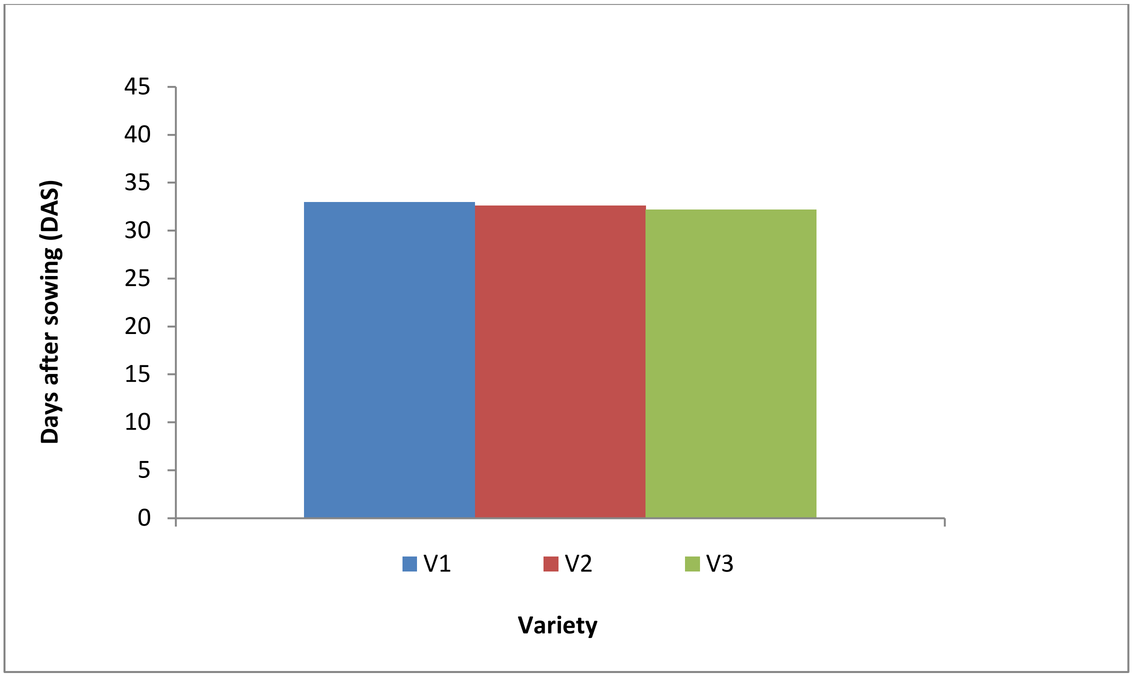
Treatments	Number of branches plant^{-1}			
	30 DAS	45 DAS	60 DAS	At harvest
V_1M_0	0.00 b	0.27 b	0.53 b	1.40 bc
V_1M_1	0.00 b	0.47 ab	0.67 ab	1.73 a-c
V_1M_2	0.13 ab	0.60 ab	0.67 ab	1.33 c
V_1M_3	0.00 b	0.33 ab	0.80 ab	1.53 bc
V_1M_4	0.00 b	0.73 ab	1.00 ab	1.87 a-c
V_2M_0	0.00 b	0.53 ab	0.73 ab	1.40 bc
V_2M_1	0.40 a	1.07 a	1.40 a	2.13 ab
V_2M_2	0.00 b	0.53 ab	0.80 ab	1.60 a-c
V_2M_3	0.13 ab	0.67 ab	1.20 ab	2.33 a
V_2M_4	0.00 b	0.47 ab	0.87 ab	1.67 a-c
V_3M_0	0.00 b	0.47 ab	0.87 ab	1.53 bc
V_3M_1	0.07 b	0.80 ab	0.93 ab	1.67 a-c
V_3M_2	0.13 ab	0.80 ab	1.07 ab	2.07 a-c
V_3M_3	0.13 ab	0.60 ab	0.87 ab	1.73 a-c
V_3M_4	0.00 b	0.53 ab	1.13 ab	1.60 a-c
$LSD_{(0.05)}$	0.293	0.738	0.754	0.735
CV (%)	247.44	74.14	49.58	25.54

In a column, the means having the same letter (s) do not differ significantly,
CV = Coefficient of variation, $LSD_{(0.05)}$= Least significant difference at 5% level, DAS = Days after sowing
V_1= BARI mung-5, V_2= BARI mung-6, V_3= BU mug-4,M_0=0 (Control), M_1=2g/kg seed, M_2=4g/kg seed
M_3=6g/kg seed, M_4=8g/kg seed

4.2.2First flowering

4.2.2.1 Effect of variety

First flowering of mungbean was not significantly influenced by varieties (Appendix IX and Figure 13). First flower was seen on V_3 (BU mug-4) but this result was statistically similar to other varieties V_2 (BARI mung-6) and V_1 (BARI mung-5).

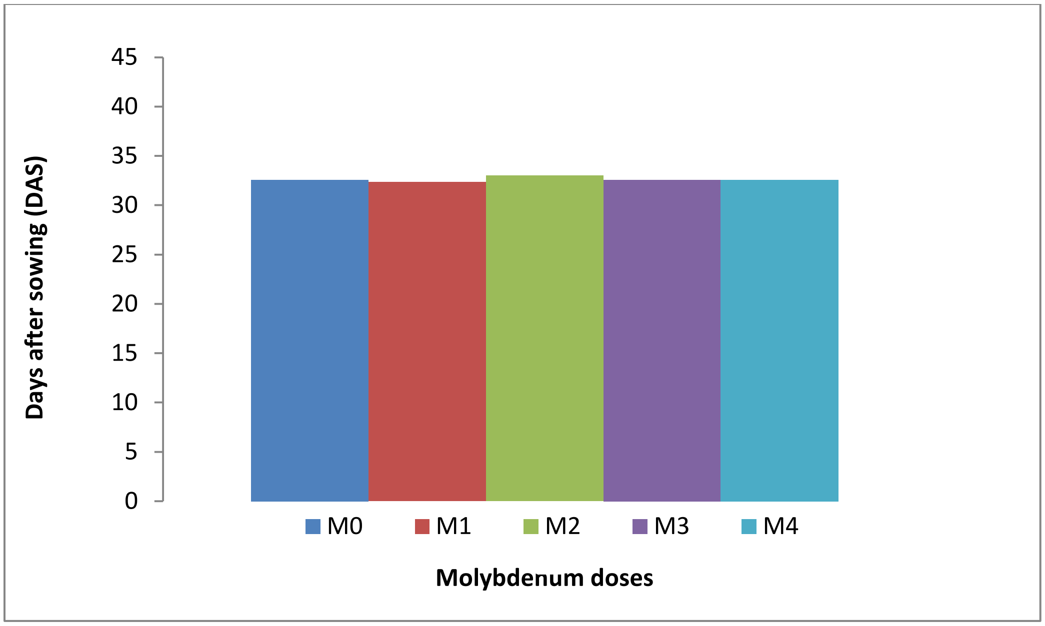


V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4

Figure 13. First flowering of mungbean as influenced by variety.

4.2.2.2 Effect of molybdenum

Molybdenum had no significant influence on first flowering of mungbean (Appendix IX and Figure 14). First flower was seen in M_1 (2g/kg seed) treatment which was statistically similar to others.

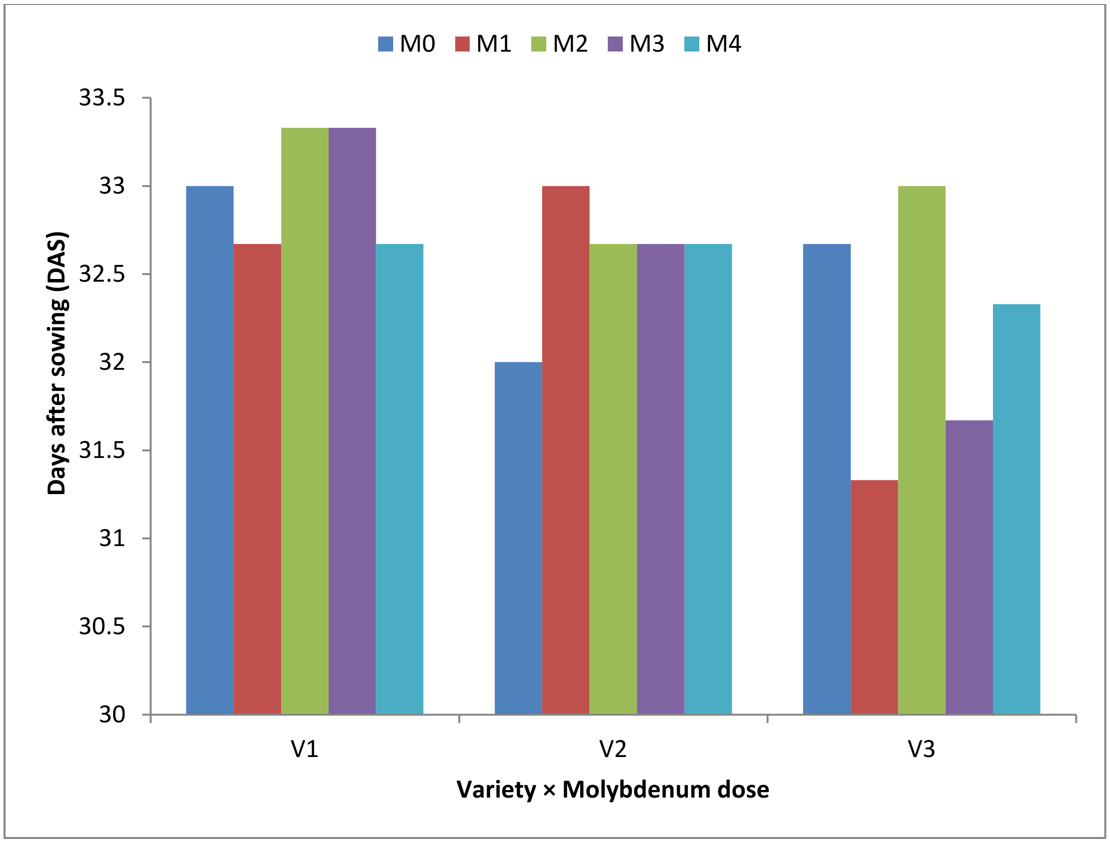


M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 14. First flowering of mungbean as influenced by molybdenum.

4.2.2.3 Interaction effect of variety and molybdenum

Interaction between variety and molybdenum had significant influence on first flowering (Figure 15).First flower was observed in V_3M_1 treatment which was statistically similar to V_3M_3, V_2M_0, V_3M_4, V_1M_1, V_1M_4, V_2M_2, V_2M_3, V_2M_4 and V_3M_0. The highest duration was required for first flowering in V_1M_2 and V_1M_3 which was statistically similar to V_1M_0, V_2M_1, V_3M_2, V_1M_1, V_1M_4, V_2M_2, V_2M_3, V_2M_4, V_3M_0, V_3M_4 and V_2M_0.



V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4

M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

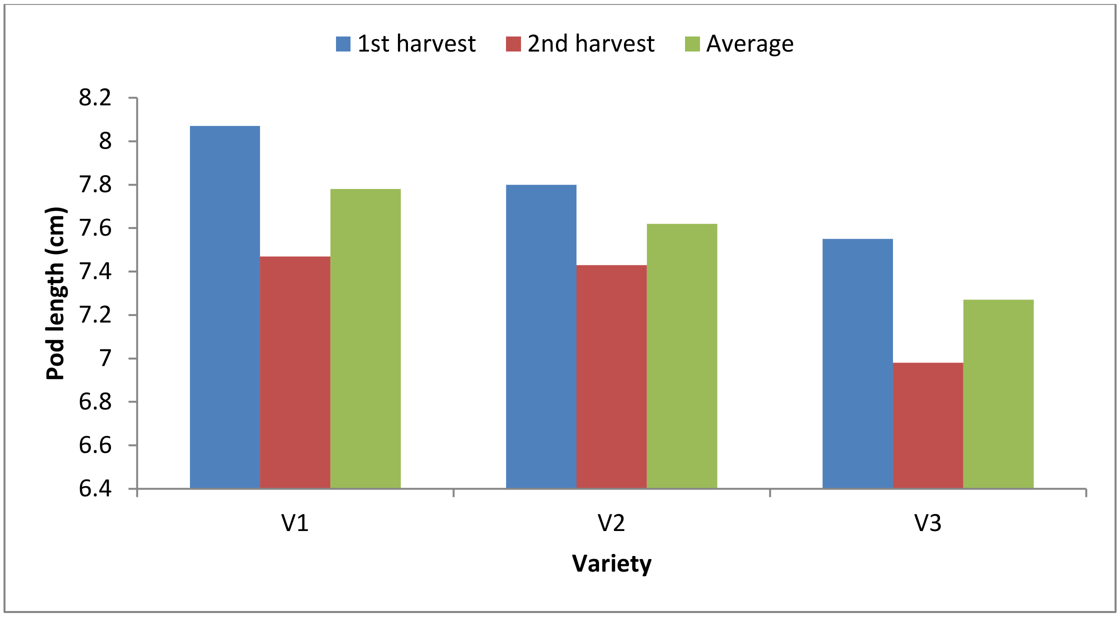
Figure 15. First flowering of mungbean as influenced by interaction between variety and molybdenum ($LSD_{0.05}$= 1.415).

4.2.3Pod length (cm)

4.2.3.1 Effect of variety

The pod length of 2nd harvest and average of two harvests varied significantly among the three varieties but pod length of 1st harvest was statistically similar among them (Appendix IX and Figure 16). The maximum pod length of 1st harvest was found in V_1 (BARI mung-5) that was statistically similar to others. The highest pod length of 2nd harvest (7.47 cm) and average of two harvests (7.78 cm) was found in V_1 (BARI mung-5) which was statistically similar to V_2 (BARI mung-6). The lowest pod length was found in V_3 (BU mug-4) that was statistically similar to V_2 (BARI mung-6). The result agreed with the findings of Farghali and

Hossain (1995) who observed varieties differ significantly in respect of pod length.

