EFFECT OF DIFFERENT LEVELS OF POTASSIUM ON NODULATION, YIELD AND NUTRIENT CONTENT OF MUNGBEAN (BARIMung-6)

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CERTIFICATE

This is to certify that the thesis entitled, "EFFECT OF DIFFERENT LEVELS OF POTASSIUM ON NODULATION, YIELD AND NUTIENT CONTENT OF MUNGBEAN (BARIMung-6)" 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 SOIL SCIENCE, embodies the result of a piece of bonafide research work carried out by SYEDA ISRAT JAHAN, Registration No. 16-07535 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

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DEDICATED

TO

MY BELOVED

PARENTS

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ABSTRACT

An experiment was conducted at the research field of the department of Soil Science of Sher-e-Bangla Agricultural University, Dhaka, during the period from April, 2017 to September, 2017 to study the effect of Potassium on nodulation, yield and nutrient content of mungbean (BARIMung-6). There were 7 treatments formulated with different potassium levels (0, 20 kg K ha^{-1}, 30 kg K ha^{-1}, 40 kg K ha^{-1}, 50 kg K ha^{-1}, 60 kg K ha^{-1}, 70 kg K ha^{-1}) which were arranged in RCB design having 3 replicators. Blanket dose of other nutrients was $N_{15}P_{20}S_{10}Zn_2B_{1.5}$. The unit plot size was 3m×2m. Highest number of branches (3.66) was recorded under T_5 (50 kg/ha) treatment and the lowest number of branches (2.66) at T_1 (control). The highest plant height (49.83 cm), the highest number of pod $plant^{-1}$ (12.33), highest pod length (9.27 cm), highest number of nodule per plant (11.00), highest number of seed per pod (11.67), the highest thousand grain weight (50.83 g), highest seed yield (1.60 t ha^{-1}), highest stover yield (1.97 t/ha), highest biological yield (3.57 t ha^{-1}) was recorded under T_6 treatment. The lowest plant height (42 cm), the lowest number of pod $plant^{-1}$ (9.33), lowest pod length (8.50 cm), lowest number of nodule per plant (5.00), lowest number of seed per pod (11.33), the lowest thousand grain weight (48 g), lowest seed yield (0.89 t ha^{-1}), lowest stover yield (1.42 t/ha), lowest biological yield (2.31 t ha^{-1}) was recorded under T_1 treatment. Highest harvest index (60.40%) was recorded under T_5 treatment. The effect of potassium on soil pH, organic matter and total nitrogen % was non-significant. The highest available phosphorus (22.05 ppm) was recorded from T_7 while the lowest available phosphorus (12.47 ppm) was recorded from T_1 treatment. The highest exchangeable potassium (0.22) was recorded in T_6 treatment while the lowest exchangeable potassium (0.18) was recorded in T_1 treatment. Highest nitrogen content in mungbean seed (3.58%) was recorded under T_5 treatment which was statistically similar with T_6 treatment and lowest nitrogen content in mungbean seed was recorded under T_1. Highest potassium content (1.52) by seed was recorded under T_6 (60 kg/ha) treatment and lowest potassium content (0.81%) by plants was recorded under T_1 treatment. Nitrogen and Phosphorus content by stover of mungbean plant were non-significant. Highest potassium content (1.70) in mungbean stover was recorded under T_6 and lowest potassium content (1.08) by plants was recorded under T_1 treatment.

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CHAPTER I

INTRODUCTION

Mungbean (*Vigna radiata*) is an important and short duration pulse crop of Bangladesh. It belongs to the family Fabaceae. It is native to the Indian subcontinent and mainly cultivated in India, China, Thailand, Philippines, Indonesia, Myanmar, Bangladesh, Laos and Cambodia but also in hot and dry regions of Europe and the United States. It has high nutritive value and it is important for soil fertility by fixing the atmospheric nitrogen (Ather Nadeem *et al.,* 2004). Its seed is more palatable, nutritive, digestible and non-flatulent than other pulses (Anjum *et al.*, 2006).

Pulse is a popular crop in the daily diet of the people of Bangladesh. Pulses have been considered as "poor men's meat" since pulses contains more protein than meat and also more economical, they are the best source of protein for the underprivileged people. According to the nutritionists, pulses are an excellent source of dietary proteins and can play an important role in fulfilling the requirements of rapidly increasing population. Mungbean is an important pulse crop that can be grown twice a year. It ranks second to chickpea (*Cicer arietinum*) amongst grain legumes from production point of view. Besides being a rich source of protein, it maintains soil fertility through biological nitrogen fixation in soil and thus plays a vital role in sustainable agriculture (Kannaiyan, 1999).

In Bangladesh, daily consumption of pulses is only 14.30 g capita^{-1} (BBS, 2010), while The World Health Organization (WHO) suggested 45 g capita^{-1} day^{-1} for a balanced diet. It contains 1-3% fat, 50.4% carbohydrates, 3.5-4.5% fibers and 4.5-5.5% ash, while calcium and phosphorus are 132 and 367 mg per 100 grams of seed, respectively (Frauque *et al.,* 2000).

The major cropping pattern in Bangladesh consists of two major crops of rice (i.e. boro rice-fellow-aman rice). In Bangladesh, more than 75% of the total cropping area is occupied by rice where pulse crop covers only 2.8% of the total cropping area (BBS, 2005). Among the pulse crops the largest area is covered by lentil (40.17%) and mungbean is grown in only 6.34% area (BBS, 2005). Life cycle of mungbean is short; it is also drought tolerant and can grow with a minimum supply of nutrients. In Bangladesh, mungbean grows well all over the country. Among the pulses, it ranks third in area and production but first in market price.

The total production of mungbean in Bangladesh in 2011-12 was 19,972 metric tons from an area of 20,117 hectares with average yield is about 0.98 tons ha^{-1} (BBS, 2012). In Bangladesh it can be grown in late winter and summer season. Summer mungbean can tolerate high temperature exceeding 40^0C and grown well in the temperature range of $30\text{-}35^0$C (Singh and Yadav, 1978). This crop is reported to be drought tolerant and can also be cultivated in areas of low rainfall, but also grows well in the areas with 750-900 mm rainfall (Kay, 1979). Various research works on mungbean have done so far. Bangladesh Agricultural Research Institute (BARI), Bangladesh Institute of Nuclear Agriculture (BINA), Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) developed 17 mungbean varieties with high yield potentials. Very recently, with the introduction of some high yielding varieties like BARIMung-6 , BARIMung-5 increasing attention is being paid to the cultivation of this crop in order to mitigate the alarmingly protein shortage in the diet of our people.

Mungbean is highly responsive to fertilizers and manures. It has a marked response to nitrogen, phosphorus and potassium. These nutrients play a key role in plant physiological process. A balanced supply of essential nutrients is indispensable for optimum plant growth. Potassium plays a remarkable role in plant physiological processes. Potassium is the third macronutrient required for plant growth, after nitrogen and phosphorus and also plays a vital role as macronutrient in plant growth and sustainable crop production. Potassium (K), as a plant nutrient is becoming increasingly important in Bangladesh and a good crop response to K is being reported from many parts of the country. 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). The supply of potassium to leguminous crops is necessary especially at the flowering and pod setting stages (Zahran *et al.,* 1998). Potassium application under drought conditions moderates the adverse effects of water shortage on plant growth (Sangakkara *et al.,* 2001; Singh and Kumar, 2009). Its adequate supply during growth period improves the water relations of plant and photosynthesis (Garg *et al.,* 2005), maintains turgor pressure of cell which is necessary for cell expansion, helps in osmotic-regulation of plant cell, assists in opening and closing of stomata (Yang *et al.,* 2004), activates more than 60 enzymes (Bukhsh *et al.,* 2011), synthesizes the protein, creates resistance against the pest attack and diseases (Arif *et al.,* 2008) and enhances the mungbean yield (Ali *et al.,* 2010).

As mungbean is an important crop so many research works have done on this crop. But little works have done on potassium application and its effect on it. The present study was undertaken with the following objectives.

1. To observe the effects of potassium on nodulation of mungbean.
2. To evaluate the effect of potassium on the yield of mungbean.
3. To determine effects of potassium on nutrient content of mungbean.

CHAPTER II

REVIEW OF LITERATURE

Abbas *et al.* (2011) investigated the effects of potassium (K) on growth and yield of mungbean under arid climate. Adequate regulation of mineral nutrients plays a significant role in improving plant growth and development. Keeping in view the role of plant nutrition, field experiments were conducted at Adaptive Research Farm and two different locations at farmer's fields to investigate the effects of potassium (K) on growth and yield of mungbean under arid climate. Five treatments including T_1 = Control; T_2 = K @ 25 kg K_2SO_4 $ha^{-1;}$ T_3 = K @ 50 kg K_2SO_4 ha^{-1} ; T_4 = K @ 75 kg K_2SO_4 ha^{-1}; T_5 = K @ 100 kg K_2SO_4 ha^{-1} were arranged in randomized complete block design with three replications. AZRI- 2006, a promising variety of mungbean for arid climate, was used as a test variety. Results showed significant impacts of applied K on plant height, number of grain pod-1 and grain yield as compared to control. Among different treatments, T_4 (K_2SO_4 @ 75 kg ha^{-1}) caused more prominent increase in yield and yield contributing parameters. It was concluded that K helped to improve the growth and yield of mungbean which played an important role in maintaining soil fertility

Mazed *et al.* (2015) studied the growth and yield of Mungbean as influenced by potassium (K) and sulphur (S). Four levels of K (0, 15, 25 and 35 kg ha^{-1}) and three levels of S (0, 3 and 6 kg ha^{-1}) were used in the study. The results revealed that grain and stover yield of mungbean increased with increasing levels of K and S. The maximum significant grain and stover yield were obtained with the treatment combinations K_2S_2 (25 kg K ha^{-1} + 6 kg S ha^{-1}) and the same treatments combinations gave the highest plant height, number of branch $plant^{-1}$, yield attributes like number of pods $plant^{-1}$, number of grains pod^{-1} , weight of 1000 seeds.

Buriro *et al* (2015) investigated growth and yield response of two mungbean (Mung-06 and NM-92) varieties to different application rates of potassium was evaluated under field condition. The data obtained from the study indicated that there was significant effect of potassium levels on growth, yield and yield components of both varieties. Compared to Mung-06, the variety NM-92 performed well by displaying maximum seed germination, taller plants with more branches, pods, seeds and biological yield. In addition to the recommended rates of nitrogen and phosphorus, the K applied @ 125 kg ha^{-1} significantly increased seed germination, plant height, number of branches per plant, number of pods, seed index and biological yield (kg ha^{-1}) as well. It is, therefore, concluded that 125 kg K ha^{-1} can be the effective rate for achieving economically higher mungbean yield.

