# EFFECT OF POTASSIUM ON THE GROWTH, YIELD AND NUTRIENTS CONTENT IN TWO VARIETIES OF MUNGBEAN

**BY**


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## CERTIFICATE

This is to certify that the thesis entitled **"Effect of Potassium on the Growth, Yield and Nutrients Content in Two Varieties of Mungbean"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science** in **Agricultural Chemistry**, embodies the result of a piece of bonafide research work carried out by **Md. Salahuddin**, Registration number: **05-01726** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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



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DEDICATED

TO

MY BELOVED PARENTS

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## EFFECT OF POTASSIUM ON THE GROWTH, YIELD AND NUTRIENTS CONTENT IN TWO VARIETIES OF MUNGBEAN


## ABSTRACT

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from March to June 2012 to study the effect of potassium on the growth, yield and nutrients content in two varieties of mungbean. The experiment consists of two factors: Factor A: 2 varieties of mungbean - $V_1$= BARI mung-2 and $V_2$= BARI mung-6; Factor B: 4 doses of inorganic fertilizer potassium - $K_0$ = 0 kg $K_2O$/ha (control); $K_1$ = 10 kg $K_2O$/ha; $K_2$ = 20 kg $K_2O$/ha and $K_3$ = 30 kg $K_2O$/ha. The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Data on different yield contributing characters, yield and nutrient content on seeds were recorded and significant variation was observed among the treatments. In case of varieties, at 25, 35, 45, 55 DAS and harvest the tallest plant (22.01 cm, 32.69 cm, 45.99 cm, 53.97 cm and 57.48 cm) was recorded from BARI mung-6, whereas the shortest plant (20.30 cm, 30.38 cm, 42.13 cm, 49.84 cm and 53.98 cm) from BARI mung-2. The maximum number of pods per plant (19.48) and highest seed yield (1.60 t/ha) was recorded from BARI mung-6, whereas the minimum number of pods per plant (18.13) and lowest seed yield (1.38 t/ha) from BARI mung-2. The highest potassium content in seeds (0.86%) was attained from BARI mung-6, again the lowest (0.63%) from BARI mung-2. For levels of potassium, at 25, 35, 45, 55 DAS and at harvest, the tallest plant (22.71 cm, 33.70 cm, 47.63 cm, 55.35 cm and 58.54 cm) was found from 20 kg $K_2O$/ha and the shortest plant (18.96 cm, 28.46 cm, 38.91 cm, 47.39 cm and 51.95 cm) from 0 kg $K_2O$/ha. The maximum number of pods per plant (20.08) and highest seed yield (1.64 t/ha) was observed from 20 kg $K_2O$/ha, again the minimum number of pods per plant (16.07) and lowest seed yield (1.23 t/ha) was recorded from 0 kg $K_2O$/ha. The highest potassium content in seeds (0.84%) was found from 20 kg $K_2O$/ha, whereas the lowest (0.54%) was recorded from 0 kg $K_2O$/ha. Consideration of interaction effect of varieties and levels of potassium, at 25, 35, 45, 55 DAS and at harvest the tallest plant (22.89 cm, 33.93 cm, 47.71 cm, 55.66 cm and 59.05 cm) was recorded from BARI mung-6 and 20 kg $K_2O$/ha, while the shortest plant (17.69 cm, 24.46 cm, 33.67 cm, 42.96 cm and 47.70 cm) from BARI mung-2 and 0 kg $K_2O$/ha. The maximum number of pods per plant (20.93) and highest seed yield (1.74 t/ha) was observed from BARI mung-6 and 20 kg $K_2O$/ha, while the minimum number of pods per plant (15.63) and lowest seed yield (1.10 t/ha) from BARI mung-2 and 0 kg $K_2O$/ha. The highest potassium content in seeds (0.95%) was recorded from BARI mung-6 and 20 kg $K_2O$/ha and the lowest (0.40%) from BARI mung-2 and 0 kg $K_2O$/ha. From the above findings it was revealed that BARI mung-6 and 20 kg $K_2O$/ha was more effective for the growth, yield and nutrients content of mungbean under the present trial.

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# Introduction

# CHAPTER I

# INTRODUCTION

Mungbean, grass pea, lentil, blackgram, chickpea, field pea and cowpea are the major pulse crop of Bangladesh. Among them mungbean (*Vigna radiata* L.) is one of the most important pulse crops of Bangladesh and belongs to the family Leguminosae and sub-family Papilionaceae. The area under pulse crops in Bangladesh is 0.406 million hectares with a production of 0.322 million tones where mungbean is cultivated in the area of 0.108 million hectares with production of 0.03 million tons (BBS, 2010). It is considered as a quality pulse in the country but production per unit area is very low (736 kg/ha) as compared to other countries of the world (BBS, 2006). Mungbean ranks the fifth position considering both acreage and production.

Pulse plays an important role in human nutrition and it is called poor man's meat because it is the cheapest source of protein for the poor people of Bangladesh. According to FAO (1999), per capita requirement of pulse by human should be 80 g, whereas it is only about 10.0 g in Bangladesh (BBS, 2007), thus the ideal cereal of pulse ratio (10:1) is not maintained which is now 30:1. This is the fact that national production of the pulses is not adequate to meet the population demand. Mungbean is an important food crop because it provides a cheap source of easily digestible dietary protein which complements the staple rice in the country. It's seed contains 24.7% protein, 0.6% fat, 0.9 fiber and 3.7% ash (Potter and Hotchkiss, 1997). Pulses, being leguminous crops, are capable of fixing atmospheric nitrogen in the soil and enrich soil fertility and productivity. Thus they are considered as soil fertility development crops. It can also fix atmospheric nitrogen through symbiotic relationship with soil bacteria and improve the soil fertility (Yadav *et al.*, 1994). The global mungbean growing area has increased during the last 20 years at an annual growth rate of 2.5% (Green and King, 1992). The crop has many advantages in cropping system because of its rapid growth, early maturation and short duration.

Mungbean plays an important role to supplement protein in the cereal-based low-protein diet of the people of Bangladesh, but the acreage production of mungbean is gradually declining (BBS, 2010). However, it is one of the least cared crops. Mungbean is cultivated with minimum tillage, local varieties with no or minimum fertilizers, pesticides and very early or very late sowing, no practicing of irrigation and drainage facilities etc. All these factors are responsible for low yield of mungbean which is incomparable with the yields of developed countries of the world (FAO, 1999). The low yield of mungbean besides other factors may partially be due to lack of knowledge and nutrition and modern production technology (Hussain *et al.*, 2008). Moreover, lack of attention on fertilizer use is also instrumental in lowering mungbean yields (Mansoor, 2007). Being leguminous in nature, mungbean needs low nitrogen but require optimum doses of other major nutrients as recommended. An improved variety is the first and foremost requirement for initiation and accelerated production program of any crop. Variety plays an important role in producing high yield of mungbean because different varieties differently for their genotypic characters.

Potassium as an inorganic fertilizer plays a vital role for proper growth and development of mungbean and as a plant nutrient is becoming increasingly important in Bangladesh. Pulse crops showed yield benefits from potassium application. Improved potassium supply also enhances biological nitrogen fixation and protein content of pulse grains (Srinivasarao *et al.*, 2003). Soil fertility was improved significantly with farmyard manure used either alone or in combination with NPK over that of initial soil status (Singh *et al.*, 2001). The supply of potassium to leguminous crops is necessary especially at the flowering and pod setting stages (Zahran *et al.*, 1998). Potassium also plays a vital role as macronutrient in plant growth and sustainable crop production (Mrschner and Baligar, 2001). It maintains turgor pressure of cell which is necessary for cell expansion. It helps in osmo-regulation of plant cell, assists in opening and closing of stomata (Yang *et al.*, 2003). It plays a key role in activation of more than 60 enzymes (Bushkh *et al.*, 2011).

Application of potassium in appropriate time, dose and proper method is prerequisite for mungbean cultivation. Most of the agronomic traits of mungbean varieties were significantly influenced by potassium fertilizers except seed weight per plant and seed index were non-significant (Oad *et al.*, 2003). Nita *et al.* (2002) reported that leaf area index, seed yield, protein yield, harvest index and net production value increased with increasing rates of K fertilizer. Sangakkara *et al.* (2001) reported that potassium increased shoot growth of mungbean to a greater extent under suboptimal moisture conditions. Lack of quality seeds of high yielding varieties and application of fertilizer especially potassium fertilizer are the two major limiting factors hindering the productivity of mungbean. Therefore, experimental evidences indicate that there are enough scopes to increase the productivity of mungbean under proper management.

In this study, an attempt was made to evaluate potassium fertilizer to maximize the reproductive behavior and yield attributes of mungbean varieties. Considering the above factors the present experiment was conducted with the following objectives:

i. To compare between the 2 varieties of mungbean.

ii. To observe the effect of potassium on growth, yield and nutrient content of mungbean.

iii. To find out the suitable amount of potassium for the production of mungbean.

iv. To find out the best combination of variety and potassium doses for better yield of mungbean.

# Chapter II

# Review of Literature

# CHAPTER II

# REVIEW OF LITERATURE

In Bangladesh and in many countries of the world mungbean is an important pulse crop. The crop has conventional less attention by the researchers on various aspects because normally it grows without care or management practices. Based on this a very few research work related to growth, yield and development of mungbean have been carried out in our country. However, researches are going on in home and abroad to maximize the yield of mungbean. Variety and fertilizer, especially potassium play an important role in improving mungbean yield. But research works related to variety and potassium on mungbean are limited in Bangladesh context. However, some of the important and informative works and research findings related to the variety and potassium so far been done at home and abroad and have been reviewed in this chapter under the following headings-

## 2.1 Effects of varieties on plant characters of mungbean

Four mungbean accessions from the Asian Vegetable Research and Development Centre (AVRDC) were grown by Agugo *et al.* (2010). Results showed a significant difference in the yield of the varieties with VC 6372 (45-8-1) producing the highest seed yield of 0.53 t/ha. This was followed by NM 92, 0.48 t/ha; NM 94, 0.40 t/ha; and VC 1163 with 0.37 t/ha. The variety, VC 6372 (45-8-1), also formed good agronomic characters.

Field studies were conducted by Kumar *et al.* (2009) in Haryana, India to determine the growth behaviour of mungbean genotypes sown on different dates under irrigated conditions. The treatments consisted of 2 genotypes (SML 668 and MH 318) and 6 sowing dates starting from 1 March to 19 April, at of 10-day intervals. Results showed that SML 668 had higher plant height than MH 318 and the less height of both the genotypes during summer was due to low average temperature during the initial growth stage. SML 668 accumulated more dry matter than MH 318. The contribution of leaves and stem was more in SML 668, whereas the contribution of pods towards total aboveground biomass at harvest was higher in MH 318.

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 moog 4 and BARI moog 5. The two-factor experiment was laid out in Randomized Complete Block Design (RCBD) (factorial) with 3 replications. Among the mungbean varieties, BARI moog 5 performed better than that of BARI moog 4.

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

Islam *et al.* (2006) carried out an experiment at the field laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh during the period from March 2002 to June 2002 to evaluate the effect of biofertilizer (*Bradyrhizobium*) and plant growth regulators ($GA_3$ 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.

Mungbean cultivars Pusa 105 and Pusa Vishal were sown at 22.5 and 30 cm spacing and supplied with 36-46 and 58-46 kg NP/ha in a field experiment conducted in Delhi, India during the kharif season 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.

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

Rahman *et al.* (2005) 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 moog 2, BARI moog 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 lowest in Local. However, the local cultivar produced the highest portion of dry matter in leaf and stem.

Studies were conducted by Bhati *et al.* (2005) from 2000 to 2003 to evaluate the effects of cultivars and nutrient management strategies on the productivity of different kharif legumes (mungbean, mothbean and clusterbean) in the arid region of Rajasthan, India. The experiment with mungbean showed that K-851 gave better yield than Asha and the local cultivar. In another experiment, mungbean cv. PDM-54 showed 56.9% higher grain yield and 13.7% higher fodder yield than the local cultivar. The experiment with mothbean showed that RMO-40 gave 34.8-35.2% higher grain yield and 30.2-33.4% higher fodder yield over the local cultivar as well as 11.8% higher grain yield and 9.2% higher fodder yield over RMO-257. The experiment with clusterbean showed that improved cultivars of RGC-936 gave 136.0 and 73.5% higher grain yield and 124.0 and 67.3% higher fodder yield over the local cultivar and Maru Guar, respectively.

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 and phosphorus 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).

Chaisri *et al.* (2005) conducted a yield trial involving 6 recommended cultivars (KPS 1, KPS 2, CN 60, CN 36, CN 72 and PSU 1) and 5 elite lines (C, E, F, G, H) under Kasetsart mungbean breeding project in Lopburi Province, Thailand, during the dry (February-May 2002), early rainy (June-September 2002) and late rainy season (October 2002-January 2003). Line C, KPS 1, CN 60, CN 36 and CN 72 gave high yields in the early rainy season, while line H, line G, line E, KPS 1 and line C gave high yields in the late rainy session. Yield trial of the 6 recommended mungbean cultivars was also conducted in the farmer's field.

Two summer mungbean cultivars, i.e. BINA moog 2 and BINA moog 5, were grown during the kharif-1 season (February-May) of 2001, in Mymensingh, Bangladesh, under no irrigation or with irrigation once at 30 days after sowing (DAS), twice at 30 and 50 DAS, and thrice at 20, 30 and 50 DAS by Shamsuzzaman *et al.* (2004). 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.

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

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.

To find out the effects of *Rhizobium* inoculation on the nodulation, plant growth, yield attributes, seed and stover yields, and seed protein content of six mung bean (*Vigna radiata*) cultivars were investigated by Hossain and Solaiman (2004). The mungbean cultivars were BARI mung-2, BARI mung-3, BARI mung-4, BARI mung-5, BINA mung-2 and BU mung-1. Among the cultivars, BARI mung-4 performed the best in all aspects showing the highest seed yield of 1135 kg/ha. *Rhizobium* strain TAL169 did better than TAL441 in most of the studied parameters. It was concluded that BARI mung 4 in combination with TAL169 performed the best in terms of nodulation, plant growth, seed and stover yields, and seed protein content.

The performance of 20 mungbean cultivars were evaluated by Madriz-Isturiz and Luciani-Marcano (2004) in a field experiment conducted in Venezuela. Data on plant height, clusters per plant, pods per plant, pod length, seeds per pod, grain yield by plant and yield/ha were recorded. Significant differences in the values of the parameters measured due to cultivar were recorded. The average yield was 1342.58 kg/ha. VC 1973C, Creole VC 1973A, VC 2768A, VC 1178B and Mililiter 267 were the most promising cultivars for cultivation in the area.