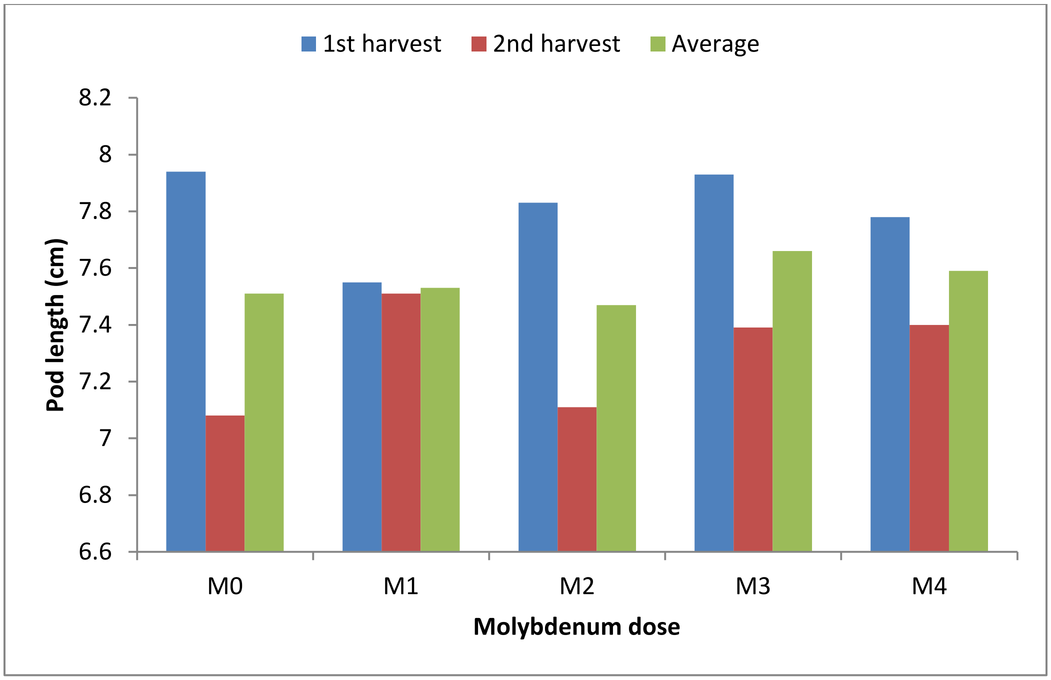


V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4

Figure 16. Pod length of mungbean as influenced by variety ($LSD_{0.05}$= 0.465 and 0.459 at 2nd harvest and average of two harvests, respectively).

4.2.3.2 Effect of molybdenum

Pod length of 1st harvest and average of two harvests was not significantly influenced by molybdenum but it was significantly influenced in 2nd harvest (Appendix IX and Figure 17). In 1st harvest maximum pod length was observed in M_0 (Control) but this result was statistically similar to others. In 2nd harvest the highest pod length (7.51 cm) was recorded in M_1 (2g/kg seed) and it was statistically similar with M_4 (8g/kg seed) and M_3 (6g/kg seed). The lowest pod length (7.08 cm) was found in M_0 (Control) but this result was statistically similar to M_2 (4g/kg seed) andM_3 (6g/kg seed). The numerically maximum pod length in average of two harvests was observed in M_3 (6g/kg seed) which was statistically similar to other doses.



M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 17. Pod length of mungbean as influenced by molybdenum ($LSD_{0.05}$= 4.355 at 2^{nd} harvest).

4.2.3.3Interaction effect of variety and molybdenum

Interaction effect of variety and molybdenum had significant effect on pod length (Table 7).The highest pod length (8.48 cm) of 1^{st} harvest was found in V_1M_3 that result was statistically similar to V_2M_4, V_1M_2, V_1M_0, V_3M_0, V_1M_4, V_3M_2,V_2M_0, V_2M_3, V_1M_1 and V_2M_1. The lowest pod length (7.20 cm) was observed in V_3M_4 which was statistically similar with V_3M_1, V_3M_3, V_2M_2, V_2M_1, V_1M_1, V_2M_3, V_2M_0, V_3M_2, V_1M_4 and V_3M_0. At 2^{nd} harvest, the highest pod length (7.94 cm) was found in V_3M_0 treatment but this result was statistically similar with V_1M_4, V_1M_3, V_2M_3, V_3M_1, V_1M_1 and V_2M_1. The lowest pod length (6.69 cm) was observed in V_3M_3 treatment but this result was statistically similar with V_3M_2, V_3M_4 and V_1M_0. The highest pod length (8.13 cm) in average of two harvests was recorded in V_1M_3 which was statistically similar with V_1M_4, V_2M_4, V_2M_3, V_1M_2 and V_1M_1. The lowest pod length (7.11 cm) observed in V_3M_4 treatment that statistically similar with V_3M_3, V_3M_2, V_3M_1, V_3M_0, V_2M_2, V_2M_0, V_1M_0, V_2M_1 and V_1M_1.

Table 7. Interaction effect of variety and molybdenum on pod length of mungbean at different harvest

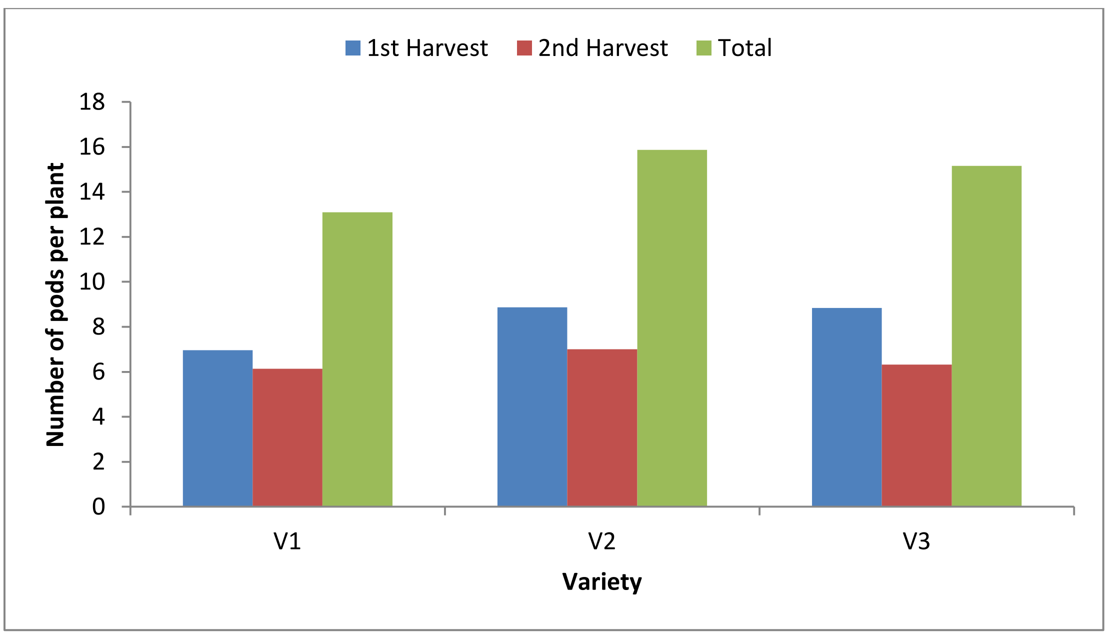
Treatments	Pod length (cm)		
	1st harvest	2nd harvest	Average
V_1M_0	8.09 ab	7.02 de	7.56 b-d
V_1M_1	7.71 a-c	7.54 a-d	7.63 a-d
V_1M_2	8.12 ab	7.26 cd	7.69 a-c
V_1M_3	8.48 a	7.77 a-c	8.13 a
V_1M_4	7.92 a-c	7.81 ab	7.87 ab
V_2M_0	7.77 a-c	7.29 b-d	7.53 b-d
V_2M_1	7.69 a-c	7.41 a-d	7.56 b-d
V_2M_2	7.57 bc	7.36 b-d	7.47 b-d
V_2M_3	7.76 a-c	7.70 a-c	7.73 a-c
V_2M_4	8.23 ab	7.38 b-d	7.81 ab
V_3M_0	7.96 a-c	7.94 a	7.45 b-d
V_3M_1	7.23 c	7.58 a-c	7.41 b-d
V_3M_2	7.79 a-c	6.70 e	7.24 cd
V_3M_3	7.55 bc	6.69 e	7.13 d
V_3M_4	7.20 c	7.01 de	7.11 d
$LSD_{(0.05)}$	0.823	0.537	0.539
CV (%)	6.25	4.36	4.23

In a column, the means having the same letter (s) do not differ significantly, CV = Coefficient of variation, $LSD_{(0.05)}$= Least significant difference at 5% level, DAS = Days after sowing
V_1= BARI mung-5, V_2= BARI mung-6, V_3= BU mug-4,M_0=0 (Control), M_1=2g/kg seed, M_2=4g/kg seed M_3=6g/kg seed, M_4=8g/kg seed

4.2.4 Number of pods plant^{-1}

4.2.4.1 Effect of variety

The number of pods plant^{-1} did not differ significantly due to varietal variation (Appendix X and Figure 18). The numerically mazimum number of pods plant^{-1} in 1st harvest, 2nd harvest and total of two harvest were found in V_2 (BARI mung-6) which was statistically similar to others. Pahlwan and Hossain (1983) observed the highest number of pods plant^{-1} from variety Mubarik but the result disagreed with Pookpadi *et al*. (1980) who observed the lowest number of pods plant^{-1} in local variety. Masood and Meena (1986) reported that number of pods plant^{-1} varied significantly with genotypes. Islam (1983), Haque*et al*. (2002) opined that pods plant^{-1} is a useful agronomic character contributing to higher yield of mungbean and there was a significant positive correlation between the number of pods plant^{-1} and yield plant^{-1}.

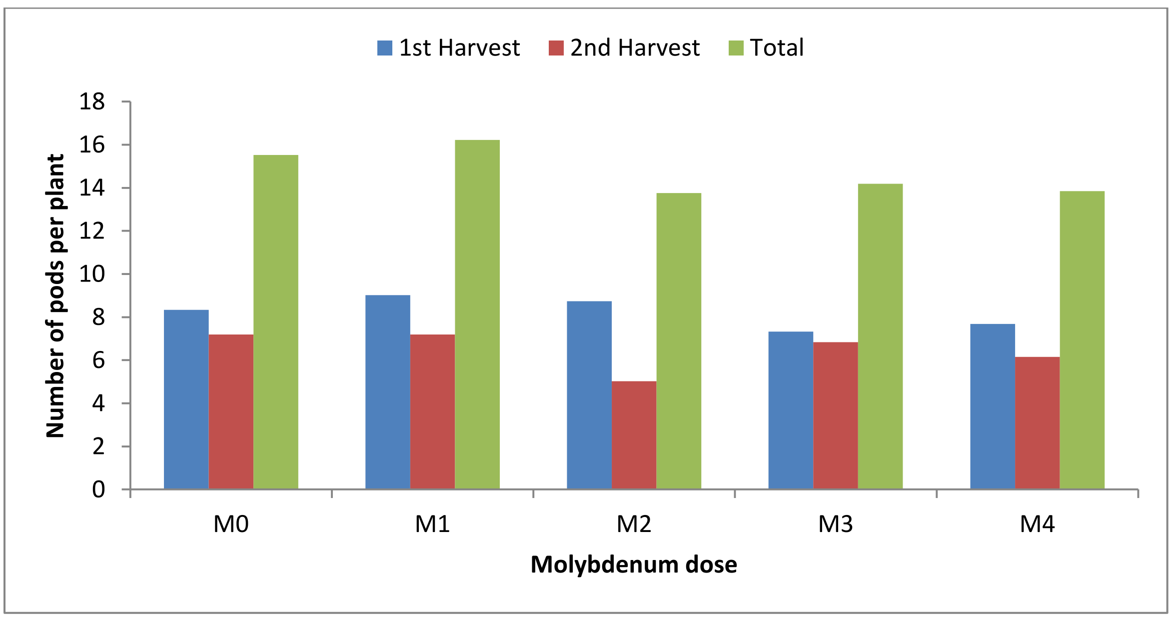


V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4

Figure 18. Number of pods plant^{-1} of mungbean as influenced by variety.

4.2.4.2 Effect of molybdenum

The number of pods plant^{-1} did not differ significantly at different molybdenum doses (Appendix X and Figure 19). The maximum number of pods plant^{-1} in 1st harvest and total of two harvests was observed in M_1 (2g/kg seed) treatment but this result was statistically similar to other doses. The maximum number of pods plant^{-1} in 2nd harvest was found in M_0 (Control) and M_1 (2g/kg seed) treatment which was statistically similar to others. Mohan and Rao (1997) observed that seed yield and number of pods/plant generally increased with increased with increasing rate of Mo (0.50 kg Moha^{-1}) and P (90 kg P_2O_5 ha^{-1}). Gupta and Narayanan (1992) reported that the pod number, seed number and weight and shoot dry weight showed significantly higher values on exposure to 2 kg Mo ha^{-1} soil.



M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 19. Number of pods plant^{-1} of mungbean as influenced by molybdenum.

4.2.4.3Interaction effect of variety and molybdenum

Interaction of variety and fertilizer materials had significant effect on pods plant^{-1} in 1st harvest but it showed no significant difference in 2nd harvest and total of two harvests (Table 8). In 1st harvest, the highest number of pods plant^{-1} (10.80) was recorded in V_2M_1 which was statistically similar with V_2M_0, V_2M_2, V_3M_3, V_3M_2, V_3M_1, V_3M_4, V_2M_4 and V_1M_0. The lowest number of pods plant^{-1} (5.73) was observed in V_2M_3 which was statistically similar with V_1M_4, V_1M_3, V_1M_2, V_1M_1, V_3M_0, V_1M_0, V_2M_4, V_3M_1 and V_3M_4. The numerically maximum number of pods plant^{-1} was observed in V_2M_3 for 2nd harvest and V_2M_0 for total of two harvests which was statistically similar with other interactions.

Table 8. Interaction effect of variety and molybdenum on pods plant^{-1} of mungbean at different harvest

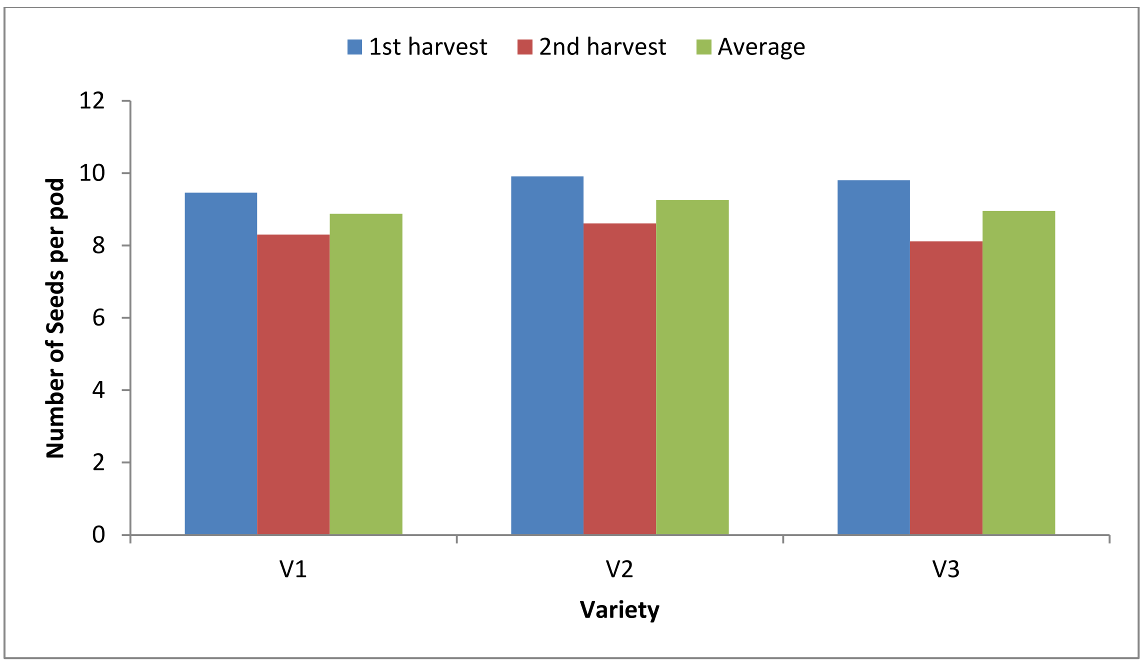
Treatments	Number of pods plant^{-1}		
	1st harvest	2nd harvest	Total
V_1M_0	7.53 a-d	6.00	13.53
V_1M_1	7.33 b-d	8.13	14.47
V_1M_2	6.73 b-d	5.27	12.00
V_1M_3	6.67 b-d	5.33	12.00
V_1M_4	6.53 cd	5.93	12.47
V_2M_0	10.13 ab	8.20	18.33
V_2M_1	10.80 a	7.47	18.27
V_2M_2	10.07 ab	4.13	14.20
V_2M_3	5.73 d	8.53	14.27
V_2M_4	7.60 a-d	6.67	14.27
V_3M_0	7.33 b-d	7.40	14.73
V_3M_1	8.93 a-d	6.00	14.93
V_3M_2	9.40 a-c	5.67	15.07
V_3M_3	9.60 a-c	6.67	16.27
V_3M_4	8.93 a-d	5.87	14.80
$LSD_{(0.05)}$	3.456	NS	NS
CV (%)	24.95	55.66	33.22