Sirazul *et al.* (2004) analyzed the effect of potassium on productivity and water relations in bushbean (*Phaseolus vulgaris L.*) under water stress conditions. Water stress led to a considerable decrease in the leaf area, shoot dry weight, and grain yield, and or increase in the root dry weight. Dry matter accumulation in different plant organs except for the root dry weight was more impaired by severe water stress than that by mild water stress. Plants that received a higher level of potassium exhibited a higher relative water content and transpiration rate, and lower diffusion resistance than the plants that received a lower level of potassium. The beneficial effect of fertilizer potassium on dry matter production and distribution in bushbean plants was probably associated with the maintenance of better water relations in the plants due to potassium application.

Biswash *et al.* (2014) studied the effect of potassium fertilizer and vermicompost on growth, yield and nutrient contents of mungbean (BARI Mung 5). Potassium and vermicompost doses as well as their interactions showed significant effect on growth and yield parameters. The two-factorial experiment was conducted by using RCBD (Randomized Completely Block Design) with three replications. During the experiment, following treatments were included: K_0 -Control, K_1-K_2O @ 10 kg ha-1, K_2- K_2O @15 kg ha^{-1}, K_3 - K_2O @ 20 kg ha-1 and V_0- No Vermicompost, V_1- Vermicompost @ 4 t ha^{-1}, V_2- Vermicompost @ 6 t ha^{-1}, V_3 – Vermicompost @ 8 t ha-1. Potassium and vermicompost doses as well as their interactions showed significant effect on growth and yield parameters. At harvest highest plant height, number of leaves and branches $plant^{-1}$, average dry weight $plant^{-1}$, number of pods $plant^{-1}$, number of seeds pod^{-1}, number of seeds $plant^{-1}$, 1000-seed weight, seed yield and stover yield were recorded in K_3 (K_2O @ 20 kg ha^{-1}) and it was either closely followed by or statistically similar with the application of K_2O @15 kg ha^{-1} (K_2) and subsequently followed by K_1 (K_2O @ 10 kg ha^{-1}). N, P and K content in seed were recorded in K_3 (K_2O @ 20 kg ha^{-1}) and it was followed by the application of K_2O @15 kg ha^{-1} (K_2) and then K_1 (K_2O @ 10 kg ha-1). Lowest results for above parameters were found from the treatment using no potassium fertilizer (K0). Similarly, the highest values for highest plant height, number of leaves and branches $plant^{-1}$, average dry weight plant^{-1} , number of pods plant^{-1}, number of seeds pod^{-1}, number of seeds plant^{-1}, 1000-seed weight, seed yield and stover yield were recorded in V_3 (vermicompost @ 8 t ha^{-1}) which was either closely followed by or statistically similar with Vermicompost @ 6 t ha^{-1} and then followed by Vermicompost @ 4 t ha^{-1}. Lowest results were found from the treatment using no vermicompost (V_0).

Fooladivanda *et al.* (2014) conducted to evaluate the impact of water stress and levels of potassium on yield and yield components of two varieties of mung bean (*Vigna radiata*) (promising lines VC6172 and Indian. Results showed that water stress and potassium fertilizer significantly affect all traits. The highest grain yield (2093 kg ha^{-1}) was obtained from no stress treatment in the case of 80 kg ha^{-1} potassium. Total dry matter, number of pods and grain yield, were significantly different between the two varieties. The interaction between fertilizer and variety, on dry matter and grain yield and the interaction between irrigation and variety, on dry matter were significant. We conclude that use of potassium fertilizer can reduce the adverse effects of water stress.

Hussain *et al.* (2011) carried out an experiment was to find out the best level of potash fertilizer on growth and yield response of two mungbean (*Vigna radiata L.)* cultivars (Niab Mung-92 and Chakwal Mung-06) to different levels of potassium. Different potassium levels significantly affected the seed yield and yield contributing parameters except number of plants per plot. Maximum seed yield (753 Kg ha^{-1}) was obtained with the application of 90 Kg potash per hectare. Genotype M-06 produced higher seed yield than that of NM92. The interactive effect of Mungbean varieties and Potassium level was found significant in parameter of protein contents (%). Maximum protein contents were observed in case of Mung-06 with application of 90 Kg potash per hectare. It is concluded that the application of Potash fertilizer gave higher yield of mungbean cultivars under agro-climatic conditions of Faisalabad.

Ahmed *et al.* (2018) studied the influence of different levels of phosphorous and zinc on yield and yield attributes of mungbean (BARI Mug 6). Four phosphorus (P) levels (0, 15, 20 and 25 kg P ha^{-1}) and three zinc (Zn) levels (0, 1.5 and 4kg Zn ha^{-1}) were used in the study. The results of the study shown that stover and seed yield of mung bean improved with increasing phosphorus and zinc levels up to positive level. For instance, of Phosphorous the significant maximum stover yield (2.59 t ha^{-1}) and seed yield (1.53 t ha^{-1}) were obtained with the treatment P_3 (25kg P ha^{-1})

and the significant minimum stover yield (2.08 t ha^{-1}) and minimum seed yield (1.43 t ha^{-1}) were obtained with the treatment P_0 (0kg P ha^{-1}). In case of Zn the significant maximum stover yield (2.77 t ha^{-1}) and maximum seed yield (1.77 t ha^{-1}) were obtained with the treatment Zn_2 (4 kg Zn ha^{-1}) and the significant minimum stover yield (2.19 t ha^{-1}) and minimum seed yield (1.38 t ha^{-1}) were achieved with the treatment Zn_0 (0 kg Zn ha^{-1}). The significant maximum number of branch $plant^{-1}$ (3.32), taller plant (53.45cm), seed yield (1.94 t ha^{-1}), yield supporting factors as number of pods $plant^{-1}$ (20.89), 1000 seeds weight (45.66 g) and number of seeds pod^{-1} (12.98) were achieved with the treatment combination P_2Zn_2 (20 kg P ha^{-1} + 4 kg Zn ha^{-1}).

Habibullah *et al.* (2014) evaluated the performance of phosphorus level on growth, yield and quality of BARIMung-6. Randomized completely block designed (RCBD) was laid out to determine this experiment with three replications. Phosphorus fertilizer was applied at four 7 treatments like as P_0, control; P_1,15 kg ha^{-1} ; P_2, 20 kg ha^{-1} ; P_3, 25 kg ha^{-1} respectively. Highest plant height (cm), no. of branches per plant, no. of pods per plant, pod length (cm), no. of grain per pod, weight of 1000 grain (gm), grain yield (t ha^{-1}) and Stover yield (t ha^{-1}) were counted in 20 kg ha^{-1} level of phosphorus, where as minimum was showed in control application of phosphorus fertilizer. Significant variation on concentration of N, P, K and S was found at 20 kg ha^{-1} application of phosphorus, where as minimum was observed with control treatment in both stover and grain yield.

Kurhade *et al.* (2015) conducted a field experiment to study the effect of potassium on yield, quality, available nutrient status and its uptake of blackgram and showed that yield quality, nutrient status and its uptake of blackgram were significantly increased due to increased level of potassium fertilizer.

Ganga *et al.* (2014) conducted a field experiment to study the effect of potassium levels and foliar application of nutrients on growth and yield of late sown chickpea and observed that application of 60 kg K_2O ha^{-1} at sowing and combined foliar spraying of 2% urea and 0.25% multiplex at pre-flowering stage of chickpea resulted in maximum grain yield and ancillary characters.

Thesiya *et al.* (2013) conducted an experiment during the kharif season to study the effect of potassium and sulphur on growth and yield of black gram (*Vigna mungo L.* Hepper) under rainfed condition. There was a significant effect of potash and sulphur levels on plant height, number of branches per plant, number of pods per plant, length of pod, 100-grain weight, straw yield and grain yield. Significantly the highest grain yield (9.17 q ha^{-1}) and straw (18.28 q ha^{-1}) yield was recorded under 20 kg K_2O ha^{-1} , which was at par with 40 kg K_2O ha^{-1} in case of grain yield.

Chanda *et al.* (2003) reported that the potassium application had significant effect on plant height, yield attributes and grain yield of mungbean.

Ali *et al.* (1996) studied the effect of different potassium levels (0, 25, 75,100 and 125 Kg/ha) on yield and quality of mungbean and reported that no. of pods/plant, no. of seeds per pod was influenced significantly by potassium application.

Khokar and Warsi (1987) reported that addition of potash from 20 to 60 kg K_2O ha^{-1} raised the grain production.

Akombo *et al.* (2013) carried out to determine the ideal combination of the two elements with a view in enhancing the productivity. Four combinations of phosphorus and potassium (0kg P_2O_5/ha+0kgK_2O/ha (control), 15kg P_2O_5/ha +30kg K_2O/ha, 20kg P_2O_5/ha + 40kgK_2O/ha and 25kg P_2O_5/ha + 50kg K_2O/ha) were used as treatments. These were replicated three times in a Randomized Complete Block Design using a spacing of 25cm x 30cm. Results indicated that fertilized plots performed better than non fertilized (control) plots. In the year 2010, significant difference was recorded on plant height at 6 and 10 weeks after planting (WAP) and number of leaves at 10WAP. Year 2011 recorded significant differences on plant height (10WAP), number of leaves (6 and 10 WAP), seed weight before and after shell removal. Increasing levels of fertilizer combination translated to increased performance of bambaranut. Hence, the combination 25kg P_2O_5/ha + 50kg K_2O/ha was recommended.

Zahan *et al.* (2009) studied the effects of potassium levels on the growth, yield and yield contributing characters of lentil. The experiment comprised of three varieties viz. BARImasur-4, BARImasur-5 and BARImasur-6 and five potassium levels viz. 0, 15, 25, 35 and 45 Kg K ha^{-1}. The results revealed that among the three varieties, BARImasur-6 produced the highest seed yield (2.24 t ha^{-1}) and BARImasur-4 produced the lowest seed yield (1.79 t ha^{-1}). Grain and stover yield of all varieties were increased with the increase of potassium application up to 35 kg

ha^{-1}. The highest grain yield (2.16 t ha^{-1}) was found at 35 kg K ha^{-1} and the lowest grain yield (1.61 t ha^{-1}) was exhibited from control potassium level and the highest stover yield (3.89 t ha^{-1}) was also found in 35 kg K ha^{-1} and the lowest (3.32 t ha^{-1}) was found in control potassium level. In case of interaction, the highest seed yield (2.58 t ha^{-1}) was produced by BARImasur-6 with 35 kg K ha^{-1}. Therefore, fertilization of all the varieties with 35 kg K ha^{-1} appeared as the best rate of potassium in respect of grain and stover yield. It can be suggested that farmers may be used BARImasur-6 with 35 kg K ha^{-1} for better grain and stover production of lentil.