The effect of sowing rates on the growth and yield of mungbean cultivars NM-92, NARC mung-1 and NM-98 was investigated in Faisalabad, Pakistan during 2002-03 by Riaz *et al.* (2004). NM-98 produced the maximum pod number of 77.30, grain yield of 983.75 kg/ha and harvest index value of 24.91%. NM-92 also produced the highest seed protein content of 24.64%.



Brar *et al.* (2004) introduced SML 668 high yielding variety of summer mungbean selection from AVRDC line NM 94, is a cultivar recommended for general cultivation in irrigated areas of Punjab, India in 2002. This early maturing cultivar flowers in 34 days and matures in 60 days. It has an average plant height of 44.6 cm and bears an average of 16 pods per plant and 10.4 seeds per pod. Seeds are bold with 100-seed weight of 5.7 g and devoid of hard seeds. Protein content is 22.7% and water absorption capacity is high (91%).

Seed treatment with biofertilizers in controlling foot and root rot of mungbean cultivars BINA moog-3 and BINA moog-4 was investigated by Mohammad and Hossain (2003) under field conditions in Pakistan. Treatment of seeds of BINA moog-3 with biofertilizer showed a 5.67% increase in germination over the control, but in case of BINA moog-4 10.81% increase in germination over the control was achieved by treating seeds with biofertilizer. The biofertilizers caused 77.79% reduction of foot and root rot disease incidence over the control along with BINA moog-3 and 76.78% reduction of foot and rot disease in BINA moog-4. Seed treatment with biofertilizer also produced up to 20.83% higher seed yield in BINA moog-3 and 12.79% higher seed yield BINA moog-4 over the control.

Three mungbean cultivars (LGG 407, LGG 450 and LGG 460) and two urd bean [black gram] cultivars (LBG 20 and LBG 623) were sown on 15 June 2001 in Lam, Guntur, Andhra Pradesh, India, by Durga *et al.* (2003) and subjected to severe moisture stress during the first 38 days after sowing (DAS) and only a rainfall of 21.4 mm was received during this period. Mungbean registered higher root length (11.83%), root volume (37.50), root weight (31.43%), lateral roots (81.71%), shoot length (13.04%), shoot weight (84.62%), leaf number (25.75%), leaf weight (122.86%) and leaf area (108.60%) than the urd bean. Mungbean recorded better leaf characters than urd bean, but root and shoot characters were better in the latter. Among the mungbean cultivars, LGG 407 recorded the highest yield. Between the urd bean cultivars, LBG 20 had a higher yield than LBG 623. Among the mung bean cultivars, LGG 407 was the most tolerant, while in urd bean, LBG 20 was more efficient in avoiding early drought stress than LBG 623.

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

Satish *et al.* (2003) conducted an experiment in Haryana, India in 1999 and 2000 to investigate the response of mung bean cultivars Asha, MH 97-2, MH 85-111 and K 851 to different P levels. Results revealed that the highest dry matter content in the leaves, stems and pods was obtained in Asha and MH 97-2. The total above-ground dry matter as well as the dry matter accumulation in leaves, stems and pods increased with increasing P level up to 60 kg P $ha^{-1}$. MH 97-2 and Asha produced significantly more number of pods and branches/plant compared to MH 85-111 and K 851.

The development phases and seed yield were evaluated by Infante *et al.* (2003) in mungbean cultivars ML 267, Acriollado and VC 1973C under the agroecological conditions of Maracay, Venezuela, during May-July 1997. The differentiation of the development phases and stages, and the morphological changes of plants were studied. The variable totals of pod clusters, pods per plant, seeds per pods and pod length were also studied. The earliest cultivar was ML 267 with 34.87 days to flowering and 61.83 to maturity. There were significant differences for total pod clusters per plant and pods per plant, where ML 267 and Acriollado had the highest values. The total seeds per pod of VC 1973C and Acriollado were significantly greater than ML 267. Acriollado showed the highest yield with 1438.33 kg/ha.

Seeds of mungbean cultivars BM-4, S-8 and BM-86 were inoculated with *Rhizobium* strains M-11-85, M-6-84, GR-4 and M-6-65 before sowing in a field experiment conducted by Navgire *et al.* (2001) in Maharashtra, India during the kharif season of 1993-94 and 1995-96. S-8, BM-4 and BM-86 recorded the highest mean nodulation (16.66), plant biomass (8.29 q/ha) and grain yield (4.79 q/ha) during the experimental years. S-8, BM-4 and BM-86 recorded the highest nodulation, plant biomass and grain yield.

Hamed (1998) carried out two field experiments in Shalakan, Egypt, to evaluate mung bean cultivars Giza 1 and Kawny 1 under 3 irrigation intervals after flowering (15, 22 and 30 days) and 4 fertilizer treatments: inoculation with *Rhizobium* (R) + Azotobacter (A) + 5 ($N_1$) or 10 kg N/feddan ($N_2$), and inoculation with R only +5 ($N_3$) or 10 kg N/feddan ($N_4$). Kawny 1 surpassed Giza 1 in pod number per plant (24.3) and seed yield (0.970 t/feddan), while Giza 1 was superior in 100-seed weight (7.02 g), biological and straw yields (5.53 and 4.61 t/feddan, respectively). While Kawny 1 surpassed Giza 1 in oil yield (35.78 kg/feddan), the latter cultivar recorded higher values of protein percentage and yield (28.22% and 264.6 kg/feddan). The seed yield of both cultivars was positively and highly significantly correlated with all involved characters, except for 100-seed weight of Giza 1 and branch number per plant of Kawny 1.

## 2.2 Effects of potassium on plant characters of mungbean

A study was conducted by Nigamananda and Elamathi (2007) in Uttar Pradesh, India during 2005-06 to evaluate the effect of N application time as basal and as DAP (diammonium phosphate) or urea spray and plant growth regulator (NAA at 40 ppm) on the yield and yield components of green gram cv. K-851. The recommended rate of N:P:K (20:50:20 kg $ha^{-1}$) as basal was used as a control. Treatments included: 1/2 basal N + foliar N as urea or DAP at 25 or 35 days after sowing (DAS); 1/2 basal N + 1/4 at 25 DAS + 1/4 at 35 DAS as urea or DAP; and 1/2 basal N + 1/2 foliar spraying as urea or DAP + 40 ppm NAA. Results showed that 2% foliar spray as DAP and NAA, applied at 35 DAS, resulted in the highest values for number of pods/plant (38.3), seeds/pod, test weight, flower number, fertility coefficient and grain yield (9.66 q $ha^{-1}$).

Tickoo *et al.* (2006) carried out an experiment on mungbean cultivars Pusa 105 and Pusa Vishal were sown at 22.5 and 30 m spacing and supplied with 36-46 and 58-46 kg NP $ha^{-1}$ in a field experiment conducted in Delhi, India during the kharif season of 2000. Cultivar Pusa Vishal recorded higher biological and grain yield (3.66 and 1.63 t $ha^{-1}$, respectively) compared to cv. Pusa 105. Differences in the values of the parameters examined. NP rates had no significant effects on both the biological and grain yield of the crop.

A field study conducted by Sharma and Sharma (2006) for two years at the Indian Agricultural Research Institute, New Delhi on a sandy clay loam soil showed that the application of NP increased the total grain production of a rice-wheat-mungbean cropping system by 0.5-0.6 t $ha^{-1}$, NK by 0.3-0.5 t $ha^{-1}$ and NPK by 0.8-0.9 t $ha^{-1}$ compared to N alone, indicating that the balanced use of primary nutrients was more advantageous than their imbalanced application. The application of farmyard manure (FYM) along with NPK further increased the total productivity of the rice-wheat-mungbean cropping system by 0.3-0.6 t $ha^{-1}$, the organic C by 0.13%, the available N by 10.7 kg $ha^{-1}$, the available P by 4.7 kg $ha^{-1}$ and the available K by 15 kg $ha^{-1}$ compared to NPK after two crop cycles of the system. The results of the present study thus indicate that integrated nutrient management involving FYM and NPK fertilizers is a must for the sustainability of a cropping system.

A field experiment was conducted by Raman and Venkataramana (2006) during February to May 2002 in Annamalainagar, Tamil Nadu, India to investigate the effect of foliar nutrition on crop nutrient uptake and yield of green gram (*V. radiata*). There were 10 foliar spray treatments, consisting of water spray, 2% diammonium phosphate (DAP) at 30 and 45 days after sowing, 0.01% Penshibao, 0.125% Zn chelate, 30 ppm NAA, DAP + NAA, DAP + Penshibao, DAP + Zn chelate, DAP + Penshibao + NAA, and DAP + NAA + Zn chelate. Crop nutrient uptake, yield and its attributes (number of pods per plant and number of seeds per pod) of green gram augmented significantly due to foliar nutrition. The foliar application of DAP + NAA + Penshibao was significantly superior to other treatments in increasing the values of N, P and K uptakes, yield attributes and yield. The highest grain yield of 1529 kg $ha^{-1}$ was recorded with this treatment.

Oad and Buriro (2005) conducted a field experiment to determine the effect of different NPK levels (0-0-0, 10-20-20, 10-30-30, 10-30-40 and 10-40-40 kg $ha^{-1}$) on the growth and yield of mung bean cv. AEM 96 in Tandojam, Pakistan, during the spring season of 2004. The different NPK levels significantly affected the crop parameters. The 10-30-30 kg NPK $ha^{-1}$ was the best treatment, recording plant height of 56.25, germination of 90.50%, satisfactory plant population of 162.00, prolonged days taken to maturity of 55.50, long pods of 5.02 cm, seed weight per plant of 10.53 g, seed index of 3.52 g and the highest seed yield of 1205.2 kg $ha^{-1}$. There was no significant change in the crop parameters beyond this level.

A field experiment was conducted by Oad *et al.* (2003) to assess the growth and yield performance of mungbean (*Vigna radiata*) varieties under various phosphorus and potash levels at Student's Experimental Farm, Sindh Agriculture University, Tandojam. Four mungbean varieties viz. AEM/25, AEM-6/20, NM-20/21 and AEM-10/2/87 were tested. Most of the agronomic traits of mungbean varieties were significantly influenced by phosphorus and potassium fertilizers except pod number, seed weight per plant and seed index were non-significant. However, 100-100 PK kg $ha^{-1}$ showed an increase in the yield of the crop. Thus, it is recommended that the mungbean crop should be fertilized with phosphorus and potassium at the level of 100-100 PK kg $ha^{-1}$ for achieving satisfactory seed yield.

The effects of K and S at 0, 20 and 40 kg/ha, applied singly or in combination, on the growth and productive attributes of mung bean as well as on the fertility of the soil were determined in a field experiment conducted by Nita *et al.* (2002) in West Bengal, India during the summer of 1998-99. Leaf area index, seed yield, protein yield, harvest index and net production value increased with increasing rates of K fertilizer.

Mahboob and Asghar (2002) studied the effect of seed inoculation at different nitrogen levels on mungbean at the agronomic research station, Farooqabad in Pakistan. They revealed that various yield components like 1000 grain weight were affected significantly with 50-50-0 NPK kg $ha^{-1}$. Again they revealed that seed inoculation +50-50-0 NPK kg $ha^{-1}$ exhibited superior performance in respect of seed yield (955 kg $ha^{-1}$).

Sangakkara *et al.* (2001) conducted a study to determine the benefits of potassium in overcoming water stress in mungbean cv. MI5 and cowpea cv. Arlington, with different adaptabilities to soil moisture regimes. The impact of potassium (at 0.1, 1.0 and 3.0 mM) was different in the two legumes grown at optimal and suboptimal soil moisture. Potassium increased shoot growth of mungbean to a greater extent under suboptimal moisture conditions.

A pot experiment was conducted by Prasad *et al.* (2000) at the Institute of Agricultural Sciences in Varanasi, Uttar Pradesh, India to study the effect of potassium on yield, water use efficiency and K-uptake by summer mungbean (cv. T-44) under varying levels of moisture stress. The experiment was laid out in a randomized block design with four potassium levels viz., 0, 10, 20 and 30 mg K $kg^{-1}$ soil applied through KCl and three levels of moisture stress. Total biomass production increased with $K_{20}$ and $K_{30}$ in comparison to control. The grain yield also increased with potassium application but result was statistically non-significant.

The effect of different potassium levels (0, 25, 50, 75, 100 and 125 kg/ha) on yield and quality of mungbean was determined by Asghar *et al.* (1996) in a field experiment in 1990 at Faisalabad on a sandy clay loam soil having 0.035% N, 7.21 ppm available phosphorus and 123 ppm extractable potash. The number of pods/plant, number of seeds/pod, seed yield/ha and seed protein contents were influenced significantly by potassium application. The highest seed yield (1.67 t/ha) was obtained with application of 75 kg $K_2O$/ha.

Suhartatik (1991) in a study observed that increased application of NPK fertilizers significantly increased the plant height of mungbean. Arya and Kalra (1988) reported that application of N at the rate of 50 kg $ha^{-1}$ along with 50 kg P $ha^{-1}$ increased mungbean yield. Results of an experiment, conducted by Sardana and Verma (1987) in Delhi, India, revealed that application of nitrogen, phosphorus and potassium fertilizers in single resulted in significant increase in plant height of mungbean. They also stated that the application of nitrogen, phosphorus and potassium fertilizers in combination resulted in the significant increase in seed yield of mungbean. They also stated that application of nitrogen, phosphorus and potassium fertilizers combinedly resulted in significant increases in 1000 seed weight of mungbean.

# Chapter III

# Materials and Methods

# CHAPTER III

# MATERIALS AND METHODS

The experiment was conducted during the period from March to June 2012 to study the effect of potassium on the growth, yield and nutrients content in two varieties of mungbean. This chapter includes materials and methods that were used in conducting the experiment are presented below under the following headings:

## 3.1 Experimental site

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

## 3.2 Soil

The soil of the experimental field belongs to the Tejgaon series under the Agroecological Zone, Madhupur Tract (AEZ- 28) and the General Soil Type is Deep Red Brown Terrace Soils. A composite sample was made by collecting soil from several spots of the field at a depth of 0-15 cm before the initiation of the experiment. The collected soil was air-dried, ground and passed through 2 mm sieve and analyzed for some important physical and chemical properties. The analytical data of the soil sample collected from the experimental area were determined in the SRDI, Soil Testing Laboratory, Khamarbari, Dhaka and presented in Appendix I.

## 3.3 Climate

The climate of experimental site is subtropical, characterized by three distinct seasons, the monsoon from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October (Edris *et al.*, 1979). Meteorological data related to the temperature, relative humidity and rainfalls during the period of the experiment was collected from the Bangladesh Meteorological Department (Climate Division), Sher-e-Bangla Nagar and presented in Appendix II.