In a column, the means having the same letter (s) do not differ significantly
NS= Not Significant, CV = Coefficient of variation, $LSD_{(0.05)}$= Least significant difference at 5% level, DAS = Days after sowing
V_1= BARI mung-5, V_2= BARI mung-6, V_3= BU mug-4, M_0=0 (Control), M_1=2g/kg seed, M_2=4g/kg seed M_3=6g/kg seed, M_4=8g/kg seed

4.2.5 Number of seeds pod^{-1}

4.2.5.1 Effect of variety

The number of seeds pod^{-1} did not differ significantly among the three varieties of mungbean (Appendix XI and Figure 20). In 1st harvest, 2nd harvest and average of two harvest, the numerically maximum number of seeds pod^{-1} found in V_2 (BARI mung-6). Pahlwan and Hossain (1983) and Pookpakdi *et al.* (1980) found the highest yield from two mungbean cultivars Mubarik and CES 14 with the highest number of seeds pod^{-1}. Ghosh (2007) found that number of seeds pod^{-1} did not differ significantly between BARI mung-6 and Sona mung.

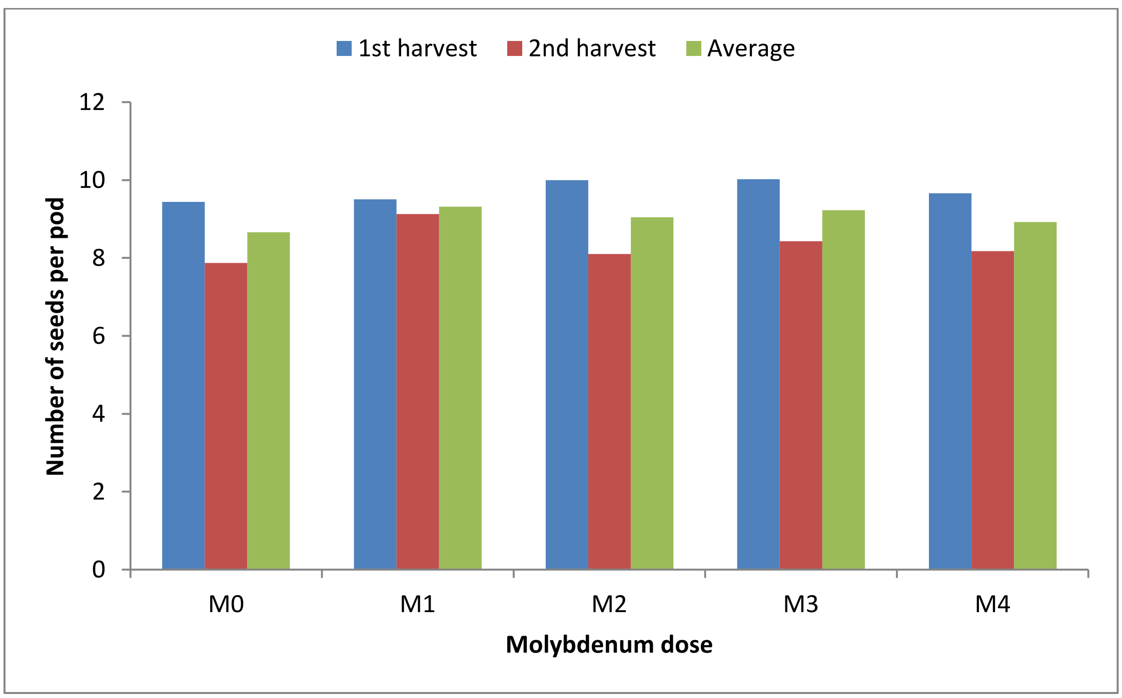


V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4

Figure 20. Number of seeds pod^{-1} of mungbean as influenced by variety.

4.2.5.2 Effect of molybdenum

The number of seeds pod^{-1} did not differ significantly at different molybdenum doses in 1st harvest but it differ significantly in 2nd harvest and in average of two harvests (Appendix XI and Figure 21).In 1st harvest, numerically maximum number of seeds pod^{-1} found in M_3 (6g/kg seed) but this result was statistically similar to others. In 2nd harvest, the highest number of seeds pod^{-1}(9.13) was observed in M_1 (2g/kg seed) this result was statistically similar to M_3 (6g/kg seed). The lowest number of seeds pod^{-1} (7.87) was found in M_0 (Control) which was statistically similar with M_4 (8g/kg seed) andM_2 (4g/kg seed). The average maximum number of seeds pod^{-1} (9.32) was recorded in M_1 (2g/kg seed) that statistically similar to M_3 (6g/kg seed), M_2 (4g/kg seed) and M_4 (8g/kg seed). The lowest number of seeds pod^{-1} (8.66) was found in M_0 (Control) which was statistically similar with M_4 (8g/kg seed), M_2 (4g/kg seed) and M_3 (6g/kg seed). Gupta and Narayanan (1992) reported that the pod number, seeds pod^{-1}, seed weight and shoot dry weight showed significant higher values on exposure to 2 kg Mo ha^{-1} soil.



M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 21. Number of seeds pod^{-1} of mungbean as influenced by molybdenum ($LSD_{0.05}$= 0.834 and 0.629 in 2nd harvest and average of two harvests).

4.2.5.3Interaction effect of variety and molybdenum

Interaction effect of variety and molybdenum was found significant in respect of seeds pod^{-1} (Table 9). In 1st harvest, the highest number of seeds pod^{-1} (10.83) was recorded in V_2M_1 which was found statistically similar with V_3M_3, V_3M_2, V_1M_3, V_1M_2, V_2M_2, V_2M_4, V_1M_4, V_2M_3, V_3M_0, V_2M_0, V_3M_4, V_1M_0 and V_3M_1. The lowest number of seeds pod^{-1} was recorded in V_1M_1 (8.43) which was found statistically similar with V_1M_0, V_3M_1, V_3M_4, V_2M_0, V_3M_0, V_2M_3, V_1M_4, V_2M_4, V_1M_2, V_2M_2 and V_1M_3. In 2nd harvest the highest number of seeds pod^{-1} (9.70) was observed in V_2M_1 which was statistically similar to V_2M_3, V_1M_1, V_3M_1, V_1M_4, V_1M_3, V_2M_2 and V_3M_4. The lowest number of seeds pod^{-1} (7.53) was found in V_3M_3 which was found statistically similar with V_1M_0, V_2M_4, V_3M_0, V_1M_2, V_3M_2, V_2M_0, V_3M_4, V_2M_2, V_1M_3, V_1M_4, V_3M_1 and V_1M_1. The highest number of seeds pod^{-1} in average of two harvests (10.27) was observed in V_2M_1 which was statistically similar to V_2M_3, V_1M_3, V_3M_2 and V_1M_4. The lowest number of seeds pod^{-1} (8.42) was recorded in V_1M_0 which was found statistically similar with V_1M_1, V_2M_4, V_3M_0, V_1M_2, V_2M_0, V_3M_4, V_3M_3, V_3M_1, V_2M_2, V_1M_4, V_3M_2, V_1M_3 and V_2M_3.

Table 9. Interaction effect of variety and molybdenum number of seeds pod^{-1} mungbean at different harvest

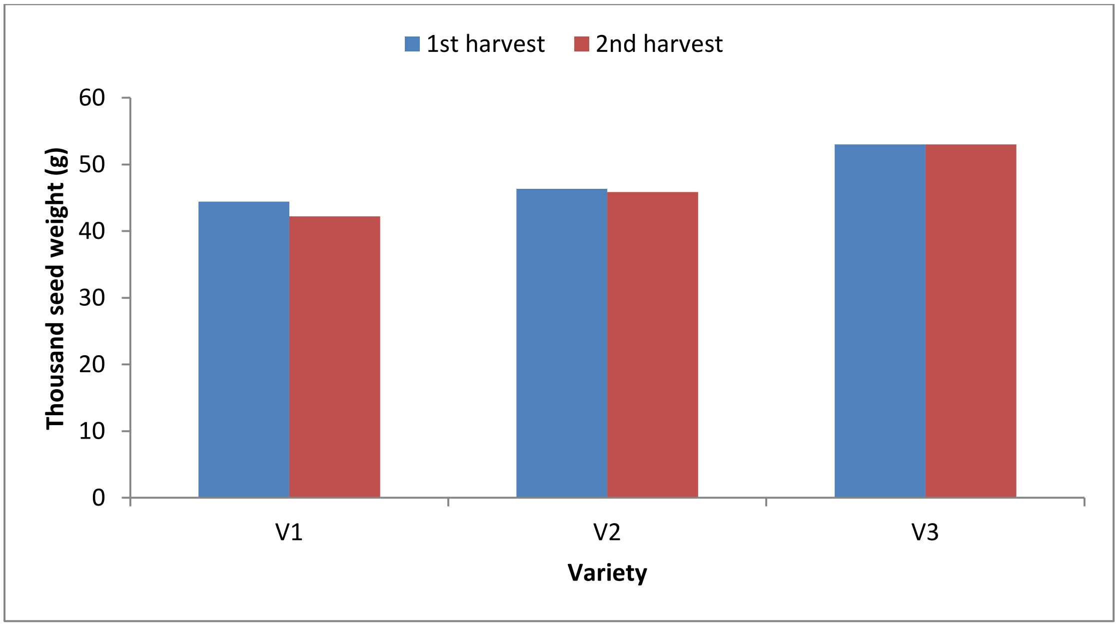
Treatments	Number of seeds pod^{-1}		
	1st harvest	2nd harvest	Average
V_1M_0	9.27 ab	7.57 c	8.42 b
V_1M_1	8.43 b	8.87 a-c	8.65 b
V_1M_2	9.83 ab	7.83 bc	8.83 b
V_1M_3	10.03 ab	8.57 a-c	9.30 ab
V_1M_4	9.73 ab	8.67 a-c	9.20 ab
V_2M_0	9.47 ab	8.23 bc	8.85 b
V_2M_1	10.83 a	9.70 a	10.27 a
V_2M_2	9.83 ab	8.30 a-c	9.07 b
V_2M_3	9.63 ab	9.20 ab	9.42 ab
V_2M_4	9.80 ab	7.60 c	8.70 b
V_3M_0	9.60 ab	7.80 bc	8.70 b
V_3M_1	9.27 ab	8.83 a-c	9.05 b
V_3M_2	10.33 a	8.17 bc	9.25 ab
V_3M_3	10.40 a	7.53 c	8.97 b
V_3M_4	9.43 ab	8.27 a-c	8.85 b
$LSD_{(0.05)}$	1.632	1.445	1.089
CV (%)	9.96	10.28	7.16

In a column, the means having the same letter (s) do not differ significantly,
CV = Coefficient of variation, $LSD_{(0.05)}$= Least significant difference at 5% level, DAS = Days after sowing
V_1= BARI mung-5, V_2= BARI mung-6, V_3= BU mug-4, M_0=0 (Control), M_1=2g/kg seed, M_2=4g/kg seed M_3=6g/kg seed, M_4=8g/kg seed

4.2.6 Weight of 1000-seed (g)

4.2.6.1 Effect of variety

The weights of 1000-seeds were significantly influenced by variety (Appendix XII and Figure 22). In 1st and 2nd harvest, highest1000-seed weight was obtained from V_3 (BU mug-4) and the lowest was obtained from V_1 (BARI mung-5). The result was agreed with the findings of Katial and Shah (1998) and Ghosh (2007) who reported that 1000-seed weight of mungbean was significantly influenced by variety.



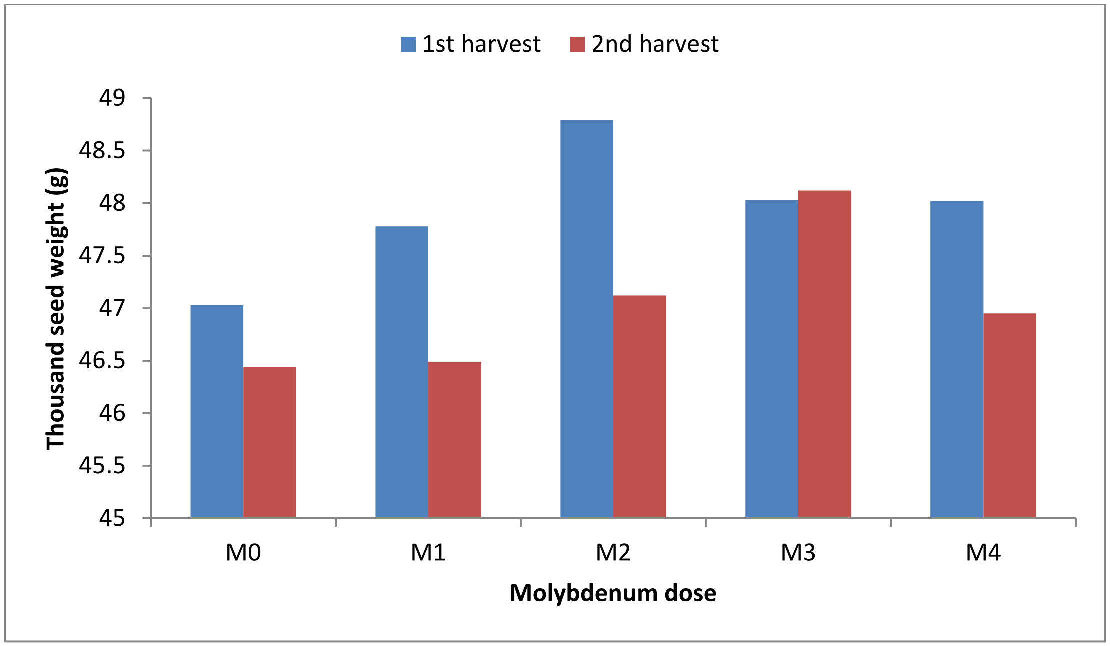
V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4

Figure 22. Thousand seed weight of mungbean as influenced by variety ($LSD_{0.05}$= 1.139 and 1.250 in 1st harvest and 2nd harvest, respectively).