Ali *et al.* (2007) carried out an experiment to study the effect of varying levels of potash (0, 25, 50, 75, 100, 125 and 150 kg K_2O ha^{-1}) on growth and yield of chickpea (*Cicer arietinum L.)* cultivar CM-2000 at the Agronomic Research Area, University of Agriculture, Faisalabad, during the winter season 2003-2004. The growth and yield components were significantly increased by different potash levels. However, the differences between control and 25 kg K_2O ha^{-1} were non-significant for the number of pods per plant and 1000-seed weight. The application of 25 kg K_2O ha^{-1} could not increase the seed and biological yield significantly thereafter, seed yield increased gradually with the increase in potash levels and the maximum seed yield (2341 kg ha^{-1}) was obtained with 150 kg K_2O ha^{-1}. The seed protein contents also increased gradually with an increase in potash level and maximum protein contents (23.87%) were recorded with application of 150 kg K_2O ha^{-1}. The highest potash level resulted in maximum net benefit as well.

Chaudhari *et al.* (2018) experiment was conducted in kharif season 2016-17 at experimental farm of Department of Soil Science and Agril. Chemistry, College of Agriculture, Badnapur using black gram as a test crop to study the effect of graded levels of potassium on growth, yield and quality of black gram. The experiment was laid out on Vertisols with six treatment combination, replicated four times in randomized block design. The treatment consists of T_1 Absolute control (No fertilizer application), T_2 RDF (25:50:00 N, P_2O_5 and K_2O ha-1 kg ha^{-1}), T_3 (RDF + 15 kg K_2O ha^{-1}), T4 (RDF + 30 kg K_2O ha^{-1}), T5 (RDF + 45 kg K_2O ha^{-1}), T6 (RDF + 60 kg K_2O ha^{-1}). The results emerged out clearly indicated that various growth parameters like plant height, germination percentage, number of pods, dry matter and seed yield was increased due to application of potassium. It was inferred from the results that application of 25 kg N, 50 kg $P_2O_5$and 30 kg K_2O per hectare found superior over only N and P application i.e. RDF (25:50:00

N, P_2O_5 and K_2O kg ha^{-1}). The K application showed synergistic effects on other nutrients (N, P, K) uptake. Soil fertility was also found to be improved due to application of potassium to black gram.

Johnson and Wallingford (1983) also reported the beneficial effect of fertilizer potassium on the grain yield of corn and soybean under stressful conditions.

Malik *et al.* (1988) observed the significant effect on number of grains pod^{-1} against T_1 (control). Number of grains pod-1 was recorded maximum i.e. 8.06, 9.47, and 5.00 in T_4 (K_2SO_4 @ 75 kg ha^{-1}) at all the three locations i.e. A.R. Farm, farmer's field 1 and farmer's fields 2, respectively.

Samiullah and Khan (2003) founded that seed yield of chickpea significantly affected by potassium levels up to the 80 kg/ha. Minimum seed yield (700 kg/ha) was observed in plot where no potash fertilizer was applied even though that was not significantly different with 20 (kg/ha). The highest seed yield (1096 kg/ha) in case of 120 kg K_2O per hectare can be attributed to more number of pod per plant and number of seed per pod.

Jahan *et al* (2009) founded the highest pod length (9.51 cm), 1000- seed weight (43.87 g) and grain yield (1.597 t ha^{-1}) were obtained from 25 kg K ha^{-1} whereas, the lowest pod length (6.60 cm), 1000-seed weight (39.89 g) and grain yield (1.113 t ha^{-1}) were observed from control treatment. Different doses of K caused significant variation on the stover yield of mungbean. The highest stover yield of mungbean (2.475 t ha^{-1}) was recorded from K_3 (35 kg K ha^{-1}) which was statistically similar from K_3 treatment. The lowest stover yield (2.067 t ha^{-1}) was recorded from control treatment.

Fatima *et al*. (2001) also reported that the application of potassium fertilizer improves length of stem, branches, pods, seed weight and seed yield. Results for height of mungbean plants as affected by K levels revealed a statistically significant difference among varieties. The maximum plant height (44.4 cm) was recorded in variety NM-92, while minimum plant height (41.4 cm). The effect of K levels showed that the mungbean plants receiving higher K levels of 125 or 100 kg ha^{-1} grew taller i.e. 45.5 and 44.8 cm, respectively as compared to lower K levels. This increase in plant height under higher K levels was mainly associated with adequacy of nutrients in soil after K application.

Chanda *et al.* (2002) also investigated that the 120 kg K ha^{-1} application increases grain yield and harvested 1.52 t ha^{-1} of mungbean seed with the application of 80 kg K ha^{-1}. The highest seed yield (1801.50 kg ha^{-1}) was produced by mungbean variety NM-92, while the lowest seed yield (1717.50 kg ha^{-1}) was produced by variety Mung-06. The seed yield was decreased considerably from 1869.90 and 1849.80 kg ha^{-1} to 1794.40 and 1719.80 kg ha^{-1} , when the mungbean crop was fertilized with 75 and 50 kg K ha^{-1} from 125 and 100 kg K ha^{-1}.

Rose *et al.* (2008) reported that for achieving the highest grain yield in canola, getting enough potassium application is important at early flowering stage. Minimum seed yield (650 kg/ha) was observed in plot where no potash fertilizer was applied even though that was not significantly different with 25 (kg/ha). The highest seed yield (1000 kg/ha) in case of 100 kg K_2O per hectare.

Nasri *et al.* (2011) studied the effect of potassium on quantity and quality of bean and found that it has an important role in increasing grain yield through its effect on number of pods and number of grains per pod. The experiment was laid out in Randomized Complete Block Design with factorial arrangements and replicated thrice. Treatments were comprised of five levels of potash fertilizer (0, 30, 60, 90,120 Kg ha^{-1}). Different potassium levels significantly affected the seed yield and yield contributing parameters except number of plants per plot. Maximum seed yield (753 Kg ha^{-1}) was obtained with the application of 90 Kg potash per hectare. The interactive effect of Mungbean varieties and Potassium level was found significant in parameter of protein contents (%). Maximum protein contents were observed in case of Mung-06 with application of 90 Kg potash per hectare. It is concluded that the application of Potash fertilizer gave higher yield of mungbean cultivars under agro-climatic conditions.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at the research plot of the department of Soil Science of Sher-e-Bangla Agricultural University, Dhaka, during the period from April, 2017 to September, 2017 to study influence of Potassium on nodulation and yield of mungbean. Materials used and methodologies followed in the present investigation have been described in this chapter.

3.1 Description of the experimental site

3.1.1 **Site and soil:**

Geographically the experimental field was located at 23^0 77´ latitude and 88^0 33´ E longitudes at an altitude of 8.5 m above the mean sea level. The soil is belonged to the Agro-ecological Zone (AEZ 28), Madhupur Tract. The land topography was medium high and soil texture was clay loam with pH 5.6. The morphological, physical and chemical characteristics of the experimental soil have been presented in Table-1.

Table 1. Salient features of the experimental field

Morphological Features	Characteristics
Location	Sher-e-Bangla Agricultural University Farm, Dhaka
AEZ	AEZ-28, Madhupur Tract
General Soil Type	Deep Red Brown Terrace Soil
Soil Series	Tejgaon
Topography	Fairly leveled
Depth of inundation	Above flood level
Drainage condition	Well drained
Land type	High land

Table 2. Initial physical and chemical properties of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

Characteristics	Value
Particle size analysis	
% Sand	33
%Silt	41
% Clay	26
Textural class	Clay loam
pH	5.6
Organic matter (%)	1.32
Total N (%)	0.05
Available P (ppm)	21.54
Exchangeable K (meq/100 g soil)	0.15
Available sulphur (ppm)	22.0

3.1.2 **Climate and weather:**

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

3.2 **Plant materials:**

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

3.3 **Treatments under investigation:**

There was a single factor in the experiment namely potassium levels as mentioned below:

7 level of Potassium

T_1 = 0

T_2 = 20 kg K ha^{-1}

T_3 = 30 kg K ha^{-1}

T_4= 40 kg K ha^{-1}

T_5= 50 kg K ha^{-1}

T_6= 60 kg K ha^{-1}

T_7= 70 kg K ha^{-1}

Blanket dose= $N_{15}P_{20}S_{10}Zn_2B_{1.5}$ kg/ha

Blanket doses were applied in all the plots. Nitrogen was applied in split doses.

3.4 **Experimental design and layout:**

The experiment was laid out in a two factors randomized complete block design (RCBD) design having three replications. There are 21 unit plots to which the treatment combinations were assigned randomly. The unit plot size was 6 m^2 (3m × 2m). The blocks and unit plots were separated by 100 cm × 50 cm spacing respectively.

3.5 **Land preparation:**

The experimental land was opened with a power tiller on 1st April, 2017. Ploughing and cross ploughing were done with country plough followed by laddering. Land preparation was completed on 2nd April, 2017 and was ready for sowing of seeds.

3.6 **Fertilizers application**:

Urea, Triple Super Phosphate (TSP), Muriate of Potash (MoP), ZnO, Borax and Gypsum were used as a source of nitrogen, phosphorous, potassium, Zn, boron and sulphur, respectively. Potassium was applied in the experiment as per treatment. Half amount of urea was applied during the final land preparation and rest of the urea was applied as top dressing at 25 DAS. MoP was applied during the final land preparation. TSP, ZnO and gypsum were applied during the final land preparation according to BARI recommendation.

3.7 **Sowing of seeds:**

Seeds were sown on the furrow on 2nd April, 2017 and the furrows were covered by soils soon after seeding. Seeds were treated with Bavistin fungicide before sowing to control the seed borne diseases.

3.8 **Intercultural operations:**

3.8.1 **Weed control:**

Weeding was done once in all the unit plots with care so as to maintain a uniform plant population as per treatment in each plot at 10 DAS and 25 DAS.