### 3.4 Planting material

The variety BARI mung-2 and BARI mung-6 was used as the test crops. The seeds were collected from the Pulse Seed Division of Bangladesh Agricultural Research Institute, Joydevpur, Gajipur. BARI mug-2 and BARI mug-6 are the released varieties of mungbean, which was recommended by the national seed board. They grow both in *Kharif* and *Rabi* season. Life cycle of this variety ranges from 55-60 days. Maximum seed yield is 1.1-1.6 t/ha.

### 3.5 Land preparation

The land was irrigated before ploughing. After having 'zoe' condition the land was first opened with the tractor drawn disc plough. Ploughed soil was brought into desirable fine tilth by 4 ploughing and cross-ploughing, harrowing and laddering. The stubble and weeds were removed. The first ploughing and the final land preparation were done on 22 March and 03 April, 2012, respectively. Experimental land was divided into unit plots following the design of experiment.

### 3.6 Treatments of the experiment

The experiment consists of two factors:

Factor A: Mungbean variety (2)

i) $V_1$= BARI mung-2

ii) $V_2$= BARI mung-6

Factor B: Inorganic fertilizer potassium (4 levels)

i) $K_0 = 0$ kg $K_2O$/ha (Control)

ii) $K_1 = 10$ kg $K_2O$/ha

iii) $K_2 = 20$ kg $K_2O$/ha

iv) $K_3 = 30$ kg $K_2O$/ha

There were in total 8 (2×4) treatment combinations such as $V_1K_0$, $V_1K_1$, $V_1K_2$, $V_1K_3$, $V_2K_0$, $V_2K_1$, $V_2K_2$ and $V_2K_3$.

### 3.7 Fertilizer application

Urea, Triple super phosphate (TSP), Muriate of potash (MOP) and gypsum were used as a source of nitrogen, phosphorous, potassium and sulphur respectively. Muriate of potash (MOP) was applied as per treatment. Urea and TSP were applied at the rate of 45 and 80 kg per hectare, respectively following the Bangladesh Agricultural Research Institute (BARI) recommendation. All of the fertilizers except urea were applied during final land preparation and urea was applied in three equal installments at 15, 25 and 35 days after sowing (DAS).

### 3.8 Experimental design and layout

The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. An area of 22.5 m ×16 m was divided into three equal blocks. Each block was divided into 8 plots where 8 treatment combinations were allotted at randomly. There were 24 unit plots altogether in the experiment. The size of the each unit plot was 4.0 m × 2.0 m. The space between two blocks and two plots were 1.0 m and 0.5 m, respectively. The layout of the experiment is shown in Figure 1.

### 3.9 Sowing of seeds in the field

The seeds of mungbean were sown on April 03, 2012 in solid rows in the furrows having a depth of 2-3 cm and row to row distance was 30 cm. Before sowing seeds were treated with Bavistin to control the seed borne disease.

### 3.10 Intercultural operations

#### 3.10.1 Thinning

Seeds started germination of four DAS. Thinning was done two times; first thinning was done at 8 DAS and second was done at 15 DAS to maintain optimum plant population in each plot.

#### 3.10.2 Irrigation and weeding

Irrigation was done as per requirements. The crop field was weeded as per treatment.

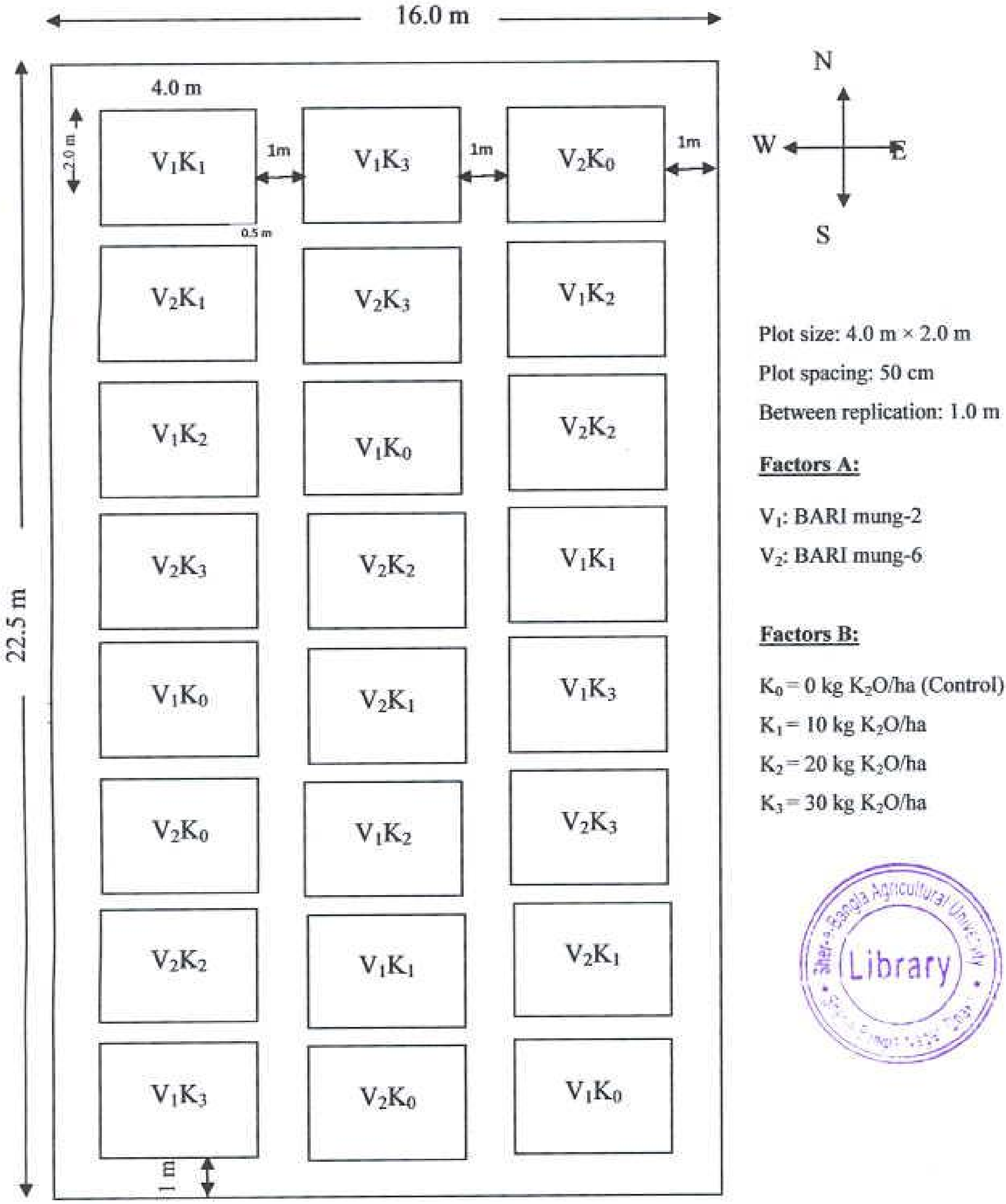



Figure 1. Layout of the experimental plot

### 3.10.3 Protection against insect and pest

At early stage of growth few worms (*Agrotis ipsilon*) and virus vectors (jassid) infested the young plants and at later stage of growth pod borer (*Maruca testulalis*) attacked the plant. Dimacron 50EC was sprayed at the rate of 1 litre/ha to control the insects.

### 3.11 Crop sampling and data collection

Five plants from each treatment were randomly selected and marked with sample card. Plant height, branches plant$^{-1}$ and leaves plant$^{-1}$were recorded from selected plants at an interval of 10 days started from 25 DAS to 55 DAS ant harvest.

### 3.12 Harvest and post harvest operations

Harvesting was done when 90% of the pods became brown to black in color. The matured pods were collected by hand picking from a pre demarcated area of three linear meter at the center of each plot.

### 3.13 Data collection

The following data were recorded

i. Plant height
ii. Number of branches per plant
iii. Number of leaves per plant
iv. Days to 1$^{st}$ flowering
v. Days to 80% pod maturity
vi. Number of pods per plant
vii. Number of seeds per pod
viii. Pod length
ix. Weight of 1000 seeds
x. Seed yield per hectare
xi. Stover yield per hectare
xii. N, P, K and S content in seeds

### 3.14 Procedure of data collection

#### 3.14.1 Plant height

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

#### 3.14.2 Number of branches per plant

The number of branches plant$^{-1}$ was counted from selected plants. The average number of branches per plant was determined.

#### 3.14.3 Number of leaves per plant

The number of leaves plant$^{-1}$ was counted from selected plants. The average number of leaves per plant was determined.

#### 3.14.4 Days to 1$^{st}$ flowering

Days to 1$^{st}$ flowering were recorded by counting the number of days required to start flower initiation in each plot.

#### 3.14.5 Days to 80% pod maturity

Days to 80% pod maturity were measured by counting the number of days required to attain maturity of 80% pods. Maturity was measured on the basis of brown colour of leaves and stem and dark grey colour of pods.

#### 3.14.6 Number of pods per plant

Numbers of total pods of selected plants from each plot were counted and the mean numbers were expressed as per plant basis. Data were recorded as the average of 5 plants selected at random from the inner rows of each plot.

#### 3.14.8 Number of seeds per pod

The number of seeds per pods was recorded randomly from selected pods at the time of harvest. Data were recorded as the average of 10 pods selected at random from each plot.

### 3.14.7 Pod length

Pod length was taken of randomly selected ten pods and the mean length was expressed on per pod basis.

### 3.14.9 Weight of 1000 seeds

One thousand cleaned, dried seeds were counted randomly from each harvest sample and weighed by using a digital electric balance and weight was expressed in gram (g).

### 3.14.10 Seed yield

The seeds collected from 8 (4 m ×2 m) square meter of each plot were sun dried properly. The weight of seeds was taken and converted the yield in t/ha.

### 3.14.11 Stover yield

The stover collected from 8 (4 m ×2 m) square meter of each plot was sun dried properly. The weight of stover was taken and converted the yield in t/ha.

## 3.15 Determination of N, P, K and S from seed samples

### 3.15.1 Estimation of the amount of nitrogen by Macro Kjeldahl method

The macro kjeldahl method was used to determine the total nitrogen consisting of organic and ammonium forms (Page *et al.*, 1982). It was a wet oxidation procedure where complex form of nitrogen in sample was converted to simple nitrogen. Three steps were involved in this procedure as digestion, distillation and Titration and finally N was calculated by using the following formula-

$$\% N = (T-B) \times N \times 1.4/S$$

Where,

T = Titration value for sample (ml.)

B = Titration value for blank (mL)

N = Normality of $H_2SO_4$

S = Weight of the sample (g)

1.4 = Conversion factor

### 3.15.2 Phosphorus

Phosphorus was digested from the seeds sample with 0.5 M $NaHCO_3$ solutions, pH 8.5 (Olsen *et al.*, 1954). Phosphorus in the digest was determined by using 1 ml for seed sample from 100 ml extract was then determined by developing blue color with reduction of phosphomolybdate complex and the color intensity were measured colorimetrically at 660 nm wavelength and readings were calibrated with the standard P curve (Page *et al.*, 1982).

### 3.15.3 Potassium

Five milli-liter of digest sample for the seeds were taken and diluted 50 ml volume to make desired concentration so that the absorbance of sample were measured within the range of standard solutions. The absorbance was measured by atomic absorption flame photometer.

### 3.15.4 Sulphur

Sulphur content was determined from the digest of the seeds samples with $CaCl_2$ (0.15%) solution as described by (Page *et al.*, 1982). The digested S was determined by developing turbidity by adding acid seed solution (20 ppm S as $K_2SO_4$ in 6N HCl) and $BaCl_2$ crystals. The intensity of turbidity was measured by spectrophotometer at 420 nm wave lengths (Hunter, 1984).

### 3.16 Statistical analysis

The data obtained for different parameters were statistically analyzed to find out the significant difference of different mungbean variety and potassium on yield and yield contributing characters of mungbean. The mean values of all the characters were calculated and analysis of variance was performed by the 'F' (variance ratio) test. The significance of the difference among the treatment means was estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

# Chapter IV

# Results and Discussion

# CHAPTER IV

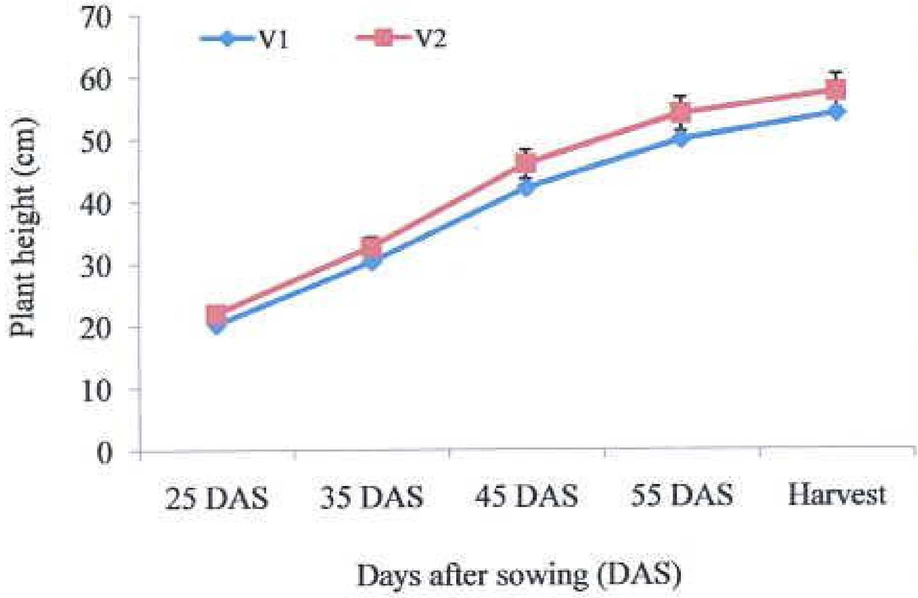
# RESULTS AND DISCUSSION

The experiment was conducted to study the effect of potassium on the growth, yield and nutrients content in two varieties of mungbean. The analyses of variance (ANOVA) of the data on different parameters are presented in Appendix III-X. The results have been presented with the help of table and graphs and possible interpretations given under the following headings:

## 4.1 Plant height

Statistically significant variation was recorded in terms of plant height of BARI mung-2 and BARI mung-6 at 25, 35, 45, 55 DAS and at harvest (Figure 2). At 25, 35, 45, 55 DAS and harvest the tallest plant (22.01 cm, 32.69 cm, 45.99 cm, 53.97 cm and 57.48 cm) was recorded from $V_2$ (BARI mung-6), whereas the shortest plant (20.30 cm, 30.38 cm, 42.13 cm, 49.84 cm and 53.98 cm) from $V_1$ (BARI mung-2). Different varieties produced different plant height on the basis of their varietal characters and an improved varieties is the first and foremost requirement for initiation and accelerated production program of any crop. Brar *et al.* (2004) reported that SML 668 has an average plant height of 44.6 as an early maturing cultivar.