4.2.6.2 Effect of molybdenum

In 1st harvest the weight of 1000-seeds did not differ significantly at different molybdenum doses but it differ significantly in 2nd harvest (Appendix XII and Figure 23). At 1st harvest the numerically maximum weight of 1000-seeds were observed in M_2 (4g/kg seed) which was statistically similar to others. In 2nd harvest, the highest weight of 1000-seeds (48.12 g) was found in M_3 (6g/kg seed) which was statistically similar to M_2 (4g/kg seed). The lowest weight of 1000-seeds (46.44 g) was found in M_0 (Control) but this result was statistically similar to M_1 (2g/kg seed), M_4 (8g/kg seed) and M_2 (4g/kg seed). Zaman *et al.* (1996)

conducted an experiment on mungbean and observed that 1000 seed weight increased by 34.32% over control due to application of Mo (2 kg ha^{-1}).



M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 23. Thousand seed weight of mungbean as influenced by molybdenum ($LSD_{0.05}$=1.091 in 2nd harvest).

4.2.6.3Interaction effect of variety and molybdenum

Interaction effect of variety and molybdenum had significant influence on 1000-seed weight (Table 10). At 1st harvest, the highest weight of 1000-seeds (54.56 g) was recorded in V_3M_2 but this result was statistically similar toV_3M_1, V_3M_3, V_3M_4 and V_3M_0. The lowest weight of 1000-seeds (43.21 g) was observed in V_1M_0 this result was statistically similar to V_1M_2, V_1M_1, V_1M_3, V_2M_4, V_2M_0, V_2M_1, V_1M_4 and V_2M_3. In 2nd harvest, the highest weight of 1000-seeds (54.65 g) was recorded in V_3M_3 but this result was statistically similar to V_3M_4 and V_3M_1. The lowest weight of 1000-seeds (41.16 g) was observed in V_1M_4 which was statistically similar to V_1M_1 and V_1M_1.

Table 10. Interaction effect of variety and molybdenum on weight of 1000-seed of mungbean at different harvest

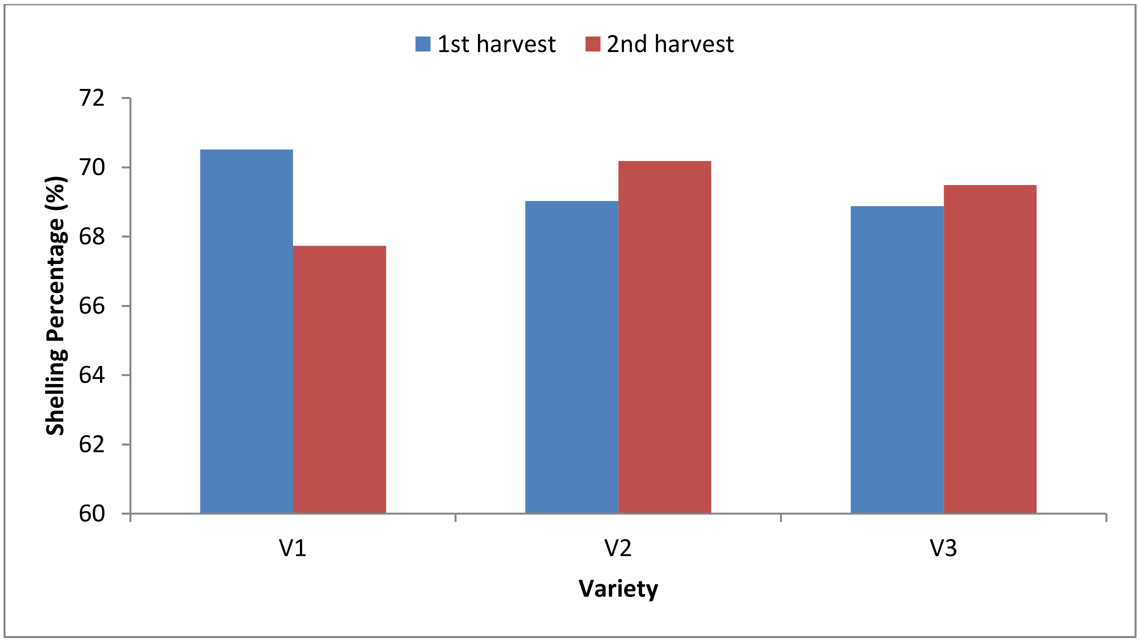
Treatments	Weight of 1000-seeds (g)	
	1st harvest	2nd harvest
V_1M_0	43.21 c	41.98 ef
V_1M_1	44.15 c	41.59 ef
V_1M_2	43.74 c	43.25 de
V_1M_3	44.69 bc	43.13 e
V_1M_4	46.32 bc	41.16 f
V_2M_0	45.52 bc	45.31 c
V_2M_1	46.19 bc	45.12 cd
V_2M_2	48.07 b	45.97 c
V_2M_3	46.60 bc	46.58 c
V_2M_4	45.32 bc	46.19 c
V_3M_0	52.34 a	52.04 b
V_3M_1	52.99 a	52.79 ab
V_3M_2	54.56 a	52.14 b
V_3M_3	52.80 a	54.65 a
V_3M_4	52.43 a	53.48 ab
$LSD_{(0.05)}$	3.518	1.890
CV (%)	4.36	2.39

In a column, the means having the same letter (s) do not differ significantly,
CV = Coefficient of variation, $LSD_{(0.05)}$= Least significant difference at 5% level, DAS = Days after sowing
V_1= BARI mung-5, V_2= BARI mung-6, V_3= BU mug-4, M_0=0 (Control), M_1=2g/kg seed, M_2=4g/kg seed
M_3=6g/kg seed, M_4=8g/kg seed

4.2.7 Shelling percentage

4.2.7.1 Effect of variety

Shelling percentage of mungbean was significantly influenced by variety in 1st harvest but in 2nd harvest there is no significant difference found among the three varieties (Appendix XII and Figure 24). In 1st harvest, V_1 (BARI mung-5) showed highest shelling percentage (70.51%) but this result was statistically similar to V_2 (BARI mung-6). The lowest shelling percentage (68.88%) was found in V_3 (BU mug-4) which was statistically similar to V_2 (BARI mung-6). In 2nd harvest maximum shelling percentage was observed in V_2 (BARI mung-6) but all the three varieties showed statistically similar result.

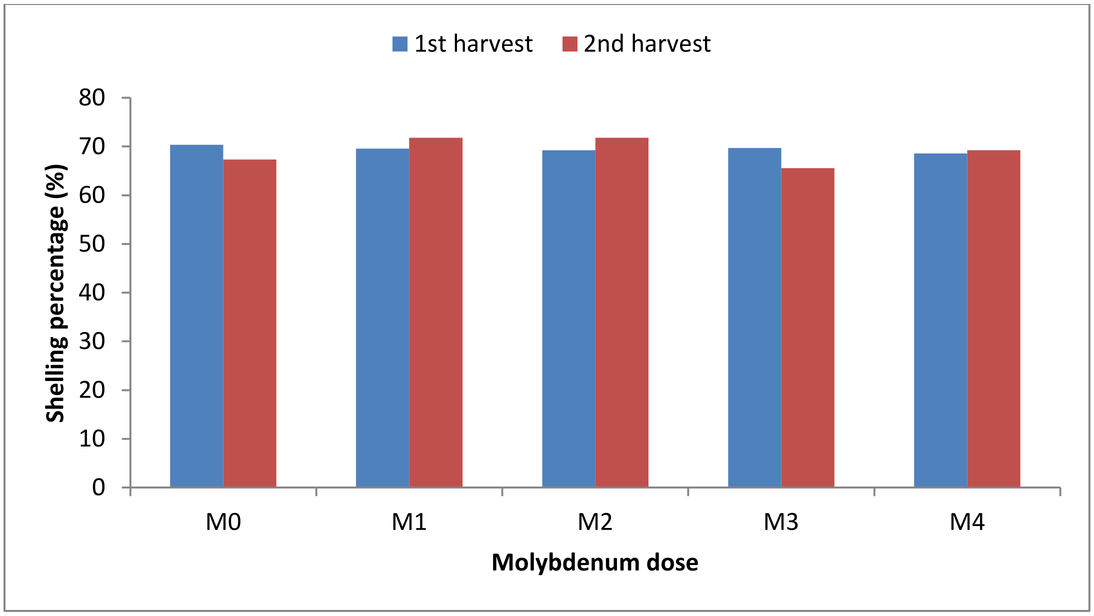


V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4

Figure 24. Shelling percentage of mungbean as influenced by variety ($LSD_{0.05}$= 1.614 in 1st harvest).

4.2.7.2 Effect of molybdenum

Shelling percentage of mungbean was not significantly influenced by molybdenum (Appendix XII and Figure 25). In 1st harvest, the maximum shelling percentage was observed in M_0 (Control) and in 2nd harvest numerically maximum shelling percentage was found in M_1 (2g/kg seed).



M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 25. Shelling percentage of mungbean as influenced by molybdenum.

4.2.7.3 Interaction effect of variety and molybdenum

Interaction effect between variety and molybdenum had significant effect on shelling percentage of mungbean in 1st harvest but it had no significant difference in 2nd harvest (Table 11). In 1st harvest, the highest shelling percentage (72.03%) was found in V_1M_0 and this result was statistically similar with V_1M_3, V_1M_4, V_2M_0, V_2M_1, V_3M_1, V_1M_2, V_2M_2, V_2M_3, V_3M_2, V_3M_3 and V_3M_4.The lowest shelling percentage (65.91%) was recorded in V_2M_4 which was statistically similar with V_1M_1, V_3M_0, V_3M_4, V_3M_3, V_3M_2, V_2M_3 and V_2M_2.In case of 2nd harvest, the V_2M_2 showed numerically maximum shelling percentage.

Table 11. Interaction effect of variety and molybdenum on shelling percentage of mungbean at different harvest

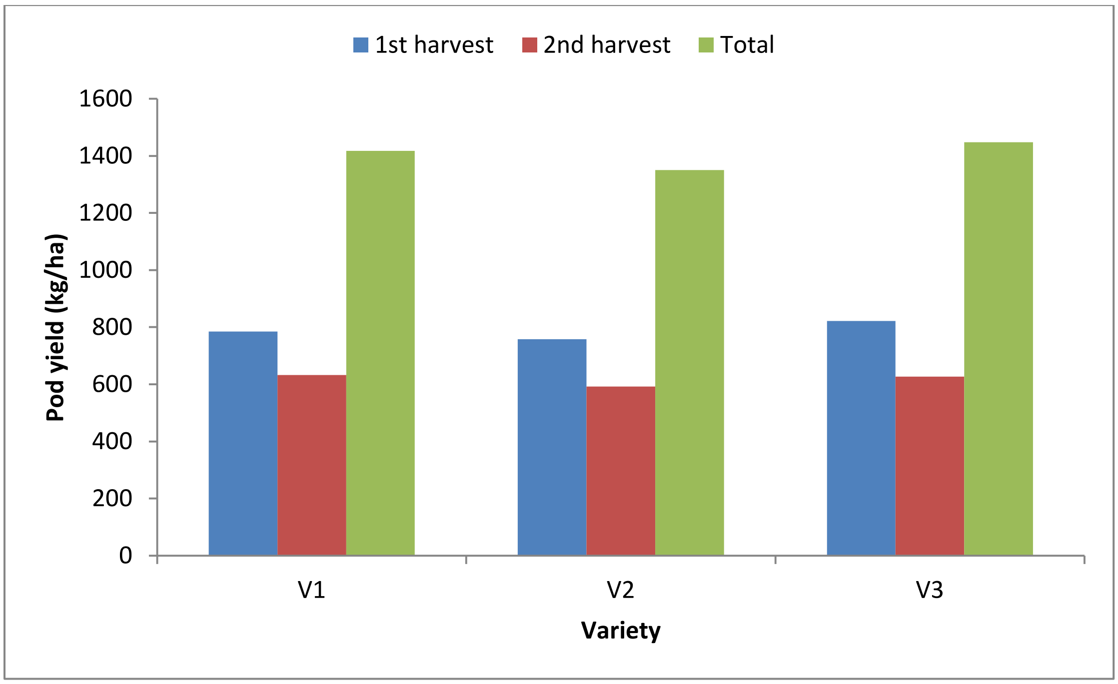
Treatments	Shelling percentage	
	1^{st} harvest	2^{nd} harvest
V_1M_0	72.03 a	62.09
V_1M_1	67.99 cd	69.92
V_1M_2	69.86 a-c	71.77
V_1M_3	71.49 ab	67.21
V_1M_4	71.17 a-c	67.64
V_2M_0	70.71 a-c	70.83
V_2M_1	70.69 a-c	69.53
V_2M_2	68.97 a-d	76.33
V_2M_3	68.90 a-d	66.11
V_2M_4	65.91 d	68.13
V_3M_0	68.27 b-d	69.04
V_3M_1	69.97 a-c	75.98
V_3M_2	68.83 a-d	67.27
V_3M_3	68.69 a-d	63.35
V_3M_4	68.61 a-d	71.86
$LSD_{(0.05)}$	3.481	NS
CV (%)	2.97	14.71

In a column, the means having the same letter (s) do not differ significantly
NS= Not Significant, CV = Coefficient of variation, $LSD_{(0.05)}$= Least significant difference at 5% level, DAS = Days after sowing
V_1= BARI mung-5, V_2= BARI mung-6, V_3= BU mug-4, M_0=0 (Control), M_1=2g/kg seed, M_2=4g/kg seed M_3=6g/kg seed, M_4=8g/kg seed

4.2.8 Pod yield (kg ha^{-1})

4.2.8.1 Effect of variety

Pod yield was not significantly influenced by varities in 1^{st} harvest, 2^{nd} harvest and total of two harvests (Appendix XIII and Figure 26). The numerically higher pod yield of 1st harvest and total of two harvest was observed in V_3 (BU mug-4) but in 2nd harvest maximum pod yield found in V_1 (BARI mung-5). The finding was dissimilar with Singh and Singh (1988) who reported that cultivars played a key role in increasing yield. Pahlwan and Hossain (1983) reported that the highest yield from the variety Mubarik was attributed to the highest number of pods $plant^{-1}$ and seeds $plant^{-1}$.