3.8.2 **Thinning:**

Thinning was done at 20 days after sowing (DAS). Plant to plant distance was maintained at 30 cm.

3.8.3 **Irrigation and drainage:**

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

3.8.4 **Insect and pest control:**

Hairy caterpillar was successfully controlled by the application of Malathion 57 EC @ 1.5 L ha^{-1} on the time of 50% pod formation stage (45 DAS).

3.9 **Determination of maturity:**

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

3.10 **Harvesting and processing:**

The pods were harvested in three times from the plants. Harvesting operation was done when 90% of the pods became dark brown in color. The matured pods were collected by hand picking from the area of 6 m^2 of each plot. The crop was finally harvested on 29th May, 6th June and 13th June, 2017. Before harvesting, ten plants were selected randomly from each plot, data were recorded from the plants and pods were collected from the plants. The harvested crops of each plot was bundled separately. Grain and straw yields were recorded plot wise and the yields were expressed in t ha^{-1}. The rest of the plants were harvested plot wise and were bundled separately, tagged and brought to the threshing floor. The pods and plants were dried under the sun.

3.11 **Threshing:**

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

3.12 **Drying, cleaning and weighing:**

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

3.13 **Recording of characters:**

I. **Plant height (cm):**

The height of the selected plant was measured from the ground level to the tip of the plant at 30, 50, and 70 days after sowing.

II. **Number of branches per plant:**

Number of branches per plant was counted from each selected plant sample and then averaged.

III. **Number of pods per plant:**

Number of pods per plant was counted from the selected plant samples. Pods were collected from 10 selected plants.

IV. **Number of seeds per pod:**

Number of seeds per pod were collected from 10 randomly selected pods from each plant from each plot were counted and averaged.

V. **Pod length (cm):**

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

VI. **1000 seed weight (g):**

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

VII. **Seed yield per 6 m^2 (g):**

Seed yield was recorded on the basis of total harvested seeds per 6 m^2 and was expressed in terms of yield (g). Seed yield was adjusted to 12% moisture content by drying under sun.

VIII. **Seed yield (kg ha^{-1}):**

Seed yield was recorded on the basis of total harvested seeds per 6 m^2 and was expressed in terms of yield (kg ha^{-1}).

IX. **Biological yield (t ha^{-1}):**

The summation of seed yield and above ground stover yield was the biological yield.

Biological yield =Grain yield + Stover yield.

X. **Harvest index (%):**

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

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

Here, Biological yield = Grain yield + stover yield

3.14 **Soil analysis:**

Soil samples were analyzed for both physical and chemical characteristics viz. organic matter, pH, total N and available P and K contents. The soil samples were analyzed by the following standard methods as follows:

3.14.1 **Textural class:**

Mechanical analysis of soil were done by hydrometer method (Bouyoucos, 1926) and the textural class was determined by plotting the values of % sand, % silt and % clay to the Marshall's textural triangular co-ordinate following the USDA system.

3.14.2 **Soil pH:**

Soil pH was measured with the help of a glass electrode pH meter, the soil water ratio being maintained at 1: 2.5 (Jackson, 1962).

3.14.3 **Organic matter:**

Organic carbon in soil sample was determined by wet oxidation method of Walkley and Black (1935). The underlying principle was used to oxidize the organic matter with an excess of 1N $K_2Cr_2O_7$ in presence of conc. H_2SO_4 and conc. H_3PO_4 and to titrate the excess $K_2Cr_2O_7$ solution with 1N $FeSO_4$. To obtain the content of organic matter was calculated by multiplying the percent organic carbon by 1.73 (Van Bemmelen factor) and the results were expressed in percentage (Page *et al.*, 1982).

3.14.4 **Total nitrogen:**

Total N content of soil were determined followed by the Micro Kjeldahl method. One gram of oven dry ground soil sample was taken into micro kjeldahl flask to which 1.1 gm catalyst mixture (K_2SO_4: $CuSO_4$. $5H_2O$: Se in the ratio of 100: 10: 1), and 7 ml H_2SO_4 were added. The flasks were swirled and heated 160^0C and added 2 ml H_2O_2 and then heating at 360^0C was continued until the digest was clear and colorless. After cooling, the content was taken into 50 ml volumetric flask and the volume was made up to the mark with distilled water. A reagent 23 blank was prepared in a similar manner. These digests were used for nitrogen determination (Page *et al.*, 1982). Then 20 ml digest solution was transferred into the distillation flask, Then 10 ml of H_3BO_3 indicator solution was taken into a 250 ml conical flask which is marked to indicate a volume of 50 ml and placed the flask under the condenser outlet of the distillation apparatus so that the delivery end dipped in the acid. Add sufficient amount of 10N-NaOH solutions in the container connecting with distillation apparatus. Water runs through the condenser of distillation apparatus was checked. Operating switch of the distillation apparatus collected the distillate. The conical flask was removed by washing the delivery outlet of the distillation apparatus with distilled water. Finally the distillates were titrated with standard 0.01 N H_2SO_4 until the color changes from green to pink. The amount of N was calculated using the following formula:

$$\% \text{ N} = \frac{(T-B)\times N\times 0.014\times 100}{S}$$

Where,

T = Sample titration (ml) value of standard H_2SO_4

B = Blank titration (ml) value of standard H_2SO_4

N = Strength of H_2SO_4

S = Sample weight in gram

3.14.5 **Available phosphorus:**

Available P was extracted from the soil with 0.5 M $NaHCO_3$ solutions, pH 8.5 (Olsen et al., 1954). Phosphorus in the 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 the standard P curve (Page *et al.*, 1982).

3.14.6 **Available potassium:**

Exchangeable K was determined by 1N NH_4OAc (pH 7) extraction methods and by using flame photometer and calibrated with a standard curve (Page *et al.*, 1982).

3.15 Chemical analysis of plant sample

3.15.1 **Digestion of plant samples with sulphuric acid for N:**

For the determination of nitrogen an amount of 0.5 g oven dry, ground sample were taken in a micro kjeldahl flask. 1.1 g catalyst mixture (K_2SO_4: $CuSO_4$. $5H_2O$: Se in the ratio of 100: 10: 1), and 7 ml conc. H_2SO_4 were added. The flasks were heated at 160^0 C and added 2 ml 30% H_2O_2 then heating was continued at 360^0 C until the digests become clear and colorless. After cooling, the content was taken into a 50 ml volumetric flask and the volume was made up to the mark with de-ionized water. A reagent blank was prepared in a similar manner. Nitrogen in the digest was estimated by distilling the digest with 10 N NaOH followed by titration of the distillate trapped in H_3BO_3 indicator solution with 0.01N H_2SO_4.

3.15.2 **Digestion of plant samples with nitric-perchloric acid for P and K:**

A sub sample weighing 0.5 g was transferred into a dry, clean 100 ml digestion vessel. Ten ml of di-acid (HNO_3: $HClO_4$ in the ratio 2:1) mixture was added to the flask. After leaving for a while, the flasks were heated at a temperature slowly raised to 200^0C. Heating were stopped when the dense white fumes of $HClO_4$ occurred. The content of the flask were boiled until they were became clean and colorless. After cooling, the content was taken into a 50 ml volumetric flask and the volume was made up to the mark with de-ionized water. P, K and S were determined from this digest by using different standard methods.

3.15.3 **Determination of P and K from plant samples**

3.15.3.1 Phosphorus Plant samples (stover) were digested by diacid (Nitric acid and Perchloric acid) mixture and P content in the digest was measured by blue color development (Olsen *et al.*, 1954). Phosphorus in the digest was determined by using 5 ml for stover sample from 50 ml digest 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).

3.15.3.2 Potassium One milli-liter of digest sample for the stover was taken and diluted 20 ml volume to make desired concentration so that the flame photometer reading of samples were measured within the range of standard solutions. The concentrations were measured by using standard curves.

3.16 **Data analysis technique:**

The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique with the help of a computer package program MSTAT-C and the mean differences were adjusted by Least Significance Difference (LSD) test (Gomez and Gomez, 1986).

CHAPTER IV

RESULT AND DISCUSSION

This chapter comprises the presentation and discussion of the results obtained from the experiment. The experiment was conducted to determine the effects of potassium on vegetative growth nodulation, quality and yield of mungbean (BARIMung-6). The growth and yield components such as plant height, number of branch ,leaf number, pod length, and yield of mungbean as influenced by potassium are presented in Table and Figures. The analysis of variance of data in respect of all the parameters has been shown in Appendix 4-6. The results have been presented and discussed with the help of table and graphs. The results of each parameter have been adequately discussed and possible interpretations whenever necessary have been given under the following headlines:

4.1 **Crop growth characters**

4.1.1 **Plant height (cm):**

The effects of potassium on the plant height of mungbean (BARIMung-6) are presented in Fig. 1. The plant height was significantly influenced by different levels potassium. Potassium showed statistically significant variation in respect of plant height when fertilizers in different doses were applied. However among the different doses of fertilizer, T_6 (60 kg/ha) showed the highest plant height (49.83cm). The lowest plant height (42 cm) at T_1 was observed where no potassium was applied. The similar result was recorded by Mazed *et al.*, he found the highest plant height under the potassium doses of 65 kg/ ha.