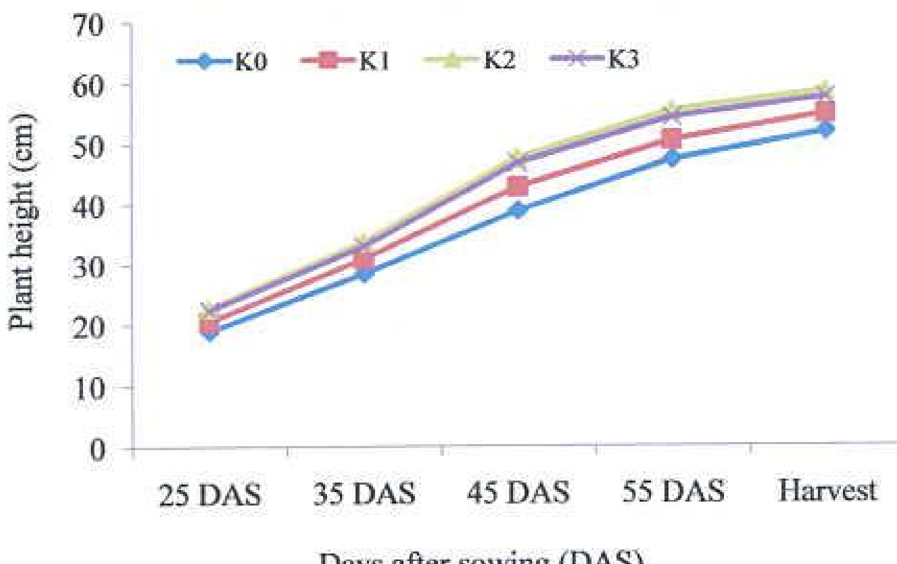
Plant height showed significant variation for different levels of potassium at 25, 35, 45, 55 DAS and at harvest (Figure 3). At 25, 35, 45, 55 DAS and at harvest, the tallest plant (22.71 cm, 33.70 cm, 47.63 cm, 55.35 cm and 58.54 cm) was found from $K_2$ (20 kg $K_2O$/ha), which was statistically identical (22.39 cm, 33.02 cm, 46.84 cm, 54.32 cm and 57.58 cm) with $K_3$ (30 kg $K_2O$/ha) and closely followed (20.56 cm, 30.47 cm, 42.86 cm, 50.56 cm and 54.83 cm) by $K_1$ (10 kg $K_2O$/ha). On the other hand, the shortest plant (18.96 cm, 28.46 cm, 38.91 cm, 47.39 cm and 51.95 cm) was observed from $K_0$ (0 kg $K_2O$/ha). It was revealed that with the increase of potassium fertilizer plant height increased upto a certain level. Oad and Buriro (2005) reported that the 30 kg K/ha was the best for plant height of 56.25 cm.




$V_1$: BARI mung-2 $V_2$: BARI mung-6

Figure 2. Effect of varieties on plant height of mungbean






$K_0$: 0 kg $K_2O$/ha (control) $K_1$: 10 kg $K_2O$/ha

$K_2$: 20 kg $K_2O$/ha $K_3$: 30 kg $K_2O$/ha

Figure 3. Effects of potassium on plant height of mungbean

Interaction effect of mungbean varieties and levels of potassium showed significant differences on plant height at 25, 35, 45, 55 DAS and at harvest (Table 1). At 25, 35, 45, 55 DAS and at harvest the tallest plant (22.89 cm, 33.93 cm, 47.71 cm, 55.66 cm and 59.05 cm) was recorded from $V_2K_2$ (BARI mung-6 + 20 kg $K_2O$/ha), while the shortest plant (17.69 cm, 24.46 cm, 33.67 cm, 42.96 cm and 47.70 cm) from $V_1K_0$ (BARI mung-2 + 0 kg $K_2O$/ha).

### 4.2 Number of branches per plant

Number of branches per plant of BARI mung-2 and BARI mung-6 showed significant variation at 25, 35, 45, 55 DAS and at harvest (Table 2). At 25, 35, 45, 55 DAS and harvest the maximum number of branches per plant (0.65, 1.40, 2.02, 2.98 and 3.13) was found from $V_2$, while the minimum number (0.32, 0.93, 1.58, 2.60 and 2.82) from $V_1$. Management practices influence the number of branches per plant. Quaderi *et al.* (2006) reported that BARI moog 5 performed better than that of BARI moog 4.

Different levels of potassium showed significant differences for number of branches per plant at 25, 35, 45, 55 DAS and at harvest (Table 2). At 25, 35, 45, 55 DAS and at harvest, the maximum number of branches per plant (0.70, 1.57, 2.23, 3.23 and 3.43) was obtained from $K_2$, which was statistically similar (0.53, 1.33, 2.10, 3.03 and 3.20) with $K_3$ and closely followed (0.43, 1.00, 1.60, 2.77 and 2.97) by $K_1$. On the contrary, the minimum number of branches per plant (0.27, 0.77, 1.27, 2.13 and 2.30) was recorded from $K_0$. Potassium plays a vital role as macronutrient in plant growth and sustainable crop production (Mrschner and Baligar, 2001).

Significant differences on number of branches per plant at 25, 35, 45, 55 DAS and at harvest was observed due to the interaction effect of mungbean varieties and levels of potassium (Table 3). At 25, 35, 45, 55 DAS and at harvest the maximum number of branches per plant (0.87, 1.80, 2.40, 3.40 and 3.53) was observed from $V_2K_2$, whereas the minimum number (0.20, 0.73, 0.93, 2.00 and 2.20) from $V_1K_0$.

**Table 1. Interaction effect of different varieties and levels of potassium on plant height of mungbean**

| Treatment | Plant height (cm) at | | | | |
|---|---|---|---|---|---|
| | 25 DAS | 35 DAS | 45 DAS | 55 DAS | Harvest |
| $V_1K_0$ | **17.69 c** | **24.46 b** | **33.67 c** | **42.96 c** | **47.70 c** |
| $V_1K_1$ | 18.84 bc | 30.03 a | 40.59 b | 48.14 b | 53.36 b |
| $V_1K_2$ | 22.52 a | 33.46 a | 47.54 a | 55.03 a | 58.03 a |
| $V_1K_3$ | 22.13 a | 33.54 a | 46.72 a | 53.23 a | 56.81 ab |
| $V_2K_0$ | 20.23 b | 32.46 a | 44.14 ab | 51.82 ab | 56.20 ab |
| $V_2K_1$ | 22.29 a | 31.87 a | 45.14 ab | 52.98 a | 56.31 ab |
| $V_2K_2$ | **22.89 a** | **33.93 a** | **47.71 a** | **55.66 a** | **59.05 a** |
| $V_2K_3$ | 22.64 a | 32.49 a | 46.95 a | 55.41 a | 58.35 a |
| $LSD_{(0.05)}$ | 1.736 | 4.534 | 5.171 | 3.906 | 3.994 |
| Level of significance | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| CV(%) | 4.69 | 8.21 | 6.70 | 4.30 | 4.09 |

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

$V_1$: BARI mung-2 $V_2$: BARI mung-6

$K_0$: 0 kg $K_2O$/ha (control) $K_1$: 10 kg $K_2O$/ha

$K_2$: 20 kg $K_2O$/ha $K_3$: 30 kg $K_2O$/ha

**Table 2. Effect of different varieties and levels of potassium on number of branches per plant of mungbean**

| Treatment | Number of branches per plant at | | | | |
|---|---|---|---|---|---|
| | 25 DAS | 35 DAS | 45 DAS | 55 DAS | Harvest |
| **Varieties** | | | | | |
| $V_1$ | 0.32 b | 0.93b | 1.58 b | 2.60 b | 2.82 b |
| $V_2$ | 0.65 a | 1.40 a | 2.02 a | 2.98 a | 3.13 a |
| $LSD_{(0.05)}$ | 0.083 | 0.136 | 0.171 | 0.251 | 0.257 |
| Level of significance | 0.01 | 0.01 | 0.05 | 0.01 | 0.01 |
| **Levels of potassium** | | | | | |
| $K_0$ | **0.27 c** | **0.77 d** | **1.27 c** | **2.13 c** | **2.30 c** |
| $K_1$ | 0.43 b | 1.00 c | 1.60 b | 2.77 b | 2.97 b |
| $K_2$ | **0.70 a** | **1.57 a** | **2.23 a** | **3.23 a** | **3.43 a** |
| $K_3$ | 0.53 b | 1.33 b | 2.10 a | 3.03 ab | 3.20 ab |
| $LSD_{(0.05)}$ | 0.118 | 0.192 | 0.241 | 0.355 | 0.363 |
| Level of significance | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| CV(%) | 9.15 | 13.29 | 10.81 | 10.27 | 9.88 |

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

$V_1$: BARI mung-2 $V_2$: BARI mung-6

$K_0$: 0 kg $K_2O$/ha (control) $K_1$: 10 kg $K_2O$/ha

$K_2$: 20 kg $K_2O$/ha $K_3$: 30 kg $K_2O$/ha

**Table 3. Interaction effect of different varieties and levels of potassium on number of branches per plant of mungbean**

| Treatment | Number of branches per plant at | | | | |
|---|---|---|---|---|---|
| | 25 DAS | 35 DAS | 45 DAS | 55 DAS | Harvest |
| $V_1K_0$ | **0.20 c** | **0.73 e** | **0.93 e** | **2.00 b** | **2.20 b** |
| $V_1K_1$ | 0.27 c | 0.60 e | 1.27 de | 2.27 b | 2.47 b |
| $V_1K_2$ | 0.53 b | 1.33 bc | 2.07 ab | 3.07 a | 3.33 a |
| $V_1K_3$ | 0.27 c | 1.07 cd | 2.07 ab | 3.07 a | 3.27 a |
| $V_2K_0$ | 0.33 c | 0.80 de | 1.60 cd | 2.27 b | 2.40 b |
| $V_2K_1$ | 0.60 b | 1.40 b | 1.93 bc | 3.27 a | 3.47 a |
| $V_2K_2$ | **0.87 a** | **1.80 a** | **2.40 a** | **3.40 a** | **3.53 a** |
| $V_2K_3$ | 0.80 a | 1.60 ab | 2.13 ab | 3.00 a | 3.13 a |
| $LSD_{(0.05)}$ | 0.166 | 0.271 | 0.341 | 0.502 | 0.514 |
| Level of significance | 0.05 | 0.05 | 0.01 | 0.05 | 0.01 |
| CV(%) | 9.15 | 13.29 | 10.81 | 10.27 | 9.88 |

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

$V_1$: BARI mung-2 $V_2$: BARI mung-6

$K_0$: 0 kg $K_2O$/ha (control) $K_1$: 10 kg $K_2O$/ha

$K_2$: 20 kg $K_2O$/ha $K_3$: 30 kg $K_2O$/ha

### 4.3 Number of leaves per plant

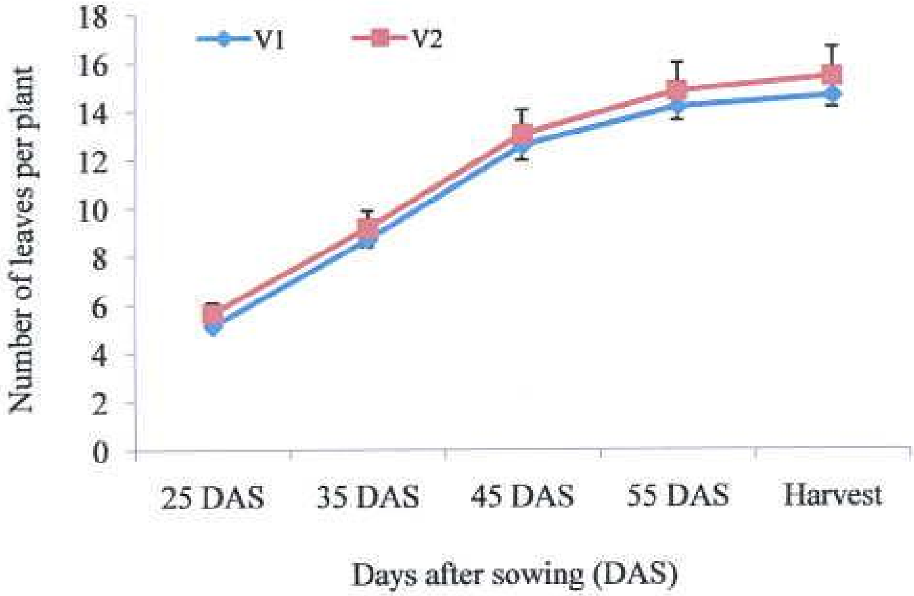
BARI mung-2 and BARI mung-6 varied significantly for number of leaves per plant at 25, 35, 45, 55 DAS and at harvest (Figure 4). At 25, 35, 45, 55 DAS and harvest the maximum number of leaves per plant (5.65, 9.17, 13.04, 14.83 and 15.42) was observed from $V_2$ and the minimum number (5.13, 8.70, 12.59, 14.18 and 14.63) from $V_1$. Management practices influence the number of leaves per plant but varieties itself also manipulated it.

Statistically significant variation was recorded for number of leaves per plant due to different levels of potassium at 25, 35, 45, 55 DAS and at harvest (Figure 5). At 25, 35, 45, 55 DAS and at harvest, the maximum number of leaves per plant (6.02, 9.73, 13.73, 15.90 and 16.20) was observed from $K_2$, which was statistically identical (5.60, 9.37, 13.35, 15.17 and 15.85) with $K_3$, while the minimum number of leaves per plant (4.53, 7.70, 11.38, 12.67 and 13.18) was found from $K_0$. Potassium fertilizer ensured favorable condition for the growth of mungbean plant with optimum vegetative growth and the ultimate results was the maximum leaves per plant.

Number of leaves per plant at 25, 35, 45, 55 DAS and at harvest showed significant differences due to the interaction effect of mungbean varieties and levels of potassium (Table 4). At 25, 35, 45, 55 DAS and at harvest the maximum number of leaves per plant (6.37, 9.87, 13.83, 16.07 and 14.23) was recorded from $V_2K_2$, again the minimum number (4.03, 7.17, 11.03, 11.77 and 12.40) from $V_1K_0$.