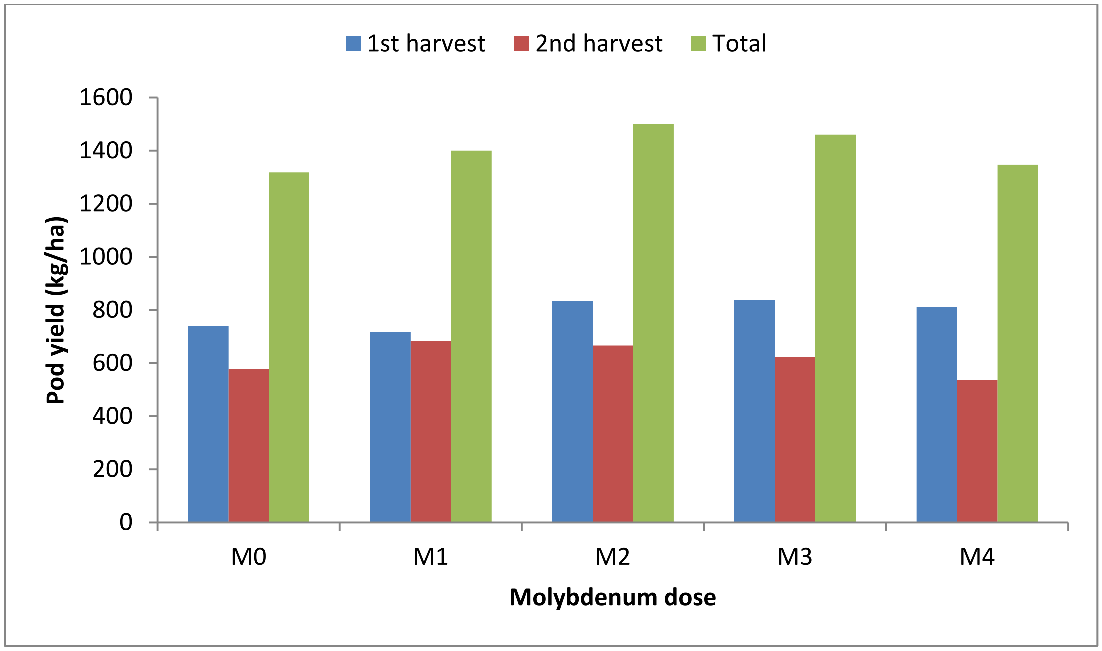


V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4

Figure 26. Pod yield of mungbean as influenced by variety.

4.2.8.2 Effect of molybdenum

Pod yield was not significantly influenced by molybdenum application (Appendix XIII and Figure 27). In first harvest the numerically higher pod yield was observed in M_3 (6g/kg seed). But in 2nd harvest maximum pod yield was found in M_1 (2g/kg seed). The maximum pod yield in the total of two harvests was found in M_2 (4g/kg seed).



M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 27. Pod yield of mungbean as influenced by molybdenum.

4.2.8.3 Interaction effect of variety and molybdenum

Interaction of variety and molybdenum showed significant effect on pod yield of mungbean (Table 12). In 1st harvest, the highest pod yield (968.33 kg/ha) was observed in V_1M_3 treatment but this result was statistically similar with V_2M_4, V_3M_1, V_3M_3, V_3M_2, V_1M_2, V_2M_2, V_3M_4, V_2M_0, V_3M_0, V_1M_4, V_1M_0, V_2M_3 and V_1M_1. The lowest pod yield (602.50 kg/ha) was found in V_2M_1 treatment that statistically similar with V_1M_1, V_2M_3, V_1M_0, V_1M_4, V_3M_0, V_2M_0, V_3M_4, V_2M_2, V_1M_2, V_3M_2, V_3M_3, V_3M_1 and V_2M_4. In 2nd harvest, the highest pod yield (845.83 kg/ha) was found in V_3M_1 treatment which was statistically similar with V_1M_1, V_2M_2, V_2M_3, V_3M_2, V_1M_2, V_1M_3, V_1M_0, V_1M_4 and V_3M_0. The lowest pod yield (476.67 kg/ha) was recorded in V_3M_4 treatment which was statistically similar with V_2M_1, V_2M_0, V_2M_4, V_3M_3, V_3M_0, V_1M_4, V_1M_0, V_1M_3, V_1M_2, V_3M_2, V_2M_3, V_2M_2 and V_1M_1. The highest total pod yield (1707.50 kg/ha) was found in V_3M_1 treatment which was statistically similar with V_1M_3, V_3M_2, V_2M_2, V_1M_2, V_2M_4, V_3M_3, V_1M_1, V_2M_3, V_2M_0, V_3M_0, V_1M_0, V_1M_4 and V_3M_4. The lowest total pod yield (1095.83 kg/ha) was obtained in V_2M_1 treatment which was statistically similar with V_3M_4, V_1M_4, V_1M_0, V_3M_0, V_2M_0, V_2M_3, V_1M_1, V_3M_3, V_2M_4, V_1M_2, V_2M_2 and V_3M_2.

Table 12. Interaction effect of variety and molybdenum on pod yield of mungbean at different harvest

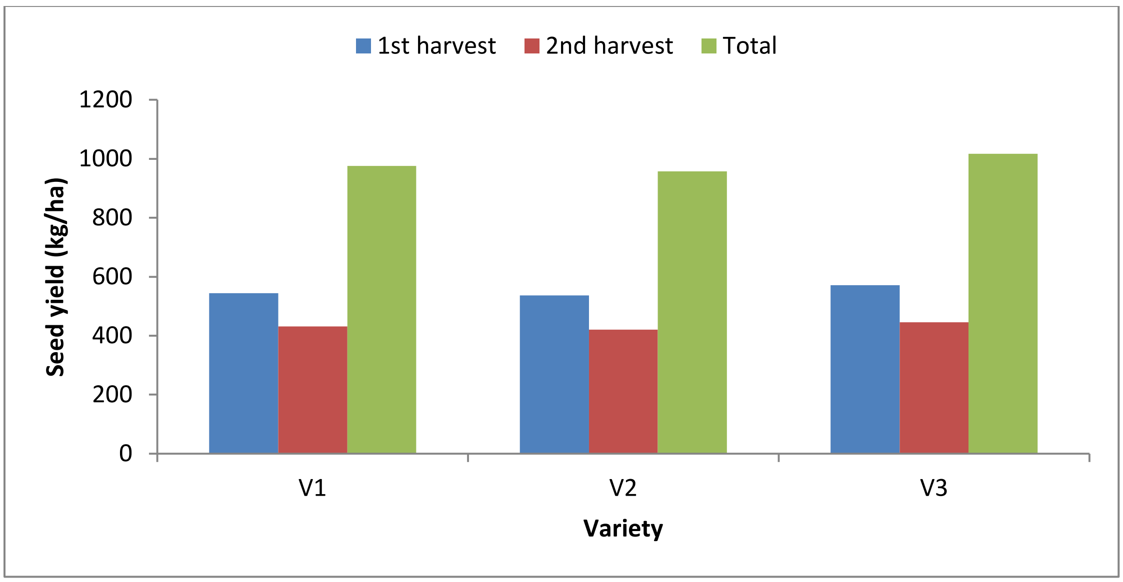
Treatments	Pod yield (kg/ha)		
	1st harvest	2nd harvest	Total
V_1M_0	705.83 ab	604.17 ab	1310.00 ab
V_1M_1	685.00 ab	710.83 ab	1395.83 ab
V_1M_2	839.17 ab	640.83 ab	1480.00 ab
V_1M_3	968.33 a	632.50 ab	1600.83 a
V_1M_4	723.33 ab	576.67 ab	1300.00 ab
V_2M_0	771.67 ab	554.17 b	1325.83 ab
V_2M_1	602.50 b	493.33 b	1095.83 b
V_2M_2	821.67 ab	680.00 ab	1501.67 ab
V_2M_3	695.00 ab	679.17 ab	1374.17 ab
V_2M_4	898.33 ab	554.17 b	1452.50 ab
V_3M_0	741.67 ab	575.83 ab	1317.50 ab
V_3M_1	861.67 ab	845.83 a	1707.50 a
V_3M_2	840.83 ab	676.67 ab	1517.50 ab
V_3M_3	850.83 ab	556.67 b	1407.50 ab
V_3M_4	812.50 ab	476.67 b	1289.17 ab
$LSD_{(0.05)}$	299.808	277.437	437.561
CV (%)	22.58	26.68	18.48

In a column, the means having the same letter (s) do not differ significantly
CV = Coefficient of variation, $LSD_{(0.05)}$= Least significant difference at 5% level, DAS = Days after sowing
V_1= BARI mung-5, V_2= BARI mung-6, V_3= BU mug-4,M_0=0 (Control), M_1=2g/kg seed, M_2=4g/kg seed
M_3=6g/kg seed, M_4=8g/kg seed

4.2.9 Seed yield (kg/ha)

4.2.9.1Effect of variety

Seed yield of mungbean was not significantly influenced by variety (Appendix XIV and Figure 28). The numerically maximum seed yield of 1st harvest, 2nd harvest and total of two harvests was obtained in V_3 (BU mug-4) and the minimum seed yield obtained in V_2 (BARI mung-6) but all the yield was statistically similar with the varieties. Pahlwan and Hossain (1983) reported the highest yield from the variety Mubarik along with the highest number of pods plant^{-1} and seeds plant^{-1}.

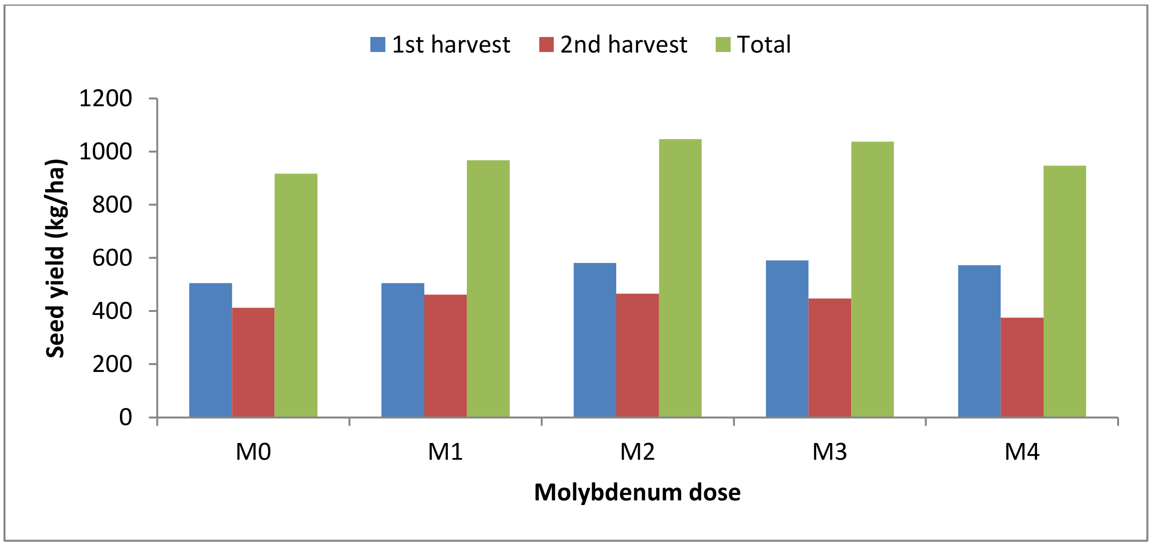


V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4

Figure 28. Seed yieldof mungbean as influenced by variety.

4.2.9.2 Effect of molybdenum

Molybdenum doses had no significant effect on seed yield of mungbean (Appendix XIV and Figure 29). In 1st harvest, the maximum seed yield was found in M_3 (6g/kg seed) which was statistically similar to others. In 2nd harvest and in total of two harvest, the maximum seed yield was recorded in M_2 (4g/kg seed) but this result was statistically similar to others. Ahmed *et al.* (1988) observed that Mo application increased seed yield of green gram *(Vigna radiata)* by 28% and DM yield by 34%. All trace element treatments increased yield compared with the control. Pariccaet *al.* (1983) conducted a field experiment with *Vigna radiata L.* and observed that Mo alone increased the yield by 26.4%. Molybdenum was required for increasing yield in mungbean (Velu and Savithri, 1982).



M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 29. Seed yield of mungbean as influenced by molybdenum.

4.2.9.3Interaction effect of variety and molybdenum

Interaction of variety and molybdenum had significant effect on seed yield of mungbean (Table 13). In 1st harvest, the highest seed yield (659.17 kg/ha) was observed in V_1M_3 treatment which was statistically similar with V_2M_4, V_3M_1, V_3M_2, V_3M_3, V_2M_2, V_1M_2, V_3M_4, V_2M_0, V_1M_4, V_2M_3, V_3M_0, V_1M_1 and V_1M_0. The lowest seed yield (420.00 kg/ha) was found in V_2M_1 treatment but this result was statistically similar with V_1M_0, V_1M_1, V_3M_0, V_2M_3, V_1M_4, V_2M_0, V_3M_4, V_1M_2, V_2M_2, V_3M_3, V_3M_2 and V_3M_1. In 2nd harvest, the highest seed yield (595.00 kg/ha) was recorded in V_3M_1 treatment but this result was statistically similar with V_2M_2, V_2M_3, V_3M_2, V_1M_1, V_1M_3, V_3M_0 and V_1M_4. The lowest seed yield (312.50 kg/ha) was found in V_3M_4 treatment that statistically similar with V_2M_1, V_2M_4,

V_2M_0, V_3M_3, V_1M_2, V_1M_0, V_1M_4, V_3M_0, V_1M_3, V_1M_1 and V_3M_2. The highest total seed yield (1210.83 kg/ha) was obtained in V_3M_1 treatment which was statistically similar with V_1M_3, V_2M_2, V_3M_2, V_2M_3, V_2M_4, V_3M_3, V_1M_2, V_1M_4, V_3M_0 and V_1M_1. The lowest total seed yield (758.33 kg/ha) was found in V_2M_1 treatment but this result was statistically similar with V_3M_4, V_1M_0, V_2M_0, V_1M_1, V_3M_0, V_1M_4, V_1M_2, V_3M_3, V_2M_4 and V_2M_3.