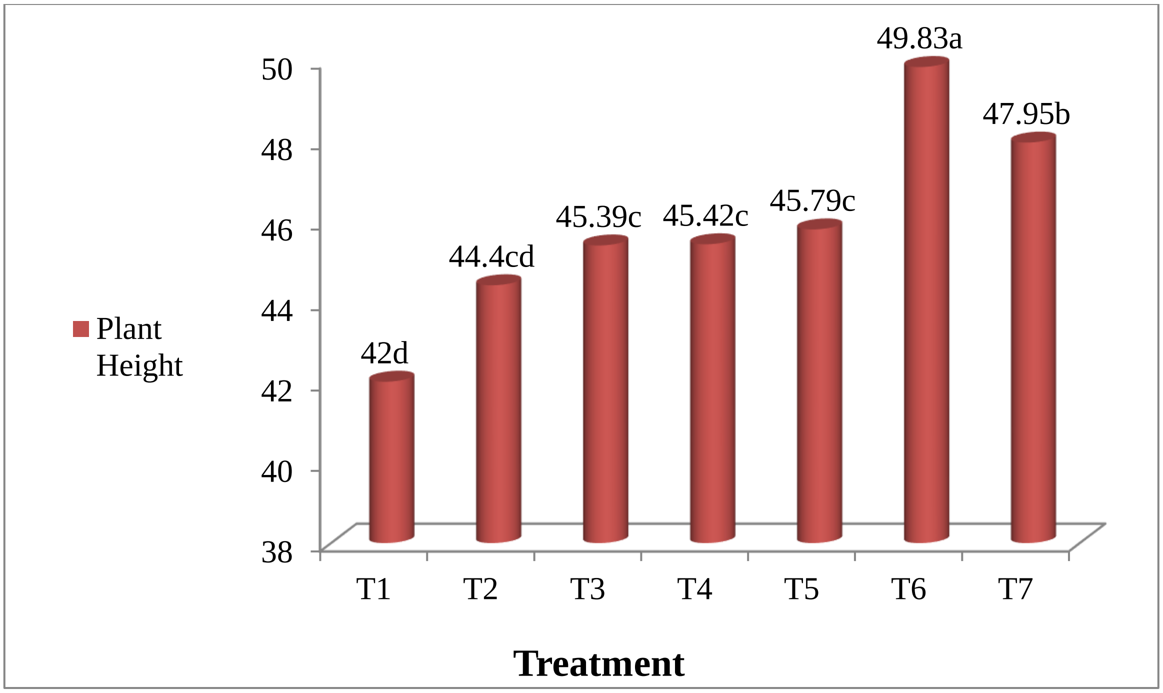

Figure. 1. Effect of different levels of potassium on plant height of mungbean (BARIMung-6)

T_1 = 0 g K ha^{-1}, T_2 = 20 kg K ha^{-1}, T_3 = 30 kg K ha^{-1}, T_4= 40 kg K ha^{-1}, T_5= 50 kg K ha^{-1}, T_6= 60 kg K ha^{-1}, T_7= 70 kg K ha^{-1}

4.1.2 **Number of branch:**

The effect of potassium on the number of branch of mungbean (BARIMung-6) was presented in Fig. 2. The number of branch was significantly influenced by different levels of potassium. Potassium showed statistically significant variation in respect to number of branch when fertilizers in different doses were applied. However among the different doses of fertilizer, T_5 (50 kg/ha) showed the highest number of branches (3.66). The lowest number of branches (2.66) was observed at T_1 (control) which was statistically similar with T_2 (20 kg/ha). The similar result was recorded by Abbas *et al.*, he found the number of branches was increased with increasing potassium up to 60 kg/ ha.

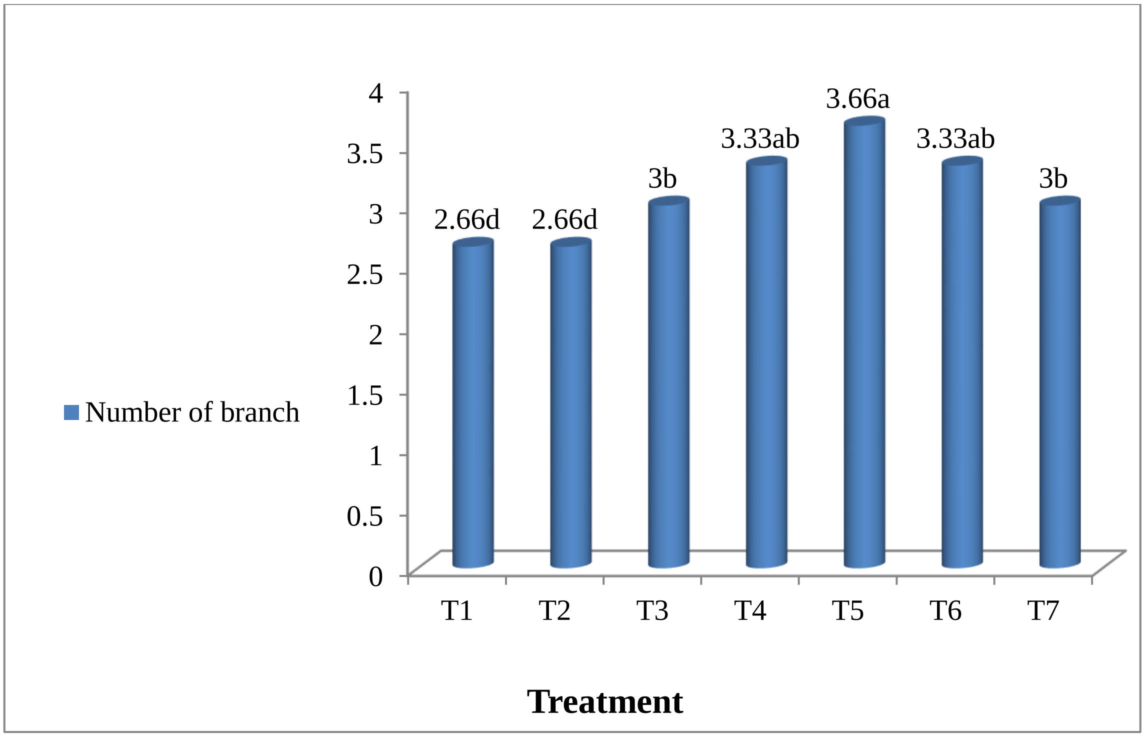

Figure. 2. Effect of different levels of potassium on number of branch of mungbean (BARIMung-6)

T_1 = 0 g K ha^{-1}, T_2 = 20 kg K ha^{-1}, T_3 = 30 kg K ha^{-1}, T_4= 40 kg K ha^{-1}, T_5= 50 kg K ha^{-1}, T_6= 60 kg K ha^{-1}, T_7= 70 kg K ha^{-1}

4.1.3 **Number of pod plant^{-1}:**

Table. 3. Effect of different levels of potassium on number of pods per plant mungbean (BARIMung-6)

Treatment	**Number of Pod/Plant**
T_1	9.33c
T_2	9.67bc
T_3	10.00bc
T_4	10.33b
T_5	10.00bc
T_6	12.33a
T_7	10.00bc
LSD (0.05)	0.75
CV (%)	6.74

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly by LSD at 0.05 level of probability.

(LSD0.05= 0.75)

T_1 = 0 g K ha^{-1}, T_2 = 20 kg K ha^{-1}, T_3 = 30 kg K ha^{-1}, T_4= 40 kg K ha^{-1}, T_5= 50 kg K ha^{-1}, T_6= 60 kg K ha^{-1}, T_7= 70 kg K ha^{-1}

Significant variation was observed in number of pod $plant^{-1}$ of mungbean when different doses of potassium were applied (Table 3). Among the different doses of fertilizers T_6 treatment showed the highest number of pod $plant^{-1}$ (12.33). On the contrary, the lowest number of pod $plant^{-1}$ (9.33) was observed under T_1 (control), where no potassium fertilizer was applied.

4.1.4 **Pod length (cm)**:

Table. 4. Effect of different levels of potassium on pod length of mungbean (BARIMung-6)

Treatment	**Pod Length**
T_1	8.50b
T_2	9.00a
T_3	8.83ab
T_4	8.83ab
T_5	8.90ab
T_6	9.27a
T_7	9.00a
LSD (0.05)	0.44
CV (%)	6.19

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly by LSD at 0.05 level of probability.

(LSD0.05= 0.44)

T_1 = 0 g K ha^{-1}, T_2 = 20 kg K ha^{-1}, T_3 = 30 kg K ha^{-1}, T_4= 40 kg K ha^{-1}, T_5= 50 kg K ha^{-1}, T_6= 60 kg K ha^{-1}, T_7= 70 kg K ha^{-1}

There was significant variation in pod length in mungbean when different doses of potassium fertilizer were applied (Table 4). The highest pod length (9.27 cm) was recorded in T_6 treatment which was statistically similar with treatment T_7, T_2, T_3, T_4 and T_5. The lowest pod length (8.50 cm) was recorded in the T_1 treatment where no potassium fertilizer was applied.

4.1.5 **Number of nodule per plant**

Table. 5. Effect of different levels of potassium on no of nodule per plant of mungbean (BARIMung-6)

Treatment	Number. of nodule/ plant
T_1	6.00c
T_2	5.00d
T_3	6.00c
T_4	11.00a
T_5	9.00b
T_6	11.00a
T_7	9.00b
LSD (0.05)	0.70
CV (%)	0.16

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly by LSD at 0.05 level of probability.

(LSD0.05= 0.70)

T_1 = 0 g K ha^{-1}, T_2 = 20 kg K ha^{-1}, T_3 = 30 kg K ha^{-1}, T_4= 40 kg K ha^{-1}, T_5= 50 kg K ha^{-1}, T_6= 60 kg K ha^{-1}, T_7= 70 kg K ha^{-1}

There was significant variation in the number of nodule per plant in mungbean (BARIMung-6) when different doses of potassium fertilizer applied (Table 5). Among the different fertilizer doses T_6 treatment showed the highest number of nodule per plant (11.00) which was statistically identical with T_4 treatment. The lowest number of nodule per plant was recorded under T_2 treatment (5.00).

4.2 **Yield and yield components**

4. 2. 1 **Number of seeds per pod:**

There was significant variation in the number of seeds per pod in mungbean (BARIMung-6) when different doses of potassium fertilizer were (Fig. 3). Among the different fertilizer doses T_6 treatment showed the highest number of seed per pod (11.67) which was statistically similar with T_2, T_4 and T_5 treatment. The lowest number of seed per pod (10.13) was recorded with T_1 treatment where no potassium was applied which was statistically similar with T_7 treatment. Optimum fertilizer doses might be increased the vegetative growth and development of mungbean (BARIMung-6) that lead to the highest number of seed per pod.