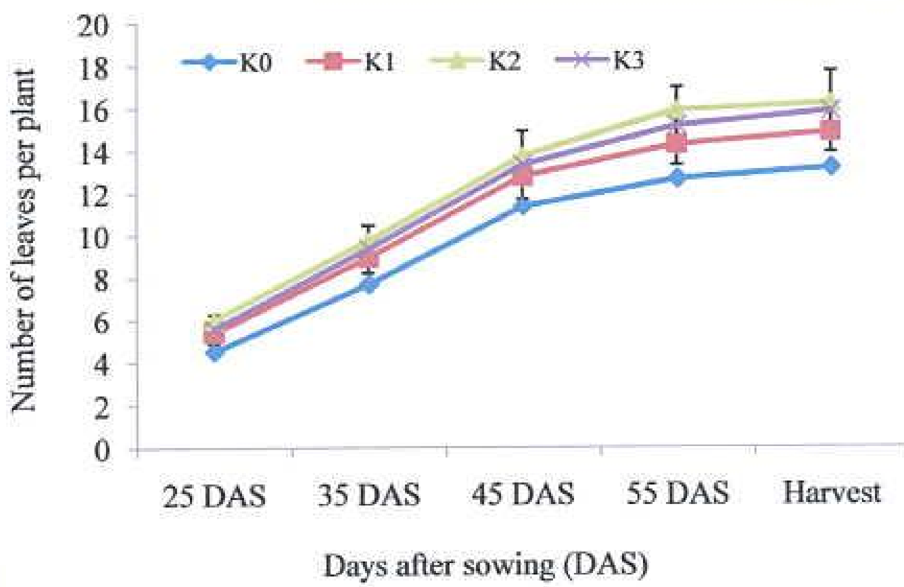
### 4.4 Days to 1st flowering

Days to 1st flowering of BARI mung-2 and BARI mung-6 showed statistically significant differences under the present trial (Table 5). The minimum days to 1st flowering (35.92) was attained from $V_2$, whereas the maximum days (38.25) from $V_1$. Days to 1st flowering varied for different varieties might be due to genetical and environmental influences as well as management practices.




$V_1$: BARI mung-2 $V_2$: BARI mung-6

Figure 4. Effect of varieties on number of leaves per plant of mungbean




$K_0$: 0 kg $K_2O$/ha (control) $K_1$: 10 kg $K_2O$/ha

$K_2$: 20 kg $K_2O$/ha $K_3$: 30 kg $K_2O$/ha

Figure 5. Effects of potassium on number of leaves per plant of mungbean

**Table 4. Interaction effect of different varieties and levels of potassium on number of leaves per plant of mungbean**

| Treatment | Number of leaves per plant at | | | | |
|---|---|---|---|---|---|
| | 25 DAS | 35 DAS | 45 DAS | 55 DAS | Harvest |
| $V_1K_0$ | **4.03 e** | **7.17 d** | **11.03 d** | **11.77 c** | **12.40 c** |
| $V_1K_1$ | 5.27 cd | 8.67 bc | 12.43 bc | 13.80 b | 14.17 b |
| $V_1K_2$ | 5.67 b | 9.60 a | 13.63 a | 15.73 a | 16.17 a |
| $V_1K_3$ | 5.53 bc | 9.37 a | 13.27 a | 15.40 a | 15.77 a |
| $V_2K_0$ | 5.03 d | 8.23 c | 11.73 cd | 13.57 b | 13.97 b |
| $V_2K_1$ | 5.53 bc | 9.23 ab | 13.17 ab | 14.77 ab | 15.53 a |
| $V_2K_2$ | **6.37 a** | **9.87 a** | **13.83 a** | **16.07 a** | **16.23 a** |
| $V_2K_3$ | 5.67 b | 9.37 a | 13.43 a | 14.93 ab | 15.93 a |
| $LSD_{(0.05)}$ | 0.332 | 0.591 | 0.787 | 1.283 | 1.080 |
| Level of significance | 0.01 | 0.05 | 0.05 | 0.05 | 0.05 |
| CV(%) | 4.51 | 5.78 | 6.50 | 5.05 | 4.11 |

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

$V_1$: BARI mung-2 | $V_2$: BARI mung-6

$K_0$: 0 kg $K_2O$/ha (control) | $K_1$: 10 kg $K_2O$/ha

$K_2$: 20 kg $K_2O$/ha | $K_3$: 30 kg $K_2O$/ha

**Table 5. Effect of different varieties and levels of potassium on yield contributing characters and yield of mungbean**

| Treatment | Days to 1st flowering | Days to 80% pod maturity | Number of pods per plant | Pod length (cm) | Seeds yield (t/ha) | Stover yield (t/ha) |
|---|---|---|---|---|---|---|
| **Varieties** | | | | | | |
| $V_1$ | 38.25 a | 68.08 a | 18.13 b | 7.98 b | 1.38 b | 2.28 b |
| $V_2$ | 35.92 b | 65.92 b | 19.48 a | 9.00 a | 1.60 a | 2.73 a |
| $LSD_{(0.05)}$ | 1.441 | 2.161 | 0.798 | 0.412 | 0.0554 | 0.144 |
| Level of significance | 0.01 | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 |
| **Levels of potassium** | | | | | | |
| $K_0$ | **38.83 a** | **70.17 a** | **16.07 b** | **7.54 c** | **1.23 c** | **1.94 c** |
| $K_1$ | 38.00 ab | 68.00 ab | 19.07 a | 8.23 b | 1.50 b | 2.47 b |
| $K_2$ | **35.33 c** | **64.17 c** | **20.08 a** | **9.30 a** | **1.64 a** | **2.84 a** |
| $K_3$ | 36.17 bc | 65.67 bc | 20.00 a | 8.89 a | 1.59 a | 2.76 a |
| $LSD_{(0.05)}$ | 2.038 | 3.056 | 1.129 | 0.582 | 0.078 | 0.204 |
| Level of significance | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| CV(%) | 4.44 | 3.68 | 4.85 | 5.53 | 4.36 | 4.51 |

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

$V_1$: BARI mung-2 $V_2$: BARI mung-6

$K_0$: 0 kg $K_2O$/ha (control) $K_1$: 10 kg $K_2O$/ha

$K_2$: 20 kg $K_2O$/ha $K_3$: 30 kg $K_2O$/ha

Statistically significant variation was recorded for days to 1st flowering due to different levels of potassium (Table 5). The minimum days to 1st flowering (35.33) was observed from $K_2$, which was statistically identical (36.17) with $K_3$. On the other hand, the maximum days (38.83) was found from $K_0$ which was statistically similar (38.00) with $K_1$.

Mungbean varieties and levels of potassium showed significant differences on days to 1st flowering for their interaction effect (Table 6). The minimum days to 1st flowering (34.67) was found from $V_2K_0$ and $V_2K_2$, again the maximum days (43.00) from $V_1K_0$.

**4.5 Days to 80% pod maturity**

Statistically significant variation was recorded for days to 80% pod maturity of BARI mung-2 and BARI mung-6 (Table 5). The minimum days to 80% pod maturity (65.92) was recorded from $V_2$ and the maximum days (68.08) from $V_1$. Aghaalikhani *et al.* (2006) reported that VC-1973A line was superior due to its early and uniform seed maturity. Brar *et al.* (2004) reported that early maturing cultivar flowers in 34 days and matures in 60 days.

Days to 80% pod maturity showed significant variation for different levels of potassium (Table 5). The minimum days to 80% pod maturity (64.17) was observed from $K_2$, which was statistically identical (65.67) with $K_3$, whereas the maximum days (70.17) was observed from $K_0$ which was statistically similar (68.00) with $K_1$. Oad and Buriro (2005) reported that the 30 kg K/ha was the best for prolonged days taken to maturity of 55.50.

Interaction effect of mungbean varieties and levels of potassium showed significant differences on days to 80% pod maturity (Table 6). The minimum days to 80% pod maturity (62.67) was attained from $V_2K_2$, while the maximum days (74.00) from $V_1K_0$.

**Table 6. Interaction effect of different varieties and levels of potassium on yield contributing characters and yield of mungbean**

| Treatment | Days to 1st flowering | Days to 80% pod maturity | Number of pods per plant | Pod length (cm) | Seed yield (t/ha) | Stover yield (t/ha) |
|---|---|---|---|---|---|---|
| $V_1K_0$ | **43.00 a** | **74.00 a** | **15.63 c** | **6.73 c** | **1.10 d** | **1.34 d** |
| $V_1K_1$ | 39.00 b | 69.67 b | 18.20 b | 7.30 c | 1.36 c | 2.33 c |
| $V_1K_2$ | 36.00 bc | 65.67 bc | 19.23 ab | 9.23 ab | 1.54 b | 2.76 ab |
| $V_1K_3$ | 35.00 c | 66.00 bc | 19.43 ab | 8.67 ab | 1.51 b | 2.68 ab |
| $V_2K_0$ | **34.67 c** | 66.33 bc | 16.50 c | 8.36 b | 1.36 c | 2.54 bc |
| $V_2K_1$ | 37.00 bc | 66.33 bc | 19.93 a | 9.16 ab | 1.65 a | 2.61 abc |
| $V_2K_2$ | **34.67 c** | **62.67 c** | **20.93 a** | **9.37 a** | **1.74 a** | **2.92 a** |
| $V_2K_3$ | 37.33 bc | 65.33 bc | 20.57 a | 9.11 ab | 1.67 a | 2.85 ab |
| $LSD_{(0.05)}$ | 2.882 | 4.321 | 1.596 | 0.823 | 0.111 | 0.288 |
| Level of significance | 0.01 | 0.01 | 0.05 | 0.01 | 0.05 | 0.01 |
| CV(%) | 4.44 | 3.68 | 4.85 | 5.53 | 4.36 | 4.51 |

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

$V_1$: BARI mung-2 $V_2$: BARI mung-6

$K_0$: 0 kg $K_2O$/ha (control) $K_1$: 10 kg $K_2O$/ha

$K_2$: 20 kg $K_2O$/ha $K_3$: 30 kg $K_2O$/ha

### 4.6 Number of pods per plant

Number of pods per plant of BARI mung-2 and BARI mung-6 varied significantly under the present trial (Table 5). The maximum number of pods per plant (19.48) was recorded from $V_2$, whereas the minimum number (18.48) from $V_1$. Different varieties responded differently for pods per plant to input supply, method of cultivation and the prevailing environment during the growing season. Riaz *et al.* (2004) reported that NM-98 produced the maximum pod number of 77.30.

Different levels of potassium showed significant differences for number of pods per plant (Table 5). The maximum number of pods per plant (20.08) was observed from $K_2$, which was statistically identical (20.00 and 19.07) with $K_3$ and $K_1$, again the minimum number of pods per plant (16.07) was recorded from $K_0$.

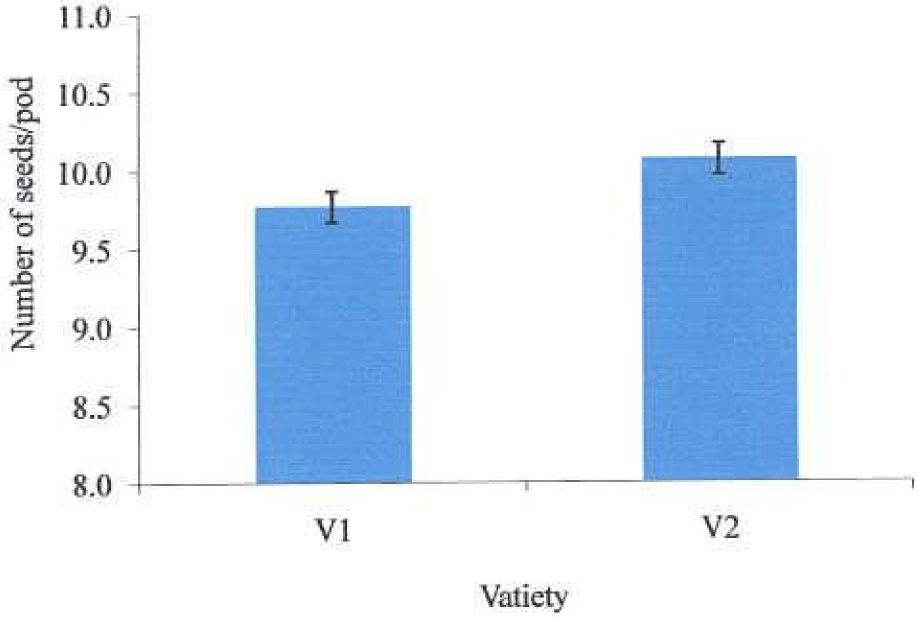
Statistically significant variation was recorded due to the interaction effect of mungbean varieties and levels of potassium on number of pods per plant (Table 6). The maximum number of pods per plant (20.93) was observed from $V_2K_2$, while the minimum number (15.63) from $V_1K_0$.

### 4.7 Number of seeds per pod

Significant differences was recorded for number of seeds per pod of BARI mung-2 and BARI mung-6 (Figure 6). The maximum number of seeds per pod (10.07) was found from $V_2$, while the minimum number (9.77) from $V_1$. Taj *et al.* (2003) found that highest average seeds per pod 9.79 from cultivars, NM 121-125.

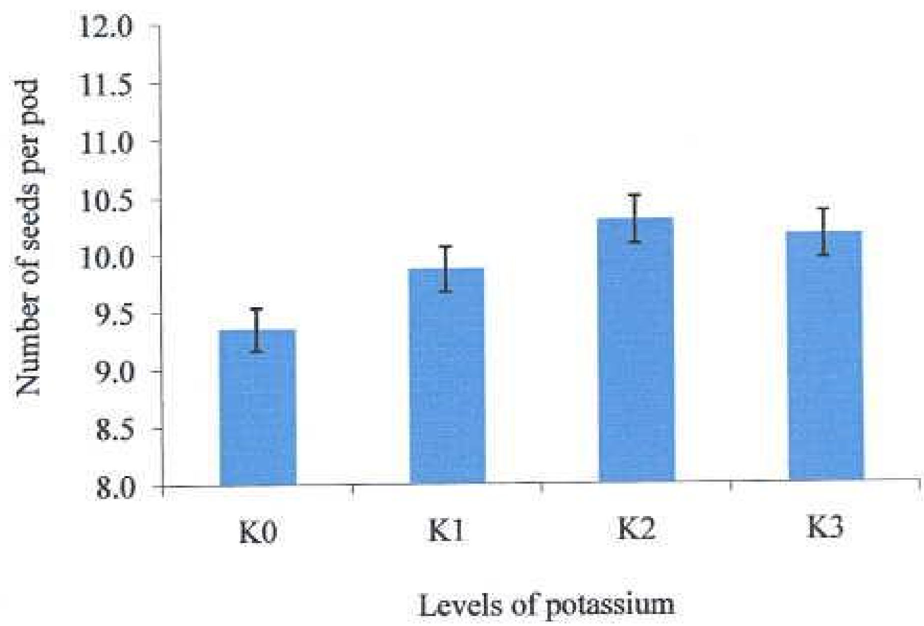
Number of seeds per pod showed significant variation for different levels of potassium (Figure 7). The maximum number of seeds per pod (10.30) was recorded from $K_2$, which was statistically identical (10.17) with $K_3$ and closely followed (9.87) by $K_1$, whereas the minimum number (9.35) from $K_0$.