Table 13. Interaction effect of variety and molybdenum on seed yield of mungbean at different harvest

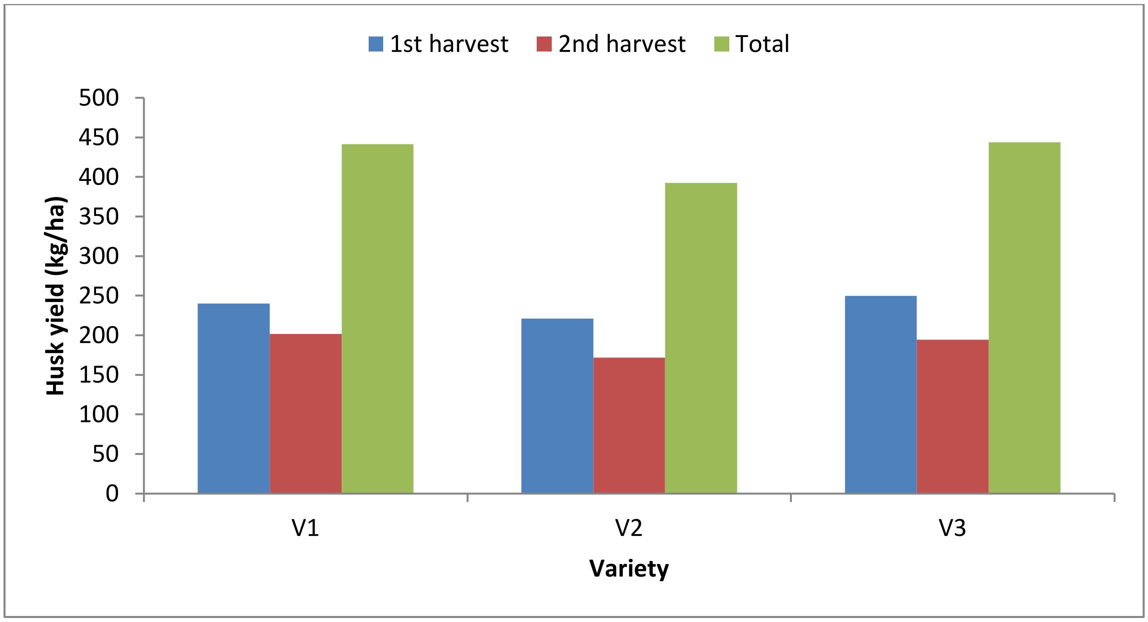
Treatments	Seed yield (kg/ha)		
	1st harvest	2nd harvest	Total
V_1M_0	479.17 ab	407.50 b-d	886.67 bc
V_1M_1	480.00 ab	454.17 a-d	934.17 a-c
V_1M_2	571.67 ab	404.17 b-d	975.83 a-c
V_1M_3	659.17 a	452.50 a-d	1111.67 ab
V_1M_4	531.67 ab	439.17 a-d	970.83 a-c
V_2M_0	543.33 ab	382.50 b-d	925.83 bc
V_2M_1	420.00 b	338.33 cd	758.33 c
V_2M_2	577.50 ab	517.50 ab	1095.00 ab
V_2M_3	522.50 ab	491.67 a-c	1014.17 a-c
V_2M_4	620.83 a	372.50 b-d	993.33 a-c
V_3M_0	491.67 ab	446.67 a-d	938.33 a-c
V_3M_1	615.83 ab	595.00 a	1210.83 a
V_3M_2	595.00 ab	475.83 a-d	1070.83 ab
V_3M_3	590.83 ab	397.50 b-d	988.33 a-c
V_3M_4	565.83 ab	312.50 d	878.33 bc
$LSD_{(0.05)}$	200.561	176.051	281.237
CV (%)	21.60	24.16	16.97

In a column, the means having the same letter (s) do not differ significantly,
CV = Coefficient of variation, $LSD_{(0.05)}$= Least significant difference at 5% level, DAS = Days after sowing
V_1= BARI mung-5, V_2= BARI mung-6, V_3= BU mug-4, M_0=0 (Control), M_1=2g/kg seed, M_2=4g/kg seed
M_3=6g/kg seed, M_4=8g/kg seed

4.2.10 Husk yield (kg/ha)

4.2.10.1 Effect of variety

Husk yield of mungbean was not significantly influenced by variety in 1st harvest, 2nd harvest and total of two harvests (Appendix XV and Figure 30).The maximum husk yield was recorded in V_3 (BU mug-4) for 1^{st} harvest and in total but this was statistically similar to others but in 2^{nd} harvest, the maximum husk yield was found in V_1 (BARI mung-5).

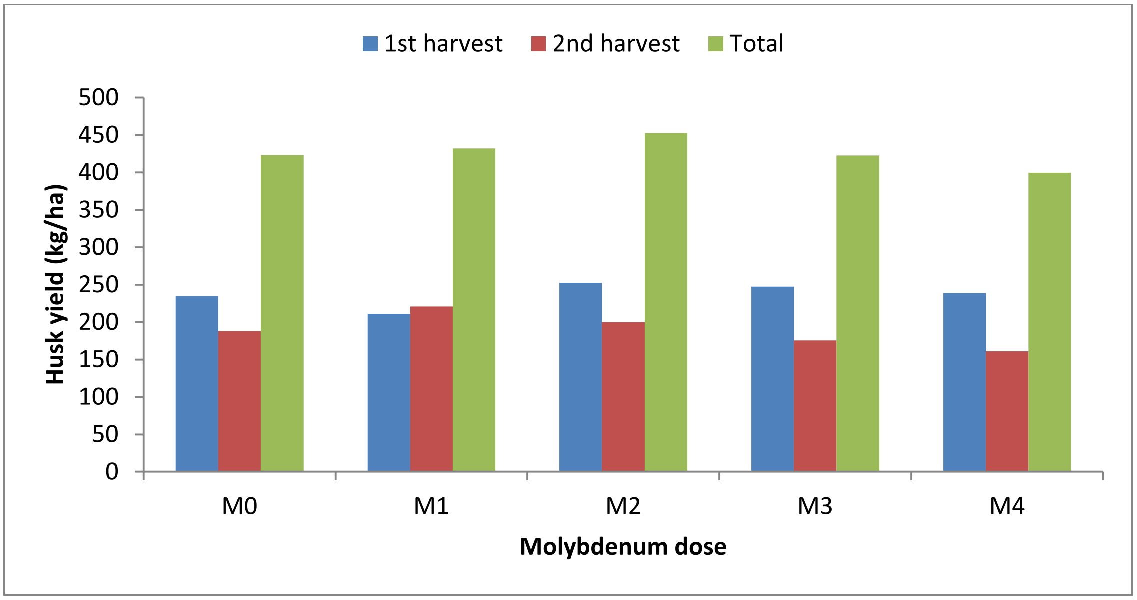


V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4

Figure 30. Husk yield of mungbean as influenced by variety.

4.2.10.2 Effect of molybdenum

Molybdenum had no significant effect on husk yield of mungbean (Appendix XV and Figure 31). In 1^{st} harvest and in total of two harvests maximum husk yield was obtained in M_2 (4g/kg seed) that was statistically similar to others. But in 2^{nd} harvest, husk yield was higher in M_1 (2g/kg seed) which was statistically similar to others.



M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 31. Husk yield of mungbean as influenced by molybdenum.

4.2.10.3Interaction effect of variety and molybdenum

Interaction between variety and molybdenum had significant effect on husk yield of mungbean in 1st and 2nd harvest but it showed no significant variation in total husk yield (Table 14). In 1st harvest, the highest husk yield (309.17 kg/ha) was obtained in V_1M_3 which was statistically similar with V_2M_4, V_1M_2, V_3M_3, V_3M_0, V_3M_4, V_3M_1, V_3M_2, V_2M_2, V_2M_0, V_1M_0, V_1M_1 and V_1M_4. The lowest husk yield (172.50 kg/ha) was observed in V_2M_3 that statistically similar with V_2M_1, V_1M_4, V_1M_1, V_1M_0, V_2M_0, V_2M_2, V_3M_1, V_3M_2, V_3M_4, V_3M_0, V_3M_3, V_1M_2 and V_2M_4. In 2nd harvest, the highest husk yield (256.67 kg/ha) was found in V_1M_1 which was statistically similar with V_3M_1, V_1M_2, V_3M_2, V_1M_0, V_3M_0,V_2M_3, V_2M_4, V_1M_3, V_2M_0, V_3M_4, V_3M_2, V_3M_3 and V_2M_1. The lowest husk yield (137.50 kg/ha) was recorded in V_1M_4 which was statistically similar with V_2M_1, V_3M_3, V_3M_2, V_3M_4, V_2M_0, V_1M_3, V_2M_4, V_2M_3, V_3M_0, V_1M_0, V_3M_2 and V_1M_2. The total numerically maximum husk yield (504.17 kg/ha) was found in V_1M_2 which was statistically similar to others.

Table 14. Interaction effect of variety and molybdenum on husk yield of mungbean at different harvest

Treatments	Husk yield (kg/ha)		
	1st harvest	2nd harvest	Total
V_1M_0	226.67 ab	196.67 ab	423.33
V_1M_1	205.00 ab	256.67 a	461.67
V_1M_2	267.50 ab	236.67 ab	504.17
V_1M_3	309.17 a	180.00 ab	489.17
V_1M_4	197.67 ab	137.50 b	329.17
V_2M_0	228.33 ab	171.67 ab	400.00
V_2M_1	182.50 b	155.00 ab	337.50
V_2M_2	244.17 ab	162.50 ab	406.67
V_2M_3	172.50 b	187.50 ab	360.00
V_2M_4	277.50 ab	181.67 ab	459.17
V_3M_0	250.00 ab	195.83 ab	445.83
V_3M_1	245.83 ab	250.83 a	496.67
V_3M_2	245.83 ab	200.83 ab	446.67
V_3M_3	260.00 ab	159.17 ab	419.17
V_3M_4	246.67 ab	164.17 ab	410.83
$LSD_{(0.05)}$	118.899	111.495	NS
CV (%)	29.79	34.99	26.12

In a column, the means having the same letter (s) do not differ significantly
NS= Not Significant, CV = Coefficient of variation, $LSD_{(0.05)}$= Least significant difference at 5% level, DAS = Days after sowing
V_1= BARI mung-5, V_2= BARI mung-6, V_3= BU mug-4,M_0=0 (Control), M_1=2g/kg seed, M_2=4g/kg seed M_3=6g/kg seed, M_4=8g/kg seed

4.2.11 Stover yield (kg/ha)

4.2.11.1 Effect of variety

Varieties had no significant effect on stover yield (Appendix XVI and Table 15). The numerically maximum stover yield (2766.33 kg/ha) was found in V_3 (BU mug-4) that followed by V_1 (BARI mung-5) and V_2 (BARI mung-6) which were statistically similar.

4.2.11.2 Effect of molybdenum

Stover yield did not differ significantly at different molybdenum level (Appendix XVI and Table 15).The maximum stover yield (2541.06 kg/ha) was observed in M_3 (6g/kg seed) and this result was statistically similar to others.

Table 15. Influence of variety and molybdenum on stover yield, biological yield and harvest index of mungbean

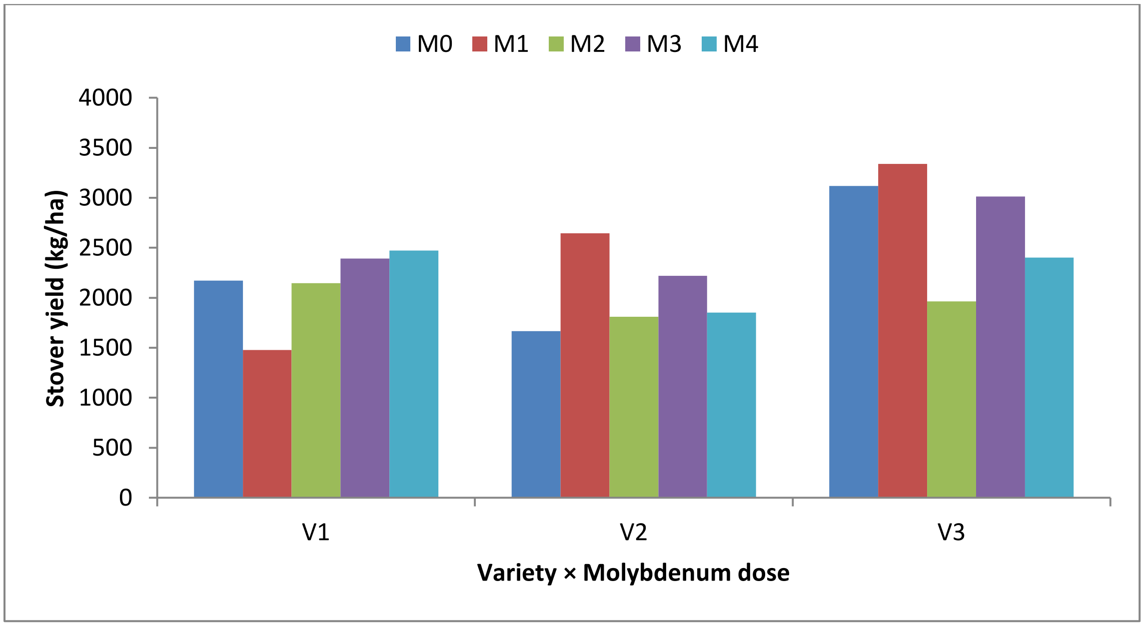
Treatments	Stover yield (kg/ha)	Biological yield (t/ha)	Harvest index (%)
Variety			
V_1	2132.57	3.11	37.00
V_2	2039.00	2.99	35.27
V_3	2766.33	3.78	27.87
$LSD_{(0.05)}$	NS	NS	NS
CV (%)	45.18	32.64	52.25
Molybdenum dose			
M_0	2319.11	3.24	30.94
M_1	2486.67	3.46	34.88
M_2	1973.89	3.02	37.54
M_3	2541.06	3.58	31.01
M_4	2242.44	3.19	32.54
$LSD_{(0.05)}$	NS	NS	NS
CV (%)	25.75	18.87	32.90

In a column, the means having the same letter (s) do not differ significantly
NS = Not significant, CV = Coefficient of variation, $LSD_{(0.05)}$=Least significant difference at 5% level, DAS = Days after sowing
V_1= BARI mung-5, V_2= BARI mung-6, V_3= BU mug-4,
M_0=control, M_1=2g/kg seed, M_2=4g/kg seed, M_3=6g/kg seed, M_4=8g/kg seed

4.2.11.3 Interaction effect of variety and molybdenum

Interaction between variety and molybdenum had significant effect on stover yield (Figure 32). The highest stover yield (3338.00 kg/ha) was recorded in V_3M_1 treatment which was statistically similar with V_3M_0, V_3M_3, V_2M_1, V_1M_4, V_3M_4

and V_1M_3. The lowest stover yield (1478.67 kg/ha) was found in V_1M_1 treatment which was statistically similar with V_2M_0, V_2M_2, V_2M_4, V_3M_2, V_1M_2, V_1M_0, V_2M_3, V_1M_3, V_3M_4 and V_1M_4.



V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4
M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 32. Stover yield of mungbean as influenced by interaction effect of variety and molybdenum ($LSD_{0.05}$= 1003.57).

4.2.12 Biological yield (t/ha)

4.2.12.1 Effect of variety

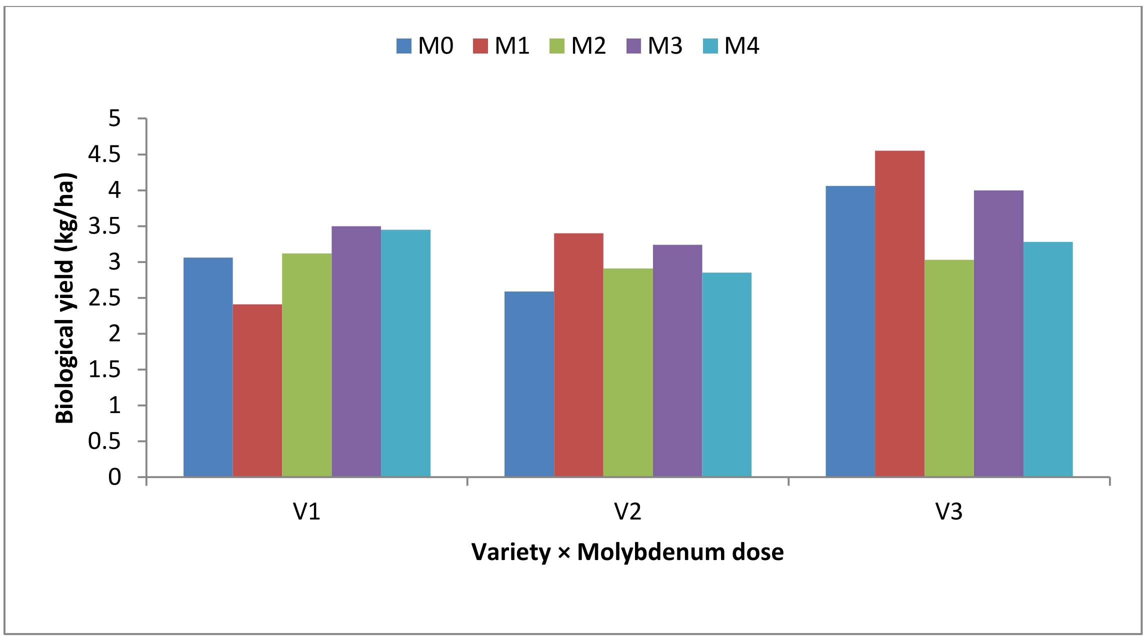
Biological yield of mungbean was not significantly influenced by variety (Appendix XVI and Table 15). The numerically maximum biological yield (3.79 t/ha) was obtained from V_3 (BU mug-4) that followed by V_1 (BARI mung-5) and V_2 (BARI mung-6) which were statistically similar.