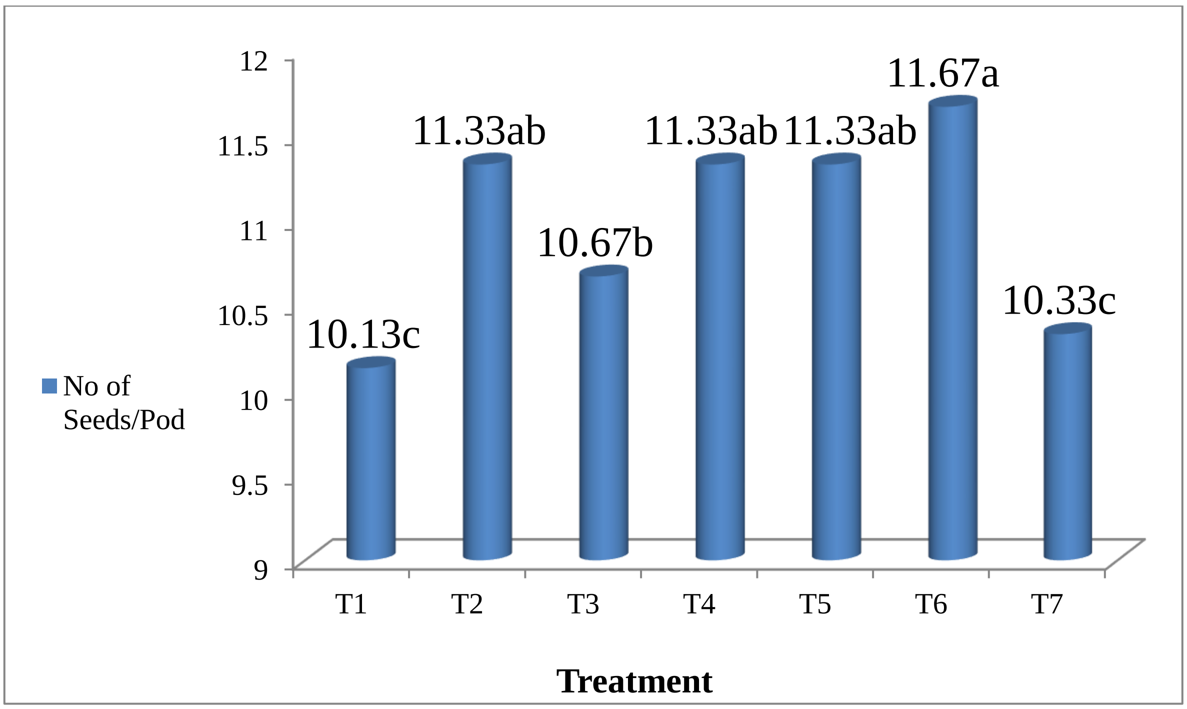

Figure. 3. Effect of different levels of potassium on number of seeds per pod of mungbean (BARIMung-6)

T_1 = 0 g K ha^{-1}, T_2 = 20 kg K ha^{-1}, T_3 = 30 kg K ha^{-1}, T_4= 40 kg K ha^{-1}, T_5= 50 kg K ha^{-1}, T_6= 60 kg K ha^{-1}, T_7= 70 kg K ha^{-1}

4.2.2 **Thousand seed weight (g):**

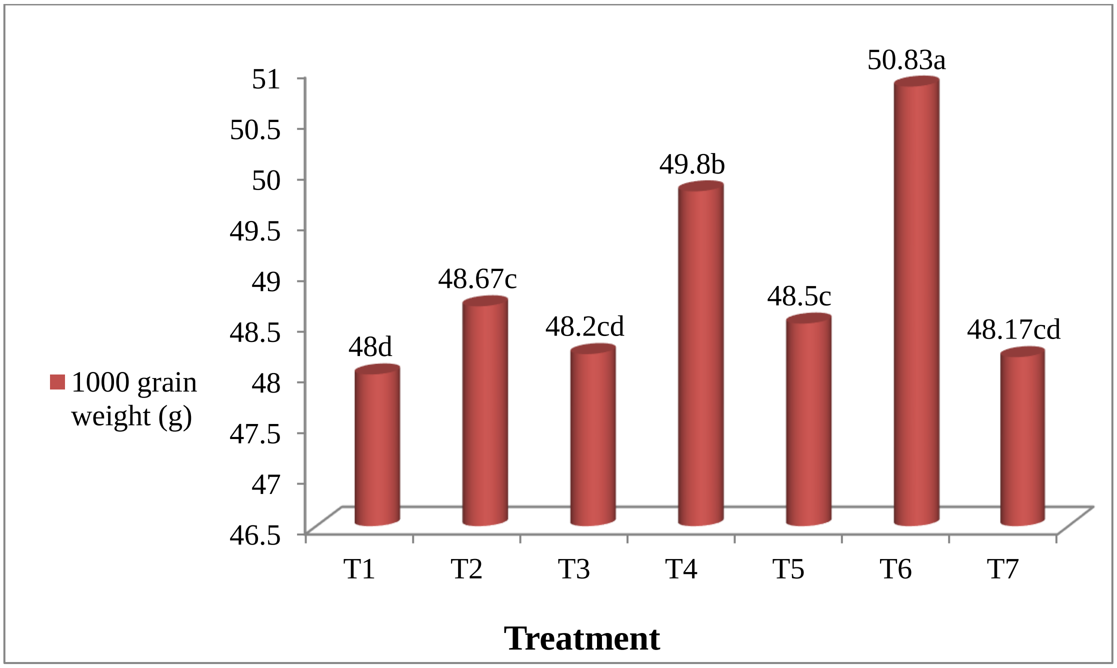

Figure. 4 . Effect of different levels of potassium on thousand grain weight of mungbean (BARIMung-6)

T_1 = 0 g K ha^{-1}, T_2 = 20 kg K ha^{-1}, T_3 = 30 kg K ha^{-1}, T_4= 40 kg K ha^{-1}, T_5= 50 kg K ha^{-1}, T_6= 60 kg K ha^{-1}, T_7= 70 kg K ha^{-1}

The effect of different doses of potassium was significant on thousand seed weight of BARIMung-6 in Fig. 4. Among the different treatments the highest thousand seed weight (50.83) was found under treatment T_6 (60 kg/ha). The lowest thousand seed weight (48) was found under treatment T_1 (control).

4.2.3 **Seed yield (t ha^{-1}):**

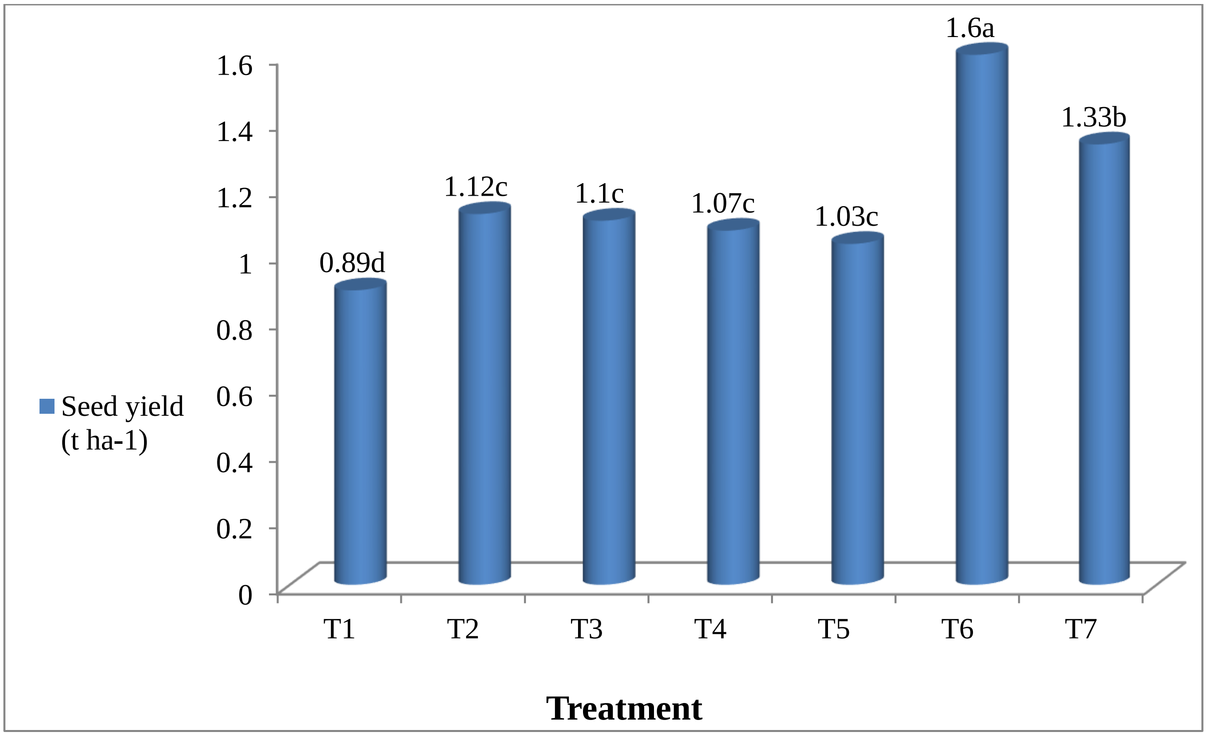

Figure. 5. Effect of different levels of potassium on seed yield (t ha^{-1}) of mungbean (BARIMung-6)

T_1 = 0 g K ha^{-1}, T_2 = 20 kg K ha^{-1}, T_3 = 30 kg K ha^{-1}, T_4= 40 kg K ha^{-1}, T_5= 50 kg K ha^{-1}, T_6= 60 kg K ha^{-1}, T_7= 70 kg K ha^{-1}

Significant variation was observed on the seed yield of mungbean when different doses of applied potassium (Fig. 5). From the table it was revealed that T_1 (control) treatment gave the lowest yield (0.89 t ha^{-1}). On the contrary, highest seed yield (1.60 t ha^{-1}) was obtained under T_6 treatment.

4.2.4 **Stover yield (t ha^{-1}):**

Table. 6. Effect of different levels of potassium on stover yield (t ha^{-1}) of mungbean (BARIMung-6)

Treatment	Stover yield (t/ha)
T_1	1.42 f
T_2	1.59b
T_3	1.50e
T_4	1.54d
T_5	1.57c
T_6	1.97a
T_7	1.50e
LSD (0.05)	0.02
CV (%)	5.61

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly by LSD at 0.05 level of probability.

(LSD0.05= 0.02)

T_1 = 0 g K ha^{-1}, T_2 = 20 kg K ha^{-1}, T_3 = 30 kg K ha^{-1}, T_4= 40 kg K ha^{-1}, T_5= 50 kg K ha^{-1}, T_6= 60 kg K ha^{-1}, T_7= 70 kg K ha^{-1}

There was significant variation in stover yield (t ha^{-1}) in mungbean (BARIMung-6) when different doses of potassium fertilizer were applied (Table 6). Among the different fertilizer doses T_6 treatment showed the highest stover yield (1.97 t/ha). The lowest stover yield (1.42 t/ha) was recorded with T_1 (control) treatment where no potassium was applied.