Interaction effect of mungbean varieties and levels of potassium showed significant differences on number of seeds per pod (Figure 8). The maximum number of seeds per pod (10.33) was attained from $V_2K_2$ and the minimum number (8.90) from $V_1K_0$.




$V_1$: BARI mung-2 $V_2$: BARI mung-6

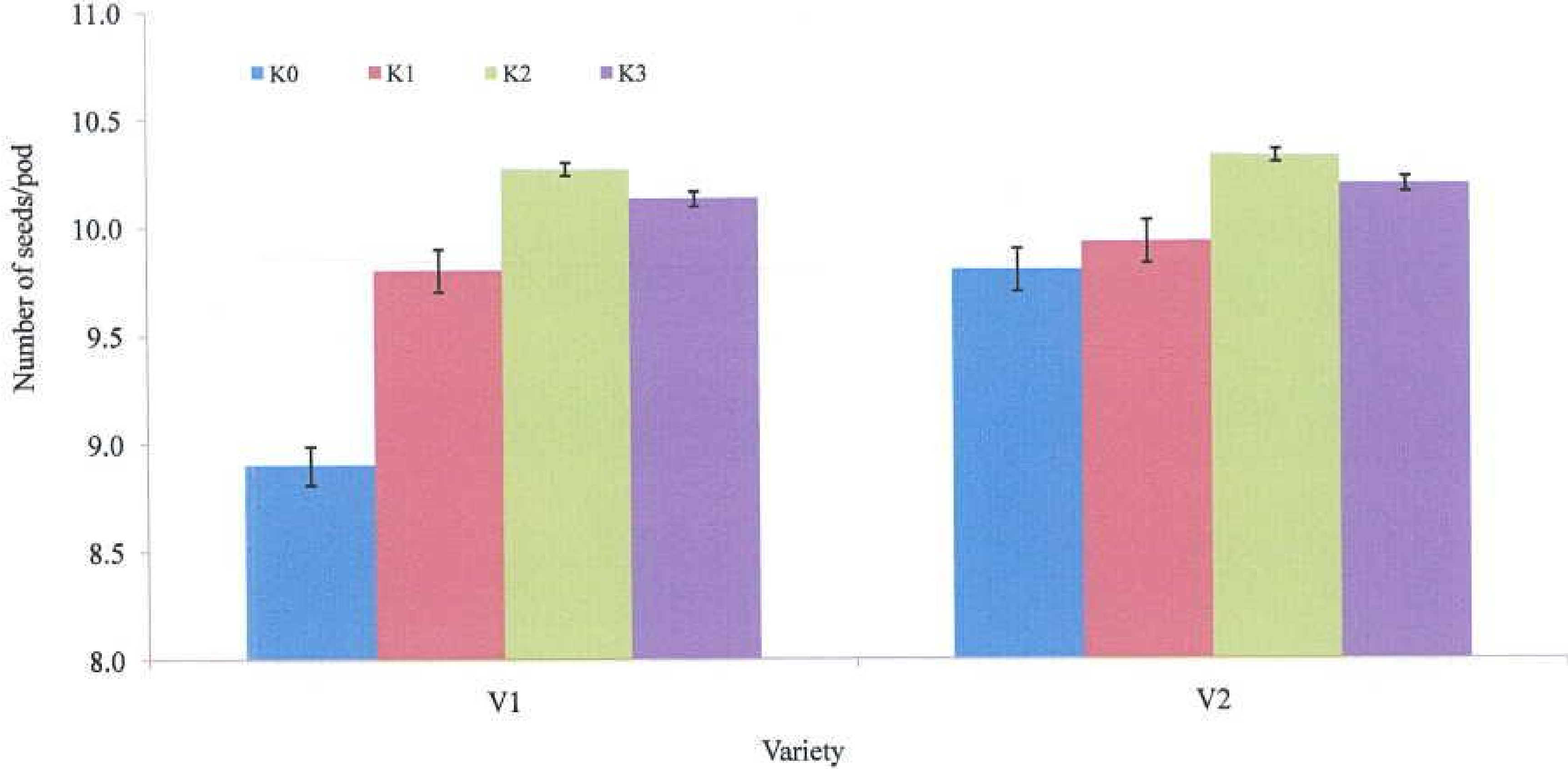
Figure 6. Effect of varieties on number of seeds/pod of mungbean




$K_0$: 0 kg $K_2O$/ha (control) $K_1$: 10 kg $K_2O$/ha

$K_2$: 20 kg $K_2O$/ha $K_3$: 30 kg $K_2O$/ha

Figure 7. Effect of potassium on number of seeds/pod of mungbean




$V_1$: BARI mung-2 $V_2$: BARI mung-6

$K_0$: 0 kg $K_2O$/ha (control) $K_1$: 10 kg $K_2O$/ha

$K_2$: 20 kg $K_2O$/ha $K_3$: 30 kg $K_2O$/ha

Figure 8. Interaction effect of varieties and potassium on number of seeds per pod of mungbean

### 4.8 Pod length

Statistically significant variation was recorded for pod length of BARI mung-2 and BARI mung-6 (Table 5). The longer pod (9.00 cm) was found from $V_2$ and the shorter pod (7.98 cm) from $V_1$.

Different levels of potassium varied significantly for pod length under the present trial (Table 5). The longest pod (9.30 cm) was attained from $K_2$, which was statistically identical (8.89 cm) with $K_3$ and closely followed (8.23 cm) by $K_1$, while the lowest pod (7.54 cm) was observed from $K_0$. Oad and Buriro (2005) reported that the 30 kg K/ha was the best for long pods of 5.02.

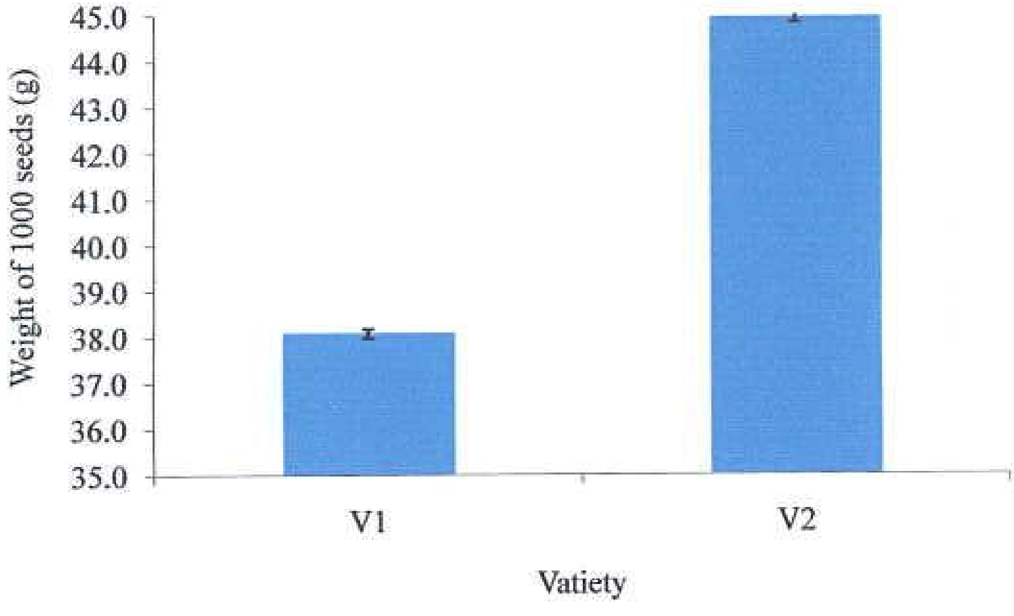
Pod length showed significant differences due to the interaction effect of mungbean varieties and levels of potassium (Table 6). The longest pod (9.37 cm) was recorded from $V_2K_2$, whereas the shortest pod (6.73 cm) from $V_1K_0$.

### 4.9 Weight of 1000 seed

Weight of 1000 seed of BARI mung-2 and BARI mung-6 showed statistically significant variation under the present trial (Figure 9). The highest weight of 1000 seed (44.94 g) was recorded from $V_2$, while the lowest weight (38.08 g) from $V_1$. Taj *et al.* (2003) recorded that highest average 1000-seeds weight 28.09 g from cultivars, NM 121-125.

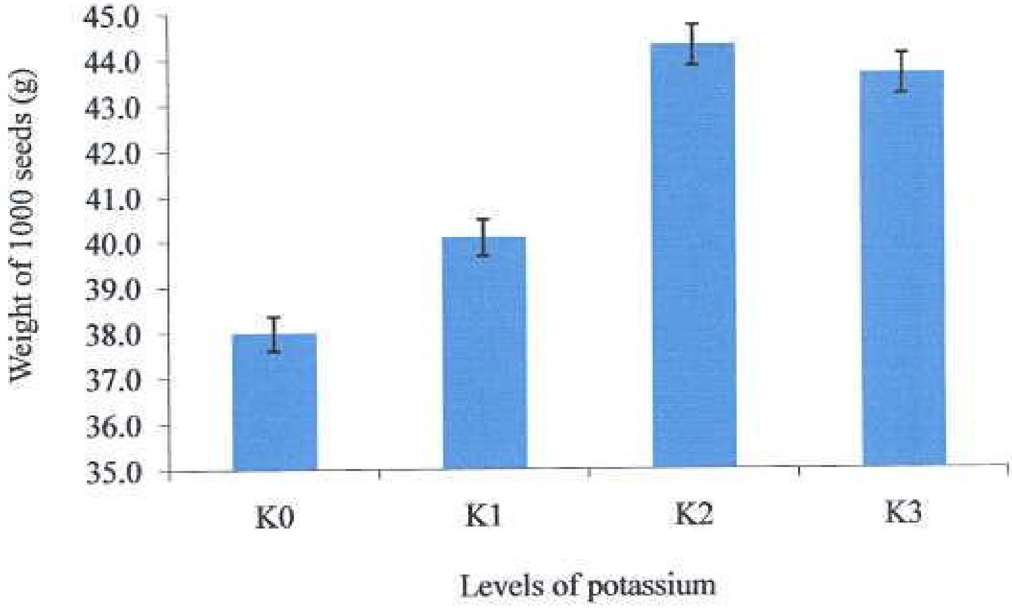
Statistically significant variation was recorded for weight of 1000 seed due to different levels of potassium (Figure 10). The highest weight of 1000 seed (44.30 g) was found from $K_2$, which was statistically identical (43.67 g) with $K_3$ and closely followed (40.09 g) by $K_1$, whereas the lowest weight (37.98 g) from $K_0$. But Oad *et al.*, 2003 reported that most of the agronomic traits of mungbean were significantly influenced by potassium fertilizers except seed weight per plant.

Mungbean varieties and levels of potassium showed significant differences on weight of 1000 seed due to their interaction effect (Figure 11). The highest weight of 1000 seeds (47.02 g) was recorded from $V_2K_2$ and the lowest weight (32.03 g) from $V_1K_0$.




$V_1$: BARI mung-2 $V_2$: BARI mung-6

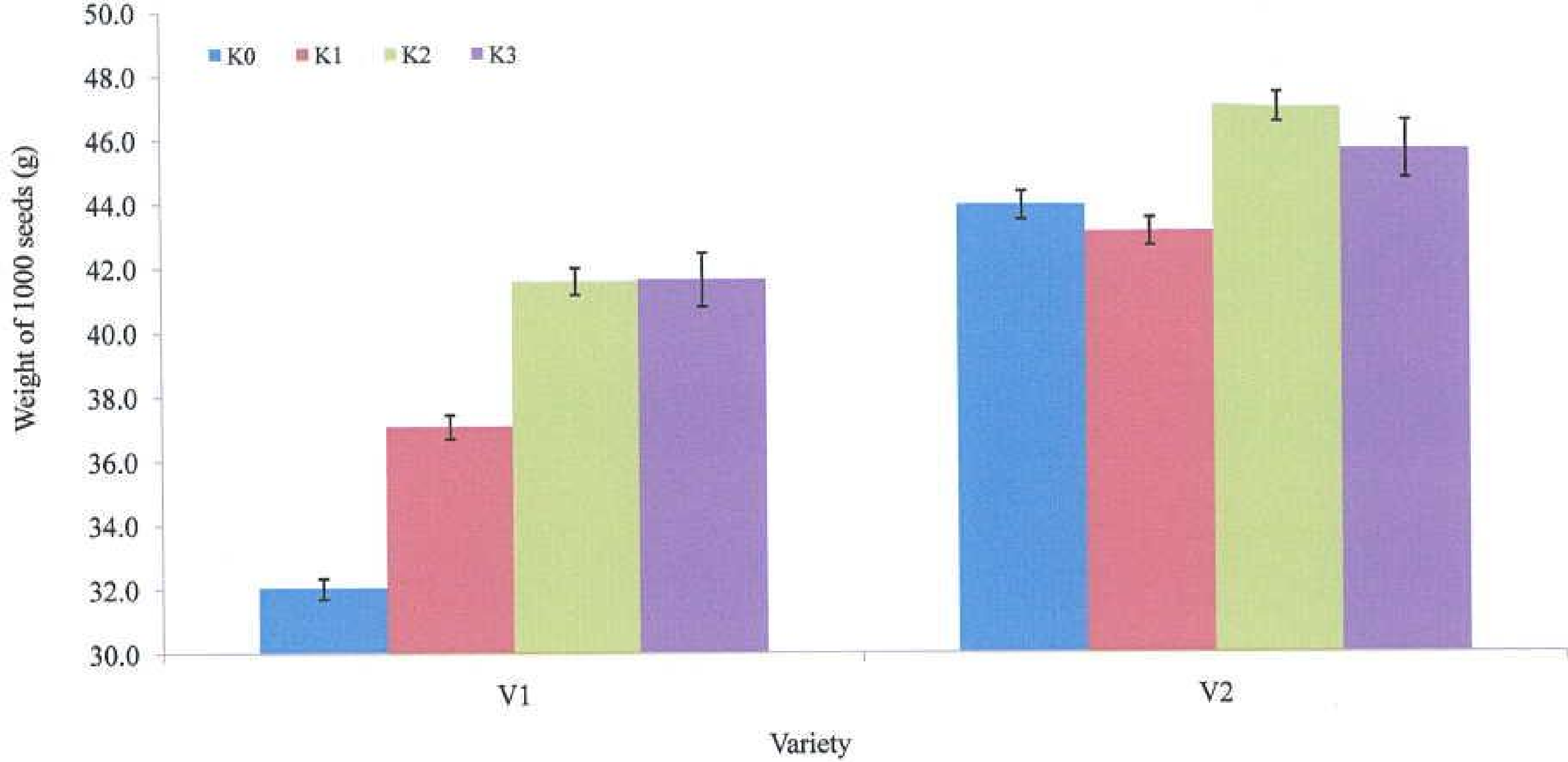
Figure 9. Effect of varieties on weight of 1000 seeds of mungbean




$K_0$: 0 kg $K_2O$/ha (control) $K_1$: 10 kg $K_2O$/ha

$K_2$: 20 kg $K_2O$/ha $K_3$: 30 kg $K_2O$/ha

Figure 10. Effect of potassium on weight of 1000 seeds of mungbean




$V_1$: BARI mung-2 $V_2$: BARI mung-6

$K_0$: 0 kg $K_2O$/ha (control) $K_1$: 10 kg $K_2O$/ha
$K_2$: 20 kg $K_2O$/ha $K_3$: 30 kg $K_2O$/ha

Figure 11. Interaction effect of varieties and potassium on weight of 1000 seeds of mungbean

### 4.10 Seed yield

Statistically significant variation was recorded for seed yield per hectare of BARI mung-2 and BARI mung-6 (Table 5). The highest seed yield (1.60 t/ha) was recorded from $V_2$, whereas the lowest seed yield (1.38 t/ha) from $V_1$. Varieties plays an important role in producing high yield of mungbean and yield varied for different varieties might be due to genetical and environmental influences as well as management practices. Islam *et al.* (2006) reported that BINA moog 5 performed better than that of BINA moog 2 and BINA moog 4. Tickoo *et al.* (2006) recorded highest seed yield (1.63 t/ha) from cultivar Pusa Vishal.