4.2.12.2 Effect of molybdenum

Molybdenum had insignificant effect on biological yield (Appendix XVI and Table 15). The maximum biological yield (3.58 t/ha) was in M_3 (6g/kg seed) which was statistically similar to others. So biological yield of mungbean was not affected by molybdenum.

4.2.12.3 Interaction effect of variety and molybdenum

Interaction between variety and molybdenum had significant effect on biological yield (Figure 33). The highest biological yield (4.55 t/ha) was observed in V_3M_1which was statistically similar with V_3M_0, V_3M_3 and V_1M_3. The lowest biological yield (2.41 t/ha) was found in V_1M_1 that statistically similar with V_2M_0, V_2M_4, V_2M_2, V_3M_2, V_1M_0, V_1M_2, V_2M_3, V_3M_4, V_2M_1 and V_2M_0.



V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4
M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 33. Biological yield of mungbean as influenced by interaction effect of variety and molybdenum ($LSD_{0.05}$=1.048)

4.2.13 Harvest index

4.2.13.1 Effect of variety

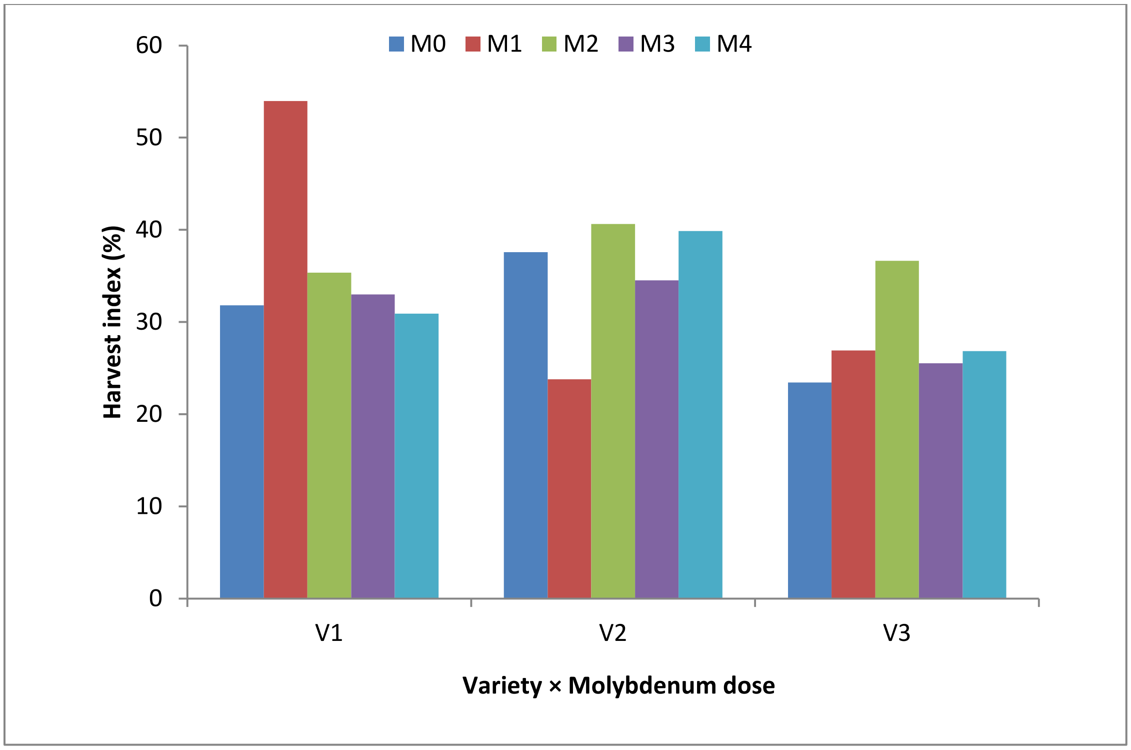
The harvest index was not significantly influenced by variety (Appendix XVI and Table 15). The numerically maximum harvest index was obtained in V_1 (BARI mung-5) which was statistically similar with the other varieties. The result was dissimilar with the findings of Aguliar and Villarea (1989) and Ghosh (2007) who reported that the harvest index of mungbean was significantly influenced by the variety.

4.2.13.2 Effect of molybdenum

Molybdenum had no significant influence on harvest index (Appendix XVI and Table 15). The maximum harvest index was found in M_2 (4g/kg seed) that followed by M_1 (2g/kg seed), M_4 (8g/kg seed), M_3 (6g/kg seed) and M_0 (control) which were statistically similar.

4.2.13.3 Interaction effect of variety and molybdenum

Interaction between variety and molybdenum had significant influence on harvest index (Figure 34). The highest harvest index (53.96%) was obtained in V_1M_1 which was statistically similar with V_2M_2, V_2M_4, V_2M_0 and V_3M_2. The lowest harvest index (23.43%) was recorded in V_3M_0 that statistically similar with V_2M_1, V_3M_3, V_3M_4, V_3M_1, V_1M_4, V_1M_0, V_1M_3, V_2M_3, V_1M_2, V_3M_2, V_2M_0, V_2M_4 and V_2M_2.



V_1 = BARI mung-5, V_2 = BARI mung-6, V_3= BU mug-4
M_0= 0(Control), M_1= 2g/kg seed, M_2= 4g/kg seed, M_3 = 6g/kg seed, M_4= 8g/kg seed

Figure 34. Harvest index of mungbean as influenced by interaction effect of variety and molybdenum ($LSD_{0.05}$= 18.508).

CHAPTER 5

SUMMARY AND CONCLUSION

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during March, 2016 to May, 2016 to study the effect of variety and molybdenum dose on the growth and yield of mungbean. The treatment of the experiment consists of three varieties viz. BARI mung-5, BARI mung-6, and BU mug-4 and five molybdenum doses viz. 0 (Control), 2g/kg seed, 4g/kg seed, 6g/kg seed and 8g/kg seed. The experiment was laid out in Split-plot design following the principles of randomization with three replications. The sowing date was on March 10, 2016.

Observation were made on emergence, plant height, number of leaves plant^{-1}, dry weight, number of nodules plant^{-1}, number of branches plant^{-1}, first flowering, number of pods plant^{-1}, pod length, number of seeds pod^{-1}, weight of 1000 seeds, shelling percentage, pod yield (kg/ha), seed yield (kg/ha), husk yield (kg/ha), stover yield (kg/ha), biological yield (t ha^{-1}) and harvest index. Emergence was recorded as number of plants emerged in 1m^2 area. Five plants were randomly selected from each unit plot for taking observations on plant height, number of leaves plant^{-1} and dry weight plant^{-1} with 15 days interval at 15, 30, 45, 60 days after sowing and at harvest. Number of branches plant^{-1} was recorded from 30 DAS to harvest at 15 days interval. Number of nodules plant^{-1} was observed at 30 and 45 DAS. Central six lines from each plot were harvested for pod yield, pods plant^{-1}, pod length, number of seeds pod^{-1}, shelling percentage, seed yield, biological yield and harvest index (%). Thousand seed weight was measured from sampled seed. Data were analyzed using CROPSTAT program. The mean differences among the treatments were compared by least significant difference (LSD) test at 5% level of significance.

Among the growth parameters, emergence was higher in BU mug-4, but plant height, number of nodules plant^{-1}, dry weight and leaf number upto 60 DAS were unaffected by variety, leaf number at harvest was higher in BU mug-4. In case of yield parameter branches number at 30 DAS was maximum in BARI mung-6 after that it was statistically similar. Number of pods plant^{-1}, number of seeds pod^{-1}, first flowering, pod yield, seed yield, husk yield, stover yield, biological yield and harvest index were unaffected by mungbean varieties. Thousand seed weight was significantly influenced by molybdenum at 2nd harvest but at 1st harvest it was unaffected.

Molybdenum showed significant influence on emergence of mungbean at 4, 5, 7, 8 and 9 DAS but it was insignificant at 6, 10, 11 DAS. Plant height was not affected by molybdenum, but leaf number was insignificant upto 45 DAS and dry weight upto 60 DAS later it was significant. Nodules number plant^{-1} was insignificant at 30 DAS and significant at 45 DAS. No significant variation observed due to molybdenum in number of branches plant^{-1}, first flowering, number of pods plant^{-1}, shelling percentage, pod yield, seed yield, husk yield, stover yield, biological yield and harvest index. Significant variation observed in pod length at 2nd harvest, number of seeds pod^{-1} were significant at 2nd harvest and average and significant influence was observed in thousand seed weight at 2nd harvest.

The findings showed that the interaction of variety and molybdenum had significant effect on emergence of mungbean. At 4, 5, 6 and 11 DAS, the highest emergence was observed in V_3M_4 whereas, at 7, 8, 9 and 10 DAS, the highest emergence was found in V_3M_4 treatment combination. At 5 DAS, the lowest emergence was in V_1M_2, at 6 and 7 DAS lowest emergence found in V_1M_3 treatment but at 8, 9, 10 and 11 DAS, the lowest emergence was recorded in V_1M_4 treatment. Plant height was significantly influenced by interaction between variety and molybdenum. At 15, 45, 60 DAS, the highest plant height observed in V_3M_4

treatment but at 30 DAS, the V_3M_3 treatment showed maximum plant height. The lowest plant height observed at 15 DAS in V_1M_1, at 30 DAS in V_2M_2 and later from 45 DAS upto harvest, the lowest plant height was found in V_2M_0 treatment combination. Leaf number was unaffected by interaction between variety and molybdenum at 15 DAS, after that it was significant. The highest leaf number from 30 DAS to harvest was in V_3M_2 treatment combination. Number of nodules plant^{-1} was significantly influenced by interaction between variety and molybdenum. At 30 DAS, the highest number of nodules plant^{-1} was found in V_1M_2 treatment and lowest was in V_3M_2 treatment. But at 45 DAS, maximum number of nodules plant^{-1} was obtained in V_1M_3 and the minimum in V_3M_1 treatment combination. Interaction between variety and molybdenum showed insignificant effect on dry weight plant^{-1} at 15 DAS but later it was significant. At 30 DAS, the highest dry weight plant^{-1} was found in V_3M_3 and the lowest was in V_1M_3 treatment combination. At 45 DAS, the highest was in V_2M_4 treatment and the lowest was in V_3M_0 treatment. At 60 DAS, the highest dry weight was observed in V_2M_0 treatment and the lowest in V_1M_0 treatment. At harvest, the highest dry weight was in V_2M_3 and the lowest was in V_1M_0. In case of yield and yield contributing parameter, branch number was significantly influenced by interaction between variety and molybdenum. The highest branch number from 30 DAS to 60 DAS was in V_2M_1 treatment and the lowest was in V_1M_0 treatment. At harvest, the highest branch number was recorded in V_2M_3 and the lowest was in V_1M_2 treatment combination. Interaction between variety and molybdenum significantly affect the pod length which was higher in V_1M_3 treatment and the lowest in V_3M_4. Number of pods plant^{-1} was significantly influenced by interaction between variety and molybdenum in 1st harvest but 2nd harvest and total of two harvests, number of pods plant^{-1} was not affected. Number of seeds pod^{-1} was significantly influenced by variety and molybdenum interaction. The highest number of seeds pod^{-1} was observed in V_2M_1 and the lowest was in V_1M_1, V_3M_3 and V_1M_0 in 1st harvest, 2nd harvest and average of two harvests, respectively. Interaction between variety and molybdenum significantly affected thousand seed weight. In 1st harvest, the highest weight of 1000-seed was found in V_3M_2 and the lowest was in V_1M_0 and in 2nd harvest, the highest was in V_3M_3 and the lowest was in V_1M_4 treatment combination. Pod yield, seed yield, stover yield, biological yield and harvest index was significantly influenced by interaction between variety and molybdenum dose. Seed yield was higher in V_3M_1 and the lowest was in V_2M_1. Stover yield was higher in V_3M_1 and the lowest was in V_1M_1 treatment combination. Higher biological yield was obtained in V_3M_1 and the lowest was in V_1M_1. The highest harvest index was found in V_1M_1 and the lowest was in V_3M_0 treatment combination.

Considering the above observations of the present experiment, the following conclusions may be drawn-

- Varieties had no significant effect on growth and yield characters of mungbean.
- Number of seeds pod^{-1} increased in M_1 (2g/kg seed) and number of nodules $plant^{-1}$ increased in M_3 (6g/kg seed).
- Combined effects of variety and Mo on yield and yield attributes of mungbean were found positive and significant.

However, to reach a specific conclusion and recommendation, more research work of molybdenum effect on mungbean should be done over different Agro-ecological zones.