4.2.5 **Biological yield (t ha^{-1}):**

Table. 7. Effect of different levels of potassium on biological yield (t ha^{-1}) of mungbean (BARIMung-6)

Treatment	Biological yield (t ha^{-1})
T_1	2.31d
T_2	2.71bc
T_3	2.60c
T_4	2.61c
T_5	2.60c
T_6	3.57a
T_7	2.83b
LSD (0.05)	0.15
CV (%)	5.04

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly by LSD at 0.05 level of probability.

(LSD0.05= 0.15)

T_1 = 0 g K ha^{-1}, T_2 = 20 kg K ha^{-1}, T_3 = 30 kg K ha^{-1}, T_4= 40 kg K ha^{-1}, T_5= 50 kg K ha^{-1}, T_6= 60 kg K ha^{-1}, T_7= 70 kg K ha^{-1}

Significant variation was observed on the biological yield (t ha^{-1}) of mungbean (BARIMung-6) when different doses of potassium applied (Table 7). From the table it was revealed that T_1 (control) treatment gave the lowest biological yield (2.31 t ha^{-1}). On the contrary, highest biological yield (3.57 t ha^{-1}) was observed with T_6 treatment. The biological yield (t ha^{-1}) was almost significantly varied.

4.1.11 **Harvest index(%):**

Table. 8. Effect of different levels of potassium on harvest index (%) of mungbean (BARIMung-6)

Treatment	Harvest index(%)
T_1	57.80ab
T_2	58.81ab
T_3	58.81ab
T_4	59.01ab
T_5	60.40a
T_6	55.11b
T_7	53.3c
LSD (0.05)	2.08
CV (%)	5.81

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly by LSD at 0.05 level of probability.

(LSD0.05= 3.93)

T_1 = 0 g K ha^{-1}, T_2 = 20 kg K ha^{-1}, T_3 = 30 kg K ha^{-1}, T_4= 40 kg K ha^{-1}, T_5= 50 kg K ha^{-1}, T_6= 60 kg K ha^{-1}, T_7= 70 kg K ha^{-1}

There was significant variation in harvest index (%) of mungbean (BARIMung-6) when potassium fertilizer at different doses was applied (Table 8). Among the different fertilizer doses T_5 treatment showed the highest harvest index (60.40%) which was statistically similar with T_1, T_2, T_3, T_4 treatment. The lowest harvest index (53.03 %) was recorded with T_7 treatment. The harvest index (%) was significantly varied.

4.3. **Properties of Post Harvest Soil:**

Table. 9. Effect of different levels of potassium on pH, Organic matter, % Total N, Available Phosphorus and Exchangeable K of post harvest soil

Treatment	pH	Organic matter	% Total N	Available P (ppm)	Exchangeable K (meq/100g)
T_1	5.65	1.30	0.06	12.47 f	0.18d
T_2	5.69	1.34	0.06	13.67 e	0.21c
T_3	5.71	1.37	0.08	14.32 e	0.20cd
T_4	5.75	1.32	0.07	16.91 d	0.19cd
T_5	5.78	1.35	0.06	18.20 c	0.21c
T_6	5.89	1.39	0.08	20.01 b	0.22a
T_7	6.01	1.37	0.07	22.05 a	0.21c
LSD $_{(0.05)}$	NS	NS	0.08	1.12	0.10
CV (%)	10.84	10.46	11.26	5.72	8.21

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly by LSD at 0.05 level of probability.

(LSD0.05= NS, 0.15, 0.08, 1.12, and 0.10 respectively)

T_1 = 0 g K ha^{-1}, T_2 = 20 kg K ha^{-1}, T_3 = 30 kg K ha^{-1}, T_4= 40 kg K ha^{-1}, T_5= 50 kg K ha^{-1}, T_6= 60 kg K ha^{-1}, T_7= 70 kg K ha^{-1}

Soil pH:

The effect of potassium on soil pH was not significantly varied of post harvest soil (Table 9). The observation showed the effect of different levels of potassium was statistically similar. Soil pH (6.01) was maximum under T_7 treatment and minimum under T_1 treatment.

Organic matter:

There was not any significant variation found in the Organic matter content of post harvest soil (Table 9). The effect of different doses of potassium was non-significant. Maximum organic matter content (1.39) of post harvest soil under T_6 treatment and minimum (1.30) under T_1 treatment

% Total N:

Total nitrogen was not significantly influenced by different treatment. % total nitrogen under all the treatments was statistically similar (Table 9). Maximum % total nitrogen (0.08) of post harvest soil was recorded under T_6 treatment and minimum (0.06) under T_1 treatment which was statistically identical with T_2 and T_5 treatment.

Available Phosphorus (ppm):

The different treatment showed significantly variation in the Available phosphorus. The highest available phosphorus (22.05ppm) was recorded under T_7 while the lowest available phosphorus (12.47 ppm) was recorded under T_1 treatment (Table 9).

Exchangeable K (meq/100g):

Exchangeable potassium was significantly influenced by different doses of potassium. The highest exchangeable potassium (0.22) was recorded in T_6 treatment while the lowest exchangeable potassium (0.18) was recorded in T_1 treatment. (Table 9)

4. 4 **Nutrient analysis of mungbean:**

4. 4. 1 **Nutrient % in mungbean seed:**

Table. 10: Effect of different levels of potassium on %Nitrogen, %Phosphrus and %Potassium in mungbean seed

Treatment	%N in mungbean seed	% P in mungbean seed	% K in mungbean seed
T_1	3.30 b	0.49	0.81 d
T_2	3.35 ab	0.50	0.91 cd
T_3	3.43 ab	0.54	0.97 c
T_4	3.50 ab	0.58	1.19 b
T_5	3.58 a	0.61	1.38 a
T_6	3.56 a	0.63	1.52 a
T_7	3.54 ab	0.62	1.52 a
LSD (0.05)	0.23	NS	0.14
CV (%)	3.62	4.39	6.64

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly by LSD at 0.05 level of probability.

(LSD0.05= NS, 0.15, 0.08, 1.12, and 0.10 respectively)

T_1 = 0 g K ha^{-1}, T_2 = 20 kg K ha^{-1}, T_3 = 30 kg K ha^{-1}, T_4= 40 kg K ha^{-1}, T_5= 50 kg K ha^{-1}, T_6= 60 kg K ha^{-1}, T_7= 70 kg K ha^{-1}

% Nitrogen in mungbean seed:

Nitrogen uptakes by plant were significantly influenced by different doses of potassium treatment (Table 10). Highest nitrogen % (3.58) in mungbean seed was recorded under T_5 treatment which was statistically similar with T_2, T_3, T_4, T_6 and T_7 treatment. Lowest nitrogen % (3.30) in mungbean seed was recorded under T_1 treatment.

% Phosphorus in mungbean seed:

Phosphorus uptake by plant was not significantly influenced by different doses of potassium treatment. All the treatments had statistically similar values (Table 10). Highest phosphorus uptake (0.63) was under T_6 and lowest phosphorus uptake (0.49) was under T_1 treatment.

% Potassium in mungbean seed:

Potassium uptakes by plant were significantly influenced by different doses of potassium treatment (Table 10). Highest potassium uptake (1.52) by plants was recorded under T_6 treatment which was statistically identical with T_7 and statistically similar with T_5 treatment. Lowest potassium uptake (0.81) by plants was recorded under T_1 treatment.

4. 4. 2 **Nutrient % in mungbean stover:**

Table. 11: Effect of different levels of potassium on %Nitrogen, %Phosphrus and %Potassium in mungbean stover

Treatment	%N in mungbean stover	%P in mungbean stover	%K in mungbean stover
T_1	1.46	0.25	1.08 c
T_2	1.50	0.26	1.15c
T_3	1.60	0.29	1.35b
T_4	1.65	0.32	1.44b
T_5	1.72	0.34	1.68a
T_6	1.81	0.38	1.70a
T_7	1.78	0.35	1.67a
LSD (0.05)	NS	NS	0.19
CV (%)	5.93	3.51	7.53

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly by LSD at 0.05 level of probability.

(LSD0.05= NS, 0.15, 0.08, 1.12, and 0.10 respectively)

T_1 = 0 g K ha^{-1}, T_2 = 20 kg K ha^{-1}, T_3 = 30 kg K ha^{-1}, T_4= 40 kg K ha^{-1}, T_5= 50 kg K ha^{-1}, T_6= 60 kg K ha^{-1}, T_7= 70 kg K ha^{-1}

% Nitrogen in mungbean stover:

% Nitrogen in mungbean stover was not significantly influenced by different treatment of potassium (Table 11). The effect of different doses of potassium was non-significant in nitrogen uptake by mungbean. Highest nitrogen % (1.81) in mungbean stover was recorded under T_6 treatment. Lowest nitrogen % (1.46) in stover was recorded under T_1 treatment.

% Phosphorus in mungbean stover:

Phosphorus uptakes by stover of mungbean plant were not significantly influenced by different doses of potassium treatment. All the treatments had statistically similar values (Table 11). Highest phosphorus % (0.38) in mungbean stover was recorded under T_6 treatment. Lowest phosphorus % (0.25) in stover was recorded under T_1 treatment.

% Potassium in mungbean stover:

% Potassium in mungbean stover was significantly influenced by different doses of potassium treatment (Table 11). Highest potassium % (1.70) in mungbean stover was recorded under T_6 treatment which was statistically similar with T_7 and T_5 treatment. Lowest potassium uptake (1.08) by plants was recorded under T_1 treatment which was statistically similar with T_2 treatment.

CHAPTER V

SUMMARY AND CONCLUSION

An experiment was conducted at the research plot of the department of Soil Science of Sher-e-Bangla Agricultural University, Dhaka, during the period from April, 2017 to September, 2017 to study the influence of Potassium on nodulation, yield and nutrient uptake of mungbean (BARIMung-6). Single factor experiments with Randomized Complete Block Design (RCBD) was followed with 7 (0, 20, 30, 40, 50, 60 and 70 kg k per ha) treatments having unit plot size of 3 m x 2 m (6 m^2) and replicated thrice. The data were collected plot wise for plant height (cm), number of branches $plant^{-1}$, number of pods $plant^{-1}$, pod length (cm), number of seeds pod^{-1}, weight of l000-grain (g), seed yield (t ha^{-1}) and stover yield (t ha^{-1}).