Seed yield per hectare showed significant variation for different levels of potassium (Table 5). The highest seed yield (1.64 t/ha) was observed from $K_2$, which was statistically identical (1.59 t/ha) with $K_3$ and closely followed (1.50 t/ha) by $K_1$, again the lowest seed yield (1.23 t/ha) was recorded from $K_0$. It was revealed that potassium ensured favorable condition for the growth of mungbean plant with optimum vegetative growth and the ultimate results was the highest yield. Nita *et al.* (2002) reported that seeds yield increased with increasing rates of K fertilizer. Asghar *et al.* (1996) recorded the highest seed yield (1.67 t/ha) was obtained with application of 75 kg $K_2O$/ha. Oad and Buriro (2005) reported that the 30 kg K/ha was the best for the highest seed yield of 1205.2 kg $ha^{-1}$.

Interaction effect of mungbean varieties and levels of potassium showed significant differences on seed yield per hectare (Table 6). The highest seed yield (1.74 t/ha) was observed from $V_2K_2$, while the lowest (1.10 t/ha) from $V_1K_0$.

### 4.11 Stover yield

Stover yield per hectare of BARI mung-2 and BARI mung-6 showed statistically significant differences (Table 5). The highest stover yield (2.73 t/ha) was found from $V_2$, while the lowest stover yield (2.28 t/ha) from $V_1$.

Different levels of potassium showed significant differences in terms of stover yield per hectare (Table 5). The highest stover yield (2.84 t/ha) was attained from

$K_2$, which was statistically identical (2.76 t/ha) with $K_3$ and closely followed (2.47 t/ha) by $K_1$, whereas the lowest stover yield (1.94 t/ha) was observed from $K_0$.

Statistically significant variation was found due to the interaction effect of mungbean varieties and levels of potassium on stover yield per hectare (Table 5). The highest stover yield (2.92 t/ha) was recorded from $V_2K_2$ and the lowest stover yield (1.34 t/ha) from $V_1K_0$.



### 4.12 Nitrogen content in seed

Significant differences was recorded for nitrogen content in seed of BARI mung-2 and BARI mung-6 (Table 7). The highest nitrogen content in seeds (4.35%) was recorded from $V_2$ and the lowest (4.23%) from $V_1$.

Nitrogen content in seed showed significant differences for different levels of potassium (Table 7). The highest nitrogen content in seed (4.41%) was recorded from $K_2$, which was statistically identical (4.39%) with $K_3$ and closely followed (4.31%) by $K_1$, while the lowest (4.05%) was found from $K_0$.

Interaction effect of mungbean varieties and levels of potassium showed significant differences on nitrogen content in seed (Table 8). The highest nitrogen content in seeds (4.51%) was observed from $V_2K_2$, whereas the lowest (4.04%) from $V_1K_0$.

### 4.13 Phosphorus content in seeds

Phosphorus content in seeds of BARI mung-2 and BARI mung-6 showed significant variation under the present trial (Table 7). The highest phosphorus content in seeds (0.45%) was found from $V_2$, while the lowest (0.43%) from $V_1$.

Different levels of potassium showed significant variation in terms of phosphorus content in seeds (Table 7). The highest phosphorus content in seeds (0.46%) was observed from $K_2$, which was statistically identical (0.45%) with $K_3$ and closely followed (0.43%) by $K_1$ again the lowest (0.41%) was found from $K_0$.

**Table 7. Effect of different varieties and levels of potassium on nutrient content of mungbean**

| Treatment | Nitrogen (%) | Phosphorus (%) | Potassium (%) | Sulphur (%) |
|---|---|---|---|---|
| **Varieties** | | | | |
| $V_1$ | 4.23 b | 0.43 b | 0.63 b | 0.130 b |
| $V_2$ | 4.35 a | 0.45 a | 0.86 a | 0.142 a |
| $LSD_{(0.05)}$ | 0.068 | 0.009 | 0.048 | 0.009 |
| Level of significance | 0.01 | 0.01 | 0.01 | 0.01 |
| **Levels of potassium** | | | | |
| $K_0$ | **4.05 c** | **0.41 c** | **0.54 b** | **0.115 c** |
| $K_1$ | 4.31 b | 0.43 b | 0.78 a | 0.137 b |
| $K_2$ | **4.41 a** | **0.46 a** | **0.84 a** | **0.152 a** |
| $K_3$ | 4.39 ab | 0.45 a | 0.82 a | 0.140 ab |
| $LSD_{(0.05)}$ | 0.096 | 0.012 | 0.068 | 0.0124 |
| Level of significance | 0.01 | 0.01 | 0.01 | 0.01 |
| CV(%) | 5.88 | 4.38 | 6.82 | 8.37 |

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

$V_1$: BARI mung-2 $V_2$: BARI mung-6

$K_0$: 0 kg $K_2O$/ha (control) $K_1$: 10 kg $K_2O$/ha

$K_2$: 20 kg $K_2O$/ha $K_3$: 30 kg $K_2O$/ha

**Table 8. Interaction effect of different varieties and levels of potassium on nutrient content of mungbean**

| Treatment | Nitrogen (%) | Phosphorus (%) | Potassium (%) | Sulphur (%) |
|---|---|---|---|---|
| $V_1K_0$ | **4.04 c** | **0.38 e** | **0.40 d** | **0.101 d** |
| $V_1K_1$ | 4.18 c | 0.41 d | 0.61 c | 0.126 c |
| $V_1K_2$ | 4.31 b | 0.46 ab | 0.77 b | 0.140 bc |
| $V_1K_3$ | 4.38 ab | 0.45 ab | 0.73 b | 0.149 ab |
| $V_2K_0$ | 4.06 c | 0.43 cd | 0.69 bc | 0.129 c |
| $V_2K_1$ | 4.44 ab | 0.44 bc | 0.91 a | 0.149 ab |
| $V_2K_2$ | **4.51 a** | **0.46 a** | **0.95 a** | **0.164 a** |
| $V_2K_3$ | 4.41 ab | 0.46 ab | 0.92 a | 0.132 bc |
| $LSD_{(0.05)}$ | 0.136 | 0.018 | 0.096 | 0.018 |
| Level of significance | 0.05 | 0.05 | 0.01 | 0.01 |
| CV(%) | 5.88 | 4.38 | 6.82 | 8.37 |

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

$V_1$: BARI mung-2 $V_2$: BARI mung-6

$K_0$: 0 kg $K_2O$/ha (control) $K_1$: 10 kg $K_2O$/ha

$K_2$: 20 kg $K_2O$/ha $K_3$: 30 kg $K_2O$/ha

Mungbean varieties and levels of potassium showed significant differences on phosphorus content in seeds due to their interaction effect (Table 8). The highest phosphorus content in seeds (0.46%) was observed from $V_1K_2$, $V_2K_3$ and $V_2K_2$, while the lowest (0.38%) from $V_1K_0$.

### 4.14 Potassium content in seeds

Statistically significant variation was recorded for potassium content in seeds of BARI mung-2 and BARI mung-6 (Table 7). The highest potassium content in seeds (0.86%) was attained from $V_2$, again the lowest (0.63%) from $V_1$.

Potassium content in seeds showed significant variation for different levels of potassium (Table 7). The highest potassium content in seeds (0.84%) was found from $K_2$, which was statistically identical (0.82% and 0.78%) with $K_3$ and $K_1$, whereas the lowest (0.54%) was recorded from $K_0$.

Statistically significant variation was recorded due to the interaction effect of mungbean varieties and levels of potassium on potassium content in seeds (Table 8). The highest potassium content in seeds (0.95%) was recorded from $V_2K_2$ and the lowest (0.40%) from $V_1K_0$.

### 4.15 Sulphur content in seeds

Sulphur content in seeds of BARI mung-2 and BARI mung-6 showed statistically significant differences (Table 7). The highest sulphur content in seeds (0.142%) was observed from $V_2$, whereas the lowest (0.130%) from $V_1$.

Different levels of potassium showed statistically significant variation on sulphur content in seeds (Table 7). The highest sulphur content in seeds (0.152%) was observed from $K_2$, which was statistically identical (0.140%) with $K_3$ and closely followed (0.137%) by $K_1$, while the lowest (0.115%) was attained from $K_0$.

Sulphur content in seeds showed significant differences due to interaction effect of varieties and levels of potassium (Table 8). The highest sulphur content in seeds (0.164%) was found from $V_2K_2$ and the lowest (0.101%) from $V_1K_0$.

# Chapter V
# Summary and Conclusion

# CHAPTER V

# SUMMARY AND CONCLUSION

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from March to June 2012 to study the effect of potassium on the growth, yield and nutrients content in two varieties of mungbean. The experiment consists of two factors: Factor A: Mungbean varieties (2) - $V_1$= BARI mung-2 and $V_2$= BARI mung-6; Factor B: Inorganic fertilizer potassium (4 levels) - $K_0$ = 0 kg $K_2O$/ha (Control); $K_1$ = 10 kg $K_2O$/ha; $K_2$ = 20 kg $K_2O$/ha and $K_3$ = 30 kg $K_2O$/ha. The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Data on different yield contributing characters, yield and nutrient content on seeds were recorded and significant variation was observed.

For mungbean varieties, at 25, 35, 45, 55 DAS and harvest the tallest plant (22.01 cm, 32.69 cm, 45.99 cm, 53.97 cm and 57.48 cm) was recorded from $V_2$, whereas the shortest plant (20.30 cm, 30.38 cm, 42.13 cm, 49.84 cm and 53.98 cm) from $V_1$. At 25, 35, 45, 55 DAS and harvest the maximum number of branches per plant (0.65, 1.40, 2.02, 2.98 and 3.13) was found from $V_2$, while the minimum number (0.32, 0.93, 1.58, 2.60 and 2.82) from $V_1$. At 25, 35, 45, 55 DAS and harvest the maximum number of leaves per plant (5.65, 9.17, 13.04, 14.83 and 15.42) was observed from $V_2$ and the minimum number (5.13, 8.70, 12.59, 14.18 and 14.63) from $V_1$. The minimum days to $1^{st}$ flowering (35.92) was attained from $V_2$, whereas the maximum days (38.25) from $V_1$. The minimum days to $1^{st}$ flowering (65.92) was recorded from $V_2$ and the maximum days (68.08) from $V_1$. The maximum number of pods per plant (19.48) was recorded from $V_2$, whereas the minimum number (18.13) from $V_1$. The maximum number of seeds per pod (10.07) was found from $V_2$, while the minimum number (9.77) from $V_1$. The longer pod (9.00 cm) was found from $V_2$ and the shorter pod (7.98 cm) from $V_1$. The highest weight of 1000 seeds (44.94 g) was recorded from $V_2$, while the lowest weight (38.08 g) from $V_1$. The highest seed yield (1.60 t/ha) was recorded from $V_2$, whereas the lowest seed yield (1.38 t/ha) from $V_1$. The highest stover yield (2.73 t/ha) was found from $V_2$, while the lowest stover yield (2.28 t/ha) from $V_1$. The highest nitrogen content in seed (4.35%) was recorded from $V_2$ and the lowest (4.23%) from $V_1$. The highest phosphorus content in seed (0.45%) was observed from $V_2$, whereas the lowest (0.43%) from $V_1$. The highest potassium content in seed (0.86%) was attained from $V_2$, again the lowest (0.63%) from $V_1$. The highest sulphur content in seed (0.142%) was observed from $V_1$, whereas the lowest (0.130%) from $V_2$.

In case of levels of potassium fertilizer, at 25, 35, 45, 55 DAS and at harvest, the tallest plant (22.71 cm, 33.70 cm, 47.63 cm, 55.35 cm and 58.54 cm) was found from $K_2$ and the shortest plant (18.96 cm, 28.46 cm, 38.91 cm, 47.39 cm and 51.95 cm) was observed from $K_0$. At 25, 35, 45, 55 DAS and at harvest, the maximum number of branches per plant (0.70, 1.57, 2.23, 3.23 and 3.43) was obtained from $K_2$ and the minimum number (0.43, 1.00, 1.60, 2.77 and 2.97) was recorded from $K_0$. At 25, 35, 45, 55 DAS and at harvest, the maximum number of leaves per plant (6.02, 9.73, 13.73, 15.90 and 16.20) was observed from $K_2$, while the minimum number (4.53, 7.70, 11.38, 12.67 and 13.18) was found from $K_0$. The minimum days to 1st flowering (35.33) was observed from $K_2$, and the maximum days (38.83) was found from $K_0$. The minimum days to 80% pod maturity (64.17) was observed from $K_2$, whereas the maximum days (70.17) was observed from $K_0$. The maximum number of pods per plant (20.08) was observed from $K_2$, again the minimum number of pods per plant (16.07) was recorded from $K_0$. The maximum number of seeds per pod (10.17) was recorded from $K_2$, whereas the minimum number (9.35) was recorded from $K_0$. The longest pod (9.30 cm) was attained from $K_2$, while the lowest pod (7.54 cm) was observed from $K_0$. The highest weight of 1000 seeds (44.30 g) was found from $K_2$, whereas the lowest weight (37.98 g) was observed from $K_0$. The highest seed yield (1.64 t/ha) was observed from $K_2$, again the lowest seed yield (1.23 t/ha) was recorded from $K_0$. The highest stover yield (2.84 t/ha) was attained from $K_2$, whereas the lowest stover yield (1.94 t/ha) was observed from $K_0$. The highest nitrogen content in seed (4.41%) was recorded from $K_2$, while the lowest (4.05%) was found from $K_0$. The highest phosphorus content in seed (0.46%) was observed from $K_2$, again the lowest (0.41%) was found from $K_0$. The highest potassium content in seed (0.84%) was found from $K_2$, whereas the lowest (0.54%) was recorded from $K_0$. The highest sulphur content in seed (0.152%) was observed from $K_2$, while the lowest (0.115%) was attained from $K_0$.