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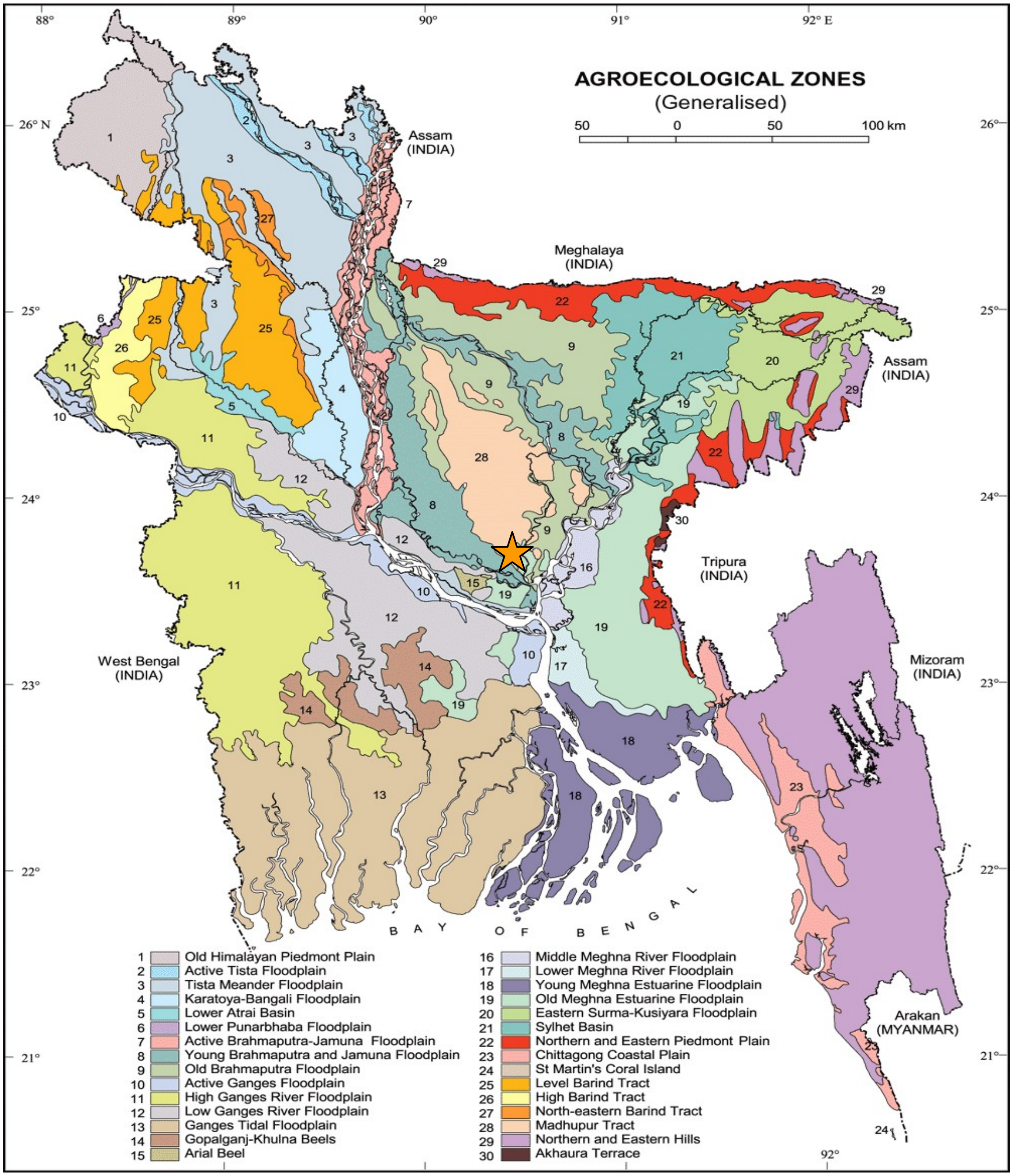
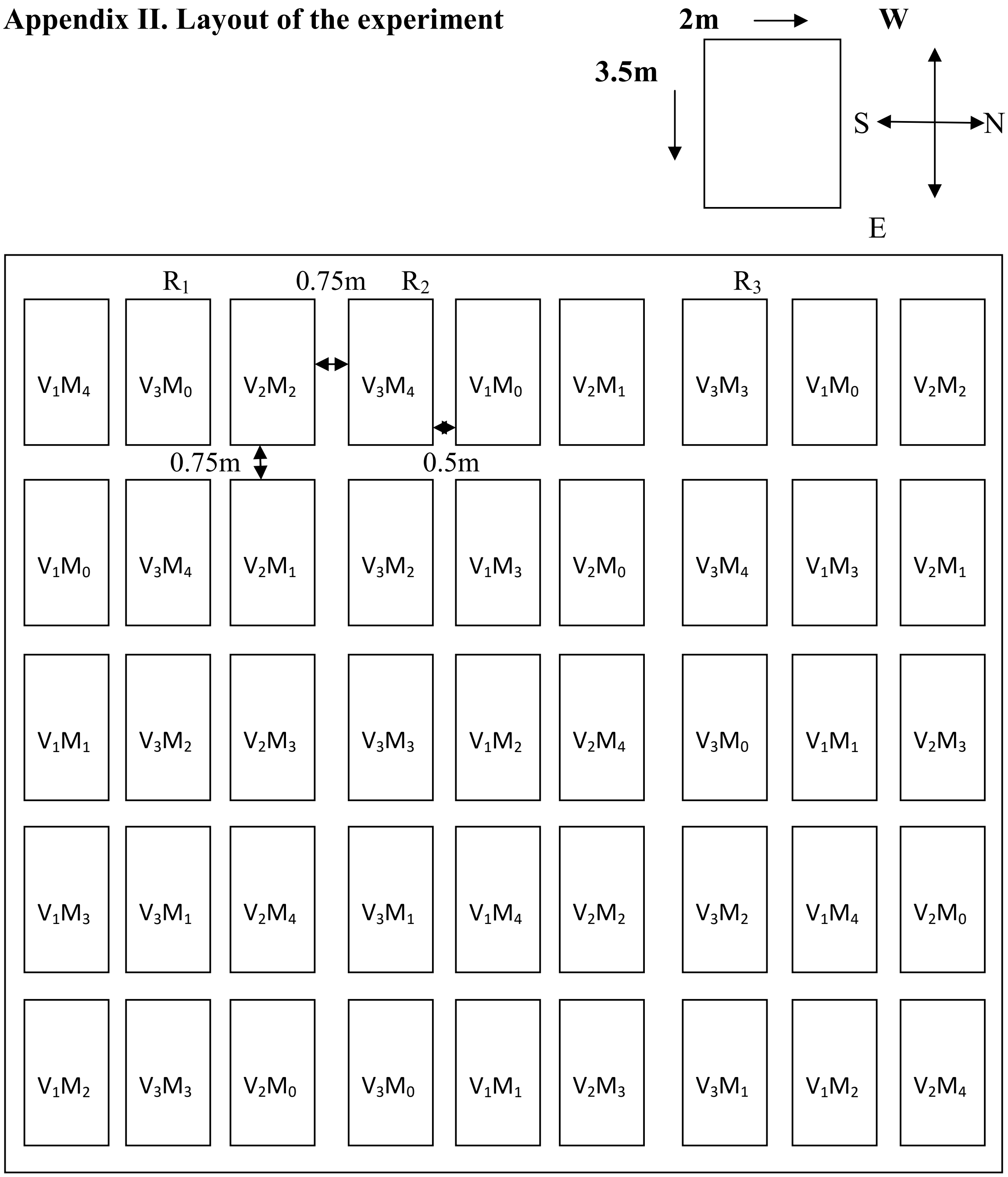
APPENDICES

Appendix I. Map showing the experimental sites under study



☆ **The experimental site under study**

Appendix II. Layout of the experiment



Appendix III. Mean square values for emergence of mungbean at different days after sowing

Sources of variation	Degrees of freedom	Mean square values							
		4 DAS	5 DAS	6 DAS	7 DAS	8 DAS	9 DAS	10 DAS	11 DAS
Replication	2	55.022	113.40	142.48	150.48	122.07	101.42	112.156	140.47
Variety (V)	2	234.289	1554*	2714*	3110*	3203*	3158*	3043*	2958*
Error (a)	4	76.056	337.86	334.28	378.82	336.83	328.28	301.222	244.13
Molybdenum(M)	4	38.611*	93.2*	156.31	197.8*	160.1*	145.6*	124.144	115.08
V X M	8	24.92 *	74.23*	106.2*	130.2*	122.9*	108.6*	116.6*	130.9*
Error (b)	24	15.572	62.739	89.856	100.54	111.161	112.75	117.033	112.97

* Significant at 5% level

Appendix IV. Mean square values for plant height of mungbean at different growth stages

Sources of variation	Degrees of freedom	Mean square values				
		15 DAS	30 DAS	45 DAS	60 DAS	At harvest
Replication	2	1.779	19.013	44.828	55.378	64.341
Variety (V)	2	24.658	157.382	603.855	603.380	580.568
Error (a)	4	18.822	140.183	260.933	254.581	213.078
Molybdenum(M)	4	1.003	10.619	13.193	18.857	19.208
V X M	8	0.337*	11.376*	23.107*	22.142*	25.138*
Error (b)	24	2.518	13.263	42.464	39.822	42.835

* Significant at 5% level

Appendix V. Mean square values for number of leaves plant^{-1} of mungbean at different growth stages

Sources of variation	Degrees of freedom	Mean square values				
		15 DAS	30 DAS	45 DAS	60 DAS	At harvest
Replication	2	0.0595	0.344	3.1476	4.8222	5.230
Variety (V)	2	0.0248	0.4667	3.1049	5.2702	4.187*
Error (a)	4	0.1689	0.907	1.4476	1.3156	0.396
Molybdenum(M)	4	0.0298	0.1409	2.548	2.308*	3.490*
V X M	8	0.0371	0.222*	1.516*	1.108*	0.808*
Error (b)	24	0.0380	0.239	1.915	1.560	1.024

* Significant at 5% level

Appendix VI. Mean square values for number of nodules plant^{-1} of mungbean at different growth stages

Sources of variation	Degrees of freedom	Mean square values	
		30 DAS	45 DAS
Replication	2	91.974	151.574
Variety (V)	2	28.513	182.566
Error (a)	4	37.893	65.698
Molybdenum(M)	4	6.795	91.383*
V X M	8	25.5296*	87.455*
Error (b)	24	33.259	46.329

* Significant at 5% level

Appendix VII. Mean square values for dry weight plant^{-1} of mungbean at different growth stages

Sources of variation	Degrees of freedom	Mean square values				
		15 DAS	30 DAS	45 DAS	60 DAS	At harvest
Replication	2	0.00059	0.0941	9.097	44.851	79.011
Variety (V)	2	0.00171	0.2027	12.542	34.315	39.385
Error (a)	4	0.00143	0.7902	12.391	28.979	10.075
Molybdenum(M)	4	0.00050	0.04404	2.778	9.5511	21.753*
V X M	8	0.00069	0.19437*	3.285*	23.580*	20.303*
Error (b)	24	0.00102	0.1609	4.322	12.616	14.495

* Significant at 5% level

Appendix VIII. Mean square values for number of branches plant^{-1} of mungbean at different growth stages

Sources of variation	Degrees of freedom	Mean square values			
		30 DAS	45 DAS	60 DAS	At harvest
Replication	2	0.0187	0.739	0.8435	1.952
Variety (V)	2	0.024*	0.139	0.3236	0.2427
Error (a)	4	0.0027	0.1716	0.34489	0.4347
Molybdenum(M)	4	0.040	0.1569	0.139	0.2587
V X M	8	0.0373*	0.09956*	0.1224*	0.239*
Error (b)	24	0.0302	0.192	0.200	0.190

* Significant at 5% level

Appendix IX. Mean square values for first flowering and pod length of mungbean at different harvest

Sources of variation	Degrees of freedom	Mean square values			
			Pod length		
		First flowering	1st harvest	2nd harvest	Average
Replication	2	2.0667	0.01558	0.0559	0.0283
Variety (V)	2	2.400	1.0166	1.1168*	1.0173*
Error (a)	4	7.067	0.5698	0.2104	0.2051
Molybdenum(M)	4	0.5333	0.2298	0.3334*	0.0515
V X M	8	0.8167*	0.26804*	0.2387*	0.1199*
Error (b)	24	0.7056	0.2383	0.1014	0.1024

* Significant at 5% level

Appendix X. Mean square values for number of pods plant^{-1} of mungbean at different harvest

Sources of variation	Degrees of freedom	Mean square values		
		Number of pods plant^{-1}		
		1st harvest	2nd harvest	Total
Replication	2	20.8862	32.4702	97.579
Variety (V)	2	17.926	3.1209	31.1547
Error (a)	4	31.206	8.4742	66.0613
Molybdenum(M)	4	4.473	7.6498	11.0431
V X M	8	6.0773*	3.6031	5.7091
Error (b)	24	4.2073	13.024	23.8704

* Significant at 5% level

Appendix XI. Mean square values for number of seeds pod^{-1} of mungbean at different harvest

Sources of variation	Degrees of freedom	Mean square values		
		Number of seeds pod^{-1}		
		1st harvest	2nd harvest	Average
Replication	2	1.4047	0.3849	0.8091
Variety (V)	2	0.8427	0.9082	0.5984
Error (a)	4	1.907	0.3249	0.3336
Molybdenum(M)	4	0.6598	2.1286*	0.6252*
V X M	8	1.1254*	0.8316*	0.5414*
Error (b)	24	0.9376	0.7349	0.4182

* Significant at 5% level

Appendix XII. Mean square values for thousand seed weight and shelling percentage of mungbean at different harvest

Sources of variation	Degrees of freedom	Mean square values			
		Thousand seed weight		Shelling percentage	
		1st harvest	2nd harvest	1st harvest	2nd harvest
Replication	2	7.4972	0.7169	0.0140	134.343
Variety (V)	2	305.697*	453.326*	12.1617*	24.0894
Error (a)	4	1.2634	1.5207	2.5359	66.559
Molybdenum(M)	4	3.6021	4.1120*	3.8104	68.257
V X M	8	3.3374*	1.54697*	8.4163*	42.0837
Error (b)	24	4.3585	1.2585	4.2683	103.445

* Significant at 5% level

Appendix XIII. Mean square values for pod yield of mungbean at different harvest

Sources of variation	Degrees of freedom	Mean square values		
		Pod yield		
		1st harvest	2nd harvest	Total
Replication	2	150125	5866.25	197619
Variety (V)	2	15342.6	7197.92	37588.5
Error (a)	4	117505	10763.5	133748
Molybdenum(M)	4	28388.8	33576.2	51892.9
V X M	8	30054.8*	27680.0*	78564.5*
Error (b)	24	31653.6	27105.9	67424

* Significant at 5% level

Appendix XIV. Mean square values for seed yield of mungbean at different harvest

Sources of variation	Degrees of freedom	Mean square values		
		Seed yield		
		1st harvest	2nd harvest	Total
Replication	2	32786.3	6131.67	50545.4
Variety (V)	2	5093.75	2355.0	14161.2
Error (a)	4	49858.7	4359.17	45514.2
Molybdenum(M)	4	16237.4	13449.0	29271.7
V X M	8	12275.2*	19740.9*	44967.2*
Error (b)	24	14165.5	10914.8	27853.6

* Significant at 5% level

Appendix XV. Mean square values for husk yield of mungbean at different harvest

Sources of variation	Degrees of freedom	Mean square values		
		Husk yield		
		1st harvest	2nd harvest	Total
Replication	2	53697.6	670.972	64517.9
Variety (V)	2	3190.56	3625.14	12520.4
Error (a)	4	21167.0	2889.93	19857.1
Molybdenum(M)	4	2298.4	4710.90	3256.11
V X M	8	5241.42*	3253.61*	10686.2
Error (b)	24	4978.44	4377.71	12378.1

* Significant at 5% level

Appendix XVI. Mean square values for stover yield, biological yield and harvest index of mungbean at different harvest

Sources of variation	Degrees of freedom	Mean square values		
		Stover yield	Biological yield	Harvest index
Replication	2	6196120	7.1217	698.705
Variety (V)	2	2348570	2.7183	352.757
Error (a)	4	1091760	1.1584	304.243
Molybdenum(M)	4	454906	0.4415	71.6205
V X M	8	719457*	0.7912*	212.705*
Error (b)	24	354673	0.3867	120.624

* Significant at 5% level

LIST OF PLATES

Plate 1. Experimental field under study at 30 days after sowing

Plate 2. Experimental field under study at 55 days after sowing

Plate 3. Nodules at 45 days after sowing

Plate 4. First harvesting at 07 May, 2016