The plant height was significantly influenced by different levels potassium. However among the different doses of fertilizer, T_6 (60 kg/ha) showed the highest plant height (49.83 cm) and lowest plant height (42 cm) at T_1 (control) potassium was applied. Potassium showed statistically significant variation in respect of number of branch when fertilizers in different doses were applied. However among the different doses of fertilizer, T_5 (50 kg/ha) showed the highest number of branches (3.66). The lowest no of branch (2.66) at T_1 (control) and T_2 (20 kg/ha) was observed. Among the different doses of T_6 fertilizers treatment, showed the highest number of pod $plant^{-1}$ (12.33). On the contrary, the lowest number of pod $plant^{-1}$ (9.33) was observed with T_1 (control), where no fertilizer was applied. The highest pod length (9.27 cm) was recorded in T_6 treatment. The lowest pod length (8.50 cm) was recorded in the T_1 treatment where no potassium fertilizer was applied. T_4 and T_6 treatment showed the highest number of nodule per plant (11.00). The lowest number of nodule per plant at T_2 treatment (5.00) was recorded. T_6 treatment showed the highest number of seed per pod (11.67). The lowest number of seed per pod (10.13) was recorded with T_1 (control) treatment. T_6 treatment showed the highest thousand grain weight (50.83 g) and lowest thousand seed weight (48 g) was recorded with T_1 treatment. T_1 (control) treatment gave the lowest yield (0.89 t ha^{-1}) and highest seed yield (1.60 t ha^{-1}) was observed with T_6 treatment. T_6 treatment showed the highest stover yield (1.97 t/ha) and the lowest stover yield (1.42 t/ha) was recorded with T_1 (control) treatment. T_1 (control) treatment gave the lowest biological yield (2.31 t ha^{-1}) and the highest biological yield (3.57 t ha^{-1}) was observed with T_6 treatment. T_5 treatment showed the highest harvest index (60.40%) and the lowest harvest index (%) was recorded with T_7 treatment. The effect of potassium on soil pH, organic matter and total nitrogen % was non-significant. The highest available phosphorus (22.05 ppm) was recorded from T_7 while the lowest available phosphorus (12.47 ppm) was recorded from T_1 treatment. The highest exchangeable potassium (0.22) was recorded in T_6 treatment while the lowest exchangeable potassium (0.18) was recorded in T_1 treatment.

Highest % nitrogen in mungbean seed (3.58%) was recorded under T_5 treatment which was statistically similar with T_6 and lowest % nitrogen in mungbean seed was recorded under T_1 treatment. Phosphorus uptakes by plant were not significantly influenced by different doses of potassium treatment. Highest potassium uptake (1.52) by seed was recorded under T_6 treatment which was statistically identical with T_7 and statistically similar T_5 treatment. Lowest potassium uptake (0.81%) by plants was recorded under T_1 treatment. %Nitrogen in mungbean stover was not significantly influenced by different treatment. Phosphorus uptakes by stover of mungbean plant were not significantly influenced by different doses of potassium treatment. Highest % potassium (1.70) in mungbean stover was recorded under T_6 treatment which was statistically similar with T_7 and T_5 treatment. Lowest potassium uptake (1.08%) by plants was recorded under T_1 treatment which was statistically identical with T_2 treatment.

The results of this research work indicated that the plants performed better in respect of seed yield in T_6 treatment over the control treatment T_1 showed the least performance. It can be therefore, concluded from the above study that the T_6 treatment was found to the most suitable treatment for the highest yield of mungbean (BARIMung-6) in soils of Bangladesh.

Based on the results of the present study, the following recommendation may be drawn:-

- As mungbean is a great source of protein so number of research works have to be increased to fulfill the demand of pulse.
- Fertilizer effects on various varieties should be taken under consideration.

CHAPTER VI

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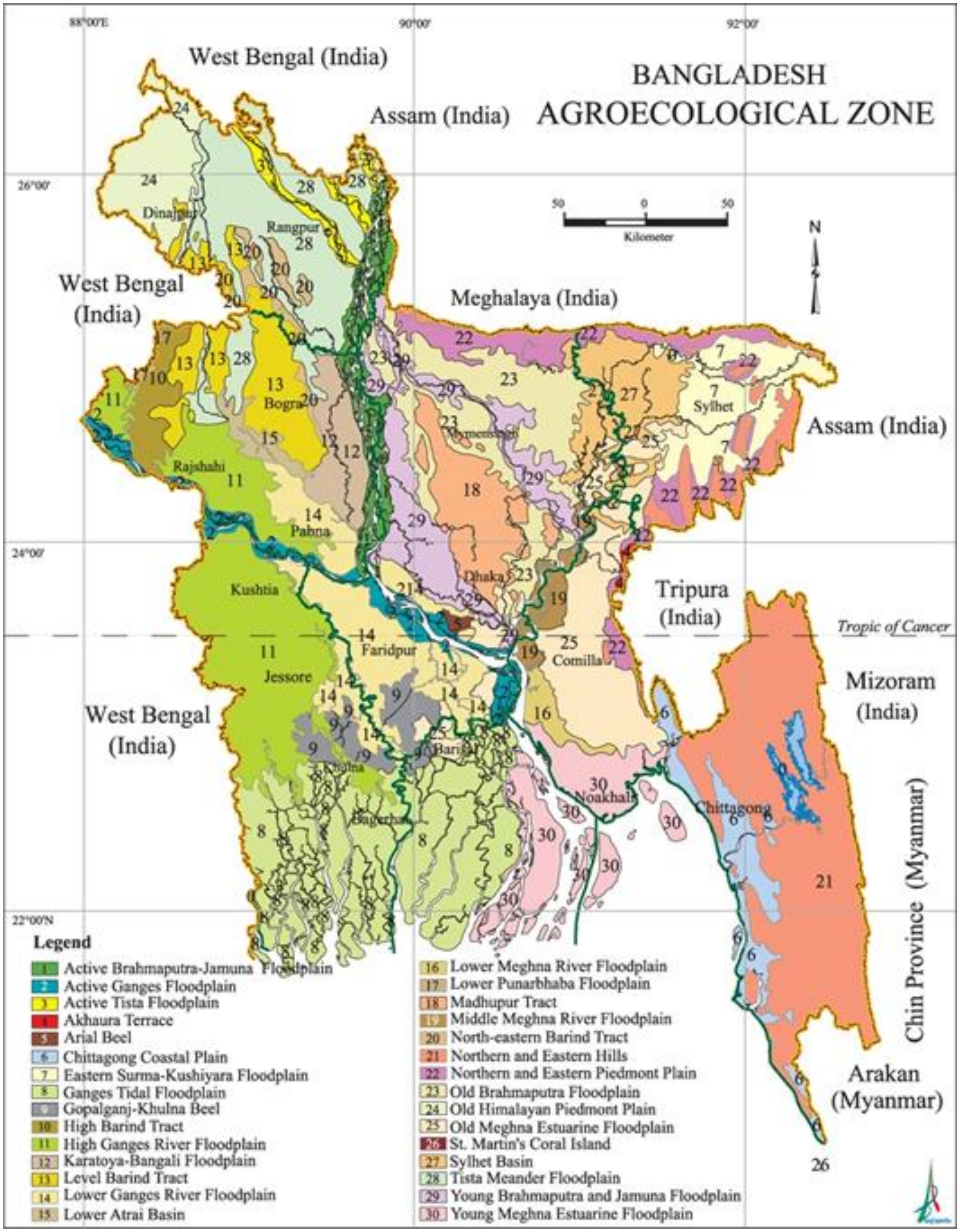
CHAPTER VII

APPENDIX

Appendix. 1. Map showing the experimental site under study



Appendix. 2. Commonly used symbols and abbreviations

Abbreviations	**Full word**
%	Percent
@	At the rate
AEZ	Agro-Ecological Zone
ANOVA	Analysis of variance
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BD	Bangladesh
BINA	Bangladesh Institute of Nuclear Agriculture
CEC	Cation Exchange Capacity
Cm	Centi-meter
CV%	Percentage of coefficient of variation
Df	Degrees of Freedom
LSD	Least Significant Difference
et al	and others
Etc	Etcetera
FAO	Food and Agricultural Organization
G	Gram
H	Hours
J.	Journal
kg ha-1	Kilograms per hector
t ha-1	Ton per hectare
Kg	kilogram

M	Meter
m2	square meter
MOA	Ministry of Agriculture
MSE	Mean square of the error
No.	Number
Ppm	parts per million
RCBD	Randomized Complete Block Design
Sci.	Science
SE	Standard Error
var.	variety

Appendix. 3. Layout for experimental field.

Total number of unit plots: 7 × 3 = 21

Unit plot size: 3m×2 m = 6 m^2

The blocks and unit plots were separated by 0.5 m and 0.5 m, respectively.

Treatment/Replication	**R_1**	**R_2**	**R_3**
Treatment	**T_6**	**T_5**	**T_4**
	T_2	**T_3**	**T_1**
	T_4	**T_6**	**T_5**
	T_3	**T_2**	**T_6**
	T_5	**T_1**	**T_7**
	T_7	**T_4**	**T_3**
	T_1	**T_7**	**T_2**

Anova

Appendix. 4. Analysis of variance of the data on plant height, number of branch, Number of pods per plant, Pod length, Number of seed per pod, thousand grain weight of mungbean as influenced by potassium

Source	Degrees of freedom	Mean square					
		Plant height	**No of Branch**	**No of Pod/Plant**	**Pod Length**	**No of Seed/Pod**	**weight of 1000**
Replication	2	40.229	0.905	1.476	0.389	0.19	55.083
Factor A	6	21.499*	0.413*	2.857*	0.162*	0.635*	6.038*
Error	12	15.805	0.294	0.476	0.303	1.302	3.736

Appendix. 5. Analysis of variance of the data on yield and yield contributing characters of mungbean as influenced by different levels of potassium

Source	Degrees of freedom	Mean square				
		no of nodule/ plant	**Stover yield (t/ha)**	seed yield (t/ha)	**biological yield**	**harvest indes**
Replication	2	10.321	0.011	0.037	0.059	16.088
Factor A	6	18.429*	0.094*	0.165*	0.469*	25.813*
Error	12	0.155	0.008	0.003	0.007	4.882

Appendix. 6. Analysis of variance of the data on pH, Organic matter, Total N, Available P and Available K contributing characters of mungbean as influenced by different levels of potassium

Source	**Degrees of freedom**	**Mean square**				
		pH	**organic matter**	**total N %**	**available P (ppm)**	**available K (meq/100g)**
Replication	2	12.89	6.223	0.013	12.893	0.013
Factor A	6	0.048	0.011	0.04	37.267*	0.70*
Error	12	0.393	0.007	0.002	0.393	0.003