Considering, interaction effect of varieties and levels of potassium, at 25, 35, 45, 55 DAS and at harvest the tallest plant (22.89 cm, 33.93 cm, 47.71 cm, 55.66 cm and 59.05 cm) was recorded from $V_2K_2$, while the shortest plant (17.69 cm, 24.46 cm, 33.67 cm, 42.96 cm and 47.70 cm) from $V_1K_0$. At 25, 35, 45, 55 DAS and at harvest the maximum number of branches per plant (0.87, 1.80, 2.40, 3.40 and 3.53) was observed from $V_2K_2$, whereas the minimum number (0.20, 0.73, 0.93, 2.00 and 2.20) from $V_1K_0$. At 25, 35, 45, 55 DAS and at harvest the maximum number of leaves per plant (6.37, 9.87, 13.83, 16.07 and 14.23) was recorded from $V_2K_2$, again the minimum number (4.03, 7.17, 11.03, 11.77 and 12.40) from $V_1K_0$. The minimum days to 1st flowering (34.67) was found from $V_2K_0$ and $V_2K_2$, again the maximum days (43.00) from $V_1K_0$. The minimum days to 80% pod maturity (62.67) was attained from $V_2K_2$, while the maximum days (74.00) from $V_1K_0$. The maximum number of pods per plant (20.93) was observed from $V_2K_2$, while the minimum number (15.63) from $V_1K_0$. The maximum number of seeds per pod (10.33) was attained from $V_2K_2$ and the minimum number (8.90) from $V_1K_0$. The longest pod (9.37 cm) was recorded from $V_2K_2$, whereas the shortest pod (6.73 cm) from $V_1K_0$. The highest weight of 1000 seeds (47.02 g) was recorded from $V_2K_2$ and the lowest weight (32.03 g) from $V_1K_0$. The highest seed yield (1.74 t/ha) was observed from $V_2K_2$, while the lowest seed yield (1.10 t/ha) from $V_1K_0$. The highest stover yield (2.92 t/ha) was recorded from $V_2K_2$ and the lowest stover yield (1.34 t/ha) from $V_1K_0$. The highest nitrogen content in seeds (4.51%) was observed from $V_2K_2$, whereas the lowest (4.04%) from $V_1K_0$. The highest phosphorus content in seeds (0.46%) was observed from $V_1K_2$, $V_2K_2$

and $V_2K_3$, while the lowest (0.38%) from $V_1K_0$. The highest potassium content in seeds (0.95%) was recorded from $V_2K_2$ and the lowest (0.40%) from $V_1K_0$. The highest sulphur content in seeds (0.164%) was recorded from $V_2K_2$, while the lowest (0.101%) from $V_1K_0$.

**Conclusion**

From the above findings it was revealed that BARI mung-6 and 20 kg $K_2O$/ha was more effective for the growth, yield and nutrient content of mungbean under the present trial.

**Recommendations**

Considering the situation of the present experiment, further studies in the following areas may be suggested:

1. Such study needs to be conducted in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability;
2. Other mungbean varieties may be included for further study.
3. Other levels of potassium and other organic and inorganic fertilizer may be included for future study.

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# Appendices

# APPENDICES

## Appendix I. Characteristics of the soil of experimental field analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

### A. Morphological characteristics of the soil of experimental field

| Morphological features | Characteristics |
|---|---|
| Location | Expeimental Field , SAU, Dhaka |
| AEZ | Madhupur Tract (28) |
| General Soil Type | Shallow red brown terrace soil |
| Land type | High land |
| Soil series | Tejgaon |
| Topography | Fairly leveled |
| Flood level | Above flood level |
| Drainage | Well drained |

### B. Physical and chemical properties of the initial soil

| Characteristics | Value |
|---|---|
| % Sand | 27 |
| % Silt | 43 |
| % Clay | 30 |
| Textural class | Silty-clay |
| pH | 5.6 |
| Organic carbon (%) | 0.45 |
| Organic matter (%) | 0.78 |
| Total N (%) | 0.03 |
| Available P (ppm) | 20.00 |
| Exchangeable K (me/100 g soil) | 0.10 |
| Available S (ppm) | 45 |

**Source:** SRDI, 2012

## Appendix II. Monthly record of air temperature, relative humidity and rainfall of the experimental site during the period from March to June 2012

| Month (2012) | Air temperature ($^0$C) | | Relative humidity (%) | Rainfall (mm) |
|---|---|---|---|---|
| | Maximum | Minimum | | |
| March | 23.2 | 16.5 | 64 | 12 |
| April | 26.2 | 18.1 | 61 | 88 |
| May | 27.0 | 19.2 | 63 | 54 |
| June | 27.1 | 16.7 | 67 | 145 |

Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka – 1212

**Appendix III. Effect of different varieties and levels of potassium on plant height of mungbean**

| Treatment | Plant height (cm) at | | | | |
|---|---|---|---|---|---|
| | 25 DAS | 35 DAS | 45 DAS | 55 DAS | Harvest |
| **Varieties** | | | | | |
| $V_1$ | 20.30 b | 30.38 b | 42.13 b | 49.84 b | 53.98 b |
| $V_2$ | 22.01 a | 32.69 a | 45.99 a | 53.97 a | 57.48 a |
| $LSD_{(0.05)}$ | 0.868 | 2.267 | 2.585 | 1.953 | 1.997 |
| Level of significance | 0.01 | 0.05 | 0.01 | 0.01 | 0.01 |
| **Levels of potassium** | | | | | |
| $K_0$ | 18.96 c | 28.46 b | 38.91 c | 47.39 c | 51.95 c |
| $K_1$ | 20.56 b | 30.95 ab | 42.86 b | 50.56 b | 54.83 b |
| $K_2$ | 22.71 a | 33.70 a | 47.63 a | 55.35 a | 58.54 a |
| $K_3$ | 22.39 a | 33.02 a | 46.84 a | 54.32 a | 57.58 ab |
| $LSD_{(0.05)}$ | 1.228 | 3.206 | 3.656 | 2.762 | 2.824 |
| Level of significance | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| CV(%) | 4.69 | 8.21 | 6.70 | 4.30 | 4.09 |

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

$V_1$: BARI Mung-2 $V_2$: BARI Mung-6

$K_0$: 0 kg $K_2O$/ha (control) $K_1$: 10 kg $K_2O$/ha

$K_2$: 20 kg $K_2O$/ha $K_3$: 30 kg $K_2O$/ha

**Appendix IV. Effect of different varieties and levels of potassium on number of leaves per plant of mungbean**

| Treatment | Number of leaves per plant at | | | | |
|---|---|---|---|---|---|
| | 25 DAS | 35 DAS | 45 DAS | 55 DAS | Harvest |
| **Varieties** | | | | | |
| $V_1$ | 5.13 b | 8.70 b | 12.59 b | 14.18 b | 14.63 b |
| $V_2$ | 5.65 a | 9.18 a | 13.04 a | 14.83 a | 15.42 a |
| $LSD_{(0.05)}$ | 0.166 | 0.296 | 0.394 | 0.642 | 0.540 |
| Level of significance | 0.01 | 0.01 | 0.05 | 0.05 | 0.01 |
| **Levels of potassium** | | | | | |
| $K_0$ | 4.53 c | 7.70 c | 11.38 c | 12.67 c | 13.18 c |
| $K_1$ | 5.40 b | 8.95 b | 12.80 b | 14.28 b | 14.85 b |
| $K_2$ | 6.02 a | 9.73 a | 13.73 a | 15.90 a | 16.20 a |
| $K_3$ | 5.60 b | 9.37 ab | 13.35 ab | 15.17 ab | 15.85 a |
| $LSD_{(0.05)}$ | 0.235 | 0.418 | 0.557 | 0.907 | 0.763 |
| Level of significance | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| CV(%) | 5.96 | 4.72 | 6.50 | 5.05 | 5.85 |

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

$V_1$: BARI Mung-2 $V_2$: BARI Mung-6

$K_0$: 0 kg $K_2O$/ha (control) $K_1$: 10 kg $K_2O$/ha

$K_2$: 20 kg $K_2O$/ha $K_3$: 30 kg $K_2O$/ha

**Appendix V. Effect of different varieties and levels of potassium on number of seeds per pod and weigh of 1000 seeds of mungbean**

| Treatment | Number of seeds per pod | Weight of 1000 seeds (g) |
|---|---|---|
| $V_1$ | 9.77 b | 38.08 b |
| $V_2$ | 10.07 a | 44.94 a |
| $LSD_{(0.05)}$ | 0.220 | 1.461 |
| Level of significance | 0.01 | |
| $K_0$ | 9.35 c | 37.98 c |
| $K_1$ | 9.87 b | 40.09 b |
| $K_2$ | 10.30 a | 44.30 a |
| $K_3$ | 10.17 ab | 43.67 a |
| $LSD_{(0.05)}$ | 0.311 | 2.067 |
| Level of significance | 0.01 | 0.01 |
| $V_1K_0$ | 8.90 c | 32.03 e |
| $V_1K_1$ | 9.80 b | 37.07 d |
| $V_1K_2$ | 10.27 ab | 41.58 c |
| $V_1K_3$ | 10.13 ab | 41.63 c |
| $V_2K_0$ | 9.80 b | 43.93 bc |
| $V_2K_1$ | 9.93 ab | 43.11 bc |
| $V_2K_2$ | 10.33 a | 47.02 a |
| $V_2K_3$ | 10.20 ab | 45.70 ab |
| $LSD_{(0.05)}$ | 0.440 | 2.922 |
| Level of significance | 0.05 | 0.01 |
| CV(%) | 6.52 | 4.02 |

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

$V_1$: BARI Mung-2 $V_2$: BARI Mung-6

$K_0$: 0 kg $K_2O$/ha (control) $K_1$: 10 kg $K_2O$/ha

$K_2$: 20 kg $K_2O$/ha $K_3$: 30 kg $K_2O$/ha

**Appendix VI. Analysis of variance of the data on plant height of mungbean as influenced by varieties and levels of potassium management**

| Source of variation | Degrees of freedom | Mean square | | | | |
|---|---|---|---|---|---|---|
| | | Plant height (cm) at | | | | |
| | | 25 DAS | 35 DAS | 45 DAS | 55 DAS | Harvest |
| Replication | 2 | 0.111 | 1.339 | 4.846 | 0.249 | 0.372 |
| Factor A (Variety) | 1 | 17.630** | 32.072* | 89.305** | 102.121** | 73.547** |
| Factor B (Level of potassium) | 3 | 18.171** | 33.283** | 96.788** | 79.761** | 52.833** |
| Interaction (A×B) | 3 | 3.476* | 23.659* | 35.456* | 19.480* | 17.649* |
| Error | 14 | 0.983 | 6.703 | 8.718 | 4.974 | 5.201 |

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

**Appendix IV. Analysis of variance of the data on number of branches per plant of mungbean as influenced by varieties and levels of potassium**

| Source of variation | Degrees of freedom | Mean square | | | | |
|---|---|---|---|---|---|---|
| | | Number of branches $plant^{-1}$ | | | | |
| | | 25 DAS | 35 DAS | 45 DAS | 55 DAS | Harvest |
| Replication | 2 | 0.002 | 0.087 | 0.462 | 0.303 | 0.432 |
| Factor A (Variety) | 1 | 1.707** | 3.375** | 4.335* | 17.340** | 18.027** |
| Factor B (Level of potassium) | 3 | 1.238** | 5.508** | 15.446** | 29.044** | 36.153** |
| Interaction (A×B) | 3 | 0.120* | 0.644* | 3.202* | 4.420* | 18.200** |
| Error | 14 | 0.026 | 0.224 | 0.894 | 1.104 | 1.700 |

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

**Appendix V. Analysis of variance of the data on number of leaves per plant of mungbean plant as influenced by varieties and levels of potassium**

| Source of variation | Degrees of freedom | Mean square | | | | |
|---|---|---|---|---|---|---|
| | | Number of leaves plant$^{-1}$ at | | | | |
| | | 25 DAS | 35 DAS | 45 DAS | 55 DAS | Harvest |
| Replication | 2 | 0.105 | 0.047 | 0.102 | 1.607 | 0.002 |
| Factor A (Variety) | 1 | 6.615** | 5.226** | 4.860** | 10.402* | 15.042** |
| Factor B (Level of potassium) | 3 | 9.366** | 19.008** | 25.436** | 46.499** | 43.868** |
| Interaction (A×B) | 3 | 0.953** | 1.285* | 7.237* | 5.539* | 3.695* |
| Error | 14 | 0.143 | 0.712 | 0.806 | 2.148 | 1.522 |

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

**Appendix VI. Analysis of variance of the data on yield contributing characters and yield of mungbean as influenced by varieties and levels of potassium**

| Source of variation | Degrees of freedom | Mean square | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Days to 1st flowering | Days to 80% pod maturity | Number of Pods per plant | Number of seeds per pods | Pod length (cm) | Weight of 1000 seeds (g) | Seed yield (t/ha) | Stover yield (t/ha) |
| Replication | 2 | 2.042 | 0.375 | 9.102 | 0.025 | 0.013 | 0.391 | 0.004 | 0.009 |
| Factor A (Variety) | 1 | 32.667** | 28.167* | 174.960** | 0.511** | 1.979** | 5.185** | 0.309** | 1.233** |
| Factor B (Level of potassium) | 3 | 15.611** | 41.667** | 342.278** | 1.066** | 1.242** | 13.451** | 0.371** | 0.993** |
| Interaction (A×B) | 3 | 29.444** | 30.278** | 37.773* | 0.248* | 0.505** | 4.479** | 0.011* | 0.380** |
| Error | 14 | 2.708 | 6.089 | 13.317 | 0.063 | 0.047 | 0.696 | 0.005 | 0.027 |

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

**Appendix VII. Analysis of variance of the data on nutrient content in mungbean seeds as influenced by varieties and levels of potassium**

| Source of variation | Degrees of freedom | Mean square | | | |
|---|---|---|---|---|---|
| | | Nitrogen (%) | Phosphorus (%) | Potassium (%) | Sulphur (%) |
| Replication | 2 | 0.002 | 0.0001 | 0.001 | 0.0001 |
| Factor A (Variety) | 1 | 0.093** | 0.003** | 0.330** | 0.001* |
| Factor B (Level of potassium) | 3 | 0.167** | 0.004** | 0.115** | 0.001** |
| Interaction (A×B) | 3 | 0.022* | 0.0001* | 0.014** | 0.001** |
| Error | 14 | 0.006 | 0.0001 | 0.003 | 0.0001 |

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance